LOW-CARBON HEATING AND COOLING STRATEGIES FOR EUROPE

Final Publishable Report of the
EU-funded project STRATEGO
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Stratego
ENHANCED HEATING
& COOLING PLANS

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

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STRATEGO project partners*

* Additionally, two members of Euroheat & Power participated in the project: AIRU - Associazione Italiana Riscaldamento Urbano and Svensk Fjärrvärme

EXECUTIVE SUMMARY

STRATEGO (www.stratego-project.eu) is a European co-funded project developed in the framework of the Intelligent Energy Europe Programme. The overall aim of STRATEGO is to support local and national authorities in the implementation of more efficient heating and cooling solutions. This support was provided in a variety of ways throughout the different tasks and work packages (WPs). Key work packages were WP2 - on supporting the development of National Heating and Cooling Plans, WP3 and WP4 which focused on the local heating and cooling projects and their reality check in the field.

STRATEGO WP2 builds on the two previous Heat Roadmap Europe studies, which analysed alternatives for the heating sector at the EU scale. In STRATEGO WP2, the Heat Roadmap Europe methodology was enhanced and applied at a Member State level. As a result, 5 national Heating and Cooling Strategies were developed and proposed as a basis for implementation of Art. 14 of the EU Energy Efficiency Directive, which requires Member States to carry out a comprehensive assessment of their potential for efficiency in heating and cooling. Additionally, a set of recommendations for the heating and cooling sector was developed to support the EU Heating and Cooling Strategy. More details are available in Chapter 1. The recommendations and conclusions of WP2 can be found on pp.14-19.

Building on the results, tools and recommendations of WP2, STRATEGO WP3 partners have developed local heating and cooling maps and action plans for 30 target cities, as well as identified 43 energy efficiency projects which were proposed for implementation to local authorities. WP3 achievements and challenges are described in Chapter 2 of this report. Main conclusions of WP3 are summarised on pp.26-27.

In parallel, coaching meetings conducted in the framework of STRATEGO WP4 ensured cross-border cooperation and exchange of best practices between learning cities and regions and experienced ones. Lessons from WP4 and best practices from the STRATEGO project are presented in Chapter 3. Main conclusions and recommendations of WP4 can be found on pp.32-34.

Key outputs of STRATEGO described in this report include:

- Pan-European Thermal Atlas
- Low-carbon heating and cooling strategies (Heat Roadmaps) for each of the STRATEGO target countries: Czech Republic, Croatia, Italy, Romania and the United Kingdom
- A set of recommendations to make the heating and cooling sector more sustainable
- Lessons from the local mapping exercise
- 43 sustainable heating and cooling projects proposed for implementation to local authorities
- Business models for local partners
- Coaching guidelines and lessons from the national authority meetings
- Best practices of international cooperation

Overall, we hope that this report, as well as the project results, conclusions and recommendations will help cities and local authorities all over Europe in identifying and implementing sustainable heating and cooling solutions suitable for their area.

Yours sincerely,
STRATEGO project team

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

CHAPTER 1

NATIONAL HEATING & COOLING STRATEGIES

The overall aim of the STRATEGO WP2 was to **develop low-carbon heating and cooling strategies**, which are called Heat Roadmaps, and subsequently to **quantify the impact of implementing them at a national level** for five EU Member States, which are the Czech Republic, Croatia, Italy, Romania and the United Kingdom.

STRATEGO WP2 has fulfilled this aim by combining results from nine Background Reports for each of these five countries. The Background Reports provide detailed information about the current and future energy system, including:

- The structure and scale of the existing and future energy system (Background Report 1)
- The hourly pattern of demand and supply across heating, cooling and electricity (Background Report 2)
- The cost of heat savings in EU Member States (Background Report 3)
- The current heating and cooling demand in buildings (Background Reports 4 and 5)
- The future development of the heating and cooling demands in buildings (Background Reports 3 and 4)
- The potential to expand district heating and cooling (Background Report 6)
- The quantification of excess heat available for district heating and cooling (Background Report 7)
- The potential renewable energy resources available (Background Reports 8 and 9)

All the reports can be found on http://stratego-project.eu/reports/.

Pan-European Thermal Atlas

One of the main tools developed on the basis of the above mentioned reports is the Pan-European Thermal Atlas (Peta).

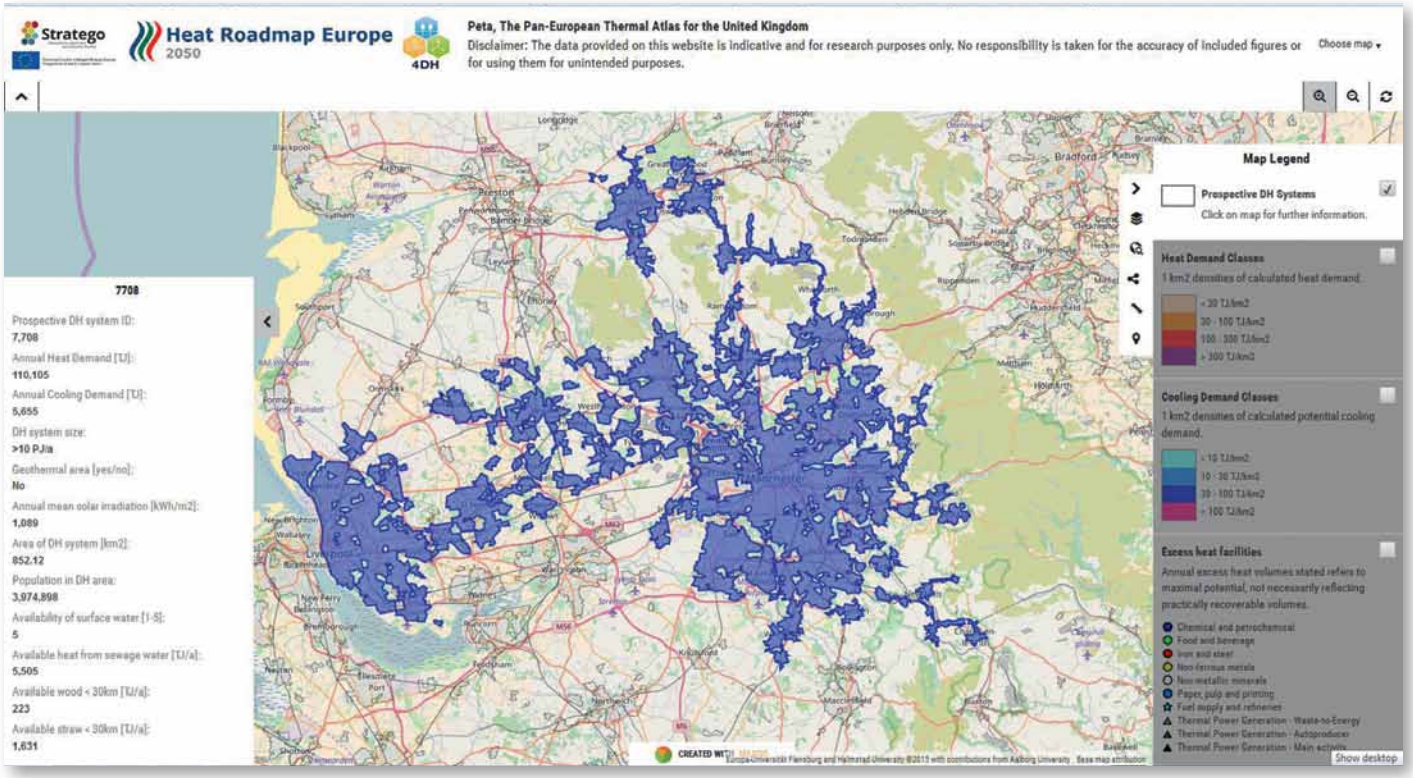
Peta (http://stratego-project.eu/pan-european-thermal-atlas/) is a **very useful tool for cities** willing to check local thermal demand on a 1 km^2 resolution, identify the potential to expand district heating and cooling, as well as quantify the available waste heat resources and renewable energy sources (solar thermal, geothermal, relative accessibility of biomass). It is a **perfect basis for an informed decision** to invest in energy efficiency measures and increase the use of locally available residual waste and renewable energy sources for heating and cooling purposes.

Quick guide on how to use the Pan-European Thermal Atlas

Peta covers all 28 EU Member States, but the data is not as specific as for the 5 STRATEGO target countries. These national maps were created in the framework of the STRATEGO project specifically for Czech Republic, Croatia, Romania, Italy and the United Kingdom.

On each map, it is possible to zoom in and out like on a typical Google map. To find a specific area, it is also possible to go to the address search on the top right and type in a city or street name – which will be brought closer by the map.

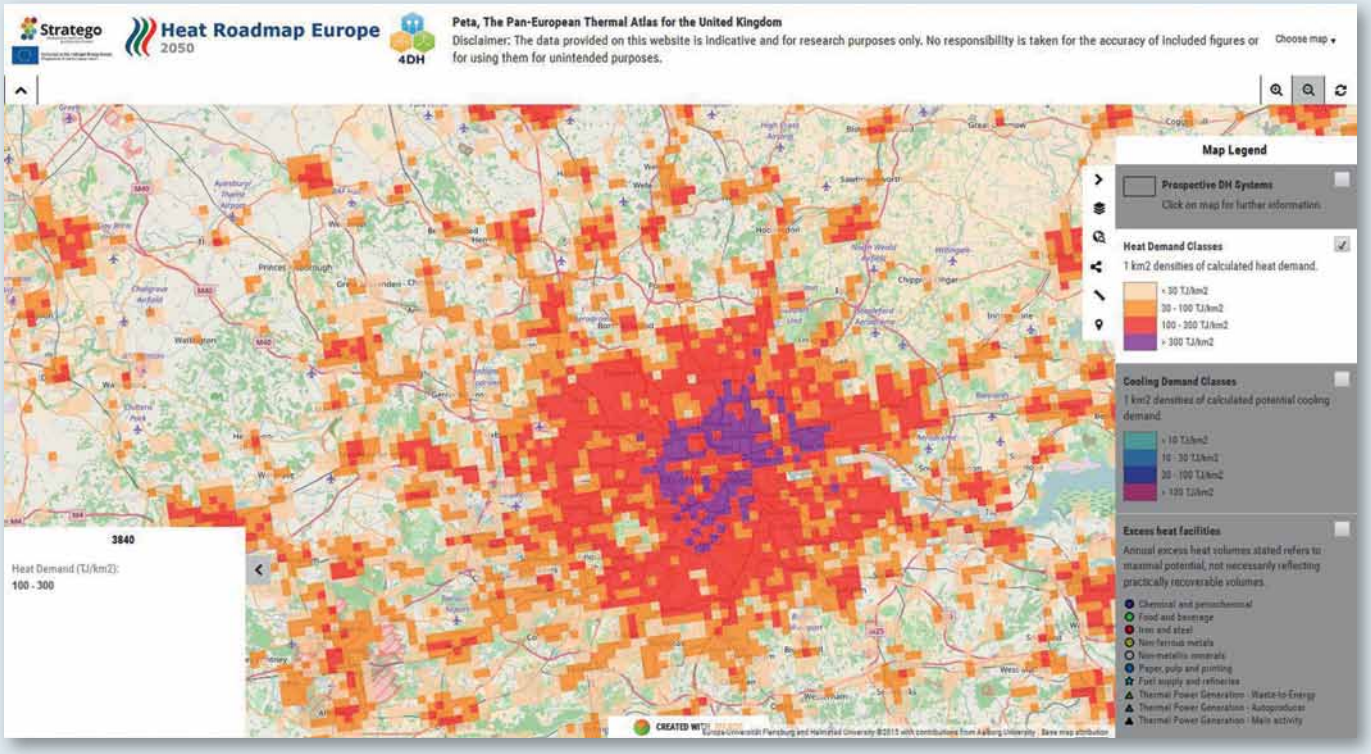
Specific features available in the legend on the right hand side are:
Prospective DH Systems → when turned on in a densely populated area, black lines appear on the map. Those black lines represent the potential district heating networks. A blue area which appears after clicking on a city represents all the territory that could economically be transferred to district heating.



When a specific area is selected information appears on the left hand side: annual heat demand for that selected area (today's actual heat demand that can be converted to district heating); annual cooling demand (maximum cooling that can be implemented in the future); DH system size; geothermal area; annual mean solar irradiation; area of DH system; population in DH area; availability of surface water (for the use in large-scale heat pumps); available heat from sewage water; available bio-energy resources such as wood and straw within a 30 km distance around this area.

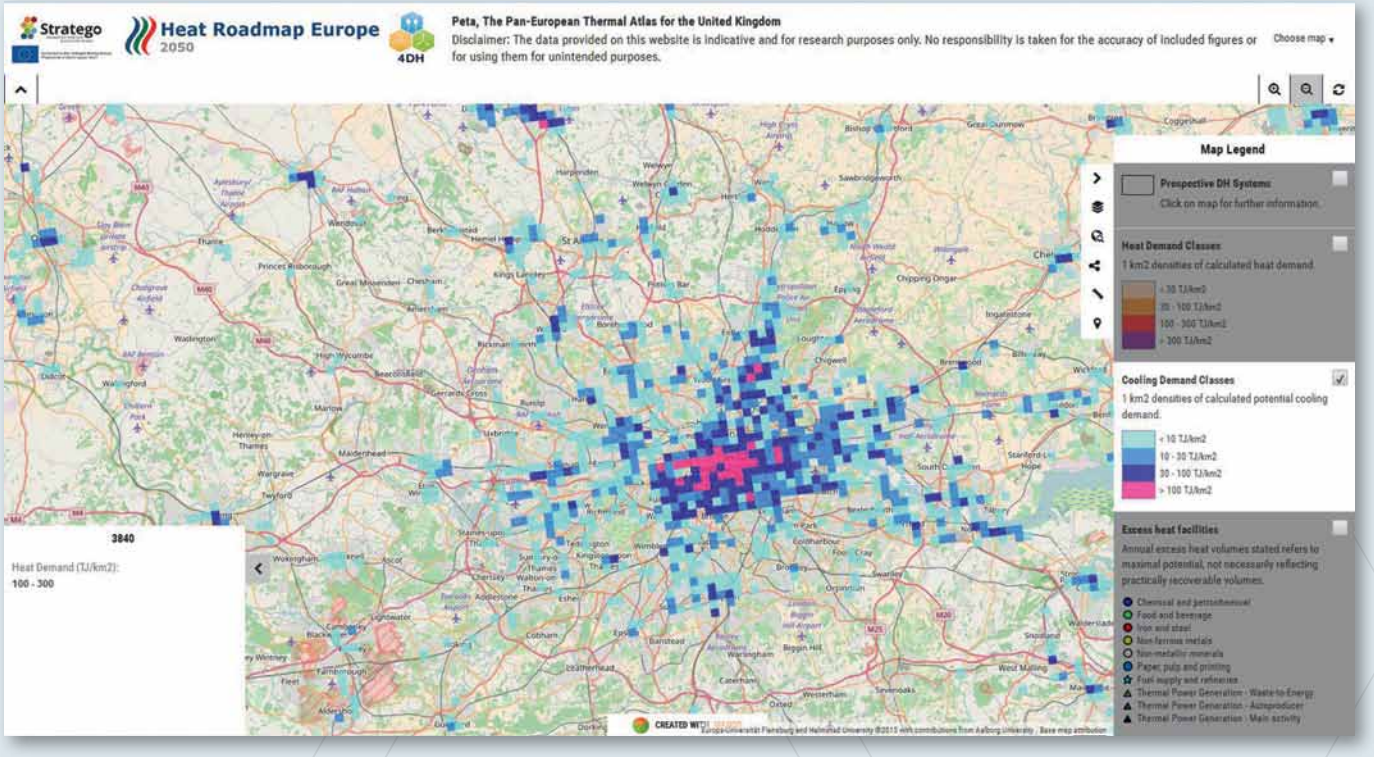
This feature can help identify what is the maximum potential of developing district heating networks in a specific city, looking over a long term future. The feature "Heat Demand Classes" allows looking into a more short term perspective of utilising existing district heating technologies.

