Chapter 8 The Barriers of Geothermal Development and Necessity of Government Support

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In this chapter the barriers of geothermal development and the necessity of government support is discussed using a price model of the geothermal power generation. The price model used in this study is a very simple one and is developed only for discussions of policy incentives. The rough cost estimation for 49 fields are also very rough one using the price model and carried out for discussions of policy incentives. There are many assumptions in the price model and the rough cost estimation. The results are obtained only to observe the tendency and don't guarantee the real development cost.

8.1 Significance of Geothermal Energy

The significance of geothermal energy is already described in Chapter 1. However, prior to discussions of the barriers of geothermal development and the necessity of government support, it is useful to reconfirm them.

Geothermal energy is an energy source that has a tremendous significance when used to generate electricity. The advantages are as follows (Table 8.1-1):

(a) It is very reliable and greatly contributes to an stable supply of energy,
(b) It is an indigenous resource of energy, and therefore, the utilization of the energy contributes to the saving of foreign currency in energy importing countries, and in energy exporting countries it greatly contributes to promote fossil energy export and to gain foreign currency through saving fossil energy in domestic consumption.
(c) Although it needs the large amount of initial investment, there is no need of fuel cost, and it is possible to supply stable energy even in the situation of unstable international oil price or fluctuation of exchange rate.
(d) Because it does not have combustion process, it is an environmentally friendly energy source,
(e) Hot water produced in the process of generation also contributes to the development of the local host community.

The further explanations of these advantages are as follows.

(a) The Value as a High Reliable Energy Source

Geothermal energy does not have much seasonal change and it can be utilized around the clock and around the year. Therefore, geothermal energy has, being different from other energy sources, a very high plant availability. From this advantage geothermal power generation has a merit that it is able to supply a large amount of energy at stable price, and it becomes the power source facility for reliable power source (Fig.8.1-1, Fig.8.1-2)

(b) The Value as an Indigenous Energy Source

Geothermal energy is purely a domestically produced energy. Even in a country which does not have fossil energy resources, the utilization of geothermal energy leads to the reduction of imported energy. In energy exporting countries, by covering the domestic consumption by indigenous geothermal energy, it is able to increase export of equivalent amount of oil or gas energy. For example, when a geothermal power plant of 55MW is constructed, the effect of the plant is equivalent to the exploitation of an oil field which has an annual production of 500,000 bbl. In addition, since geothermal resource is renewable, the oil field can be regarded as an oil field which is not exhausted. As oil of 500,000 bbl. is, at the moment, equivalent to 31 US million dollars in a year, the amount of oil which is cut down by the geothermal energy is 18.5 million bbl, which is equivalent to about 925 million US dollars for 30 year operation period (Table 8.1-2).

(c) The Value as a Stable Energy Source

Geothermal energy requires a large amount of initial investment, but in the operation process, on the contrary, it is not affected by the fluctuations of international oil price and/or the domestic currency's exchange rates, because it does not use imported fuel in operation process. As a result, once it is constructed, it is able to supply power at a stable price. This advantage is becoming attractive today again when international oil price soars. It is also obtaining attention in many developing countries where their own currency drops and import prices are rising. Even in such kind of situation, geothermal energy is able to be provided at a stable price. (Fig.8.1-3, Fig.8.1-4, Fig.8.1-5).

(d) The Value as an Environmentally Friendly Energy Resource

Geothermal energy is steam and hot water which are heated in underground. In other words it is a power generation form without combustion process. Therefore, Sulfur oxide, Nitrogen oxide and dust and other pollutants in combustion process are not produced. In other words it is energy resources with very small environmental burden. And the production of carbon dioxide is also negligible. (Fig. 8.1-6, Fig.8.1-7, Fig.8.1-8)

(e) The Value as an Energy Resource which are able to Contribute to the Local Host Society

The hot water obtained in geothermal plants can be utilized for heat energy for the local industries such as horticulture, fish farming and others. Even in warm regions the heat can be utilized for drying of crops and timbers. In short, geothermal energy is the resource which can be used for energy development and promotion of local industry in parallel

(Fig.8.1-9).

