Poddębice

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Pre-feasibility studies of geothermal energy uses for heating in selected towns and pilot project proposals

M. Hajto – **AGH UST**,

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Pre-feasibility studies of geothermal energy uses for heating in selected towns and pilot project proposals:

❑ Poddębice Town - *Geothermal reservoir issues*

Marek Hajto[1], Helga Tulinius[2], Iwona Monika Gałeczka[2], Anna Karska[3], Andrzej Peraj[3]

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(2) ISOR Iceland Geosurvey, Reykjavik Iceland
(3) Geotermia Poddębice Sp z o.o.

AGH Akademia Górniczo-Hutnicza im. Stanisława Staszica w Krakowie

ORKUSTOFNUN National Energy Authority

Geotermia Poddębice

Tło geologiczne projektu
Geological background of the project

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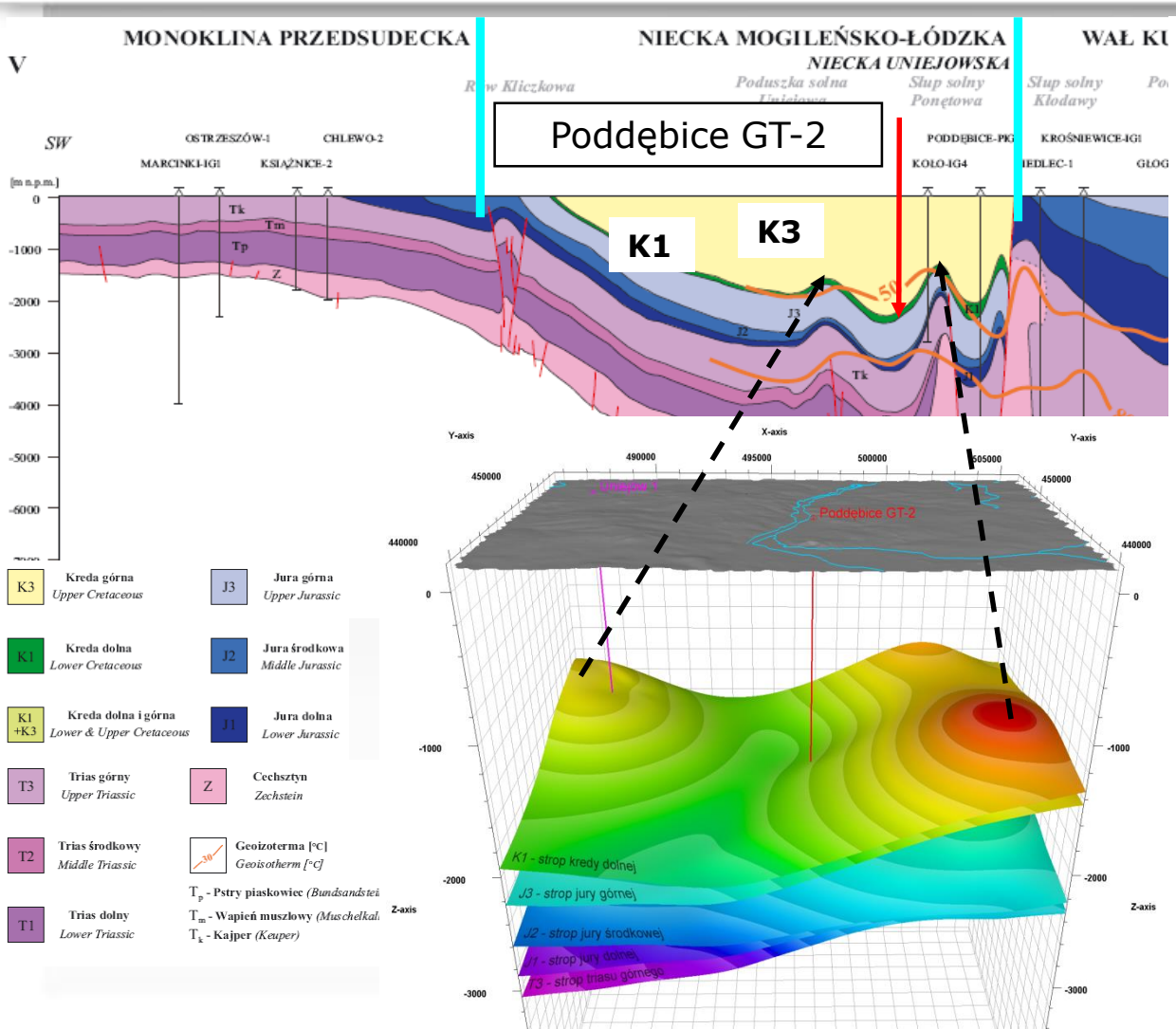

- inwersja laramijska (kreda/paleogen) ok. 70 mln lat temu
  laramide inversion (Cretaceous/Paleogene) ca. 70 mio years ago

- przewaga osadów morskich, głównie mezozoicznych o miąższości 7-12km głównie wapienie, margle, piaskowce - wodonośne
  domination of sedimentary formations of Mesozoic age, thickness 7-12km mainly: limestones, marls, sandstones – waterbearing

