



ESPs in geothermal applications

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Definition: geothermal energy

“Energy obtained by extracting the earth’s internal heat”

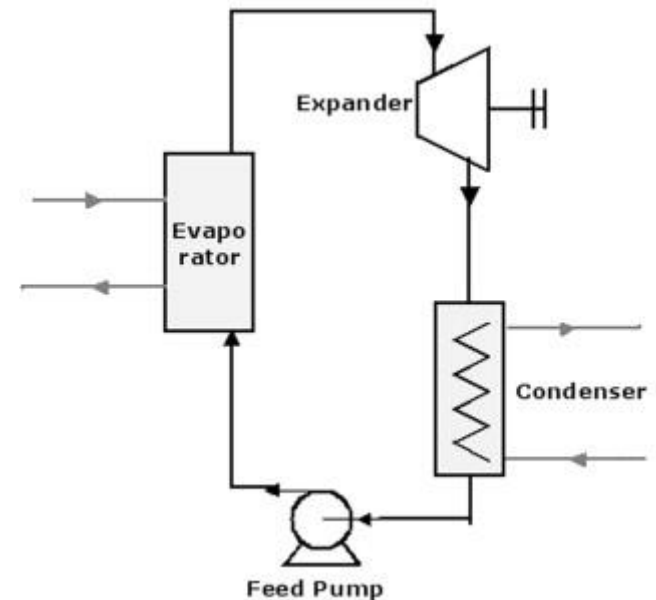
Low-enthalpy systems: < 200 °C

Current capabilities of ESPs

- Max. 100,000 BPD
- 1700 BHP @ ~150°C

Used for

- Electricity generation (binary power plants)
- District heating / industrial purposes



Simple schematic of an organic rankine cycle power plant

Specifics in ESPs for geothermal

PUMP STAGES

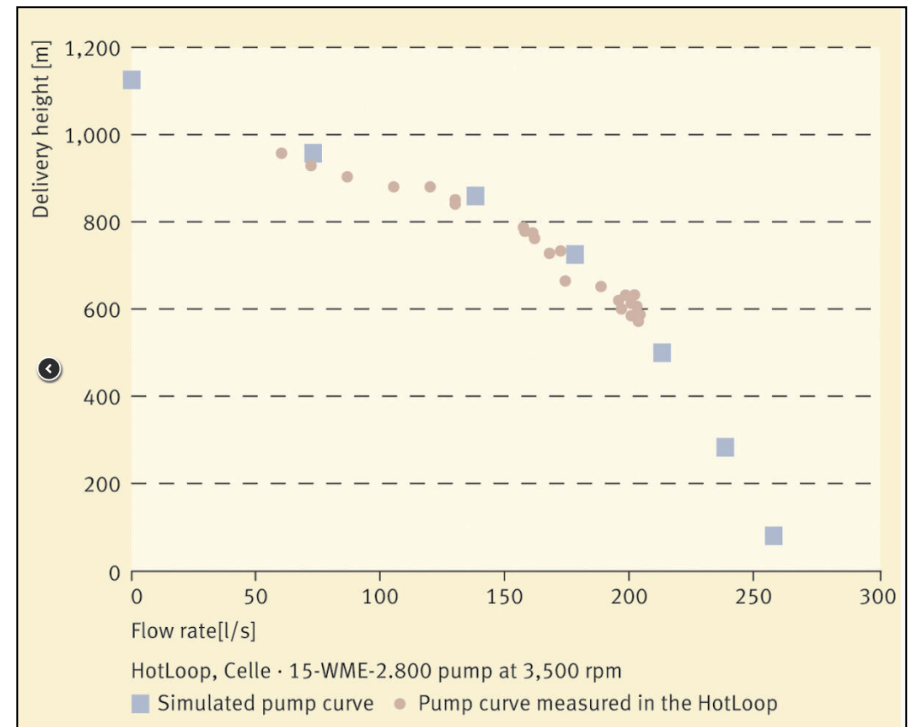
- Bolted bowl pump stages
- Bronze alloy metallurgy
- Corrosion resistant