8.2 Characteristics of Geothermal Energy and Barriers to its Development

In the exploitation of geothermal energy, steam and hot water existing 1,500~3,000m deep under the ground is taken up to the surface and converted to electricity. In this process, therefore, major risk, as in the development of petroleum, natural gas and minerals, exists and large amount of capital funds are needed. Although the exploration technology has been developed and the accuracy of exploration has been enhanced, still the development risk and fund raising remain as big barriers to geothermal development. For this reason, the utilization of geothermal energy is not progressed much enough, comparing with the tremendous storage of geothermal energy. Indonesia is not an exception in this respect. However, as mentioned before, good geothermal energy, when it is developed, provides excellent energy with stability, energy with less environmental loads, energy with good economic performance in long term. In order to extract these values it is needed to overcome the barriers of development risks and initial capital investment. In this chapter, the characteristics of geothermal power generation and problems and measures for development are discussed.

8.2.1 Risk of Exploration of Geothermal Energy

Development of geothermal energy is that of underground resources. Therefore, there exist risks of many kinds such as market risks, technological risks and financial risks and so on. Here let us discuss technological risks. Main technological risks in the project of geothermal development are as follows:

(a) Exploration Stage

— Difficulty in construction of access roads and others
— Difficulty in exploration due to geological conditions
— Success rate of exploration well
and others may create cost overrun

(b) Development Stage

— Depth of the reservoir
— Productivity of the reservoir
— Quality of geothermal fluid, concentration of non condensable gasses
— Success ratio of production well
— Rising cost of construction materials

(c) Operation Stage

— Decrease of steam
— Decrease of availability

and other factors may cause the deterioration of plant performance.

In order to evaluate these risks accompanied in the development of geothermal energy and also to make economic evaluation, we make a simplified price model for the evaluation of geothermal power generation.

8.2.2 Price Model of Geothermal Power Generation

The economic feature of geothermal project depends on the characteristics of the area and differs one by one. However, here discussions are made by assuming a model field and model plant with the output of 55MW, which is a standard level.

(a) Development Stage

Here the following model development process is assumed.

Surface survey stage ~ Resource confirmation stage	:	3 years
Development stage (Reservoir evaluation stage)	:	3 years
Construction stage	:	2 years
(Development lead time total)	:	(8 years)
Operation period		30 years

(b) Development Cost

A problem in making a price model of geothermal power generation in Indonesia is that the necessary data related to steam development is not so officially published as in Japan. It is possible to grasp the data about depths of production wells from the data-base of Ministry of Minerals and Energy, Center for Geological Resources (CGR) (Fig.8.2.2-1, Table 8.2.2-1), but when it comes to delicate data like the quantities of steam in the production wells, there is not enough reliable data that is overtly released. Therefore, a small number of data which were collected in the published documents or the data which were collected in the field survey were referred (Table 8.2.2-2). The main data which were used in the model are shown in Table 8.2.2-3 and Table 8.2.2-4.

The cost of development of model plant in this price model is estimated as about 136 million USD, which is 2,470 USD per kW (Table 8.2.2-3). It becomes 146 million USD including the interest during construction, IDC, of 8.5% annual rate. The plan of activities and the funds procurement were assumed as shown in Fig.8.2.2-2 and Fig.8.2.2-3.

(c) Cost of Power Generation, Selling Price and Profitability of the Project

The power generation cost of geothermal power plant consists of (1) depreciation of plant and equipment in initial investment, (2) depreciation of additional investment during operation period such as additional production wells, (3) cost of O&M, (4) interest of payment. However, the power producer which executes the project cannot sell power at this generation cost. He needs to mark up the selling price to cover other factors such as (5) corporate tax and (6) investment profit. Therefore, the selling price is higher than the generation cost. The detail discussions on these issues will be made latter, but the result of price model calculation on power generation cost, selling price and profitability is as follows.

Power generation cost 3.9 US cents/kWh (at 12% discount rate)
Selling price 8.7 US cents/kWh
Project profitability (Project IRR) 18% (in the case of 8.7 US cents/kWh selling price)

8.2.3 Risk Evaluation of Resource Development in Geothermal Power Generation

As mentioned before, the main causes obstructing the promotion of geothermal power generations are (1) risks of resources development, and (2) tremendous initial investment. Then let us discuss first how the risks of resources development obstruct the promotion of the projects.

