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Pathway for shallow geothermal energy potential in district heating systems development in Slovenia

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Jožef Stefan Institute
Energy Efficiency Centre

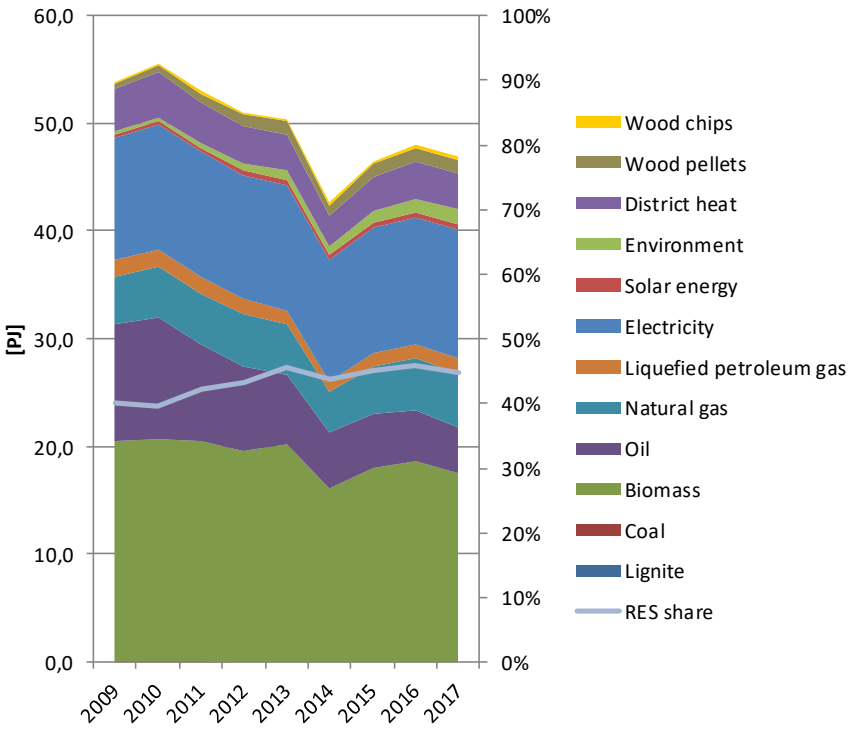
GeoZS

4DH
4th Generation District Heating
Technologies and Systems

Energy balance in Slovenia

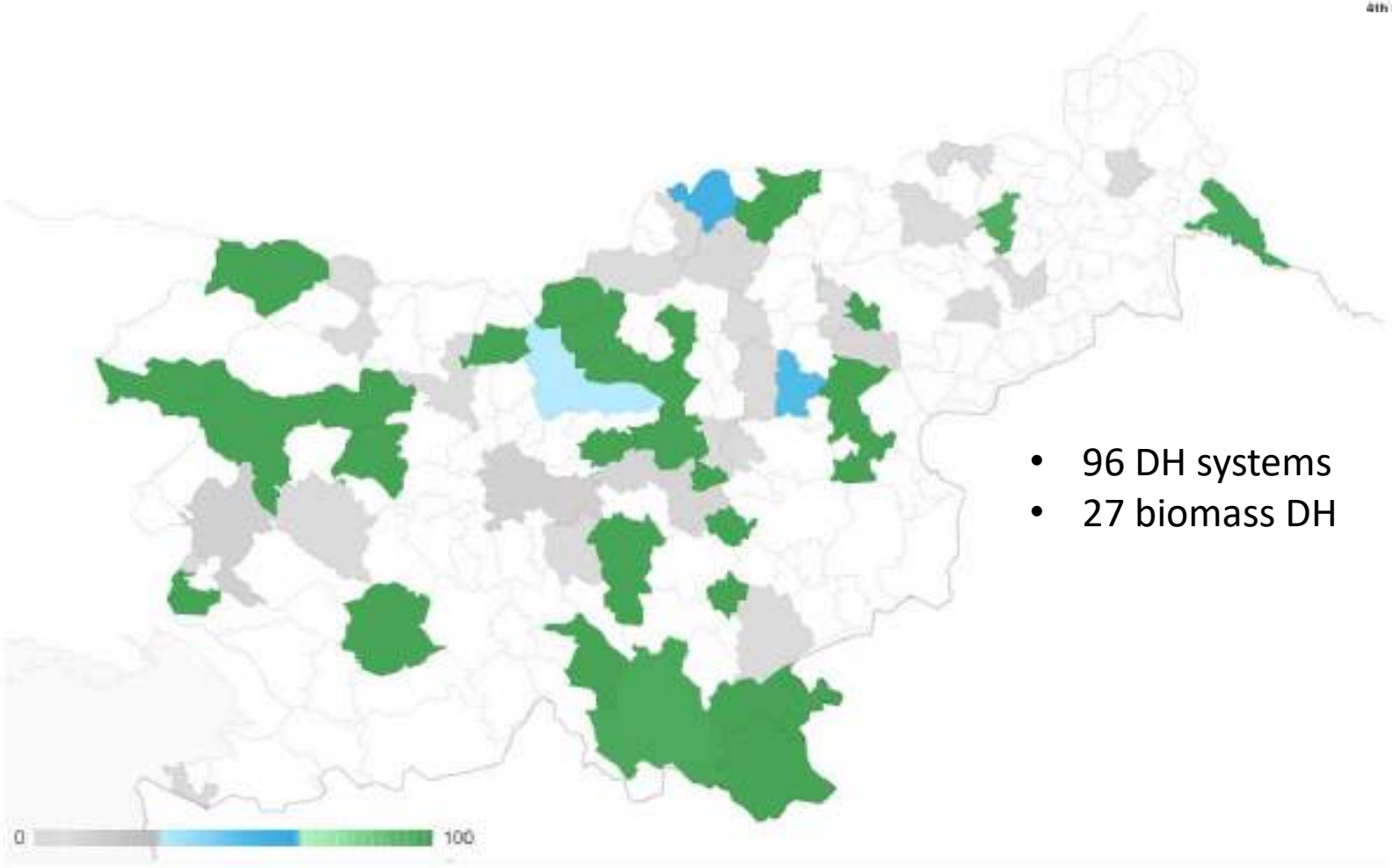
Households

- residential sector represents 23% of final energy consumption;
- 20,9% 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

