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MGC, 08 October 2015

RIEHEN: THE PATH TO PROFITABLE GEOTHERMAL DISTRICT HEATING

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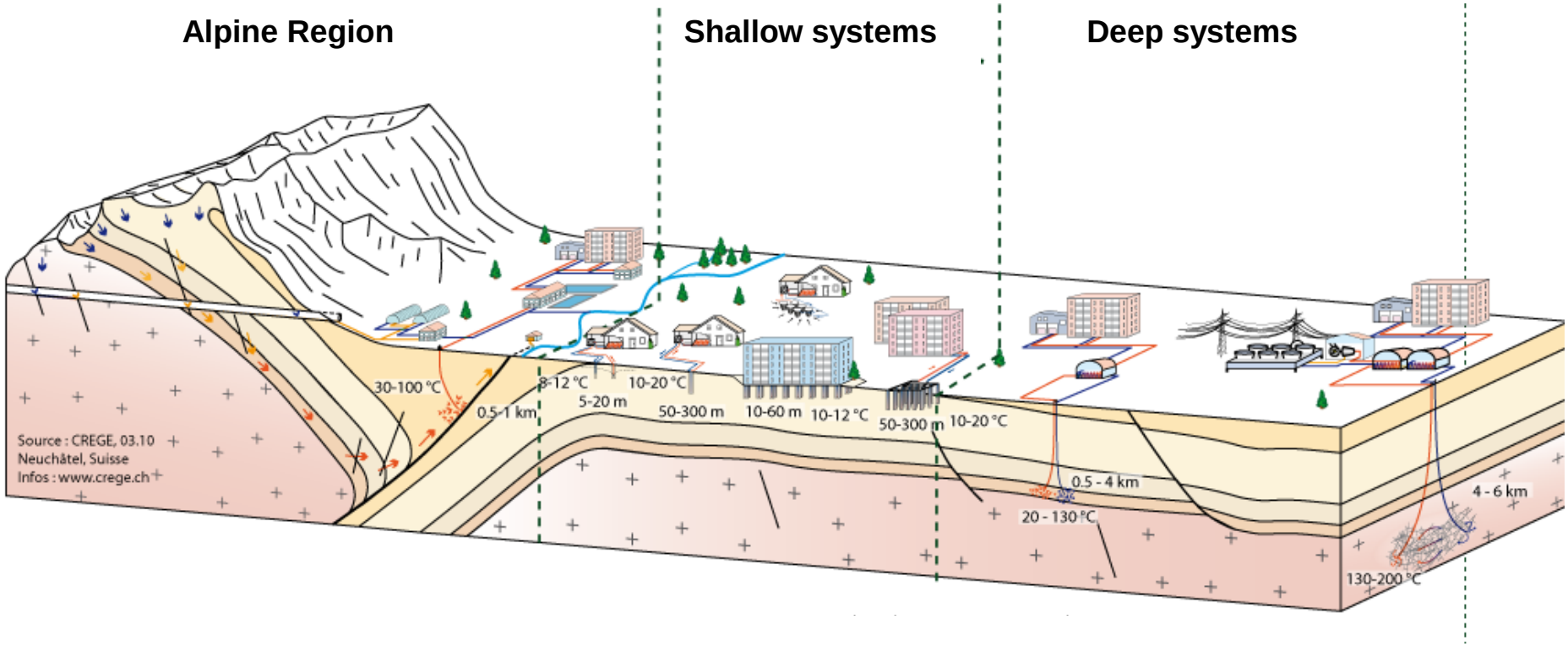
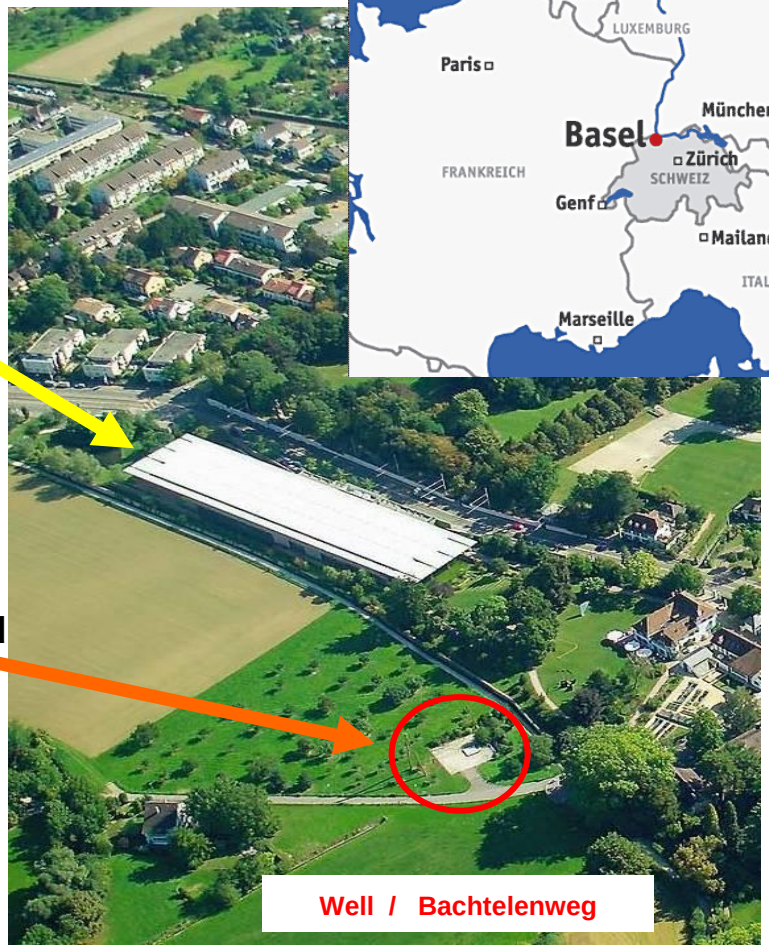
Geothermal energy in Switzerland

