Geothermal Development in the Pacific Rim

TJC / GRC

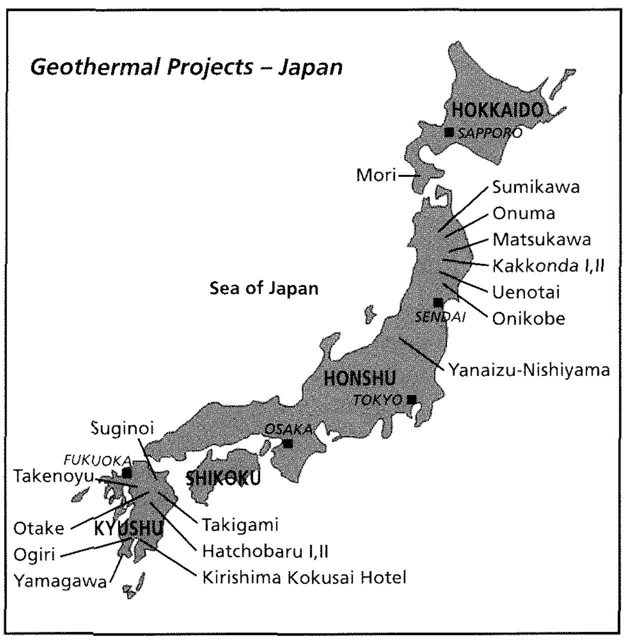
Philippines Secretary of Energy Mario Tiaoqui Provides Insights into the Past, Present and Future Use of Geothermal Energy Within the "Ring of Fire"

Editor's Note: The following article was edited from a Keynote Address by Philippines Secretary of Energy Mario V. Tiaoqui during the Opening Session at the 1999 GRC Annual Meeting on Oct. 18, in Reno, NV.

This last GRC Annual Meeting for both the decade and the millennium—with the theme, "Global Geothermal Resources–Sustainable Energy for the Future"—is indeed a good opportunity to reflect on geothermal development in the Pacific Rim. This is true particularly in terms of what the geothermal industry has achieved to date and current issues affecting development. More importantly, we must look at actions needed now to ensure that geothermal energy remains a cost effective, environmentally acceptable and sustainable global energy option.

Countries in the western Pacific Rim now using geothermal power range from Russia in the far north, to Japan and the Philippines, Indonesia, Papua Guinea, and New Zealand in the far south. Although geothermal development in the Pacific Rim commenced in New Zealand in 1958 with the commissioning of the Wairakei geothermal power plant, the bulk of the region's geothermal capacity today is located in Southeast Asia. This capacity was installed between the mid-1970s and the late-1990s, with particularly rapid development achieved between 1990 and 1997—before the onset of the Asian economic crisis.

The last major review of geothermal capacity in the Pacific Rim was at the 1995 World Geothermal Congress in Florence, Italy. At that time, the industry was exceedingly upbeat. Six months from now, at the WGC2000 in Japan, there will a similar review of geothermal industry achievements over the past five years. It's no news to most of you that the past few years have seen a considerable loss in the momentum of geothermal development that characterized the first half of the 1990s, particularly in Indonesia.



Russian Geothermal Development

The Kamchatka Peninsula, located on the eastern seaboard of Russia, defines the northwestern Pacific Rim. This is an area of spectacular volcanic terrain with considerable potential for geothermal development. Despite its remote location and the area's extreme climatic conditions, a 12-megawatt (MW) pilot geothermal power plant has been recently constructed and commissioned by the Geotherm Stock Co. at Mutnovsky, some 100 km west of Petropavlosk.

This is the first commercial geothermal power plant in Russia. A second 40-MW geothermal power plant at Mutnovsky is now in advanced planning. The facility will utilize a combination of new and existing geothermal wells. It is expected to be funded by EBRD for commissioning in the year 2001. There is good evidence for further development potential at Mutnovsky of between 200 and 300 MW. It can thus be expected that Russia will develop significant geothermal capacity during the next decade.

