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Luca Angelino (EGEC); Philippe Dumas (EGEC); Thomas Garabetian (EGEC); Valentina Pinzuti (EGEC)

DESIGN

Valentina Pinzuti (EGEC)

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In 2011, EGEC published its first market report evaluating the development of the geothermal sector in Europe. This because since 2007/2008 we had witnessed a resurgence of interest following nearly a decade of only limited development of capacity in the deep geothermal sector, both for electricity and for direct uses, mainly district heating (DH).

Over the last five years (2012-2016), a substantial number of projects have been developed throughout Europe, and geothermal energy is on its way to becoming a key player in the European energy market.

The 2016 edition of this EGEC Market Report is a five-year assessment of the electricity, DH and geothermal heat pump sectors.

The report shows that while interesting new projects have emerged, there are unfortunately projects in the pipeline that have not yet been realised. In this respect, it should not be forgotten that project development time, from the date that the geothermal project is officially announced to the first heat or power being delivered, is usually in the order of 4-7 years. It is for this reason that this report presents not only the plants in operation, but also those under development and others under investigation.

The use of geothermal energy, particularly for heat, is slowly but steadily increasing across Europe. Analysing the development of both the electricity and the heat sectors up until December 2016, the 6th edition of the EGEC Market Report shows growth in all areas, but notes that there is a great deal of untapped potential. Greater ambition is needed if Europe is to fully benefit from this energy source.

The growth of geothermal power is mainly due to rapid expansion in Turkey, which is set to continue. Italy, the traditional home of geothermal, is an area of focus, as are France and Germany. New and innovative projects are also expected in other countries in the coming years.

Enhanced geothermal systems (EGS), also known as engineered geothermal systems, are a breakthrough technology which first began in Europe. Three electricity plants (Inshein and Landau in Germany, Soultz-sous-Forêts in France) and one heat plant (Rittershofen in France) are now in operation, with a further ten plants under development: the NER300 projects in Hungary (Battonya) and France (Grand Est-Eckbolsheim). In addition, there are ideas for projects, especially in France, Germany, UK, and...
FIG. 1 / INSTALLED CAPACITY FOR GEOTHERMAL ELECTRICITY AND DISTRICT HEATING IN 2016 (MW)
Switzerland. Regarding the manufacturers, the turbines market continues to be dominated by European manufacturers.

District heating and cooling has been a real success story for geothermal, with 280 systems in operation. It continues to expand into new markets. The shallow geothermal market is the largest market by far. Around 1.7 million Ground Source Heat Pumps (GSHP) are installed in Europe, but the growth here is stagnating.

To expand the geothermal market, it is key to highlight the role of the different geothermal technologies in the energy sector. The on-going reform of the electricity market’s design may open the door to new business models (for geothermal plants between base load and flexible power production, and for power only or combined heat and power generation). By moving beyond the traditional electricity mix based on nuclear and fossil fuels, and beyond a simplified mix with photovoltaic (PV), wind and gas, geothermal electricity could make an increased contribution to the transition towards a more sustainable and affordable system.

Moreover, an effort towards developing hybrid plants using geothermal energy in combination with solar, biomass and other renewable energy sources should be pursued; it is possible to obtain a substantial benefit by utilising the combined synergies which result from the peculiarities of both hybrid energy sources in order to increase the overall efficiency and the energy output. The possibility of using large batteries for energy storage in geothermal plants can be seen as a further contribution to grid stability, both in terms of frequency and voltages.

The heat market also needs to be redesigned. Its decarbonisation should first take place in renewable heating and cooling technologies such as geothermal. The geothermal district heating systems are already numerous, and they will continue to grow, given their advantage of being both sizable and a response to the challenge of meeting heat demand. With a new vision of our cities, the development of smart thermal grids using geothermal will also offer new opportunities.