Wyniki badań – parametry złoża
The results – reservoir parameters

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Badania laboratoryjne i geofizyka wiertnicza (*lab. & borehole geoph.)*

Głębokość otworu / *well depth*	2101 m
Typ wody / mineralizacja / *mineralisation*	HCO_3-Na-Ca / 432 mg/L
Warstwa wodonośna / *aquifer depth*	1962-2063 m ppt
Miąższość warstwy wodonośnej / *thickness*	98 m
Porowatość intergranularna / *tot. porosity*	16-23% (brak porowatości wtórnej)
Porowatość efektywna / *eff. porosity*	13.7-17.0% (średnia: 16.2%)
Zailenie / *clay content*	VCL = 9.8%
Przepuszczalność / *permeability*	87.98-1021.10 mD (średnia: 620 mD)
Wskaźnik produktywności PHI*NET	17.76 nV/V
Nasycenie wodą / *water saturation*	100%
Oporność wody złożowej / *wat. resistivity*	Rwa = 2.6 ohmm
Wiek wody / *water age*	27 tyś lat (C14) ~ 10-14 tyś lat (zlodowacenie)

Pompowania pomiarowe 2014
Pumping tests 2014

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2014 pompowanie pomiarowe – próbna eksploatacja w celu określenia wyższych zasobów Q = 252 m^3/h
exploitation test with downhole pump – target 252 m^3/h

Parametr / ***parameter***	**Jednostka /** ***unit***	**Wartość /** ***value***
Zasoby eksploatacyjne (Qe) / *exploitation reserves*	m^3/h	**252**
Wydatek jednostkowy (q) / *productivity index*	$m^3/h/1m$	2.96
Depresja ekspl. (Se) / *depression*	m	**85.3**
Zasięg leja depresji (R) / *radius of depress. cone*	m	**857.0**
Gł. statycznego zw. wody / *static water level*	m n.p.t. /a.g.l.	26.0
Gł. dyn. zw. wody / *depth of dynamic water level*	m p.p.t. /b.g.l.	59.3
Rzędna terenu / *ground elevation*	m n.p.m. /a.s.l.	119.5
Mineralizacja / *mineralization*	mg/dm^3	432
Temperatura / *outflow temperature*	^oC	**68.4**
Obszar górniczy / *mining area*	km^2	7.18

6 lat eksploatacji złoża Poddębice GT-2
6 years of production history

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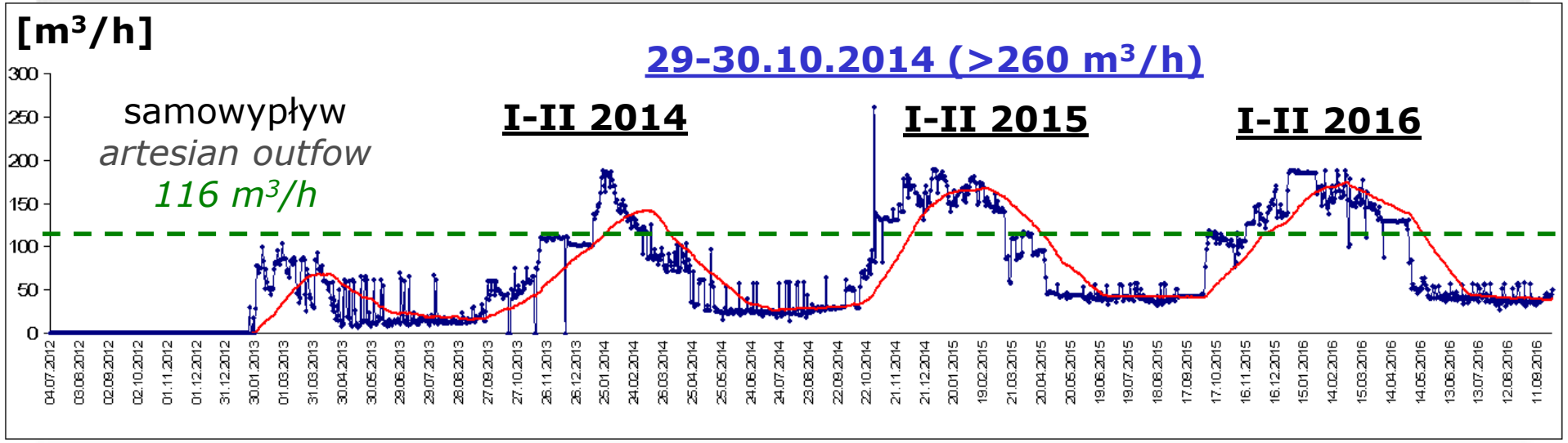
Samowypływ do 116 m^3/h
Artesian outflow to ca. 116 m^3/h

Eksploatacja przy użyciu pompy wgłębnej: listopad – luty
Submersible pump used in period: November - February



Data / *Date*

Wnioski – warunki złożowe, eksploatacja
Conclusions – reservoir conditions, exploitation