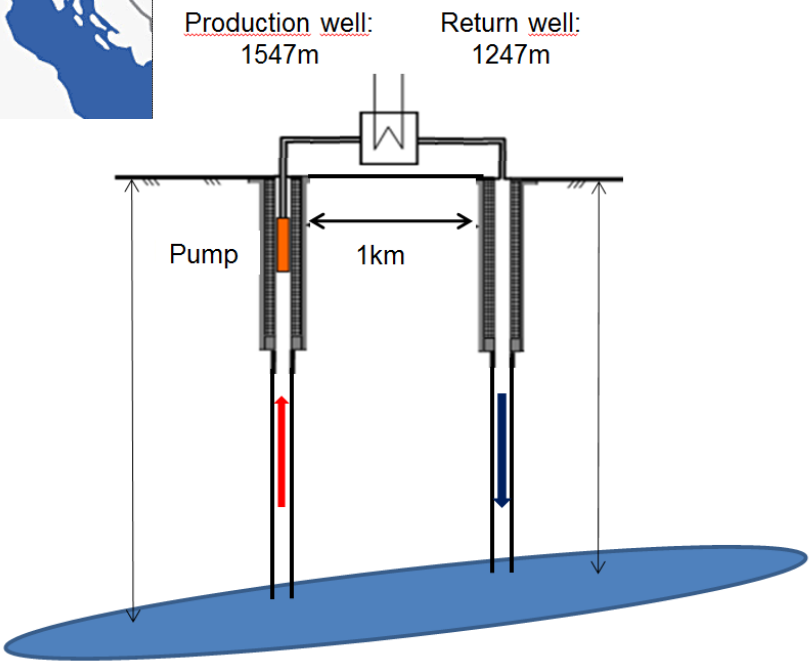


Geothermal Site Riehen

Fondation Beyeler Museum

Pumping station and well





Tectonic framework of Riehen

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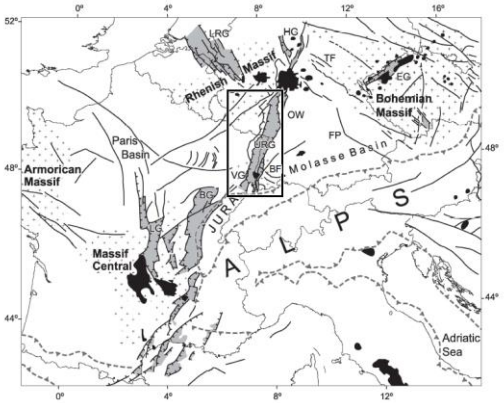
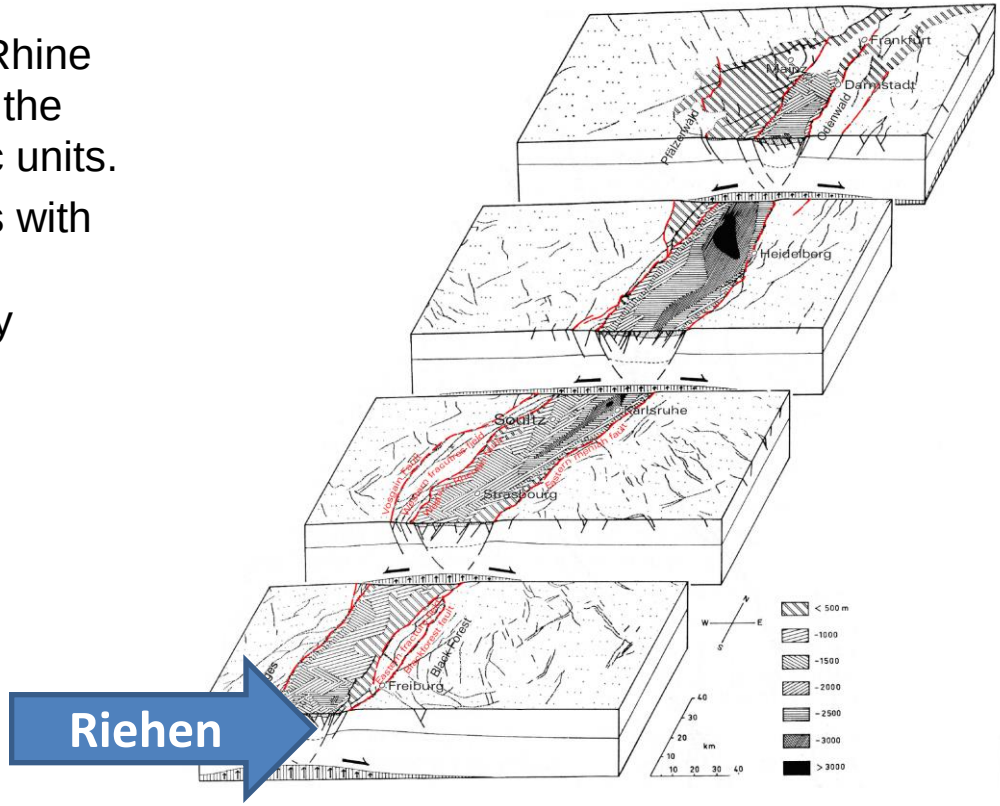
- SSW-NNE-striking eastern boundary fault of the Upper Rhine valley
- The development of the Upper Rhine graben in the Oligocene causes the formation of many small tectonic units.
- It is assumed that the sediments with the geothermally relevant Upper Muschelkalk in this area is highly fractured.





[Ustazewsky et al., 2009]

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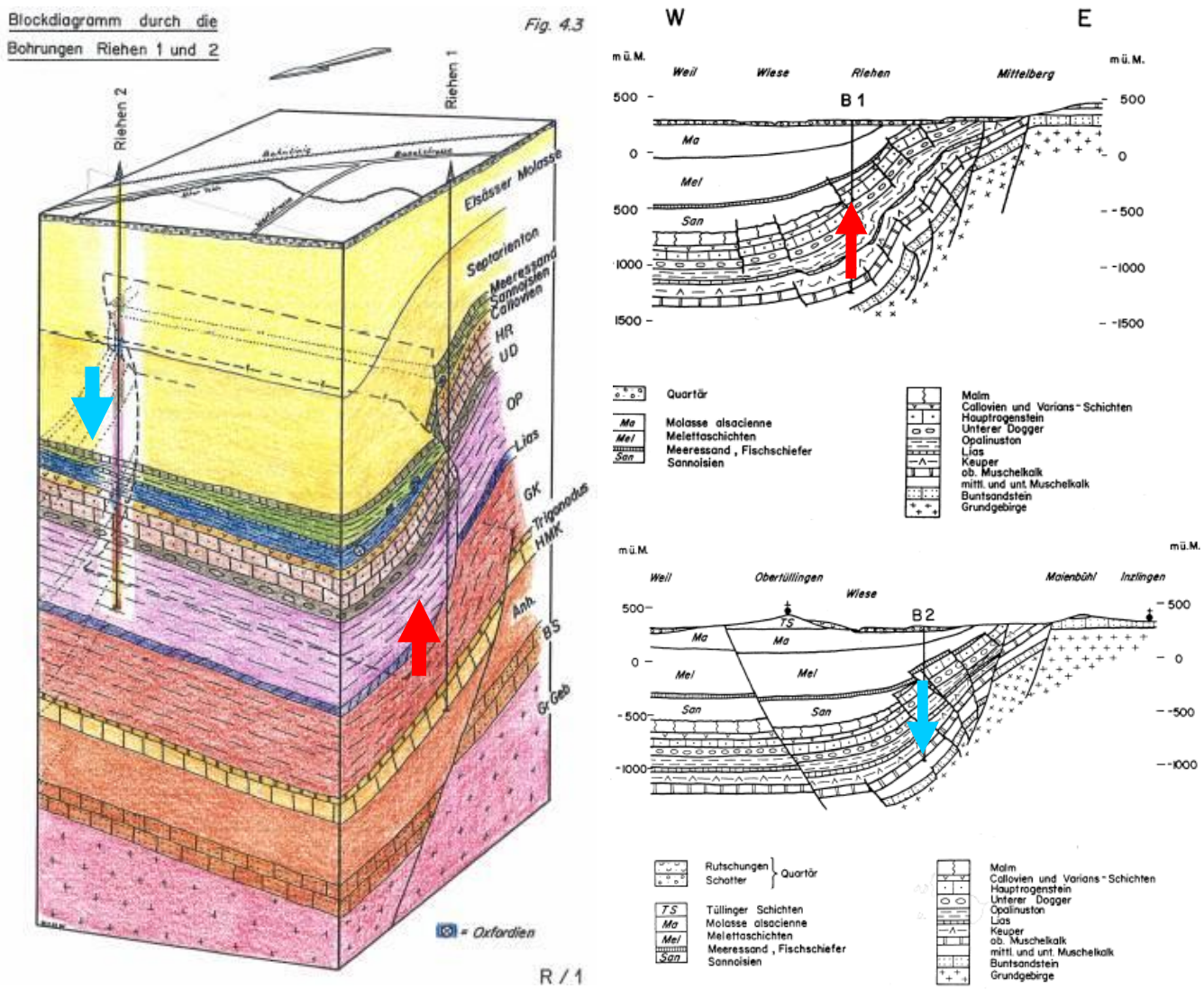
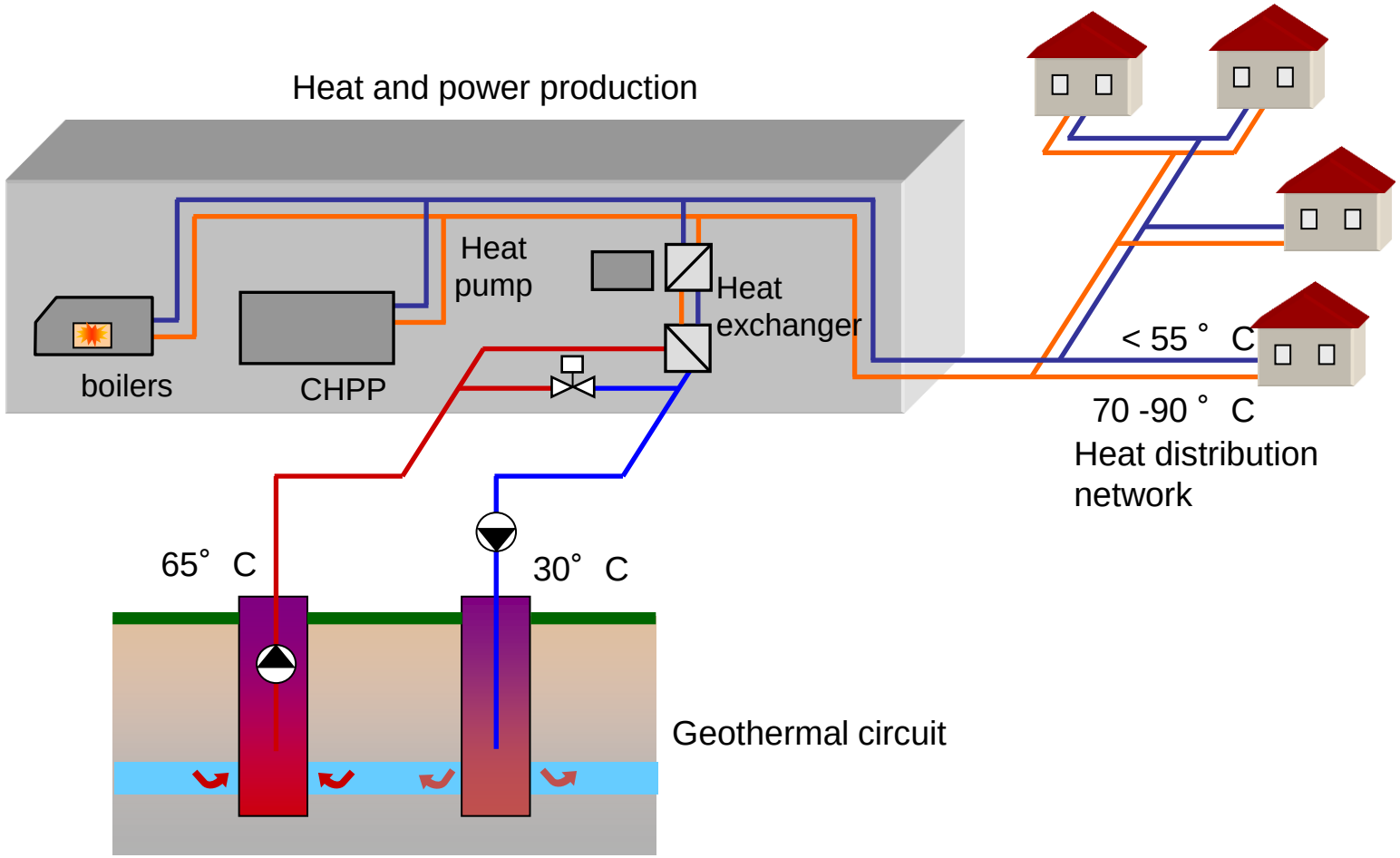
Riehen – Geology