Deep geothermal for heating and cooling also encompasses supply to industrial and service sectors. Geothermal has a particular role to play in switching fuels in the agro-industry (greenhouses and low-medium process heat) as well as for leisure and medical purposes (bathing, balneology). An important extra benefit from geothermal is that its CO₂ can be utilised for agricultural applications in greenhouses, leading to a significant reduction in its natural emissions into the atmosphere.

To conclude with the shallow geothermal sector, several trends can be noticed in terms of technological and market developments in Europe. While the geothermal heat pump sector focuses more upon heating and cooling supply to buildings, its future competitiveness is still unknown as regards the refurbishment of existing buildings and new buildings, individual or collective buildings, heating, cooling and sanitary hot water. Moreover, the role of underground thermal energy storage must still be further highlighted to increase its market share.

Ruggero Bertani
ENEL Green Power
EGEC President
KEY FINDINGS

INTRODUCTION

Since its first edition in December 2011, the EGEC Geothermal Market Report has come to be seen as the authoritative overview of the entire geothermal sector in Europe, covering subjects ranging from deep geothermal for electric power and district heating to shallow geothermal, in addition to specific issues across the geothermal sector. Every edition also offers an in-depth review of different geothermal technologies: the focus of the 2016 edition will be the market as regards equipment and operation and maintenance costs. This year, for the first time, the report also includes a global market overview.

The use of geothermal energy, particularly for heat, is slowly but steadily increasing across Europe. By analysing market developments both for the electricity and heat sectors up until December 2016, the 6th edition of the EGEC Geothermal Market Report reveals growth in all areas, but also notes that the true potential of geothermal is far from being met. Greater ambition is needed for Europe to fully benefit from this energy source.

GEOTHERMAL POWER

In Europe, there are more than 100 geothermal power plants, with an installed capacity that amounted to around 2.5 GWe in 2016 (of which 1 GWe is in the EU), producing some 15 TWh of electrical power every year. Given the 26 projects under development (with another 160 under investigation), it is believed that the installed capacity on the continent will grow to around 3 GWe in 2020, with this major increase linked to the rapid growth of the Turkish market.

Indeed, during the period of 2011-2016, 90% of the new installed capacity was in Turkey, a market which will continue to grow in years to come. A few other plants are also expected in Italy, France, and Germany, while innovative pilot projects are being finalised in Croatia, Hungary, and Belgium. Also, it is worth highlighting that most of the new power plants are binary ORC technology.

GEOTHERMAL DISTRICT HEATING AND OTHER DIRECT USES

District heating and cooling (DHC) is a success story for geothermal in Europe, and it looks set to see rapid and dynamic expansion in coming years. New networks are being built, while existing fossil fuel based systems are being retrofitted to run on geothermal energy.

Between 2012 and 2016, 51 new plants have entered into operation (all in the EU), while several systems have been renovated. Currently, there are 280 geothermal district heating (geoDH) plants in Europe, including cogeneration systems. The total installed capacity in Europe is now approximately 4.9 GWth with the main markets for future years being France, Netherlands, Germany, and Hungary. Compared to 2012, the installed capacity in EU countries has increased by more than 550 MWth; this represents an average annual growth of 10%.

In light of the over 200 projects planned, capacity is estimated to grow up to 6.5 GWth by the end of this decade, and there is potential for this industry to keep growing up until 2050 – 25% of Europeans live in areas directly suitable for geothermal district heating.
GROUND SOURCE HEAT PUMPS

In terms of the number of installations, installed capacity and energy produced, the shallow geothermal market is the largest market by far. The installation growth rate in the shallow geothermal sector is declining; a capacity of more than 20 GWth was achieved at the end of 2015, distributed in over more than 1.7 million installations in Europe. Sweden, Germany, France, and Switzerland have the highest number, accounting for around 70% of the total installed capacity.

CONCLUSIONS

Geothermal energy uses the heat from the earth to deliver power, heat, and cold. It is a clean, renewable, stable resource, used everywhere in Europe, but largely hidden within the landscape.