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- Bardzo dobre warunki złożowe i wydobywcze złoża geotermalnego
  Very good reservoir and production parameters of geothermal aquifer
- Potrzeba opracowania modelu złoża (MODFLOW, TOUGH, etc…)
  wód geotermalnych i jego stosowanie dla potrzeb zrównoważonej eksploatacji wód, prognozowania zachowania złoża w trakcie eksploatacji, lokalizacji następnych otworów, itd., etc
  A need to construct a geothermal reservoir model (MODFLOW, TOUGH, etc.) and its use for the purposes of long-term sustainable exploitation, prediction of its possible reaction for long-term exploitation, optimal location of next wells, etc.
- *Stabilność parametrów złożowych i eksploatacyjnych podczas dotychczasowego wydobycia (złoże jest w początkowej fazie eksploatacji)*
  Stable reservoir and exploitation parameters during the-so-far production (however: geothermal aquifer at initial stage of exploitation)
- *Bieżąca produkcja nie jest agresywna i nie przewiduje się spadku poz. wody*
  The current production is not aggressive and the water level is not predicted to decrease if continued
- *Podtrzymanie rekomendacji dotyczących okresowej symulacji pracy złoża w tym: poziomu wody i/lub ciśnienia programem Lumpfit*
  Potential water level/pressure change during long-term production – periodic simulation by Lumpfit software

Analizy termodynamiczne wody geotermalnej z otworu Poddębice GT-2
Thermodynamic analyzes of water from Poddębice GT-2 well

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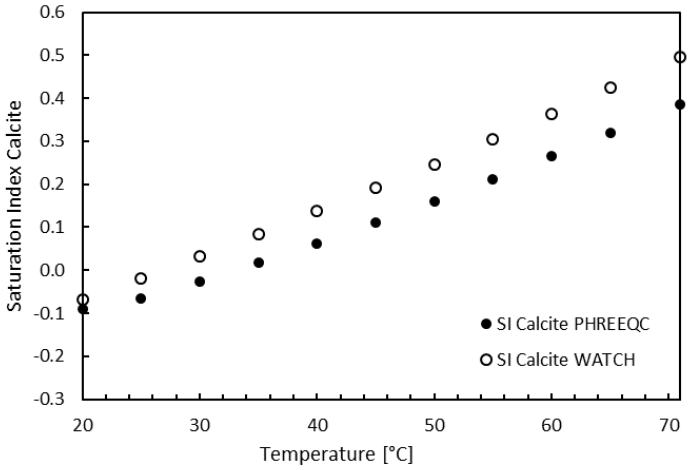
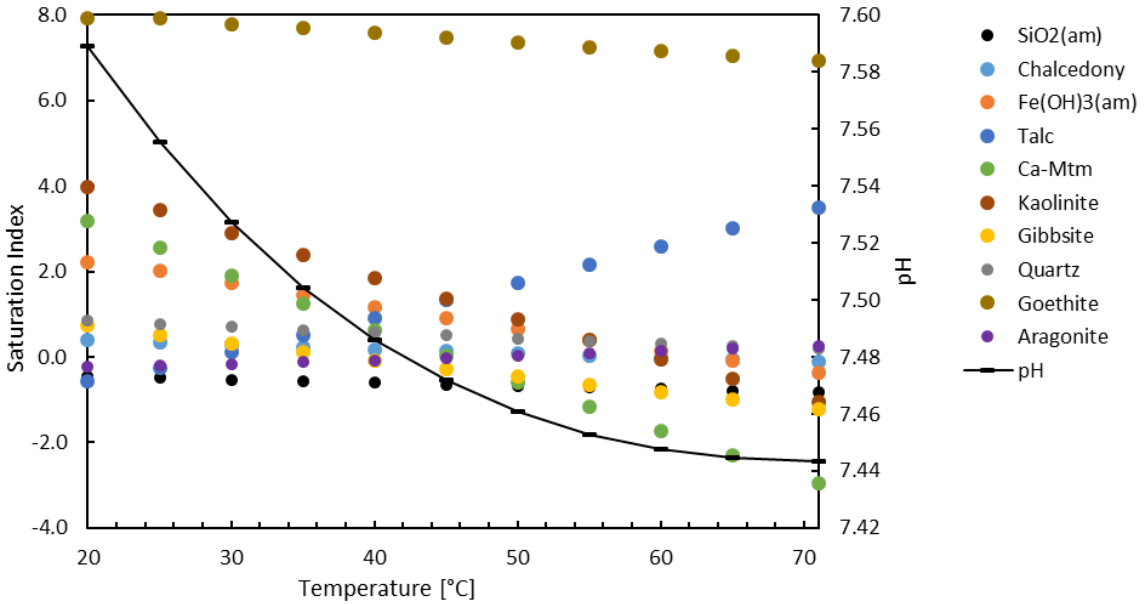
Stan nasycenia płynu w odniesieniu do niektórych faz mineralnych

Saturation state of the fluid with respect to several mineral phases





Wnioski – chemizm, analiza termodynamiczna
Conclusions - chemical, thermodinamic analyzes

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- Chociaż woda geotermalna ma relatywnie niskie stężenia rozpuszczonych składników mineralnych, to może wykazywać skłonność do wytrącania niewielkich ilości kalcytu w wyższych temperaturach, a w niższych niewielkie ilości minerałów ilastych /zaw. anion dioksydanido (-OOH)/ i chalcedon