The sediments in the vicinity of the boundary faults are highly factured and typical graben structures such as small tectonic units are observed [Gürler et al., 1987]. The productive formation is the Upper Muschelkalk. In order to obtain maximum production, the highly fractured zones near the boundary fault were selected for the doublet system [Boissavy & Hauber, 1994].

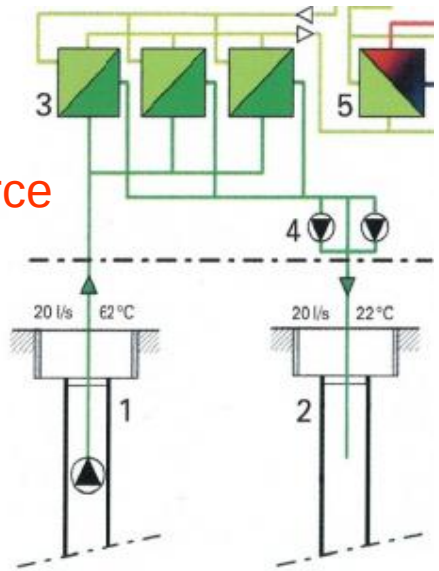


Basic concept of Riehen



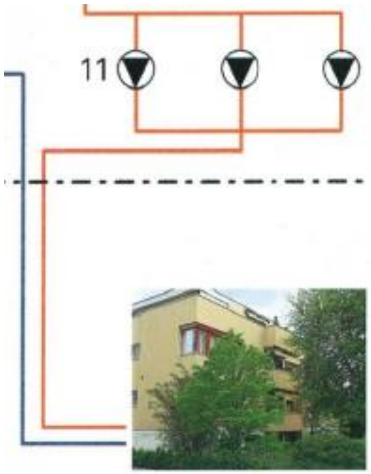
Why heat pumps?

Heat source



heat

Heat consumers



Heat flows from a warm to a cold medium

(2nd law of thermodynamics)

consequence

- **Temperature Geothermal heat source > temperature heating system**

  return temperature of heating system < temperature in injection well

Geothermal system without heat pump

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Heat source

Heat distribution network

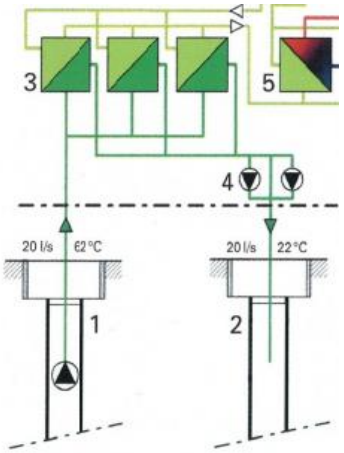
Heat consumers

70 ° C

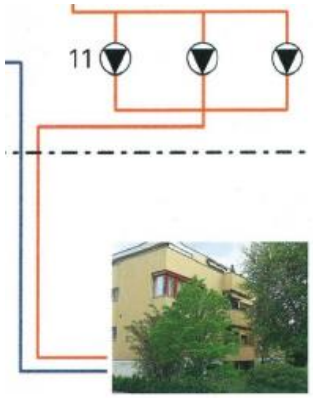
67 ° C

65 ° C

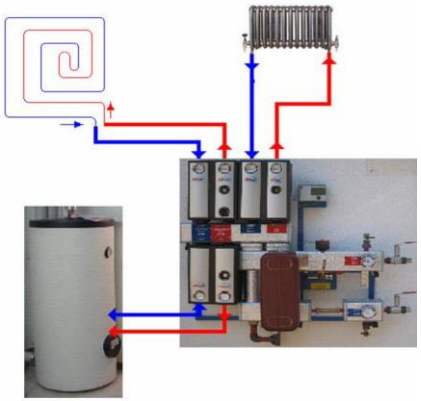
618 kW



Heat exchanger



Heat exchanger



56 ° C

54 ° C

53 ° C

Power of geothermal system

Flow rate * Temperature difference

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Supercooling with heat pumps

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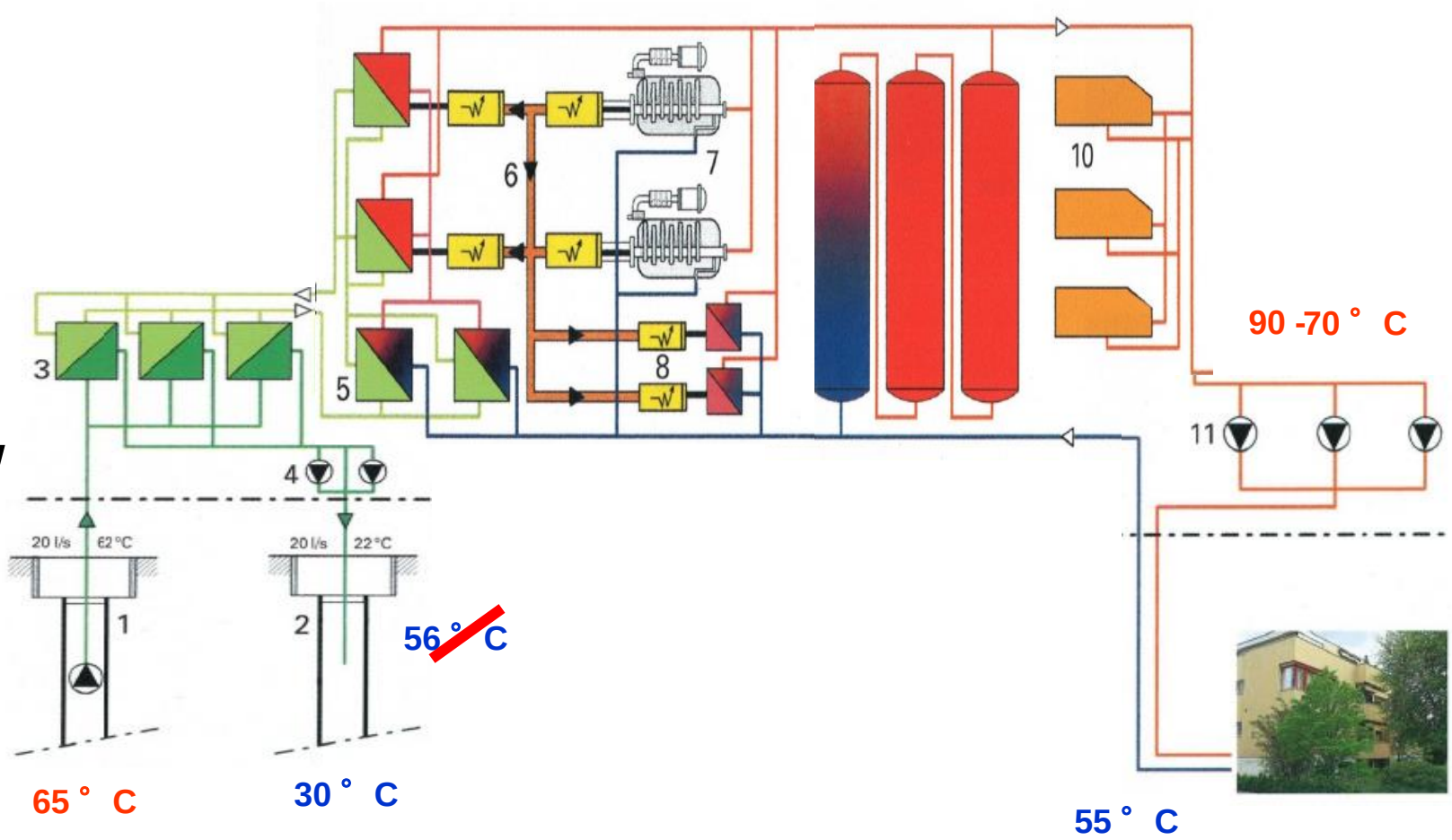
2580 kW