(1) Depth of Reservoir

Fig.8.2.3-1 shows the depths of production wells in the main geothermal power plants in Japan. As this picture shows, the depths of production wells in the plants range between about 500m and about 3,000m. The depths vary depending upon the locations. Even in the same power plant the depths of production well varies, and of course, depths of production wells differ if the location differs. It must be remembered that the depths of production wells greatly affect the drilling cost and therefore greatly affects the profitability of the project. Although the surface survey methods are advanced nowadays and it becomes possible to estimate the depth of the reservoir to some accuracy, but the only method of knowing the exact depth is by drilling wells actually. Therefore, when the depth of the reservoir turn to be deeper than the estimated value, the drilling cost exceeds the expected value and suppresses the profitability of the project. Fig.8.2.3-2 shows the influence of drilling costs on the profitability of the project (Project IRR). If the drilling cost rises from 3 million to 4 million US dollars, Project IRR decreases from 18.0 to 16.7%.

(2) Steam Productivity

Fig.8.2.3-3 shows distribution of output per one production well in main geothermal power plants in Japan. As shown in the figure, the average output per one well varies between 1.5MW and 7.0MW, and the average is 4~5 MW in Japan. In Indonesia, It is estimated as 6~9 MW in general and there are some reports of production wells with the output more than 10MW. In this price model the value of 8MW per well is used. The steam productivity of the production well greatly affects the economy of power generation. But in the initial stage of surface survey and test drilling stage, it is difficult to predict accurately the productivity of the well. Therefore, when the productivity is lower than expectation, more production wells than the initial plan are needed, and the construction costs increase. Fig.8.2.2-4 shows the influence of steam production upon the profitability. When the output per one well decreases from 8MW to 6MW, the Project IRR drops by about 1.6% point.

Hot brine is also produced together with steam from the production well. Brine is normally put into the ground again to protect surface environment and to preserve underground resources. In case the amount of the brine increases, the number of required reinjection wells also increases, deteriorating the profitability. In the price model it is assumed that the ratio of steam and brine is 1:1. But the increase in the ratio worsens the profitability of the project, although it is not as much as other parameters do (Fig.8.2.2-5).

(3) Availability of Power Plant

Fig.8.2.3-6 shows how the plant availability affects the profitability in geothermal power plant. Most of geothermal power plants are able to generate electricity stably and most of them have the availability of more than 80%. But in case an over development that exceeds the reservoir capacity is made, the imbalance of steam production out of reservoir and groundwater supply into the reservoir decreases the output in the long period and plant availability turn to be low. Therefore, the estimation of reservoir capacity in exploration stage plays an important role. However, that estimation is estimation on the desk and there still remains the risk of the reservoir capacity. In case the evaluation of the reservoir is excessively large, it leads to decrease in plant availability. In addition, in some plants a large amount of scale may generate in wells and piping system as anther deteriorating factor which leads to lower plant availability. As Fig.8.2.3-6 shows, the lowering of 10 % in equipment availability leads to lowering of profit by 1.7 % point.

(4) Overlapping of Development Risks

These factors of risk occur independently and have influences in an overlapping manner. Therefore, here simulations were performed by Monte Carlo method, in which the depth of the reservoir, the output per production well, the ratio of steam/brine and plant availability are made influential. The results of 1,000 trials are shown in Fig.8.2.3-7. According to this result, the average of the profitability (Project IRR) is about 17.8%. This is a little lower than that of the average case of price model. And it is clear that cases disperse from 13% to 21%. In short, it shows that there are some cases where the profitability turns better than the estimation, but on the contrary there are also many cases which is worse than the expectation.

In the business administration theory, business risk is not the level of the profitability itself, but is the width of variation of possible profitability cases. This large variation of possible profitability is indeed the risk of development geothermal energy, and in this model case, the risk (width of variation) extends even to about ±4% from the average. This is a very big difference, if it is compared, for example, to coal-burning power generation. In the case of coal-burning power plant, the biggest risk is the rise of the coal price in the future. But in the case of coal-burning power generation business, even if the coal price rises during operation, the operator (independent power producer; IPP) does not need to bear it. In such case, it is possible for the operator to put the increased fuel cost in selling price (this system is called as “Pass through”). In this system there is no risk in coal-burning power generation business and the investor is able to obtain almost the same profit as assumed before. Comparing with it, the uncertainty of the project in geothermal power generation business is very high. Also, in the actual project, not only this sort of risks, but also many factors are involved and it is thought that the width of risk will expand.

(5) Direction for Reducing the Development Risks

What sorts of measures will be effective for reducing the development risks and lowering the barriers? Fundamentally the following methods are effective.

i) To enhance the profitability and to change geothermal business structure into that of “high risk and high return” business.

ii) To reduce resource development risks, through the preliminary survey by government, to such level as the ordinal private company can afford to take.

iii) To let the entities who have enough financial and technical base to develop plural fields in order to disperse risks.

