Webinar EGEC Market Report 2018

Innovation in geothermal H&C: Grigny geothermal heat project:

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Outline

• Paris Basin overview
• Grigny (south Paris) district heating development
• Derisking – Paris Basin Dogger aquifer specific
• Innovative well architectures - highlights
Deep geothermal in Europe: market overview

Two important milestones:
1) More than 3 GWe installed
2) More than 300 Geothermal DH in operation

....and soon 2 millions geothermal HPs!

Installed capacity for geothermal electricity & district heating (2018, Mwe & MWth)
Paris Basin – Geological Overview

West East Cross Section

Lithostratigraphic column and target reservoir horizons

- Shallow tertiary aquifers
- Lower Cretaceous aquifers
- Target Dogger reservoir
- Trias Target reservoirs
Paris Basin Dogger Reservoir. Geothermal District Heating Status

- 48 doublets in operation
- 1100 GWht/year
- More than 1 million people benefit of geothermal district heating
The Paris Basin Geothermal learning curve

**BIRTH (1969-1980)**
- 1969 1st GHD DOUBLET @ MELLIN L'AUXOYTE
- 1973 1st OIL SHOCK
- 1977 GEOTHERMAL ACT
- 1979 2nd OIL SHOCK
- 1980 ADMINISTRATIVE FRAMEWORK
- FIVE DOUBLETS COMPLETED

**INFANTILE DISEASE (1980-1990)**
- 39 DOUBLETS COMPLETED
- SEVERE THERMOCHEMICAL DAMAGE
- REPEATED ESP FAILURES
- POOR MANAGEMENT PRACTICE
- LOW EQUITY/HIGH DEBT
- CRITICAL ECONOMICS
- 8 TRIAS WELL FAILURES

**TEENAGE LEARNING (1990-2000)**
- 21 DAMAGED/NON ECONOMIC DOUBLETS ABANDONED
- INNOVATIVE DOWNHOLE THERMOCHEMICAL INHIBITION & WORKOVER TECHNOLOGIES
- THOROUGH STATE SUPPORT (R&D, FERTIGATION)
- 1995 COMPLETION OF THE FIBERGLASS LINED ANTICORROSION WELL
- 217 GAS COGENERATION PLANTS

**SUSTAINABLE DEVELOPMENT (2010-2060?)**
- ACHIEVED (2011-2015) 12 NEW DOUBLETS/TRIPLETS
- PROJECTED (2020?) 18 NEW DOUBLETS, 6 NEW TRIPLETS, 2,000 GWa/yr

**MATURITY (2000-2010)**
- OPTIMISED HEAT PLANT & GRID OPERATION
- 34 GHD SYSTEMS ONLINE
- IMPROVED MANAGEMENT SKILLS
- FINANCE STABILISATION
- DESIGN OF SUSTAINABLE MINING SCHEMES (TRIPLET & WELL ARRAYS)
- PUBLIC/PRIVATE GHD AGREEMENTS
- 4 NEW DOUBLETS/TRIPLETS
Grigny case study
Concession areas. Reservoir properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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<tbody>
<tr>
<td>Reservoir depth TVD</td>
<td>1590 m</td>
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<tr>
<td>Transmissivity</td>
<td>12,5 et 18 D.m</td>
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<tr>
<td>Porosity</td>
<td>16 %</td>
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<tr>
<td>Salinity</td>
<td>8,5 g/L</td>
</tr>
<tr>
<td>Temperature</td>
<td>71 +/-1 °C</td>
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Western Paris Basin. Where do facies boundaries stand?
Heat plant
Main features

- Maximum flowrate 300 m3/h
- Yearly heat production ≈ 96 000 MWh -> 69 000 MWh geothermal
- Yearly average flowrate: 236 m3/h
- Reinjection temperature summer: 54 °C
- Reinjection temperature winter: 40 °C
- Average reinjection temperature: 46 °C
- Installed capacity: 10,5 MW
- Renewable heat coverage of the grid ≈ 68%
CAPEX/OPEX

- **CAPEX**
  - Geothermal loop: 14.5 M€
  - Surface installations: 8.7 M€

- **OPEX**
  - 470 K€
## Financing

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<th>ITEM</th>
<th>Amount (k€)</th>
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<tr>
<td>ADEME Subvention</td>
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<td>Pre-financing fees</td>
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<tr>
<td>Equity</td>
<td>1000</td>
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<tr>
<td>SAF Short term guarantee</td>
<td>4073</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>14479</strong></td>
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Is the Paris Basin a mature, low risk, field? A forty year production period and still the same amounts of wells display below 20 Darcy meter transmissivities.
DERISKING — PARIS BASIN SPECIFIC

FOCUS, PRIOR TO DRILLING, ON

1. **sectorial lithostratigraphic correlations**, to identify, within the Dogger carbonate platform, those layers exhibiting favourable porosity and permeability trends and design accordingly well architectures departing from the routinely engineered deviated well trajectories aimed at intercepting the whole pay interval,

2. **reprocessing of existing seismic lines** and, whenever needed, **acquisition of new high resolution 2D lines** and, exceptionally, **3D surveys**,

3. **innovative well architectures** (horizontal, subhorizontal drains, multiradial, multilateral),

4. **(wildcat?) well siting vis-à-vis identified geologic structures** (faults, anticline, horst...),

5. play reevaluation in the light of newly acquired (wireline, test) data sets (offset wells),

6. **screening** and eventual **validation** of Candidate Dogger project opportunities,

7. selection of an **eligible drill site**, and,

8. **last but not least implementation of innovative well architectures.**
SUB HORIZONTAL DOUBLET ARCHITECTURE

a) Well architectures

b) Well trajectories

c) SHW and candidature offset well trajectories
Anti-corrosion well concept
Thank you for your attention