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Chronology of Wärmeverbund Riehen AG

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1980 - General analysis for use of renewable energies in Riehen

1982 - Working Group of the cantons of Basel-Stadt and Basel-Land for the regional use of geothermal energy

1986 - Project for a heat distribution network in Riehen mit excess heat from local sewerage treatment plant

1987 - Approval of the loan for a geothermal well by Riehen and the canton Basel-Stadt

1988 - Drilling of the well RB1 Bachtelenweg und RB2 Stettenfeld

- Project for a heat distribution network with heat pumps or CHPP in case of a failure of the geothermal system. Approval of the additional loan through the munipipality of Riehen (CHF 9.3 Mio.)

1989 - Initiation of peak load plant 1 and first phase of heat distributionb network in automn 1989

- Long production tests in geothermal wells

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Chronology of Wärmeverbund Riehen AG

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1990 - Approval of project and loan (CHF 1.93 Mio) for the 2nd phase of the heat distribution network by municipality

- **Analsysis of production tests reveal the productivity of the geothermal reservoir (Press conference Decembre 1990)**

1991 - Approval of project and loan (CHF 1.93 Mio) for the 3rd phase of the heat distribution network by municipality

1992 - Approval of project and loan (CHF 1.93 Mio) for the geothermal base load plant and 4th phase of the heat distribution network by municipality (CHF 22.14 Mio.) in May 1992

- Start of construction on base load plant in Septembre 1992

1994 - **Initiation of base load plant in January 1994**

1997 - **First transnational heat delivery to Stetten (Lörrach DE)**

2006 - **Riehen-Plus**: Concept for a merger of heat districution networks of Riehen Dorf (Municipality of Riehen), Niederholz (WV Niederholz AG) and Wasserstelzen (IWB)

2009 - **Formation of Wärmeverbund Riehen AG. Implementation and expansion of geothermal heating system from autumn 2009**

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"Riehen plus": The path to profitable geothermal district heating

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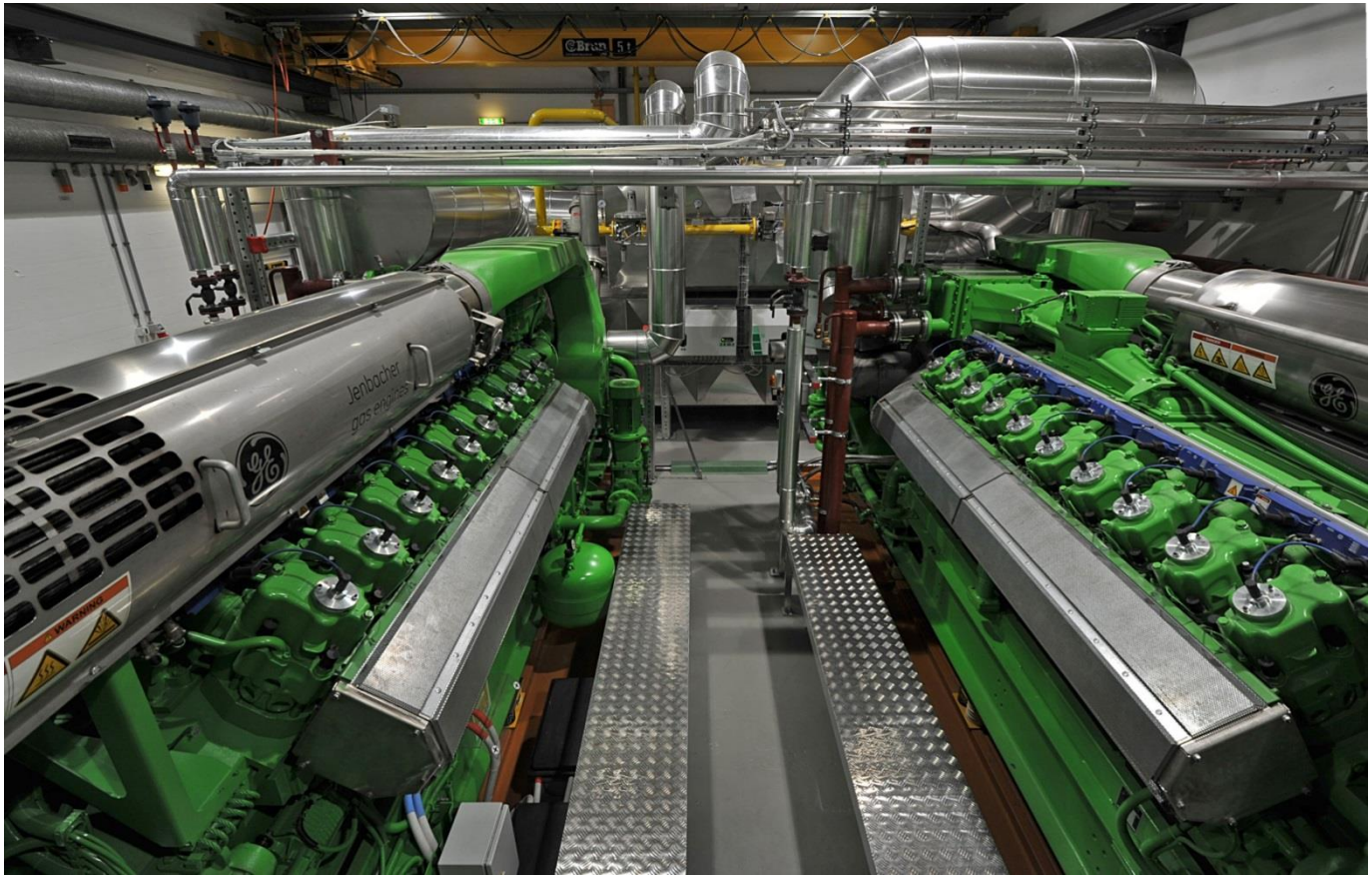

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Technical details of the project

- **Extension of district heating**

  from 26 GWh/a 54 GWh/a

- **New connection to HT-district heating (IWB)**

  9 MW

- **Higher flow in geothermal circuit**

  From 18 l/sec to 25 l/sec

- **Increased use of geothermal energy**

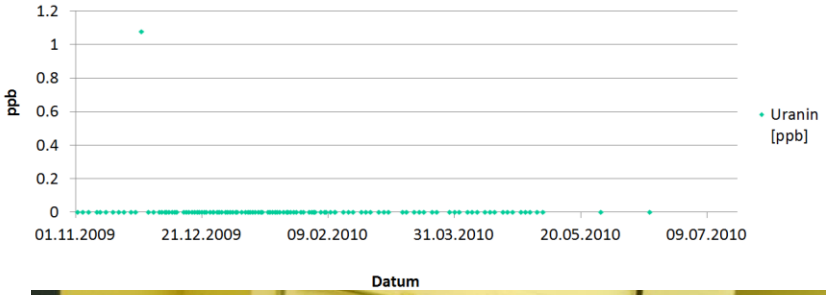
  From 12 GWh/a to 20 – 26 GWh/a

- **Reduction of carbon emissions (CO_2)**

  From 3'180 t/a to 5‘800– 6‘890 t/a

Tracer test

- 10 kg Uranin-powder (Reactolab) with 1000 l water
- 03.11. 2009 between12:30h and 14:10h
- Proben 2011, 2012 negativ
- **All samples negative** (one contaminated sample)
- Tracer test shows: **No direct connection between injection and production well**