Geothermal Projects in Japan

The volcanic arc of Kamchatka extends southward into Japan, where there is a long history of geothermal development. Japan's first commercial geothermal power generation was achieved in 1966, with a 9.5-MW plant at Matsukawa. By mid-1996, countrywide capacity had increased to 500 MW, and an increase to 600 MW is predicted by the year 2000. To date, 18 geothermal power plants have been developed in Japan, ranging from 0.1 MW to 55 MW. The largest geothermal field development is two 55-MW units at Hatchobaru.

With about 200 volcanoes—of which 83 are active—Japan has considerable geothermal potential. Much of this will never be developed, however, due to a high regard placed on protection and preservation of the environment and natural thermal activity. Additional factors which presently limit future geothermal development in Japan include consistently high currency exchange rates, low oil prices (at least until quite recently), and the high financial risks involved in new geothermal prospect areas.

Present geothermal power generation in Japan represents only 0.2 percent of its total electricity requirements of more than 200,000 MW. Nonetheless, further geothermal development is being vigorously promoted by a number of key government departments interested in obtaining greater involvement by the private sector and in reducing national fossil-fuel consumption.

Geothermal Projects in the Philippines

Commercial generation of geothermal power in the Philippines was first achieved at Leyte in 1977. By 1996, countrywide capacity had steadily increased to 1200 MW, with developments at five geothermal fields—the Makban, Tiwi, and Bacon Manito fields on the island of Luzon; the Tongonan field in Leyte; and the Palinpinon field in southern Negros. Development activities were also well advanced at that time for bringing into production a sixth commercial geothermal field at Mt. Apo in Mindanao.

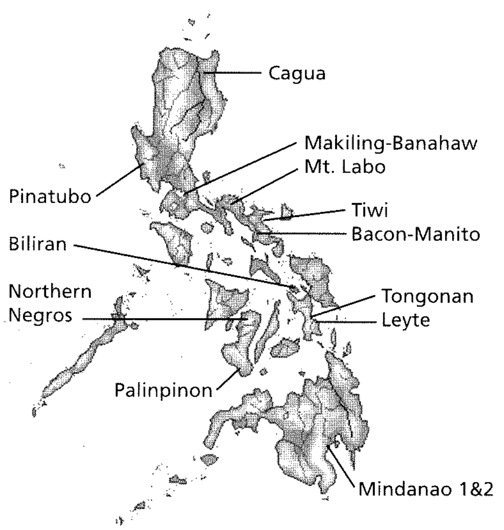
Predictions in 1995 looked toward an increase in countrywide capacity to 1900 MW by the end of the decade. This has, in fact, been achieved with a large additional block of 600 MW recently commissioned at Leyte, and a further 100 MW at Mt Apo. The result is sufficient current geothermal plant capacity to meet some 20 percent of the country's daily electricity requirements, and some 25 percent of the daily power requirements of Luzon—the major power load center.

All in all, geothermal developments have been particularly successful in the Philippines, and the industry contributes very significantly to the country's overall energy mix. With 25 years experience in developing and operating geothermal fields, the industry operating in the Philippines is now quite mature, with over half of the probable resource base developed.

Philippine Privatization Plans. The large scale of geothermal development achieved in the 1990s were driven by changes in the commercial climate in the Philippines, including deregulation of power generation and passage of a Build-Own-Transfer law, which has allowed a high level of participation by private energy companies. The commercial climate is expected to undergo substantial changes over the next several years upon passage of the pending Omnibus Electricity Act. This law will allow for:

- Restructuring of the Philippine electricity supply industry, creating a wholesale power market open to competition among generation companies, independent power producers, and distribution utilities that own and operate generation plants.
- Privatization of the National Power Corp. (NPC) and its state-owned power plants, of which 1220 MW is geothermal, with 755 MW of geothermal steam field capacity. This will involve vertically unbundling NPC into separate generation and transmission companies, and horizontally unbundling generation units into a number of generating companies, all of which will be sold.
- Privatization of the PNOC-Energy Development Corp., which owns and operates 1145 MW of geothermal steam fields, and holds 690 MW of BOT contracts with international power generation companies. These will revert in ownership to PNOC-EDC in eight years time.