As to the improvement of profitability referred in (i), petroleum/natural gas projects and mineral development projects have similar kinds of resources risks, but from its business profitability there are many participations of a large number of developers. However, in the case of geothermal power generation, the produced energy can be neither stored for high price opportunity nor transferred to other favorable market. The energy can only be transformed into electric power on site which has high public interest. Therefore, the price is strongly controlled by the government and nowadays it is difficult for geothermal generation business to expect high profitability.

Measure to lower risks referred in (ii) is a realistic measure. By doing the initial survey by the government, the width of unreliability can be narrowed and the participation becomes easier (Fig.8.2.3-8). The survey by the government has also the meaning of inventory survey, which is one of the government tasks, and this contributes greatly to the reduction of risks of the later development. In Japan as well, the initial surveys for geothermal development have been carried out for a long time period, and after the oil crisis, the budget of this survey was expanded greatly. In Indonesia, as well, initial surveys by Ministry of Minerals and Energy, Center for Geological Resources (CGR), have been executed. Therefore, the expansion of this survey will be a reasonable and realistic policy.

The measure to disperse risks by multiple developments referred in (iii) is also a feasible measure. According to the statistics theory, if we pick up a number of "n" samples from the principal group which has the average of μ and the standard deviation of σ, and if we calculate their average, the value approaches the normal distribution of the average of μ and standard deviation of $\sigma/\sqrt{n}$ (Fig.8.2.3-9). This is, in other words, the risk disperse by portfolio in the corporate financial theory. Therefore, if an entity with enough funds executes geothermal developments in four places, it is able to reduce the risk (the width of variation of profitability) to 1/2 ($=1/\sqrt{4}$), and if it is possible to develop 9 places, the risk can be reduced to 1/3 ($=1/\sqrt{9}$). This is, in practice, the strategy which is seen in PNOC-EDC in the Philippines. PNOC- EDC has been involved in most of all geothermal projects and has promoted geothermal developments in the country. In the case of Indonesia as well, by letting PERTAMINA and PLN to develop many geothermal energy, it is possible to disperse the risks and to promote the development.

8.2.4 Initial Investment and Economy of Geothermal Project

The second largest barrier is the burden of tremendous initial investment. In this section, we discuss this barrier and how the initial investment burden affects the economy of the project.

(1) Power Generation Cost and Selling Price of Electricity

The power generation cost in a geothermal power plant consists of, (i) depreciation of equipment in the initial investment, (ii) depreciation of the additional investment during operation, (iii) O&M costs, (iv) interest of payment. Fig.8.2.4-1 shows how the generation cost of price model geothermal plant varies during the operation period. According to this result, the power generation cost varies roughly at 6 ~ 4.5 cents/kWh, rather high level due to the effect of production well depreciation, and it falls down to 3 ~ 2 cents/kWh, being influenced by equipment depreciation, during the period of between the 8 th and the 15 the year, and it lowers to a level of roughly 0.9 ~ 0.8 cents/kWh level after the 15 th year. Using discount rate of 12%, the average generation cost during 30 operation years is calculated to be 3.9 cents/kWh. The cost components are as shown in Fig.8.2.4-2. About 54% of cost is the depreciation of the initial investment.

In comparison to this geothermal generation cost, Fig.8.2.4-3 shows the evolution of generation cost of coal-burning power plant. In the case of coal-burning power plant, the power generation cost changes between 4.2 ~ 3.3 cents/kWh from the 1st year to the 15th year, which is a period of plant equipment depreciation, and after the 16th year it generally lowers to 2.5 cents/kWh. Average generation cost is estimated to be about 3.7 cents/kWh. The main portion of the cost in coal-burning power plant is that of fuel, which accounts for almost half of the power generation cost.(Fig.8.2.4-4)