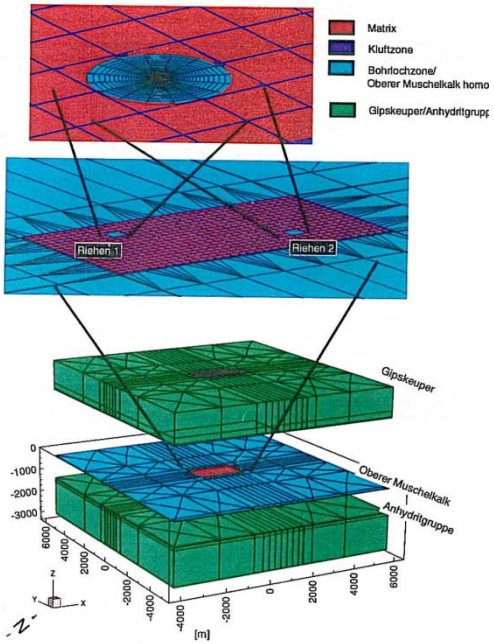


Geological model of Riehen

Model 1996: Cirkulation from production to injection well in Muschelkalk block

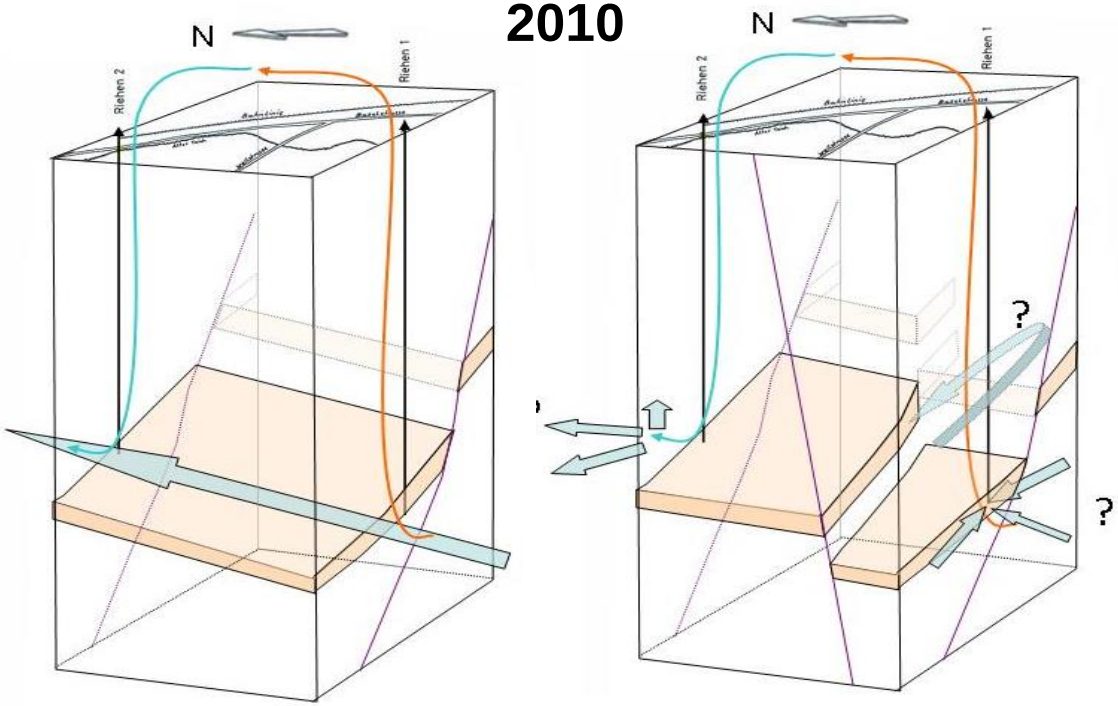
Model 2010: Dominant groundwater flow or division of the aquifer by a fault (Weil-am-Rhein fault)

1996



Mégel, T., 1996. Aqifer-Bewirtschaftung bei der Geothermischen Energienutzung, PhD. PhD, ETH Zürich, Zürich.

2010



Klingler, P., 2010. Charakterisierung des Geothermischen Reservoirs Riehen: 3DStruktur und Tracer-Test. Masterabeit, Centre d'Hydrogéologie et Géothermie CHYN, Université de Neuchâtel.

District heating perimeter before 2008

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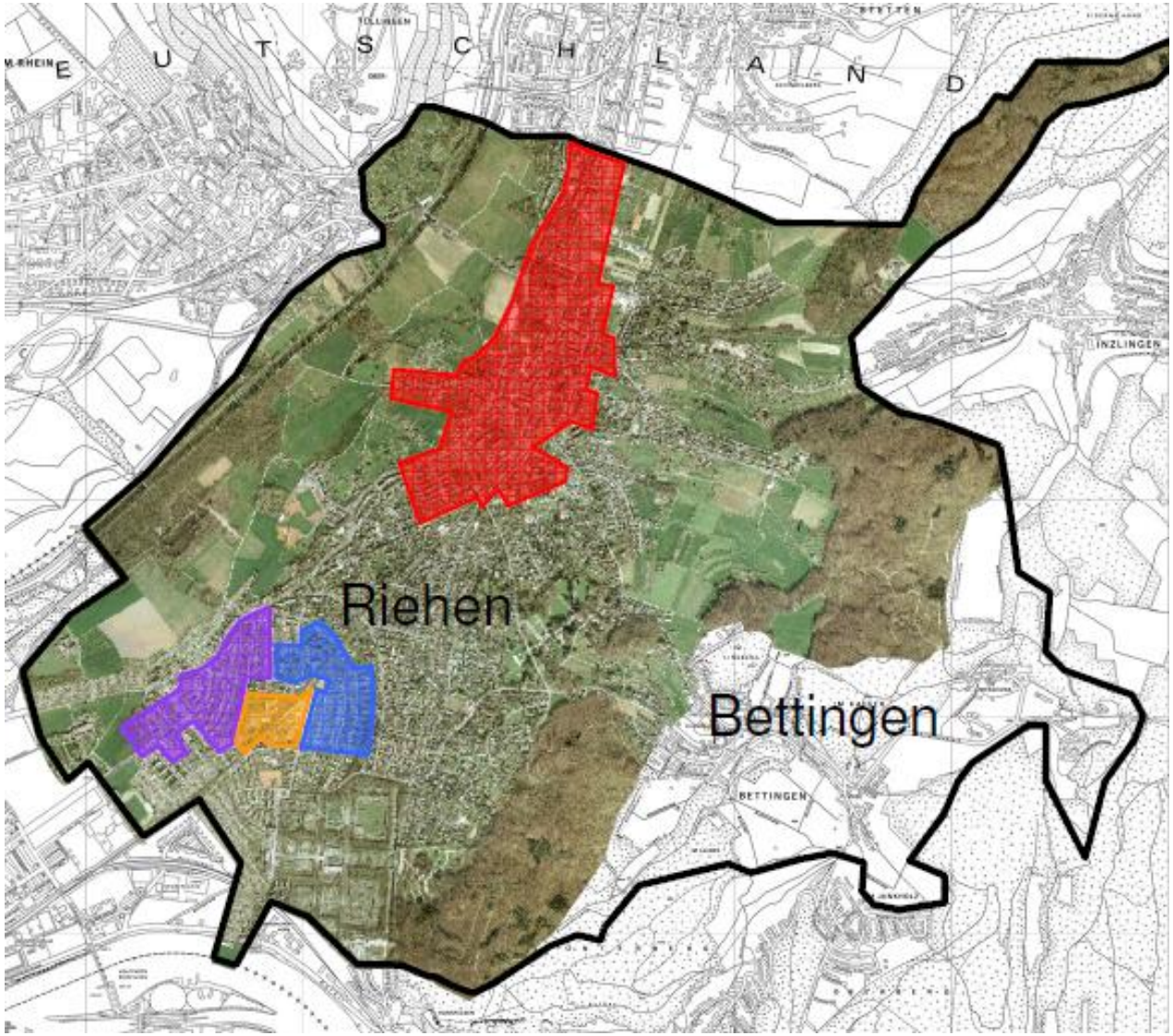