MOTOR

- Theoretical: 2800 BHP induction motors in tandem
- 175°C Max
- > 80% Efficiency

SCALE INHIBITION

- Biodegradable scale inhibitor in testing
- Specialized coatings for bearings

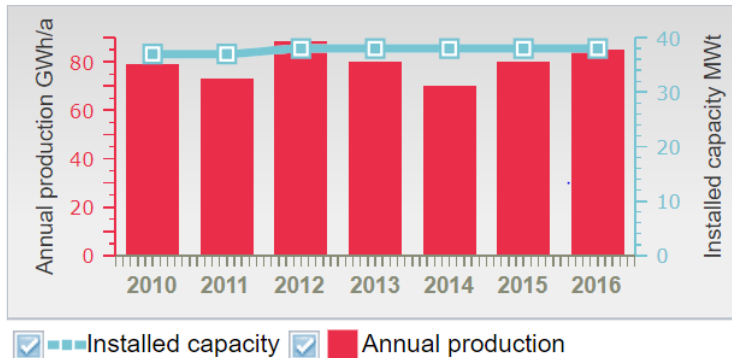


Unterhaching, Germany

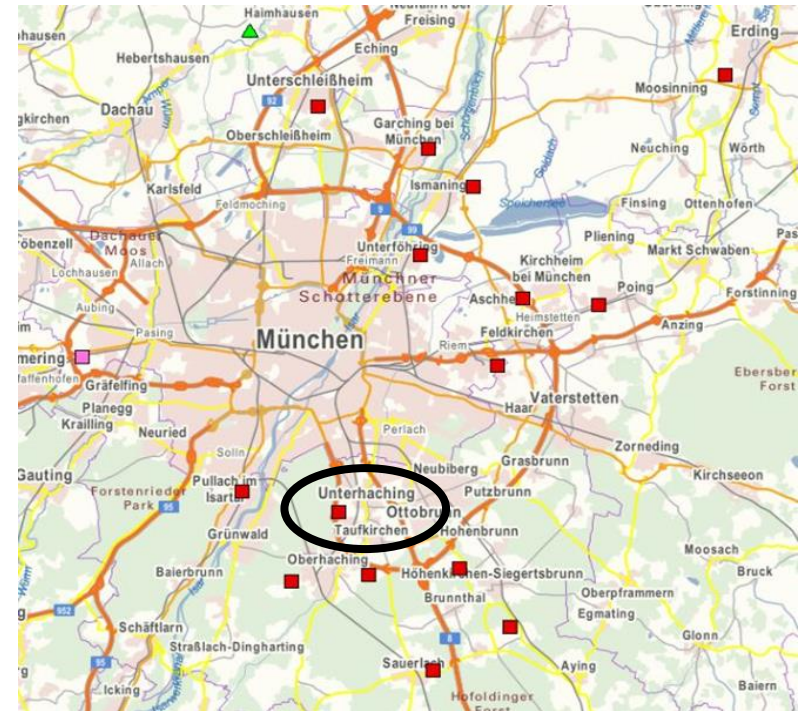
Southern Germany Molasse Basin

Kalina Cycle Power plant 3.6MWe, 38MWth

- 2 wells at 3200m
- Temperature: 125°C (257°F)
- ~68,000 BPD (130 l/s)
- Unique biodegradable scale inhibitor in testing phase
- R&D Funding support from German Government



