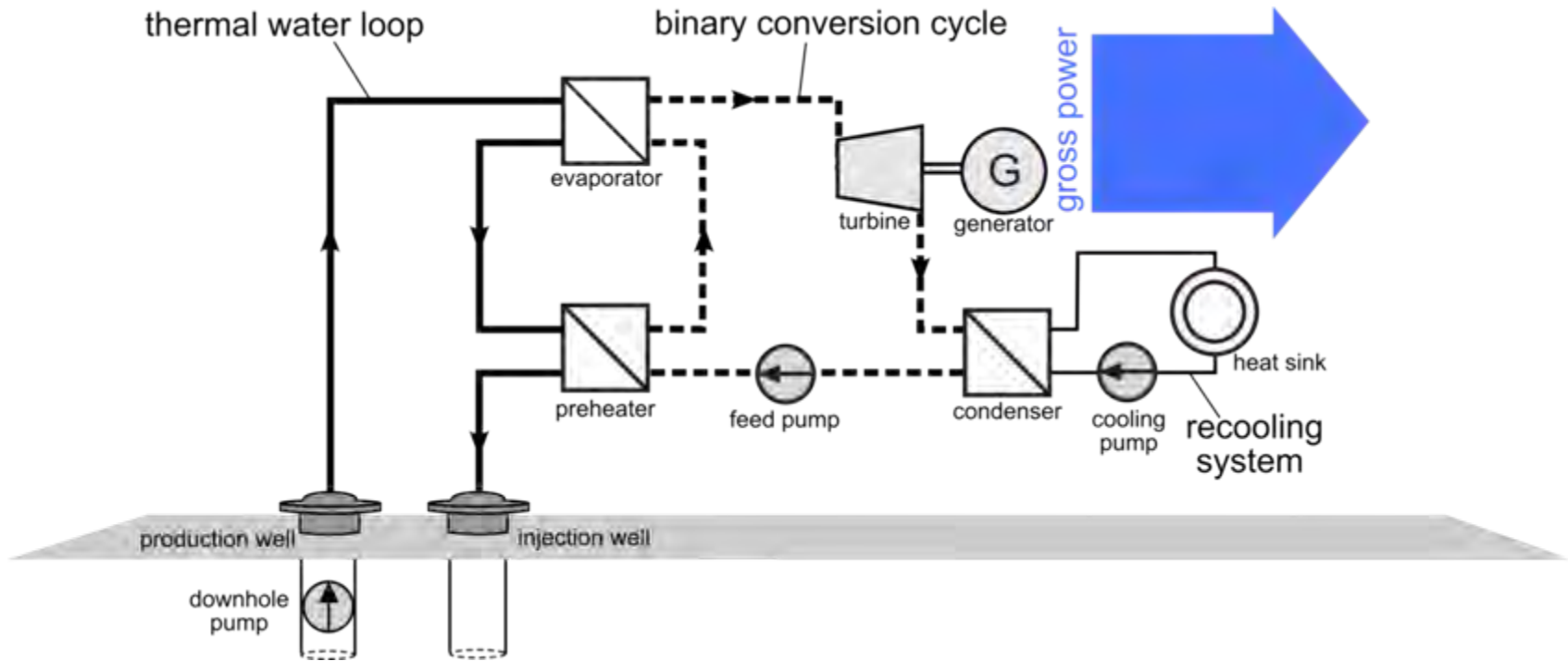


Design Approach for Geothermal Binary Power Plants

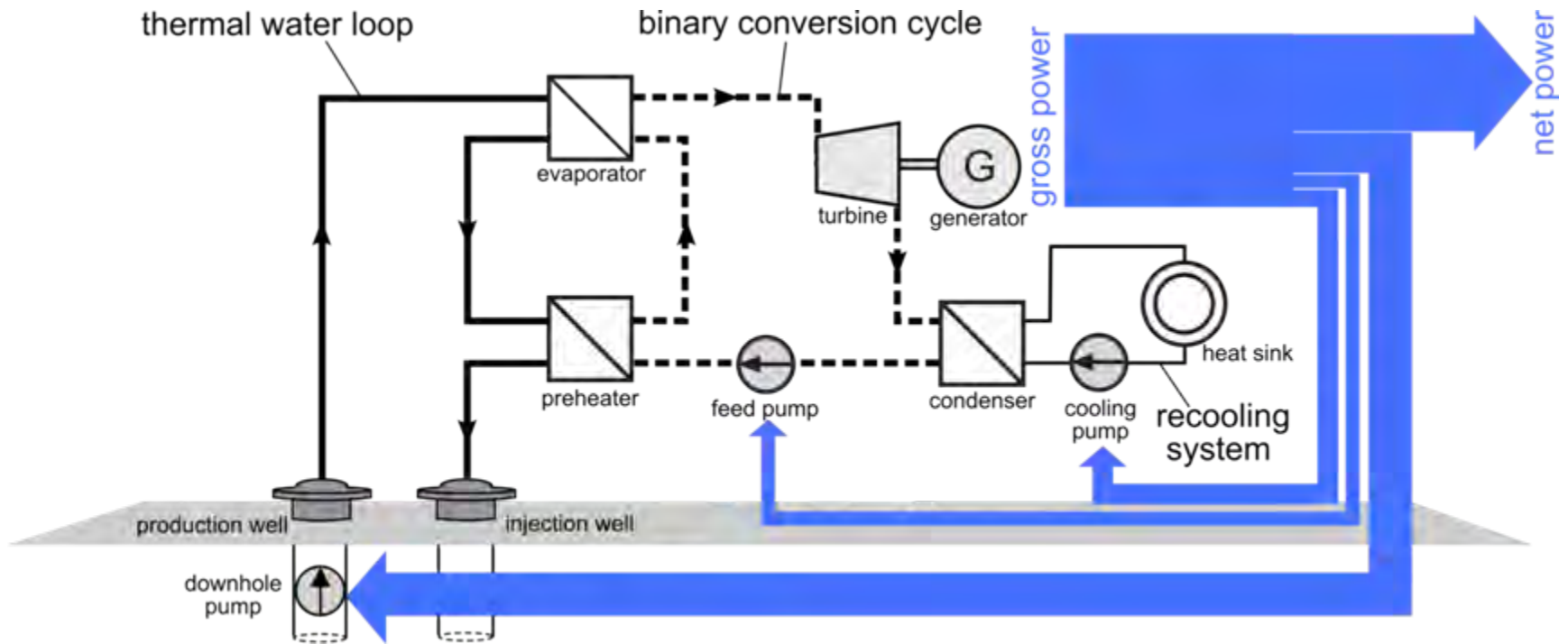
Stephanie Frick, Stefan Kranz, Ali Saadat,
Ernst Huenges