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Final perimeter

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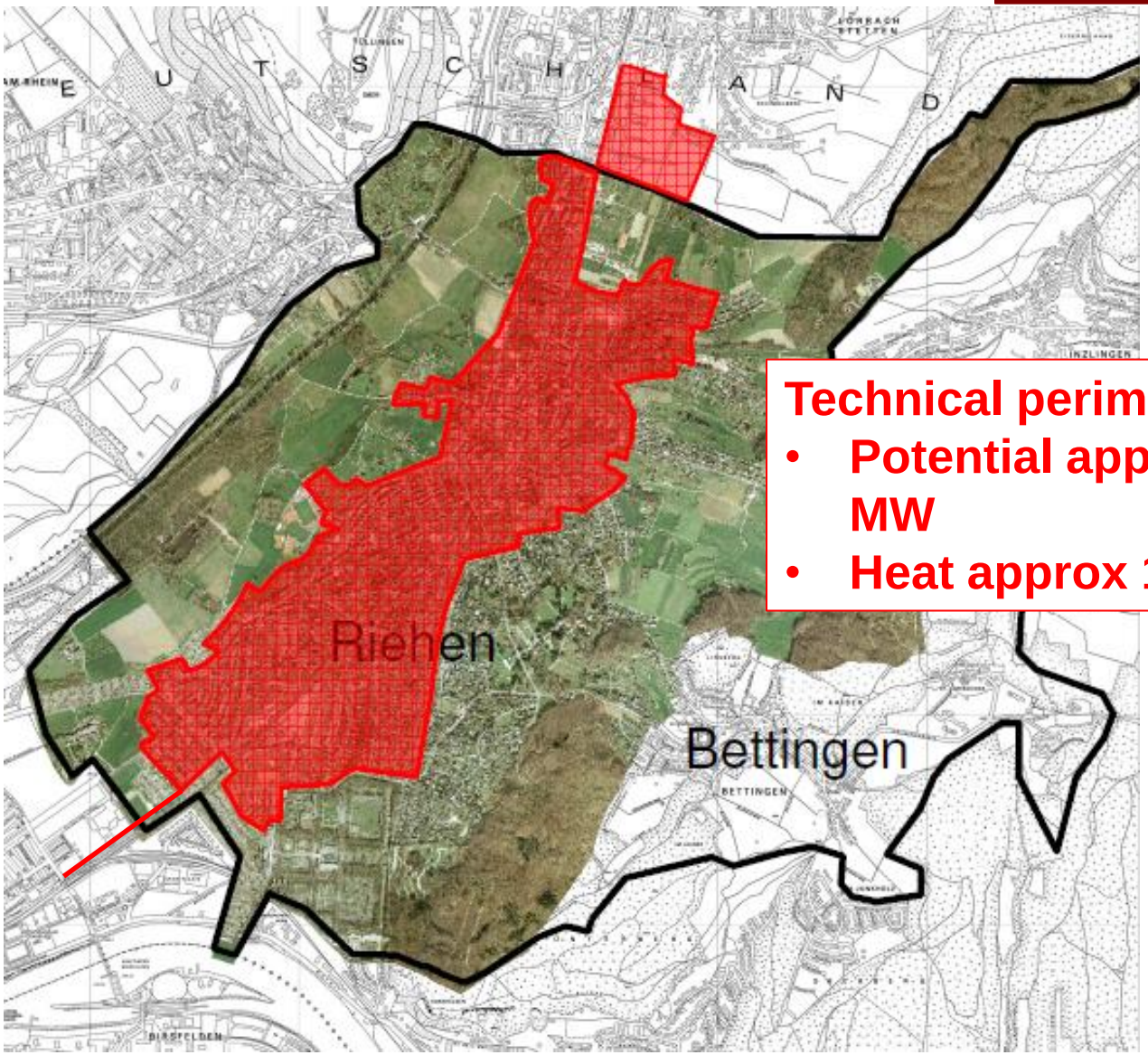

Technical perimeter:

