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ENHANCED HEATING & COOLING PLANS

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

STRATEGO

Multi-level actions for enhanced Heating & Cooling plans

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Content

- STRATEGO
- Methodology
- Results
- Cooling

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- IEE project
  - 15 partners from 12 EU countries

- Main goals:
  - Capacity building of local government and DH players
  - Mapping of heating and cooling demand
  - Assistance in the creation of NHCPs

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- Belgium
- Denmark
- Italy
- Czech Republic
- Germany
- Austria
- UK
- Spain
- Sweden
- Poland
- Romania
- Croatia

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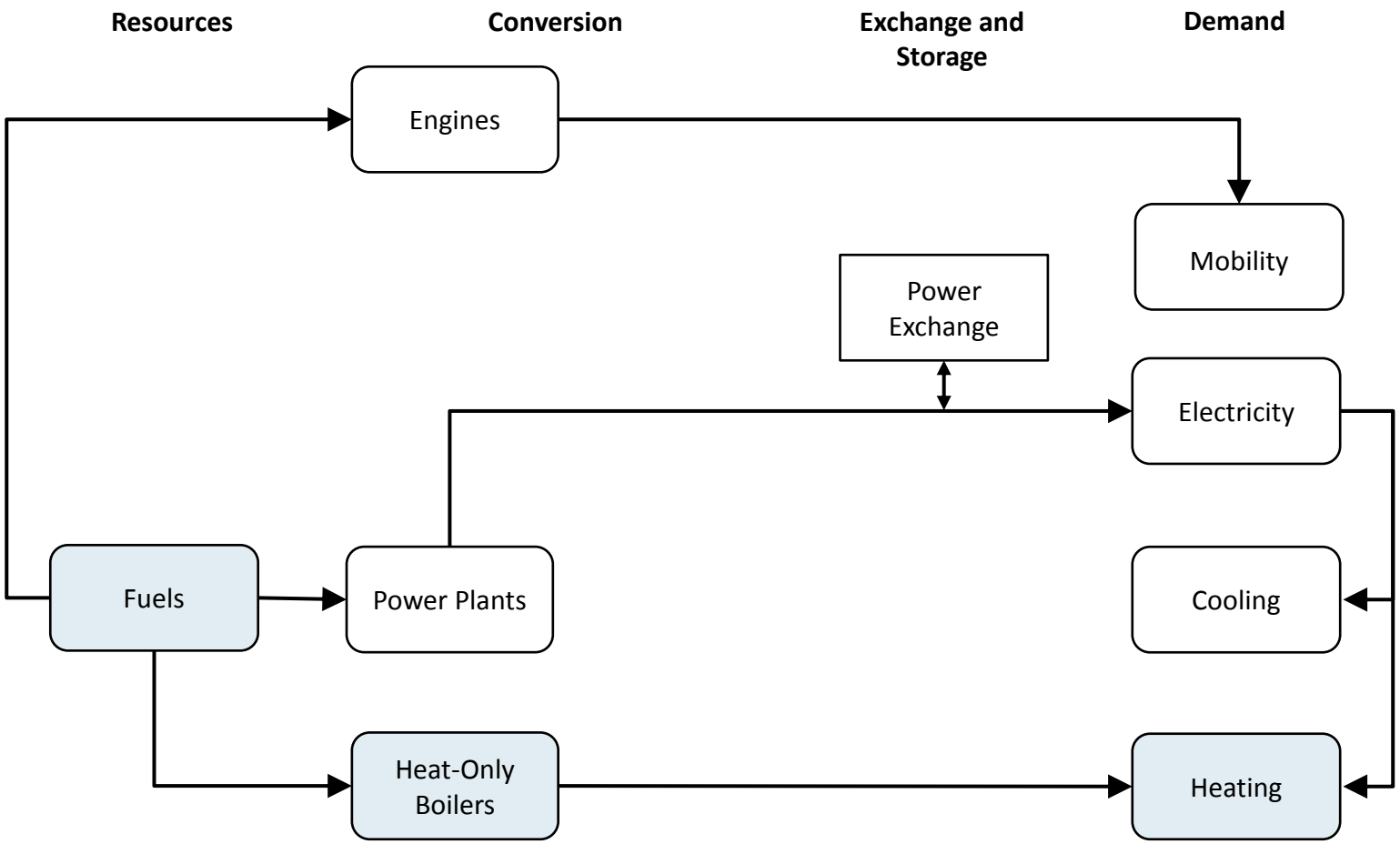
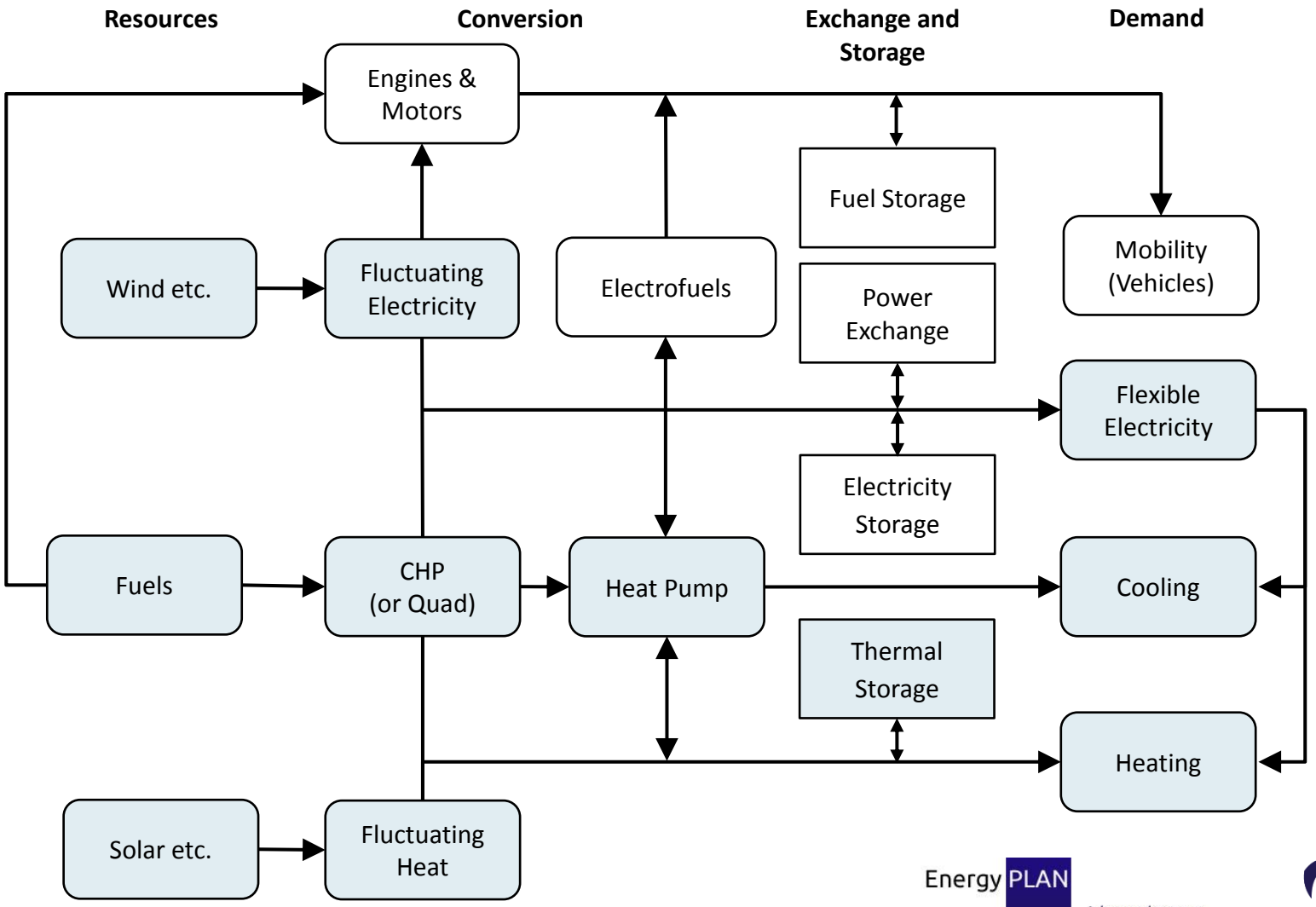
METHODOLOGY