The energy provided is steady, baseload and flexible, making it an ideal source for balancing electricity and thermal grids, thereby improving energy security. Installations have a clear impact on local economies and energy systems; jobs at all levels are created and sustained, and by developing local flexibility, it creates a much-needed link between centralised and decentralised systems.

The full version of the EGEC Geothermal Market Report, complete with supporting data and tables, is available to EGEC members.
Key Findings / Geothermal Power

**FIG. 2 - GEOTHERMAL POWER / INSTALLED CAPACITY IN EUROPE 2011 AND 2016 (MWe)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Capacity (MWe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1706</td>
</tr>
<tr>
<td>2016</td>
<td>2518</td>
</tr>
</tbody>
</table>

**FIG. 3 - GEOTHERMAL POWER / SHARES OF NEW INSTALLED CAPACITY BY COUNTRY IN 2012-2016 (%)**

- Turkey: 91%
- Italy: 5%
- Germany: 4%

**AT A GLANCE / GEOTHERMAL ELECTRICITY**

<table>
<thead>
<tr>
<th>Type</th>
<th>Europe</th>
<th>EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geothermal Plants in Operation</td>
<td>102</td>
<td>53</td>
</tr>
<tr>
<td>Geothermal Plants Under Development</td>
<td>26</td>
<td>14</td>
</tr>
<tr>
<td>Geothermal Plants Under Investigation</td>
<td>160</td>
<td>107</td>
</tr>
<tr>
<td>Gross Electricity Production</td>
<td>15 TWh</td>
<td>6.6 TWh</td>
</tr>
<tr>
<td>Installed Capacity</td>
<td>2.5 GWe</td>
<td>1 GWe</td>
</tr>
<tr>
<td>Average Annual Growth Rate Over Last 5 Years</td>
<td>10%</td>
<td>2%</td>
</tr>
</tbody>
</table>
Key Findings / Geothermal Power

FIG. 4 - GEOTHERMAL POWER / NUMBER OF GEOTHERMAL POWER PLANTS IN EUROPE

FIG. 5 - GEOTHERMAL POWER / INSTALLED AND PROJECTED CAPACITY IN SELECTED COUNTRIES (MWe)
Key Findings / Geothermal District Heating

FIG. 6 - GEODH / INSTALLED CAPACITY IN EUROPE IN 2011 AND 2016 (MWth)

<table>
<thead>
<tr>
<th>Year</th>
<th>TOTAL</th>
<th>NEW CAPACITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td>+ 554.5</td>
</tr>
</tbody>
</table>

FIG. 7 - GEODH / PROPORTION OF NEW VS RENOVATED SYSTEMS IN 2012-2016

- **NEW**: 77%
- **RENOVATED OR EXTENDED**: 23%

AT A GLANCE / GEODH

<table>
<thead>
<tr>
<th>EUROPE</th>
<th>EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEODH PLANTS IN OPERATION</td>
<td></td>
</tr>
<tr>
<td>280</td>
<td>190</td>
</tr>
<tr>
<td>GEODH PLANTS UNDER DEVELOPMENT OR INVESTIGATION</td>
<td></td>
</tr>
<tr>
<td>164</td>
<td>136</td>
</tr>
<tr>
<td>INSTALLED CAPACITY</td>
<td></td>
</tr>
<tr>
<td>4.8GW</td>
<td>1.7GW</td>
</tr>
<tr>
<td>NEW INSTALLED CAPACITY 2012-2016</td>
<td></td>
</tr>
<tr>
<td>554MWth</td>
<td>554MWth</td>
</tr>
<tr>
<td>ANNUAL AVERAGE GROWTH RATE OVER LAST 5 YEARS</td>
<td></td>
</tr>
<tr>
<td>3%</td>
<td>10%</td>
</tr>
</tbody>
</table>

