Investing in Geothermal Energy:

Geothermal Prospects of
Milos-Kimolos-Polyaigios, Nisyros, Lesvos and Methana

Athens, December 2011
Contents

- The Greek RES market within the EU 2020 targets
- PPC Renewables S.A. – Company Profile
- Geothermal Projects in Greece
Current Situation

- The high renewable energy potential in wind, solar, hydro, geothermal energy and biomass have always favoured the use of RES energy in Greece.

- Despite the significant potential of the country, its RES sector has been a flat and slowly developed market during the past years, reaching ~1.75 GW today.

- The adoption of the EU Directive (28) in 2009 led the Greek Government in passing a new legislation (L. 3851/2010), aiming to speed up renewable licensing procedures (i.e. minimizing the bureaucracy), setting thus the basis for a new national fuel mix over the coming years.

Greek RES Market* (Installed Capacity, End 2010)

- Including large HPPs

Approx. 8.5% market share of electricity consumption today

Source: HTSO, PPCR estimates
Recent Developments

According to EU directive, the national targets for 2020 are set as follows:

- Share of energy from RES in gross final energy consumption at 18% by 2020 (Directive 28/2009)

- The Government raised voluntarily the RES penetration target from 18% to 20%

- The target for the share of electric energy from RES in gross final electricity consumption is set (in the 2010 legislation) at 40% by 2020

- The other 2020 targets are:
  - Biofuels penetration: 10%
  - Energy savings: 20% (not binding)
  - CO₂ reduction as follows: For sectors outside 2003/87/EC, 4% reduction in emissions compared to 2005 level (66.7 mn) until 2020, and for sectors within 2003/87/EC, 1.74% yearly reduction
The realization of the NREAP targets set in the domestic legislation would require an average of 900 MW installations annually.

<table>
<thead>
<tr>
<th>RES Category</th>
<th>Installed Capacity target (MW)</th>
<th>% participation (MW)</th>
<th>Energy Production target (GWh)</th>
<th>% participation (GWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind Energy</td>
<td>7,500</td>
<td>69,64%</td>
<td>16,797</td>
<td>71,55%</td>
</tr>
<tr>
<td>PV</td>
<td>2,450</td>
<td>22,75%</td>
<td>3,225</td>
<td>13,74%</td>
</tr>
<tr>
<td>SHPP’s</td>
<td>350</td>
<td>3,25%</td>
<td>1,349</td>
<td>5,75%</td>
</tr>
<tr>
<td>Biomass</td>
<td>350</td>
<td>3,25%</td>
<td>1,763</td>
<td>7,51%</td>
</tr>
<tr>
<td>Geothermal energy</td>
<td>120</td>
<td>1,11%</td>
<td>343</td>
<td>1,46%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10,770</strong></td>
<td><strong>100,00%</strong></td>
<td><strong>23,477</strong></td>
<td><strong>100,00%</strong></td>
</tr>
</tbody>
</table>
PPC Renewables S.A. – Company Profile: Mission & Strategy

- PPCR is a wholly-owned subsidiary of PPC S.A. and being the only vertically integrated RES operator in Greece, its objective is to secure a leading position in the Greek RES market over the next 5 years by increasing significantly its market share of the Greek RES market from 8% currently to approximately 20%, contributing thus to the national green development vision and to the creation of the foundations for sustainable development.

- PPCR’s Strategy is founded on two central pylons:
  1. **The development of a portfolio** in all RES types, involving:
     - The construction of new large inland and island Wind Parks involving major interconnection works
     - The construction of two of the largest PV stations in Europe and in the world as well as many smaller ones
     - The exploration and development of the high enthalpy geothermal fields in the Aegean islands
     - The construction of new Small Hydro electric stations
     - The development of hybrid systems
     - The development of Biomass
     - The planning of offshore Wind Parks
  2. **The strategic co-operations** home and abroad, aiming to jointly develop RES projects and to achieve exchange of knowhow
PPCR’s Current Portfolio

- PPCR current portfolio of installed assets is 144.7 MW, holding a leading position in the country in SHPPs.

• 20 Wind Farms (mainly in islands)
• 15 SHPPs (mainly in mainland)
• 6 P/V installations
PPCR’s Pipeline

- **157 MW at the final stage of licensing procedure**
- **Additionally 620 MW are in the process to obtain the installation license**

**MW per stage of licensing process**

- **MW 302.4**
  - in operation: 144.7
  - with installation license: 157.7
  - with approved environmental terms: 110.1
  - with production license: 510.6
  - applications for production license: 620.7
  - under study: 1746.4
  - Total: 3433.4

**MW per type of RES**

- **W**: 2992
  - New: 81
  - Existing: 2911
- **SHP**: 105
  - New: 63
  - Existing: 42
- **P**: 201
  - New: 73
  - Existing: 25
- **Hybrid**: 37

**Total**: 3433.4
The total annual turnover of Greek geothermal market is estimated at ~ € 348 million based on current selling price of electricity produced in the Network.

<table>
<thead>
<tr>
<th>Description</th>
<th>Power (MW)</th>
<th>annual energy output (MWh)</th>
<th>energy price (€/MWh)</th>
<th>annual turnover (€ m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected Geothermal Installed capacity by 2020</td>
<td>170</td>
<td>1,500,000</td>
<td>99,45</td>
<td>149</td>
</tr>
<tr>
<td>Additional estimated unexploited geothermal potential</td>
<td>230</td>
<td>2,000,000</td>
<td>99,45</td>
<td>199</td>
</tr>
<tr>
<td>TOTAL estimated geothermal potential in Greece</td>
<td>400</td>
<td>3,500,000</td>
<td>99,45</td>
<td><strong>348</strong></td>
</tr>
</tbody>
</table>

The total gross turnover of the unexploited geothermal potential in Greece is estimated at around € 348 million annually.
PPC/PPCR’s Major Geothermal Milestones

- 1973: Beginning of exploratory drilling for Geothermal Fields
- 1986: Construction of the first Geothermal Power Plant in the island of Milos (2 MW)
- 1998: Founding of PPC Renewables S.A.
- 2006: Transfer of all PPC’s RES assets to PPC Renewables S.A.

