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Potential of geothermal energy in district heating systems in Slovenia

CITIES

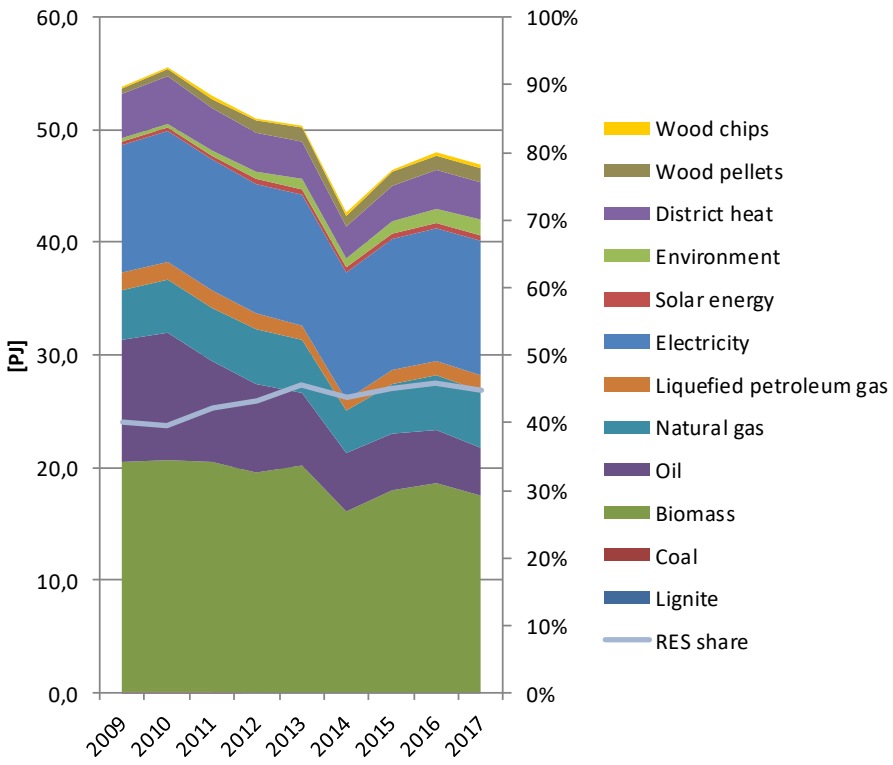
KeepWarm
Renewing district heating

Workshop - Data intelligent operation of district heating and district cooling systems

Zagreb
3 – 4 April 2019

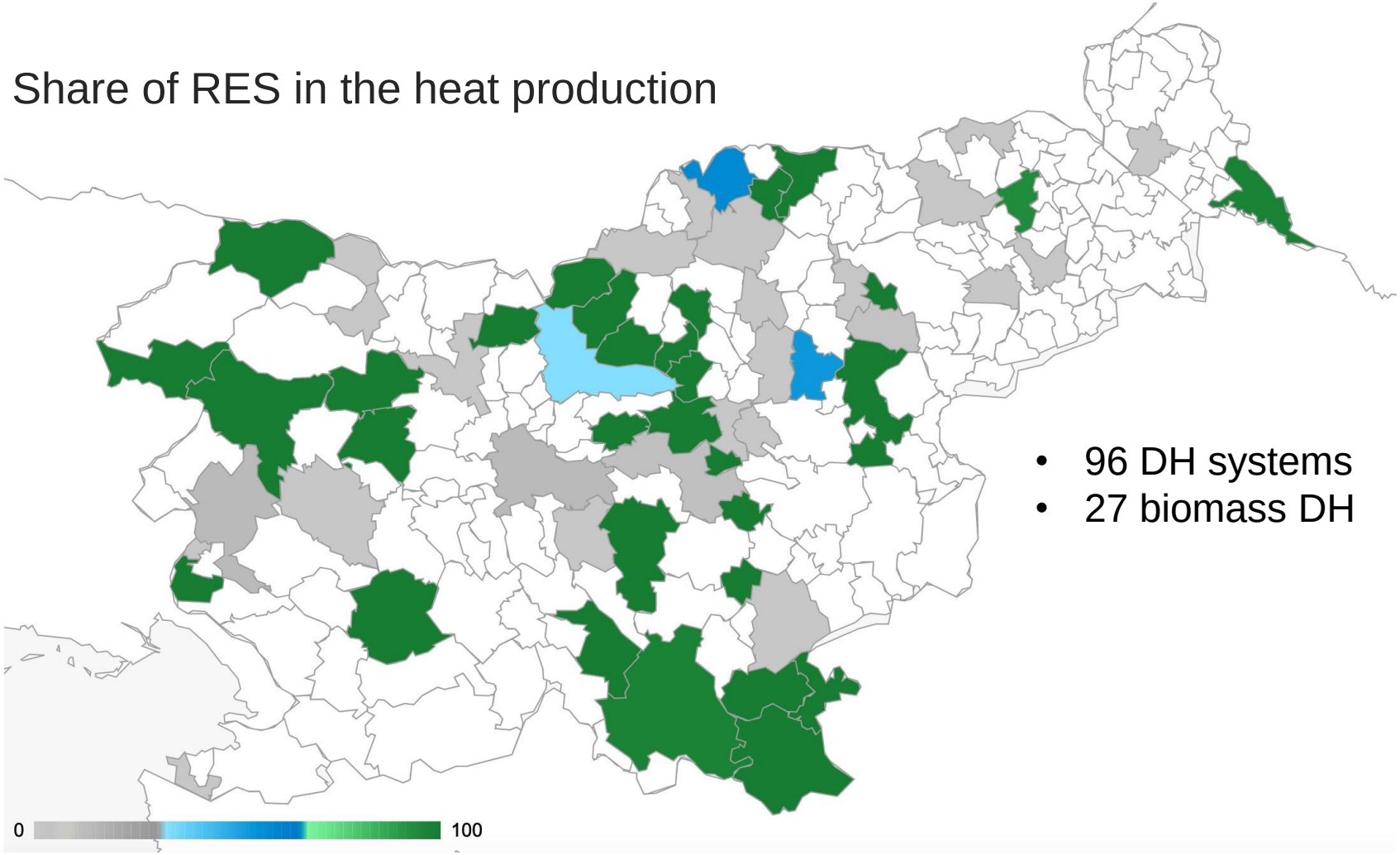
Energy balance in Slovenia
Households

- residential sector represents 23% of final energy consumption
- 21% reduction compared to 2009
- 45% share of RES in 2017
- wood fuels prevail among consumed energy sources
- increase of geothermal and solar thermal energy in the past years



