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Norway grants

Heat pumps in geothermal heating systems and thermal energy storage – recommendations for Poland

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Geothermal heat pump

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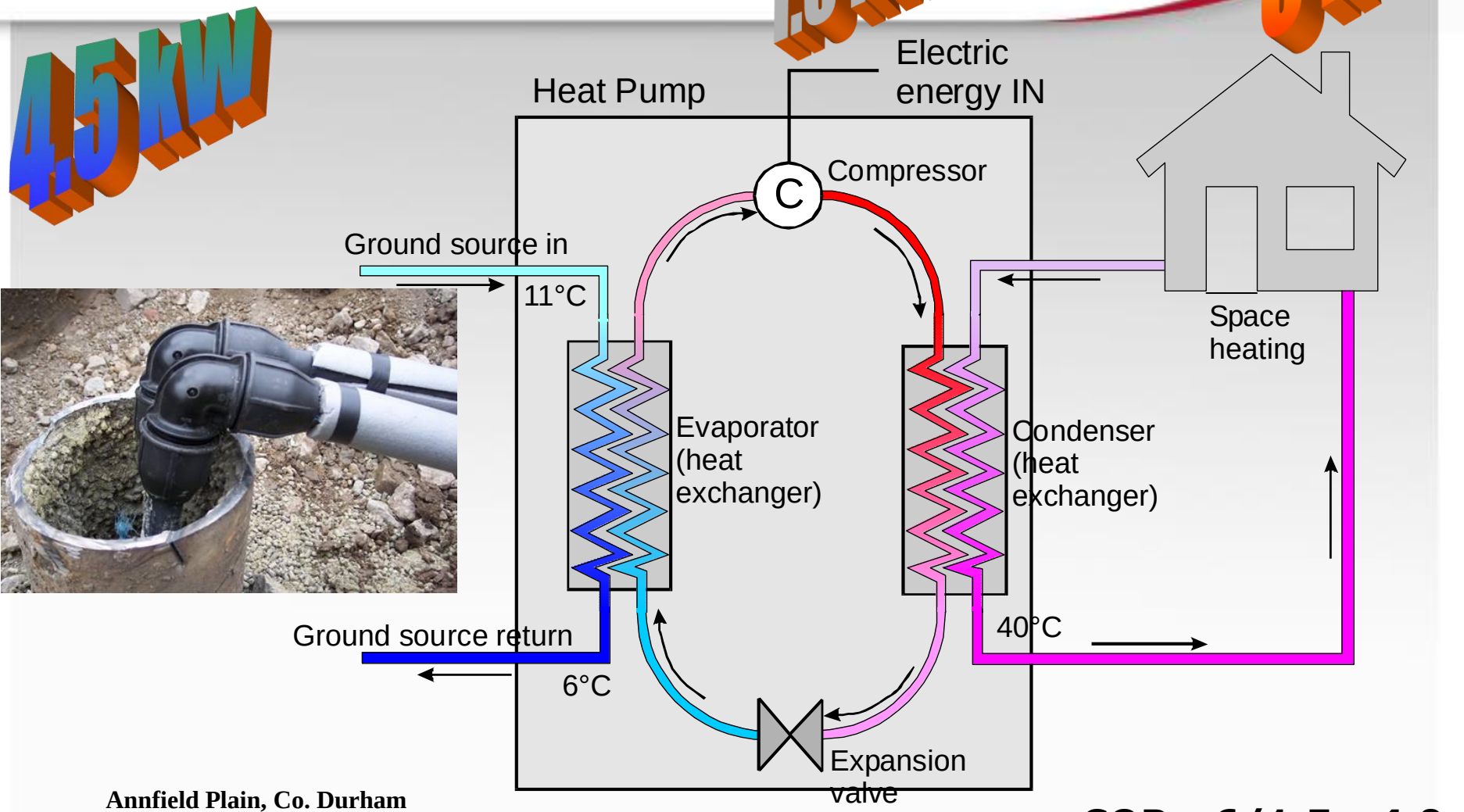

Annfield Plain, Co. Durham

COP= 6/1.5 =4.0

Status Geothermal Heat Pumps (2015)

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Norway

- Ca 60 000 GHPs installed
- Ca 5000 units sold in 2015

- Installed capacity ~1.5 GW_{th}
- Annual energy use ~ 3.0 TWh
- Population 5.2 Mill.

Poland

- Ca 45 000 GHPs installed
- Ca 5000 units sold in 2015

- Installed capacity ~0.5 GW_{th}
- Annual energy use ~ 0.7 TWh
- Population 38 Mill.

Geothermal energy source

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Closed loop systems

Borehole heat exchangers (BHE)

Open systems

Direct use of groundwater

Underground Thermal Energy Storage (UTES)
Combined heating and cooling

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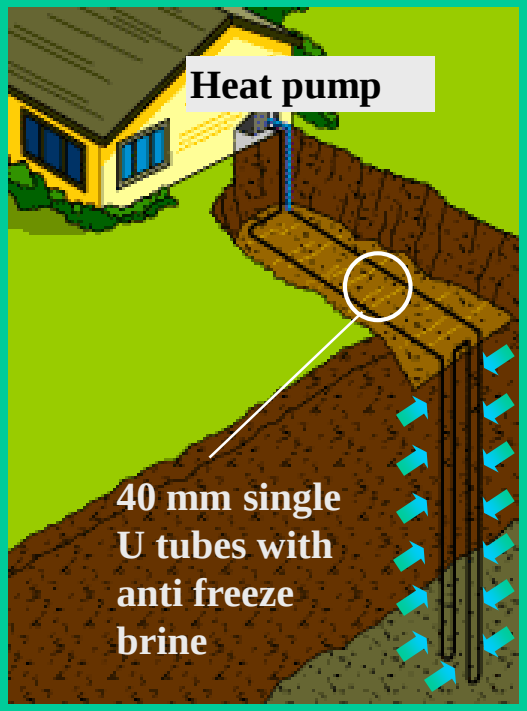
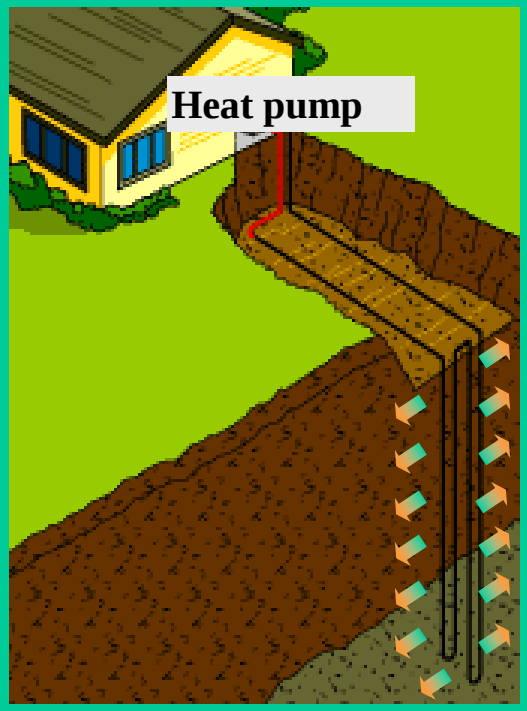