Introduction



→ Power plants serve for net power provision

Introduction

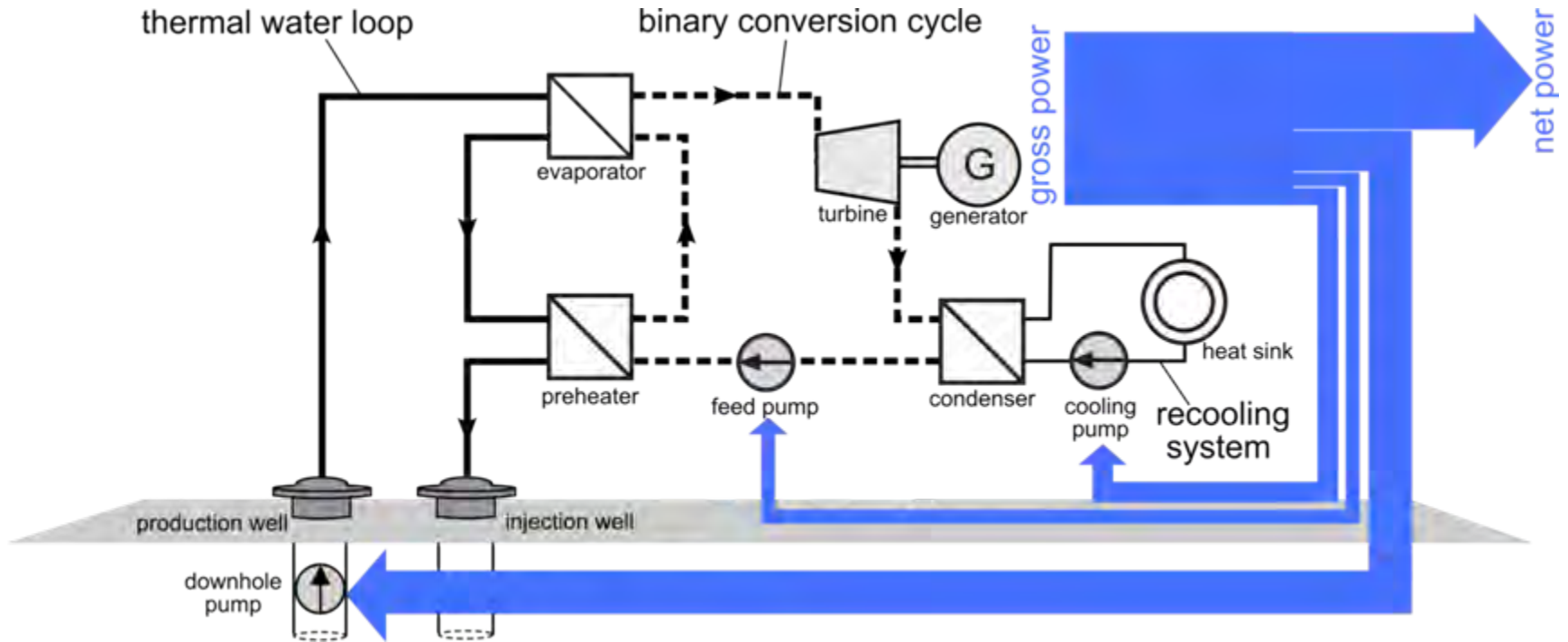


→ Geothermal binary plants need holistic design approach

Overview

- Design approaches: net vs. gross power maximisation
- Influence of surface installations and preconditions on maximum net power and optimum geothermal fluid flow
- Conclusions
- Outlook

