Altheim in Upper Austria – an example of cascaded geothermal energy use

International School on Geothermal Development

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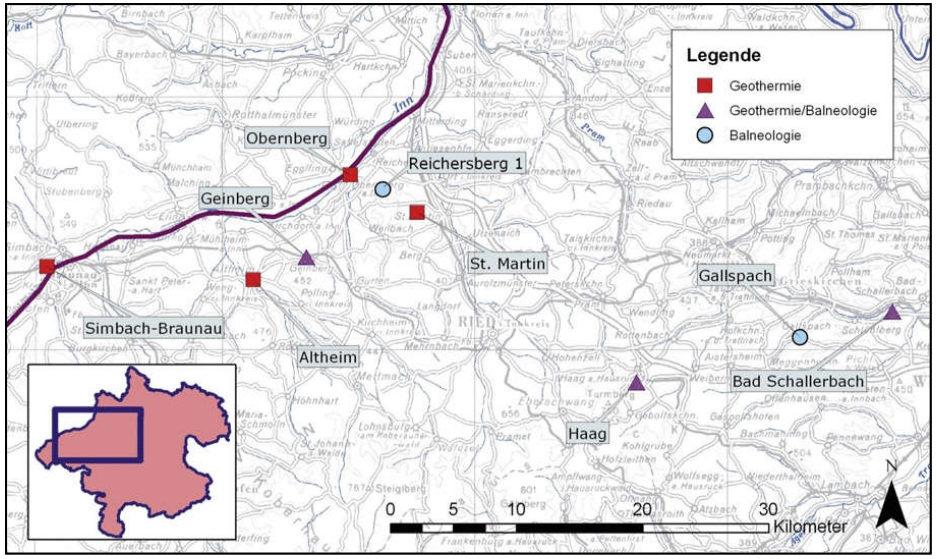
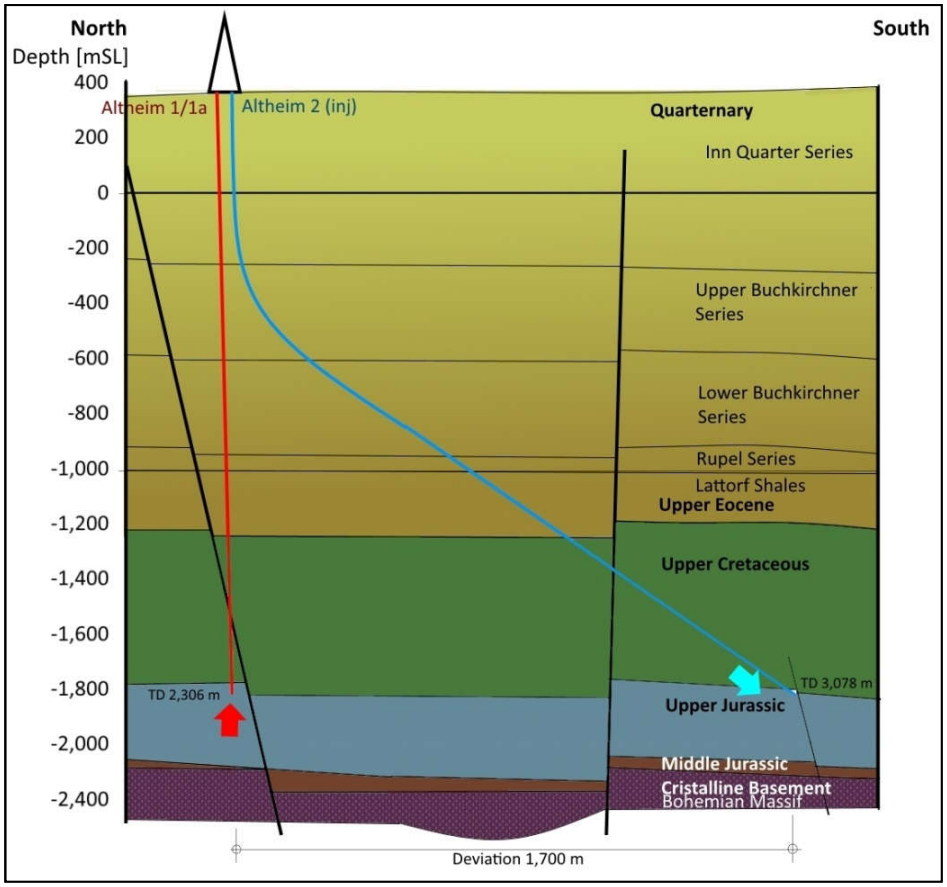
Geothermal Project in the **Upper Austrian Molasse**

- Usage of low-enthalpy geothermal water in the Austrian part of the Molasse Basin has been established since historic times
- More recently, the geothermal water flows have been studied more carefully with respect to origin, flow directions and coordinated offtake