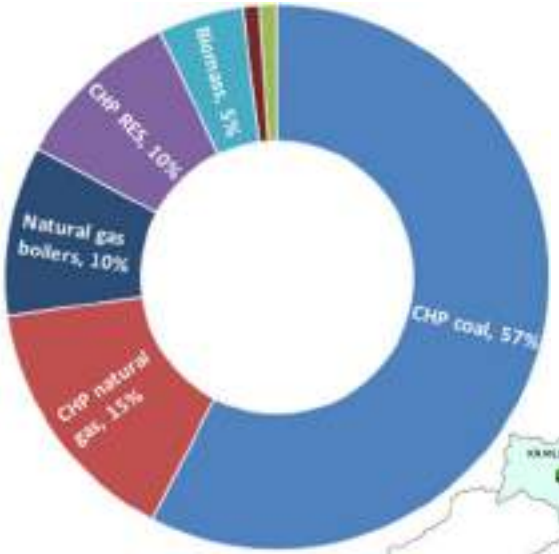
Share of RES in the heat production



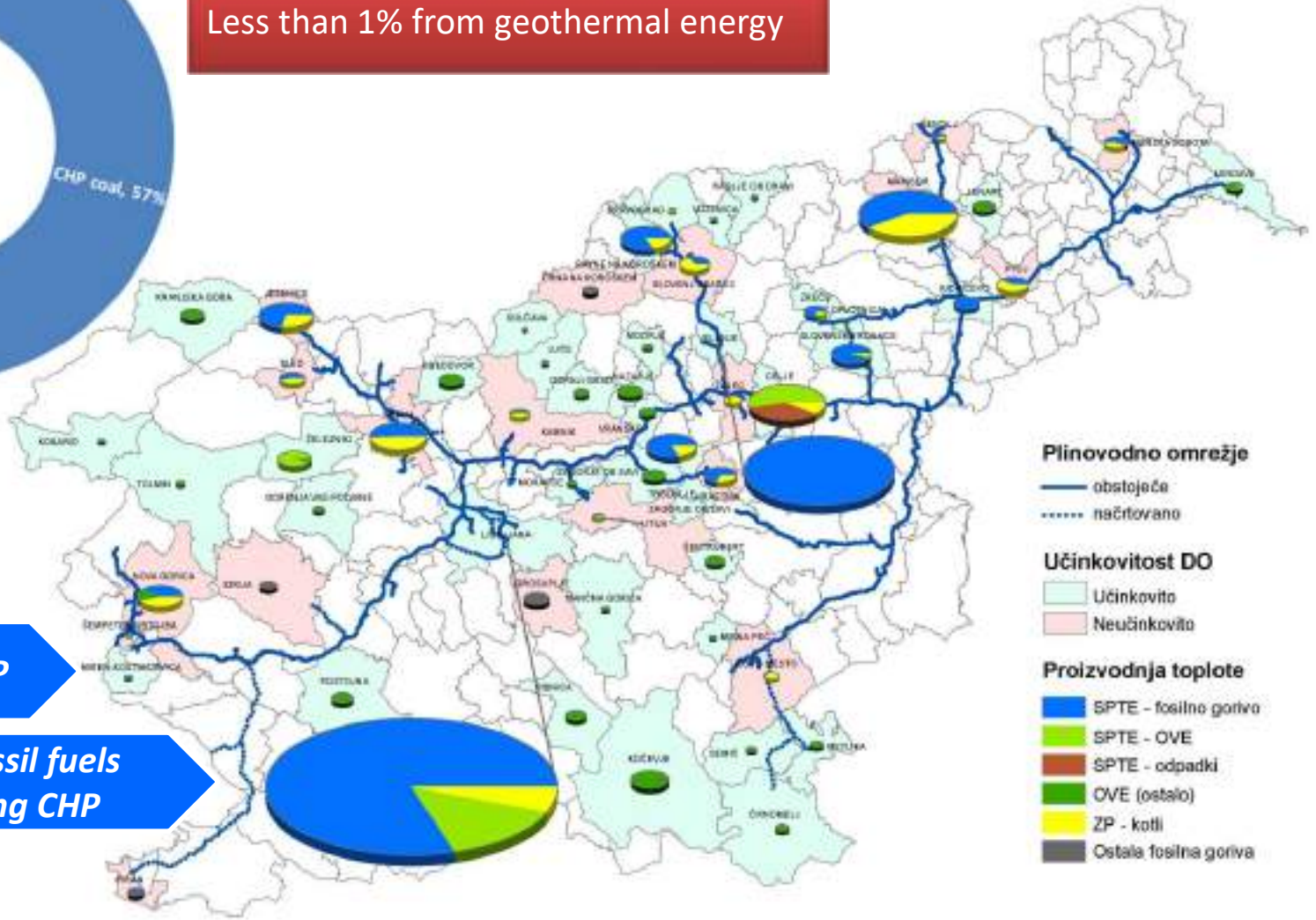
- 96 DH systems
- 27 biomass DH

District heating systems in Slovenia

Structure of heat production



Less than 1% from geothermal energy



84% heat from CHP

Replacement of fossil fuels with RES in existing CHP

4DH
4th Generation District Heating Technologies and Systems

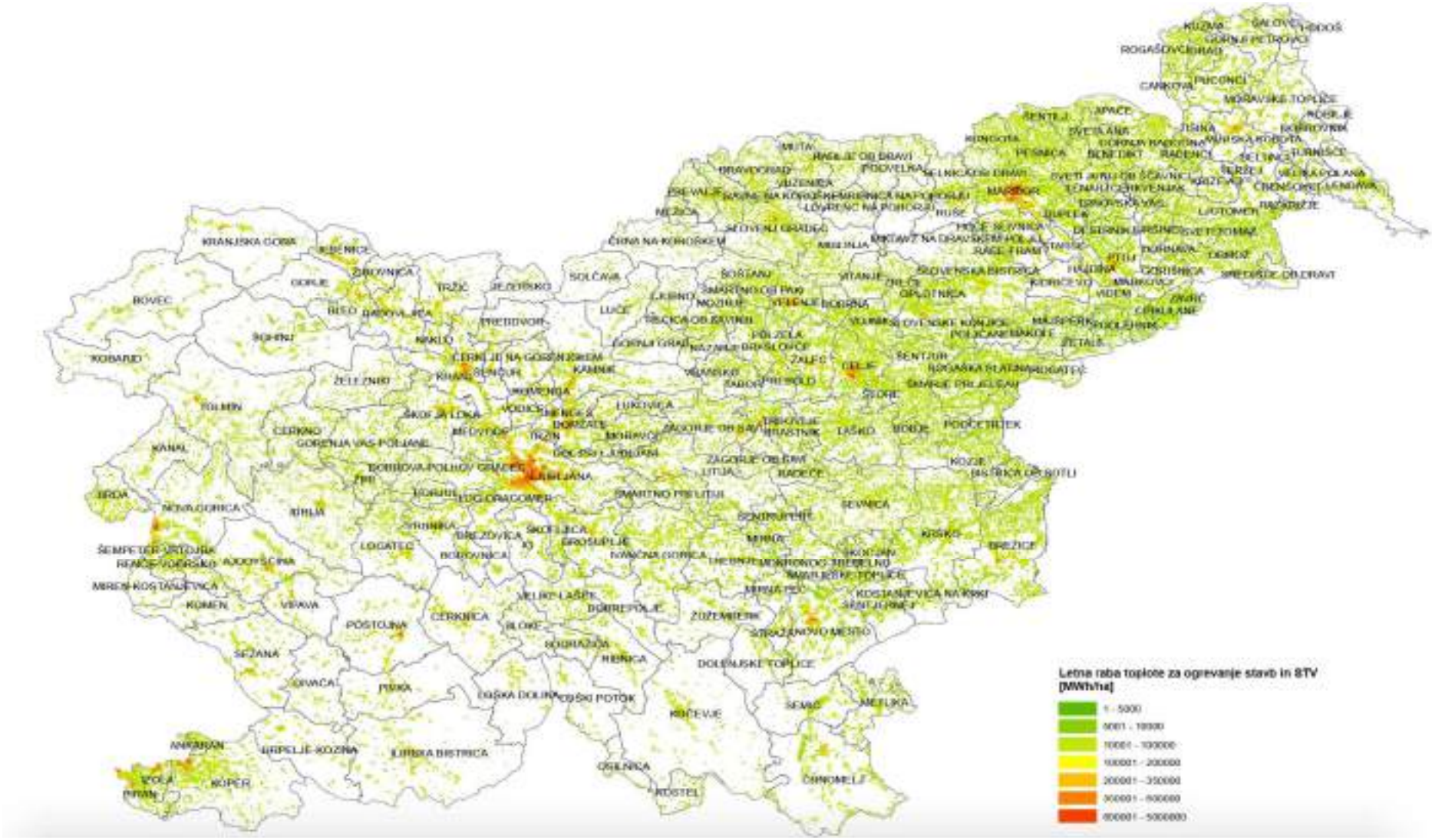
Research activities

Heat mapping

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

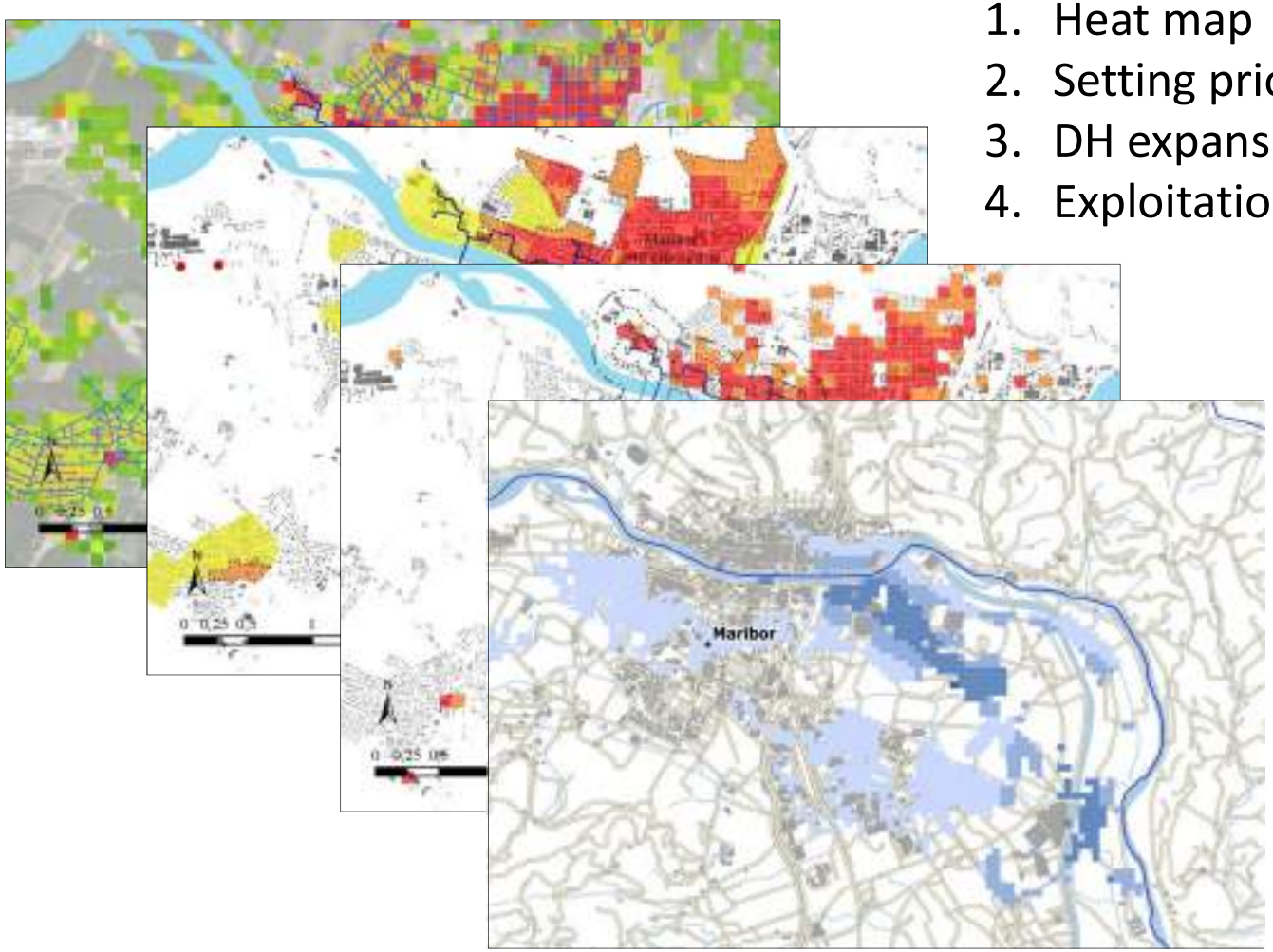
Regularly updated heat map for

demand-potential-supply side of Slovenian with systematical data quality check for advanced local and national energy planning.


Letna raba toplote za ogrevanje stavb in STV
[MWh/ha]
1 - 5000
