The combined use of geothermal and biomass for power generation - drawbacks and opportunities -

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Abstract

Geothermal heat and biomass for power generation are usually used independently. Therefore this poster addresses the possibility to increase the power generation by the combined use of heat from geothermal energy and from biomass. It can be shown that a win-win-situation can be achieved by combining a biomass driven cogeneration unit with a geothermal power plant by using the waste heat from one system within the other system.

On this background the goal of this poster is it to carry out a technical and economic analysis of such combined systems.

For this, the geothermal heat source is analysed based on three different case studies covering the geological situation in Germany. Each case study is characterised by typical specific conditions for e.g. the well depth, the possible flow rate and the available temperature.

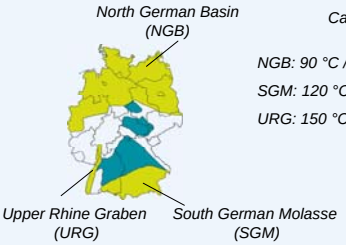
On the biomass side a biomass plant of 20 MW_{el} fired with solid biomass as well as a biogas plant operating on animal manure together with maize silage is assumed.

The combination of these different systems are simulated based on ASPEN PLUS®. The results are then assessed in terms of technology and economics.

Among other aspects and results the study shows that:

- geothermal preheating is not a very promising option for an increased power production compared to other possibilities;
- the use of waste heat from an engine operated by biogas from a biogas plant currently typical for Germany could have a positive effect on the overall efficiency (i.e. an increase in power output of the geothermal system).