Today's Energy System



The New Heat Sector



Energy PLAN
Advanced energy system analysis computer model

AALBORG UNIVERSITY
DENMARK

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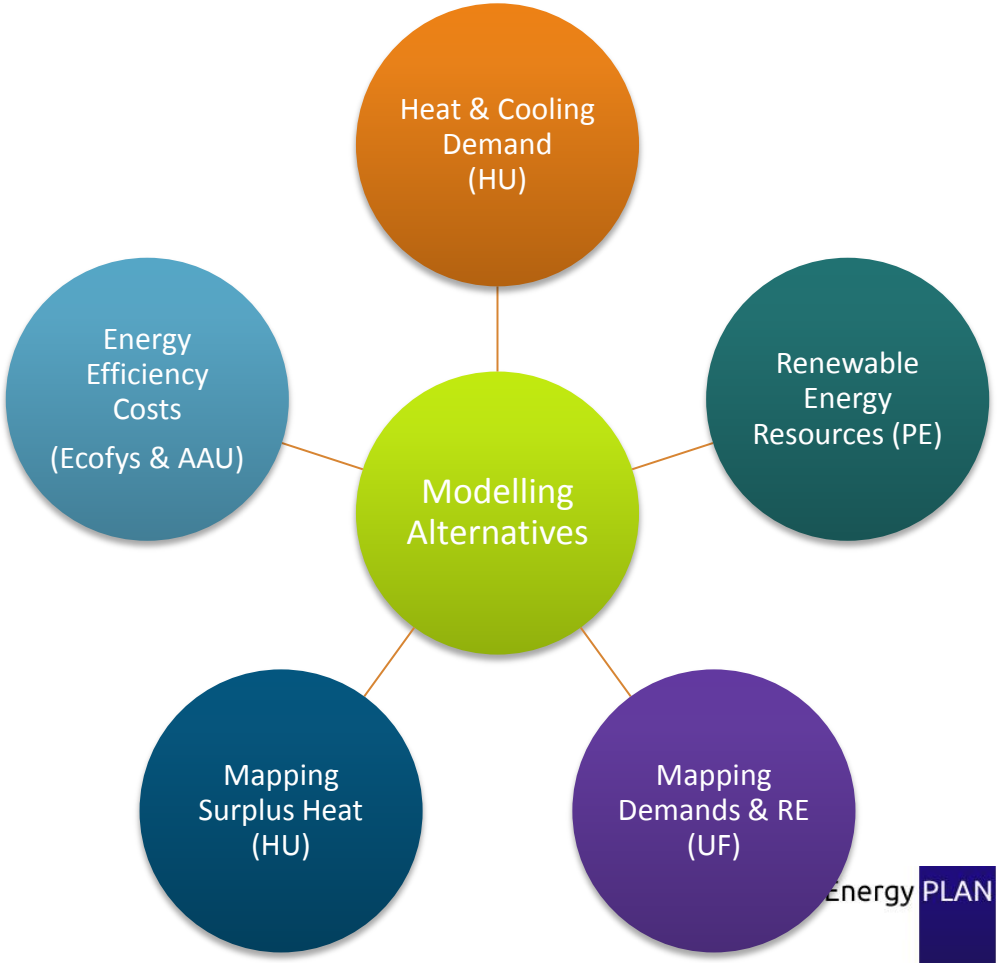
STRATEGO Methodology



Energy PLAN
Advanced energy system analysis computer model

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Nine Background Reports

1. Creating National Energy Models for 2010 and 2050
2. Creating Hourly Profiles to Model both Demand and Supply
3. Quantifying the Cost of Heat Savings in EU Member States
4. Quantifying the Heating and Cooling Demand in Europe
5. Mapping the Heating and Cooling Demand in Europe
6. Quantifying the Potential for District Heating and Cooling in EU Member States
7. Quantifying the Excess Heat Available for District Heating in Europe
8. Estimating the Renewable Energy Resources Available in EU Member States
9. Mapping the Renewable Heat Resources in Europe

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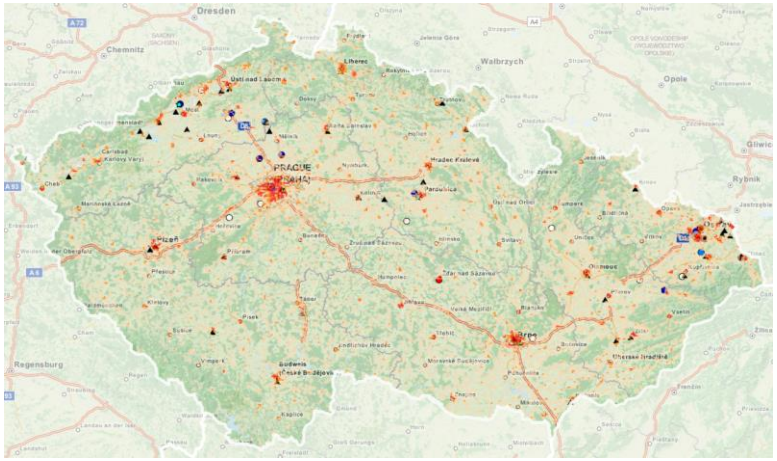
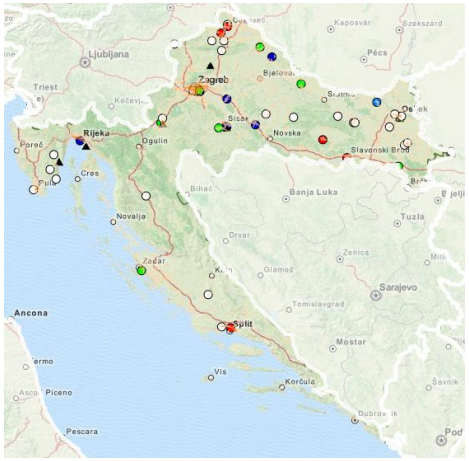
http://maps.heatroadmap.eu/



Czech Republic



Croatia

Heat Demand Classes

1 km2 densities of calculated heat demand.

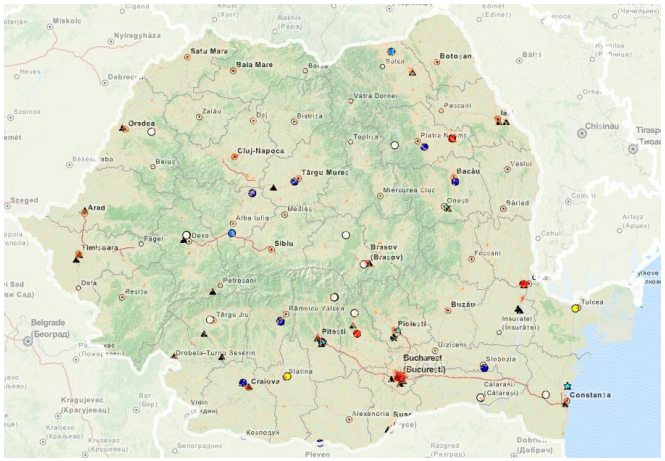
- < 30 TJ/km2
- 30 - 100 TJ/km2
- 100 - 300 TJ/km2
- > 300 TJ/km2

Excess heat facilities

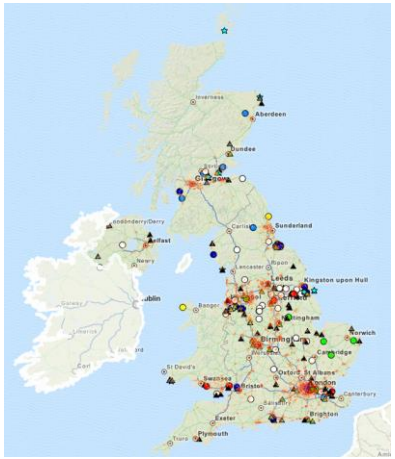
Annual excess heat volumes stated refers to maximal potential, not necessarily reflecting practically recoverable volumes.