5001 - 10000
10001 - 100000
100001 - 200000
200001 - 350000
350001 - 500000
500001 - 5000000

Heat map research

From needs to supply options



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

Ongoing research is focusing on identification of local potential of:

- **geothermal energy**,
- **solar energy** and
- **DH expansion**.

Shallow geothermal potential

Methodology

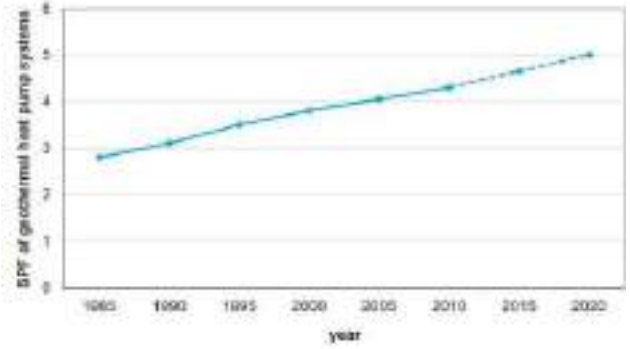
1. Evaluation of the heating demand
2. Existing DH infrastructure
3. Analytical model of BHE design
4. Identification of geothermal energy potential of densely populated areas (economical aspects, constraints, factors)
5. Mapping of geothermal energy exploitation for new DH areas or for support to existing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