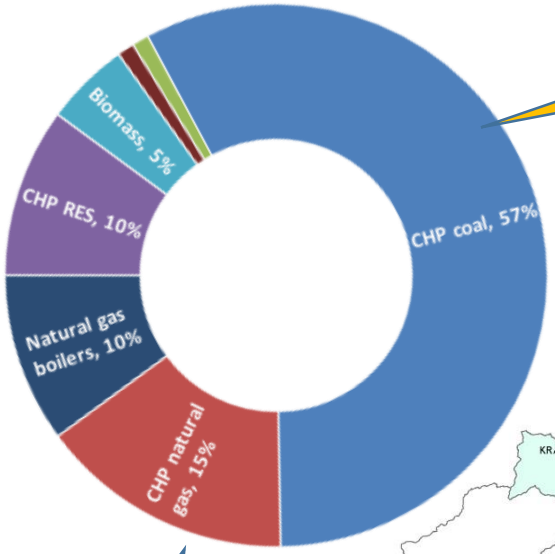
District heating systems in Slovenia

Share of RES in the heat production



- 96 DH systems
- 27 biomass DH

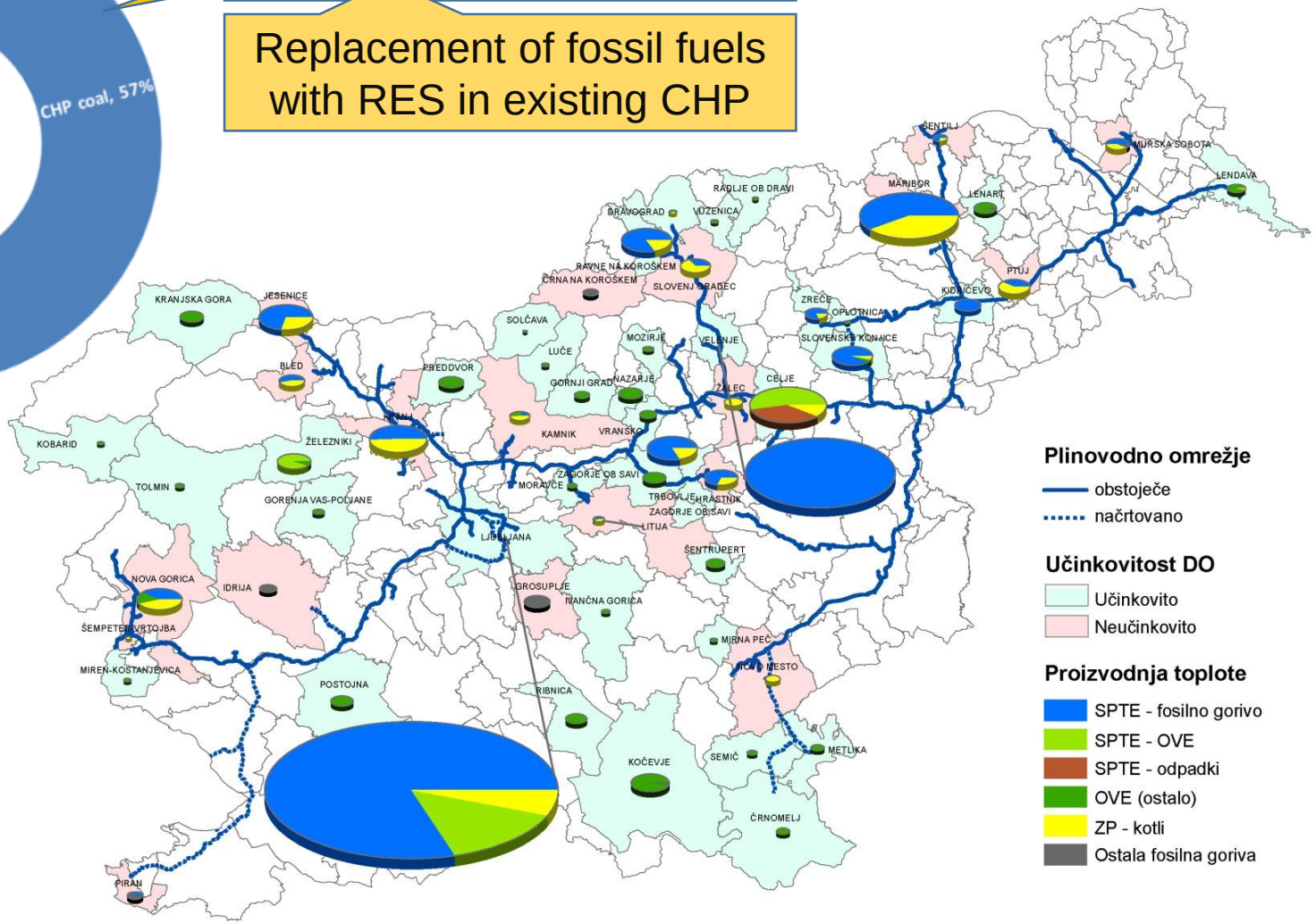
District heating systems in Slovenia



84% heat from CHP

Replacement of fossil fuels with RES in existing CHP