As we saw above, it is understood that geothermal power generation cost is not so different from that of coal-burning power generation. However, from the viewpoint of selling price of electricity, it gives an entirely different view, as shown in the followings. The selling price of electricity covers not only power generation cost, but also (v) corporate income tax and (vi) investment profit of the project. Fig.8.2.4-5 shows this structure. Here, the investment profit of the project has a character that the more profit the corporate expects, the higher the selling price increases. In other words, the selling price is a function of the expected profitability of the corporate. Fig.8.2.4-6 shows this relationship. For example, if the corporate is satisfied with the profitability of 12 %, the selling price will be something like 5.6 cents/kWh, but if the corporate wants the profitability of 15%, it will be 7.0 cents/kWh, and if it is18%, it will be 9.1 cents/kWh. So, the graph is the increasing curve with expected profitability. The gradient of this curve becomes larger, when the percentage of capital cost in the power generation cost is larger. Comparing geothermal and coal-burning power generation, it can be said that the requirement of high profitability leads to expand the difference in the selling price between geothermal power generation and coal-burning power generation (Fig.8.2.4-7).

This result is due to the fact that, in the case of geothermal power generation, comparing with coal-burning power generation, (i) the amount of initial investment is large, (ii) the development period before commercial operation is long, which means the capital fund used in the development activities requires the opportunity cost during this period, (iii) the power generation cost evolves to produce large profit in the later stage of the operation (Fig.8.2.4-8).

Fig.8.2.4-9 shows the relationship between the required profitability and the selling price in different type of power generation. How much profitability the corporate requires depends upon the decision of the corporate, and therefore, the selling price depends upon respective corporate. In other words, for example, for a corporate which expects only the profitability of 12%, the selling prices of respective power generation remain cheap and have little difference as shown in Fig.8.2.4-9, and (A) of Fig.8.2.4-10. Therefore, from the perspective of such a corporate, the selling prices of geothermal and hydraulic are not greatly different from other energy sources. In contrast to this, for the corporate which expects profitability of 15% (state company, in many cases), the selling prices rises as a whole, and particularly geothermal and hydraulic energy, which needs large up-front capital investment, look relatively expensive. In the same way, for the corporate which expects profit of 18% (many private companies), geothermal power generation and hydraulic power generation looks very expensive as shown in (c) of Fig. 2.22. This makes private companies to turn their eyes on coal-burning power generation rather than geothermal power generation. In other words, they require expensive selling price to start geothermal power generation.

There is another reason why private companies are not willing to start geothermal power generation. Fig.8.2.4-11 shows how much selling price is needed to obtain the necessary profit of investment in the geothermal power generation case in a shorter period than 30 years, such as 25 years, 20 years, 15 years, or 10 years. For instance, the selling price rises to 7.5 cents/kWh when the profit are to be collected in 20 years, while the original selling price is 7.0 cents/kWh to collect profit in 30 years. In the same way, the selling price rises to 9.2 cents/kWh to collect profit in 10 years. This means that the selling price rises as the profit collection period becomes short. On the contrary to this geothermal case, the selling prices in different profit collection periods don't have big difference in the case of coal-burning generation, which needs small up-front capital investment and needs large annual fuel cost (Fig.8.2.4-12). In general, private companies have intension to collect profit in as short a period as possible. As a result, private companies is not willing to invest in geothermal power generation as long as they are not offered a considerably high price power purchase proposal.

We sometimes observe a lot of examples that shows the power plants built by private IPPs (independent power producers) are only gas turbine plants or natural gas combined cycle power plants, which have little up-front investment, when the power generation business is left to the private sector. In such occasion, there are little examples of geothermal plants or hydraulic power plants introduced by IPPs. For instance, many Central American countries reformed the electric power sector and adopted the policy to leave the power generation business to the hand of private sector in the middle of 1990's. However, as a result, only thermal power plants have been constructed in such countries, and the share of thermal power plants has remarkably risen as shown in Fig.8.2.4-13. These countries are now facing great difficulty of sudden rise of imported fuel expense in the recent high international oil price. The only one exception is Costa Rica, which maintains the policy to leave power generation business to government-run electric power company (ICE). As a result, the diversification of the energy sources has advanced by increasing hydraulic power and geothermal power capacity. The result of the above-mentioned discussion offers a reasonable explanation to this example of Central American countries.

(2) Directions to Lower the Selling Price of Electricity

Then, what sorts of measures can be taken to lower the selling price of geothermal power generation? Fundamentally, (i) To lower power generation cost by the efforts to reduce the construction cost, (ii) To reduce taxes, (iii) To reduce expected profit of investment. Among these measures, reduction of construction cost referred in (i) should be greatly put forward, but as this study report focuses on policy measures, this measure is removed from the discussions. As for the tax reduction referred in (ii), the detail discussion will be done in section 8.4. In this section, we discuss how it is possible to reduce the expected profit of investment.