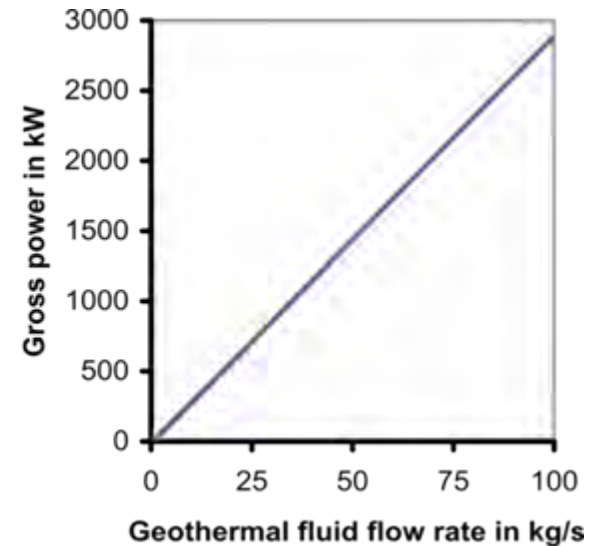
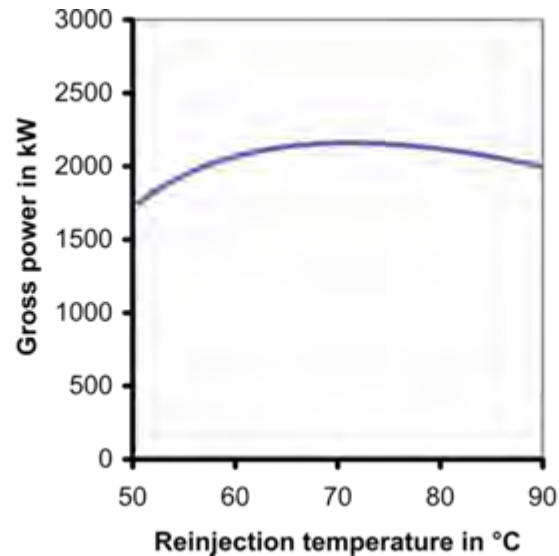
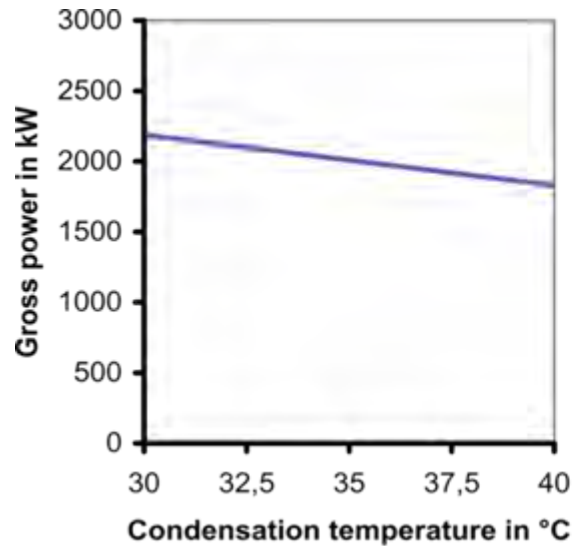
Introduction



Net vs. gross power maximisation

Design approach: **Gross** power maximisation

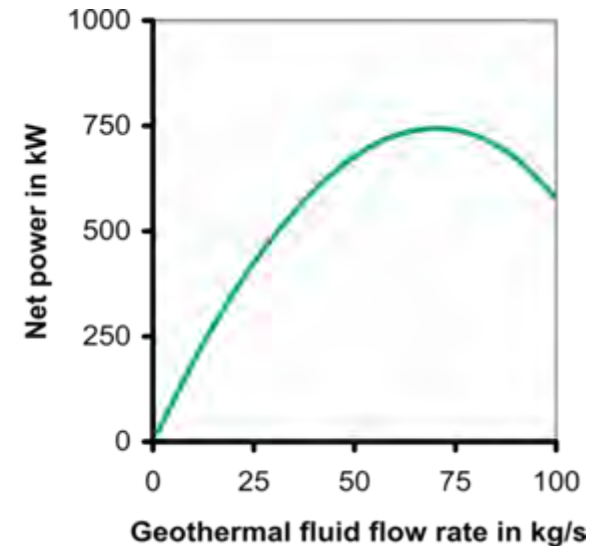
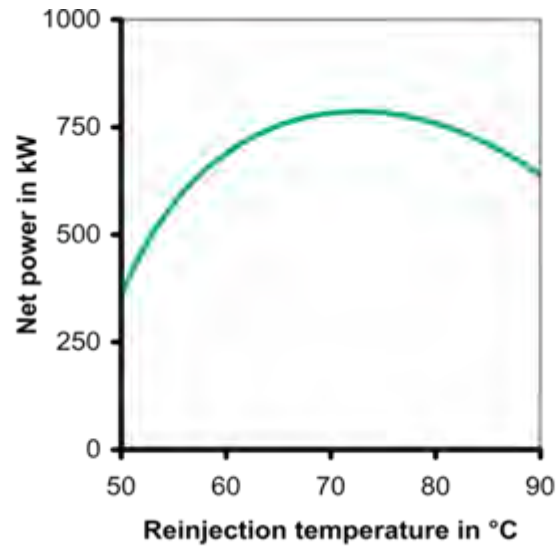
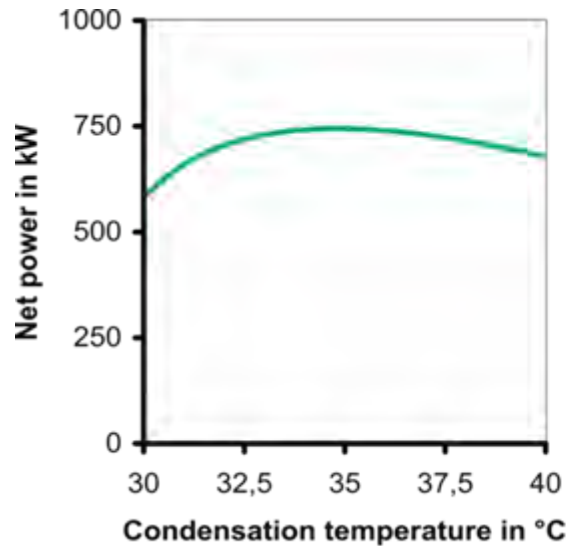
- Minimum condensation temperature
- Optimum reinjection temperature (or evaporation temperature)
- Predefined flow rate (maximum flow rate)



