Heat demand and supply mapping for energy planning of future district heating systems: Case study for the city of Velika Gorica

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Introduction

- DH is widespread throughout Eastern Europe, but in transition countries face difficulties: inefficient heat production and high distribution losses, costs that exceed revenue and declining sales
- It used to be supplying high share of DH to industry
- High share of residential heating due to industry colapse
- High residential heat to hot water ratio – high winter/summer variability, usually no heat storage
- Usually subsidized or cross-subsidized, no incentive to increase efficiency
- Usually not metered but billed per m2, or metered per building and billed per m2
- Zagreb: heat storage 750 MWh, 150 MW, to avoid peak boilers, also 60 MW electric boilers under consideration

Velika Gorica

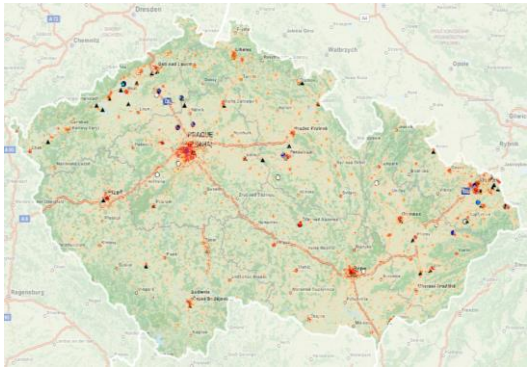
- 6th biggest city in Croatia
- Population: 63,517
- Area: 328.65 km^2

- District heating system:
  - 13 local boiler plants
  - 3 connected into one system
  - 2/3 natural gas, rest fuel oil

GIS Heat mapping

http://www.stratego-project.eu/

http://maps.heatroadmap.eu/



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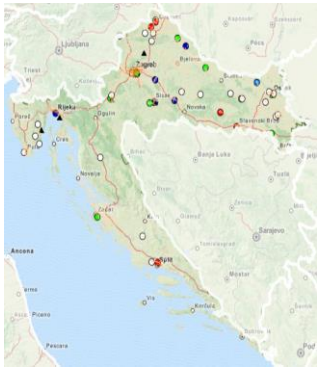
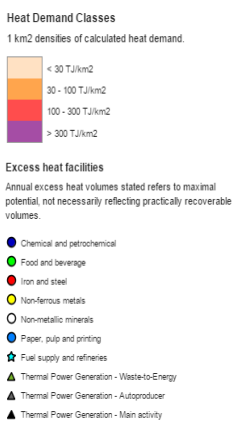
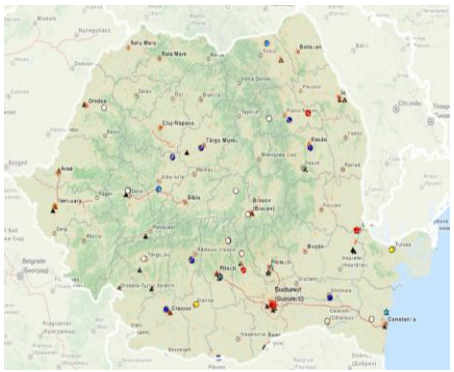