Heat Demand Classes → gives a graphical representation of the heat density on a 1 km^2 resolution. Depending on the colour (purple being the highest and beige being the lowest), it illustrates what the heat demand is within a 1 km^2 block. The purple areas mean a very high heat demand and thus usually occur within the city centres. Farther from the city centre, the heat density becomes lower and lower and therefore district heating becomes less and less economically attractive. On the edge of a city a more suitable alternative would be using individual heating technology (e.g. heat pumps) rather than developing district heating.

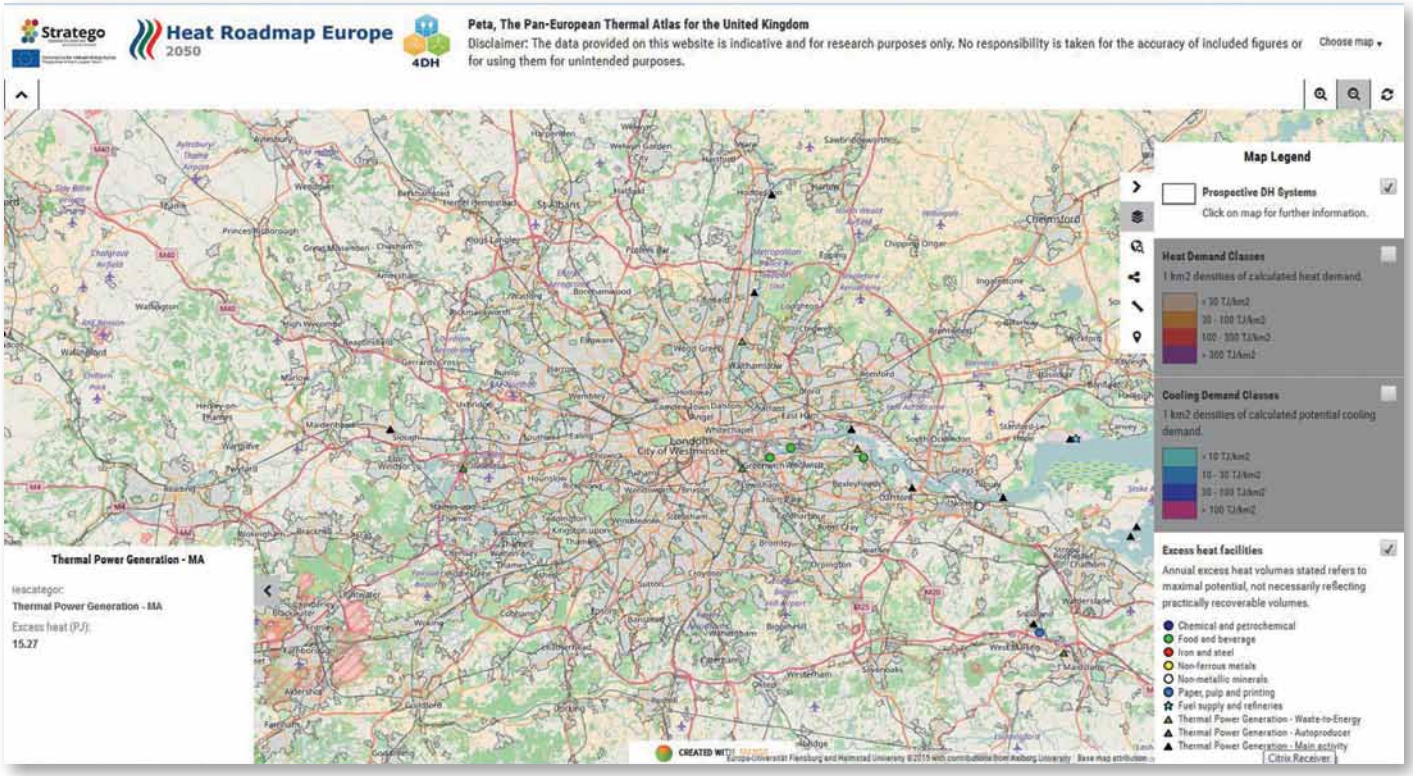


Purple and red areas would be very attractive for the district heating technologies that are already available today. Heat density above 100 TJ/km^2 (red areas) is considered very feasible economically for district heating development; 30 to 100 TJ/km^2 is more suitable for future district heating technologies (such as 4th generation district heating); while areas with less than 30 TJ/km^2 are unlikely to be converted to district heating in the future.

Cooling Demand Classes → similar to the heat demand, the colours illustrate the cooling density from a maximum of 100 TJ/km^2 down to less than 10 TJ/km^2. Likewise, the highest cooling demands occur in the city centre and get lower towards the suburbs. This data represents the future cooling demands, i.e. the maximum cooling demands that are likely to ever be experienced in this area.



Excess heat facilities ➙ provides information on the potential local supply sources for district heating. These excess heat facilities are defined in terms of circles, stars and triangles. The circle illustrates industries, the star illustrates refineries and the triangle illustrates power plants. The different colours mean different types of plants: the triangles can be either waste incinerators, autoproducers (industrial power plants located on sites for industries) or main activity (publicly or privately owned central power plants that are mainly used for electricity generation). When this part of the legend is turned on – quite a few shapes appear on the map. When, for example, a black triangle is selected – on the bottom left hand side of the screen it shows how much excess heat is available from the power plant located in this region, which could potentially be supplied in a district heating system.



This feature is very useful in the mapping because it connects not only heat demand, but also potential sources of heat supply for a district heating network that could be built in the region. When "Prospective DH Systems" are also selected – it becomes obvious that a lot of the facilities that have excess heat already available today are actually located right besides areas that have a suitable demand for the development of district heating.

A Measurement Tool on the left hand side can be useful in case a facility is located outside of a district heating system. It allows measuring the distance between the facility and the district heating area nearby to estimate the length of a pipeline necessary to bring the excess heat.

This mapping exercise indicates that there is currently more excess heat available from thermal power generation, industry and waste incineration than is required to heat all buildings in Europe. Once again, this is a very important finding, since it suggests that there is a very large potential to capture excess heat and use it to replace natural gas when heating buildings in Europe. Furthermore, the mapping in STRATEGO also identified the areas of Europe that have suitable resources for renewable heat supply in the form of solar thermal and geothermal heating, which could also be used to supplement excess heat in a district heating system.

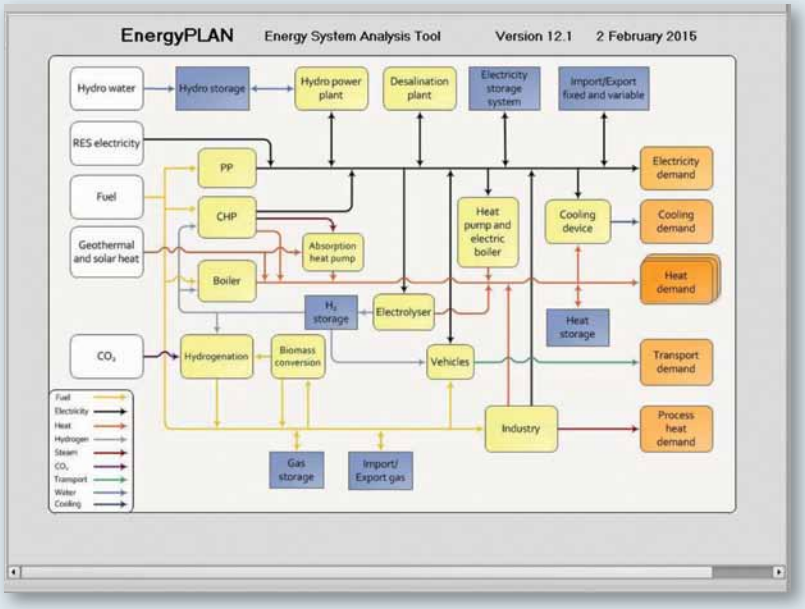
Heating and Cooling Strategies for 5 target countries

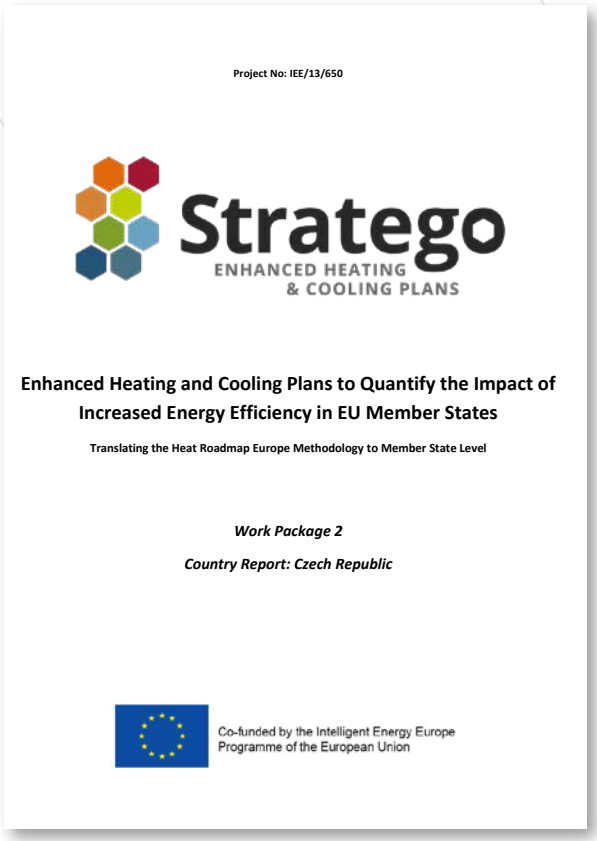
Modelling Methodology

The information from the Background Reports was combined in the main report using an energy model, called EnergyPLAN (www.EnergyPLAN.eu), which simulates the hourly operation of the heating, cooling, electricity, industry and transport sectors over a single year. Using EnergyPLAN, the current and future energy system for each of the STRATEGO countries is replicated based on the historical year 2010 (Ref 2010), and based on a future 'Business-As-Usual' forecast by the European Commission for the year 2050 (BAU 2050). These two scenarios represent where we are today and where we are likely to end up, if we continue using energy in the same way in the future as we do today. Afterwards, a Heat Roadmap scenario is created for each country for the year 2050 (HR 2050), by adding the following energy efficiency measures to the original BAU 2050 scenario:

Step 1: Adding heat savings (according to potential savings and associated costs)
Step 2: Comparing heat network solutions (gas and water networks)
Step 3: Comparing individual heating solutions (oil boilers, biomass boilers, heat pumps, electric heating)
Step 4: Integrating more excess heat and renewable heat (geothermal, waste incineration, excess industrial heat, large-scale solar thermal)
Step 5: Integrating more renewable electricity in the heating sector (large heat pumps, electric boilers)

By comparing the HR 2050 scenario with the BAU 2050 scenario, the impact of implementing these new energy efficiency measures in the heat sector is quantified separately for each country in terms of three key metrics: energy (primary energy supply), environment (carbon dioxide emissions) and economy (total annual energy system costs). A summary of the main results from this comparison as well as a specific map are presented here for each of the STRATEGO target countries.





Czech Republic

Total heat demand in buildings (city & rural): 81 TWh
Potential excess heat available (excluding nuclear): 98 TWh
Renewable heat potential in DH areas (excluding biomass): 26 TWh

Heat savings can cost-effectively reduce the demand by 40%
District heating can provide 40% of the heat demand vs 25% today
Individual heating in the rural areas should primarily be supplied by electric heat pumps, which are supplemented by smaller shares of individual solar thermal and biomass boilers

Annual change for heating, cooling and electricity sectors:

- Cost: -15% (i.e. €3 billion/year)
- Demand: -30% (i.e. > 100 TWh/year)
- CO_2: -70% (i.e. ~35 Mt/year)

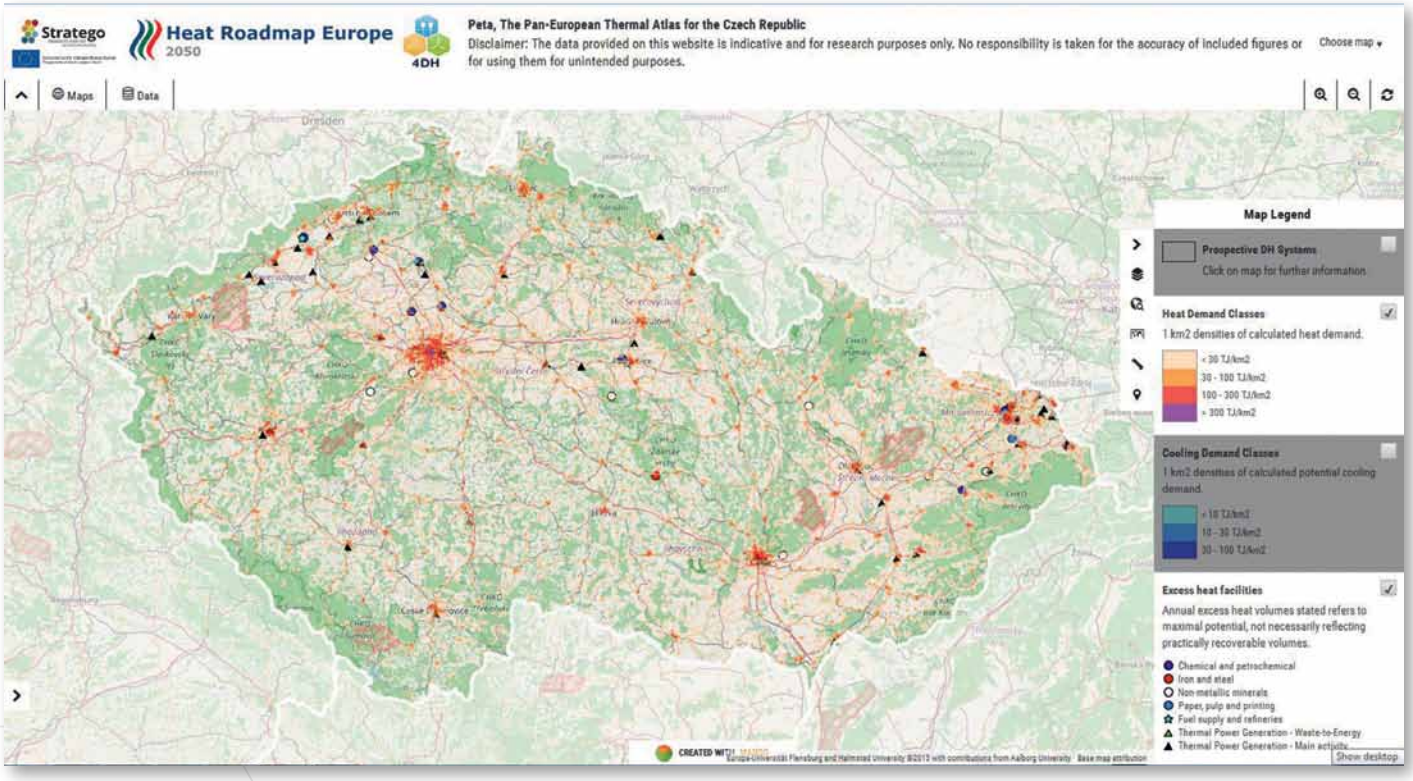
The proposed energy efficiency measures can increase:

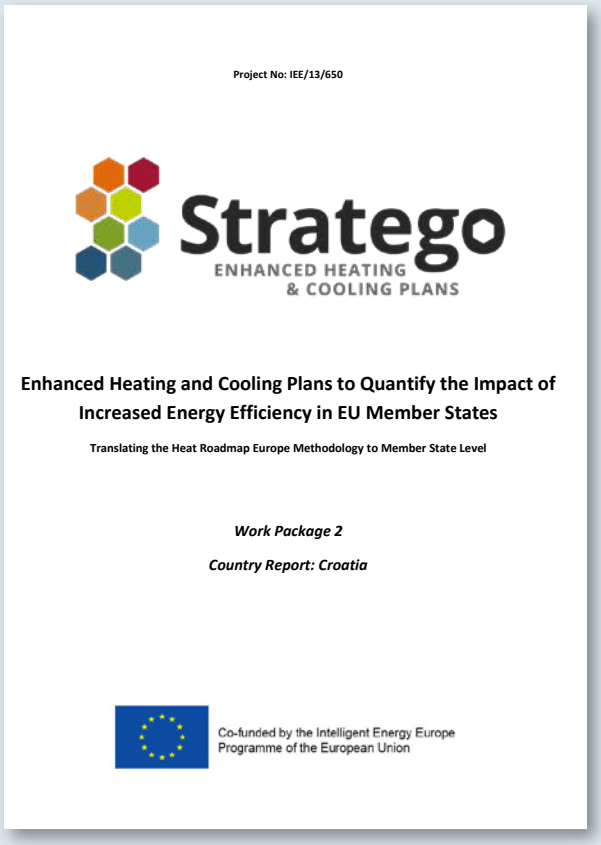
- Renewables
- Jobs
- Energy security

Approximately €50 billion of additional investments will be required in the heating and electricity sectors between 2010 and 2050 (for the detailed breakdown of investments, see country-specific report).

Country report: http://stratego-project.eu/reports/ → Czech Republic

Peta for the Czech Republic: http://stratego-project.eu/local-maps/ → Czech Republic





Croatia

Total heat demand in buildings (city & rural): 17 TWh
Potential excess heat available (excluding nuclear): 12 TWh
Renewable heat potential in DH areas (excluding biomass): 13 TWh

Heat savings can cost-effectively reduce the demand by 40%
District heating can provide 40% of the heat demand vs 15% today
Individual heating in the rural areas should primarily be supplied by electric heat pumps, which are supplemented by smaller shares of individual solar thermal and biomass boilers

Annual change for heating, cooling and electricity sectors:

- Cost: -10% (i.e. €700 million/year)
- Demand: -30% (i.e. > 20 TWh/year)
- CO_2: -45% (i.e. ~5 Mt/year)

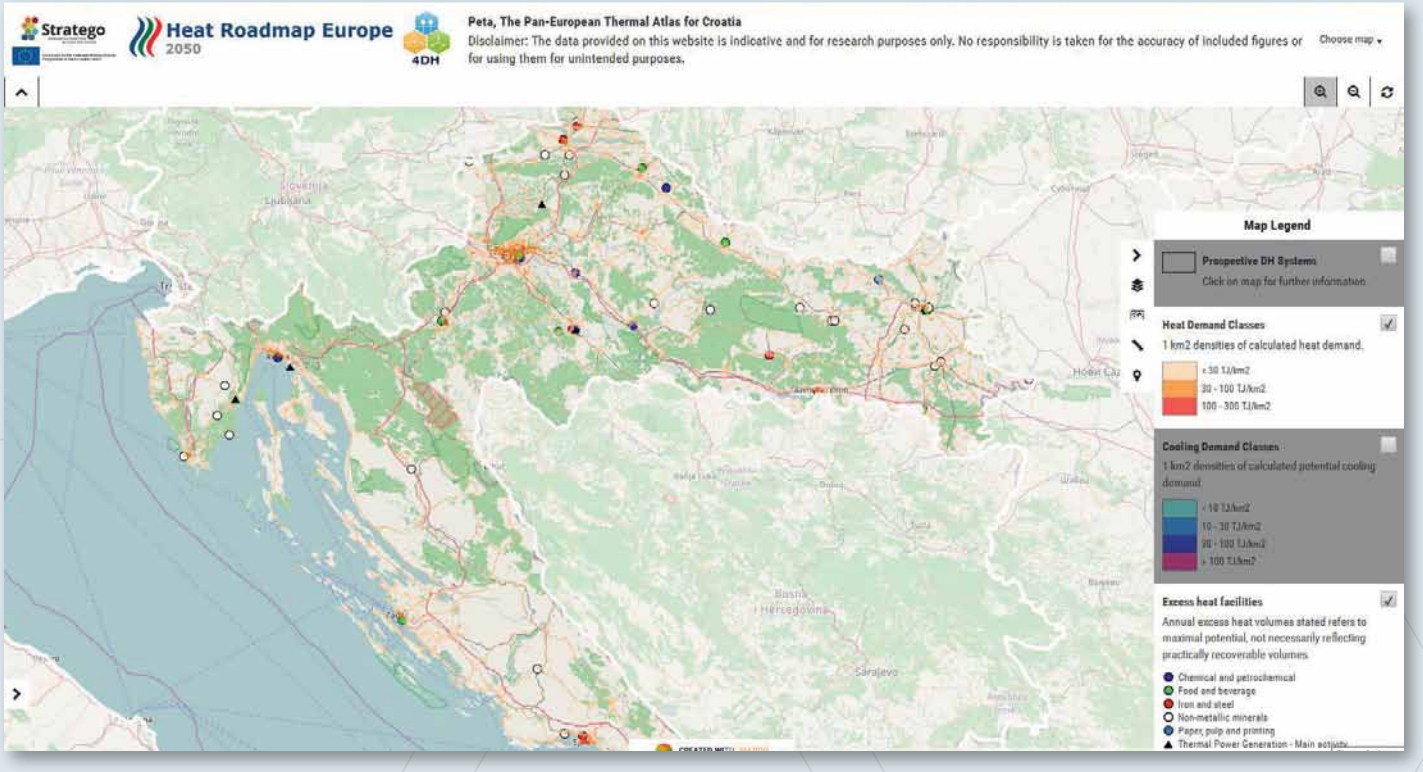
The proposed energy efficiency measures can increase:

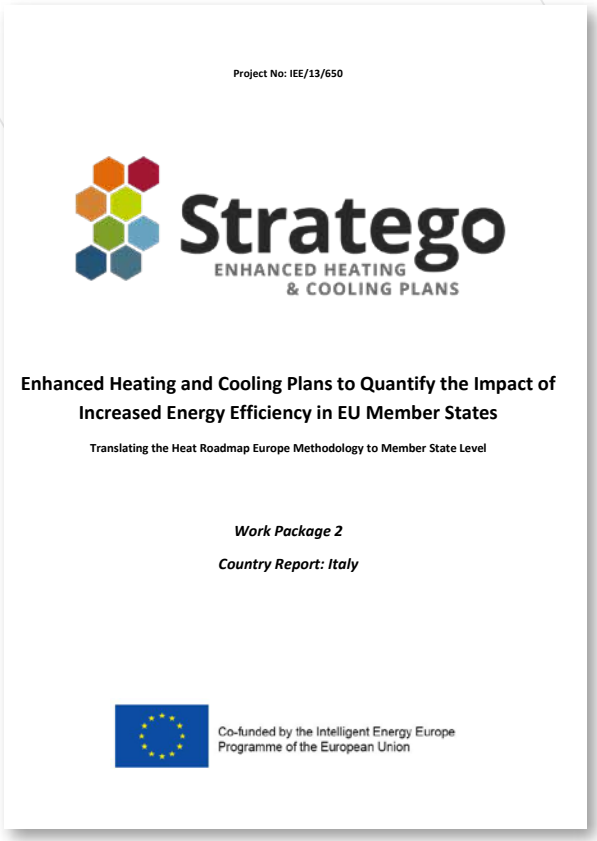
- Renewables
- Jobs
- Energy security

Approximately €22 billion of additional investments will be required in the heating and electricity sectors between 2010 and 2050 (for the detailed breakdown of investments, see country-specific report).

Country report: http://stratego-project.eu/reports/ → Croatia

Peta for Croatia: http://stratego-project.eu/local-maps/ → Croatia





Italy

Total heat demand in buildings (city & rural): 373 TWh
Potential excess heat available (excluding nuclear): 351 TWh
Renewable heat potential in DH areas (excluding biomass): 213 TWh

Heat savings can cost-effectively reduce the demand by 30%
District heating can provide 60% of the heat demand vs <5% today
Individual heating in the rural areas should primarily be supplied by electric heat pumps, which are supplemented by smaller shares of individual solar thermal and biomass boilers

Annual change for heating, cooling and electricity sectors:

- Cost: -15% (i.e. €13 billion/year)
- Demand: -30% (i.e. 400 TWh/year)
- CO_2: -45% (i.e. ~100 Mt/year)

The proposed energy efficiency measures can increase:

- Renewables
- Jobs
- Energy security

Approximately €350 billion of additional investments will be required in the heating and electricity sectors between 2010 and 2050 (for the detailed breakdown of investments, see country-specific report).

Country report: http://stratego-project.eu/reports/ → Italy

Peta for Italy: http://stratego-project.eu/local-maps/ → Italy

Project No: IEE/13/650

Stratego
ENHANCED HEATING & COOLING PLANS

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

Work Package 2

Country Report: Romania

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

Romania

Total heat demand in buildings (city & rural): 81 TWh
Potential excess heat available (excluding nuclear): 70 TWh
Renewable heat potential in DH areas (excluding biomass): 39 TWh

Heat savings can cost-effectively reduce the demand by 50%
District heating can provide 40% of the heat demand vs 20% today
Individual heating in the rural areas should primarily be supplied by electric heat pumps, which are supplemented by smaller shares of individual solar thermal and biomass boilers

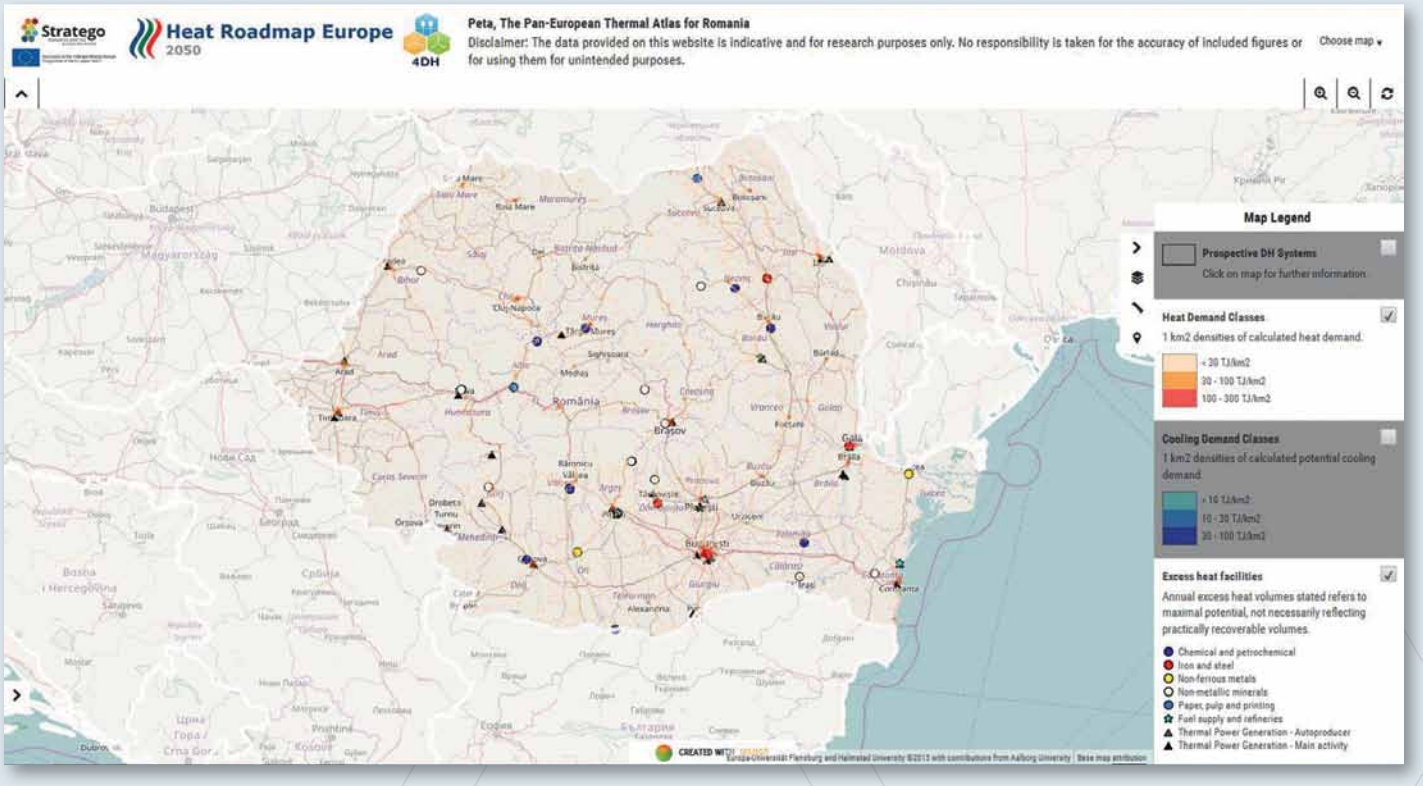
Annual change for heating, cooling and electricity sectors:
- Cost: -15% (i.e. €3 billion/year)
- Demand: -40% (i.e. ~120 TWh/year)
- CO_2: -75% (i.e. ~35 Mt/year)

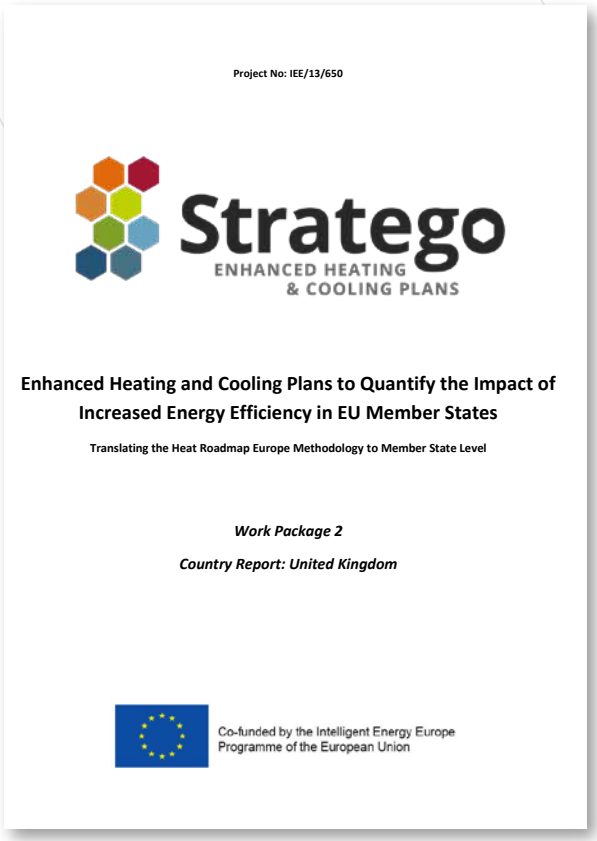
The proposed energy efficiency measures can increase:
- Renewables
- Jobs
- Energy security

Approximately €125 billion of additional investments will be required in the heating and electricity sectors between 2010 and 2050 (for the detailed breakdown of investments, see country-specific report).