Technical Analysis



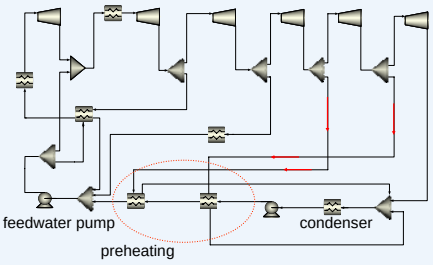
Case studies

NGB: 90 °C / 50 kg/s / 2400 m

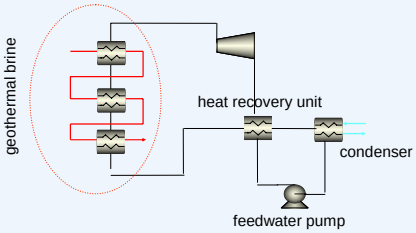
SGM: 120 °C / 50 kg/s / 3350 m

URG: 150 °C / 30 kg/s / 2900 m

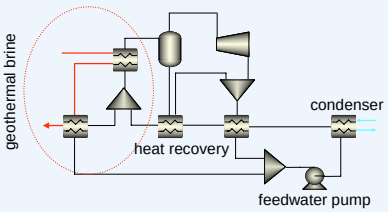
Case studies of geothermal heat sources



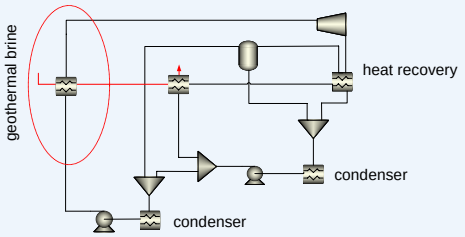
Model of the reference Biomass-Plant



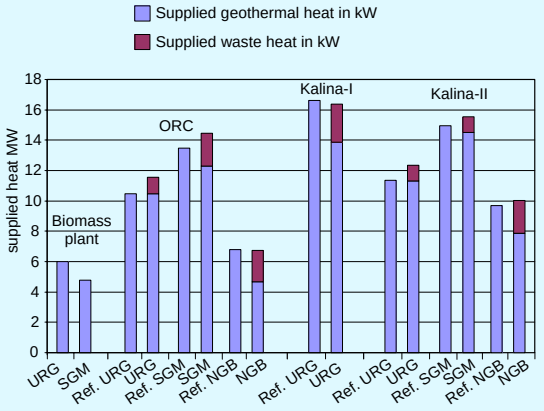
Model of the reference ORC-Plant



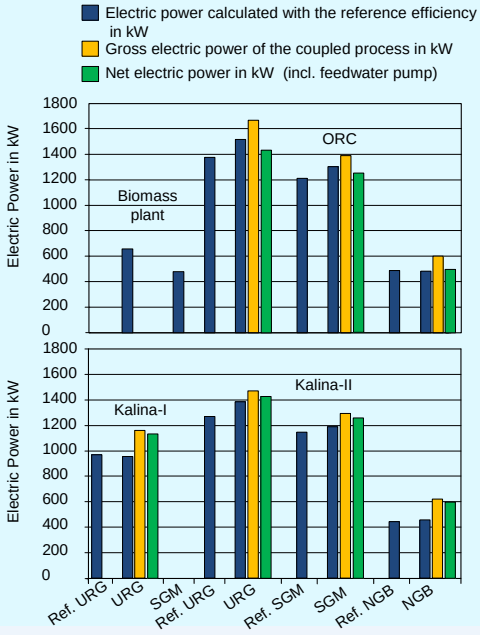
Model of the reference Kalina-Plant type II



Model of the reference Kalina-Plant type I



Supplied geothermal heat and waste heat. The possible use of the supplied waste heat depends on the selected case.



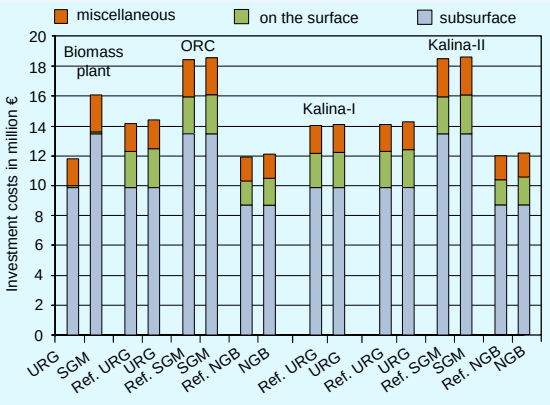
Electric power of the combined use of geothermal heat in a biomass plant and the use of waste heat within a ORC-process for different cases

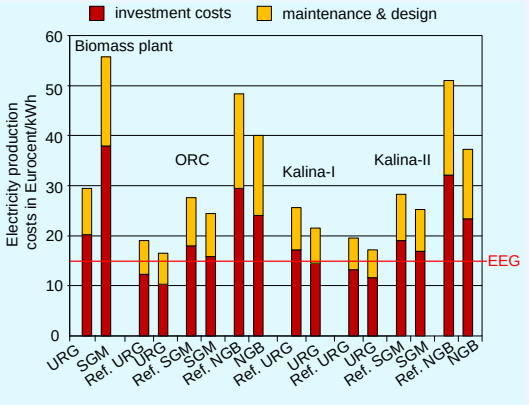
Electric power of the combined use of waste heat with a Kalina-cycle of type I and II for different cases

Economic Analysis

Investment costs for the different cases. The investment costs are dominating the overall costs. Other costs like insurance etc. mostly depend on the investment costs. The costs are divided into three parts: subsurface, on the surface and additional costs.

The figure shows the electricity prodcution costs in Eurocent/kWh. For the combined use of geothermal and waste heat, each process has been shown for the reference and the coupled case. The cost differences are the benefit of the combined use.





Conclusions

- Geothermal preheating is not as promising for an increased power production as other methods: Power generation by using the geothermal heat for preheating within a modern biomass plant is less efficient than using the geothermal heat within a geothermal power plant. The economic benefit is negligible in comparison to the cost for drilling etc.
- The use of waste heat from a biogas driven engine could have a positive effect on the overall efficiency of combined systems: By using waste heat from a CHP-plant operated by biogas it is possible to increase the thermodynamic middle temperature and therefore the cycle efficiency.
- There is an economic benefit to use the waste heat to increase the heat supplied to the power plant: Even if the heat supplied to the power plant cannot increase the overall electrical efficiency of the power plant there is an advantage by transferring the additional heat to electric power. In comparison to the drilling cost etc., the additional costs are low.
- The advantage depends on the properties of the geothermal source: The combined use of geothermal and biomass can be useful. The analysis of different cases shows that the advantage depends on the properties of the geothermal source like the well depth as well as the temperature of the geothermal brine and the characteristics of the waste heat source. The lower the temperature level the higher the electricity production costs are and thus the economic benefit for the combined use.

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