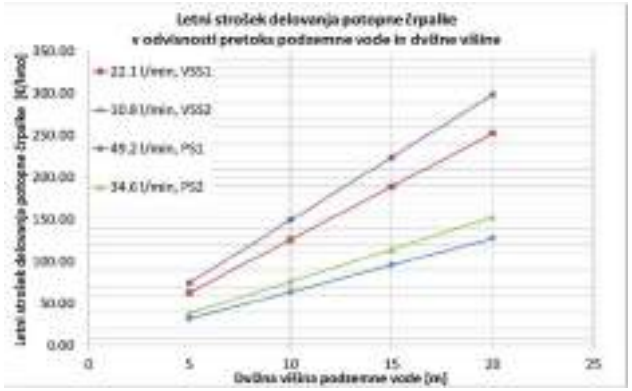
Shallow geothermal potential

Economical aspect

Taken into account:

- Ground-coupled and groundwater heat pump systems
- Capture of energy with BHE
- Capture of energy with groundwater systems
- Yearly maintenance costs and lifetime of technology





Shallow geothermal potential

Constraints

Exclusion areas: water protection areas, artesian aquifers

Warning areas:

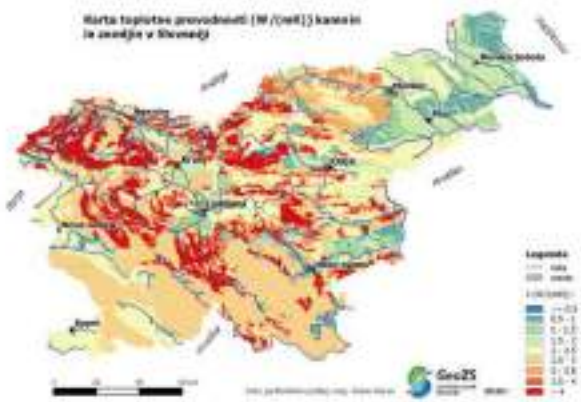
- aquifers, groundwater just below the surface, hanging aquifers, areas with aquifers one above the other, aquifer with mineral water, aquifer with thermal water, emerges of gas, unstable grounds, polluted land, karst areas, ingress of salt water
- avalanches
- higher karstification
- areas of presence 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

