

The Role of Geothermal Energy in the Locally Distributed Renewable Energy System (*EIMY: Energy In My Yard*)

Hiroshi Asanuma, Hiroaki Niitsuma, Toshihiko Nakata, Yuichi Niibori, Hirokazu Moriya, and Yoshihito Komaniwa

Graduate School of Environmental Studies, Tohoku University, Sendai, 980-8579, Japan

asanuma@ni2.kankyo.tohoku.ac.jp

Keywords: *EIMY*, locally distributed energy, direct use, renewable energy

ABSTRACT

The authors have been investigating a locally distributed energy system where a combination of local renewable energy sources is utilized to cover energy demand with economical advantage to the energy supply from the national grid. The concept of this system is referred to as *EIMY (Energy In My Yard)*, and studies from technical, economical, political and sociological points of view are underway. We have had an understanding throughout the investigation on the nature of various renewable energy that geothermal energy plays a key role in the “*EIMY* system” as a source/storage of heat. The authors made a feasibility study to introduce the “*EIMY* system” to a public facility and show the economical/environmental contribution of the geothermal energy.

1. INTRODUCTION

It has been widely accepted that the importance of utilization of renewable energy to maintain a sustainable civilization. However, the efficiency and cost in the production and consumption of renewable energy generally do not show an advantage to the energy from fossil and nuclear fusion, although a considerable number of efforts are underway in various countries to develop renewable energy. Moreover, renewable energy does not have stability in some cases. For example, wind power generation is widely realized in European countries and a considerable percentage of the energy demand is covered. However, the density and direction of wind changes daily and seasonally in temperate regions including Japan. The unstable nature of renewable energy makes it technically/economically difficult to connect output to the national grid.

Geothermal energy is a reliable and environmentally friendly source to the earth. It also has advantages over other renewable energy in stability and broad distribution although a lower average density. Hence it is expected that geothermal energy can play as a “base” energy source in the renewable energy system. However, this view is not universally shared by the general public, and many geothermal projects are aimed to generate several MWe of electricity as an “alternative energy of fossil”. The current lower price of fossil fuels and steady state in the demand of electricity in advanced countries have made the geothermal power generation less attractive to the power companies and government. In the case of Japan, no newly constructed geothermal power station is expected within the next decade.

The authors worked out a strategy to utilize geothermal energy in a combined renewable energy system to take advantage of the geothermal energy. The energy system is

referred to as *EIMY (Energy In My Yard)* (Niitsuma and Nakata, 2003), because it covers a local energy demand with a cost advantage to that from the grid and secondary merits are brought to the local community. This paper describes the concept of this energy system and describes the role and benefit of geothermal energy.

2. CONCEPT OF THE LOCALLY DISTRIBUTED RENEWABLE ENERGY SYSTEM (*EIMY: ENERGY IN MY YARD*) AND THE ROLE OF GEOTHERMAL ENERGY

EIMY is a concept of a locally distributed energy/economic system where a combination of local renewable energy resources are utilized to the maximum degree that technical and economical considerations permit. Shortfalls and surpluses in local energy production are accommodated through an interface with the national grid (Figure 1). It should be emphasized that *EIMY* is a system for local people/community and is conceived to engender the converse reaction to that of NIMBY (Not In My Back Yard).

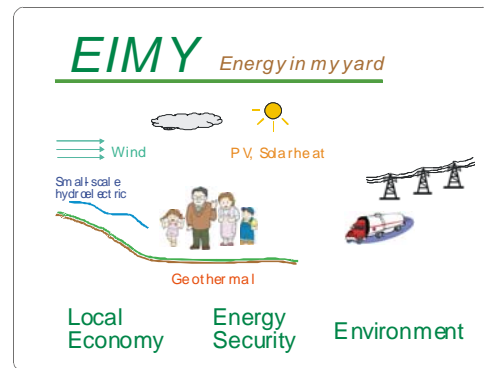


Figure 1 Concept of *EIMY*

In the business models for conventional energy/resources development in the growth period, high density and/or high quality energy/resources are explored, developed and brought to market in pursuit of substantial profit. However, in the saturated period, the cost tends to climb because of progressive exhaustion of the resources and the attendant increase in difficulty of exploration and exploitation. Eventually, the resource loses its competitiveness in the energy/resource market. In contrast, natural, renewable energy resources generally have lower density, but are widely distributed, although it has sustainability. It is therefore basically improbable that substantial profit can be derived in the short term from the development of renewable energy resources, except for limited locations that have high density/quality resources. In some countries with volcanic activities, such favorable geothermal spots

have already been practically fully developed. The same pattern may be followed for the development of wind power in the future.

The conventional business model works well for developing favorable resources. However, the vast renewable resources that fall outside this limited category can only rationally be developed within the framework of a different business model that considers additional factors besides short-term profit. *EIMY* is one such model that takes into consideration, an environmental benefit, contribution to the local economy through job/business creation, and local energy security. Such a revision of the business model would not only greatly extend the exploitable renewable resources, but would also lead to an increase in economic productivity of the host area. This in turn would provide an incentive for local people to utilize local renewable energy, and hence contribute to the usage of green energy in the country as a whole.

The function of *EIMY* within the national energy supply system can be figuratively understood through analogy with the circulation system of the human body: *EIMY* represents the pumping function of the peripheral muscles for the peripheral arteries, while the power supply to the national grid represents the pumping function of the heart for the main artery. Both functions are required.