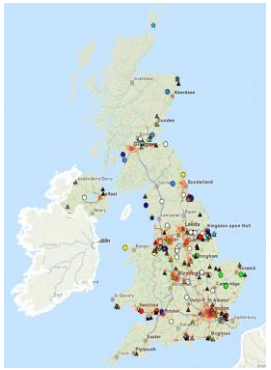
Croatia



Italy

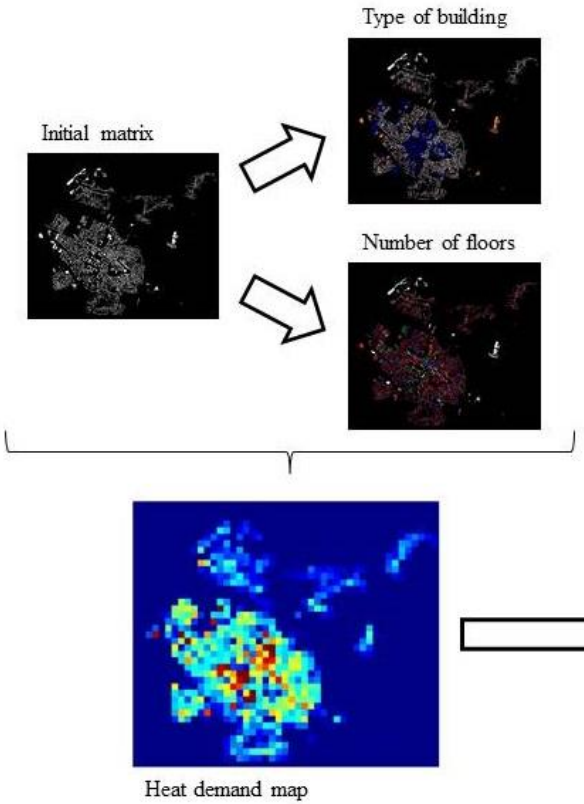


Romania



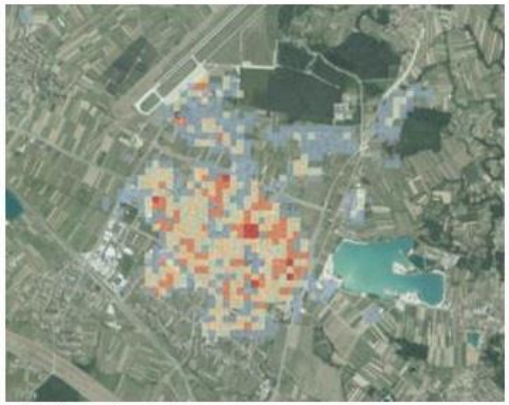
United Kingdom

GIS Heat mapping - Velika Gorica



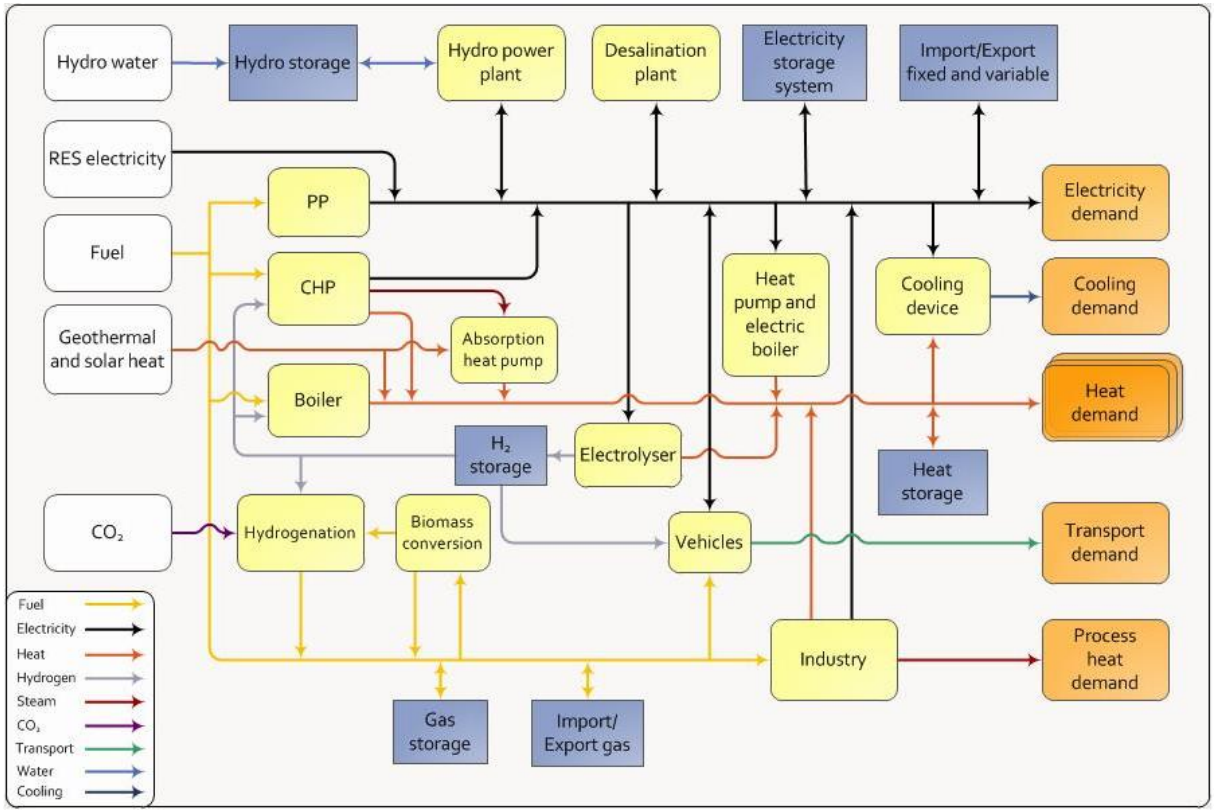
Heat demand mapping

- GEOPORTAL – location and surface areas of all buildings
- Matrix with a resolution of 1 by 1 meters
- Number of floors and building types