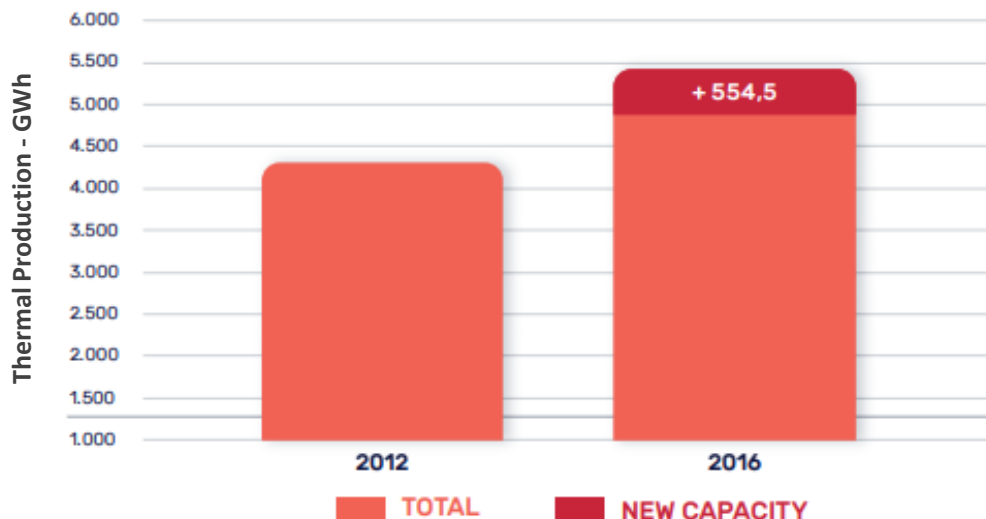
Graphic: GeotIS, <https://www.geotis.de/>



European geothermal market

CURRENT / FUTURE LANDSCAPE FOR LOW ENTHALPY SYSTEMS

- 280 district heating systems in operation, 160 more under investigation (2016)
- 10% Annual Growth between 2012 and 2016
- France, The Netherlands, Germany and Hungary



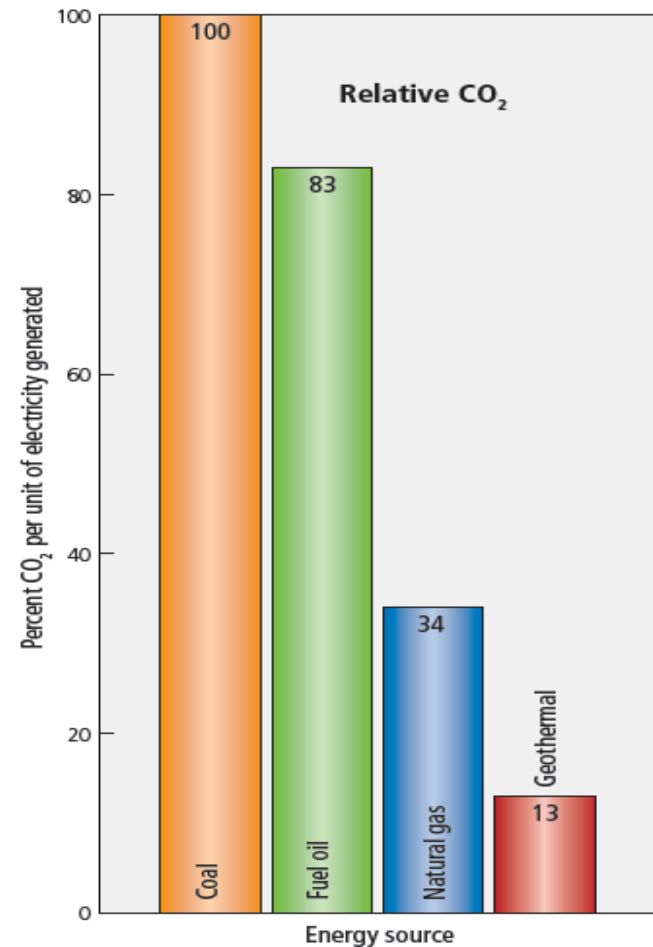
TOP 7 COUNTRIES (production in GWh, 2015 data)			
1		Iceland	6421
2		France	1335
3		Germany	662
4		Hungary	380
5		Austria	272
6		Italy	249
7		Serbia	243

Source: European Geothermal Energy Council 2016

Conclusion

GEOHERMAL: AN OIL AND GAS PLAYGROUND

- Opportunities to develop high voltage, high temperature ESPs
- Embrace synergies between petroleum and geothermal industry



We have the responsibility to develop and contribute to green energy production

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