Heating



Cooling

ATES = Aquifer thermal energy storage

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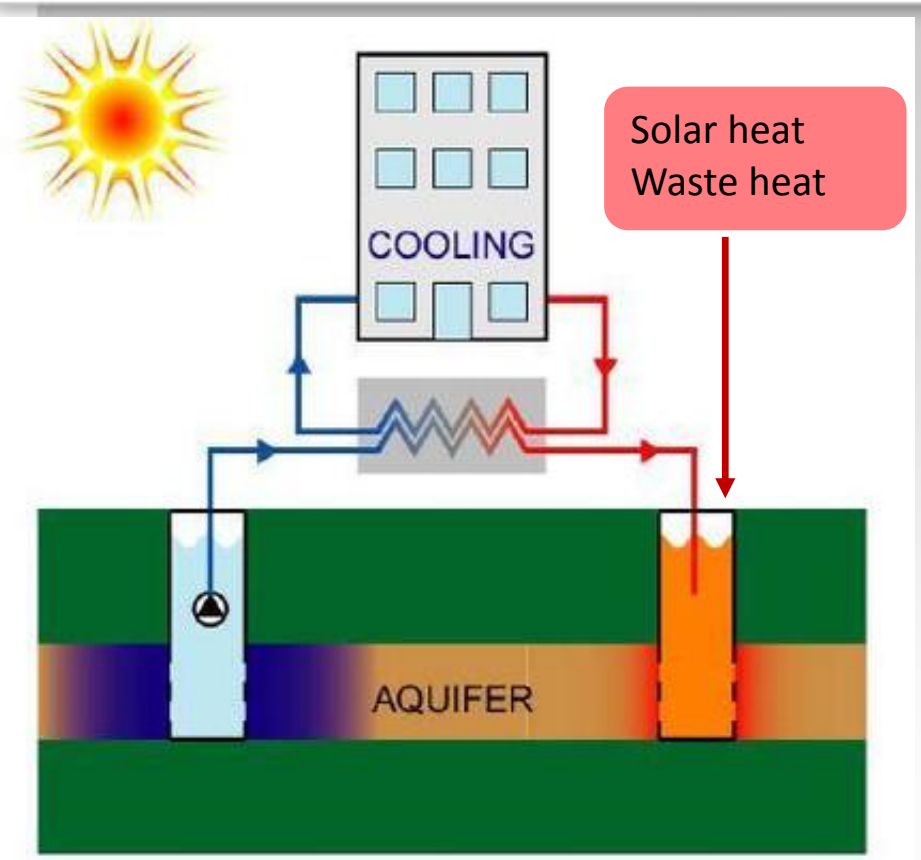

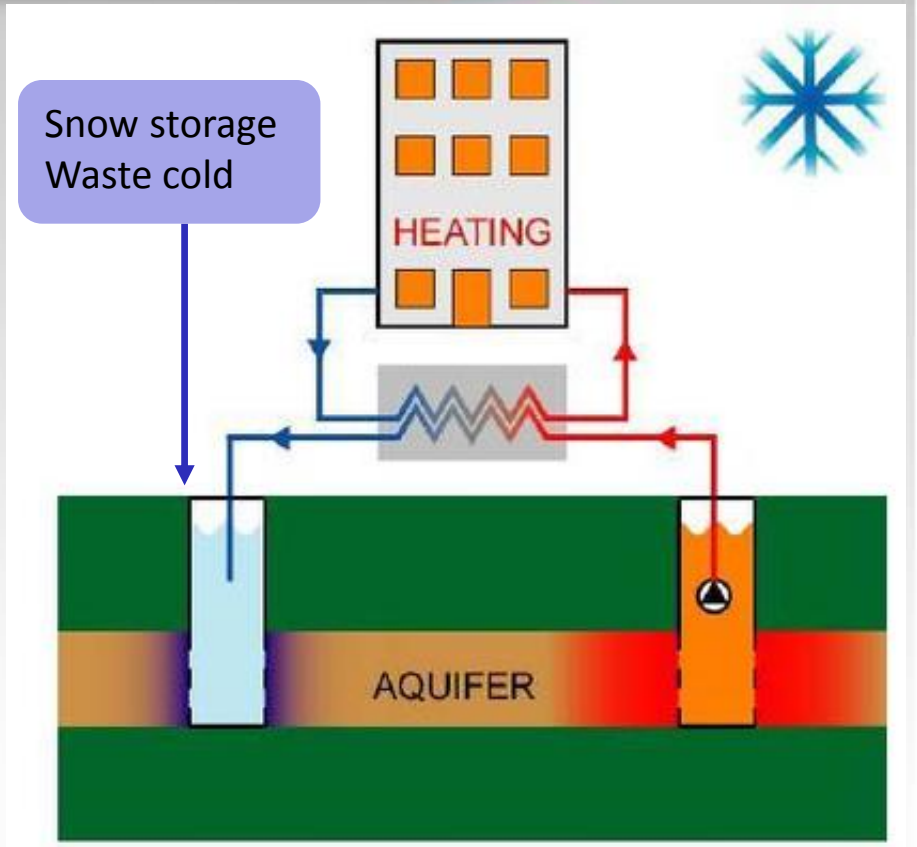

Illustration: IEA Heat pump centre

Gardermoen Oslo Airport
Norwegian largest ATES installations

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ATES from 1998

9 MW cooling and 7.5 MW heating

9 warm and 9 cold wells to 45 m depth

Groundwater temperature:

Cold wells 4.1 – 4.5 ºC

Warm wells 4.5 – 20 ºC

Investment ATES system

17 MNOK (8.7 MPLN)

Pay back time < 4 years

- Major problems with iron precipitation and iron bacteria
- Yearly maintenance is needed

Borehole Thermal Energy Storage (BTES)

Arcus, Oslo 90 boreholes á 300m depth

Geological map

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Baltic Shield: Crystalline rock with low permeability →Preferred conditions for BTES installations

Sedimentary Rocks With groundwater reservoirs →conditions for ATES installations

Fractured groundwater reservoirs in crystalline rocks

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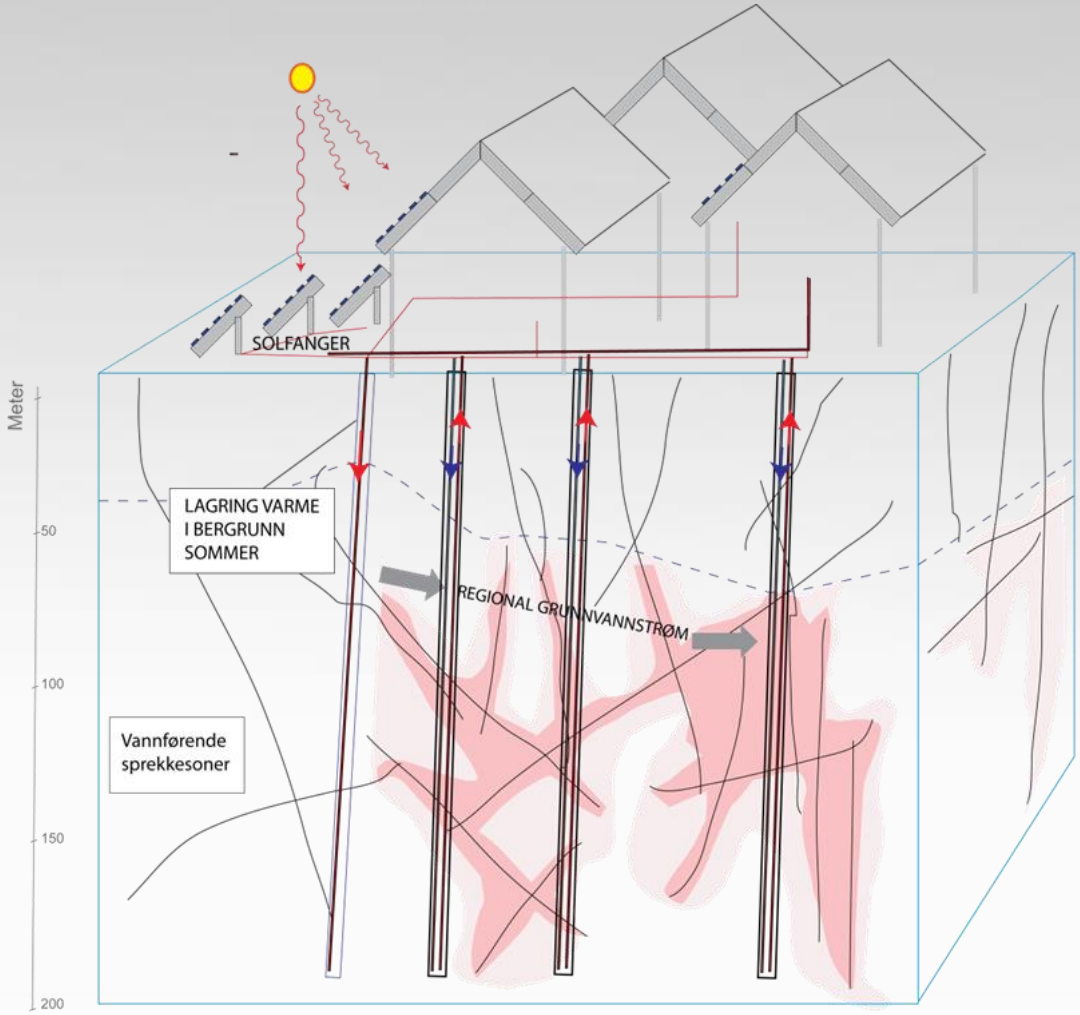

Is Geothermal Heat Pumps environmentally friendly?