- Chemical and petrochemical
- Food and beverage
- Iron and steel
- Non-ferrous metals
- Non-metallic minerals
- Paper, pulp and printing
- Fuel supply and refineries
- Thermal Power Generation - Waste-to-Energy
- Thermal Power Generation - Autoproducer
- Thermal Power Generation - Main activity

Italy

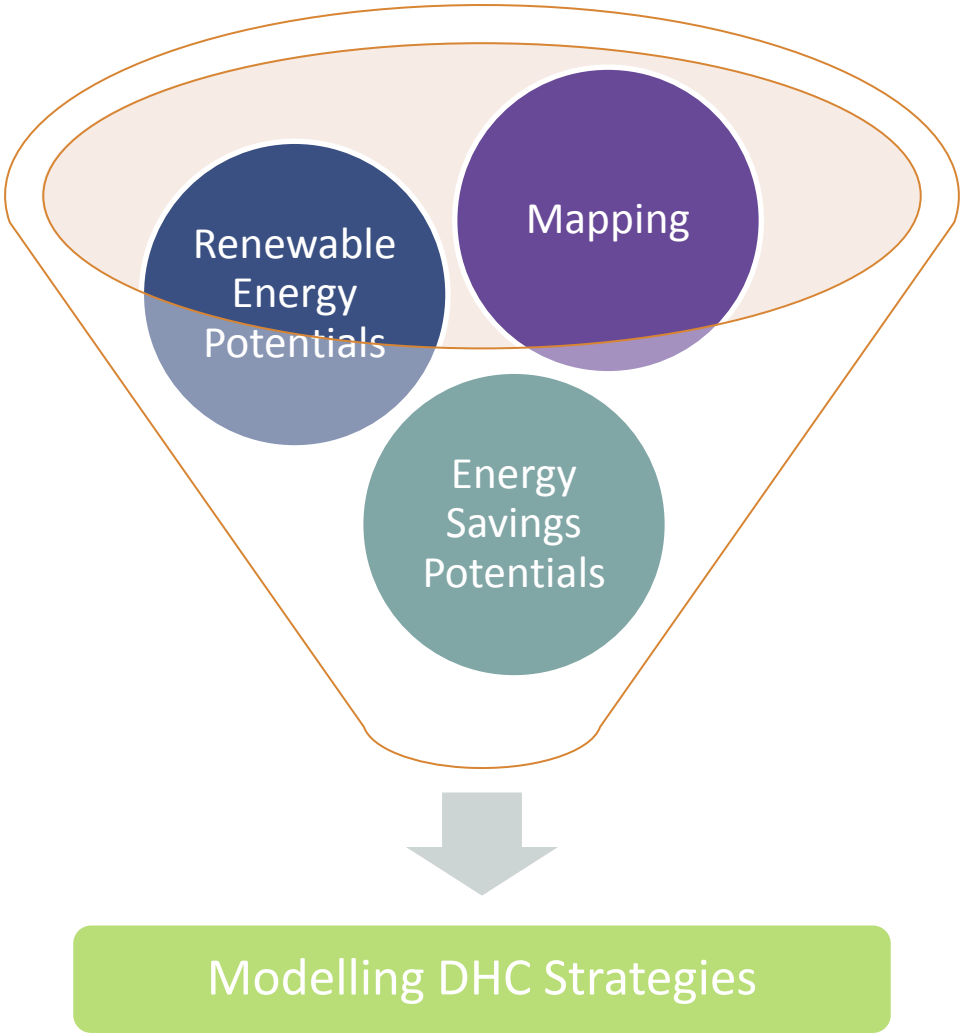


Romania



United Kingdom

Combine Inputs in Modelling



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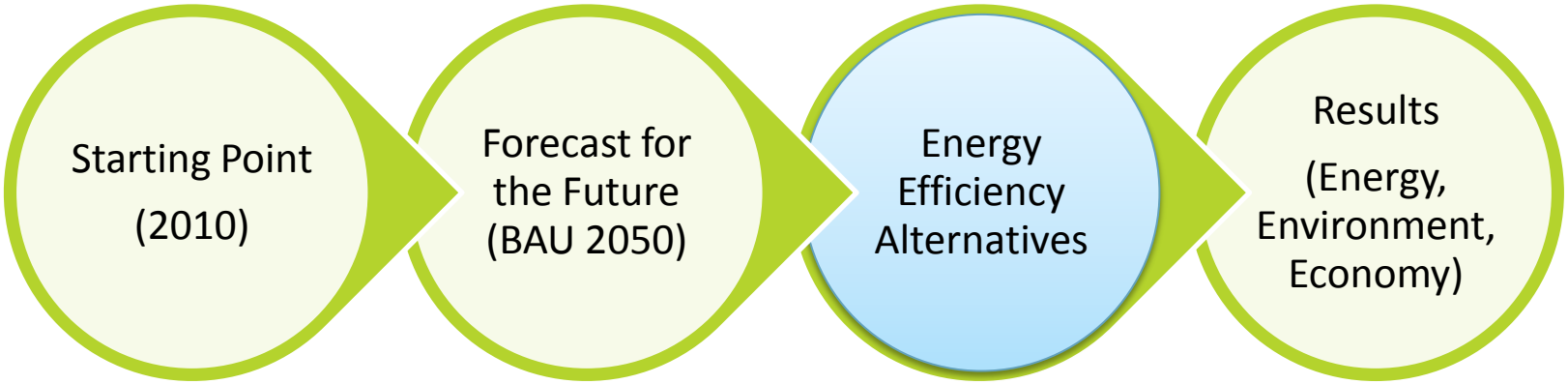
Modelling Steps



- Extra Heat Savings
- Extra District Heating
- Different Individual Heating Options

Modelling Steps for Each Country in STRATEGO (i.e. Alternatives in STRATEGO)

Step	Technologies
0a. 2010	2010 historical model (Calibration)
0b. BAU 2050	2050 business-as-usual scenario based on the latest European Commission forecasts
1: Heat savings	ADD: Heat savings
2: Heat networks	COMPARE: Gas and water (i.e. district heating) networks
3: Individual heating	COMPARE: Oil boilers, Biomass boilers, heat pumps, electric heating
4: Renewable Heat	ADD: Geothermal, waste incineration, excess industrial heat, large-scale solar thermal
5: Renewable Electricity	ADD: Large heat pumps, electric boilers
6. Heat Roadmap	OPTIMISE: Synergies in the new efficient heat sector
7. Cooling	COMPARE: Individual and District Cooling for the services sector in urban areas

