Geothermal Heat of the Bavarian Molasse Basin (Germany) for District Heating and Power Supply

With thanks to the Erdwerk Team and special thanks to Dr. Achim Schubert, Dr. Klaus Dorsch and David Lentsch
Outline

1. Introduction to the geothermal Molasse Basin
2. Project Management
3. Risk Mitigation
4. Cost Estimation
5. Lessons Learnt
The Southern German Molasse Basin

The Southern German Molasse Basin

Upper Jurassic

Malm Reservoir

Munich

Alpine Foothills

~ 130 km

~ 85 - 120 °C

~ 150 °C

Adapted from ‘Geologische Karte von Bayern 1:500000’, Bayerisches Geologisches Landesamt, 1996
Deep Geothermal Wells in 2003

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Deep Geothermal Wells Drilled up to 2015

- Very favorable reservoir conditions (low salinity and high yield).
- High rate of success, only 2 from over 40 drilled wells have been dry.
- Reliable heat source for district heating without the need for subsidies.
- Electricity production projects are driven by subsidies, with the influence currently decreasing.
Current Geothermal Claims in Southern Bavaria

- 2002: 4 Claims, 2004: over 40 Claims, Now: approx. 60
- Huge potential in and around Munich, large demand for heating
- Despite potential, economy of projects in smaller towns still challenging

Source: Bayerisches Staatsministerium für Wirtschaft, Infrastruktur, Verkehr und Technologie 2014
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From Exploration to Production

Geology & Geophysics
Geological Exploration
Geological Models
Well Site Geology
Borehole Geophysics

Reservoir Engineering
Reservoir Models
Simulation & Targeting
Risk Assessment
Well Test Analysis

Drilling Engineering
Well Design and Drilling Program
Well Site Design
Supervision
Drilling Data Analysis & Drilling Performance Analysis

Production Engineering
Completion Design
Well Test Design
Artificial Lift Systems
Stimulation Design

Project Management, Permits and Tenders
Project Management
Bidding Procedures
Approval Procedures
Typical Project Steps

Pre Planning
- Mining Approvals
- Geological analysis
- Customer Pre-assessment
- Drilling Site
  - Exploration Approval
  - "Drill Ready"

Planning
- Heating req, Network precontracts
- Seismic & Detailed Planning
- Cost Estimation
- Operational Plan
  - 3 Months
  - 3-6 Months
  - 2x3 Months

Drilling
- Drilling Site Construction
- Drilling
- Short Term-pump test
- Reservoir-Analysis
  - 4-6 Months (to max. 5 Years)

Testing
- Primary Circulation
- Long Term Pump Test
- Thermal Mining Approval
- Water Extraction Permit
  - + 25 Years

Production
- Maintenance
- District Heating Network
- >25 Year Permit
Typical Contract Structures (with Main Contractor)

Reduced Number or Single Contract

- Operator
  - Main Drilling Contractor
  - Planning/Engineering Supervision
  - Directional Drilling
  - Mud Engineering
  - Cementing Services
  - Casing
  - ...

- Lump Sum Typical for drinking water industry
- Move to day rate with a main contractor for deep geothermal exploration
- Significant cost and performance optimization benefits recognized
Day Rate Contract (without Main Contractor)

Multiple Contracts

- Traditionally role pure planning and consulting.
- Moved more towards central role.
- Significant cost and performance optimization benefits recognized
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Solution Process for Risk Mitigation

1. Recognise Root Cause
2. Evaluation and Analysis of Offset Wells
3. Develop technical mitigation measures
4. Implementation of “Lessons Learnt”

Risk / Uncertainty
Risk Mitigation Leads to Project Optimisation

Ø 14 m/h
Ø 18.5 m/h
Ø 10 m/h
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Time to Cost Estimation

- Defining the Model
- Gathering Data
- Model Evaluation
- Defining Input Distributions
- Adding Learning Trends
- Defining Correlations
- Sampling

**Time Model**

- Data from comparable wells (depth, diameter)
- Selection of appropriate distribution
- Forecast of drilling time

![Probability Distribution and Cumulative Probability Graph](Image)
Time to Cost Estimation

- Defining the Model
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Time Model

Time Dependent Costs

Time Independent Costs

Cost Model
Cost Estimation

5.0% 90.0% 15,139 18,319

Probability

Total Project Costs [T€]

Cumulative Distribution

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Risk minimisation leads to project optimisation.
Thank you

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