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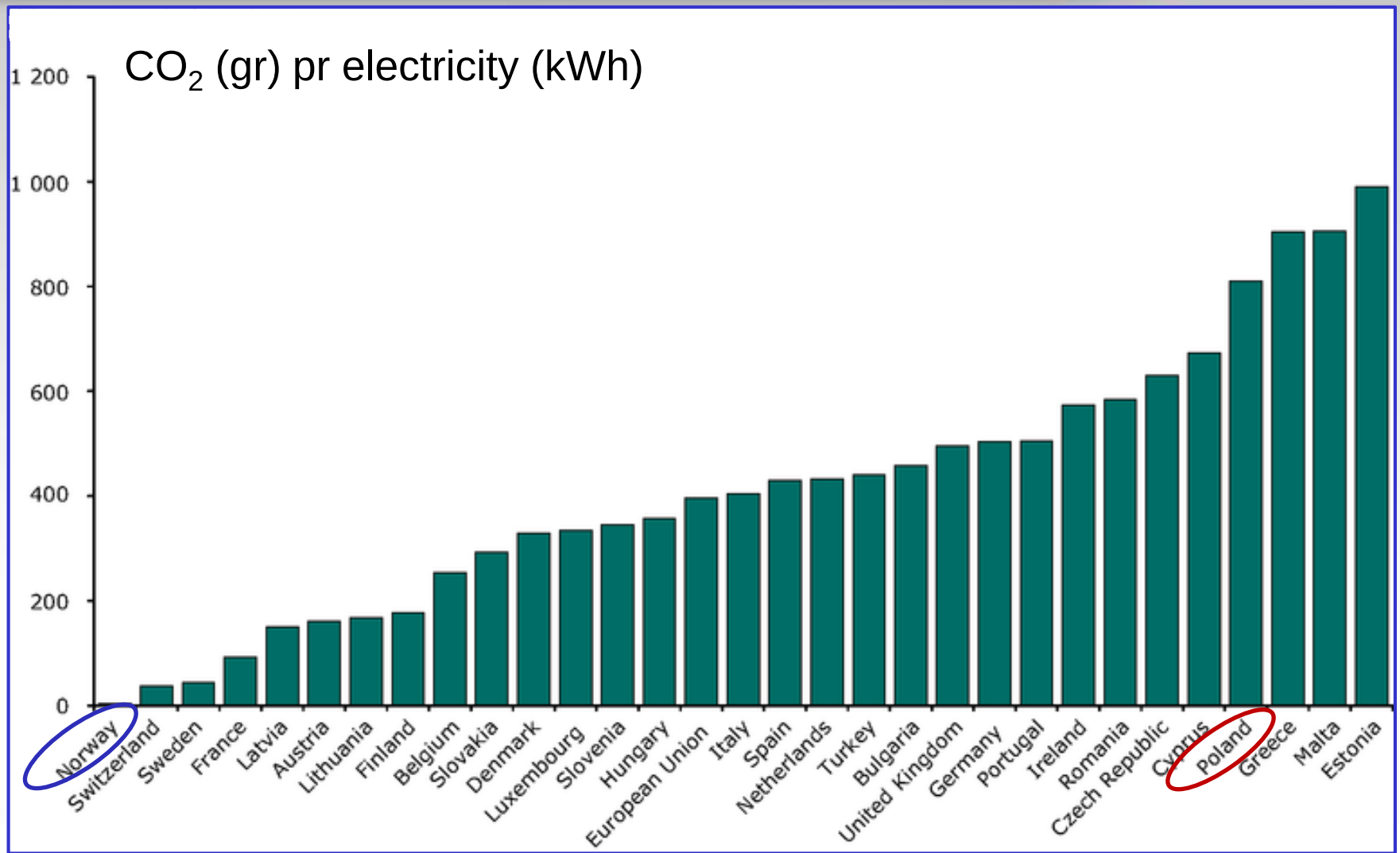
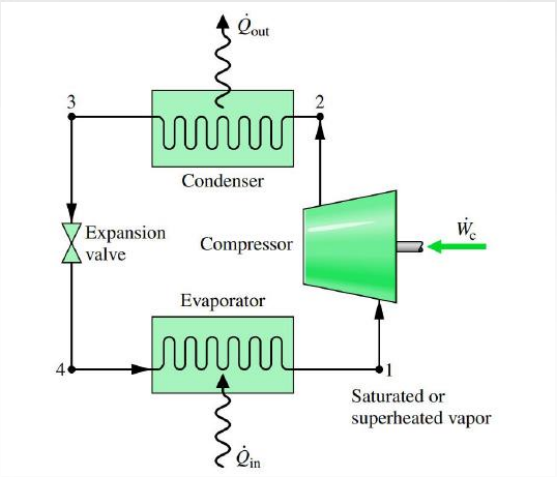
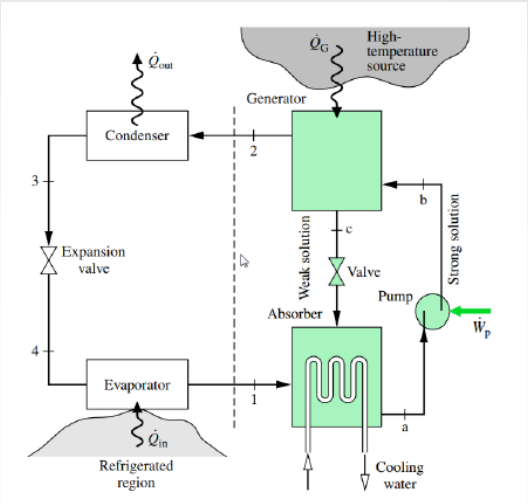


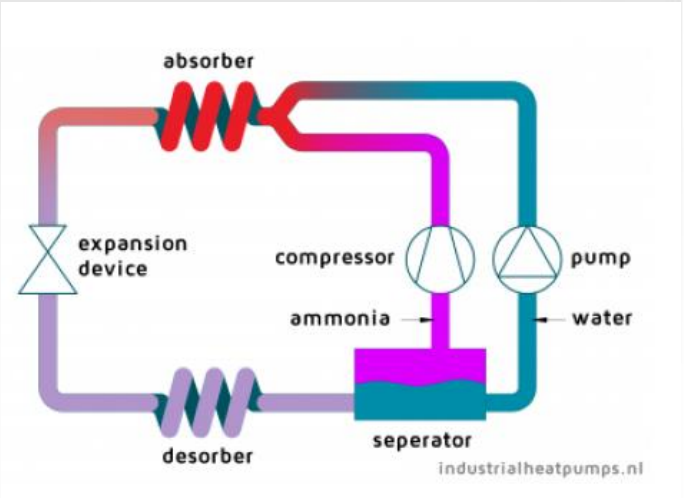
Heat Pump

Three type of technologies

- Vapor compressor cycle (VCC) heat pump
- Vapor absorption heat pump
- Hybrid heat pump (integration of above two)







Recommendations

- Holistic approach
  - Combining heating and cooling will improve the efficiency of GSHP installations
  - Consider the heating and cooling demand in the neighborhood (UTES)
  - Low temperature (60/40°C) district heating systems is favorable for geothermal heat pump
  - Base load and peak load planning

Lokalizacja obszarów miasta i gminy Sochaczew na tle głównych strategicznych zbiorników wód podziemnych (GZWP)

Location of the Sochaczew city and municipality against the map of the major groundwater reservoirs (GZWP)