Less than 1% from geothermal energy

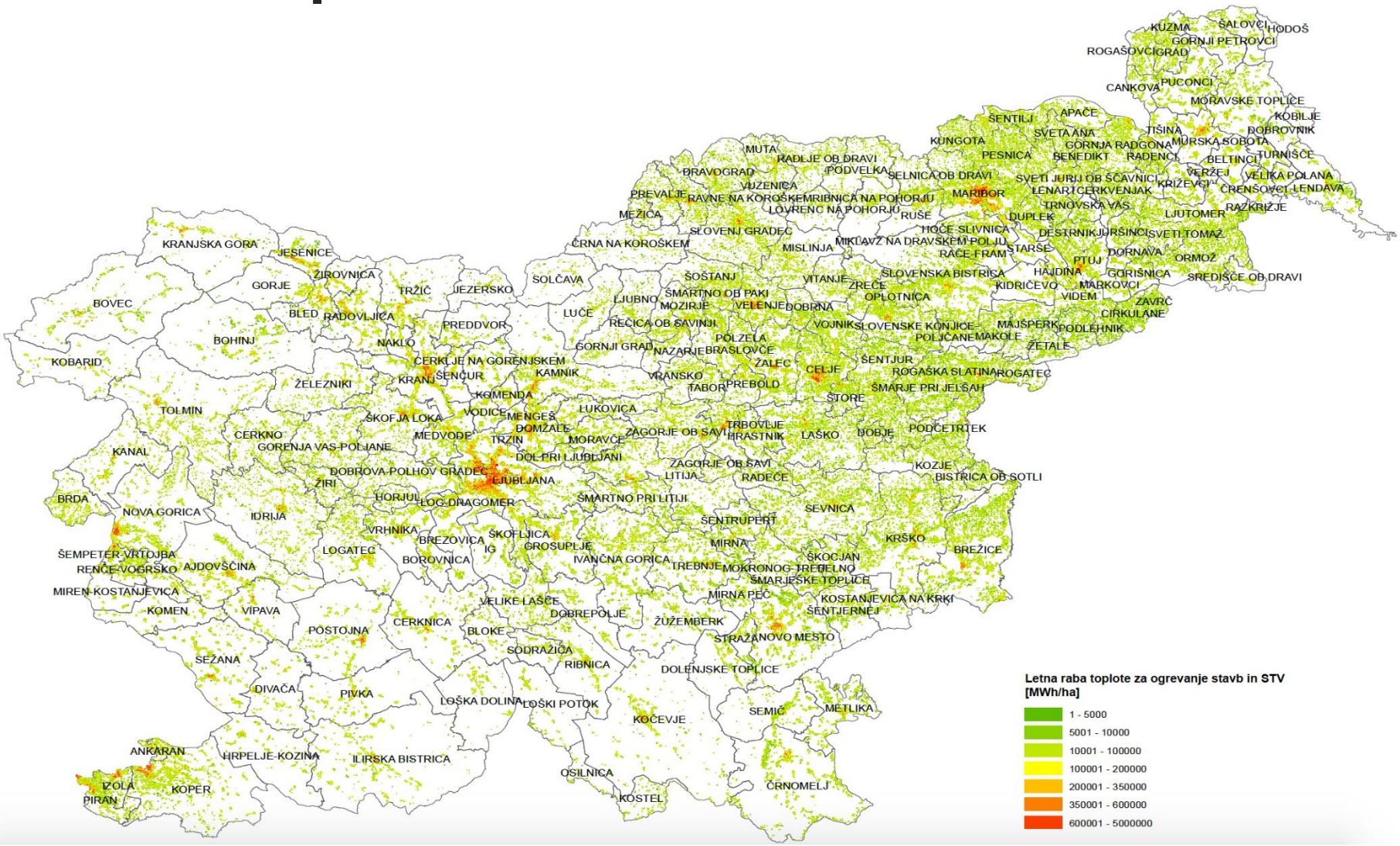


Research activities
Heat mapping

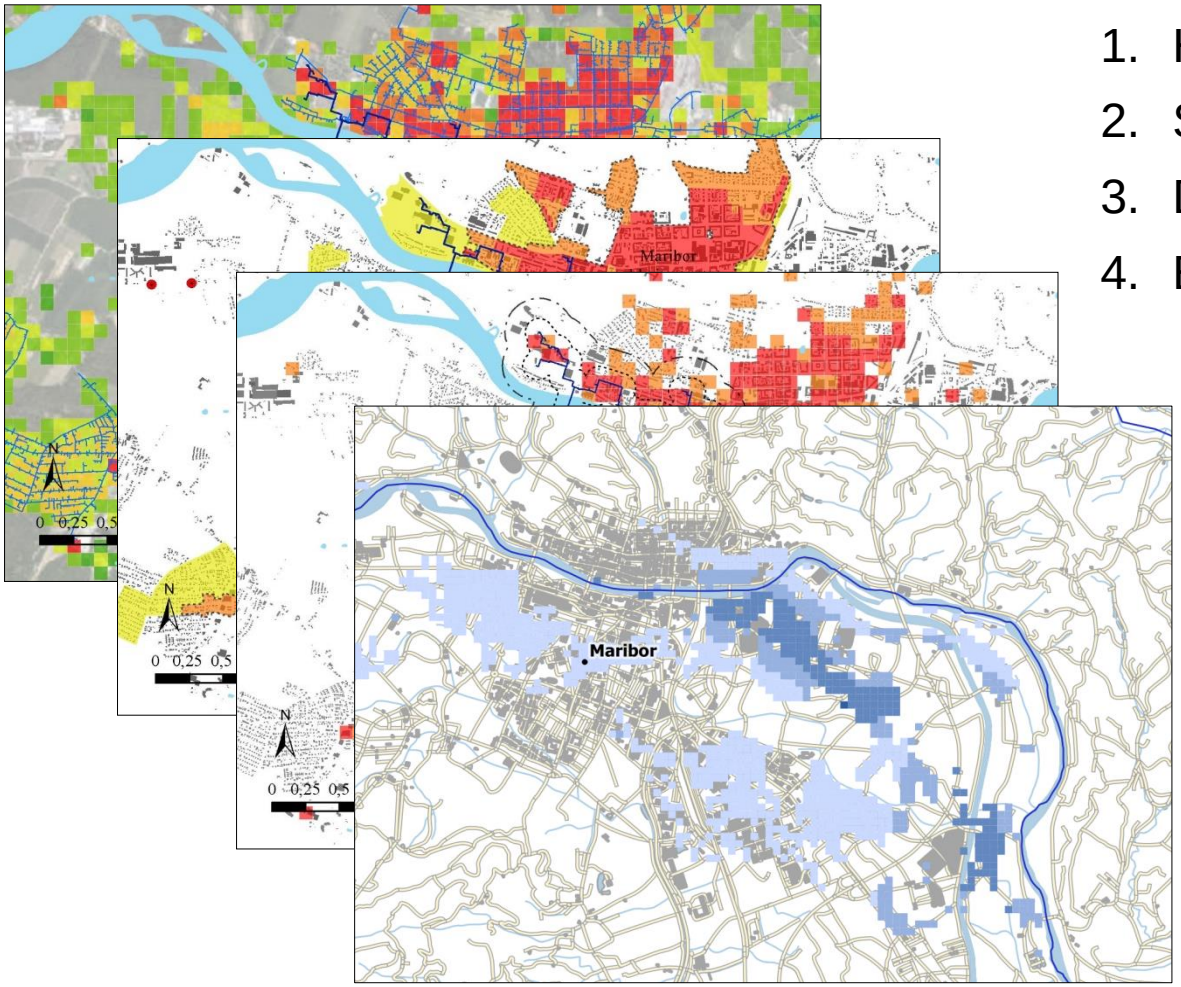
- Development of the heap map began with a local initiative in 2015.
- Currently ongoing 2 and soon 1 long-term projects focus on:

  Regularly updated heat map for
  - demand-potential-supply side of Slovenia
  - with systematical data quality check for advanced local and national energy planning

Heat map of Slovenia



Heat map reserach
From needs to supply



1. Heat map
2. Setting priority areas
3. DH expansion potential
4. Exploitation of supply potential

Ongoing research is focusing on identification of local potential of:

- **geothermal energy**,
- **solar energy,**
- **waste/excess heat** and
- **DH expansion.**

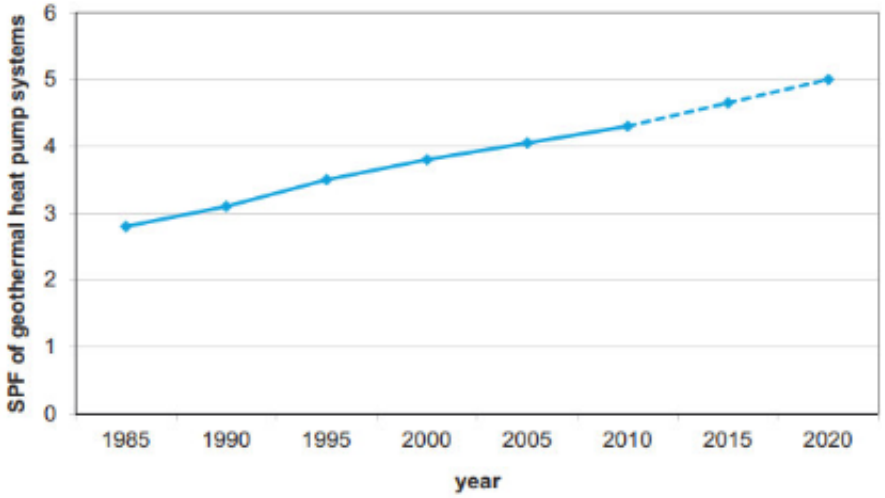
Shallow geothermal potential Methodology

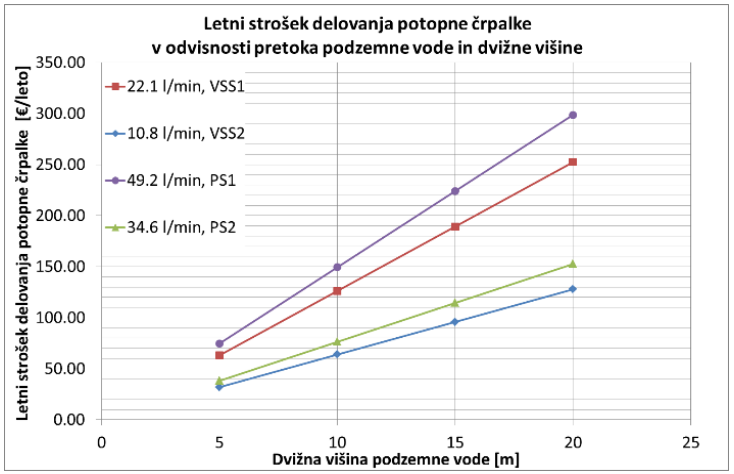
1. Evaluation of the heating demand
2. Considered all existing DH infrastructure
3. Analytical model of groundwater heat exchangers (GWE) and borehole heat exchangers (BHE) design
4. Identification of geothermal energy (GE) potential of densely populated areas (economical aspects, constraints, factors)
5. Mapping of GE exploitation for new DH areas or for support to existing DH
6. Mapping of GE exploitation as decentralized systems

Shallow geothermal potential
Economical aspects

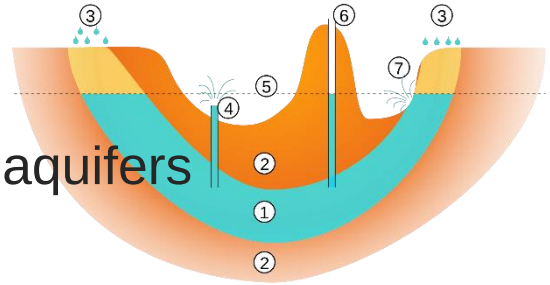
Taken into account:

1. Ground-coupled and groundwater HP **systems**
2. Drilling (BHE, GWE)
3. Yearly maintenance costs and lifetime of technology





Shallow geothermal potential
Constraints



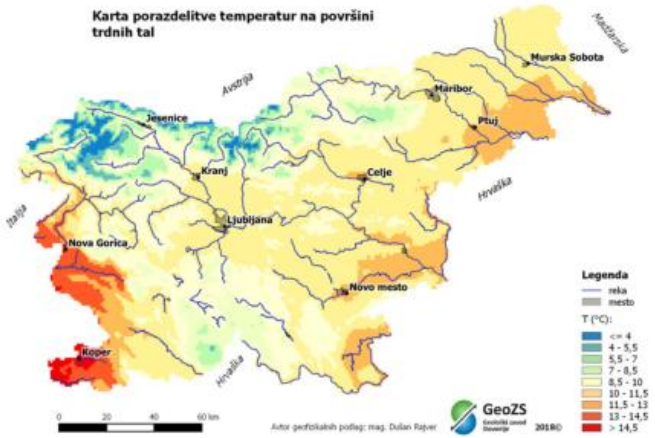
Exclusion areas: water protection areas, artesian aquifers

Warning areas:

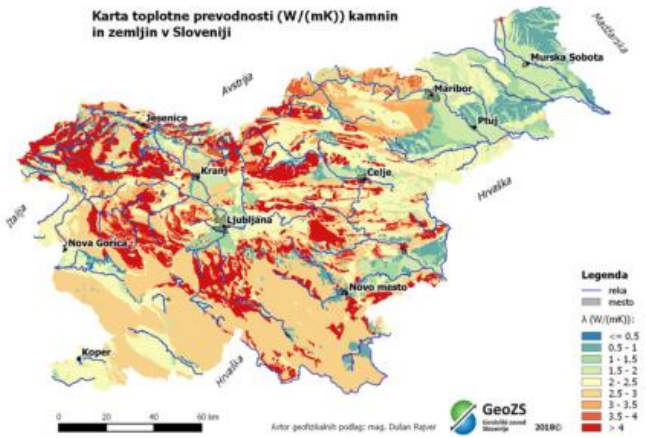
- aquifers, groundwater just below the surface, hanging aquifers, areas with aquifers one above the other, aquifer with mineral water, aquifer with thermal water, emerges of gas, unstable grounds, polluted land, karst areas, ingress of salt water
- avalanches
- higher karstification
- areas of presence of anhydrite
- the proximity of water resources coverage not protected by water protection areas