GIS heat demand map

- 100 by 100 m heat demand matrix
- ArcGIS – GIS heat demand map

EnergyPLAN



- Sustainable Energy Planning Research Group, Aalborg University, Denmark
- Deterministic input-output model
- Aggregated
- Annual analysis on an hourly basis
- Optimization of the system operation not investment

Scenarios

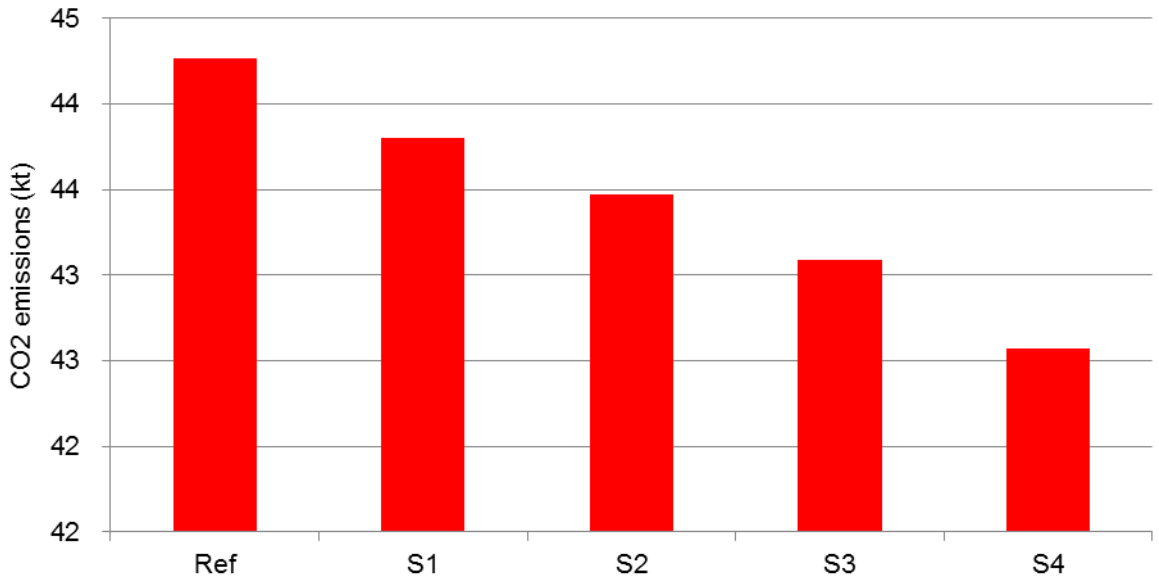
- Reference scenario and four alternatives based on the DH share in the city of Velika Gorica
- Reference scenario developed according to the data available from the cities SEAP, meteorological data obtained from METEONORM for the city and national data modeled down to the cities level

- DH Share:
  - REF: 32%
  - S1: 37%
  - S2 45%
  - S3 55%
  - S4 68%

Results

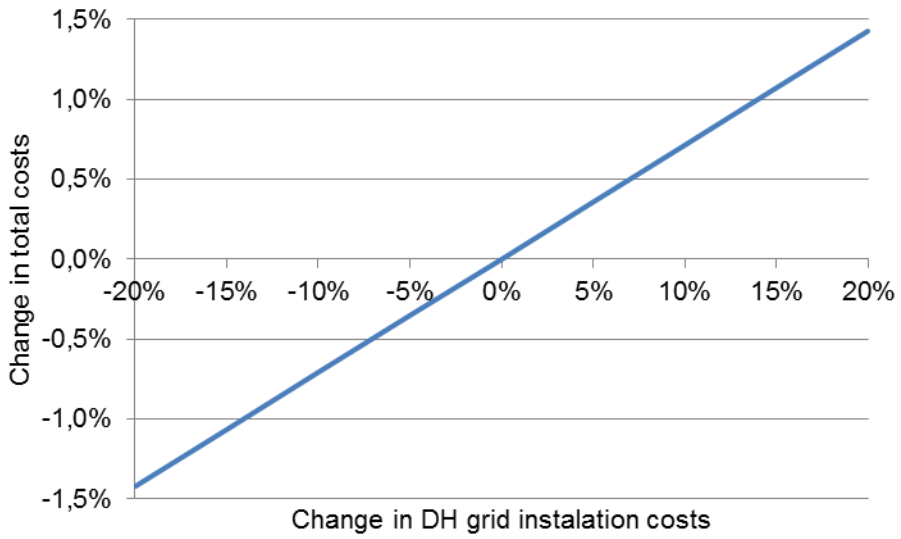
- Total cost comparison:
  - REF: 20,1 MEUR
  - S1: 19,6 MEUR
  - S2: 18,6 MEUR
  - S3: 18,5 MEUR
  - S4: 18,6 MEUR
- S3 - 8% lower total costs compared to REF