Net vs. gross power maximisation

Design approach: **Net** power maximisation

- **Optimum** condensation temperature
- Optimum reinjection temperature (or evaporation temperature)
- **Optimum** flow rate



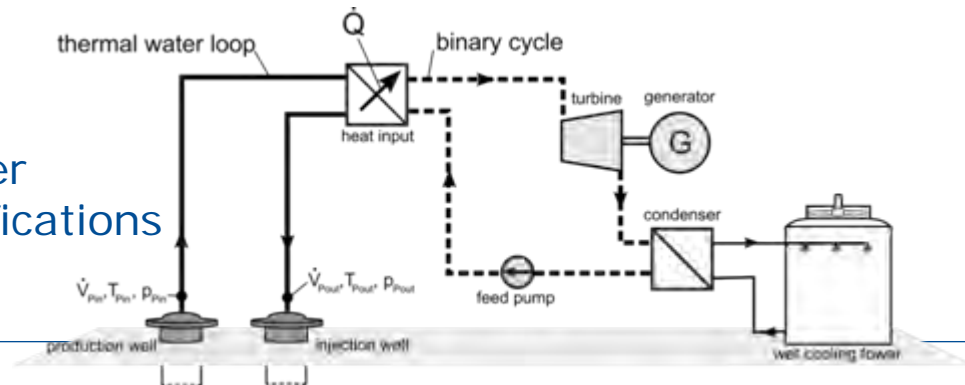
Net vs. gross power maximisation

Case study

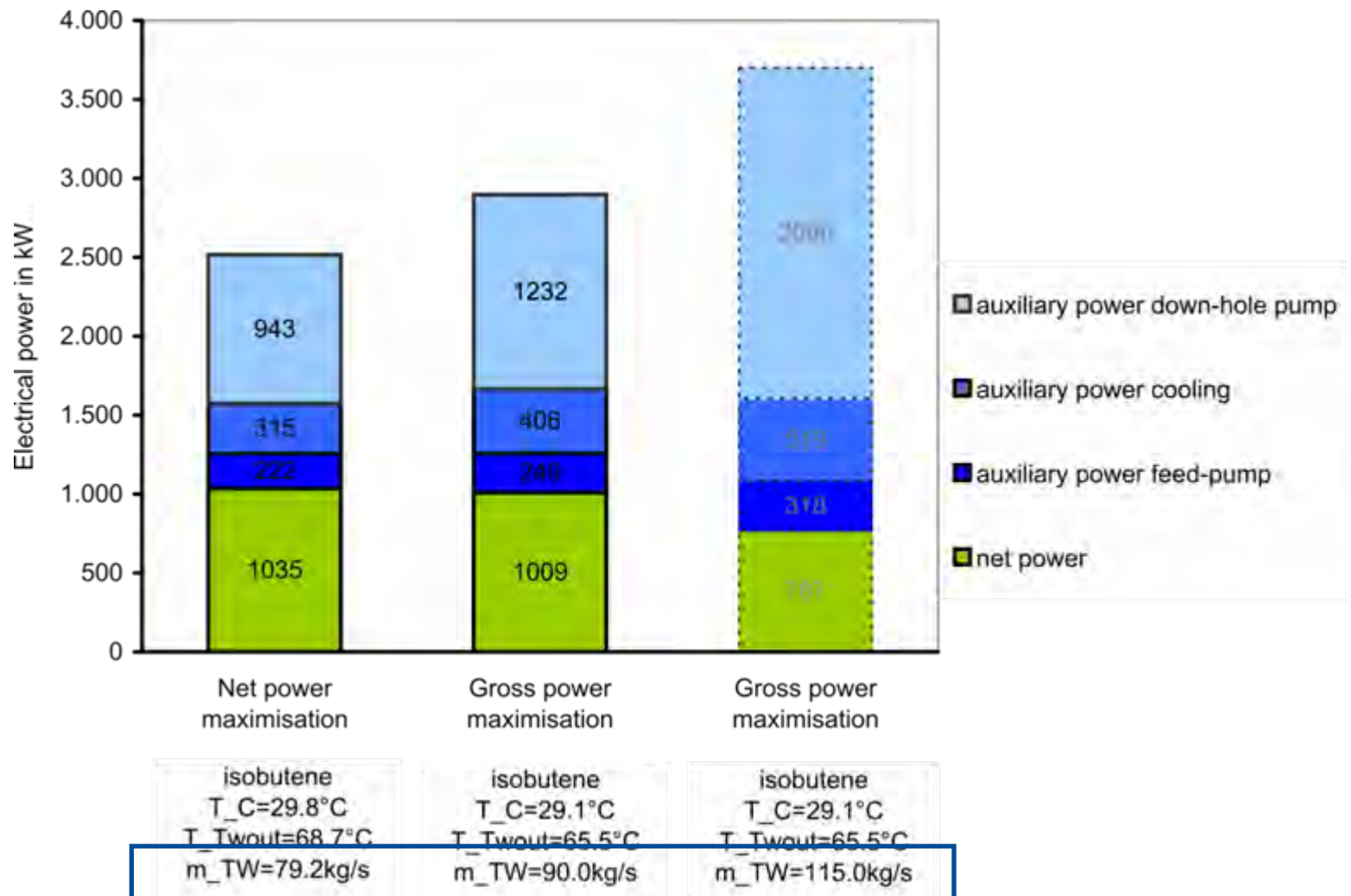
- Example site with well doublet:

reservoir temperature	150 ° C
reservoir depth	4,000 m
productivity / injectivity index	30 m ³ /(h MPa)
pore pressure gradient	10.7 bar/100m
specific heat capacity geothermal fluid	3.8 kJ/kg K
geothermal fluid density	1.147 kg/m ³
average ambient temperature	10° C
average relative humidity	80%

- Surface installations:
 - ORC with pure working fluid
 - forced draught wet cooling tower
 - equal general component specifications



Net vs. gross power maximisation



Optimum geothermal fluid flow rate

Case study

- Example site with well doublet
- Surface installations:

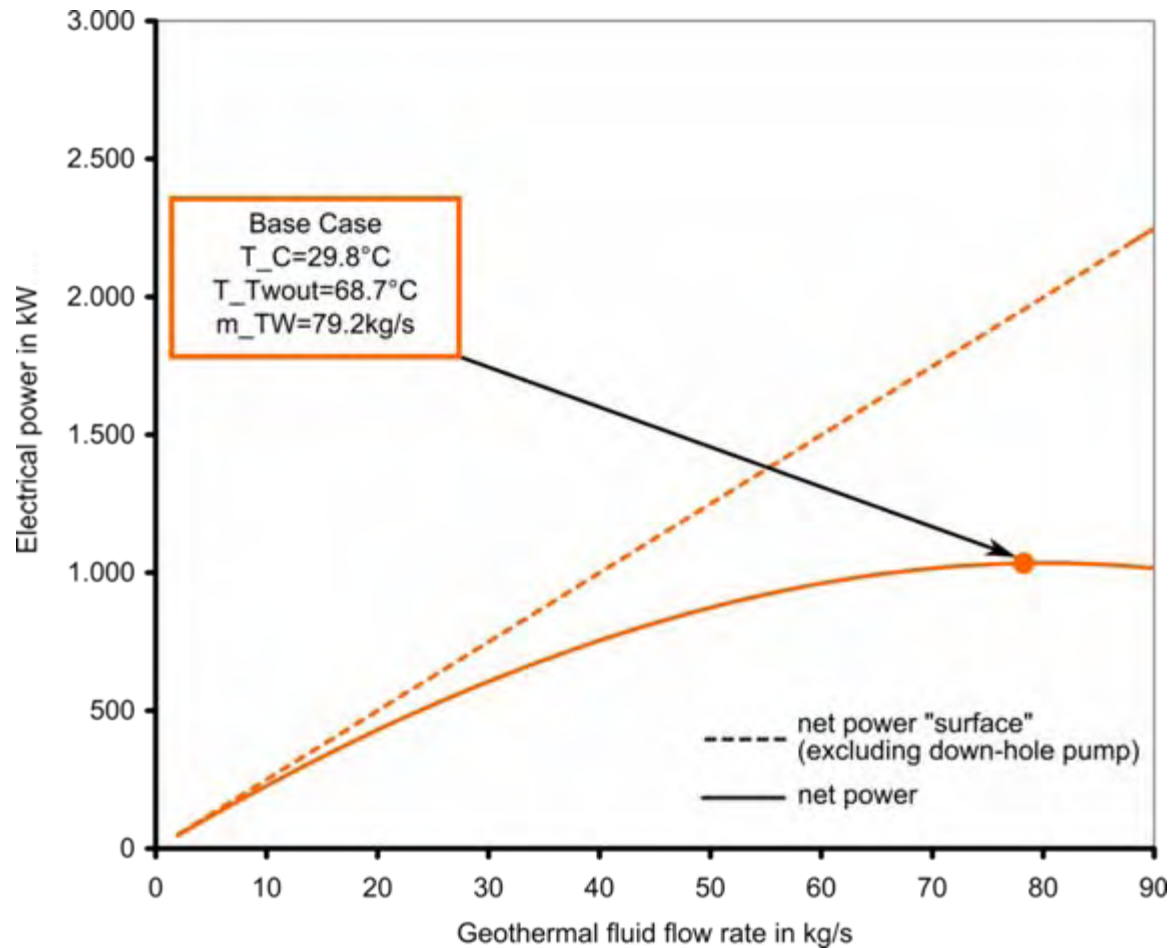
Base Case

Scenario 1: „Improved binary unit“
improved heat transfer heat input, more efficient turbine