Country report: http://stratego-project.eu/reports/ → Romania

Peta for Romania: http://stratego-project.eu/local-maps/ → Romania





United Kingdom

Total heat demand in buildings: 480 TWh
Potential excess heat available (excluding nuclear) 410 TWh
Renewable heat potential in DH areas (excluding biomass): 65 TWh

Heat savings can cost-effectively reduce the demand by 40%
District heating can provide 70% of the heat demand, due to high heat densities (>100 TJ/km2), compared to <5% today
Individual heating in the rural areas should primarily be supplied by electric heat pumps, which are supplemented by smaller shares of individual solar thermal and biomass boilers

Annual change for heating, cooling and electricity sectors:

- Cost: -15% (i.e. €15 billion/year)
- Demand: -35% (i.e. > 400 TWh/year)
- CO_2: -50% (i.e. ~100 Mt/year)

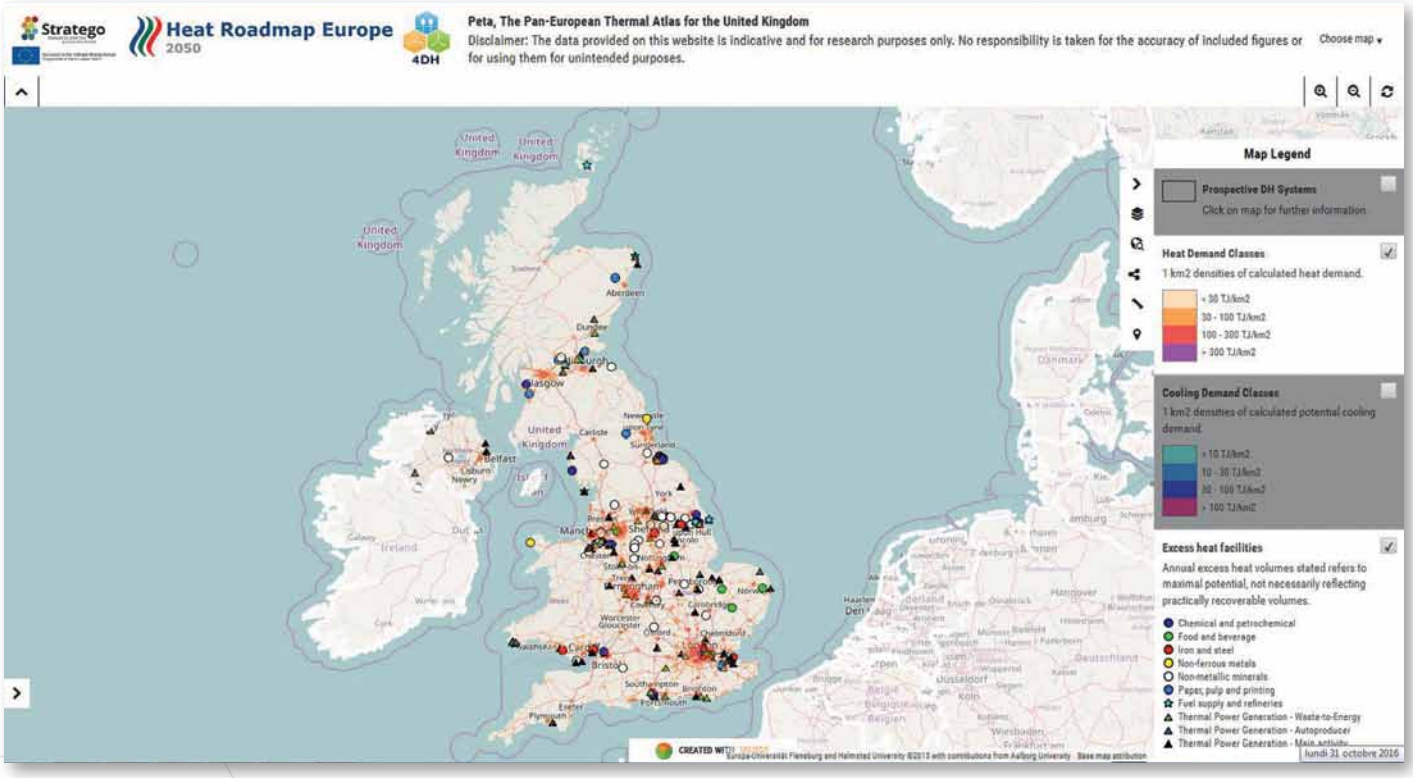
The proposed energy efficiency measures can increase:

- Renewables
- Jobs
- Energy security (80% of heat demand is currently supplied by gas)

Approximately €525 billion of additional investments will be required in the heating and electricity sectors between 2010 and 2050 (for the detailed breakdown of investments, see country-specific report).

Country report: http://stratego-project.eu/reports/ → United Kingdom

Peta for UK: http://stratego-project.eu/local-maps/ → United Kingdom



Main conclusions and recommendations

The primary energy efficiency measures which are added to the heating sector in the Business-As-Usual (BAU 2050) scenario in each of the Heat Roadmap (HR 2050) scenarios are:

- More heat savings in buildings
- Replacing natural gas with district heating in the urban areas
- A combination of various individual heating solutions in the rural areas, including electric heat pumps, biomass boilers and solar thermal

The optimal level of heat savings and district heating is identified by increasing each of them in steps of 10% until the cheapest penetration is identified. Heat pumps were identified as the primary technology which should be utilised for individual heating, but the exact mix of individual heating solutions should be further investigated in future work.

The results for each country, which are displayed in Table 1, indicate that the heat demand in buildings can be cost-effectively reduced by approximately 30-50%, district heating should be expanded from supplying 0-25% of the heat demand today to approximately 40-70% in the future, while individual heating in the rural areas should primarily be supplied by electric heat pumps, which are supplemented by smaller shares of individual solar thermal and biomass boilers.

Table 1: Final levels of each energy efficiency measure in the low-carbon heating and cooling strategies

Heat Roadmaps	Heat Savings (i.e. insulation and other building envelope measures)	District Heating	Individual Heating Technology	District Heat Supply from Renewable Heat & Excess Heat*
	Reduction as a Percentage of the BAU 2050 Heat Demand	% of Total Heat Demand after Heat Savings (vs. % today)	Primary Technology	% of District Heat Production
Czech Republic	40%	40% (25%)	Heat pumps are recommended as the primary technology with small shares for biomass boilers, and solar thermal. The exact mix of each technology is not optimised.	65%
Croatia	40%	40% (15%)		45%
Italy	30%	60% (<5%)		40%
Romania	50%	40% (20%)		50%
United Kingdom	40%	70% (<5%)		45%

* This is defined as geothermal, solar thermal, large heat pumps, electric boilers, and excess heat from existing industrial and waste incineration plants. Biomass and excess heat from thermal power plants is not included in this share.

By implementing these energy efficiency measures, it is possible to reduce the energy demand, carbon dioxide emissions and cost of the energy system in all five STRATEGO countries. As presented in Figure 1, the energy demand in the heating, cooling, and electricity sectors is reduced by approximately 30-40% in the Heat Roadmap scenarios for each country compared to the BAU 2050 scenario. This reduction in energy demand is due to a reduced heat demand and a more efficient heat supply, which also reduces the carbon dioxide emissions by approximately 45-70% and costs by approximately 10-15%. Therefore, the implementation of more energy efficiency measures can reduce energy demand, carbon dioxide emissions and energy costs at the same time.

In total, the energy demand is reduced by over 1,000 TWh/year if the Heat Roadmap scenarios are implemented in all five STRATEGO countries, which is the same as all of the energy required today in the Czech Republic, Croatia and Romania combined. Similarly, the combined reductions in carbon dioxide emissions of 275 Mt/year are more than all of the carbon dioxide emissions emitted by the Czech Republic, Croatia and Romania today (which is ~225 Mt/year). Furthermore, the annual cost of the heating, cooling and electricity sectors is reduced by approximately €35 billion/year.

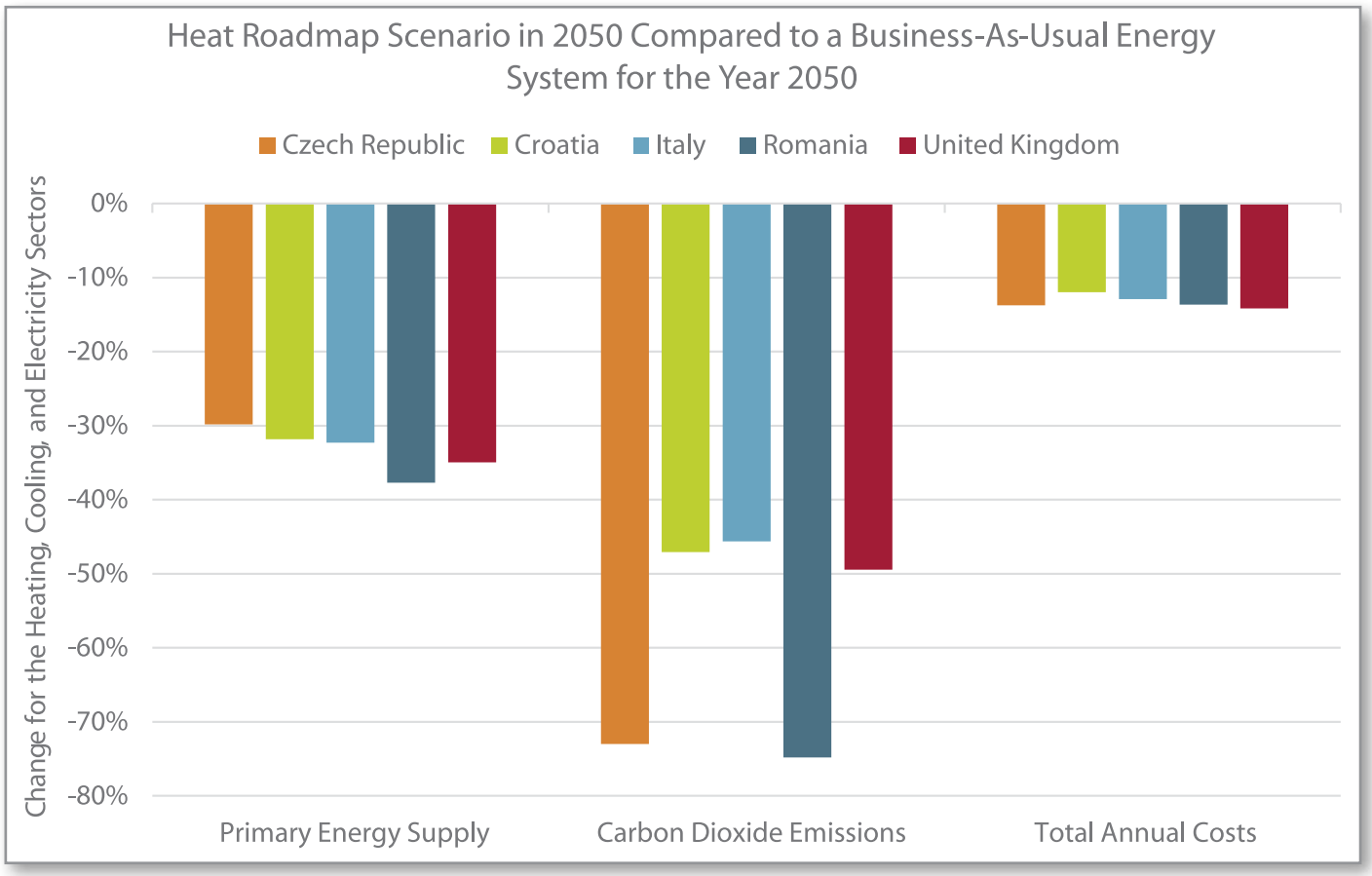


Figure 1: Heat Roadmap impacts on energy, environment and economy compared to the BAU 2050 scenario for the heating, cooling and electricity sectors (excludes the industry and transport sectors)

Even though these energy efficiency measures will require a very large increase in investment, the overall costs are reduced primarily due to a reduction in fuel consumption, which equates to a reduction in fuel costs of ~€50 Billion/year in the year 2050. Today, the EU is paying ~€350 Billion each year for imported fuels (source: https://ec.europa.eu/energy/en/topics/imports-and-secure-supplies). In total, approximately €1.1 trillion of additional investments will be required in the heating and electricity sectors between 2010 and 2050 to implement the Heat Roadmap scenarios, which are primarily used for already existing technologies. A detailed breakdown of investments required between 2010 and 2050 to implement the Heat Roadmap recommendations in all five STRATEGO countries is provided in the WP2 Main Report (http://stratego-project.eu/reports/ → Main Report).