- **Potential approx. 70 MW**
- **Heat approx 100 GWh/a**

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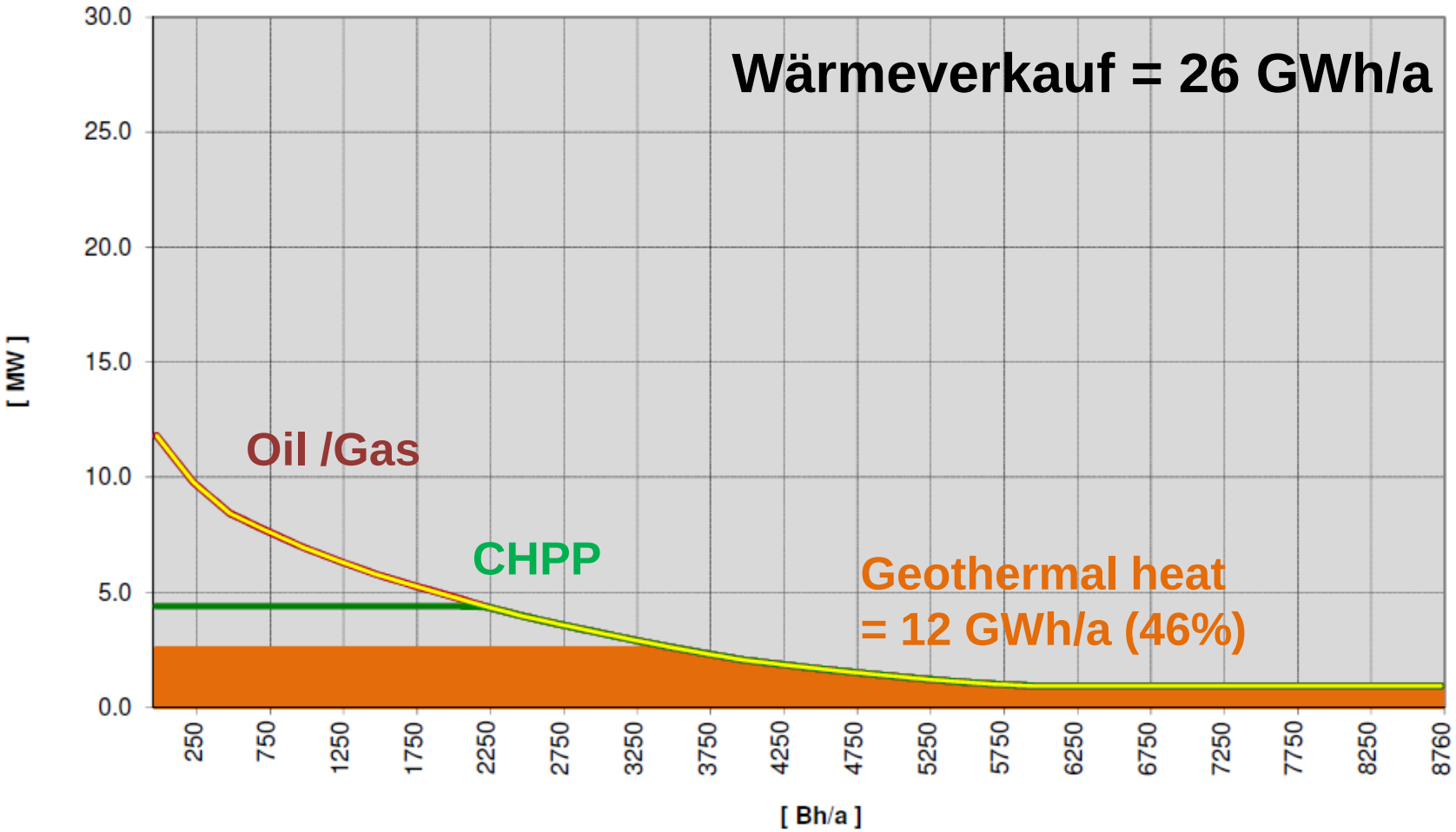
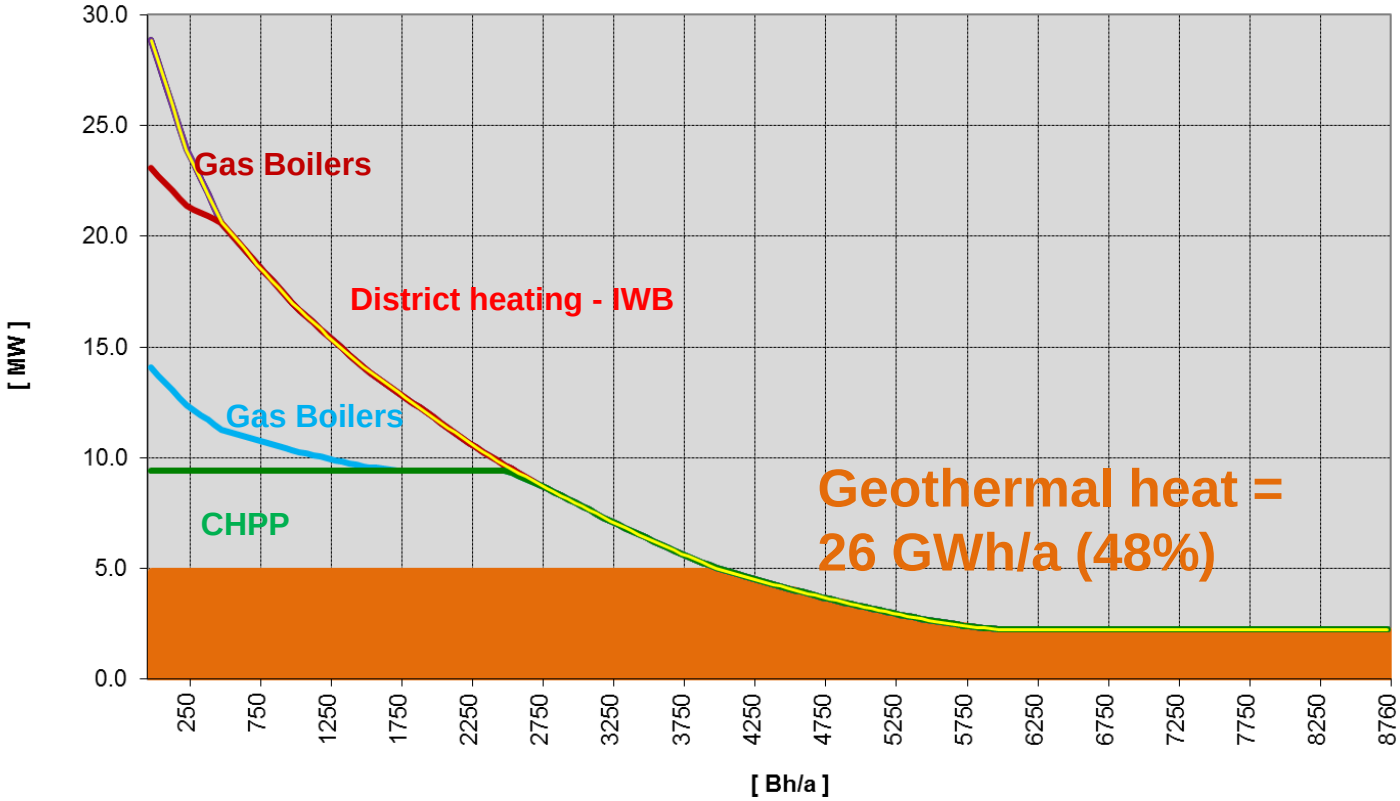
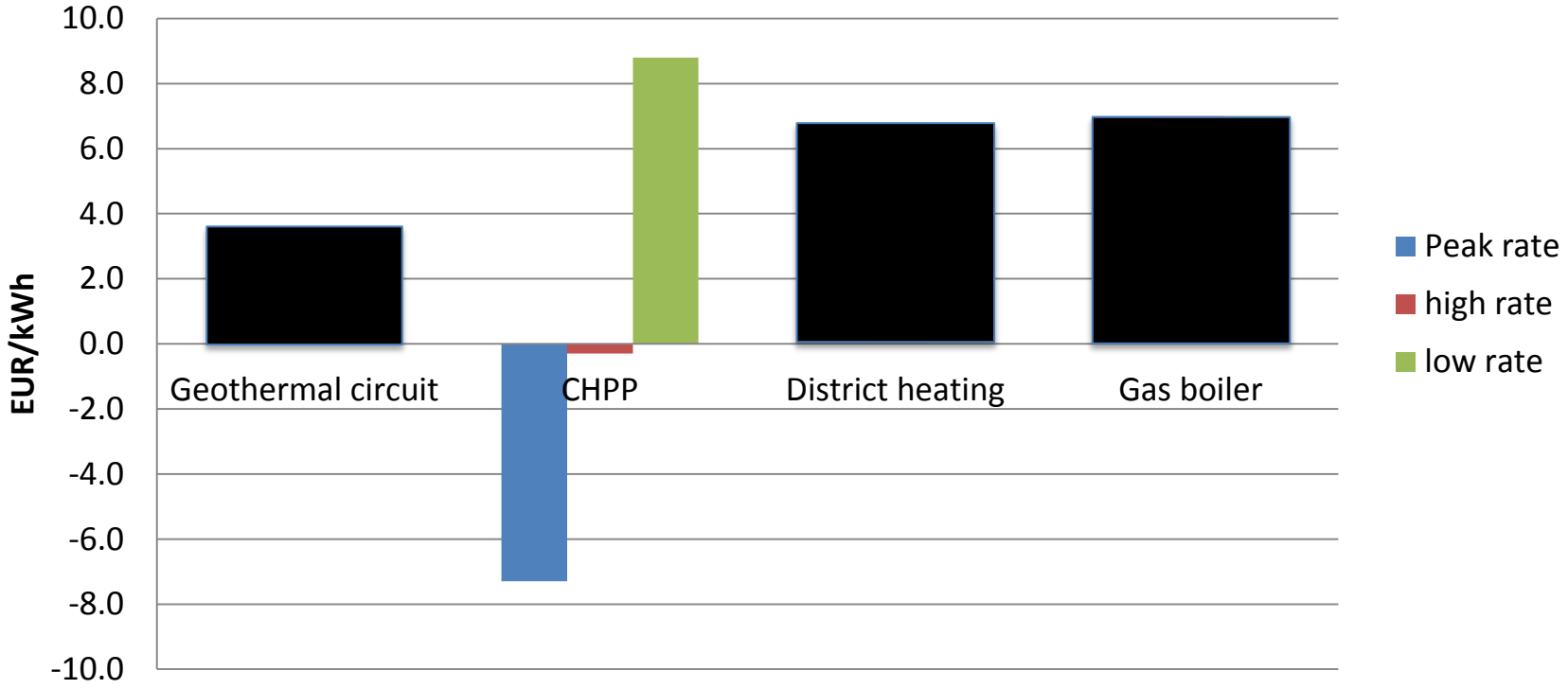
Annual load curve pre2009



Final annual load curve



Heat production costs



Subsidies vs. incentives

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POSITIVE:

ENERGY AGENCY
SWISS PRIVATE SECTOR EnAW

Energy Model: Analysis of current energetic state with efficiency goal calculated with a list of measures with a payback time < 4/8 yrs.

Benefits

- Refund on the carbon emission tax
- Generation of carbon emission reduction certificates

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Subsidies vs. incentives

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NEGATIVE:

Basel municipal CHPP Power-subsidies (peak tarif) in summer:

- Subsidized competition to geothermal heat
- No heat demand in summer
-

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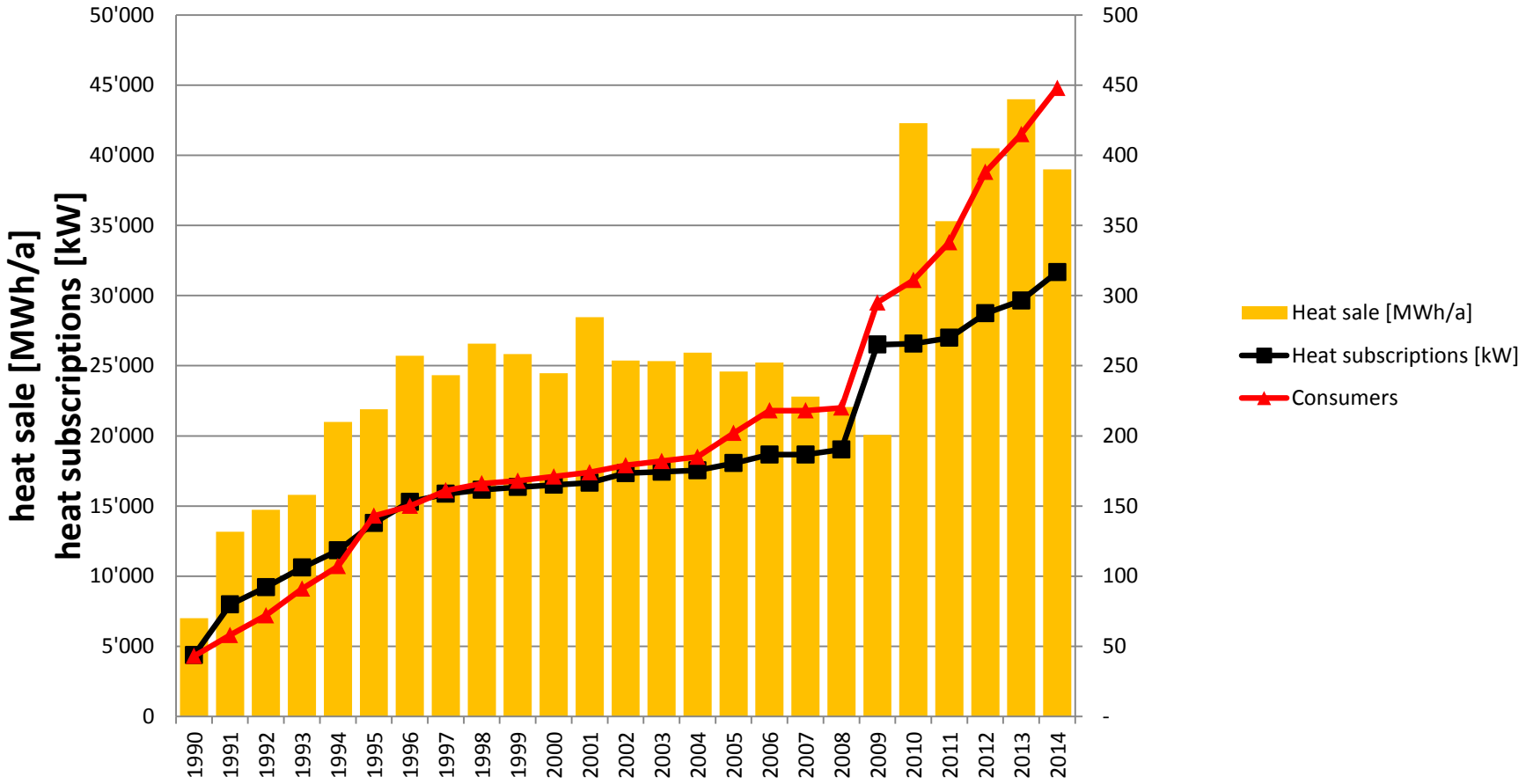
Consumer development