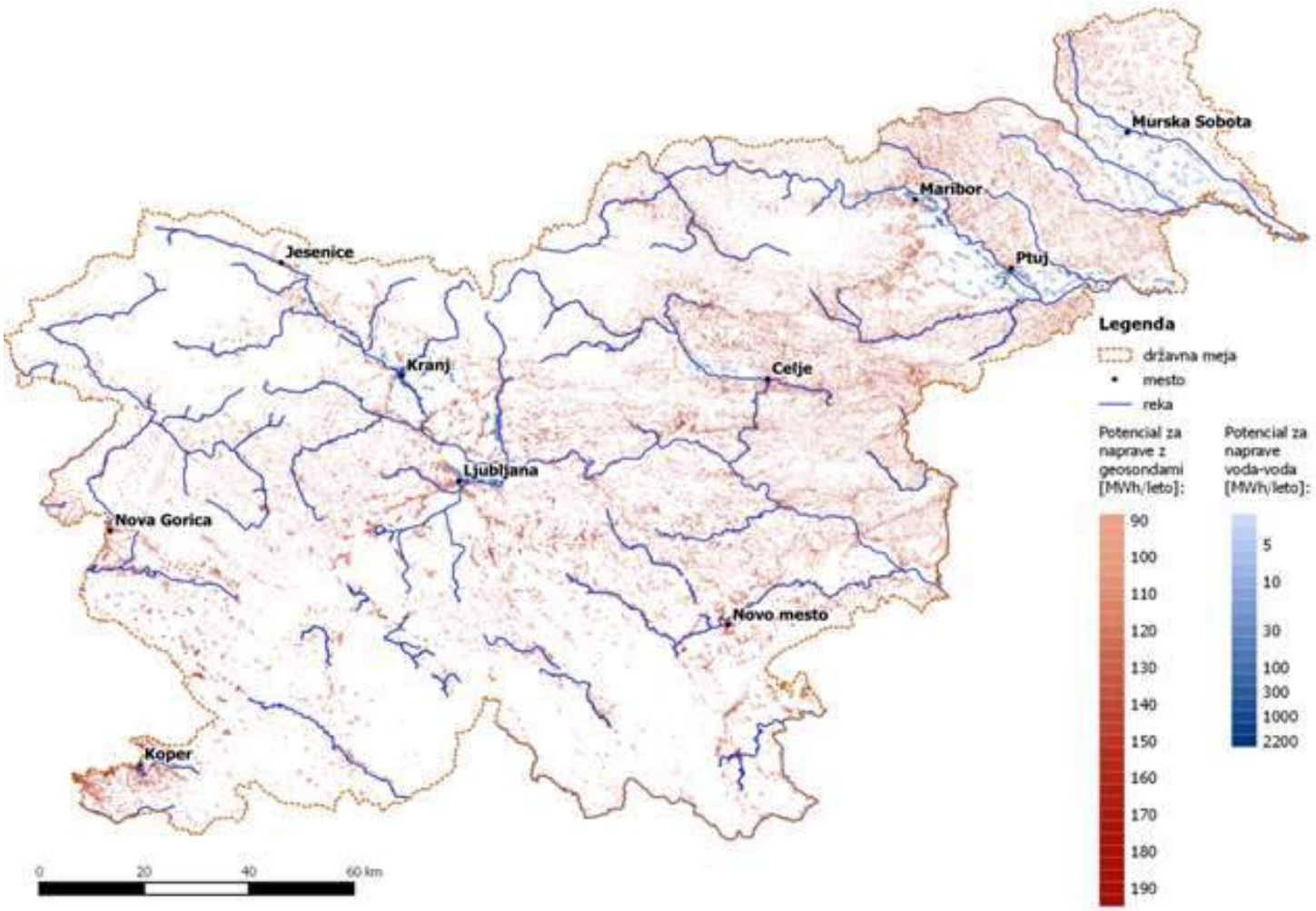


Density of geological layers

Volume heat capacity

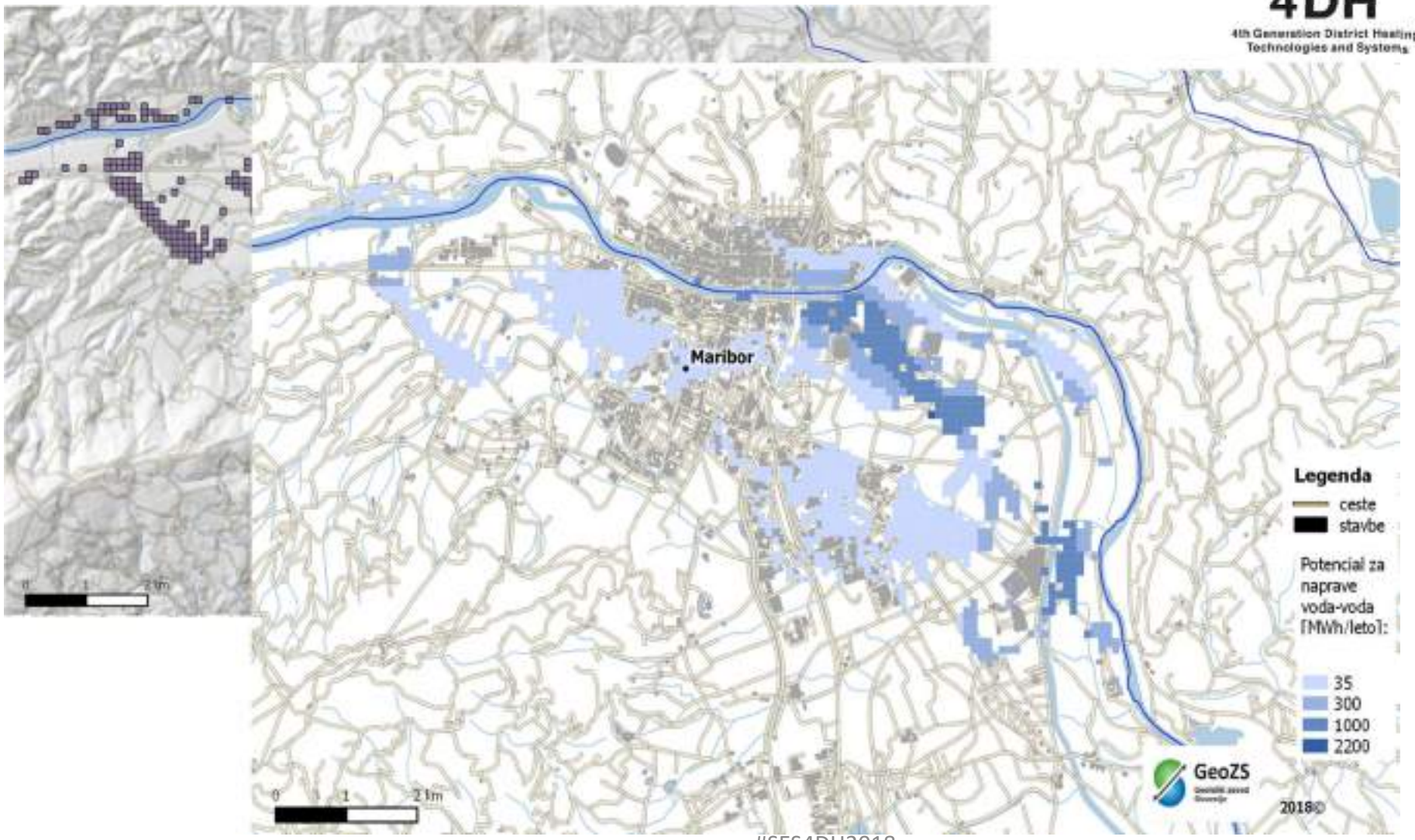
Shallow geothermal potential

Results on national level



Shallow geothermal potential

Results on local level



Shallow geothermal potential

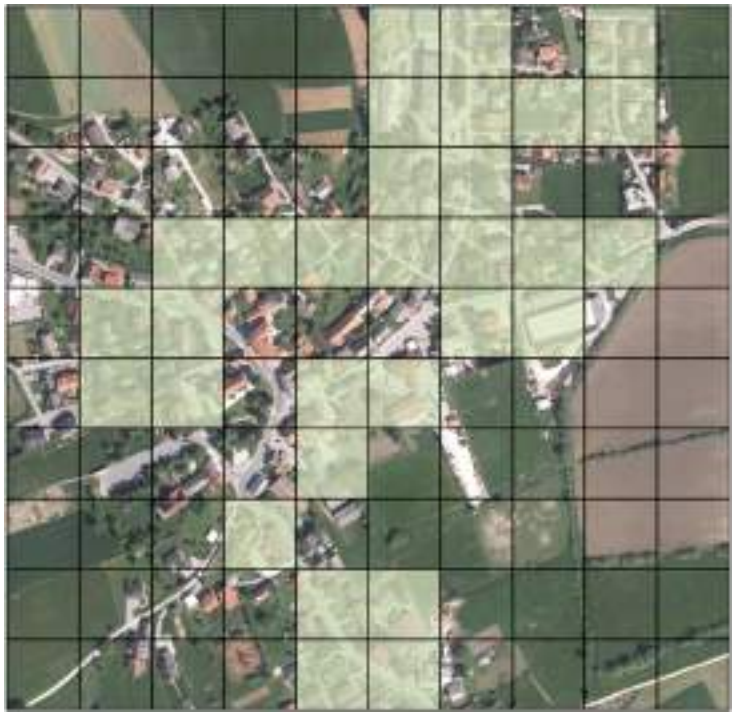
New centralized systems - METHODS

Areas with potential: > 35 GWh/a

Grid size: Areas where DH energy price competitiveness in ensured.