Pic.1: Zefyria then  Pic.2: Zefyria now
By 2020, PPCR is expected to hold shares equal to ~ 70% of the total installed capacity of geothermal energy in Greece.

PPCR’s expected installed capacity by 2020 (MW)

120 MW

PPCR is expected to play a leading role in the Greek market for geothermal power plants with 120 MW of a total of 170 MW by 2020.
## Portfolio of geothermal projects under development

<table>
<thead>
<tr>
<th>Name</th>
<th>Lesvos</th>
<th>Nisyros</th>
<th>Methana</th>
<th>Milos-Kimolos-Polyaigos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed Capacity</td>
<td>8 MW</td>
<td>5 MW</td>
<td>5 MW</td>
<td>5 MW</td>
</tr>
<tr>
<td>Annual Production</td>
<td>66.500 MWh</td>
<td>40.000 MWh</td>
<td>40.000 MWh</td>
<td>40.000 MWh</td>
</tr>
<tr>
<td>Owner</td>
<td>100% PPCR</td>
<td>100% PPCR</td>
<td>100% PPCR</td>
<td>100% PPCR</td>
</tr>
<tr>
<td>Present stage</td>
<td>Preparation for drilling</td>
<td>Application for production license</td>
<td>Signing contract with Ministry (ΥΠΕΚΑ)</td>
<td>Application to RAE for production license &amp; preparation for drilling</td>
</tr>
<tr>
<td>Total Cost</td>
<td>€ 32 m.</td>
<td>€ 40 m.</td>
<td>€ 20 m.</td>
<td>€ 20 m.</td>
</tr>
<tr>
<td>Estimated annual revenue</td>
<td>€ 8,5 m.</td>
<td>€ 4,9 m.</td>
<td>€ 4,5 m.</td>
<td>€ 4,5 m.</td>
</tr>
</tbody>
</table>
NISYROS: A GEOTHERMAL POWER PLANT WILL BE DEVELOPED ON THE ISLAND AT Ag. EIRINI

- Older drillings
- Faults of geothermal significance
- Planned position for 5 MW power plant
Nisyros: The power plant will cover the electric power needs of the 9 interconnected islands

Main Features

**Technical Information**
- Social consensus is required
- Nisyros has the second largest geothermal field (enthalpy-wise) in Greece
- In the first phase, a 5 MW unit will be developed at Aghia Eirini. There will be no intervention in the caldera of the volcano.

**Environment**
- It is far from monuments and traditional settlements
- No air pollution due to the total reinjection of the geothermal fluid
- Minimal visual impact due to a low height (<8m) and distance from settlements.
- There will be no chimneys
- Zero visual impact of cable (use of underground cables)

**Benefits**
- **70 new job-positions** (during construction) and **15** during operation (direct employment for residents of Nisyros).
- Geothermal Power Plants are worldwide an attraction pole for high level tourism (conferences, etc.).
Main features

- PPCR has achieved social consensus
- The geothermal field of Methana is not yet fully explored
- The prospect is to thoroughly explore the field
- The Geothermal Power Plant will be connected with the Greek mainland grid

Project’s history

- 8 studies have been conducted since 2000
- PPCR has secured the consent of the Local Government and has received the required approval of environmental terms.
- 11 shallow exploratory slimholes (depth 250 m) have already been drilled.

Investment Activities

- 3-4 exploratory drillholes of medium depth will be constructed
- Drilling of an exploration well of 2.000m depth will follow
Methana: Map of project

**LEGEND**

- **ARCHAEOLOGICAL SITES**
- **SLIMHOLE DRILLINGS**
- **POTENTIAL POSITION OF NEW WELLS (INCLINED WELLS)**
- **MAIN RIFT STRUCTURE OF THE REGION**
MILOS – KIMOLOS - POLYAIGOS

Main Features

- Social consensus is vital for the development of the Project
- Milos-Kimolos-Polyaigos is a field of high geothermal capacity
- With the full field development, and after connecting to Syros, this field can cover most of the energy demand of the Cyclades
- A 5 MW geothermal plant will be developed and 25-30 new jobs will be created (direct employment)

Investment Activities

Since 1973, there have been:
- more than 130 studies
- considerable investment by 2005
- 5 productive wells of 1,000 – 1800m depth
- Experimental Construction (in 1986) and operation of a 2 MW unit, which operated for 2 years (6 TWh) covering the needs of the island

Current Activities
- Informing the local community and obtaining formal social consensus
Hot Springs

PPC Slimholes
LESVOS

Present situation

✓ The initial exploratory drilling was interrupted due to technical failures in Dec. '08 at 1,410 m, not having found satisfactory temperatures

✓ 3 exploration wells are planned to be drilled at depth 600-1000m at Stipsi and Argenos areas

Future steps

✓ New geophysical survey (gravity and high-resolution DC-Resistivity)
✓ Detailed tectonic study
✓ Deep Well drilling
Areas of Geothermal interest
Stypsi Well Temperatures (°C)
Geophysical survey