  Although the geothermal water has very low concentrations of dissolved constituents, it has the potential to produce some limited amount of calcite scaling at higher temperatures and some clays/oxyhydroxide/chalcedony precipitates at lower temperatures.
- PH wody jest neutralne/alkaliczne, a zatem istnieje małe ryzyko korozji

  The pH of the water is neutral/alkaline, therefore there is low risk of corrosion
- Przy ciśnieniach powyżej 0,34 barów nie będzie odgazowywanych

  At pressures higher than 0.34 bars there will be no degassing
- Niskie stężenia substancji toksycznych i metali ciężkich wskazują na ograniczony wpływ na aktywność biologiczną, jeśli woda ta będzie odprowadzona do wód powierzchniowych

  Low toxic and heavy metal concentrations indicates limited effect on the biological activity if this water would be discharged to the surface waters
- *Woda geotermalna jest doskonała do wszechstronnego wykorzystania*

  The fluid is good for wide utilization
- *No changes in chemical concentration can be detected between samples*

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Poddębice – surface part of the system

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Pre-feasibility studies of geothermal energy uses for heating
Poddębice

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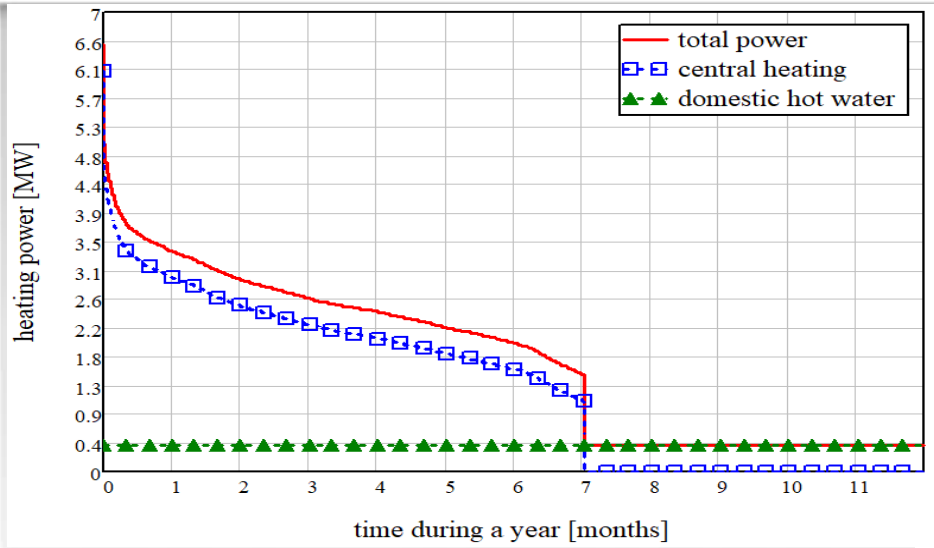
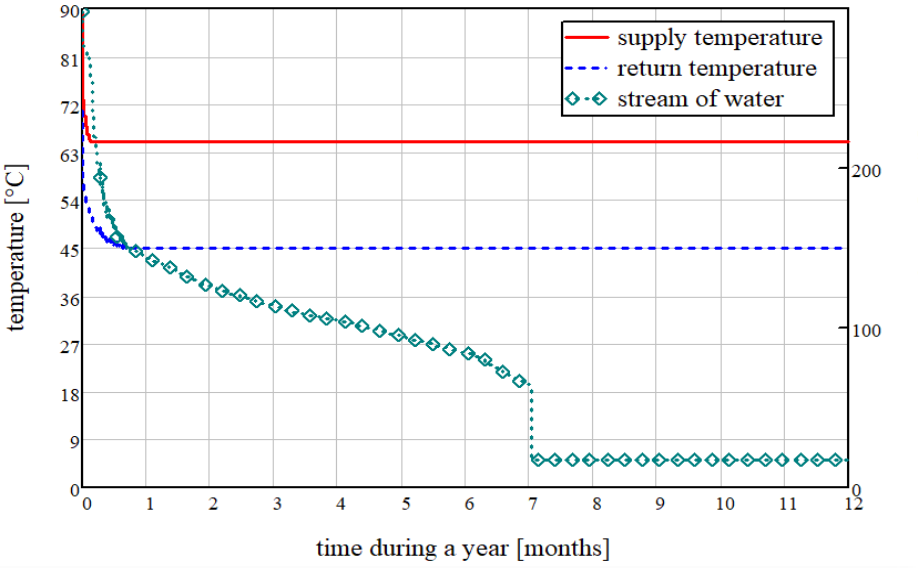


CURRENT SITUATION

Energy source: Geotermia Poddębice
~6.5 MW, ~55-55 TJ/yr

Characteristic of the thermal power demand for the recipient currently served vs time (heat user in the option dhA and dhGeoA).
Curve ordered by total power



Control of thermal power delivery - dynamic curve (heat user in the option dhGeoA)

Space heating 90/70/20/-20°C
Hot tap water 65/45°C

Pre-feasibility studies of geothermal energy uses for heating **Poddębice**

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Assumptions concerning the geothermal parameters (Kępińska et al., 2017a):

- **aquifer level: Lower Cretaceous**
- **borehole depth: 2 101 m under the ground level**
- **maximum water flow rate: 252 m^3/h**
- **temperature of geothermal water in the reservoir 73°C**

- water represents low mineralisation allowing for a single-well operation. Cooled water can be reused, e.g. as potable water (similarly to the system used in Mszczonów).