Economic feasibilty: investment, distribution, O&M (HRE D2.3)

Competitiveness: LCC comparison with the cheapest and “clean” technology available in dense areas (HP air-water)



Shallow geothermal potential

New centralized systems - RESULTS

Potential for:

new DH areas:

1,67 TWh/a in 757 systems

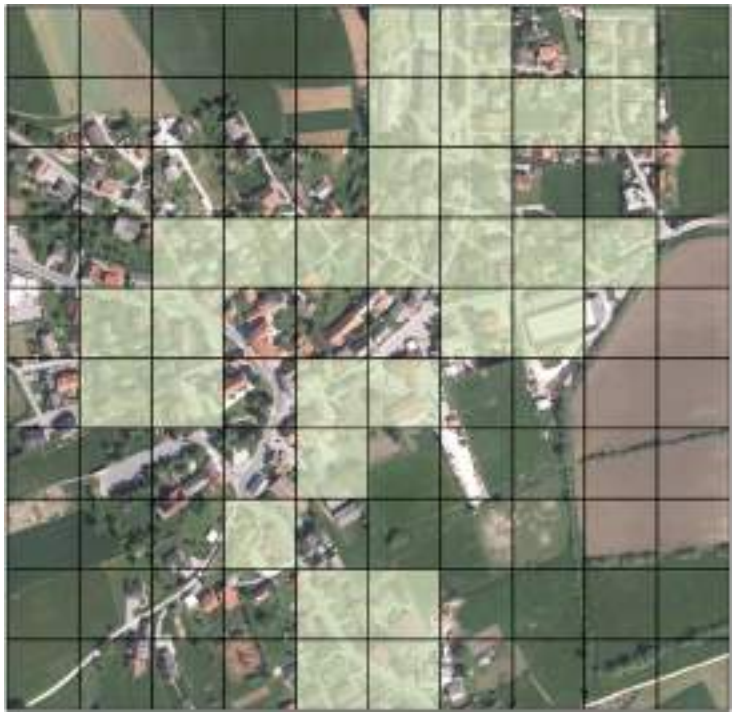
micro DH:

0,94 TWh/a in 1640 systems

COMPARISON

Geothermal energy consumption in households in 2017:

0,092 TWh/a



Shallow geothermal potential

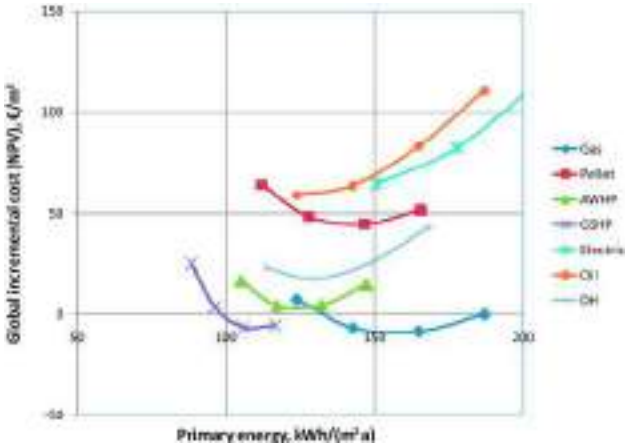
Decentralized systems - METHODS

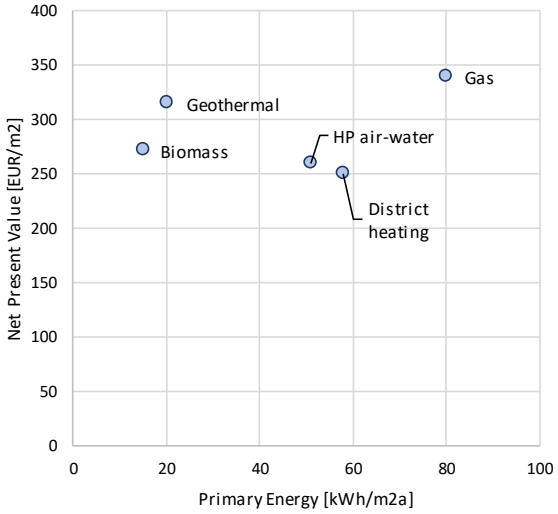
Areas with potential: < 35 GWh/a

Areas considered: Areas with no DH potential.