Shallow geothermal potential
Factors

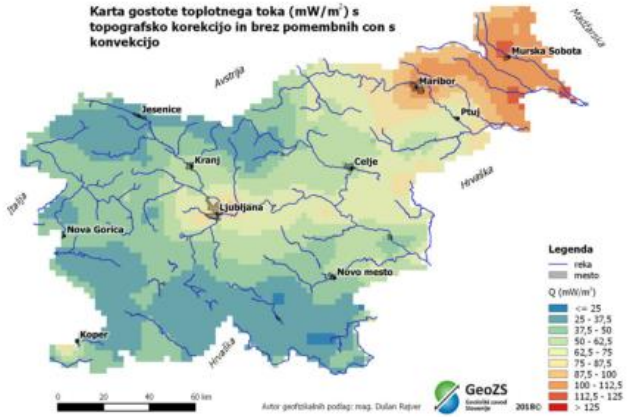
Ground surface temperature



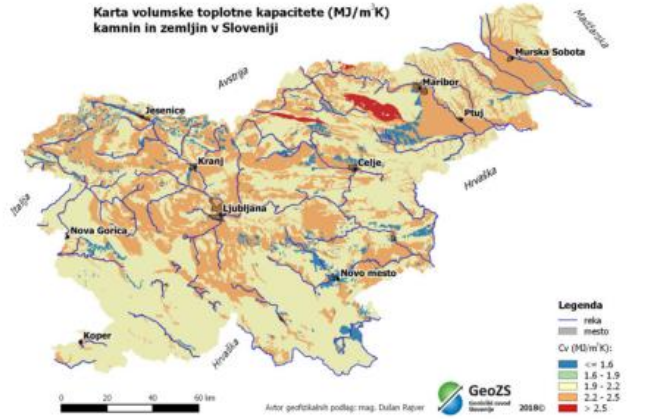
Thermal conductivity of rocks and soil



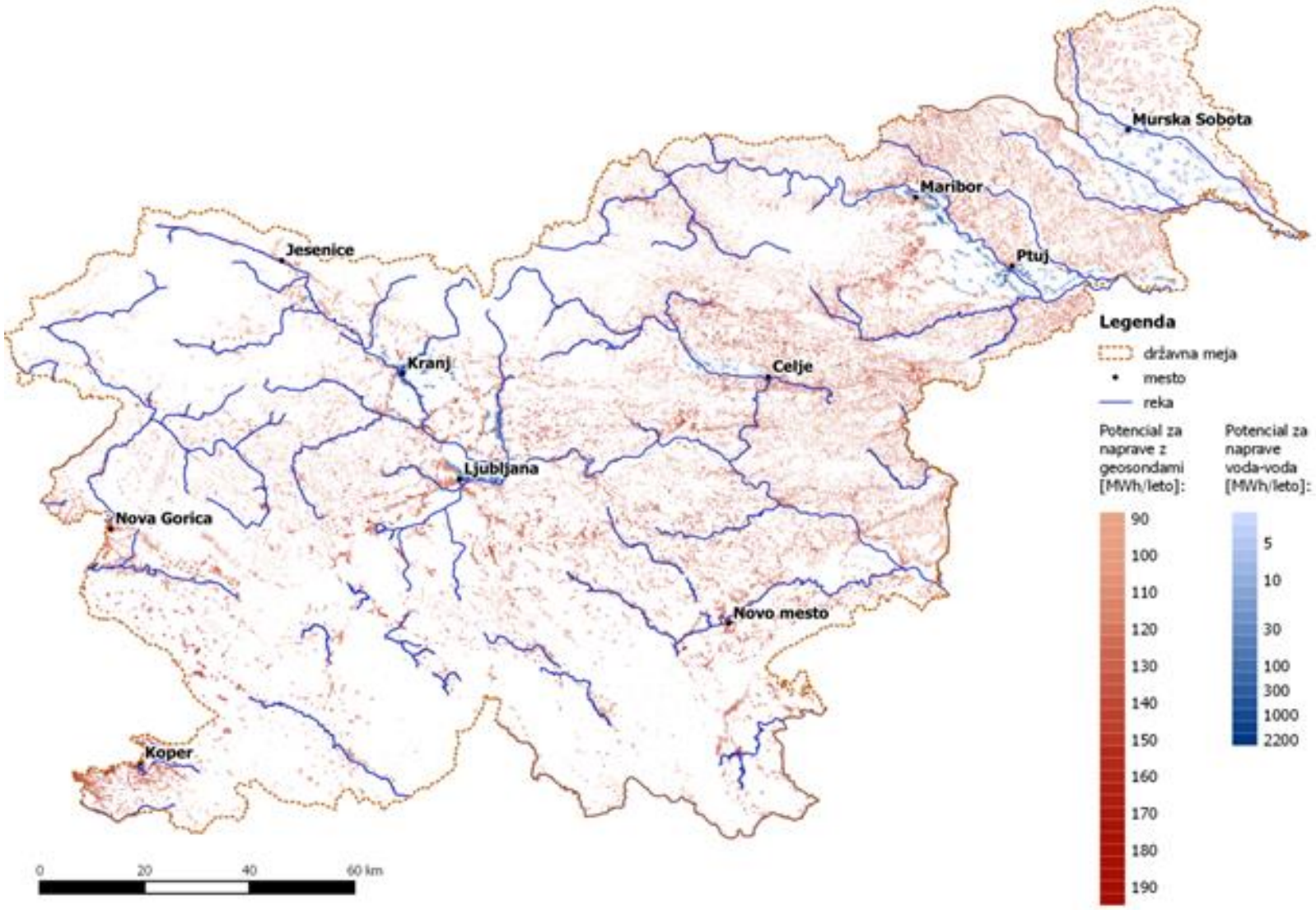
Density of geological layers



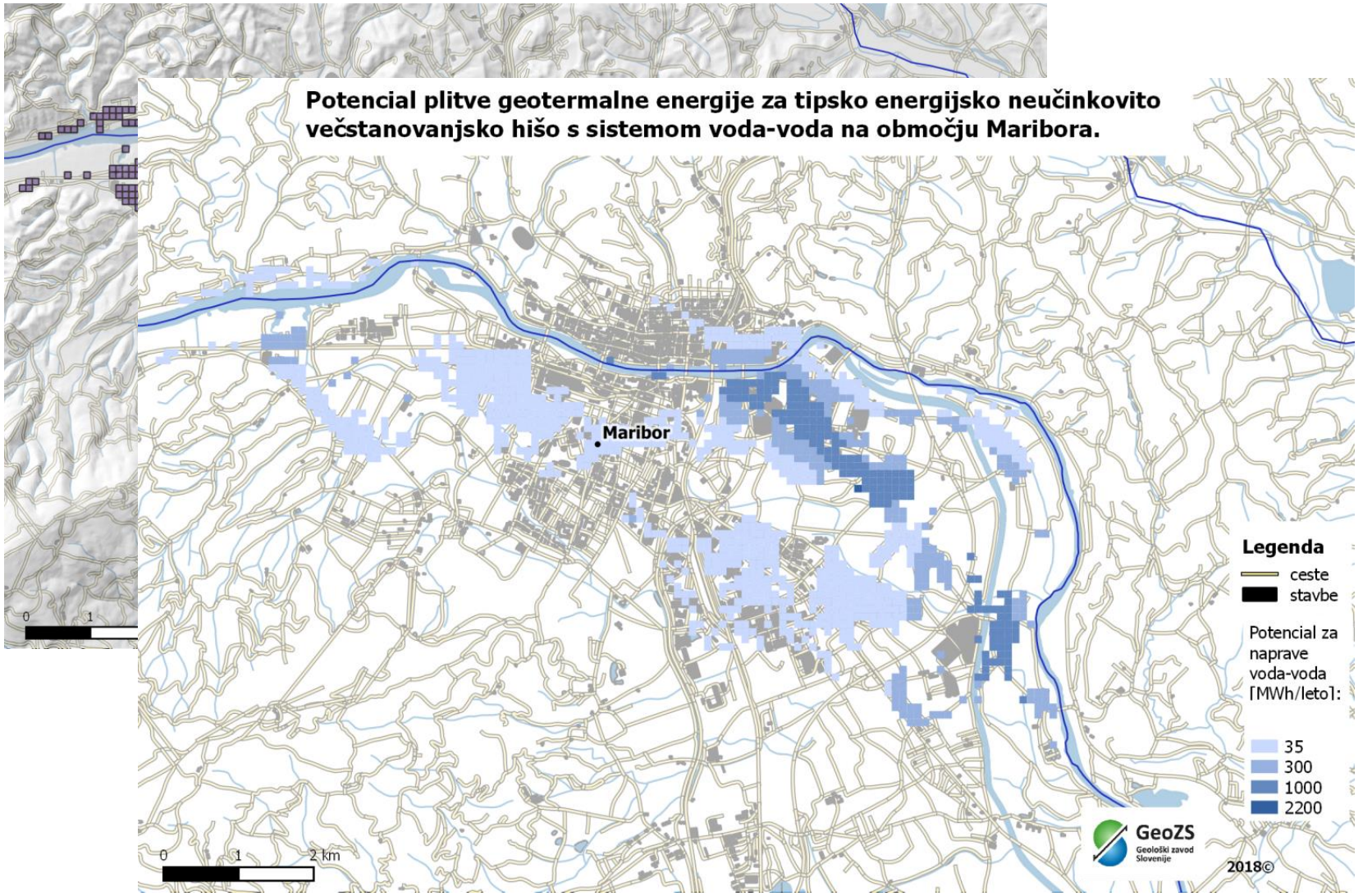
Volume heat capacity



Shallow geothermal potential
Results on national level



Shallow geothermal potential
Results on local level

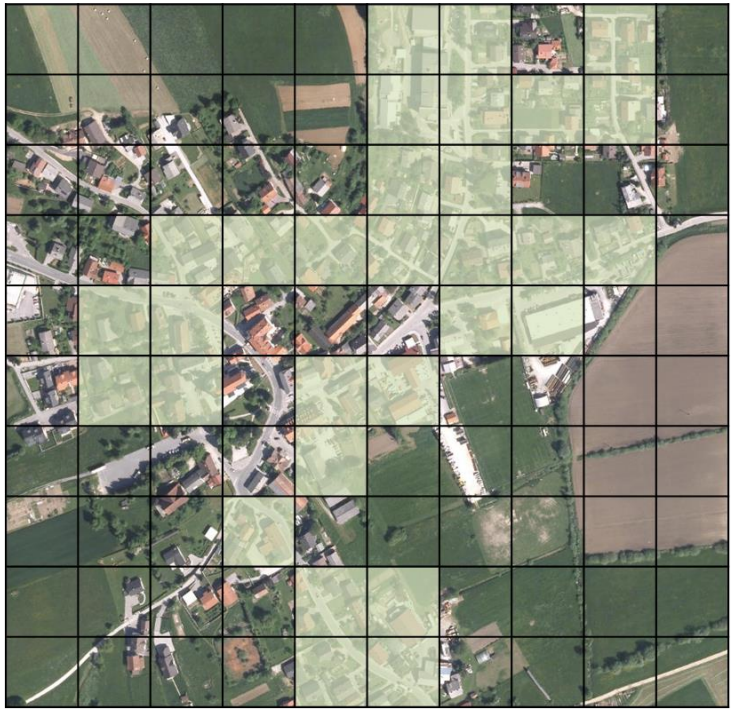


Shallow geothermal potential
New centralized systems

Methodology

- **Areas with potential**:
  > 350 MWh/a/ha
- **Grid size**: Areas where DH energy price competitiveness in ensured
- **Economic feasibilty**: investment, distribution, O&M
- **Competitiveness**: LCC comparison with the cheapest and "clean" technology available in dense areas (HP air-water)

