

OPPORTUNITIES FOR SMALL GEOTHERMAL POWER PROJECTS

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INTRODUCTION

Opportunities for small geothermal projects exist in many areas of the developing world, including Latin America, the Caribbean, and the Philippines. We define small geothermal power projects as those with less than 5 megawatts (MW) of capacity. Geothermal power plants with less than 5 MW of capacity could supply electricity in remote areas. However, such plants would serve these markets almost exclusively in countries where strong government or regional policies promote this application. Such government interventions are needed for small geothermal projects because they face special financial and operational challenges associated with their small size. One such challenge is the relatively high transaction costs of obtaining project finance, and the difficulty in establishing and supporting an operation and maintenance infrastructure for small plants in remote areas. These difficulties may be mitigated by bundling small projects together, as could occur within a national program. The widespread use of small geothermal units demonstrates the technological feasibility of small systems, but does not demonstrate operational or economic feasibility for remote applications.

TECHNOLOGIES FOR SMALL GEOTHERMAL PROJECTS

Small geothermal power plants, either binary or flash steam, can be manufactured and can be operated in remote areas; but, each type of technology enjoys different advantages and faces different challenges in this application. For example, binary plants can typically operate with lower temperature resources that are more common, and this could help a small project hold down drilling costs; however, greater system complexity can complicate operation and maintenance. The flash steam plant's simpler and less expensive design is especially welcome in a small system. However, the flash steam plants are typically used with higher temperature resources that could be more expensive to obtain than lower temperature ones. Using a flash steam plant with a lower temperature resource might not be cost effective because of reduced efficiency. Finally, the complexity of managing scale desposition is likely to impose greater costs in flash steam plants than in binary plants.

The credibility of small geothermal projects must be strengthened with lenders. Both private- and public-sector investors require extensive documentation of technology performance, operation and maintenance requirements, and other project justification materials. This information could be developed into model documents that would help project developers obtain capital investment. Developing such model documents could help identify technology or data issues that need to be addressed.

The costs of small geothermal projects depend significantly on power plant costs, drilling costs, resource quality, and costs of financing. Costs of small geothermal generation are in the same range as competitor technologies for rural electricity markets. Figure 1 shows one estimate, in which the cost of small-scale geothermal generation substantially overlaps that of diesel.

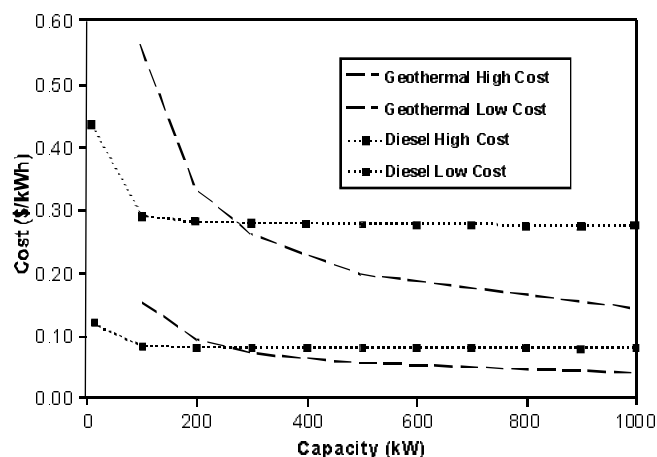


Figure 1. Cost of diesel generation and geothermal generation vs. capacity.

FINDING GEOTHERMAL RESOURCES FOR SMALL PROJECTS

An effective, economical exploration program is essential for successful small geothermal projects. When characterizing resources for small geothermal projects, the developers must inexpensively identify resources of sufficient quality, in terms of temperature with depth and chemistry, to permit a group of economically viable projects. An exploration plan for small geothermal plant sites should pool exploration risks across many small projects and identify a group of projects that will be logistically viable when bundled. Small projects cannot afford high drilling costs, such as the \$1-3 million per well spent during exploration for large projects. Drilling slim holes for exploration and production or using smaller, more portable drill rigs are promising methods to reduce costs. One can use existing data to help small geothermal projects achieve low exploration costs; but, it should be understood that exploration goals for large projects are different from goals for small projects. In some cases, existing wells could be considered.

MARKETS FOR SMALL GEOTHERMAL PROJECTS

Access to better energy technology could improve rural people's lives, and small geothermal plants could be one of

those technologies. Rural electricity services can be improved by installing individual systems, national grids, and mini-grids. Individual systems are generally too small to be cost-effective applications of geothermal technology. However, a region where individual systems would be appropriate could be even better served with small geothermal plants, if extensive economic development changed the market conditions. For small geothermal projects to be used under these circumstances, a region would need to be far from any existing grid and undergo long-term, intensive, economic development that would greatly increase the region's load density and the demand for and ability to pay for electricity.

Service in remote parts of national grids could be improved, in some cases, with distributed power generation from small geothermal plants. Even so, connection of a prospective site to an existing grid would need to be inexpensive. If the part of the national grid receiving the distributed generation needs improvements in power quality, reliability or capacity, then installing a small geothermal plant would be one solution, but should be compared to other potential solutions.