Heat available from renewable resources and excess heat

The potential availability of renewable resources was also investigated in the framework of this project for each of the STRATEGO countries. The analysis includes a detailed quantification of the renewable resources and excess potentials available for the heating sector. From the results it became obvious that **there are very large amounts of excess heat already available** in each of the STRATEGO countries from existing thermal power plants, industrial plants and waste incinerators, while there is also a huge potential to utilise renewable resources for heating. As displayed in Figure 2, there is on average **three times more renewable and excess heat available** in each of the STRATEGO countries than is required to meet the high levels of district heating supply proposed in the Heat Roadmap scenarios (see Table 1). However, these resources can only be utilised if a district heating network is put in place to connect these resources to the end-user. Without the district heating networks, these resources will continue to be wasted.

The analysis also included a review of the renewable electricity resources available, such as wind, solar, hydro, wave and tidal power, as well as the bioenergy resources available, such as forestry and energy crops. After analysing these resources, it became clear that there is likely to be a shortage of renewable electricity and bioenergy resources if the long-term objective is to decarbonise all sectors of entire energy system in the future, including industry and transport. This reinforces the importance of utilising the renewable and excess heat resources presented in Figure 2 in the heating sector. By using these resources, it is possible to minimise the pressure on renewable electricity and bioenergy resources, which are more important for all parts of the energy system where there are fewer cost-effective alternatives for decarbonisation.

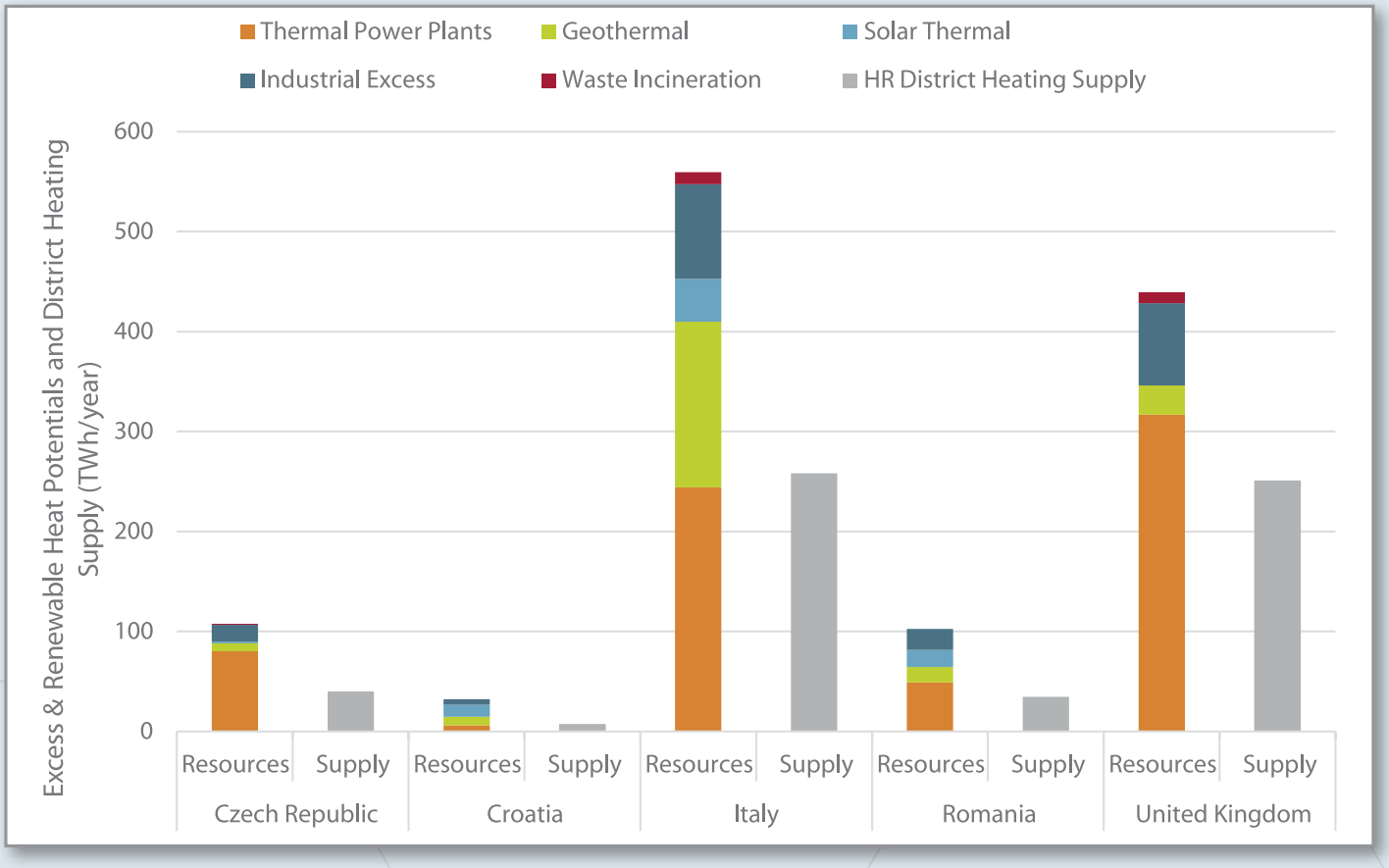


Figure 2: Excess and renewable heat potentials for each of the STRATEGO countries, in comparison to the district heating supply proposed in each of their corresponding Heat Roadmaps

Cooling sector

The initial aim in the STRATEGO WP2 study was to consider both heating and cooling in equal measure. However, after profiling the existing cooling demand in each Member State, it became clear that the cooling demand is currently much smaller than today's heat demand. As displayed in Figure 3, the cooling demand is currently less than 15% of the heat demand in each of the STRATEGO countries. The cooling demand is relatively low since less than 20% of the buildings in Europe actually meet their cooling needs today, with many buildings opting to live with the discomfort of overheating rather than pay for the cost of cooling to a comfortable level. In contrast, almost all of the buildings in Europe currently provide some level of heating.

This means that the heating and cooling demand are likely to undergo two very different developments in the coming decades. The cooling demand is likely to increase as more buildings start to meet their actual cooling needs, while the heat demand is likely to decrease as more heat saving measures are implemented in buildings. For example, as recommended by STRATEGO, the heat demand can be reduced by approximately 30-50% in the final Heat Roadmap scenarios (see Table 1). As the cooling demand increases and the heat demand decreases, the relative influence of the cooling demand is likely to increase. Once again, if the heat savings recommended in the Heat Roadmap scenarios are implemented, and at the same time all buildings actually meet their cooling needs in the future (maximum potential cooling demand), then the cooling demand will become approximately 30-70% of the heat demand (see Figure 3).

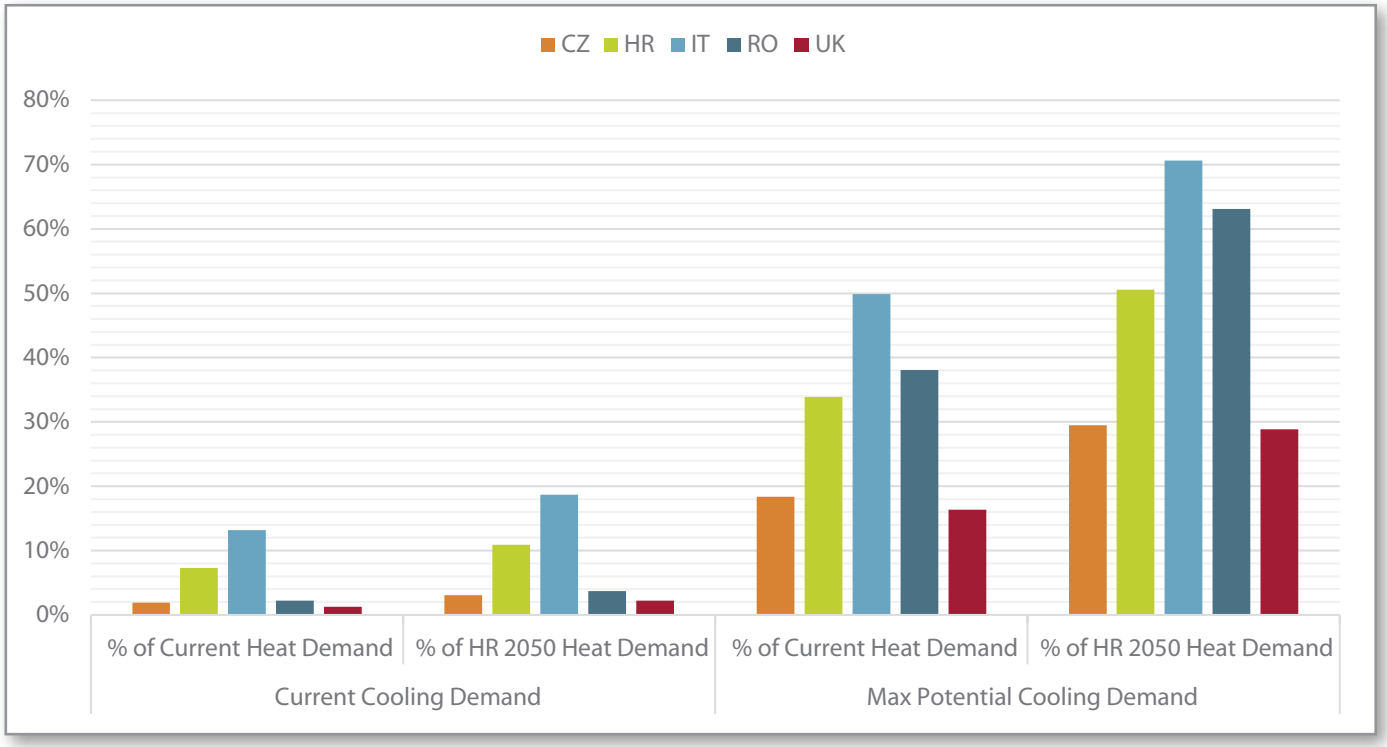


Figure 3: Scale of the current and future potential cooling demand compared to the current heat demand (2010) and the heat demand in the Heat Roadmap scenarios (HR2050)

In this study, the potential growth in the cooling demand is not investigated in detail. Instead the impact of replacing some of today's individual cooling units, which are primarily heat pumps, with district cooling was investigated under two cases: 1) where the cooling demand is at similar levels as today for all STRATEGO countries and 2) an extreme case for Italy where the cooling demand is increased to the maximum expected cooling demand in the future (i.e. where all buildings meet their cooling needs). When the cooling demand is at similar levels as today, the impact of changing the cooling sector is almost negligible from a national energy system perspective (changes all of the metrics measured by less than 1%). However, if the demand increases to the maximum demand in the future, then the cooling sector will begin to have an influence on the national system. Furthermore, in this extreme case, replacing individual cooling with district cooling had a positive impact on the energy demand and carbon dioxide emissions in the system, indicating that this should be considered as an alternative for cooling.

Main conclusions of STRATEGO WP2

The overall conclusion in STRATEGO WP2 is that a combination of energy efficiency measures, in the form of heat savings, district heating in the urban areas and primarily heat pumps, with smaller shares of biomass boilers and solar thermal in the rural areas, reduces the energy system costs, energy demand and carbon dioxide emissions in all five STRATEGO countries for the year 2050 compared to a 'Business-As-Usual' projection.

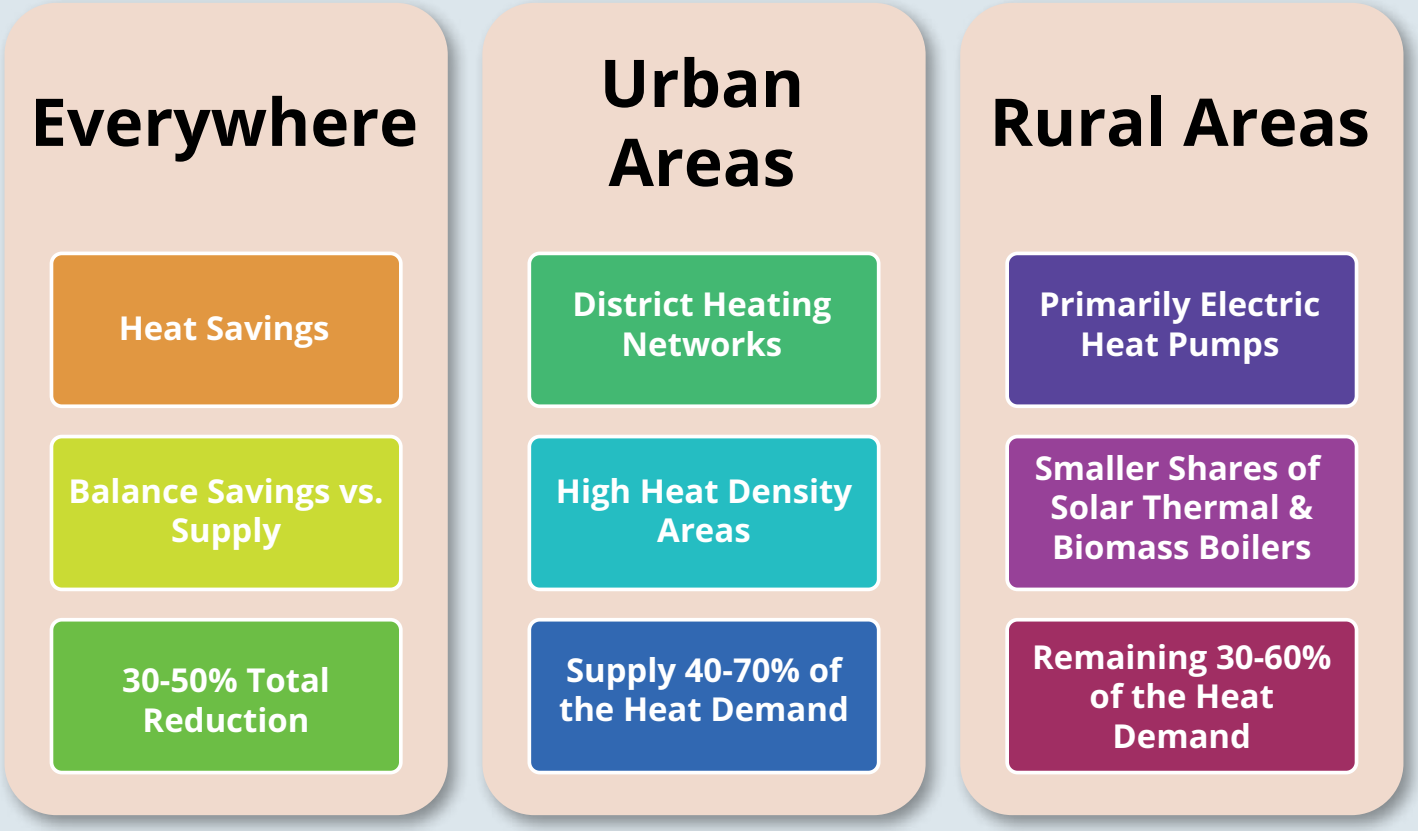


Figure 4: Key recommendations for the Heat Sector

Below is a list of 21 key conclusions and recommendations from this study, divided by specific categories relating to the heating and cooling sector. These are elaborated upon in more detail in the Main Report.