TOP 7 COUNTRIES (production in GWh, 2015 data)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Iceland</td>
<td>6421</td>
</tr>
<tr>
<td>2</td>
<td>France</td>
<td>1335</td>
</tr>
<tr>
<td>3</td>
<td>Germany</td>
<td>662</td>
</tr>
<tr>
<td>4</td>
<td>Hungary</td>
<td>380</td>
</tr>
<tr>
<td>5</td>
<td>Austria</td>
<td>272</td>
</tr>
<tr>
<td>6</td>
<td>Italy</td>
<td>249</td>
</tr>
<tr>
<td>7</td>
<td>Serbia</td>
<td>243</td>
</tr>
</tbody>
</table>
Key Findings / Geothermal District Heating

FIG. 8 - GEODH / INSTALLED CAPACITY BY COUNTRY IN 2016 (MWh)

PIPING IN A GEODH SYSTEM
Key Findings / Ground Source Heat Pumps

**FIG. 9 - GSHP / NUMBER OF INSTALLED UNITS AND NEW INSTALLATIONS IN 2015; NUMBERS SHOW RATIO OF NEW UNITS IN RELATION TO EXISTING GSHP STOCK**

![Graph showing number of installed GSHP units and new installations in 2015, with ratios in relation to existing stock.](image)

**TABLE 1 - GSHP / LARGE BOREHOLE HEAT EXCHANGERS FIELDS IN EUROPE, TOP 5**

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>CITY, NAME</th>
<th>N°. BHE</th>
<th>DEPTH BHE (M)</th>
<th>TOTAL BHE (M)</th>
<th>YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>RO</td>
<td>Magurele near Bucharest, ELI-NP</td>
<td>1080</td>
<td>125</td>
<td>135000</td>
<td>2015</td>
</tr>
<tr>
<td>FI</td>
<td>Sipoo, SDK Logistics Centre</td>
<td>300</td>
<td>300</td>
<td>90000</td>
<td>2012/2016</td>
</tr>
<tr>
<td>CH</td>
<td>Zurich, ETH-Campus Hönggerberg</td>
<td>435</td>
<td>200</td>
<td>87000</td>
<td>2014-16</td>
</tr>
<tr>
<td>CH</td>
<td>Rotkreuz, Suurstoffi 2</td>
<td>193</td>
<td>280</td>
<td>54040</td>
<td>2015</td>
</tr>
<tr>
<td>FI</td>
<td>Espoo, Lippulaiva shopping centre</td>
<td>148</td>
<td>350</td>
<td>51800</td>
<td>under construction</td>
</tr>
</tbody>
</table>
IN THE FULL REPORT:

**EDITORIAL**

**GEOTHERMAL POWER**
Analysis of the geothermal electricity market in Europe
- Market analysis
- Trends 2012-16

**GEOTHERMAL DISTRICT HEATING**
Analysis of Geothermal District heating market in Europe
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- Technological trends

**GROUND SOURCE HEAT PUMPS**
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**LARGE BOREHOLE HEAT EXCHANGERS FIELDS**
ABOUT EGEC, THE EUROPEAN GEOTHERMAL ENERGY COUNCIL

REPRESENTING THE EUROPEAN GEOTHERMAL INDUSTRY

EGEC, the European Geothermal Energy Council, is a non-profit international organisation founded in 1998 to promote the European geothermal industry and enable its development both in Europe and worldwide, by shaping policy, improving business condition, and driving more research and development.

Based in Brussels, we work with our members on policy, market intelligence, and communication for both deep and shallow geothermal, providing a link between the industry and European institutions. More than 120 members from 28 countries, including developers, equipment manufacturers, electricity providers, national associations, consultants, research centres, geological surveys, and public authorities, make EGEC a unique network, unifying and representing the entire geothermal sector.

THE EGEC GEOTHERMAL MARKET REPORT

EGEC originally developed the Geothermal Market Report to fill an information gap in the geothermal sector. It is designed to give market intelligence to companies and investors already working in the sector, and to inform new entrants about the current state of the market and its future development.

The report is compiled each year using data from various statistical analyses, local experts, utilities, energy agencies, and national associations. It includes details of all major projects in operation, under development, and under investigation, as well as an analysis of market development, the regulatory and public policy environment, financial tools and incentives, market forecast, and key players.

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