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Geothermal Power Plants, Worldwide Status — 1986

by RONALD DIPIPPO

Abstract

This paper presents a survey of geothermal power plants around the world as of 1986. The data are given mainly in tables. The current state of affairs is relatively unchanged from that reported by DiPippo at the 1985 International Symposium on Geothermal Energy. The slowdown in expansion predicted by DiPippo at the 1985 IIE/EPRl Geothermal Conference and Workshop is already becoming evident. In fact, the installed capacity worldwide has remained essentially unchanged from 1985 to 1986: projected capacity at the end of 1985 — 4763.981 MW, projected capacity at the end of 1986 — 4733.446 MW. The slight drop is due to late completion of some plants scheduled for 1985. This paper contains a country-by-country tabulation plus a summary of plants by type of energy conversion system.

Summary By Country

Table 1 shows the growth in installed geothermal capacity dating from 1979. The 17% annual growth rate that applied until 1984-85 will not continue. DiPippo predicted a growth rate of 6.1% from 1986 to 1990. The effect of the drastically depressed price of oil on the expansion of geothermal plants will be severe if oil prices remain low, i.e., in the $10-15/barrel range, for a prolonged period. Sustained geothermal growth requires countries such as the United States, the Philippines, Mexico, and Indonesia to continue their steady building programs. A relaxation of the target dates for completion of new plants or delays caused by the inability to arrange financing for new plants or delays caused by the inability to arrange financing for new projects will result in a postponement of construction or a stretching out of the schedule for completion of plants. The outcome will be a very low effective annual growth rate. Indeed the rate may even become negative; some geothermal plants (in the United States, Italy and New Zealand) are more than 25 years old and might reasonably be expected to be retired from service in the near future.

Table 2 lists the countries with active geothermal plants and gives the number of operating power units and the installed capacity for plants of four types of energy conversion system: dry steam, single-flash, double-flash, and binary.

In all, there are 190 operating units and 4733.446 MW expected by the end of 1986. The United States operates 57 units (or 30% of the total) with a combined capacity of 2006 MW (or 42% of the total). It is interesting to note that the power complex at The Geysers accounts for about 38% of the worldwide capacity, and that California alone has about 41% of the world’s geothermal capacity. The United States is also the only nation to have in operation plants of all four types.

The average size of power plants varies widely: 33 MW for dry steam units, 22 MW for single-flash units, 35 MW for double-flash units, and 2.5 MW for binary plants. If the Heber Binary Demonstration Plant (45 MW) is excluded from the averaging process, then binary units would average only 1 MW. There has been a recent proliferation of small, modular, factory-assembled binary units, as for example at East Mesa (OR-MESA Project), Mammoth Hot Springs (Mammoth-Pacific and Chance Ranch), Wabuska Hot Springs, Steamboat Springs, Hammersley Canyon, Wendel Hot Springs (Wineagle), and Cove Fort/Sulphurdale, all in the United States.

Tables 3-21 summarize the status of plants in all countries with operating geothermal plants.

Future Prospects

Table 22 lists countries that have the potential to become producers of geothermally-generated electricity in the near- to mid-term. The most certain of these are Costa Rica and Guatemala where the first plants should be under construction within a year. It is likely that at least one additional unit will follow in each country.

Some of the other countries are reported to have sizable geothermal power potential (e.g., Djibouti - 300 MW), but plans for construction of plants are indefinite.

References


### TABLE 1
RECENT GROWTH IN WORLDWIDE GEOTHERMAL PLANT CAPACITY

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<td>End 1986</td>
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### TABLE 2
GEOTHERMAL POWER PLANTS ON LINE AS OF 1986

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<tr>
<th>Type of Power Plant</th>
<th>Country</th>
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<th>2-Flash</th>
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<th>Totals</th>
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**Totals:** 72 2349.95 62 1389.086 26 917.9 30 76.51 190 4733.446

*Note: NPU = Number of power units; MWe = Installed megawatts-electric.*
TABLE 3
GEOTHERMAL POWER PLANTS AT THE GEYSERS, CA, U.S.A.