Economic feasibilty: investment, energy consumption, O&M

Competitiveness: LCC comparison with other technologies

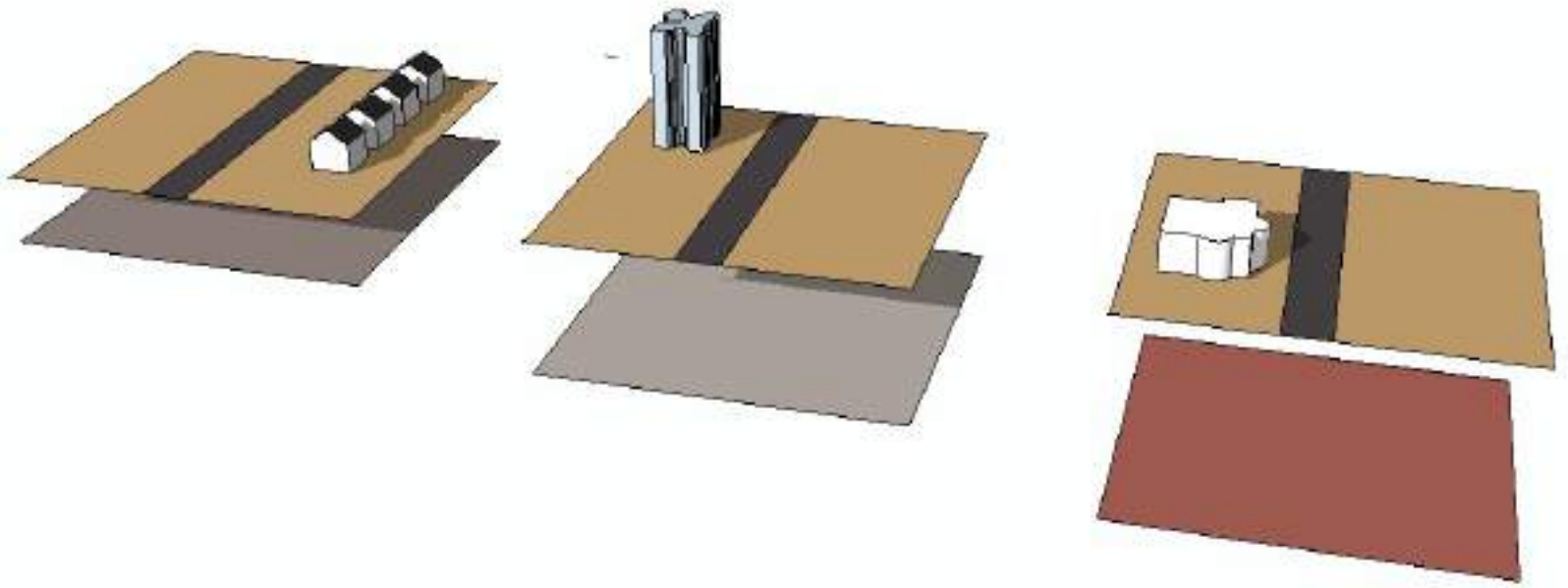




Shallow geothermal potential

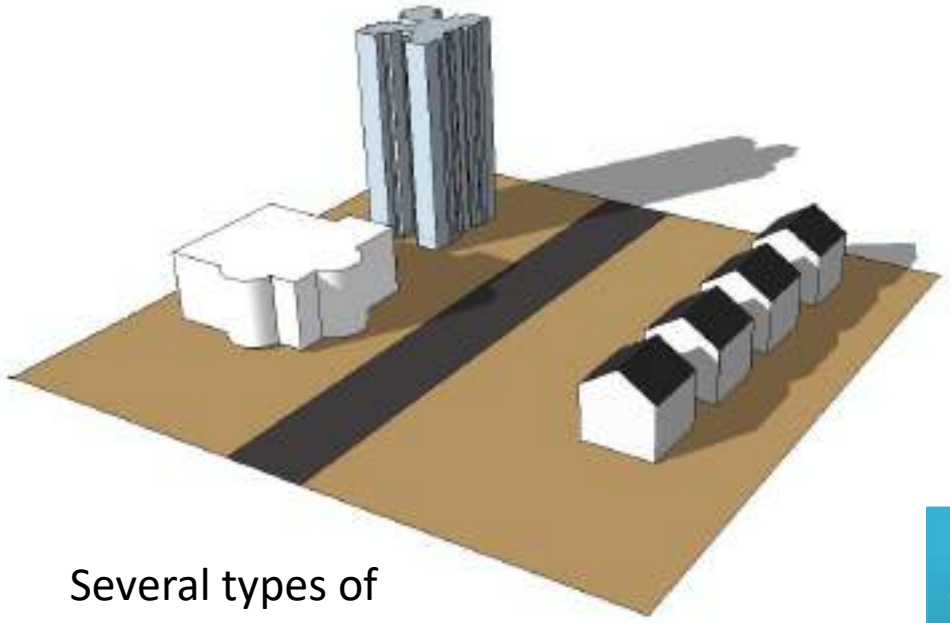
Decentralized systems - METHODS

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

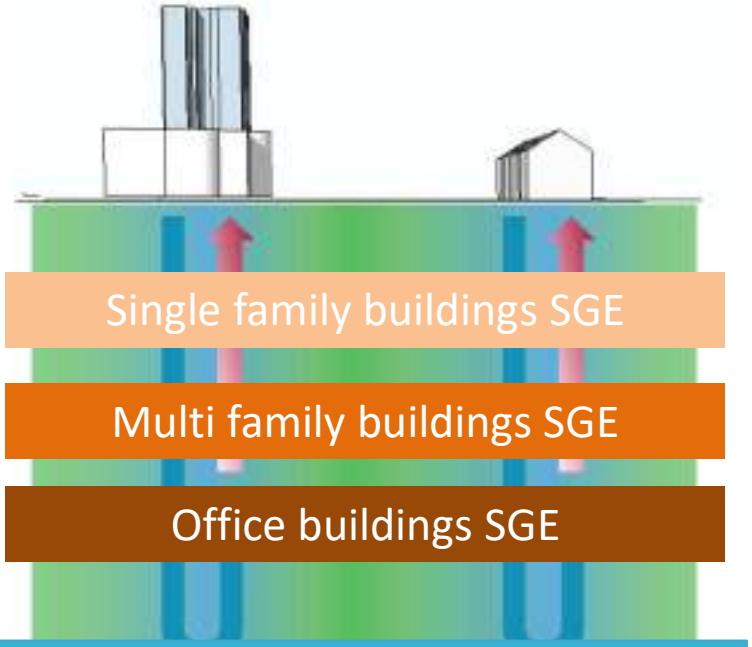


Shallow geothermal potential

Decentralized systems - example



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

Decentralized systems

Technical geothermal energy potential used for heating and DHW:

6,93 TWh/a

COMPARISON

Fuel oil energy consumption in households in 2017:

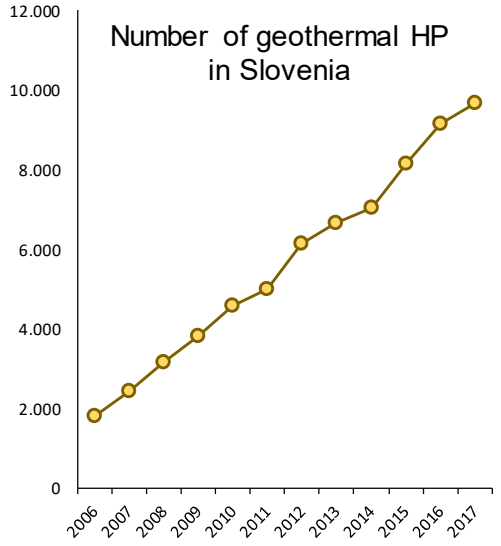
0,93 TWh/a

(www. ScienceStruck.com, 2018)

Shallow geothermal potential

CONCLUSIONS

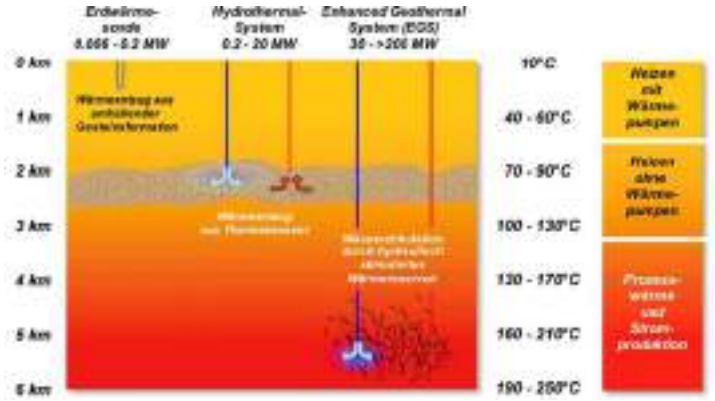
- The **benefits** of SGE are well known: reliable baseload power, carbon emission reduction and localy produced power.
- The exploitation of shallow geothermal energy has **often been overlooked** in households in the past mainly due to higher initial investment, but with **higher awareness** of its benefits, it has been increasing rapidly in the past years.



Shallow geothermal potential

CONCLUSIONS

- Economic and technical potential for **new centralized systems**, using **shallow** geothermal energy, is substantial – more than **2,5 TWh/a**, but could rarely be used as the only source for heat energy production.
- Can be used as support to existing DH networks. Each networks can exploit SGE in a range between 1 -2 MW

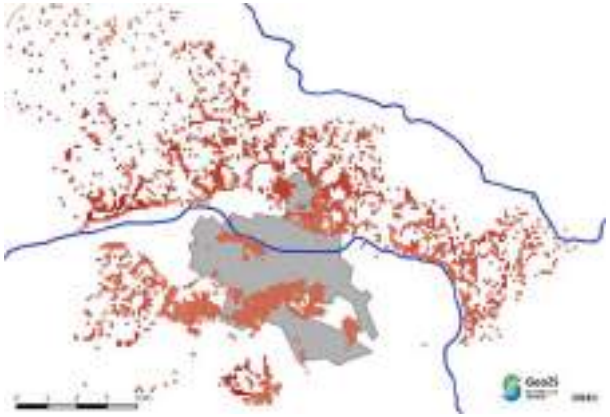


Koch, E. 2012

Shallow geothermal potential

CONCLUSIONS

- Shallow geo. potential is proving to be an opportunity for individual heating solution especially for new buildings. LCC analysis should be performed for renovation scenarios to prove economical feasibility.
- When pushing HPs into energy scenarios, electric grid load should be taken into account.



THANK YOU!

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