Pre-feasibility studies of geothermal energy uses for heating
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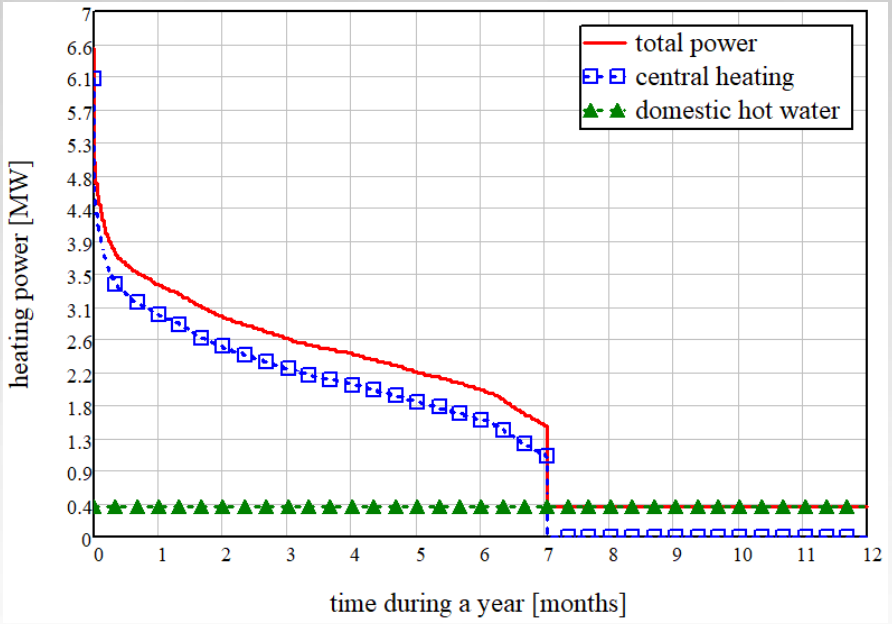
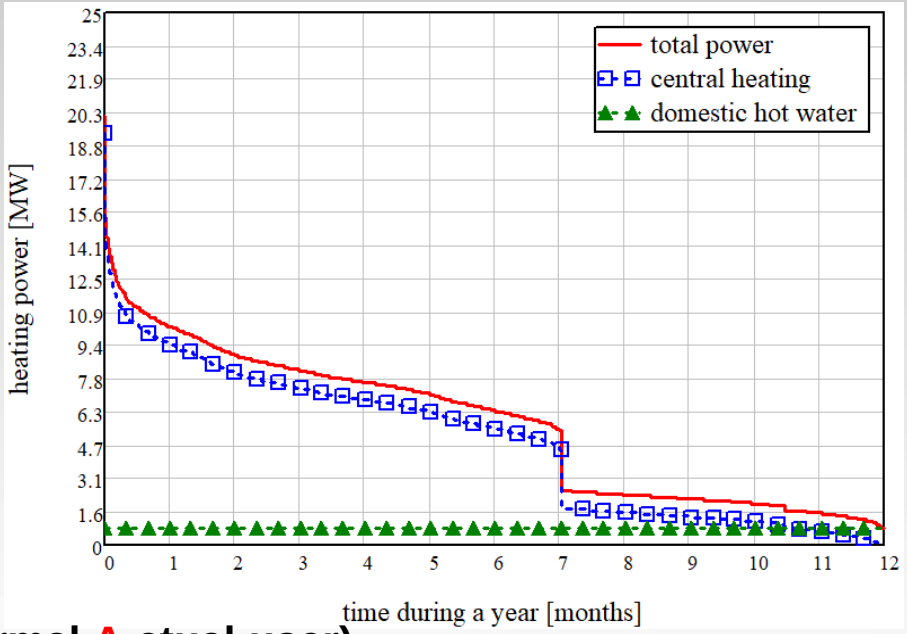
Power demand vs. time

A–ctual energy user



E-xtended energy user



considered oprions:

- **gA (g-geothermal A-ctual user)**
- **gE (g-eothermal E-xtended user)**
- **ahpA (a-sorption h-eat p-ump A-ctual user)**
- **chpA (c-mpressor h-eat p-ump A-ctual user)**
- **ahpE (a-bsorption h-eat p-ump E-xtended user)**
- **chpE (c-mpressor h-eat p-ump E-xtended user)**
- **gErf – (g-geothermal A-ctual user, rf - retrofitted)**