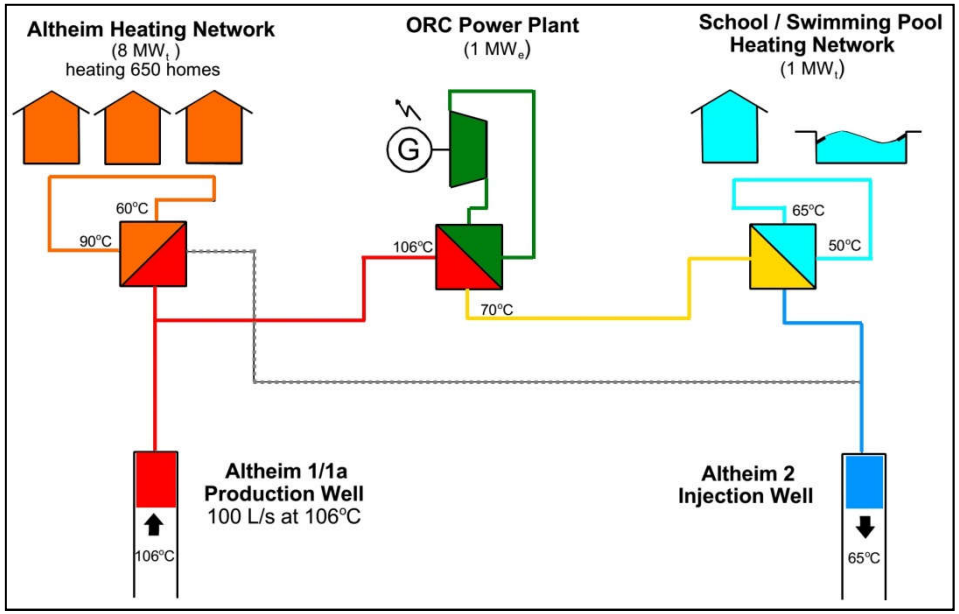
Altheim Geothermal Project – Geology

- The Phase I of the Altheim geothermal project: supply of hot water to the community for district heating of approx 1,500 households, requiring energy of some 10 $MW_{[th]}$
- A vertical production well was drilled to a TD of ~2,300 m (Upper Jurrasic), well flowed water with 46 l/sec at 104° C in free (artesian) flow
- In 1994, electrical submersible pump (ESP) was installed to increase flow to 100 l/sec; a directional disposal well was drilled; a 1 MW, ORC turbine was added for power generation



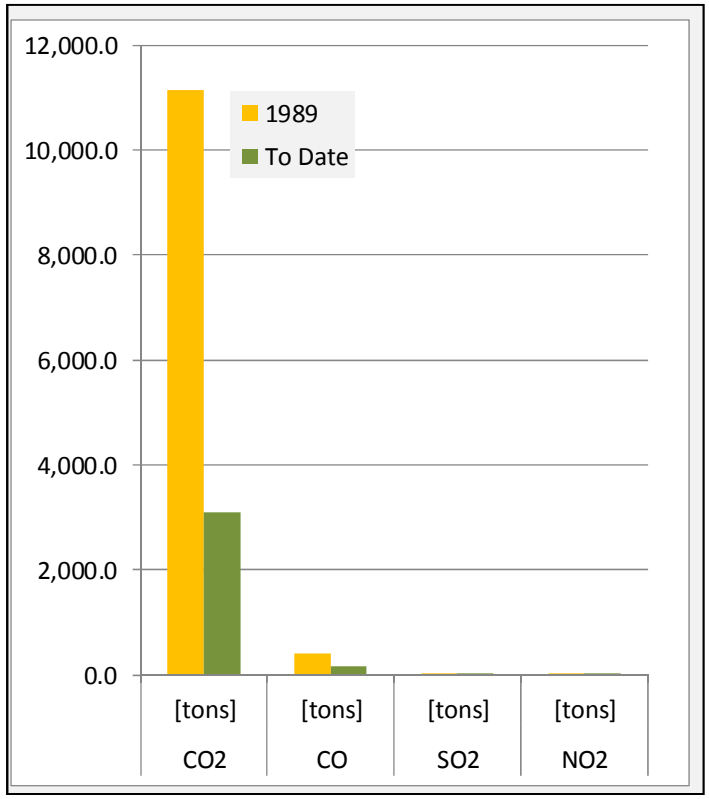
Altheim Geothermal Project – Flow Diagram

- The 104° C hot water flow from the production well is diverted into two streams
- After passing through a plate type heat exchanger and depending on ambient temperature, ~ 8 to 9 $MW_{[th]}$ at 90° C secondary closed loop flow are used for residential heating of public buildings and private residential premises
- The remainder of the hot water flow is directed to an Organic Rankine Cycle (ORC) turbine and power generator with a capacity of approx 1 $MW_{[el]}$
- The ~70° C outflow from the ORC power plant is cascaded to the local school and indoor swimming pool heating system with a capacity of approx 1 $MW_{[th]}$

