Financing the decarbonisation of regions & cities with geothermal

Business models to finance geothermal projects

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OUTLINE

• Geothermal district heating potential in Europe
• Geothermal energy system synergies
• Geothermal Financial Characteristics
• Key business factors: Derisking
• Business model building blocks
• Financial system and streams
• Regulatory framework
• Example of a typical GeoDH operation in the Paris Basin
Geothermal General Characteristics

- Well suited to base-load: capacity factors >95%, but can also accommodate variable loads
- Energy prices are site specific and there is limited capacity for export
- Economics strongly dependent on resource quality
- In some cases (when a high quality resource is available), geothermal can directly compete on price with other energy sources without incentives or subsidies
Geothermal Financial Characteristics

• High CAPEX and low OPEX compared to many sources except e.g. hydro
• Drilling may be up to 50% of total project cost
• Exploration and delineation drilling comprise significant 
  resource risk:
  • At the exploration stage that the whole project may not be feasible as planned
• Requires substantial investment in drilling before commercial financial closure is possible
  • Exploration cost independent of project size
• Requires at least 5 -8 years investment before any revenue
Geothermal Financial Characteristics: The Fundamental Problem

• The **risk** (and therefore upfront cost profile) of geothermal projects resembles oil and gas projects
  • But a barrel of hot water is worth $0.50, not $45 ($70 before COVID19)!
• The **returns** on a geothermal project resemble utility projects
  • And both utility companies and banks are risk averse
• Perversely, rising oil prices *increase* the up-front cost of geothermal projects because of competition for human resources, drilling rigs and materials
  • In recent years drilling costs have increased relative to general inflation
Key Business Factors: De-risking to Accelerate Development

• At the exploration stage:
  • Good quality geoscientific data
  • Very helpful for government agencies to carry this work out and make it accessible
    • E.g. Eastern Europe (before 1990), Turkey
  • Government agencies doing exploration drilling
    • E.g. Eastern Europe (before 1990), Turkey
    • But this raises issues of later transfer of wells and environmental liability for unsuccessful wells
Typical financial system and streams. Private taxable operating company

- **FINANCING**
  - EQUITY FUNDING
  - SHAREHOLDERS
  - BANK LOANS CREDIT LINES
  - FUND RAISING

- **INVESTMENTS**
  - SELF FINANCING

- **HEAT PRODUCTION SALES CASH FLOWS**
  - ROYALTIES
  - DEBT REPAYMENTS
  - DIVIDENDS
  - OM COSTS

- TAXES

**EGEC GEO THERMAL**
From resource to end users. A typical geothermal district heating regulatory framework.
PARIS BASIN GDH SCHEME

1. Production well
2. Submersible production pump
3. Injection pump
4. Injection well
5. Geothermal heat exchanger
6. Back-up (peak-load)/relief boiler
7. Heating grid
8. Substation
9. Geothermal reservoir (Dogger limestones)
10. Cooled fluid zone
## TYPICAL COST BREAKDOWN (10^3€) FOR A GEOTHERMAL DOUBLET

### CAPEX

<table>
<thead>
<tr>
<th>Mining</th>
<th>min</th>
<th>max</th>
<th>Mining</th>
<th>min</th>
<th>max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well drilling/completion</td>
<td>8500</td>
<td>9000</td>
<td>P1 Power, chemicals, consummables</td>
<td>200</td>
<td>250</td>
</tr>
<tr>
<td>Primary (geothermal) loop</td>
<td>1200</td>
<td>1300</td>
<td>P2 Monitoring, light maintenance</td>
<td>75</td>
<td>90</td>
</tr>
<tr>
<td>Geothermal heat exchanger</td>
<td>300</td>
<td>400</td>
<td>Heavy duty maintenance, well workover, on duty call</td>
<td>250</td>
<td>300</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10000</strong></td>
<td><strong>10700</strong></td>
<td>Miscellaneous</td>
<td><strong>30</strong></td>
<td><strong>50</strong></td>
</tr>
</tbody>
</table>

### Surface

<table>
<thead>
<tr>
<th>Surface</th>
<th>min</th>
<th>max</th>
<th>Surface</th>
<th>min</th>
<th>max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary (grid) loop</td>
<td>600</td>
<td>700</td>
<td>P1 Power, chemicals</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>Heat plant</td>
<td>800</td>
<td>900</td>
<td>P2 Heat plant/grid monitoring/maintenance</td>
<td>400</td>
<td>450</td>
</tr>
<tr>
<td>Grid (piping)</td>
<td>8000</td>
<td>10000</td>
<td>P3 Provisions for depreciation</td>
<td>250</td>
<td>350</td>
</tr>
<tr>
<td>Grid (substations)</td>
<td>2500</td>
<td>3000</td>
<td>Miscellaneous</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>11900</strong></td>
<td><strong>14600</strong></td>
<td><strong>Total</strong></td>
<td><strong>730</strong></td>
<td><strong>910</strong></td>
</tr>
</tbody>
</table>

**GRAND TOTAL** 21900 25300

**BREAKEVEN**

<table>
<thead>
<tr>
<th>BREAKEVEN (€/MWh)</th>
<th>WORST CASE</th>
<th>BEST CASE</th>
<th>MEDIUM CASE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPEX (10^3€)</td>
<td>25000</td>
<td>22000</td>
<td>23000</td>
</tr>
<tr>
<td>OPEX (10^3€/yr)</td>
<td>1600</td>
<td>1285</td>
<td>1400</td>
</tr>
<tr>
<td>SUBSIDY (% CAPEX)</td>
<td>0</td>
<td>35</td>
<td>25</td>
</tr>
<tr>
<td><strong>BREAKEVEN</strong></td>
<td><strong>81</strong></td>
<td><strong>56</strong></td>
<td><strong>64</strong></td>
</tr>
</tbody>
</table>
D4.2

BUSINESS MODELS ON GEOTHERMAL DH SYSTEMS

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Geothermal Energy: renewable-sustainable-proven-achievable-realistic

Thank you for your attention!