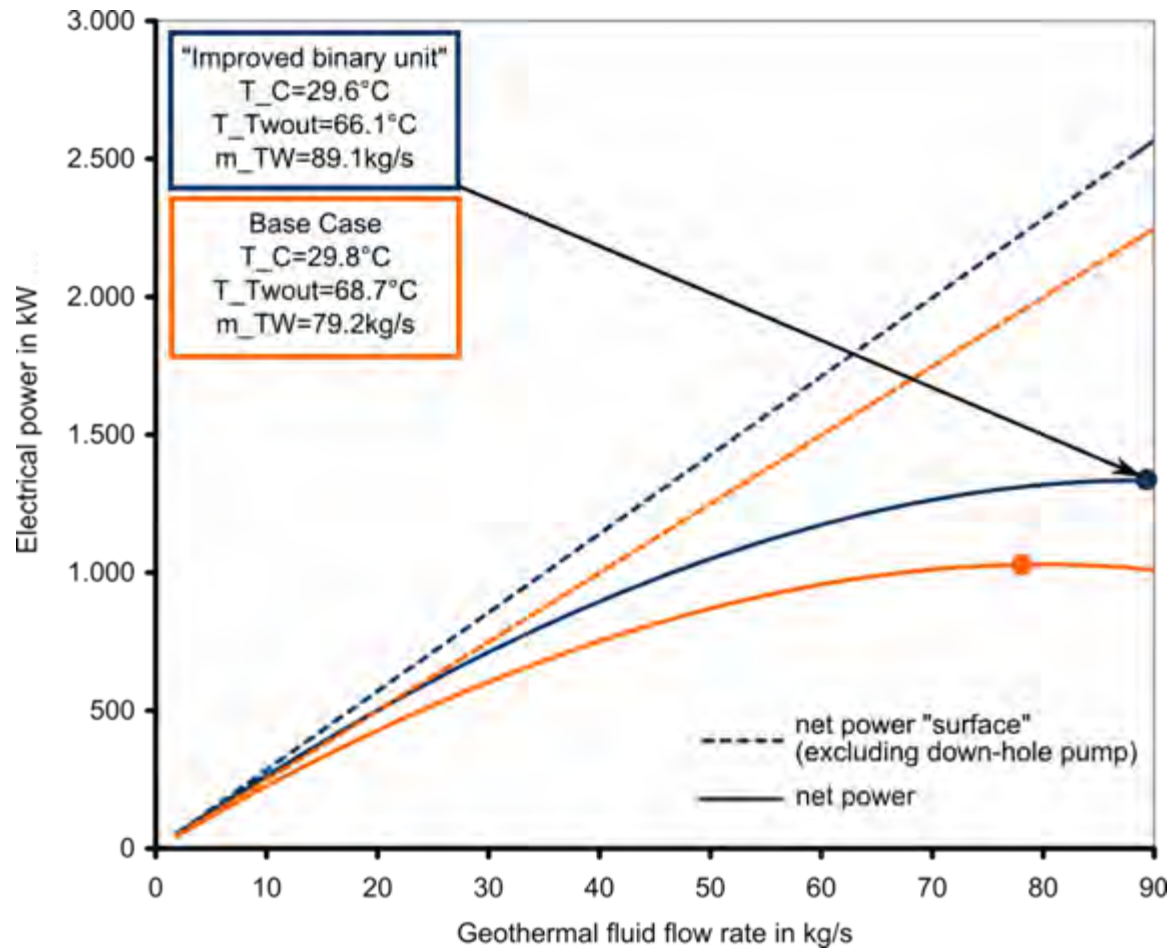
Scenario 2: „Ambient conditions“
ambient temperature 15° C, relative humidity 75%