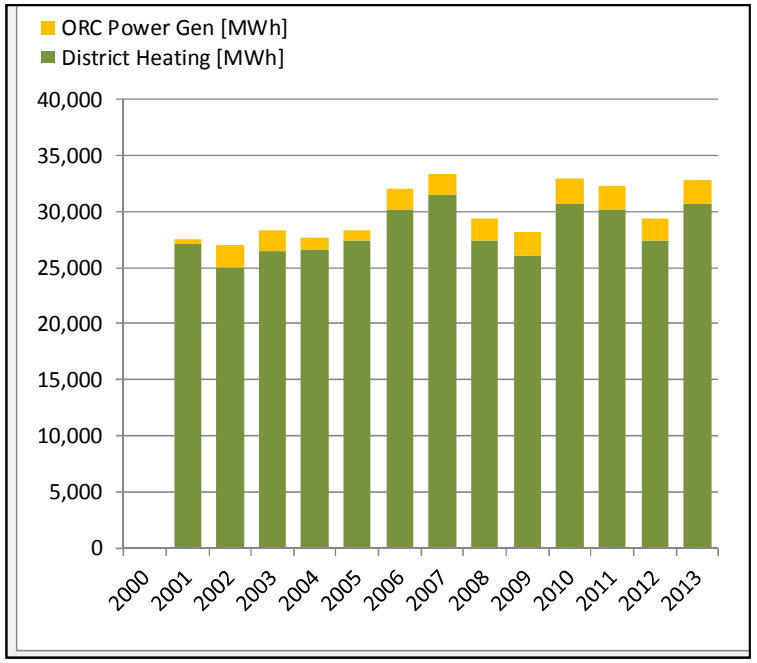


Ecological Impact and Energy Production

- Ecological Footprint was materially reduced by reducing emissions from fossil fuels use



- Total production of almost 400 GWh over last 13 years (majority of the low enthalpy geothermal water being used for district heating)



Economics of Geothermal Project

Base Assumptions		Fill in value / Calculated
Parameter		
Depth of the well	2,800	*[m]*
Geothermal gradient	0.038	*[K/m]*
Reservoir temperature	106.4	*[°C]*
Flow of the well	100.0	*[l/s]*
Well head temperature	102.5	*[°C]*
Reinjection temperature	58.4	*[°C]*
Conversion efficiency thermal power	96.0	*[%]*
Full load hours per year	8,000	*[h]*
Thermal Power	17.7	*[MW]*
Thermal Energy	141.6	*[GWh]*
Heating hours per year	3,200	*[h]*
Heating energy per year	56.6	*[GWh]*
Annual growth heat sales	1.0	*[%p.a.]*
District heating wholesale price per MWh	30.0	*[EUR]*
Electricity per year	10.2	*[GWh]*
Received price per MWh electricity sold	50.0	*[EUR]*
Size of electric power station	1.8	*[MW]*
Total Investment	17.0	*[MM EUR]*
Conversion efficiency electric power	12.0	*[%]*
Price increase for electricity bought	4.0	*[%p.a.]*
Price increase general costs	3.0	*[%p.a.]*
Price of CO_2 Emission	5.0	*[EUR]*
Capacity of 1 W =	1.16222	*[kcal/h]*

CAPEX

Parameter			***Depreciation***	
Well Drilling	6.0	*[MM EUR]*	30	*[yrs]*
Drilling Contingency	0.0	*[MM EUR]*	30	*[yrs]*
Building and Land	0.5	*[MM EUR]*	15	*[yrs]*
Submersible Pump	1.0	*[MM EUR]*	5	*[yrs]*
Heating Losses	2.0	*[MM EUR]*	5	*[yrs]*
District Heating Pipeline	5.0	*[MM EUR]*	30	*[yrs]*
Plant and Facilities	2.5	*[MM EUR]*	20	*[yrs]*
Other/Miscellaneous	0.0	*[MM EUR]*	5	*[yrs]*
Total CAPEX € million	**17.0**	*[MM EUR]*		

OPEX

Parameter		
Increase in provisions	48.0	*[M EUR p.a.]*
Material and third party costs	0.0	*[M EUR p.a.]*
thereof electric power	0.0	*[M EUR p.a.]*
thereof oil	0.0	*[M EUR p.a.]*
Personnel costs	100.0	*[M EUR p.a.]*
Other operating expenses	200.0	*[M EUR p.a.]*
Other operating	0.0	*[M EUR p.a.]*
Start up costs	0.0	*[M EUR p.a.]*
Maintenance	2.0	*[M EUR p.a.]*
Total OPEX	**350.0**	*[M EUR p.a.]*

Results

	BT	AT	
Internal rate of return (ROR)	10.3%	9.2%	*[%]*
Net present value (NPV)	6.8	4.8	*[MM EUR]*
Pay back period	12.6	14.4	*[years]*

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