Results



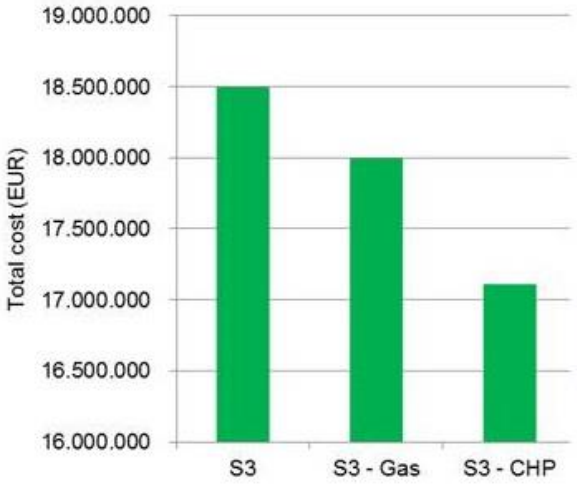
- CO2 comparison:
  - REF: 44,3 kt
  - S1: 43,8 kt
  - S2: 43,5 kt
  - S3: 43,1 kt
  - S4: 42,6 kt
- S3 – 2,7% lower total costs compared to REF

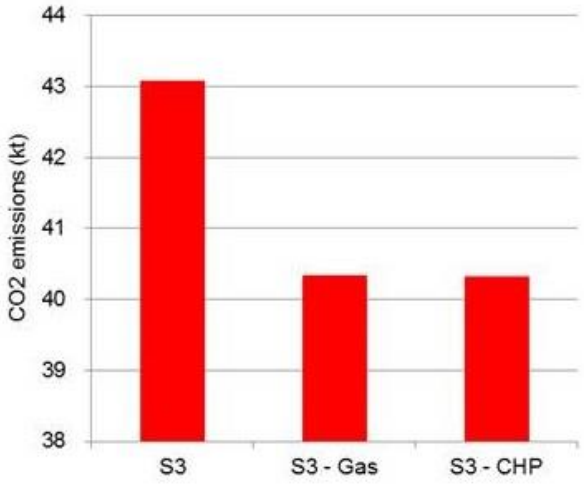
Sensitivity analysis



- DH grid cost assumption:
  - 0,2 – 0,35 EUR/kWh of total DH supply
- 20% reduction or increase of specific DH cost in S3 changed the total annual system cost by 1,4%

Results





S3 modification

- S3 Gas – complete switch from oil to natural gas in DH
- S3-CHP – additionally to S3 Gas, 50% of heat demand covered by CHP

- S3-CHP
  - Total cost reduction of 14,9% compared to RES
  - CO2 emission reduction of 8,9% compared to RES

Conclusion and future work

- Development of GIS heat demand maps
  - Current maps developed with a resolution of 100X100 meters
  - Need further validation
  - Additional layers
    - DH and gas grids, energy certificates, cooling demand, population density, electricity consumption

- Scenarios show a potential to reduce the total costs by roughly 15% and CO2 emissions by roughly 9% with the expansion of the current DH grid
- Investigation into the potential for power to heat technologies and the integration of the power, heating and cooling sectors

Acknowledgement

Financial support from the European Union's Intelligent Energy Europe project STRATEGO (grant agreement EE/13/650), Horizon2020 project CoolHeating (grant agreement 691679) and the 4DH project funded by the Innovation Fund Denmark are gratefully acknowledged.

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Thank you for your attention!

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