Geothermal Projects – Philippines



These privatization plans represent a major opportunity for companies to take positions in the second largest geothermal power market in the world, and we are already seeing a high level of interest from major international power companies.

Geothermal Projects in Indonesia

With over 70 geothermal prospects scatted throughout Indonesia, a good assessment of the country's geothermal development potential is at least 10,000 MW. This is probably twice that ultimately available in the Philippines.

The historical buildup of geothermal developments in Indonesia to 1996 followed a pattern similar to that of the Philippines, although occurring somewhat later in time and not to such an extent. The first commercial geothermal power generation in Indonesia was achieved at Kamojang in 1983 from a 30-MW unit. By 1996, countrywide capacity had increased to 310 MW with the commissioning of another 110 MW at Kamojang, 110 MW at Salak, and 55 MW at Darajat. This major increase in geothermal development activity in the first half of the decade was in response to:

- The number and quality of geothermal resources in Indonesia—particularly on Java, where population density and demand for power is high.
- The issuance of Presidential Decree 45, which allowed the government-owned steam field developer, Pertamina, to not only undertake steam field development, but also power plant construction and operation.

These factors resulted in a high level of interest from international power developers. By the mid-1990s, numerous Joint Operating Contracts (JOCs) had been entered into between these parties and Pertamina, fostering expectations that Indonesia would achieve 1200 MW of installed geothermal plant capacity by the end of 1999, and greater than 2000 MW by the year 2006.

Although a further 460 MW of geothermal capacity has been installed in Indonesia since 1996, more than half of this is not currently in service due to the impact of the Asian economic crisis and Indonesia's currency devaluation in 1997. Because the country's retail electricity market is denominated by local currency that has declined in value by a factor of eight (relative to the U.S.$), PLN—the state power utility—has been unable to meet the terms of dollar-denominated steam and electricity purchase contracts with Pertamina and its joint operating partners. A number of geothermal development projects have since been abandoned, and though plants under construction at the time of the crisis have since been completed, they were immediately decommissioned, and will not be operated until the depressed economic climate improves.

There is a large measure of concern and disappointment over the present state of the Indonesian geothermal industry, both within government and by private developers. Although the industry is expected to recover, it is unlikely that this will happen for several years because of the recent large reduction in economic activity, lower demand for electricity, and resultant substantial power oversupply.

Papua New Guinea: Lihir Island

Although there are numerous volcanic islands scattered along the western Pacific Rim, there has yet to be any commercial geothermal development in these areas. This is mostly because of their small populations, low levels of industrialization and low demand for power.

The island of Lihir, off the northeast coast of Papua, New Guinea, may prove to be a notable exception. It contains one of the world's largest epithermal gold deposits within an active geothermal system in the floor of a young caldera. The geothermal prospect is currently being drilled by the Philippine National Oil Co. for the project owner, Lihir Management Corp. The drilling has two objectives, to dewater hot geothermal fluids from open pit mine workings, and if possible, to generate up to 70 MW of electricity from the fluids for use in mining and ore processing operations.

The association at Lihir of a captive industrial project with high imported fossil-fuel costs for power generation located alongside a geothermal resource is a model with considerable potential for replication throughout Indonesia and the southwestern Pacific Rim for off-grid geothermal power developments.

Geothermal Projects in New Zealand

There have been two distinct phases of geothermal power development in New Zealand. This includes projects undertaken by government agencies between 1958 and 1989, and those undertaken since then by private-sector developers in the fully deregulated industry environment established there in 1988.