Heat savings

1. Heat savings reduce the energy demand, carbon emissions and costs in all countries, but eventually they become more expensive than the cost of sustainable heat supply.
2. The average heat demand in residential and services buildings combined, including space heating and hot water, can be cost-effectively reduced by approximately 30-50% in total. This equates to a heat density of approximately 60-110 kWh/m^2, depending on the specific country.
3. Heat savings should be implemented over a long-term time horizon, in combination with other building renovations.
4. There are synergies between the reduction of the heat demand and improvements in the heat supply such as reducing the thermal capacity required and enabling more (renewable) heat sources to be utilised on the district heating network.

Heating in Urban Areas

5. District heating is more efficient and cost effective in urban areas than natural gas networks.
6. District heating is technically and economically viable in the North and South of Europe.
7. District heating can utilise very large amounts of excess heat and heat from renewable resources, which are wasted today in the energy system.
8. District heating pipes represent a relatively small fraction of the annualised district heating system cost (~5-15%).
9. The sunk costs that could occur during the implementation of district heating do affect the results for the Heat Roadmap scenarios, but the scale of their impact is not significant enough to change the overall conclusion.

Heating in Rural Areas

10. Individual heat pumps are the most preferable individual heat solution based on a balance across energy demand, emissions, and cost. They should be supplemented by smaller shares of individual solar thermal and biomass boilers.
11. The optimal mix of individual heating technologies should be analysed in more detail.
12. Individual heat pumps may be too expensive in suburban areas, where the heat supply transitions from district heating to an individual heating solution.

Cooling

13. The current cooling demand is relatively low compared to the heat demand, but in the future the cooling demand could be relatively larger.
14. District cooling can reduce the cost and energy demand in the cooling sector, but at present the benefits occur at a local level.
15. The optimal level of district cooling needs further research.
16. The design of the district cooling network should be analysed in more detail.

Sustainable Resources for the Energy System in the Future

17. There is a large amount of excess heat and heat from renewable resources available, but there is likely to be a shortage of renewable electricity and bioenergy in the future.
18. Further energy efficiency improvements are necessary in the electricity, industry and transport soctors to decarbonise the energy system.

Methodologies and Tools for Analysing the Heating and Cooling Sector

19. Alternative technologies in the heating and cooling sector should be analysed from a complete energy systems perspective.
20. A combination of mapping and modelling is essential to analyse the heating and cooling sectors, but it should also be expanded to other parts of the energy system in the future.
21. A variety of different expertise is required to inform, design and analyse a holistic heating and cooling strategy.

CHAPTER 2

LOCAL HEATING & COOLING STRATEGIES

Within the framework of the Work Package 3, local heating and cooling action plans were drafted for in total 30 target cities. Figure 5 presents an overview of which cities were supported by the STRATEGO project.

They cover a broad variety of communities:

- 6 of the target cities are big cities with over half a million inhabitants and a population density up to 7,200 inhabitants/km²
- 5 of the target cities are medium-size cities with 100,000 to 500,000 inhabitants
- 13 of the target cities are towns with 25,000 to 100,000 inhabitants
- 6 of the target cities are rural communities with 1,000 to 16,000 inhabitants

They also cover a broad range of development phases of a local heating and cooling market. Using the categorisation defined by the Ecoheat4EU project, STRATEGO target cities are located in:

- Expansion areas: Austrian and Italian cities
- Refurbishment areas: Croatian, Czech and Romanian cities
- New development areas: Belgian, British (Scottish) and German cities

Figure 5: Map of the STRATEGO target cities

The support to the local authorities of these 30 target cities was organised in five steps, see Figure 6:

Figure 6: Infographic on the tasks in WP3 supporting local authorities

1. In the first step, heating and cooling demand, as well as potential supply points and renewable energy sources were mapped. The starting point was the Pan-European Thermal Atlas (Peta), from which data was extracted. This was complemented by locally available data.
2. Based on the map of local heating and cooling demand and supply, areas of priority for intervention were identified. These are areas where the local conditions are favourable for developing projects in the first place. In total 43 projects were defined in the STRATEGO project.
3. Business models were then developed for each of the identified projects.
4. The results of the previous steps were then discussed with local stakeholders.
5. The results of the previous steps, including the conclusions of the stakeholder meeting, were summarised and presented to the representatives of the target cities, so they can integrate this information in their local heating and cooling action plan.

The results for the individual STRATEGO cases are reported in separate sheets; they can be consulted on the webpage http://stratego-project.eu/projects-description/. The analysis of these cases reveals achievements, challenges, needs and successes for each of the five tasks, which are described further in this report.

Mapping local heating and cooling demand and supply

Achievements and success stories

Mapping local demand and supply of heating and cooling is a first step to find areas of priority where the local conditions are favourable for developing projects on sustainable heating and cooling. A guideline entitled “Local action: Methodologies and data sources for mapping local heating and cooling demand and supply” was developed in the framework of STRATEGO. The aim of this guideline is to support the mapping exercise.

Heating and cooling maps have been made for 29 STRATEGO cases (one map combines the heating demand of the two towns Karviná and Havířov, CZ). These maps include the heating demand, the layout of district heating networks, where relevant, and distinct sources of excess heat or renewable heat. Table 2 lists some showcases. It was observed that simple maps can already provide inspiration for heating and cooling projects.

Table 2: Showcases of the local heating and cooling mapping exercise

Maps of	Showcases
1. Heating and cooling demand	Edinburgh, UK: heating demands maps, based on metered data Zagreb, HR: cooling demand maps based on building characteristics Graz, AT: extract from national heating demand maps Tulcea, RO: extract from PETA, the Pan-European Thermal Atlas Limburg, BE: heat demand processes to a statistical map
2. Heating and cooling infrastructure	Vienna, AT: map showing the district heating grid and the heat sources
3. Energy savings potential	Kortrijk, BE: thermographic scan Limburg, BE: Average fuel consumption per municipality as indicator of energy savings potential
4. Excess heat potential	Ostrava, CZ : indication of thermal power plants and industrial facilities of some energy-intensive sectors on the PETA-extract
5. Renewable heat potential	Topusko, HR: map of the geothermal boreholes that can be reactivated Antwerp, BE: map of the municipal biomass waste potential and the heat extraction potential from the sewage system

Challenges and needs

Mapping heating and cooling demand at local level has proven to be a very challenging task. There is a lack of appropriate tools to support local authorities. Local authorities also need easier access to data to make estimates of the heating and cooling demands for the different buildings or estimates of the sustainable heat supply potential of various sources. The STRATEGO cases have demonstrated that cooling is a blind spot overall. Research is needed to fill these knowledge gaps.

Identification of areas of priority for intervention

Achievements and success stories

A guidance for the STRATEGO partners was compiled, explaining a list of six sustainable heating and cooling categories of projects to consider. This list has proven to be a useful tool. Areas of priority and projects have been identified in all cases; this has resulted in the definition of 43 projects over the 30 STRATEGO cases (see Figure 7).

The categories of sustainable heating and cooling projects to consider in the STRATEGO target cities were inspired by the Pan-European impact assessment of increased energy efficiency in heating and cooling and by the results of WP2 of the STRATEGO project, presented in Chapter 1.

One of the key lessons of WP2 which served as a basis for the identification of projects can be summarised as follows: ***half of the potential savings of an integrated heating and cooling strategy lay in reducing the heating and cooling consumption; the other half in optimising the supply.***

The fact that projects of all six categories have been defined demonstrates that the Heat Roadmaps, defined in Work Package 2 of the STRATEGO project, can be realised in practice.

7 projects on reducing heating and cooling demand at end-consumers
Belgium, Croatia, Romania
Energy savings: 2 – 90 GWh/year
Energy savings: up to 40%

25 projects on district heating networks – refurbishment, expansion and/or new ones
Austria, Belgium, Croatia, Czech Republic, Germany, Romania, UK
8: refurbishment
4: expansion
13: new schemes

1 project on sustainable individual heating and cooling solutions (phasing out heating oil in rural areas)

Belgium
High correlation between share of heating oil and specific heat consumption

13 projects on tapping excess heat potential
Austria, Belgium, Czech Republic, Italy, UK
1: from a data centre 6: from the industry
2: from a power plant 5: from a W-t-E plant
Potential: 70 – 1,400 GWh/year

12 projects on tapping renewable heat sources

Austria, Belgium, Croatia, Germany, UK
Potential: 0.1 – 20 GWh/year

12 projects on improved conversion of fossil fuels
Belgium, Croatia, Czech Republic, Romania, UK
4: CHP instead of HoB
5: better operation of CHP
3: condensing or electric boilers

Figure 7: Six categories of projects defined in the framework of STRATEGO

Challenges and needs

The projects are sometimes quite complex in nature, this made it challenging to assess relevant aspects, such as costs and benefits, for most of the identified projects. **It turned out that both more time and data are needed to conclude with a final design of the identified projects.** Most of the cases focussed on city centres. Yet, a sustainable heating and cooling strategy should look to all heating and cooling consumers, also those in sparsely populated areas.

Business models for local partners

Achievements and success stories

In total 36 business models have been developed for the 43 identified projects. The number of models is smaller than the number of cases since some business models are identical for multiple projects. The development of business models has been based on the Business Model Canvas (Figure 8), which has demonstrated to be a useful tool. **It put the end-consumer at the heart of the projects.**

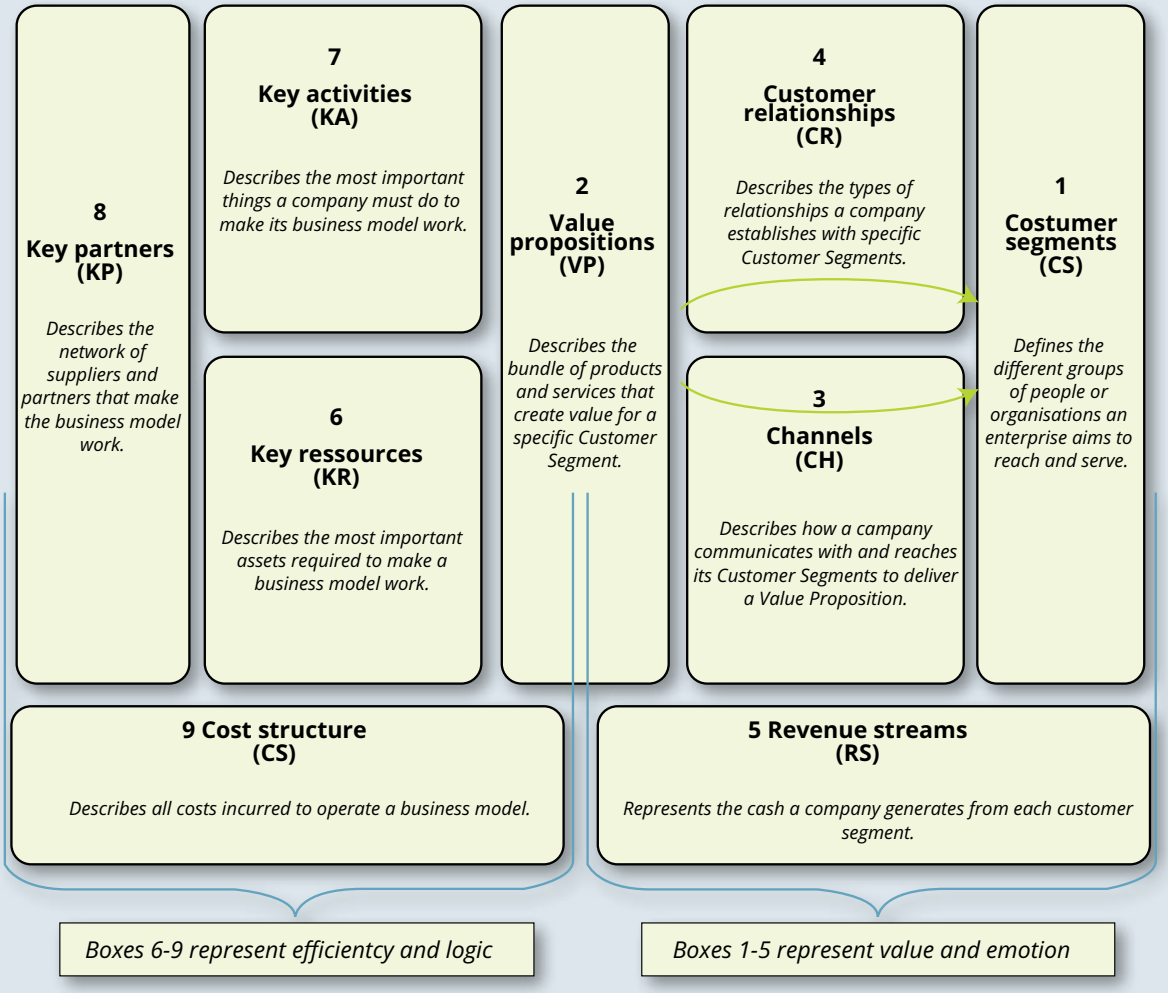


Figure 8: Business model canvas (source: Osterwalder & Pigneur, 2010)

Challenges and needs

The business models of the projects are very complex and involve a lot of stakeholders. This makes the development of an "investment ready" business model a time consuming process. **There is a need for a mechanism or support scheme** to bring such projects to a stage where they have proven their feasibility and have become ready for investment.

The main lesson from business model development in STRATEGO is that business models for district heating and cooling need to be **flexible and allow changes over time** as the focus becomes clear and uncertainties are sorted out. Business models need to take into account **different stages of maturity of different heat markets**, which prolongs the development of business models but on the other hand allows business models with long-term development potential.

Involvement of local stakeholders

Achievements and success stories

The projects and their business models have been discussed with stakeholders. In most cases, the stakeholders directly involved in the implementation of the project were involved the most. Some STRATEGO target cities however succeeded in organising a public debate involving a wide range of stakeholders, including end-consumers, heat suppliers, regional authorities or energy agencies. The outcome of these public debates is a common understanding of the city's ambition on heating and cooling and a social basis of support to realise this ambition.

Challenges and needs

The involvement of a wider range of stakeholders in a minority of cases indicates that there is a need for a public debate within the STRATEGO target cities on heating and cooling and its transition towards a more sustainable system.

Input to local heating and cooling action plans

Achievements and success stories

The final step consists of providing input to local action plans on heating and cooling in the STRATEGO target cities; the identified projects have been added to the political agenda of the STRATEGO target cities.

An analysis of the roles of local governments has indicated that the city has a significant role to play as a **heating and cooling planner**.

The least local authorities should do in new urban development areas or refurbishment areas is to consider alternatives for the default heating option (individual gas boilers in many cases); they should pay as much attention to it as to the design and the names of the streets.

The best local authorities can do is to develop a master plan on heating and cooling, based on an overall picture of the demand and the (potential) supply in the area and a vision on how to reduce the demand and to tap the sustainable heating and cooling sources.