Pre-feasibility studies of geothermal energy uses for heating
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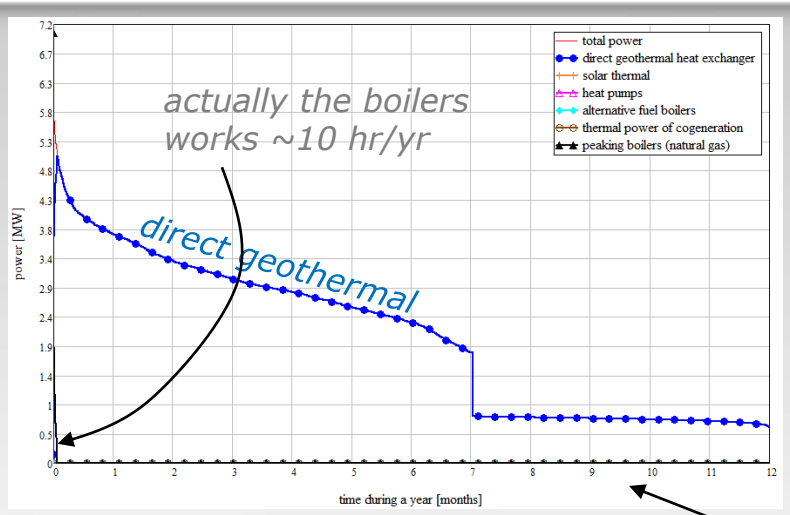
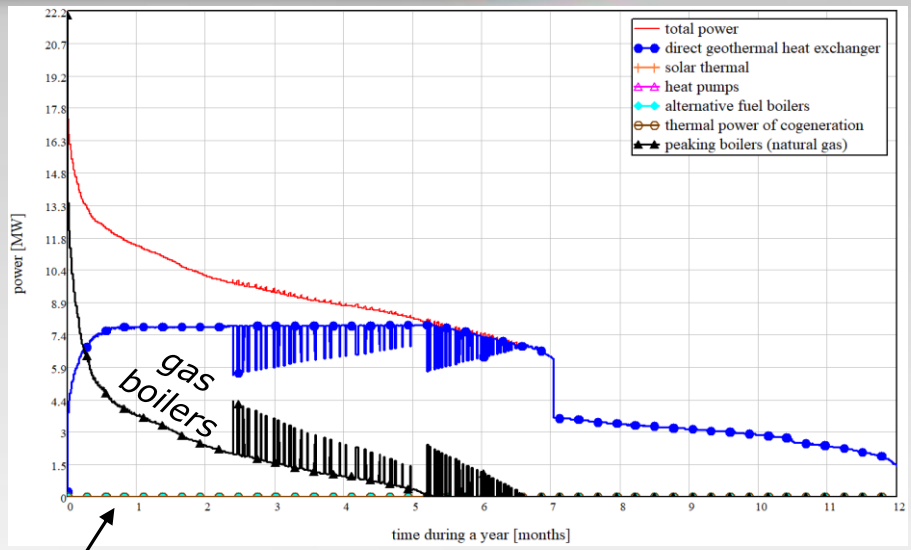
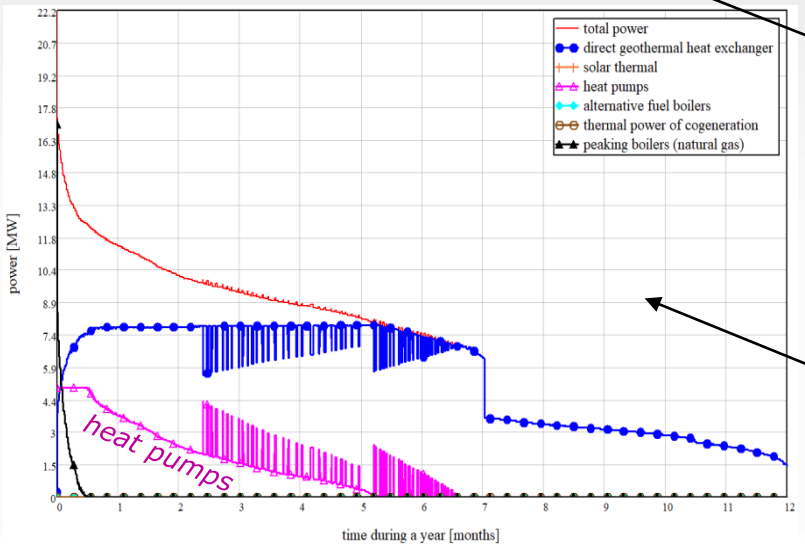
Power production vs. time