Developments carried out under the former regime include the Wairakei power plant, commissioned in 1958 at 192 MW, then derated to 154 MW; the Kawerau field, which produces only eight MW of geothermal power, but utilizes an additional 40 MWe in steam for process heat in the neighboring Tasman pulp and paper mill; and the Ohaaki development, which was commissioned at 116.5 MW in 1989 but then derated in response to rapid reservoir cooling caused by an influx of shallow fluids. Recent private sector developments include:

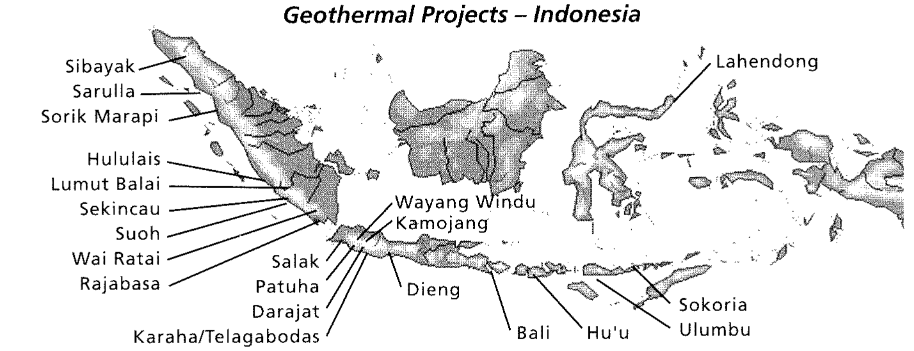
- The Mercury Geotherm power plant at Poihipi, jointly owned by the local resource owner and Mercury Energy, a major electricity retailing organization. Wells for this development were drilled by the land owner, but because they access part of the proven Wairakei geothermal field, development risk was low. Development costs have been kept low through the use of shallow wells and installation of a second-hand, 55-MW turbine.

- The 24-MW Rotokawa plant, the eight-MW Ngawha plant, and the 50-MW Mokai power plant are very similar developments, involving joint ventures between major private-sector power retailers and local Maori Trusts which hold land ownership in each case. Development risk has been low for private-sector owners, because the geothermal resources had been drilled and proven by government agencies prior to deregulation.

Lessons from the New Zealand Experience. The New Zealand geothermal industry has provided much of the technology applied to development of liquid-dominated geothermal fields in Southeast Asia. There are a number of experiences in New Zealand that should be carefully considered at other geothermal developments in the Pacific Rim. For example, the Wairakei power plant demonstrates that while HP topping cycle turbines can be very useful—particularly over the early life of a new development—additional costs of installing them must be carefully balanced against the expected time frame during which reservoir pressure will inevitably run down. Similar to the Wairakei experience, we have had some difficulty in the Philippines in maintaining steam supply to high-pressure topping cycle turbines.

Despite this, the Wairakei field provides wonderful testimony to the sustainability of geothermal power. After initial pressure derating, field output has been remarkably constant over the past 40 years. Even more remarkable, perhaps, is the fact that the Wairakei plant has averaged 99-percent availability throughout its 40th year of operation—performance unheard of in any other forms of power generation. In contrast, the performance of the Ohaaki field bears a sharp reminder that reservoir problems do occur, with the message that detailed reservoir monitoring and active management are critical.

Geothermal Projects – Indonesia



A number of recent private-sector developments have been successfully undertaken in New Zealand, which has very low power costs averaging about two cents (U.S.) per kilowatt-hour (kWh) wholesale. That private-sector companies can survive in this cost environment is remarkable, particularly considering the 6.5 to eight cents (U.S.) per kWh costs that prevail in some geothermal power projects elsewhere. New Zealand clearly has lessons to offer the industry in driving down geothermal development costs. These include:

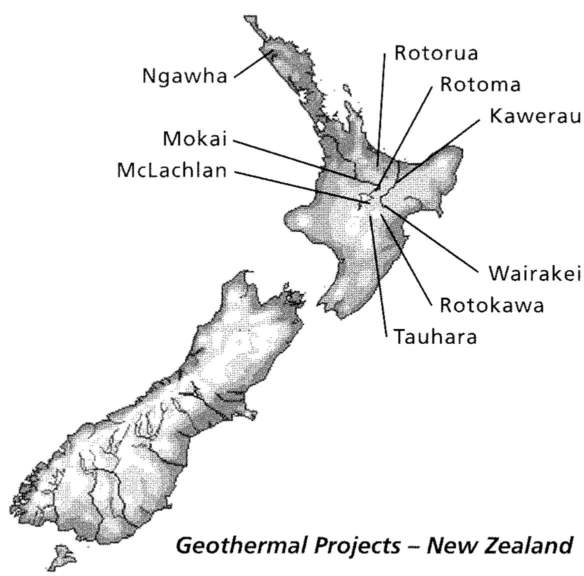
- Government undertaking of exploration and proof of geothermal resources, resulting in a major reduction in development risk for private-sector developers. Additionally, resource drilling by government will usually result in at least some wells available for use by future private-sector developers.
- Private-sector developers with joint venture partners who own the land upon which developments are undertaken.
- Use of a refurbished, second-hand electric generation plant has been a key factor for the success of the Mercury Geotherm facility. This approach merits greater consideration by the geothermal industry, particularly for small geothermal projects.

Closing Observations

First, it is clear that future expansion of geothermal energy development in the Pacific Rim will be constrained by the availability of suitable resources. In this regard, Indonesia has the greatest forward potential of Pacific Rim countries because of the large amount of resources it still has available for development. Japan has perhaps the least potential because of the preservation of many geothermal resources in national parks.

Geothermal energy will continue to face stiff competition from fossil-fuel power generation in the region. In Indonesia and the Philippines, there is particularly strong competition from natural gas. Recent increases in oil prices should, however, increase the cost of other fossil fuels. This will be beneficial to geothermal development. For example, higher oil prices may provide a strong impetus for more geothermal development in Japan than is presently programmed.

Deregulation of power generation in the 1990s has clearly been of great benefit to the geothermal industry. In the Philippines and Indonesia, this has led to strong increases in the amount and pace of geothermal developments, achieved by government agencies entering into contracts with the private sector. In the case of the Philippines, geothermal capacity developed over the 15 years prior to 1990 was doubled in the six years immediately following. Had it not been for the Asian economic crisis, Indonesia would also be showing large increases in geothermal capacity, with some 1,000 MW or more on-line.



Geothermal Projects – New Zealand

Maps after Kingston-Morrison

Privatization of government-owned energy assets in New Zealand has been ongoing for some years, and is now largely complete. This has produced cost efficiencies and service previously unattainable under government ownership. The Philippines is now about to embark on a program of privatization in which geothermal steam fields, all forms of power plants, and the national power transmission system will be sold to the private sector. This represents an excellent source of revenue for the government and an exciting opportunity for the international power industry to participate directly in a large, new power market.

In spite of the strong industry trend toward deregulation and privatization, private sector developments recently undertaken in New Zealand have relied heavily on exploration and proving studies, particularly exploration drilling, undertaken by government at some earlier time. The New Zealand government is now out of the business of proving geothermal resources, so development risk at new prospect areas will have to be fully shouldered by the private sector. This must inevitably result in increased power generation costs.

Similarly in the Philippines, PNOC-EDC as the agent of government has traditionally undertaken exploration studies, field proving and field development for all but the Tiwi and Makban geothermal fields. With PNOC–EDC soon to be privatized, the Philippine government will step away from involvement in the future proving of geothermal fields, and all field development risks will pass directly to the private sector. In contrast, the Japanese government remains committed to supporting private sector participation through development incentives and subsidies, and state-funded exploration and research. This raises questions, such as:

- How far and how fast should government disengage from direct involvement in the geothermal industry?
- In a competitive, privatized environment in which geothermal has to compete head-on with other forms of power generation, will the private sector have sufficient returns to reinvest in new project developments with much higher risk?
- Will the geothermal industry thus require preferential electricity pricing or long-term, risk-sharing support from government?

I enjoin you to discuss and debate questions such as these during and after this conference. In doing so, we can proceed into the next millennium with the sustainability of global geothermal energy assured.

Acknowledgments

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