Challenges and needs

Although input has been given to all STRATEGO target cities, only a minority of the local heating and cooling plans reached the level of a strategic master plan while the majority tends to focus on the implementation of specific projects. Such a master plan defines strategies for a transition of the heating and cooling system in the major part of the STRATEGO target cities towards a more sustainable system.

The STRATEGO five steps' approach
to support local authorities in drafting a heating / cooling plan

Main conclusions of STRATEGO WP3

Overall, the STRATEGO five steps approach to support local authorities in drafting local heating and cooling plans allows to draw some general conclusions:

- The transition towards a more sustainable heating and cooling system at city level begins with the understanding that there is a significant potential in heating and cooling to curb down the city's greenhouse gas emissions. Then there is need for political leadership to start a process of exploring the possibilities and to discuss different options with a wide range of stakeholders.

- The outcome of this process should be a strategic master plan on how to organise this transition towards a more sustainable heating and cooling system in the city. Such a master plan allows to frame single projects into a wider context.

- Individual projects need to be defined to realise the strategic master plan. The five steps' approach (see Figure 6) developed in the framework of the STRATEGO project, has demonstrated to provide appropriate guidance to cities for such a process. It was successfully applied to 30 target cities with very different characteristics.

    - A first step consists of **exploring the possibilities**. This requires mapping demand areas and supply points of heating and cooling. The experiences of the STRATEGO cases has shown that there is a need for appropriate mapping tools, having access to reliable data and expertise, certainly for cooling. However, it is proven during STRATEGO that simple maps can already give inspiration for project ideas if they combine information on demand and supply.

    - A second step is the **project definition**. A list of six categories of heating and cooling projects (reduction of demand; district heating/cooling in densely populated areas; sustainable individual heating in other areas; excess heat; renewable heat; improved conversion of fossil fuels) was used in this STRATEGO project. This list has demonstrated to be a useful tool to give guidance to local authorities in identifying their opportunities/ projects.

    - A third step is **drafting business models** for the defined projects, based on the business model canvas. This canvas looks at the projects from different perspectives; it especially puts the end-consumer at the heart of the projects. However, the assessment of all costs and benefits of projects is a long process, asking for a lot of time before the required details are gathered to draft an investment-ready business model for the projects.

    - A fourth step is the **involvement of stakeholders**. An involvement of a wide range of stakeholders can provide a social basis of public support to realise the projects. Stakeholders include local, regional or national authorities; end-consumers; energy companies; scientific institutes; etc.

    - A fifth step is **input to the local action plan on heating and cooling**. Ideally, this step is no more than an update of the strategic master plan on how to organise this transition towards a more sustainable heating and cooling system in the city. A strategic master plan at city level has the advantage to frame single projects into a wider context, which guarantees a targeted design of the project and an efficient use of public funds.

It is the hope of the STRATEGO project partners that these conclusions will support European cities in replicating the steps taken by the STRATEGO target cities in the framework of this project.

CHAPTER 3

EMPOWERING LOCAL AUTHORITIES

The STRATEGO project aimed to support the development of effective national and local heating and cooling plans. This means not only supporting development of informed and evidenced plans, but also building the capacities of local and national authorities for putting these plans into action. This part of the report summarises lessons and best practice from activities in Work Package 4 of the STRATEGO project. Under this work package, activities focused on the latter of these challenges: capacity and skills development of local authorities for effective delivery of local heating and cooling plans through a series of international coaching sessions. The work package also established productive dialogue between local and national authorities, seeking to encourage sharing of experiences and perspectives from different levels of government.

International coaching to support local delivery of heating and cooling plans

In many instances, decarbonisation of heating and cooling requires strategic and coordinated action at the local level to enable utilisation of renewable heating and cooling sources and efficient supply. However, there are many **barriers faced by local authorities** seeking to support a local strategic approach, including issues of capacity, skills, experience, and gaining public and political support for new solutions.

A key part of the STRATEGO project activities involved a series of **international coaching sessions** for local authorities. 'Learning' partners in the project have been paired with 'expert' partners, to deliver coaching for selected local authorities. These coaching sessions have enabled local authorities to see innovative technological solutions in practice and learn from the practitioners who developed these demonstration projects.

Each of the STRATEGO project 'learning' cities / regions were paired with an international expert partner who acted as a key point of contact for arranging relevant site visits and meetings. Figure 9 illustrates the pairing that was made between each country. A detailed overview of the 'learning' city / regions and their partner international 'expert' city / regions is also given in a dedicated report on WP4 best practice, along with the topics covered within the coaching sessions.

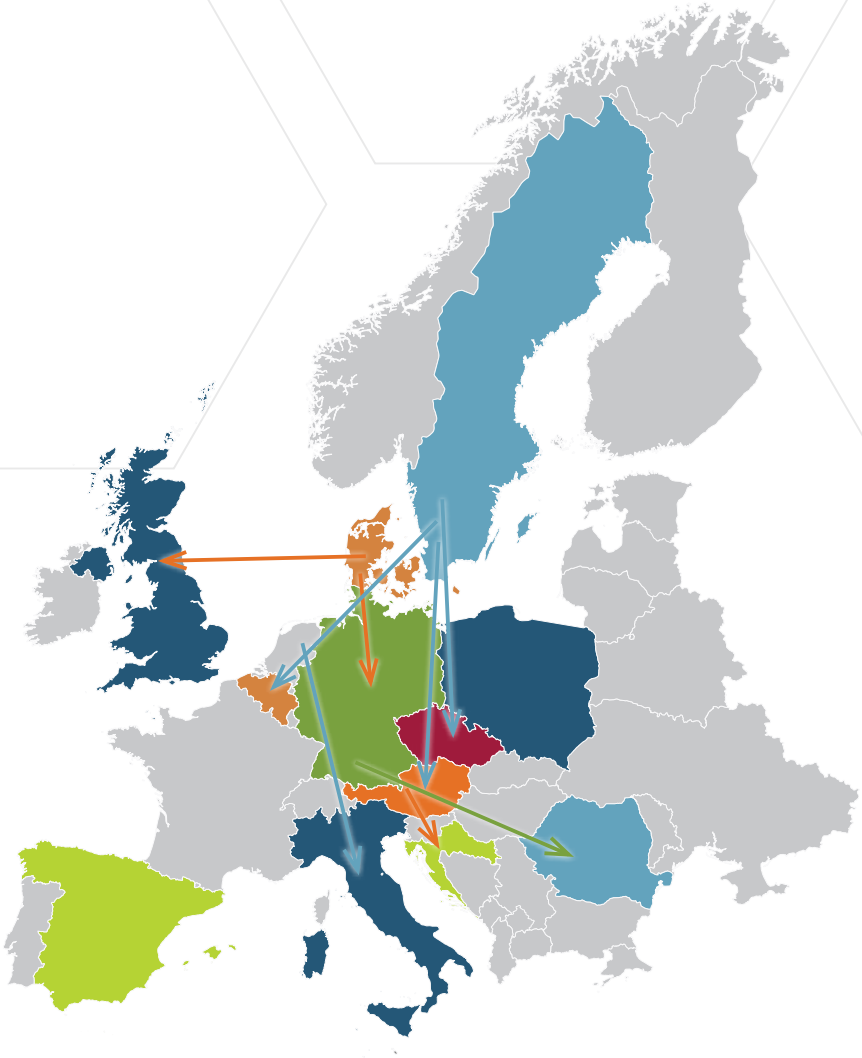


Figure 9: International pairing of project partners during the international coaching process

Delivering heating and cooling projects requires involvement of multiple stakeholders from both inside and outside local authorities. Ensuring that a range of local stakeholders take part in the coaching process is important to ensure capacity building and buy-in is present across all relevant parties, and not just in isolated pockets of stakeholders.

The range of attendees of the STRATEGO coaching events are listed below:

- Local authorities (planning, engineering, housing, energy, sustainability, economic development)
- Regional authority
- National authority (relevant energy ministry)
- Public bodies (e.g. Centre for energy saving)
- Energy agency
- District heating companies
- Utility companies
- Funding organisations
- Manufacturers
- Research institutes / academia
- NGOs
- Trade Associations
- Local politicians
- Potential financers
- Industry representatives
- Waste processing industry

Figure 10 suggests content for an international coaching programme, drawing on experiences and lessons from the project coaching partners. It is important that the details of such a coaching programme be tailored to the specific context and challenges of the learning cities / regions in focus.

Figure 10: Suggested content for an international coaching process

Allowing time for discussion and reflection within the coaching programme is just as important as hearing from speakers and visiting sites. STRATEGO partners suggest that for every one hour of presentations, there is also one hour for questions and discussion between coaching participants and expert partners.

The long timescale of project development means that it is useful to leave 6-9 months between coaching sessions. In order to maintain relationships and momentum between coaching sessions it is useful to set up follow up sessions between coaching participants.

An important objective of the first coaching session was to identify the challenges and skills / knowledge gaps experienced by the coaching participants. The outcomes of discussions from the first coaching sessions are then used as a basis for setting the agenda of the later sessions. Table 3 summarises the topics focused on in the coaching sessions for each partner.

Table 3: Summary of the topics that were focused on in each of the coaching programmes developed within the STRATEGO project.

Learning City / Region	Expert City / Region	Topics in focus
Vienna, **Austria**	Gävle District Heating Company, **Sweden** Fortum, Stockholm, **Sweden** Profu, Mölndal, **Sweden**	• Open district heating • Large scale surplus heat utilisation • Business and price models • Reduction of return temperature – organisational and technical possibilities

Ostrawa, Moravian-Silesian Region, **Czech Republic**	Linköping, **Sweden**
	
	Tekniska Verken Linköping, **Sweden**
	
	Profu, Mölndal, **Sweden**
		• Strategic plans for energy companies and local authorities
		• Cost-effective substitution of fossil fuels with renewable energy (in the context of no national action plan for heating and cooling), in particular:
		  • Surplus heat form industry
		  • Energy from waste
		• Public perceptions of renewable technologies (energy from waste)
		• Penetration of heat pumps in district heating areas
		• Use of district heating for grid balancing
		• Heat losses in networks
		• Geothermal energy installations
		• Public / private cooperation
		• Capacity market solutions on national / EU level

Milano, Regione Lombardia. **Italy**	Rotterdam, **The Netherlands**	• Environment protection • Recovering waste heat from power plants • Recovering waste heat from industrial sites • Heat transport networks to connect heat sources to heat consumers • Heat accumulator for balancing networks • Heat accumulator as a buffer for multiple heat recovery sources • Cooperation of different parties • Planning of developments
City of Zagreb, City of Velika Gorica, City of Osijek, Karlovac County, Municipality of Topusko, **Croatia**	Vienna, **Austria**	• The energy planning process • Data gathering processes • Geothermal potential • Heat losses • Lowering heat supply temperatures in networks • Financing of projects • Implementation challenges
Alsdorf, **Germany**	Odense, **Denmark** (plus an additional contribution from Kortrijk, **Belgium** to the third coaching session)	• Decision making processes for energy projects • Heating and cooling planning • Local business models for district heating • Wood-fuel boilers, gas-fuel boilers or wood-fired boilers, gas-fired boilers • Replacement of the gas supply system to district heating system • Small district heating with CHP unit running on gas
Tulcea and Alba-Iulia, **Romania**	Frankfurt, **Germany**	• Decision making process • Key elements for developing a successful H&C plans • Business Model for local projects • Energy storage • Power-to-heat installations • Interconnections between separate district heating systems • Maintenance of DH systems, rehabilitation strategies and determination and assessment of water losses
Antwerp, **Belgium** Kortrijk, **Belgium**	Gothenburg, **Sweden** Odense, **Denmark**	• How to map supply and demand of heating and cooling • The design of district heating networks when its deployment is at an early stage • Waste heat supply from (petrochemical) industry • Development of the small schemes • The market structure for heat supply • Business models for heat supply, the role of the local and the port authorities, heat supply from the industry
Aberdeen, Dundee, Edinburgh, Glasgow, Inverness, Perth, Stirling, **Scotland**	Aalborg, **Denmark**	• Energy planning and associated powers • Seasonal and short-term thermal storage • Use of renewable heat and industrial waste heat sources – business models and technical challenges • Cooperative business models • Stakeholder engagement

Main conclusions of STRATEGO WP4

Lessons for running an international coaching process:

- It is important to spend time getting to know the context of each participating partner and to allow time for discussion and reflection about how a solution might be applied in the learning country context;
- Projects can take several years to be developed from conception to operation. The coaching process should allow sufficient time between sessions for participants to develop their work (6 – 9 months);
- Involve a range of stakeholders as coaching session participants to enable a shared vision to develop across key people in the local area;
- Plan each session at least three to four months in advance. It can be difficult to organise a suitable date for a large gathering of stakeholders, especially if one is targeting specific individuals or departments;
- Build in time during an international visit to reflect on how lessons from the site visits and presentations can be translated into actions by participants in their home context;
- Include discussion sessions and group activities in your coaching programme to ensure that participants have an opportunity to share experiences with each other;
- Not all participants are used to working and talking in English on a regular basis. Consider hiring an interpreter to support participants who would find it difficult to take part in English;
- Keep participants engaged with the process between sessions using newsletters, phone calls and meeting;
- Identify the key challenges and any knowledge gaps of stakeholders in the learning country and tailor the coaching agenda to meet these.

Advice on what not to do when running an international coaching process:

- Avoid speakers story telling only about their own situation;
- Do not think, as a coaching partner, that measures / solutions from your own context are directly transferable. Be aware that each country / city / region has its own background (e.g. legal frameworks, funding systems, political issues);
- Avoid detailed technical presentations. The most useful parts of the coaching sessions were mostly the presentations related to the local planning and national financing options. The primary reason for this is most likely the mixed nature of the participants, which included both engineers and economists (or other participants of similar backgrounds). The technical shortcomings are often well known by the learning countries and do not need a coaching process.
- Do not forget to talk about the user perspectives – how are customers involved in decision making?

The full version of the International Coaching Guidelines is available on the project website: http://stratego-project.eu/coaching-sessions/.

Lessons for creating productive dialogue between local and national authorities

A key challenge of putting national heating and cooling plans into practice is ensuring that the national plans take into account the realities of the local contexts. Conversely, activities for local delivery and local plans should be in line with the visions set out in the national plans.

Therefore, an important part of the STRATEGO project activities focused on developing dialogue between national authorities and local authorities. This was done through a series of formal meetings which aimed to ensure that the local and regional plans developed through the coaching process were designed with national plans in mind, and vice versa.

Four meetings were held throughout the duration of the project in each learning country. The objectives of each of these meetings are summarised in Figure 11.