First of all, how much profit rate do the state and private companies expect from their business? It is actually difficult to know exactly the figures, because it is the sensitive figures connected with corporate administration judgment and is different company by company. But from several interviews with people concerned, we obtained a feeling to assume that it is about 15% in the case of state company (for example, PERTAMINA) and about 18 % in the case of private company. This difference in the expected profit rate comes from the facts that the state company is able to raise fund at lower cost with mortgage of the state, and in the case of private company the opportunity cost of their fund is high due to their wide range of possible investment opportunity.

There are many development styles in geothermal energy development: (1) Total project by a state company (no example at present in Indonesia), (2) Joint project by combination of state companies (PERTAMINA for steam development and PLN for power generation), (3) Joint project by a state company (PERTAMINA for steam development) and a private company (for power generation), (4) Joint project by a private company (for steam development) and PLN (for power generation), (5) Total project by a private company. In these cases the expected profit rate is 15% in the case of (1) and (2), and is 18% in the case of (5). From this number and the project cost of steam section and generation section, the expected profit rate is estimated as 16.3% in the case of (3), and 16.7% in the case of (4). Fig.8.2.4-14 shows how the selling price differs according to this expected profit rate. From this graph, it is understood that the selling price becomes higher in joint project than in total project, because 10% of value added tax (VAT) is added to steam price. The selling price increases in the following order: (1) Total project by a state company (7.0 cents/kWh), (2) Joint project by state companies (7.4 cents/kWh), (3)Joint project by PERTAMINA (steam development) and a private company (power generation) (8.2 cents/kWh), (4)Joint project by a private company (steam development) and PLN (8.5 cents/kWh). (5) Total project by a private company (8.7 cents/kWh).

This result shows the advantage of geothermal development by state company/companies to lower the selling price. The result also shows the considerable influence of VAT on steam price in the case of joint project, and the importance of exemption of it in order to lower the selling price.

8.3 Challenges in Development of Geothermal Energy in Indonesia

8.3.1 Challenges in Development of Geothermal Energy in Indonesia

Geothermal energy has such characteristics as we have seen. In this chapter we discuss the challenges to promote its development.

Indonesia has a large potential of geothermal energy, and the constructive policy target for geothermal development has been raised. The institutional framework to the target is also improved by enactment of Geothermal Energy Law. Ironically, however, for these 10 years after the economic crisis, geothermal development stays stagnant. Particularly today, no development in new areas is not started at all by private companies. What is the reason for this? People concerned point out the following problems.

(1) Not Well-Organized Legal Systems

It is already three years since the geothermal energy law came into effect, but the implementation rules for the law are still not announced yet. Particularly, the very important items remained unclear are, (i) Demarcation of roles and activities between central and local governments, (ii) New tax rate in place of 34%, (iii) Procedure for bidding in working area.

(2) Delayed Capacity Building of Officers of Local Governments

The geothermal law contains the spirit of decentralization of power from state government to local governments. In other words, the administration and sovereignty related to the use of the resources within a certain region is entrusted to the regional government. However, most of officers of the regional governments lack knowledge, ability and information related to geothermal energy. The administration ability is needed to enhance, but the capacity building for local government officers remarkably lags behind.

(3) Low Purchase Price of Electricity

PLN makes the purchase price of electricity as lower than 5 cents/kWh in all IPP cases regardless of its energy source, even though it is electricity from geothermal power generation or the electricity from coal-burning power plant. This policy is adopted to maintain consumer’s electric tariff at low level and also to establish sound financial basis of PLN. Since electricity is the indispensable energy for industrial activities and for the life of citizens, these two purposes are important public interest. On the other hand, the national energy policy aims at diversification of energy sources to secure stable energy supply, which is another important public interest. However, the consensus is not obtained yet in the point how to establish the harmony of these two interests, namely Least Cost Policy and Energy Mix Policy. Also, the government does not gain the conclusion yet what sort of economic incentives and appropriate adjustment of PLN’s purchase price should be given to promote geothermal development.

(4) Human Development of Geothermal Experts

It is nearly 10 years since the development of geothermal energy became stagnant due to the economy crisis. It is reported that during this period geothermal engineers have been dispersed. In the existing organizations as well, aging of geothermal engineers proceeds and the education and training of young engineers and technology transfer are becoming urgent issues. Now again it is expected that geothermal energy developments are extensively unfolded and a great number of geothermal engineers are needed. But it is still unclear how to educate them to be professional engineers.