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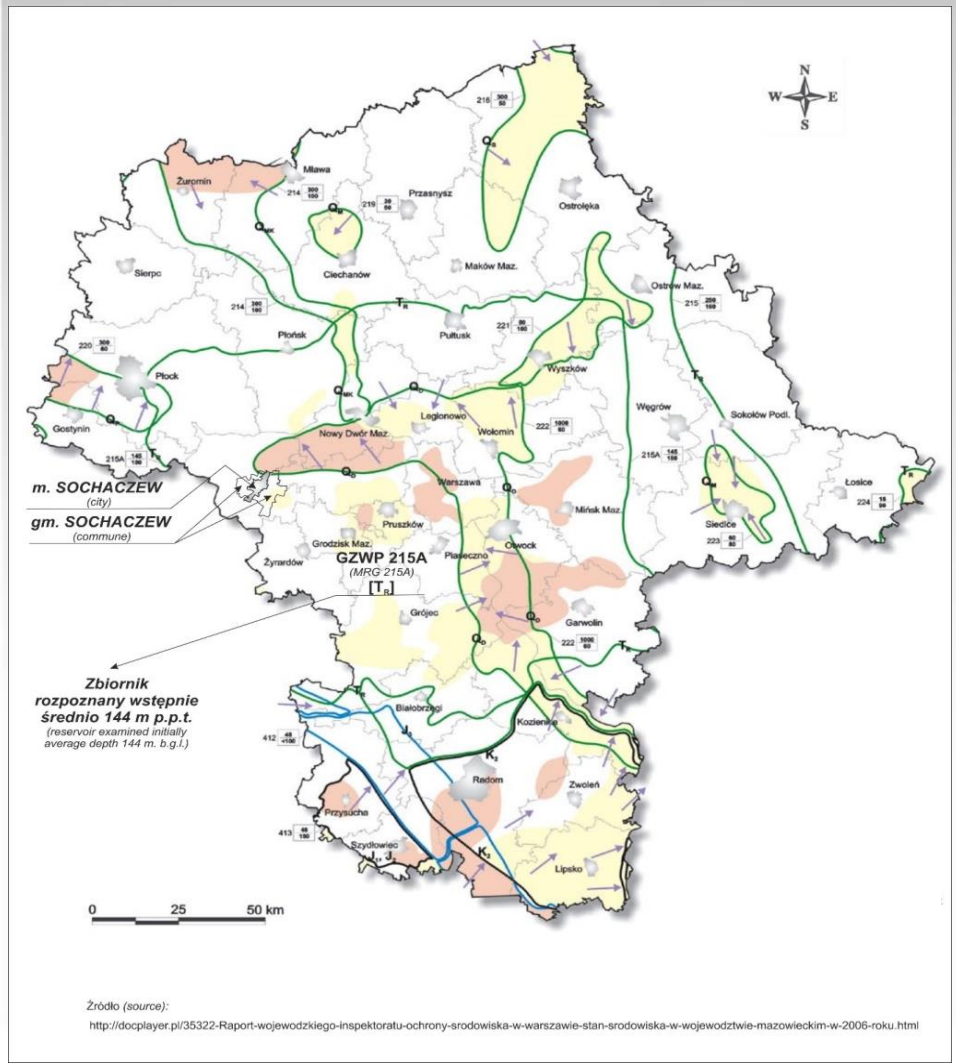

Źródło *(source)*:
http://docplayer.pl/35322-Raport-wojewodzkiego-inspektoratu-ochrony-srodowiska-w-warszawie-stan-srodowiska-w-wojewodztwie-mazowieckim-w-2006-roku.html

Granice wydzielonych GZWP w ośrodkach:
(borders of separated main reservoirs of ground waters [MRG] in:)

- **porowym** *(porous environment)*
- **szczelinowym i szczelinowo-porowym** *(fissure and fissure-porous environment)*
- **szczelinowo-krasowym** *(fissure-karst environment)*

Wiek i geneza GZWP
(age and genesis of MRG)

Q - **zbiorniki w czwartorzędzie** *(Quaternary reservoirs):*
- Q_D - **dolin** *(valleys)*
- Q_P - **pradolin** *(urstromtal)*
- Q_S - **sandrów** *(sandurs)*
- Q_K - **dolin kopalnych** *(fossil valleys)*
- Q_M - **międzymorenowe** *(intermoraine)*

- K_2 - **zbiorniki w kredzie górnej** *(upper Cretaceous reservoirs*
- T_R - **zbiorniki w trzeciorzędzie** *(Tertiary reservoirs)*
- J_3 - **zbiorniki w jurze górnej** *(upper Jurassic reservoirs)*
- J_2 - **zbiorniki w jurze środkowej** *(middle Jurassic reservoirs)*
- J_1 - **zbiorniki w jurze dolnej** *(lower Jurassic reservoirs)*

Obszary ochronne GZWP
(protected areas MRG)

- **najwyższej ochrony** *(the highest protection)*
- **wysokiej ochrony** *(high protection)*

222 | 1000 / 60 - **numer GZWP** *(numbe of MRG)*
szacunkowe zasoby w tys. m³/dobę *(estimated resources in thousands m³/day)*
średnia głębokość w m *(average depth in meters)*

- **kierunek przepływu wód w GZWP** *(direction of water flow in MRG)*

Lokalizacja studni z bazy Państwowej Służby Hydrogeologicznej (PSH) w granicach miasta i gminy Sochaczew

Location of boreholes based on the State Hydrogeological Service (PSH) database in the borders of Sochaczew town and municipality