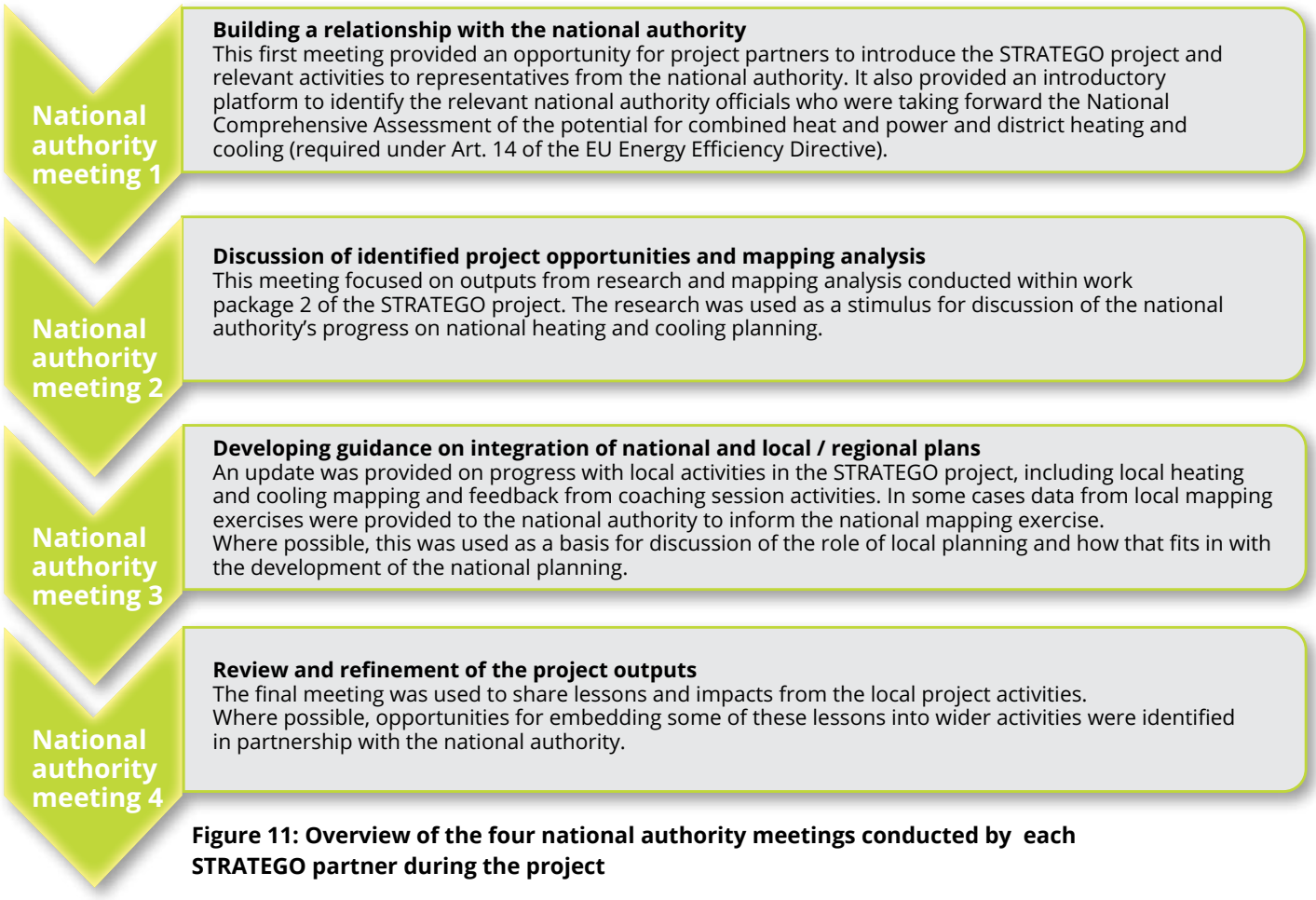


Figure 11: Overview of the four national authority meetings conducted by each STRATEGO partner during the project

Challenges of establishing national – local dialogue

- Local authorities often did not have an established role informing the national heating and cooling planning process.
- It was difficult to find the right government departments and officials to engage with since it was not always clearly defined where responsibility for national heating and cooling planning sat within Government departments.
- The governance set-up of national, regional and local authorities needs to be considered when establishing a process for dialogue. For example, Spain has approximately 8,000 local authorities, which are separated from the national authority by provincial and regional governments. It is therefore necessary to establish a means for collating experiences and perspectives at the local level in a manageable form to inform national government planning processes.

Advice for developing national – local dialogue

- If possible, establish a long-term platform that can continue to facilitate discussion between local and national authorities. This issue requires long-term dialogue and development.

- Involve representatives from national authorities in coaching sessions, study visits, and stakeholder engagement sessions where possible. This enables them to interact directly with local authorities and understand the complex challenges of project delivery.

- During engagement with local stakeholders (e.g. coaching sessions, stakeholder engagement, technical advice), note down ideas and challenges that cannot be dealt with at the local level. Where possible, share a summary of these comments to the relevant national government representatives to inform their policy development.

- Establish political agreement and recognition of the roles of local, regional and national authorities in the process of heating and cooling planning:
    - Heat mapping is not the only important element of a heating and cooling plan. Other aspects including local and national policy support, regulations, consumer engagement and behaviour change, stakeholder engagement, supply chain development and capacity building are needed to be able to realise opportunities.
    - At present the Energy Efficiency Directive does not make it clear that a strategy is needed to support delivery of the national comprehensive assessments.
    - Establish a commitment to develop the skills and resource of local authorities to enable them to take on relevant responsibilities.

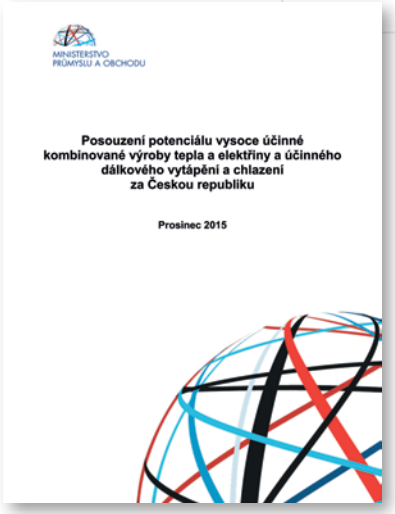
"Best practice report on how National Heating and Cooling Plans take into account local and regional plans and vice versa" is available on the project website: http://stratego-project.eu/nhcps/.

Best practices from STRATEGO

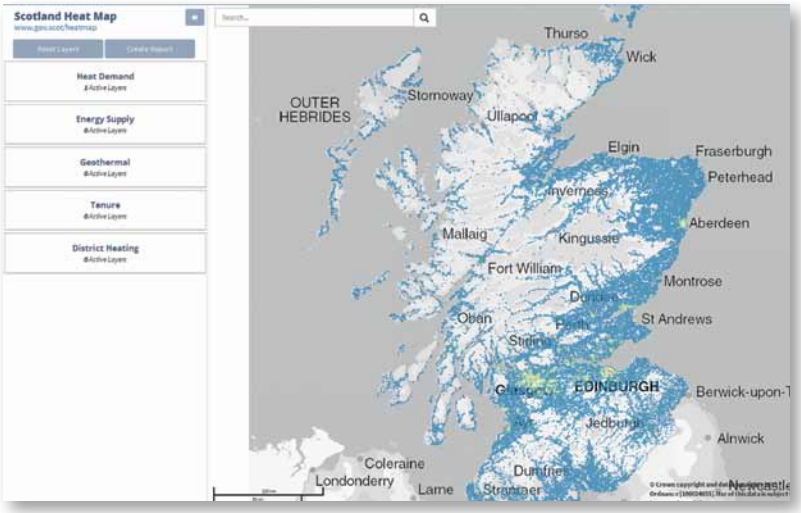
Some practical experiences, lessons learned from the coaching sessions and examples of concrete projects triggered by STRATEGO have already been published in the Brochure on good practices (available on http://stratego-project.eu/lessons-learned/). Therefore, this section features additional experiences and highlights some key successes and impacts that were observed thanks to partners taking part in this project.

Influencing national government policy

"The Ministry of Industry and Trade takes note of our findings and recommendations as, for example, the requirement to replace obsolete fossil fuel boilers by efficient district heating installations, increasing the share of cogeneration and recovery of excess heat from industrial production; attention should be paid to the generation from renewable sources and also it is necessary to set motivational economic conditions for the energy recovery of sorted municipal waste. Our comments were incorporated into the study „Comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling in Czech Republic". (TSČR Czech District Heating Association, Czech Republic)



Embedding STRATEGO lessons into long-term capacity building programmes for local authorities



"During the STRATEGO project, the Scottish Government launched a District Heating Strategy Support Programme, aiming to support all local authorities in Scotland to develop and publish district heating strategies, making use of data from the Scotland Heat Map. The STRATEGO project activities were able to complement this work and the learning from STRATEGO has been embedded into this programme of support going forward." (Scottish Government, UK)

CHAPTER 3

Collaboration between learning local authorities

"The City of Antwerp learned from their Swedish colleagues about the integration of petrochemical recoverable heat in a district heating system, priority rules for the different kinds of heat sources, communication with DH customers and balancing of multi-source DH. Thanks to the internal contact between the STRATEGO partners, a representative of the Council of Falkirk, UK, was invited to this coaching session as well. Falkirk, just like Antwerp, has the ambition to valorise the excess heat of the petrochemical industry in the port and faces similar challenges." (VITO, Belgium)

International transfer of knowledge on future heat sources

"During the coaching sessions in the framework of STRATEGO, Austrian representatives were particularly interested in large-scale integration of recoverable heat from data centres into the district heating network. The case of Stockholm showed that it is already a well-working, economically-feasible system which represents a huge potential in terms of energy savings. In September 2015, Vienna City Council determined the new RTI-Strategy "Innovative Vienna 2020". In connection to the developments within the STRATEGO project, the following action field was added in the work programme 2016: "Check settlement of data centres and the use of waste heat for city districts"." (AIT, Austria)

Inspiring cities with novel business models

"Representatives of the five STRATEGO target cities in Croatia have expressed their interest in the STRATEGO results, especially related to the business models and the developed maps. The representatives of the City of Karlovac have expressed special interest in the possibility of refurbishing and utilising an old fuel oil storage tank as a heat storage tank to increase the flexibility of their system and achieve energy savings. The City of Velika Gorica is also very interested in the possibility of realising a demonstrated business model, specifically the urban renovation of a city neighbourhood integrating building and system renovation. Both cities are actively looking for possibilities to fund these projects." (University of Zagreb, Croatia)

Image source: Gradsko stambeno gospodarstvo Velika Gorica d.o.o.

Highlighting opportunities using mapping of renewable heat potential

"The biggest success of STRATEGO is the inclusion of the option "Renewable District Heating" for the new area "Am Weiher" into the project plans and its serious consideration. Thanks to STRATEGO, the city has its heating demand mapped (and updated) and the municipal planners educated in urban development deepening their knowledge of renewable district heating. The mapping of the heating and cooling demand and the collaboration with the local supplier at an early stage of the project development contributed to the increased municipal planners' understanding of alternative supply solutions." (AGFW, Germany)

Supporting project development with existing case studies

"In the framework of STRATEGO, representatives of Regione Lombardia, Milano Municipality and A2A Calore & Servizi Srl attended a coaching session with the City of Rotterdam (the Netherlands). This coaching path allowed Regione Lombardia and Milano Municipality to discover a real case of heat distribution from production sites to utilisation areas, by means of a long distance network. Also, the coaching allowed to better understand the key conditions to start and develop such a project." (A2A, Italy)

Changing experiences based on the lessons learned

"All participants of the coaching appreciated the possibility to share experiences among cities and discuss concrete projects. The two proposed projects for Alba Iulia refer to thermal refurbishment of multi-storey residential buildings. Projects proposed for Tulcea consist in the refurbishment of the distribution network and the replacement of the existing old and oversized heat-only boilers. The specific objectives of the two projects are related to the reduction of energy consumption and pollutant emissions by energy production." (TRACTEBEL Engineering, Romania)

CHAPTER 3

EPILOGUE

STRATEGO: The End is Only the Beginning

It is now more or less three years since I arrived at Euroheat & Power. One of my first memories of this job is of a meeting with the European Commission to finalise the agreement for the STRATEGO project. Even then, I was already excited by the initiative, proud that our organisation would play a leading role, and appreciative of the Commission's support, both for the project itself and for the broader theme of sustainable heating and cooling policy and practice. As STRATEGO has developed over the months and years since that day, my enthusiasm has only grown.

Until very recently, the credibility of the EU's vision for the transition to a sustainable energy model was seriously undermined by the near total absence of a plan for the decarbonisation of the heating and cooling sector. Today, while an enormous amount of work remains to be done, we see in the first ever EU Heating and Cooling Strategy the outline of a vision for how this enormous piece of the sustainable energy challenge can be addressed. And while the European Commission's emerging thinking in this area has of course been shaped by many different voices and actors, the STRATEGO project can justifiably claim to have made a highly significant contribution to this common effort. Ideas, lessons and data developed over the course of the project can be found throughout the Heating and Cooling Strategy, and the text is undoubtedly richer for their presence. Just as importantly, as described in this report, STRATEGO has also helped point the way towards sustainable solutions at local level in cities and communities all over the European Union. In short, this project has made a real difference and somehow that's the only KPI that really matters.

Both personally and on behalf of Euroheat & Power, I would like to offer a warm word of thanks to the many partners, both individuals and organisations, whose combined efforts have made these successes possible. Such an ambitious and wide-ranging project inevitably brings challenges,

and these were invariably met with a spirit of commitment, dedication and a strong sense of purpose. We are of course also enormously grateful to the European Commission for its support, both in getting STRATEGO off the ground and throughout the lifetime of the project.

I'm sure that I speak for the whole of the consortium when I express the humble hope that the end of STRATEGO is only the beginning of a wider movement. We are delighted to see and to be involved in other projects which will be able to build on these foundations in order to go further, do better, learn more and deliver the sustainable energy future Europe and its citizens require.

We are very much looking forward to the challenge. I hope you'll join us!

Paul Voss
Managing Director,
Euroheat & Power

References

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- Creating National Energy Models for 2010 and 2050
- Creating Hourly Profiles to Model both Demand and Supply
- Quantifying the Cost of Heat Savings in EU Member States
- Quantifying the Heating and Cooling Demand in Europe
- Mapping the Heating and Cooling Demand in Europe
- Quantifying the Potential for District Heating and Cooling in EU Member States
- Quantifying the Excess Heat Available for District Heating in Europe
- Estimating the Renewable Energy Resources Available in EU Member States
- Mapping the Renewable Heat Resources in Europe

2) Work Package 2 Main Report "Enhanced Heating and Cooling Plans to Quantify the Impact of Increased Energy Efficiency in EU Member State"

3) 5 Country Summary Reports:
- Czech Republic
- Croatia
- Italy
- Romania
- United Kingdom

4) Guideline "Local action: Methodologies and data sources for mapping local heating and cooling demand and supply"

5) Work Package 3 Summary Report "National plan – local action: supporting local authorities"

6) Work Package 4 Guidelines "International coaching to support local delivery of heating and cooling plans"

7) Work Package 4 Report "Lessons for creating productive dialogue between local and national authorities"

8) STRATEGO brochure on "Good practice examples"

All sources are available on the project website: http://stratego-project.eu.

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