3. EXAMPLE OF AN *EIMY* SYSTEM AND ITS BENEFIT

The authors made several feasibility studies of the *EIMY* system in Japan. In this paper we show one of the results from the study where the advantages of the geothermal heat pump (GHP) have been revealed. Currently the energy for the facility in this study (children training institute) is covered by heat from an oil boiler (1093MWh/year) and electricity from the grid (500 MWh/year). Because the huge energy demand in this facility and lower availability of the renewable energy especially wind in this area, it is not economically suitable to try to cover the demand by the renewable energy. We hence decided to introduce a combined renewable energy system that consists of wind (40kW), PV (80kW), a wood boiler (580kW), GHP (66kW) and snow storage (1000m³). Figure 2 shows energy flow in this system. A GHP system in “HDR” style, where multiple boreholes are used for injection, production and heat is exchanged in the permeable formation, is considered in this system for larger heat production and higher COP. Although the state of the ground water in this area is unknown, considerable amounts of ground water flow from the existence of fountains nearby. The expected output from the GHP is approximately 376MW/year which is 34% of heat demand. The whole day operation of the GHP system consuming electricity from PV and wind avoiding the reverse power flow of electricity to the grid and suppress the consumption of the oil in the daily opening time of the facility. The counter flow of electricity may cause instability of the grid and power companies in Japan are starting not to allow the counter flow from renewable energy. Hence the the GHP system plays “a capacitive” role in this energy system to stabilize energy production and consumption.

This *EIMY* system has the advantage in the running cost (cost for maintenance and purchase of energy) of several percentage to the current system, although initial investment for the facility of the renewable energy is needed. From the point of environmental advantage, this system reduces the emission of CO₂ approximately 38%

where the contribution of the GHP system is 13% (see Table 1).

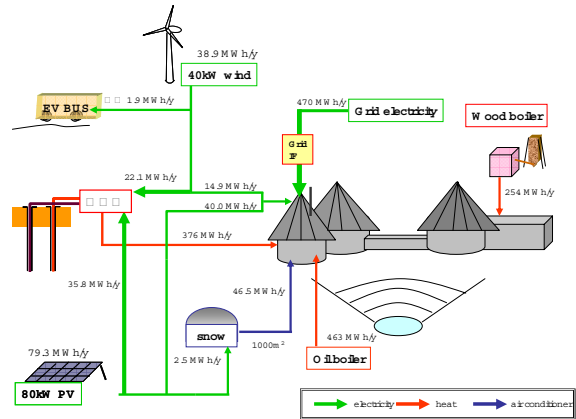


Figure 2: Energy flow of the *EIMY* system introduced children training institute

Table 1: CO₂ emission from the system in this study

	Fossil base (current)	<i>EIMY</i> system without GHP	<i>EIMY</i> system without GHP
CO ₂ emission (ton/year)	156	117	97

4. GEOTHERMAL TECHNOLOGY IN THE *EIMY* SYSTEM

The geothermal energy will play a key role in the *EIMY* system to stabilize the energy demand/supply and to avoid counter energy flow as was demonstrated by the example in the previous section. Because geothermal energy can be used for both power generation and heating, the technologies for HDR/HWR, binary system and heat pump allows utilization of geothermal energy in a diverse range of depth and conditions.

It is essential for the energy source in the *EIMY* system that it is sustainable, economical, and environmentally friendly to the earth. From this point of view, geothermal power generation in the order of several MWe is not always suitable, because (a) it has been reported that the decline of output power has been observed in many geothermal plants, (b) considerable effects on the environment by steam, gas and water from the plant are found in some cases, (c) the environmental impact of the plant distracts from nature, and (d) in many cases the unit price of electricity from the geothermal plant is much higher than generation from coal, oil and gas. To take advantage of the stable and green nature of geothermal energy, GHP, binary power generation in small scale, and cascade energy extraction are technologies of importance for *EIMY*. By introducing the HDR/HWR technologies to create an engineered reservoir, small-scale binary plant would be realized in many local communities and it is utilized for both electricity and heat. GHP can play a role as a heat source as well as a kind of capacitor for stabilization. We have researched the technologies mentioned above to realize the *EIMY* system.

4. CONCLUSIONS

In this paper, we describe the concept of *EIMY* and the role of geothermal energy within it. *EIMY* allows the utilization of renewable energy resources that are currently not used from the point of view of cost consideration. It also

contributes to the local economy, and provides for local energy security.

The integrated renewable energy systems have a considerable advantage over the independent utilization of renewable resources because the disadvantages of renewable energy can be mutually compensated. The stable, widely distributed, and flexible nature of geothermal energy is highly appreciated in the *EIMY* system and will play a key role in the *EIMY* systems. Heat pumps are of primary importance together with the geothermal technologies of re-injection, HDR/HWR, binary system. It is also important to compile a database that describes the expanded geothermal resource opened up by these technologies.

Renewable energy can supply a considerable part of the total energy requirements of an industrialized country.

However, even if the political tide turns in its favor, it will take much time and effort to establish an *EIMY* system at the national level. Nonetheless, in some mostly-rural areas, it is possible to supply more than 100% of the total energy needs by integrated renewable energy systems. These are obvious places to nucleate the development of *EIMY*. Subsequent extension of such areas to form a national *EIMY* system is one of the steadiest ways to decrease CO₂ emission in the world.

REFERENCES

- Niitsuma H., and Nakata, T.: *EIMY (Energy In My Yard)* - a concept for practical usage of renewable energy from local sources, *Geothermics*, **32**, (2003), 767-777.