(5) A Feeling of Distrust Against Investment Protection

While the participation of international private enterprises are expected, there exists still a feeling of opaqueness regarding to the legal protection policy for investment.

All of these are extremely important issues. Therefore, in the government of Indonesia, the measures to improve legal systems, to educate staff of local governments, to protect investment are under discussions. However, even if the framework of these measures is developed, probably the development of geothermal energy will not be advanced. This is because the most important issue is that of purchase price of electricity.

8.3.2 Purchase Price of Electricity

After the economic crisis in 1997, the government of Indonesia reviewed the purchase price from IPP. In this process the purchase price from geothermal power generation company was drastically cut down. Purchase price is a kind of secret matter of the related parties and there is not much information about it. Even though in such a situation, some prices are reported in media and shown in Table 8.3.1-1. The table shows that the original purchase price were between 7~10 cents/kWh at the time when the development of geothermal energy were promoted in 1990s. But now they are reduced to the level of 4 cents/kWh.

If we make this purchase price as prerequisite, the profitability of geothermal power generation is greatly worsened. Using the price model in Section 8.2, in the case of private company (with the expected profit of 18%), the selling price of 8.7 cents/kWh is needed to acquire the profit. However, when the selling price came down to 5.0 cents/kWh, the profitability of the project (Project IRR) worsens to 10.6%, which is not only less than 18% but also less than even the fund raising cost (Weighted Average Capital Cost (WACC)) of 12.9% with the deficit of 2.2%. This is the level where private companies cannot be motivated at all. (Fig.8.3.1-1)

In Chapter 7, the rough economic estimation of resources in 49 fields is calculated using this price model. Fig. 8.3.1-2, Table 8.3.1-3, Fig.8.3.1-3 show the results.
In these figures and tables, the case of 15% IRR (expected project Internal Rate of Return) is the case of state company, and the case of 18% IRR is that of private company. In the private company’s case (18% IRR), Value Added Tax (VAT) of steam sales is not considered because private company develops geothermal energy by one company on the "total project"

basis. On the other and, in the case of state company (15% IRR), 10% of VAT on steam sales is added because the state company's development case means PERTAMINA develops steam and sells it to PLN on the "joint project" basis.

According to the results, the capacity of development in total 49 areas is calculated as around 8,200 MW, of which the capacity of 11 fields[1] belonging to PERTAMINA is about 3,200 MW and that of 38 other fields is about 5,000 MW. Among these fields, there is no field which can be developed with selling price of 5 cents/kWh or less. The resource amount which can be developed with 6 cents/kWh or less is calculated as 1,240MW (15.1% of total amount). The amount of the resource with 7 cents /kWh or less price is calculated as 3,160 MW (38.5%), and the amount of the resource with 8 cents/kWh or less price is 6,480 MW (79.0%). Therefore, if the buying price of PLN remains 5 cents /kWh of the current level, the development is not expected any more. The buying price of 10 cents/kWh or more is necessary to achieve the development scenario of geothermal development master plan shown in Chapter 7.

The above discussion shows that it is indispensable to increase the buying price of PLN up to the level enough for private developers to recover their investment. Otherwise it is essential for the government to bridge the gap between the buying price and the selling price by providing the package of various economic incentives. Such government support is necessary to attract private developers and to promote geothermal development shown in the master plan.

8.4 Discussions of the Government Support to Geothermal Development

In this section, discussions are made on what sorts of policies are required in order to promote geothermal development in Indonesia. As we have seen, PLN has a policy to purchase electricity from IPPs at the price lower than 5 cents/kWh. However, according to rough economic estimation of 49 geothermal areas in the country, which we made in the previous chapter, there is no area which is able to be developed at the price lower than 5 cents/kWh. According to the price model of hypothetical standard geothermal power plant, the selling price of geothermal energy is 8.7 cents/kWh in the case of private company's development, and is 7.4 cents/kWh in the case of state company's development. Here is a great price gap between the purchase price of PLN's policy and the selling price which enable for developers to acquire the necessary return in geothermal power generation business. This price gap appears, at the moment, as the greatest hindrance to geothermal development in Indonesia. Effective measures must be taken in order to narrow and bridge this price gap.

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[1] Since G.Salak, Darajat, and Wayang-Windu is currently developed by private companies, these three areas are included in the areas of Non-PERTAMINA.