Perhaps most promising, existing mini-grids present opportunities for small geothermal power plants to supplement base load to support a small geothermal plant, or must receive additional base load in conjunction with the small geothermal project. For example, regional development could add a productive load.

Electric sector reform is transforming the potential owners and operators of small geothermal projects from public utilities to private power producers. Reform is intended to improve the overall economic efficiency of the electric sector and may open new opportunities for small geothermal projects in this more competitive market. On the other hand, reform may change the roles of public utilities and governments such that they do not provide as much vital support to geothermal projects as they have in the past. Private power producers are likely to make electric capacity investment decisions that favor technologies with a lower share of capital cost as a fraction of total cost, and lower financing costs than what small geothermal power plants require.

Small geothermal projects can benefit from lessons learned from other renewable energy technologies that have already begun to supply rural markets internationally. For small geothermal projects, as for other renewables, appropriate financial arrangements are critical to success. Attributes of successful financial arrangements include consideration of the ability and willingness of rural customers to pay for services, a suitable financing mechanism, and appropriate use of subsidies. Experience from other renewable energy technologies has shown that market infrastructure can be difficult to develop in remote areas because its services (marketing, distribution, installation, maintenance and revenue collection) require a sufficiently large base to support the needed personnel. Performance safeguards are essential in rural areas, where reliability, ease of use, and maintenance must be ensured under harsh conditions. Small geothermal plants need standards and testing for rural applications to determine what, if any, improvements are needed. The role of governments and donors in facilitating other renewable energy technologies highlights

their potential analogous role for small geothermal projects, especially in such areas as resource assessment and the establishment of a legal and regulatory structure for cost recovery for rural electricity supply.

GEOHERMAL INDUSTRY PLAYERS IN A POSSIBLE SMALL-SCALE GEOHERMAL MARKET

Companies from the United States, Europe, Japan, Iceland, New Zealand, and developing countries will compete for profitable small geothermal projects in remote areas. If this market develops, the geothermal industry can provide the relevant technologies and experience for successful small projects. However, the industry could improve its products and equipment to enhance its service to the small-scale geothermal market. Serving this market would also require the industry to develop market infrastructure and innovative financing methods. National governments influence the relative competitive advantage of their own geothermal companies in international competition for geothermal projects by funding international geothermal exploration and development, supporting trade missions, and providing aid in exchange for contracts and equipment purchases.

CONCLUSIONS

Small geothermal projects, less than 5 MW in size, could improve rural electricity supplies for the growing markets of Latin America, the Caribbean, and the Philippines. Small geothermal units could use either flash steam or binary technologies; these are technically proven and widely used in larger U.S. geothermal developments. However, their operational and economic feasibility in remote areas of developing countries is less well demonstrated. Investors in small geothermal projects will require documentation of performance in remote settings, including feasibility of plant designs, and operation and maintenance plans. The choice between binary and flash will depend on site-specific characteristics. Small geothermal plants are potential competitors with diesel generators for rural electricity markets.

Exploration for small geothermal projects must be inexpensive so that the electricity from the project will be cost competitive. Understanding the effectiveness of small-scale exploration programs, and controlling drilling costs, present a significant challenge for small projects. Methods to reducing drilling costs include using slim holes for exploration and production, and advanced drilling systems. Geothermal resources have been characterized, to varying degrees, at many sites in Latin America, the Caribbean, and the Philippines. Using and adding to this knowledge base systematically could help small geothermal projects achieve low exploration costs. Existing wells may help geothermal exploration for small projects.

Rural people have pressing energy needs, and electricity from small geothermal plants could meet some of these needs. Individual systems, national grids, and mini-grids are used to provide rural electricity, and each type of system presents small geothermal projects with different competitors. Economic development could combine individual systems into a grid that small geothermal plants could serve. Small geothermal plants could provide distributed generation to remote parts of national

grids. In mini-grids, a promising market for small geothermal plants, they would supplement or displace diesel generation. As electric sectors reform, private power producers become more likely customers from small geothermal power plants than public utilities. However, a continued public role may be important to catalyze small geothermal projects. Faced with competitive markets, small geothermal projects can benefit from lessons learned from other renewable technologies that supply rural markets: lessons about institutions to provide operation, maintenance and other services; about innovative financing and technology performance; and about effects on market development of support from governments and financial institutions.

International firms from the United States, Europe, Japan, Iceland, New Zealand, and developing countries could develop small geothermal projects. These companies have the appropriate technologies for small projects, and have experience in international geothermal project development. The industry might respond to a growing small-scale geothermal market by tailoring power plants, drilling rigs, pumps, and other equipment to small applications. Better market infrastructure and innovative financing could improve industry success in these markets. National governments enhance the competitive position of their geothermal industries by funding international geothermal activities, supporting international trade, and requiring purchases in exchange for international aid.

Editor's Note: This article is a summary of a report issued by the National Renewable Energy Laboratory, "Opportunities for Small Geothermal Projects: Rural Power in Latin America, the Caribbean, and the Philippines," by L. Vimmerstedt, November 1998 (NREL/TP-210-25107). The complete report can be downloaded from NREL's website: <www.nrel.gov/geothermal>, or a hard copy can be obtained from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springs, VA 22161, telephone: 703-487-4650.

References on slim hole drilling can be found in the following articles:

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