A–ctual energy user, actual energy source

E-xtended energy user, no heat pumps

chpE or ahpE - extended energy user, heat pumps utilzation

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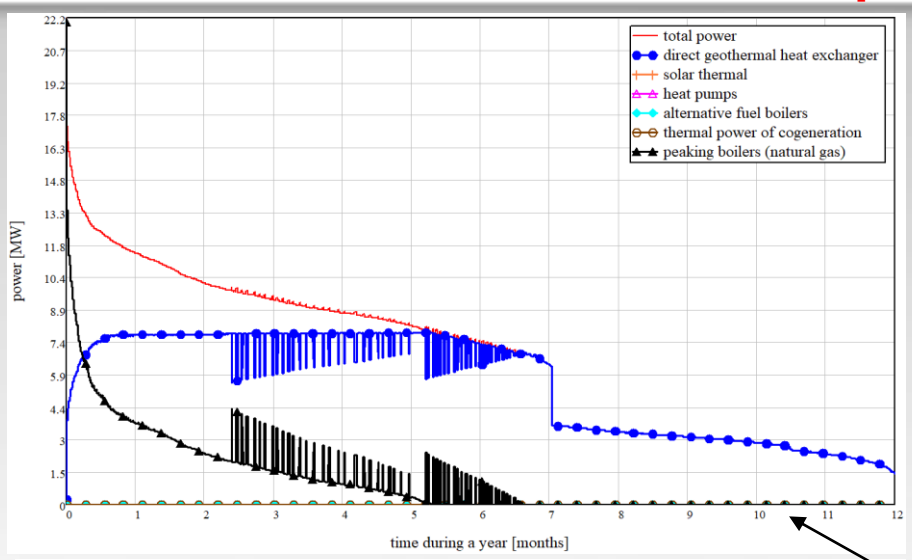
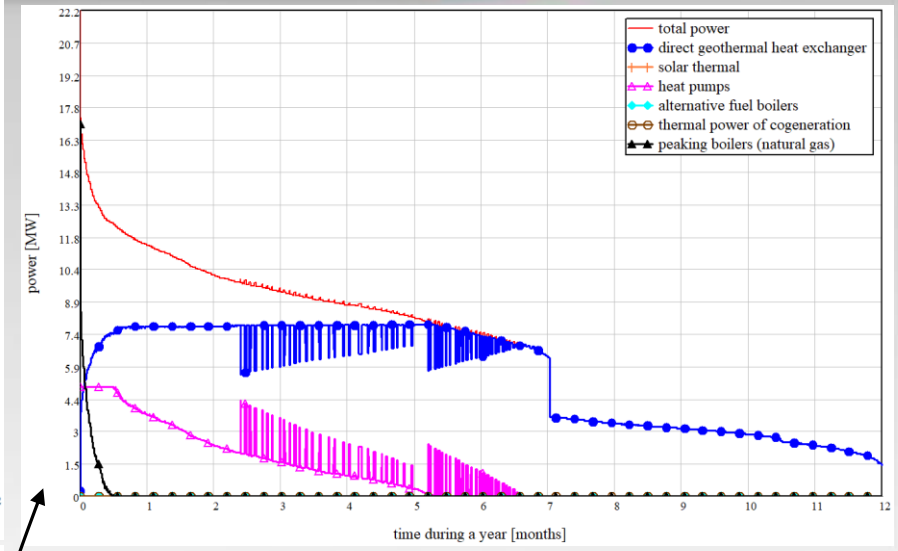
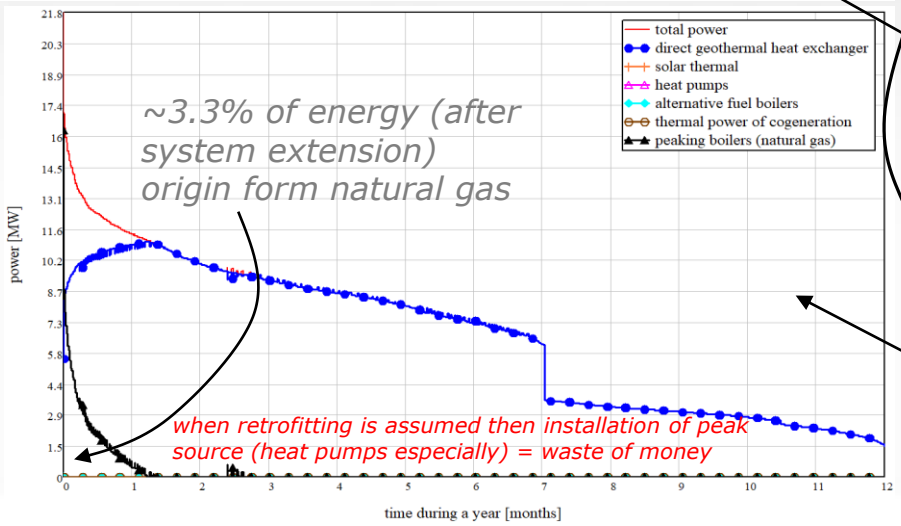
Power production vs. time







E–xtended energy user, actual heating system (90/70/20/-20°C), no heat pumps

E-xtended energy user, actual heating system (radiators), heat pumps utilised

E–xtended energy user, heating system system retroffited (65/50/20/-20°C), no heat pumps (!)