Different Tools and Methodologies in this Study

Tools

Name	Purpose	Output	Reports
EnergyPLAN	To simulate the electricity, heating, cooling, transport sectors on an hourly basis	Energy, economic, and environmental impact of different energy scenarios	This Report, BR1, BR2
PETA (Pan-European Thermal Atlas) – ArcGIS + ArcMap (GIS Mapping)	To create maps with the location and scale of heat demand, cooling demand, excess heat, and renewable heat	Technical and economic potential of district heating and district cooling networks. Quantify the heat available for district heating and cooling from thermal power plants, industry, waste incineration, geothermal, and solar thermal heat	BR5, BR6, BR7, BR9
BEAM	To simulate how the building stock will evolve over time based on different energy efficiency targets and different changes to the building stock (e.g. demolition, renovations, etc.)	Heating demand, cooling demand, and investment cost for different levels of heat savings	BR3
Meteonorm	Meteorological data necessary for developing hourly renewable energy distributions (e.g. wind, solar, etc.)	Meteorological data	BR2
MATSim	Agent based modelling to create a distribution for energy consumption in transportation	Hourly energy consumption data for transportation in Croatia also applied in other STRATEGO countries	BR2

Methodologies

Name	Purpose	Primary Tool(s) Considered	Reports
Creating National Energy Models Based on Historical Data	Converting energy statistics into a suitable format for the EnergyPLAN tool	Inputs for EnergyPLAN	BR1
Creating National Energy Models Based on Future Projections of the Energy System	Converting energy statistics from a future projection of the energy system into a suitable format for the EnergyPLAN tool	Outputs from the software used by the European Commission [25], PRIMES, and Inputs for EnergyPLAN	BR1
Creating Hourly Distribution Data	Creating an hourly profile for electricity, heating, cooling, and transport demands, as well as wind, wave, and solar production.	Inputs for EnergyPLAN	BR2
Designing the scenarios to quantify the impact of a high-efficiency heating and cooling sector	The inputs from all of the Background Reports are combined to design new scenarios in EnergyPLAN for the heating and cooling sectors. For example, what resources are available and how much of each solution can be implemented.	Inputs for EnergyPLAN	Main Report
Quantifying the impact of increased energy efficiency in the heating and cooling sectors	Simulating various renewable energy scenarios and quantifying the impact of different measures/technologies.	Outputs from EnergyPLAN	Main Report
Quantifying the Current Heating Demand in Europe	Estimating the existing heat demand in Europe based on historical data	Input for the GIS Mapping	BR4
Quantifying the Future Heating Demand in Europe	Calculating how the heating and cooling demand will evolve in the residential and services building stock	Output from the BEAM tool and Inputs for the EnergyPLAN tool	BR3
Quantifying the Current and Potential Future Cooling Demand in Europe	Calculating the existing cooling demand in buildings based on historical data and estimating the maximum cooling demand in the future if all buildings are cooled to a comfortable level	Input for the GIS Mapping	BR4
Mapping the Heat Demand in Europe	To identify the technical and economic potential of developing district heating networks	Output from the GIS Mapping and Input for the EnergyPLAN Tool	BR5
Mapping the Cooling Demand in Europe	To identify the technical and economic potential of developing district cooling networks	Output from the GIS Mapping and Input for the EnergyPLAN Tool	BR5
Calculating the Excess Heat available to Supply District Heating in Europe	Locating and quantifying the potential heat available from thermal power plants, industrial excess heat, and existing waste incineration plants in Europe	Inputs for the GIS Mapping and EnergyPLAN tool	BR7
Quantifying the renewable energy resources available	Review of existing studies to identify the renewable energy resources available in each country	Inputs for the GIS Mapping and EnergyPLAN tool	BR8
Mapping the Renewable Energy Resources	Locating and quantifying the amount of solar, geothermal, biomass, and heat for large-scale heat pumps available for district heating systems in Europe	Output from the GIS Mapping and Inputs for the EnergyPLAN tool	BR9

- 5 Tools:
  - EnergyPLAN
  - PETA
  - BEAM
  - Meteonorm
  - MATSim
- 13 Methodologies
  - (See Table 16 of the Main Report)

Mapping – Methodology for Croatia

- Geoportal – location and area of buildings
- Height (number of floors)
- Average energy consumption per type of building

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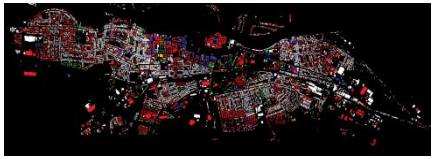
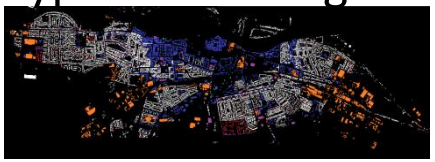
Matrix (1.36X1.36m)