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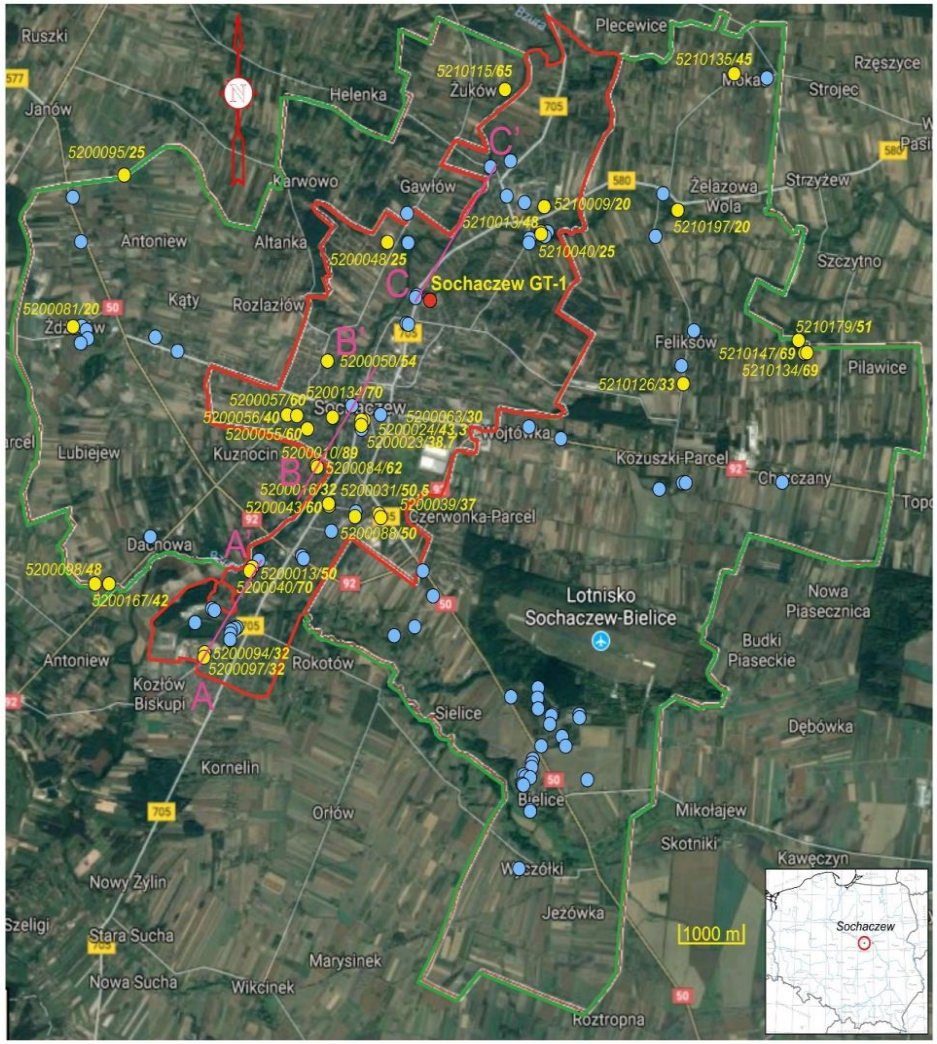

- studnie: numer/wydajność [m³/h] *(5200010/**89**)*
  (wells: number/discharge)
- studnie o wydajnościach <20 m³/h,
  lub z brakiem informacji o wydajnościach
  albo dostępu do informacji o studniach
  (wells with discharge <20 m³/h
  or with lack of informations about discharge)
- projektowany otwór Sochaczew GT-1 do głęb. 1450 m
  (projected borehole Sochaczew GT-1 depth of 1450 m)
- granica miasta Sochaczew *(border of the Sochaczew town)*
- granica gminy Sochaczew *(border of the Sochaczew commune)*
- linie wybranych profili hydrogeologicznych, uproszczonych: A-A', B-B', C-C'
  lines of selected hydrogeological profiles, simplified: A-A', B-B', C-C'

Uproszczone profile hydrogeologiczne wybranych studni rzutowanie wzdłuż linii A-A’ na ortofotomapie

Simplified hydrogeological profiles of selected wells projected along A-A’ cross section on the orthophotomap

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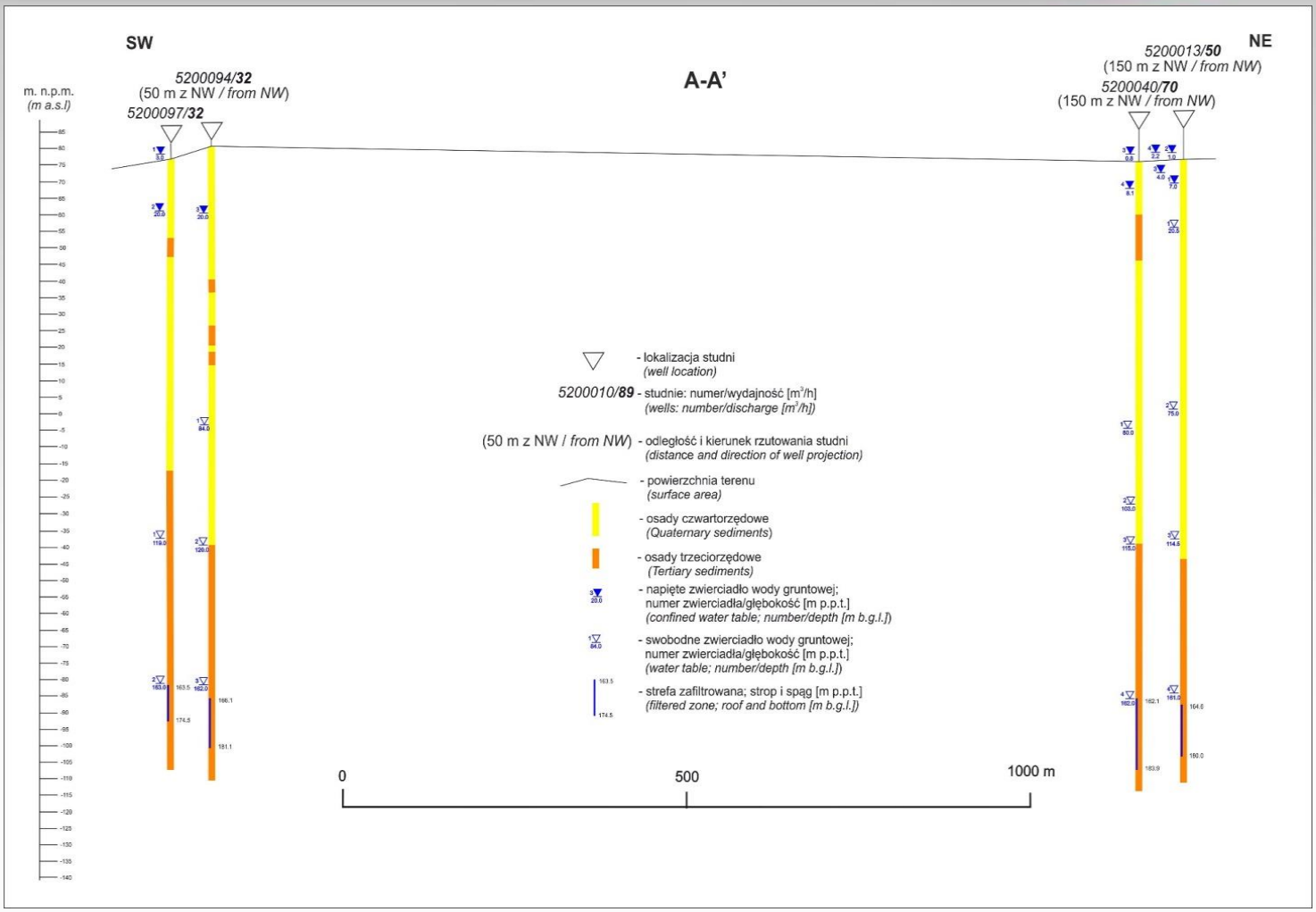