100 m x 100 m (ha) cells

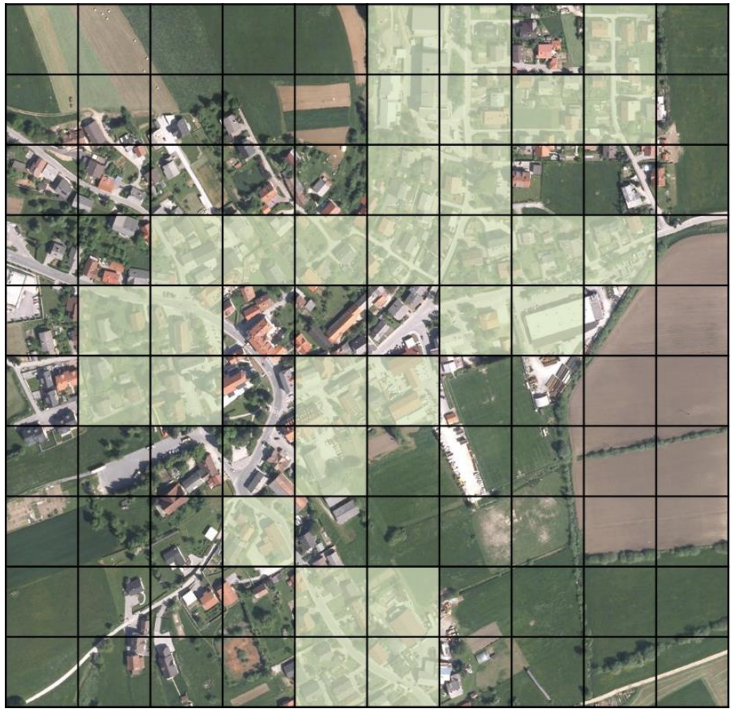


Shallow geothermal potential
New centralized systems

Results

Potential for:

- new DH areas:
  1,67 TWh/a in 757 systems
- micro DH:
  0,94 TWh/a in 1640 systems



COMPARISON

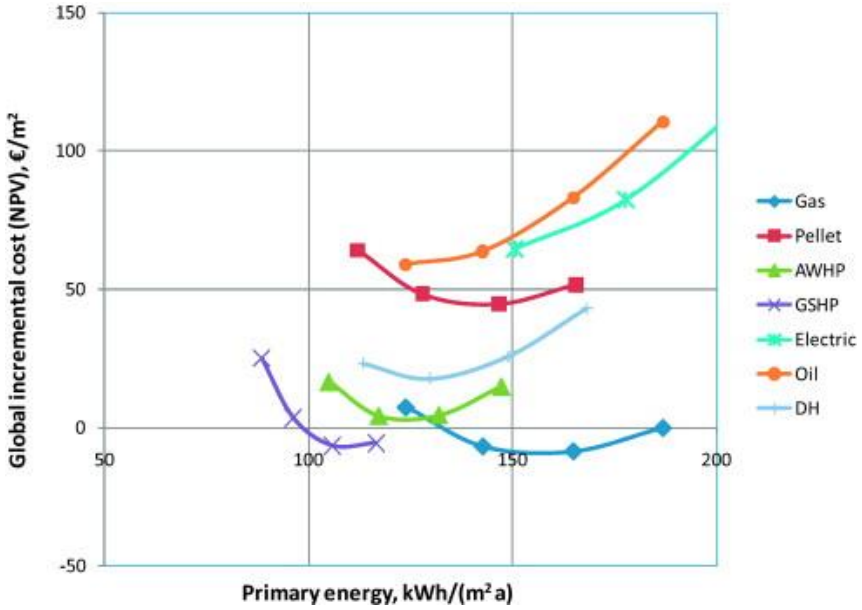
Geothermal energy consumption in households in 2017:

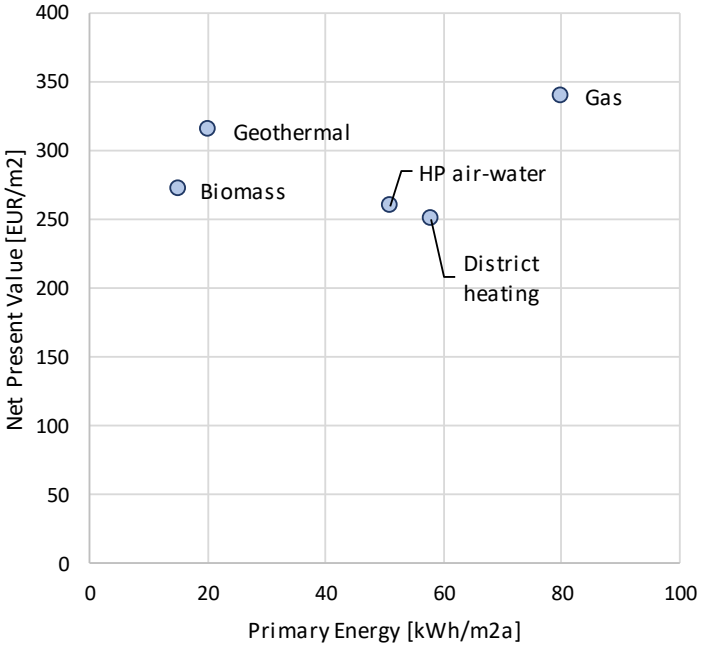
0,092 TWh/a

Shallow geothermal potential
De-centralized systems

Methodology

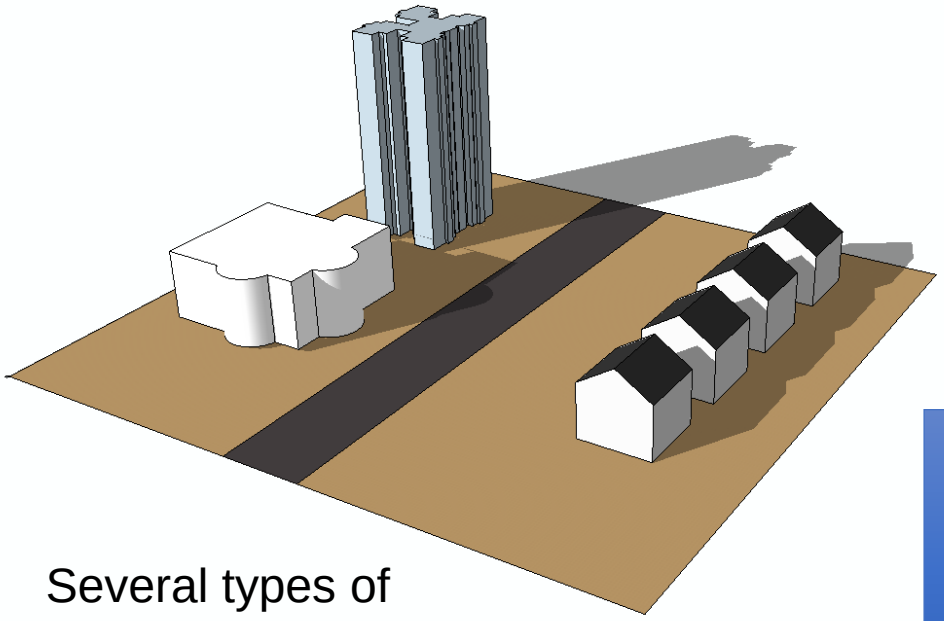
- **Areas considered**: Areas with no DH potential.
- **Economic feasibilty**: investment, energy consumption, O&M
- **Competitiveness**: LCC comparison with other technologies



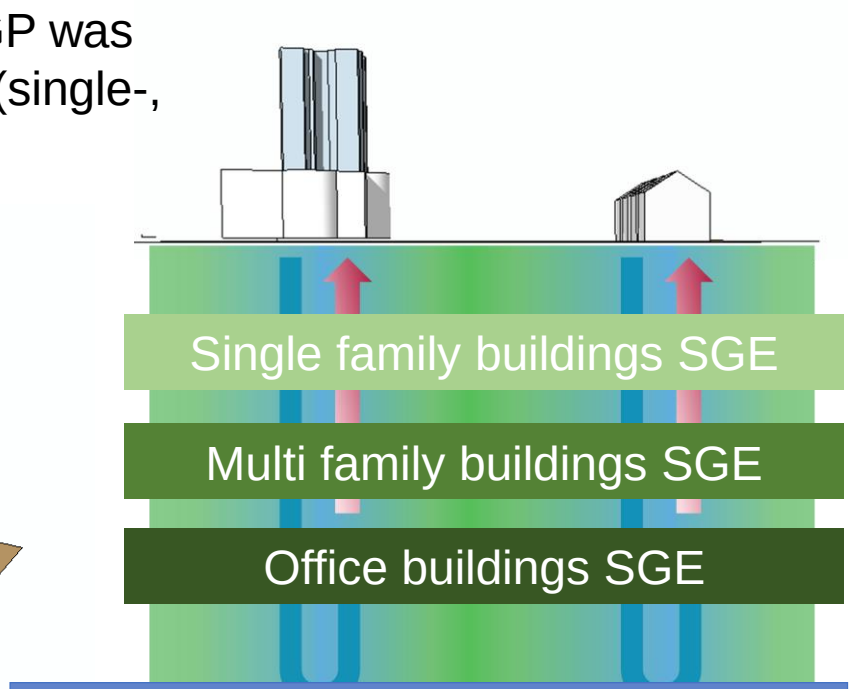


Shallow geothermal potential
De-centralized systems

For each 100x100m cell in Slovenia SGP was calculated with prevailing building type (single-, multi-family building and office building)



Several types of buildings with different levels of energy need.



Identification of potential:

1. Finding the biggest consumer
2. Supply the energy 100% from SGE
3. Repeat

Shallow geothermal potential
De-centralized systems

Technical GE potential used for heating and DHW:

6,93 TWh/a

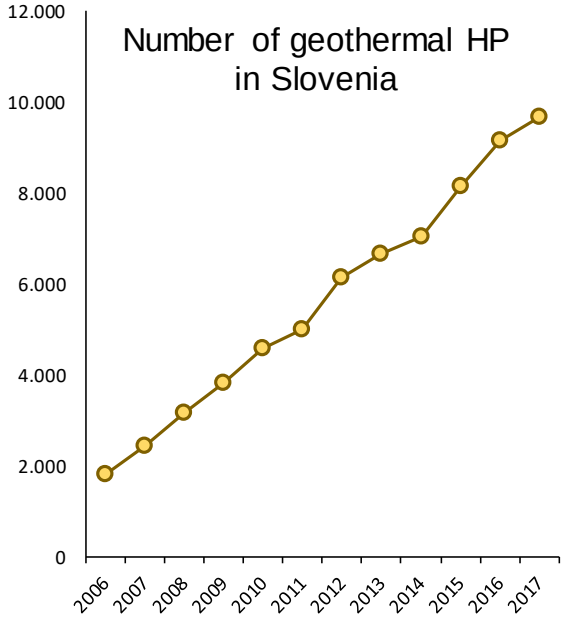
COMPARISON

Heating oil energy consumption in households in 2017:

0,93 TWh/a

Shallow geothermal potential
Conclusions

1. The **benefits** of SGE are well known: (i) reliable baseload, (ii) carbon emission reduction and (iii) local production.
2. The exploitation of SGE in households has **often been overlooked** mainly due to higher initial investment, but with **higher awareness** of its benefits, it has been increasing rapidly in the past years.
3. Can be used as support to existing DH networks.



Shallow geothermal potential
Conclusions

4. Economic and technical potential for **new centralized systems**, using **shallow** GE, is substantial – more than **2,5 TWh/a**, but could rarely be used as the only source for heat energy production.
5. Shallow GE potential is proving to be an opportunity for individual heating solutions especially for new buildings. LCC analysis should be performed for renovation scenarios to prove economical feasibility.
6. When pushing HPs into energy scenarios, electric grid load should be taken into account.

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Thank you for your attention.