<table>
<thead>
<tr>
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(1) All units are of the drysteam type.

TABLE 4
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<td>Fish Lake</td>
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*Includes plants under construction and scheduled for completion in 1986.
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GEOTHERMAL POWER PLANTS IN THE PHILIPPINES

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GEOTHERMAL POWER PLANTS IN MEXICO

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*No. of units in parentheses; only one unit otherwise.

### TABLE 9
**GEOTHERMAL POWER PLANTS IN JAPAN**

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**GEOTHERMAL POWER PLANTS IN NEW ZEALAND**

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GEOTHERMAL POWER PLANTS IN THE U.S.S.R.

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GEOTHERMAL POWER PLANTS IN GAUDÉLOUPE

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GEOTHERMAL POWER PLANTS IN THE AZORES

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<td>10.0</td>
<td>Planned</td>
</tr>
</tbody>
</table>
### TABLE 21
GEOTHERMAL POWER PLANTS IN GREECE

<table>
<thead>
<tr>
<th>Plant</th>
<th>Year</th>
<th>Type</th>
<th>MW</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milos:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pilot unit</td>
<td>1985</td>
<td>1-Flash</td>
<td>2</td>
<td>Operational</td>
</tr>
<tr>
<td>Unit 1</td>
<td>1991</td>
<td>1-Flash</td>
<td>60</td>
<td>Planned</td>
</tr>
<tr>
<td>Unit 2</td>
<td>1994</td>
<td>1-Flash</td>
<td>60</td>
<td>Planned</td>
</tr>
</tbody>
</table>

### TABLE 22
POSSIBLE FUTURE GEOTHERMAL PRODUCING COUNTRIES

<table>
<thead>
<tr>
<th>Country/Field</th>
<th>Year (Est.)</th>
<th>Plant Type and Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina/</td>
<td>n.a.</td>
<td>Flash, 50 MW (est.)</td>
</tr>
<tr>
<td>Copahue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bolivia/</td>
<td>1990</td>
<td>Flash, 30 MW (est.)</td>
</tr>
<tr>
<td>(several possible)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chile/</td>
<td>n.a.</td>
<td>1-Flash, 15 MW (est.)</td>
</tr>
<tr>
<td>El Tatio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Columbia/</td>
<td>1990</td>
<td>Flash, 3 MW (est.)</td>
</tr>
<tr>
<td>(several possible)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costa Rica/</td>
<td>1990</td>
<td>1-Flash, 55 MW (est.)</td>
</tr>
<tr>
<td>Miravalle I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miravalle II</td>
<td>1992</td>
<td>1-Flash, 55 MW (est.)</td>
</tr>
<tr>
<td>Djibouti/</td>
<td>n.a.</td>
<td>Flash, 10 MW (est.)</td>
</tr>
<tr>
<td>Lake Asal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethiopia/</td>
<td>n.a.</td>
<td>Flash, 15 MW (est.)</td>
</tr>
<tr>
<td>Lake Langano</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guatemala/</td>
<td>1990</td>
<td>1-Flash, 15 MW (est.)</td>
</tr>
<tr>
<td>Zunil I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zunil II</td>
<td>n.a.</td>
<td>1-Flash, n.a.</td>
</tr>
<tr>
<td>Amatitlan</td>
<td>n.a.</td>
<td>1-Flash, n.a.</td>
</tr>
<tr>
<td>India/</td>
<td>n.a.</td>
<td>Flash, 1 MW (est.)</td>
</tr>
<tr>
<td>Puga Valley</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Romania/</td>
<td>n.a.</td>
<td>Binary, 1 MW (est.)</td>
</tr>
<tr>
<td>(site n.a.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>St Lucia/</td>
<td>n.a.</td>
<td>Flash, 10 MW (est.)</td>
</tr>
<tr>
<td>Soufriere</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>