No. of floors

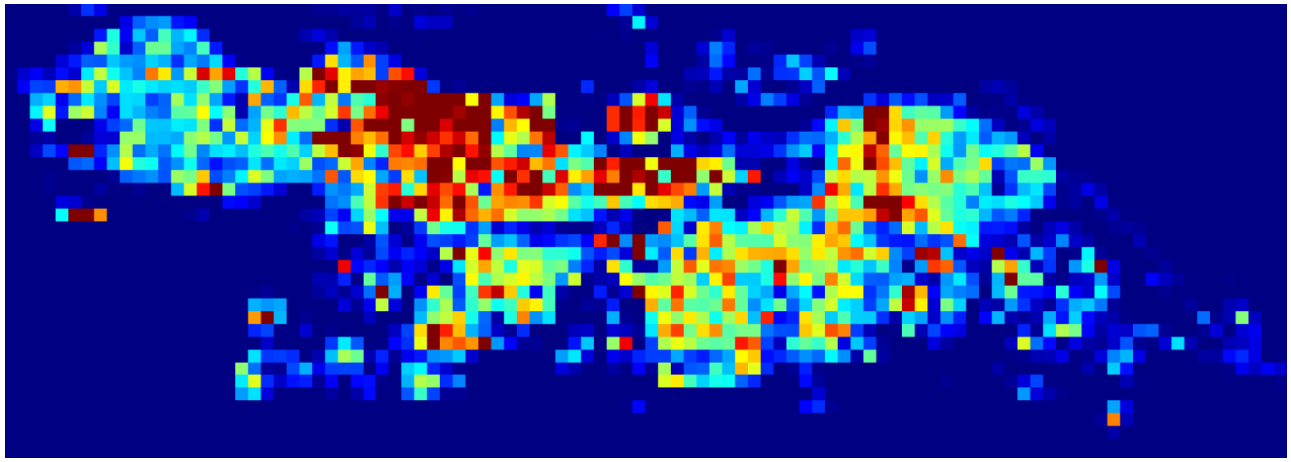


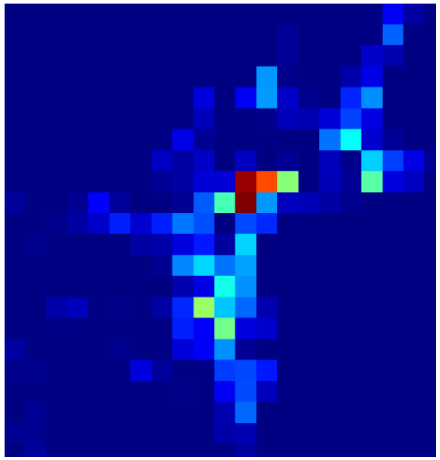
Type of buildings

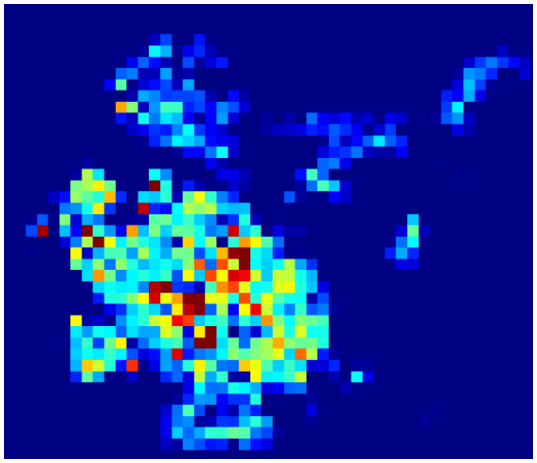


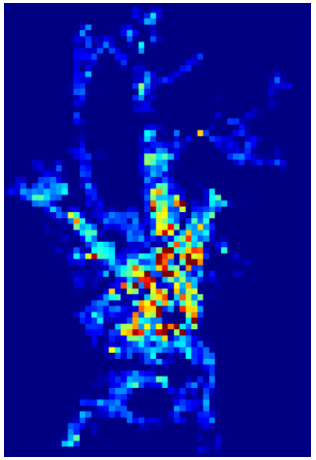
Heat map of Osijek

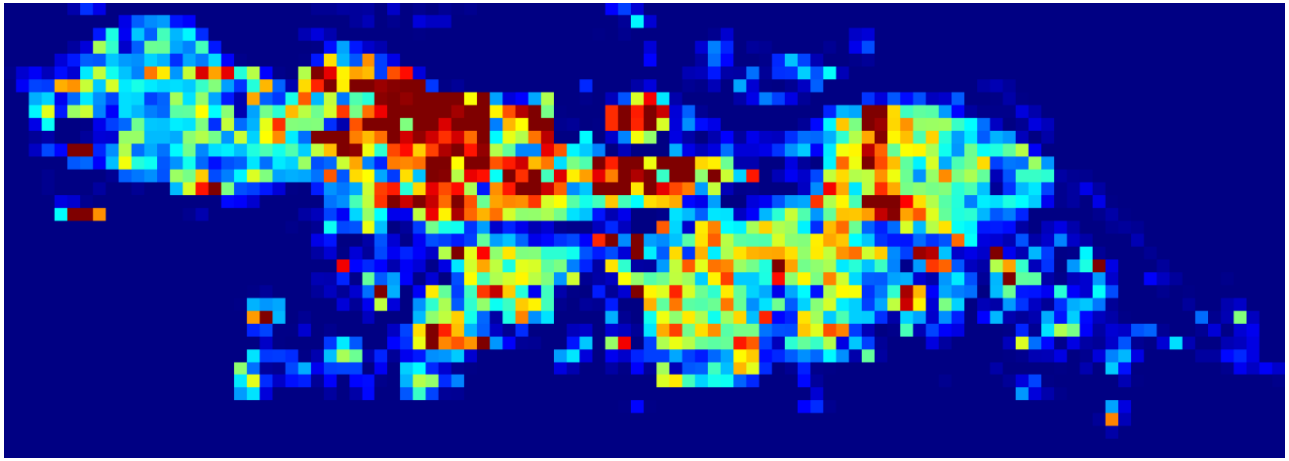
100X100m











RESULTS

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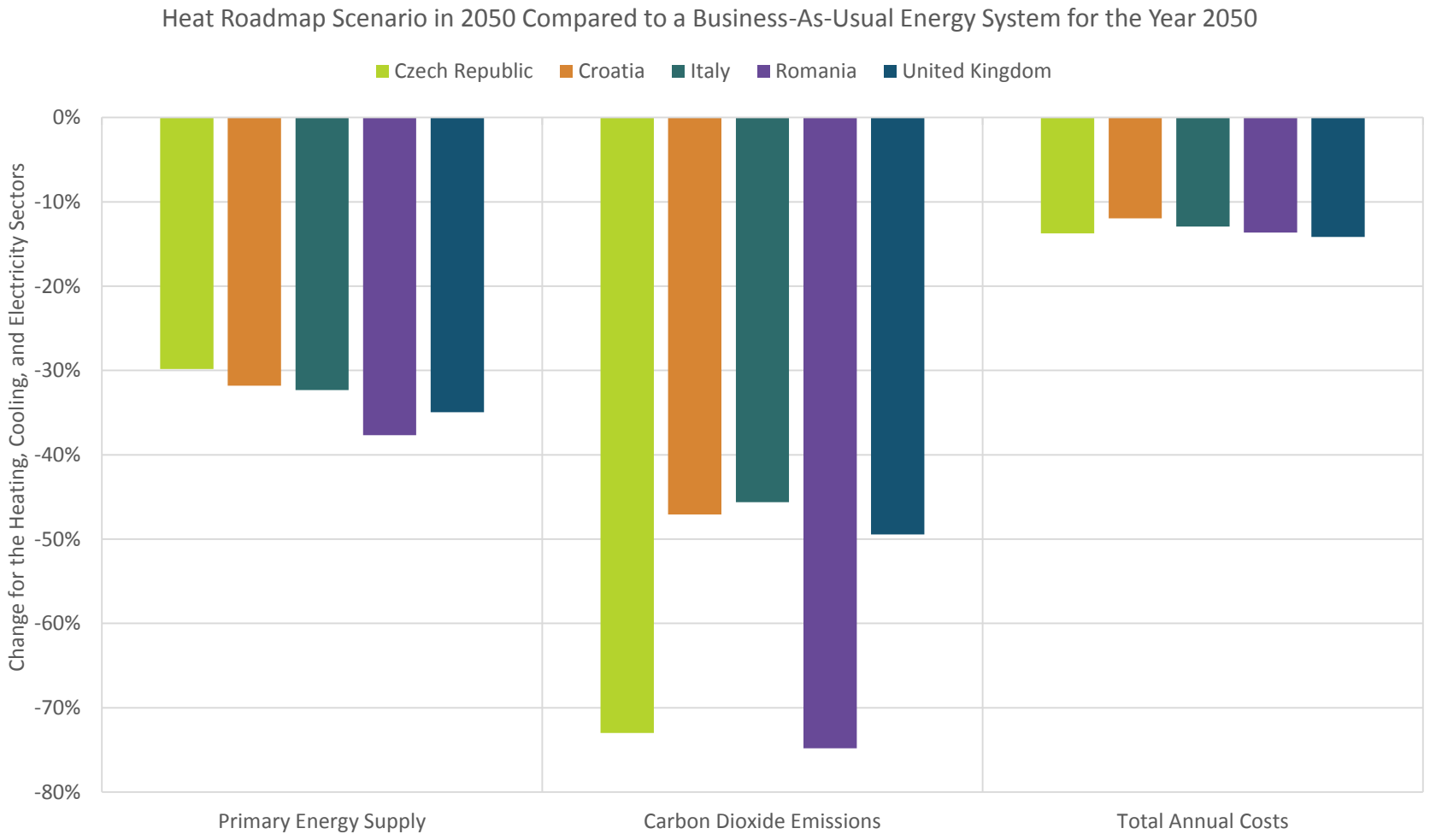
Final Levels of Each Energy Efficiency Measure in the Low-Carbon Heating and Cooling Strategies

Heat Roadmaps	Heat Savings	District Heating	Individual Heating Technology	District Heat Supply form 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.	60%
Croatia	40%	40% (15%)		45%
Italy	30%	60% (<5%)		35%
Romania	50%	40% (20%)		45%
United Kingdom	40%	70% (<5%)		40%

*Doesn't include excess heat from thermal power plants.