development of costs (history and forecast)

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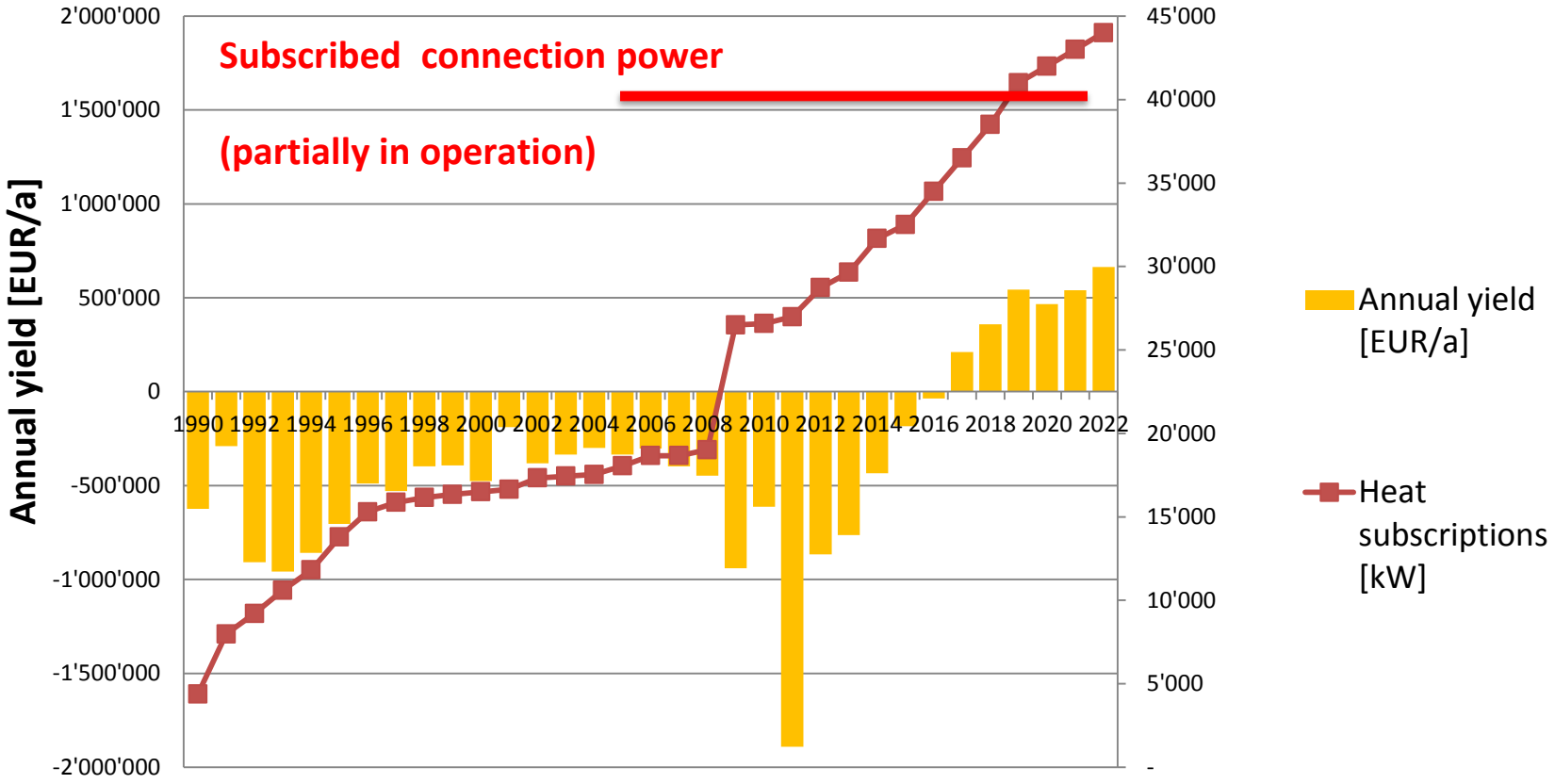

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Lessons learned

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1. Geothermal district heating can be profitable
2. Heat generation cost are competitive to gas
3. Determing factors (geology, incentives) important
4. Clients are ready to accept and pay for geothermal district heating
5. Profitable district heating schemes require a minimal size

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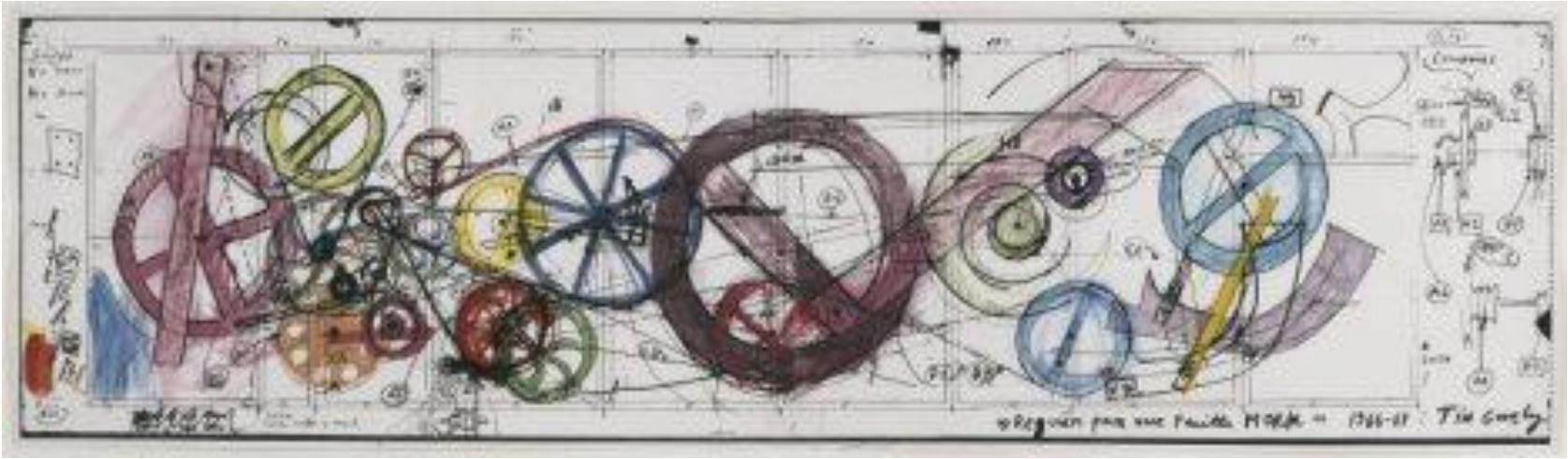

One person waits for the times to change, the other seizes the day and acts!

•Dante Alighei (1265-1321) it. Poet