Uproszczone profile hydrogeologiczne wybranych studni rzutowanie wzdłuż linii B-B’ na ortofotomapie

Simplified hydrogeological profiles of selected wells projected along B-B’ cross section on the orthophotomap

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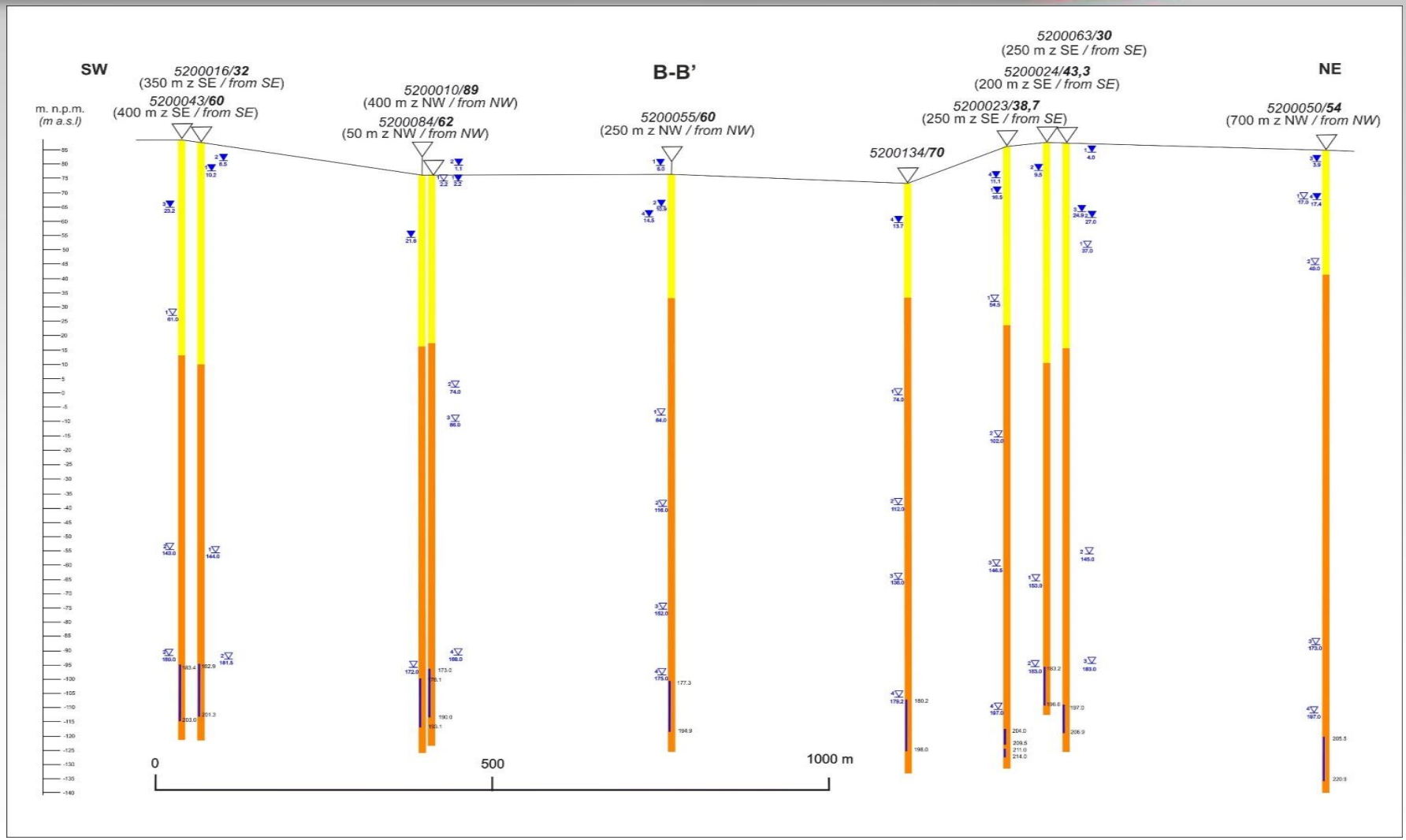

Uproszczone profile hydrogeologiczne wybranych studni rzutowanie wzdłuż linii C-C’ na ortofotomapie

Simplified hydrogeological profiles of selected wells projected along C-C’ cross section on the orthophotomap