Change in HR Scenarios



Changes for Heating, Cooling, and Electricity

Heating, Cooling and Electricity Sectors Only	Energy		Environment		Economy	
Heat Roadmap vs. BAU 2050	Change in Primary Energy Supply		Change in Carbon Dioxide		Change in Energy System Costs (excludes vehicle costs)	
Unit	TWh/year	%	Mt/year	%	Billion €/year	%
Czech Republic	-109	-30%	-35	-73%	-3	-14%
Croatia	-18	-32%	-5	-47%	-1	-12%
Italy	-380	-32%	-101	-46%	-13	-13%
Romania	-118	-38%	-36	-75%	-3	-14%
United Kingdom	-444	-35%	-109	-49%	-15	-14%
All Five Countries	**-1069**	**-34%**	**-286**	**-52%**	**-35**	**-14%**

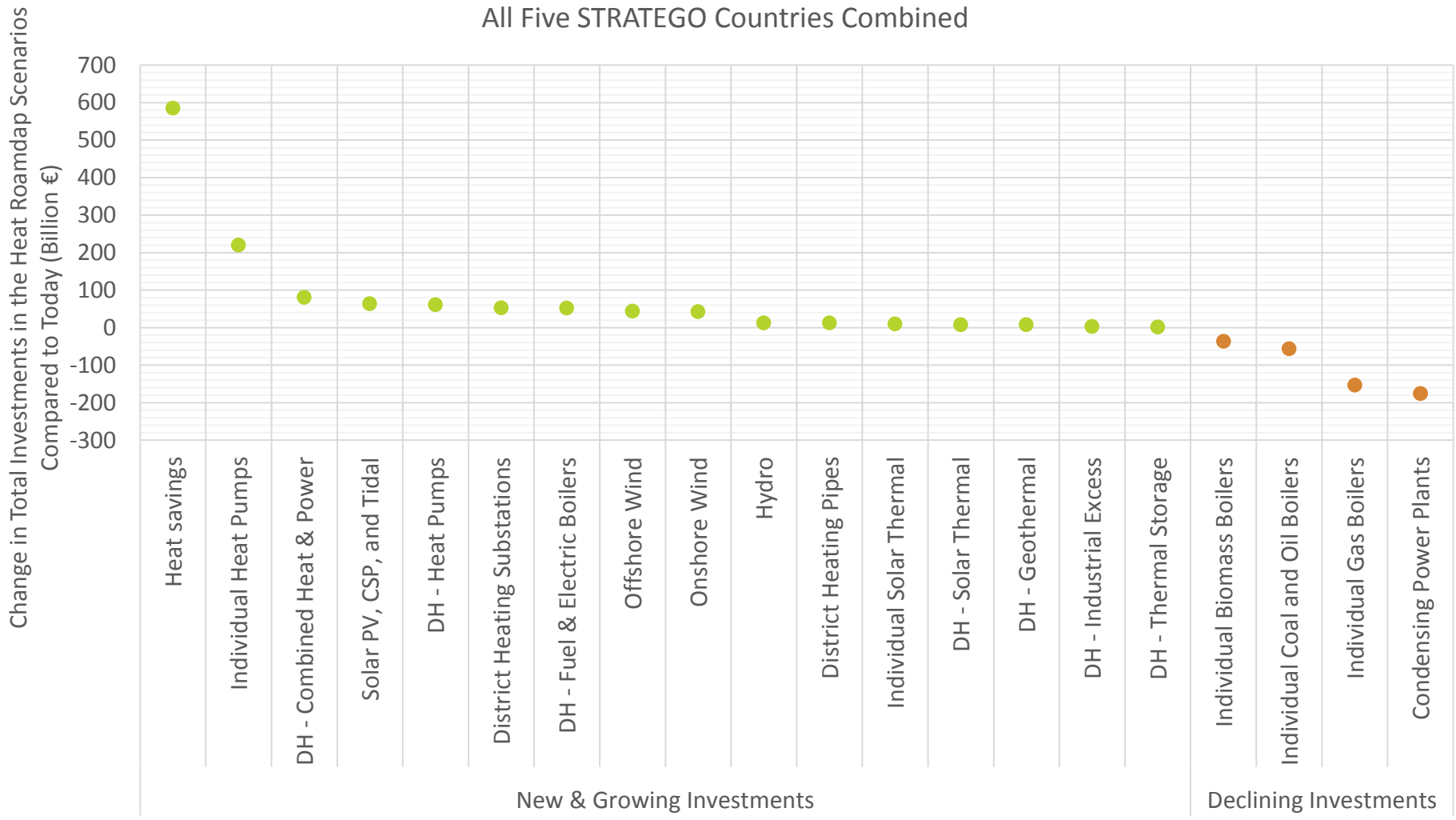
Contextualising the Changes

In total, the energy demand is reduced by ~1000 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 almost 300 Mt/year is more than all of the carbon dioxide emissions emitted from the Czech Republic, Croatia, and Romania today (which is ~225 Mt/year).

Main Results for WP2

Total Investments vs. Today



Key Messages: Heating

- Heat savings should begin today and be strongly supported to the point where their total heat demand is reduced to 60-90 kWh/m2
  - In existing buildings while they are undergoing other refurbishments and in new buildings,
- Share of district heating can be expanded significantly in all countries
  - Urban Areas
- Electric heat pumps are the most sustainable option for individual heating
  - Rural Areas
- In all the countries there are large amounts of renewable and excess heat available, but there is a limited supply of renewable electricity, while there is likely to be a shortfall of biomass if the aim is to decarbonise the entire energy system.
- The results are extremely sensitive to cost assumptions, but the conclusions are very robust

Key Recommendations for the Heat Sector

Everywhere

- Heat Savings
- Balance Savings vs. Supply
- 30-50% Total Reduction

Urban Areas

- District Heating Networks
- High Heat Density Areas
- Supply 40-70% of the Heat Demand

Rural Areas

- Primarily Electric Heat Pumps
- Smaller Shares of Solar Thermal & Biomass Boilers
- Remaining 30-60% of the Heat Demand

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Adding Cooling to the Heat Roadmaps