Summary
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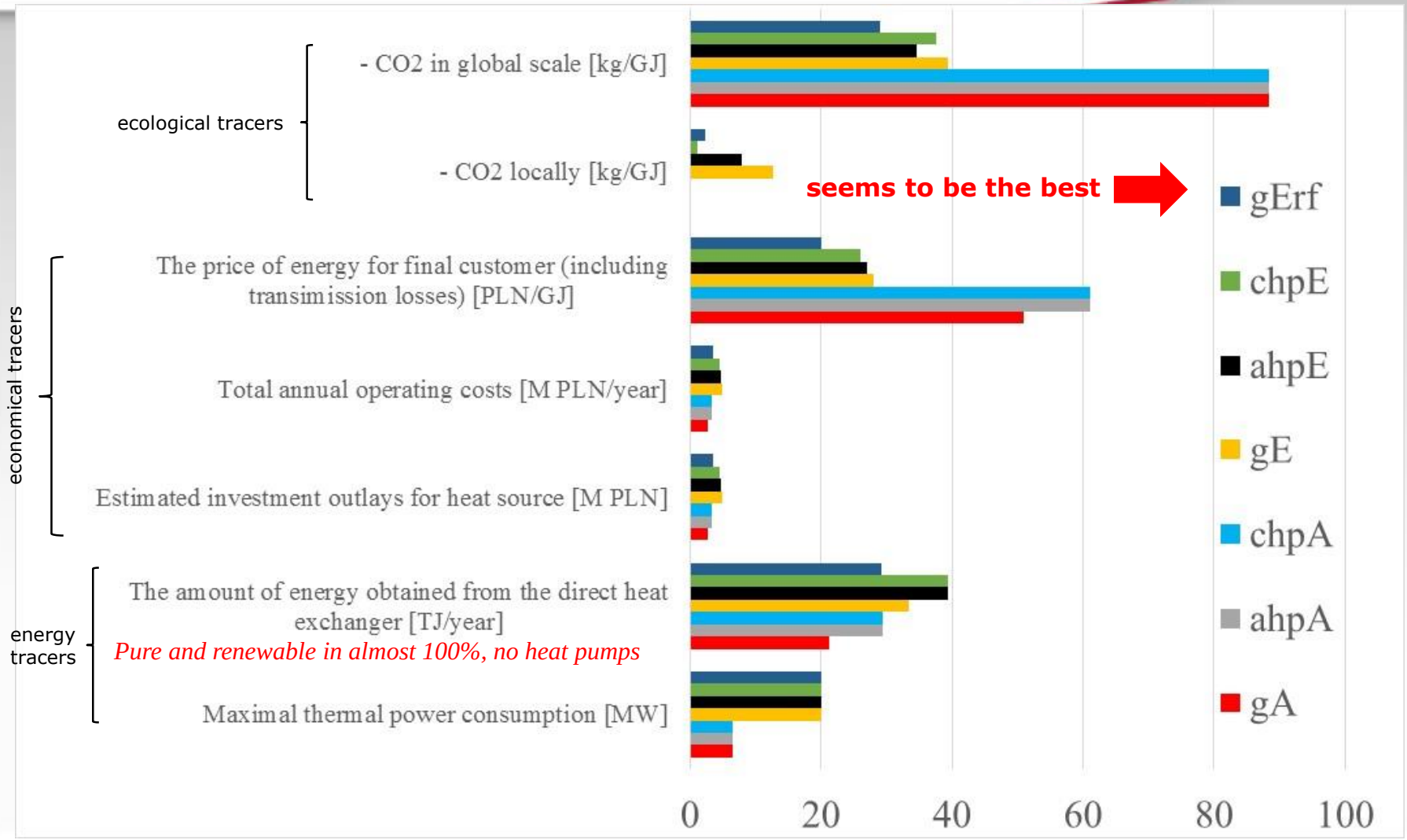

Summary

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O.P. Einarsson, H. Tulinius, I. M. Gałeczka – **OS**

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- Increase surface of radiators
- Install larger radiators in a few buildings
- Measure the return temperature, confirm that it is lower than before (30-35°C)
- Select the correct temperature control valves for the buildings
- Very simple and low-cost pilot project

Pilot project proposals, next steps
Poddębice

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It looks like Poddębice, at least for now, does not need heat pumps. The primary target is reduction of return water temperature.

1. **Geothermal energy utilisation controlling – reduction of return water temperature (automatization, telemetry and telecontrol),**

2. **Reduction of return temperature by increasing the surface of radiators and large surface heating (floor heating etc.) and cascade use of geotermal energy,**

3. **Determining the conditions for new customers (required operating parameters),**

4. **Wider use of central domestic hot tap water.**

Pilot proposition, next steps
Poddębice
(Kirsti Midtomme - CMR)

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The temperatures supplied to the DHN are not sufficient to meet the temperature requirements of heating systems installed in housing stock. The heating system in the housings therefore often run on high mass flow rates and cause high return temperatures to the DHN

This problem can be solved in two ways:

i. By increasing the supply temperature from 70°C to e.g. 85°C in the DHN that would result in reduced return temperature near to 40 - 35°C

ii. By improved heating system in connected buildings so that the heating surface area is increased/improved that would result in reduced return temperature.

Strategic development of the GeoDH

Kirsti Midtomme - CMR

District heating network at Poddebice is growing and estimated to have total capacity at around 18 MW compared to existing 4 MW. Heating system at the building level has large influence on specification of district heating network. The town has unique opportunity to move towards fourth generation district heating network with lower supply and return temperature. Several possible solutions for building level integration are shown in the report for city of Konstantynów in this project. It is highly recommended that Poddebice review these solutions and find ways to collaborate with building owner so that heating system in buildings could be transformed or designed for low temperatures.

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Thank you for your attention

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