Scenario 3: „Air cooling“
air cooled condenser

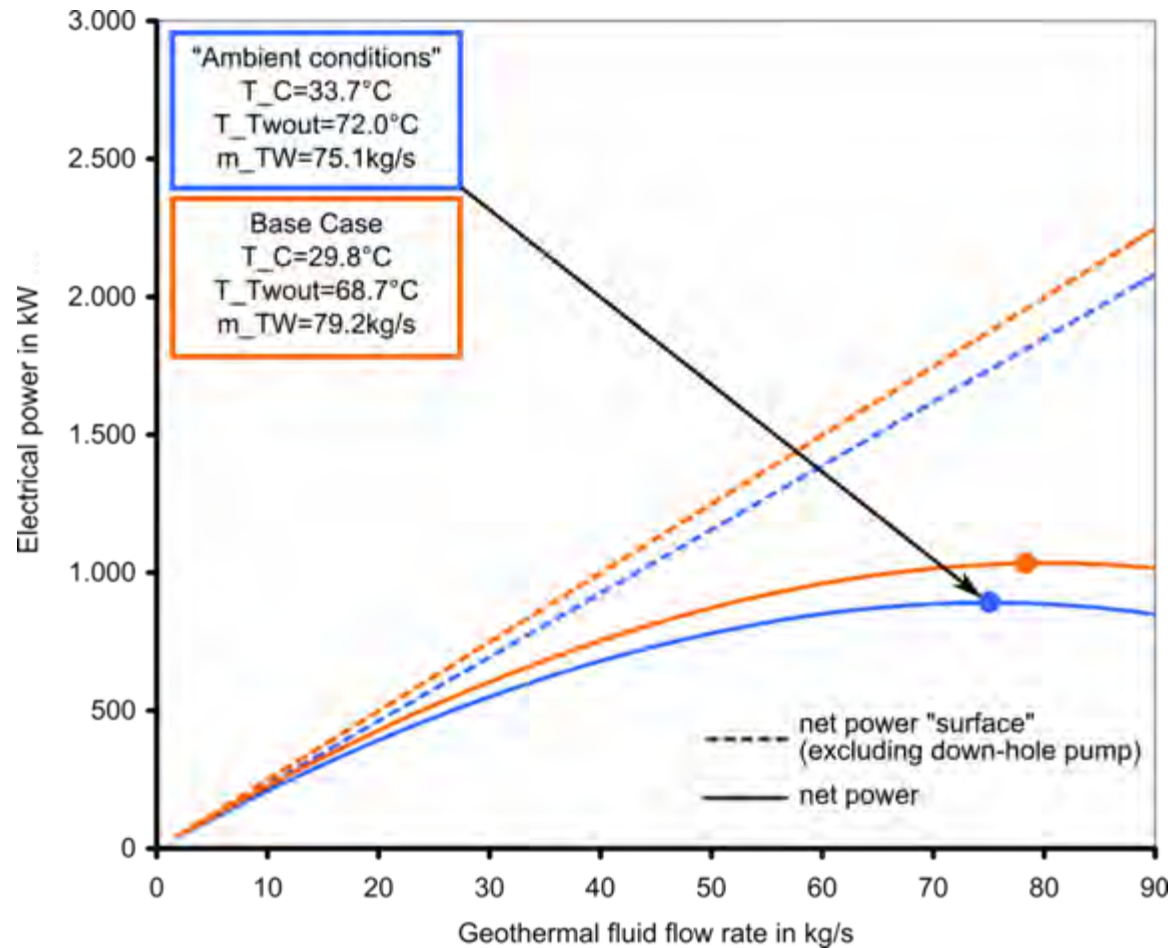
Optimum geothermal fluid flow rate



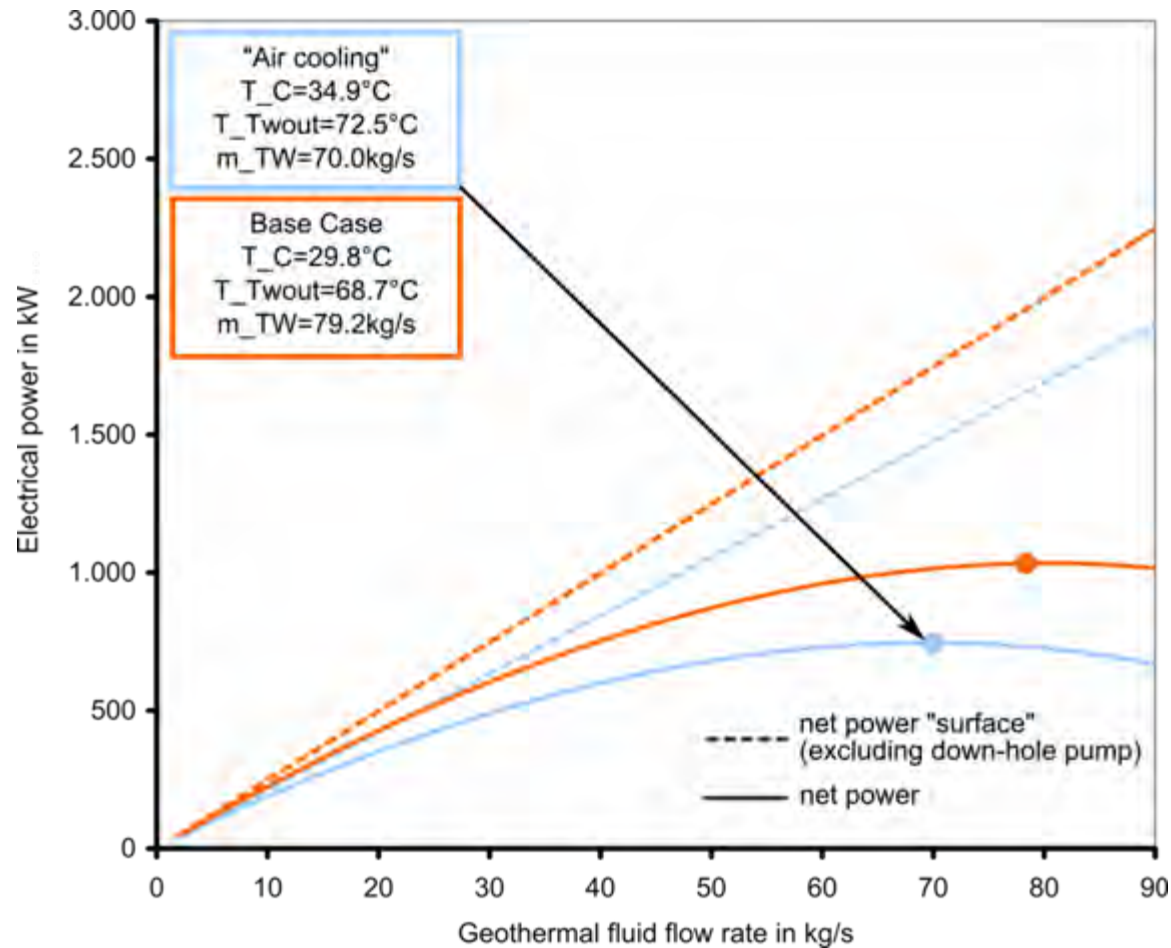
Optimum geothermal fluid flow rate



Optimum geothermal fluid flow rate



Optimum geothermal fluid flow rate

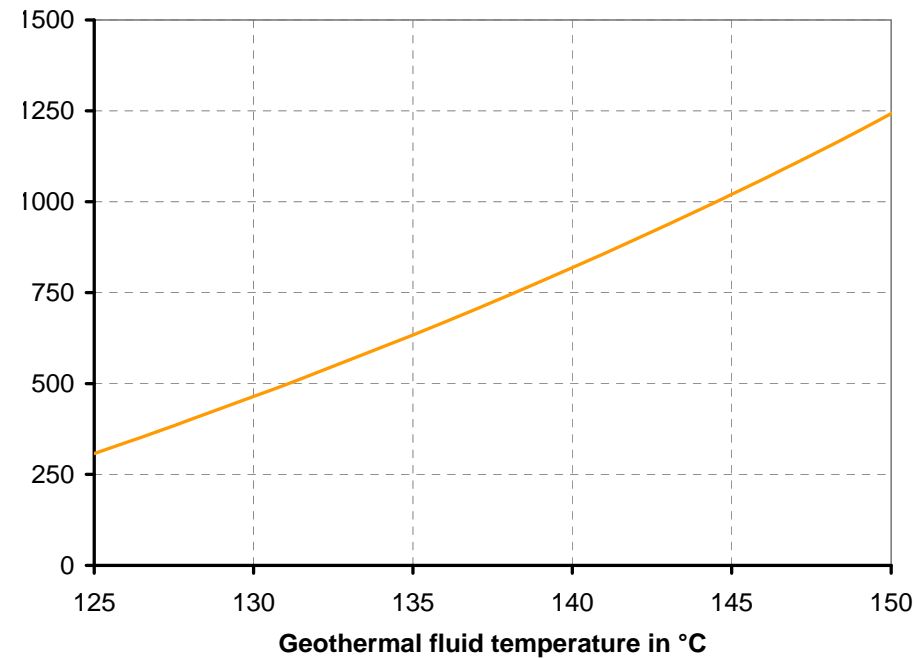
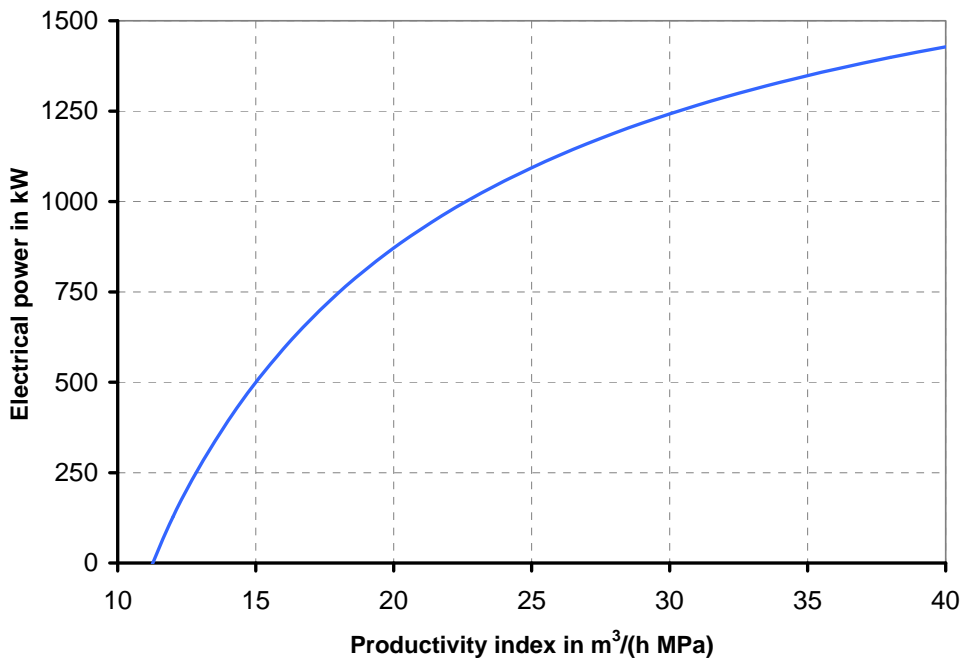


Conclusions

- Typical geothermal binary power plants
→ large auxiliary power demand (above 30%)
- Maximum net power output
→ net power optimisation with holistic design approach
- Planning and designing real plants
→ holistic design needs interaction of different disciplines
- Site-specific approach → no general plant design
- Reliable design recommendations
→ holistic design needs larger scope and more reliable data

Outlook on scope

- Holistic plant design can/must also consider:
 - seasonal part load behaviour
 - part load behaviour due to reservoir changes
 - combined energy provision
 - ...



Outlook on scope

- Holistic plant design can/must also consider:
 - seasonal part load behaviour
 - part load behaviour due to reservoir changes
 - combined energy provision
 - ...
 - Holistic plant design can also integrate non-technical aspects:
 - cooling water availability
 - economic considerations
 - required space
 - noise emissions
 - ...
- Holistic plant design needs powerful simulation tools

Outlook on data base

- Improvement of data reliability
 - site specific geothermal fluid characteristics
 - heat transfer between geothermal fluid and working fluid
 - local flow conditions in geothermal fluid loop
 - working fluid characteristics
 - Validation of theoretical approach with data of real projects
 - monitoring concept
 - project planning
- Development of generally applicable design approach for site-specific plant optimisation

Thank you very much for your attention!

Optimum geothermal fluid flow rate