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

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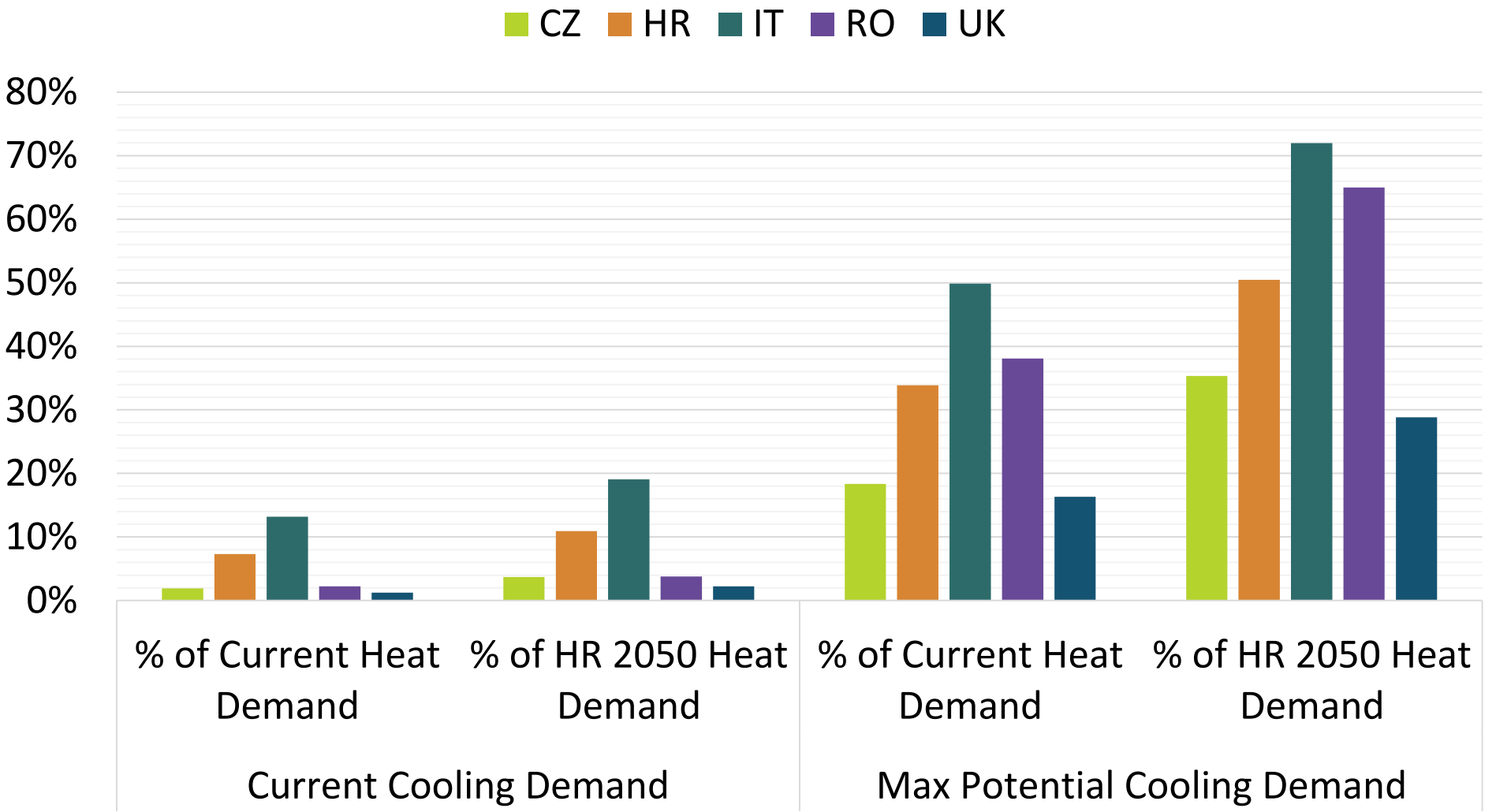
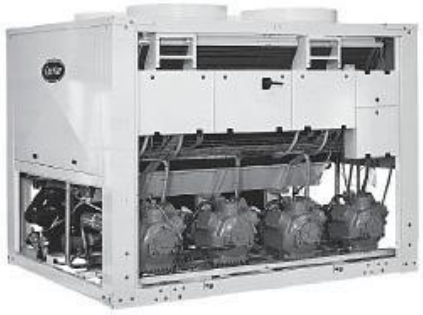
Cooling Demand is Much Lower

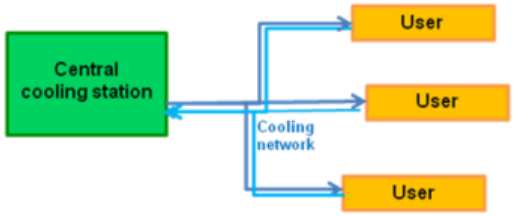


Cooling Options: Assume 35% Cooling Converted from Individual to District Cooling

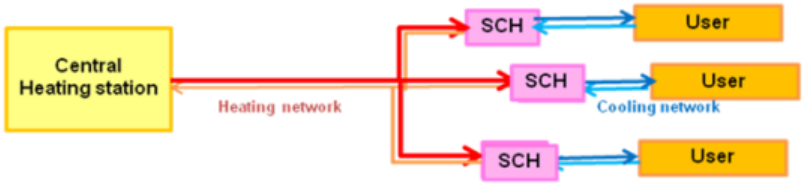
Individual Cooling: IEE RESCURE Project
('Roof-Top' Chillers)



Conventional District Cooling
(Using Cold Pipes)



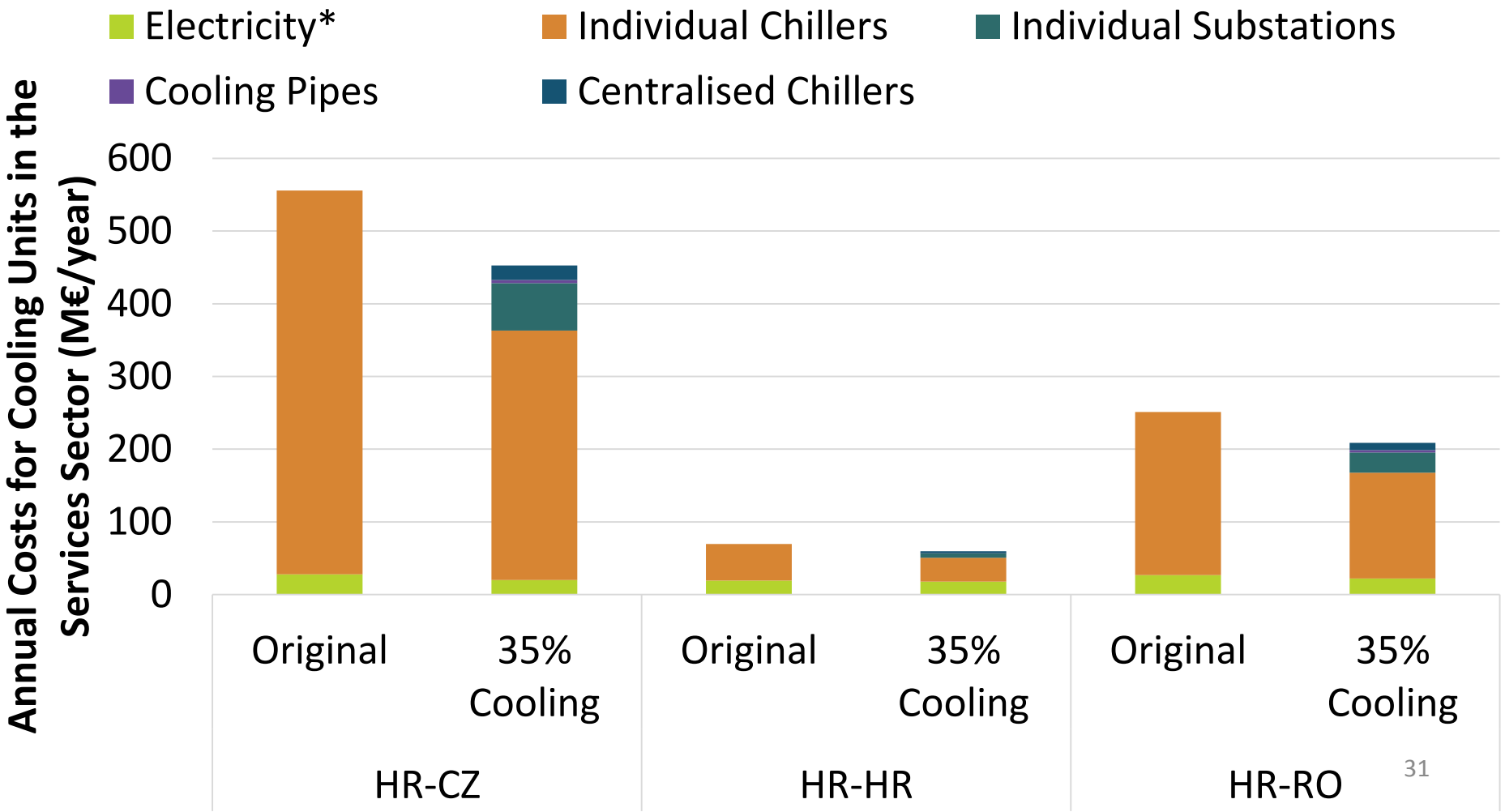
Hybrid District Cooling
(Using Warm and Cold Pipes)
Could also be Sorption DC, using warm pipes only