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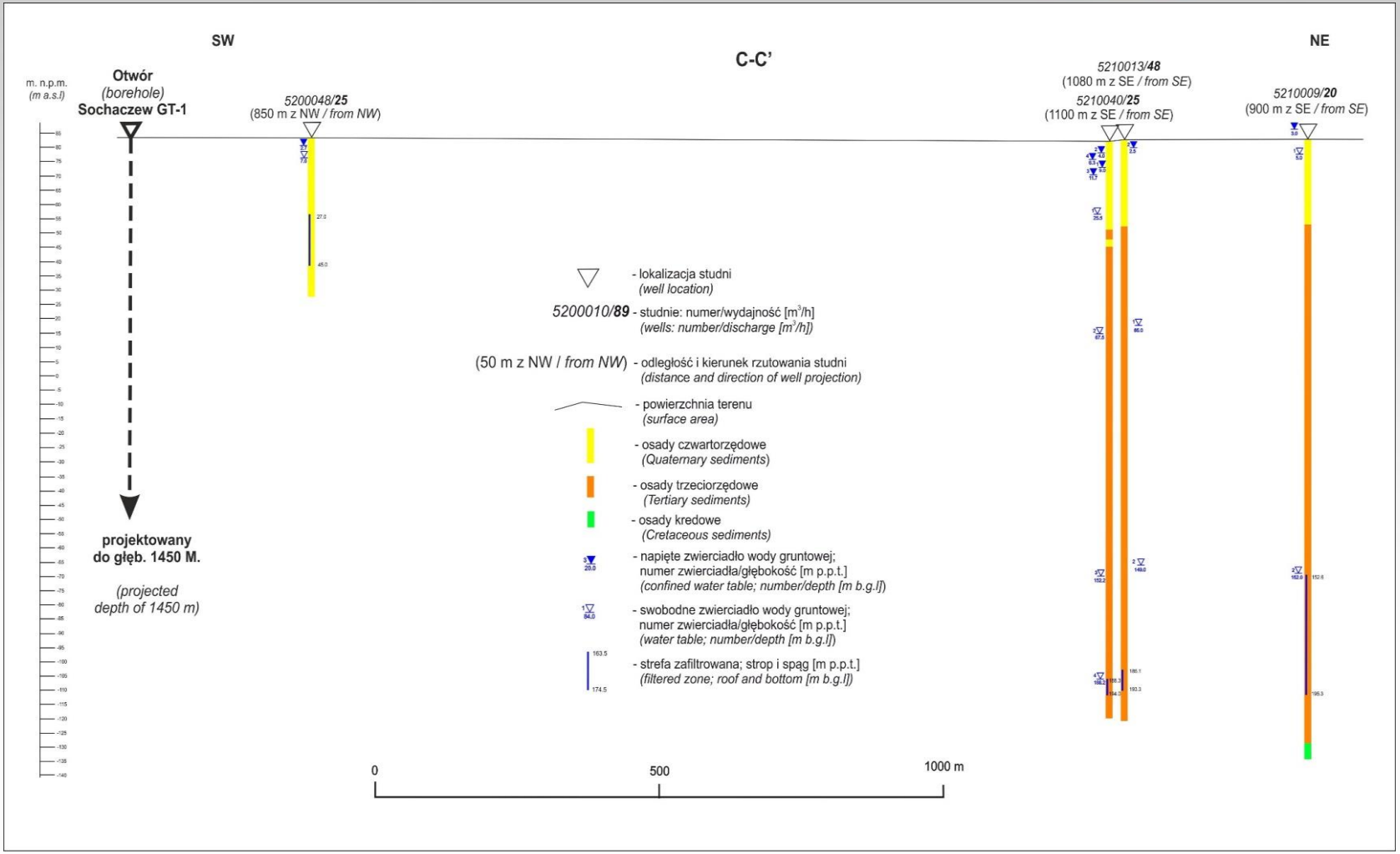

Lokalizacja systemu ATES w Sochaczewie – propozycja

Proposed location of ATES system in Sochaczew

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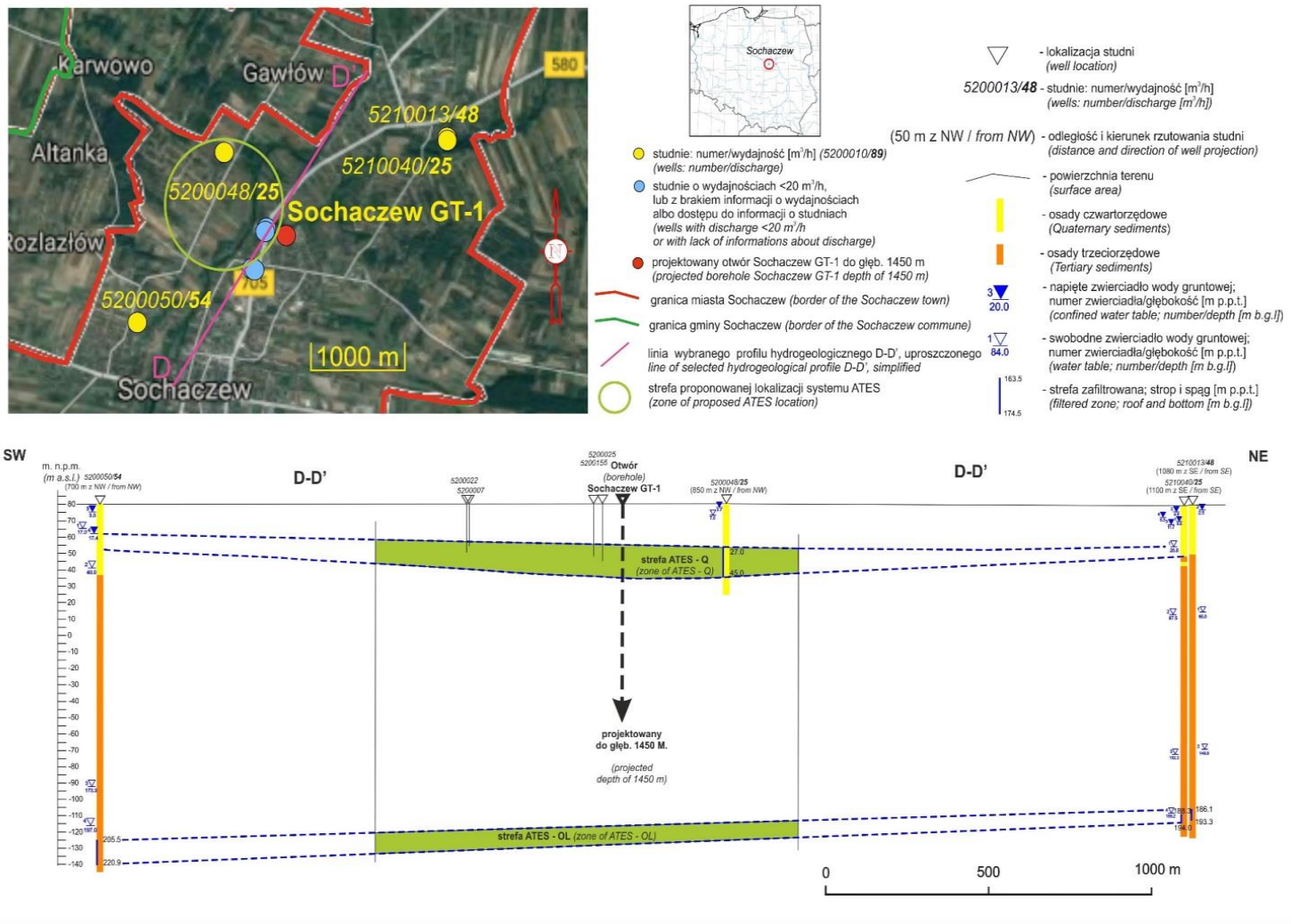

Thanks for the attention!

Dziękujemy za uwagę!

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