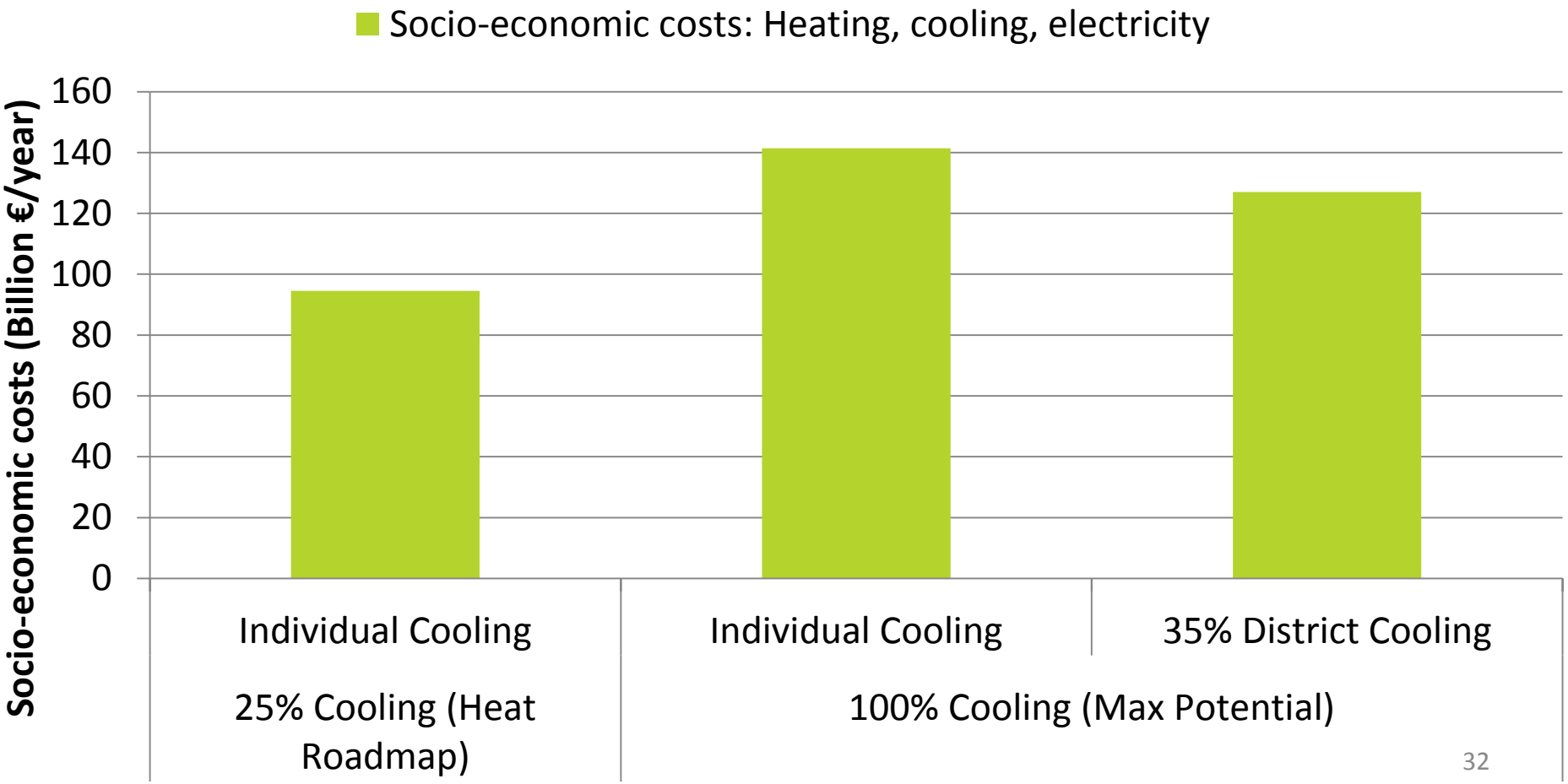
35% District Cooling for Services with Today's Level of Cooling: Very small impact on national energy system

Country	Energy		Environment		Economy	
	Primary energy		Carbon Dioxide		Energy System Costs	
	Total (TWh/year)	Change (%)	Total (Mt)	Change (%)	Total (B€/year)	Change (%)
CZ	39	-0.2%	16	-0.4%	5	0.1%
HR	250	-0.1%	5	-0.4%	17	-1.0%
IT	771	-3.1%	119	-2.1%	94	-0.2%
RO	196	-0.1%	12	-0.7%	20	-0.4%
UK	825	-0.1%	111	-0.2%	90	-1.0%

However, there is an impact on the cooling sector, so it is likely to affect the local level



If we cool the buildings in Europe to the level they 'ideally' require, then 35% district cooling has an impact on the national energy system



Cooling: Key Messages

- Today, the cooling demand is too small to have a major influence at national level
- However, implementing district cooling is likely to have a positive impact at the local level
- If buildings meet their cooling needs in the future, then the cooling sector will start influencing the national energy system
- More research is required to identify an optimal level of district cooling: mapping and local modelling is most urgent in the short term

Different Tools and Methodologies in this Study

Tools

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Quantifying the Current Heating Demand in Europe	Estimating the existing heat demand in Europe based on historical data	Input for the GIS Mapping	BR4
Quantifying the Future Heating Demand in Europe	Calculating how the heating and cooling demand will evolve in the residential and services building stock	Output from the BEAM tool and Inputs for the EnergyPLAN tool	BR3
Quantifying the Current and Potential Future Cooling Demand in Europe	Calculating the existing cooling demand in buildings based on historical data and estimating the maximum cooling demand in the future if all buildings are cooled to a comfortable level	Input for the GIS Mapping	BR4
Mapping the Heat Demand in Europe	To identify the technical and economic potential of developing district heating networks	Output from the GIS Mapping and Input for the EnergyPLAN Tool	BR5
Mapping the Cooling Demand in Europe	To identify the technical and economic potential of developing district cooling networks	Output from the GIS Mapping and Input for the EnergyPLAN Tool	BR5
Calculating the Excess Heat available to Supply District Heating in Europe	Locating and quantifying the potential heat available from thermal power plants, industrial excess heat, and existing waste incineration plants in Europe	Inputs for the GIS Mapping and EnergyPLAN tool	BR7
Quantifying the renewable energy resources available	Review of existing studies to identify the renewable energy resources available in each country	Inputs for the GIS Mapping and EnergyPLAN tool	BR8
Mapping the Renewable Energy Resources	Locating and quantifying the amount of solar, geothermal, biomass, and heat for large-scale heat pumps available for district heating systems in Europe	Output from the GIS Mapping and Inputs for the EnergyPLAN tool	BR9

- 5 Tools:
  - EnergyPLAN
  - PETA
  - BEAM
  - Meteonorm
  - MATSim
- 13 Methodologies
  - (See Table 16 of the Main Report)

STRATEGO WP2: Aim and Conclusion

- *AIM:*

  The overall aim in STRATEGO WP2 is 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 Czech Republic, Croatia, Italy, Romania, and the United Kingdom.

- *CONCLUSION:*

  The overall conclusion is that a combination of energy efficiency measures, in the form of heat savings, district heating in the urban areas, and heat pumps 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.

Recommendations

- 20 Recommendations in the Main Report, divided by:
  - Heat Savings
  - Heat Networks in Urban Areas
  - Individual Heating in Rural Areas
  - Cooling
  - Resources
  - Methodology and Tools

Financial support from the European Union's Intelligent Energy Europe project STRATEGO (grant agreement EE/13/650) is gratefully acknowledged.

Thank you for your attention!

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