8.4.1 Purchase Price of PLN

In order to promote the utilization of renewable energy the policy is widely employed that government forces the electric power companies to buy them at a compulsive price. The compulsive price is decided either as a ratio (90%, for example) of consumer's electric tariff or as the constant rate (7 cents/kWh, for example). The typical examples are PURPA Law in USA in 1980s and Electricity Purchase Law in Germany. In PURPA Law in USA, purchasing at avoidable prices was forced. In the German law, it forces them to buy it at the designated constant price. For instance, in the case of geothermal energy lower than 20 MW the price is currently designated to be 8.95 cents/kWh.

This regulation is able to promote development of renewable energies drastically in a short time period, if the level of the purchase price level is appropriate. This can be seen in the rapid development of wind power in Germany. As a matter of fact, the wind power capacity in Germany, which was only 48 MW in 1990, was quickly expanded by the introduction of the related laws and regulations and reached the tremendous output of 14,600 MW in 2003, more than 300 times capacity in 1990. On the contrary, in Italy, it was reported that the development was not advanced well because the designated price was not appropriate. This is an example that it is very difficult to specify the appropriate price.

Moreover, if the purchase price of PLN is easily raised, it may lead to another problem of deteriorating the financial base of PLN or increasing the consumer's electricity tariff. Therefore, an appropriate combination of the purchase price increase and the following economic incentives by government policy, i.e. comprehensive measures, is necessary.

8.4.2 Economic Incentives of Government

The government has three kinds of measures; tax policy, fiscal policy and financial policy. These measure work directly and indirectly on the profitability of projects. Here the following incentives are conceived.

(a) Tax Credit

The tax rate of the geothermal power generation business had been 34% for a long time. However, after the reform of tax system in 2000, discussion is going on in the government what the new tax rate should be in the geothermal power generation business. As the conclusion has not yet been reached to date, the fundamental tax rate is assumed 34% as before in this analysis. On this tax basis, the effect of a tax credit is examined. The assumed tax credit is to reduce basic tax rate to some extent, instead of 34%, for some years after the start of geothermal power plant operation. Thus the effect of tax credit was examined.

In addition, in the joint operation case, the effect of VAT exemption in steam sales is examined. This is because geothermal steam is totally useless energy for other purpose than transformed to electricity at the production site, and it seems not appropriate to impose a tax on such a commodity.

(b) Preliminary Survey by Government

It was already described that the preliminary survey by government in the initial stage of development is effective to reduce the risks of geothermal resources development. In this analysis, the effect of government preliminary survey, which comprises of the surface survey and the exploratory drilling, is examined.

(c) Low Interest Finance for Development

In order to encourage the developers to succeed geothermal exploration, the effect of low interest finance in development stage is examined. In this analysis, 'development' is defined as the stage where developers confirm 40% of required amount of steam by drilling exploration wells after the existence of steam was confirmed. Usually it is difficult for developers to have loan from commercial banks as this stage due to the development risks. Therefore, most of developers cover expenses of this stage by their own finance. However, if governmental financial institution provides loan at low interest, it would encourage the developers greatly to proceed. For this reason, the low interest finance from governmental financial institution is considered as one of incentives.

At present, the finance which financial institutions of OECD countries can provide with private companies for their power plant projects in Indonesia has a lower limit of interest rate by OECD guidelines. This rate is currently calculated as about 8.5% (in case of finance by US dollars), and the repayment period is 12 years. However, in this analysis it is assumed that the Indonesian government is able to give loan to developers at a lower interest rate than this limit. The period of loan is set as 12 years with the grace period of 3 years.

(d) Low Interest Finance for Construction

In addition, in order to encourage the developers to construct the geothermal power plants, the effect of low interest finance in construction stage is examined. In this analysis, "construction" is defined as the stage where developers acquire steam of up to 100% of required amount by drilling production wells after the confirmation of 40% of steam amount. Also in this stage, developers construct steam and brine pipelines and other facilities to provide steam. Normally, when development proceeds to this stage, the loan from the commercial banks can be expected. However, the construction of geothermal power plant needs great initial investment capital and the burden of interest of this capital becomes large hindrance. Therefore, the provision of long-term loan at a low interest rate to the construction encourages developers greatly to construct geothermal power plants. In the constriction stage, therefore, the finance from governmental financial institution with lower interest rate than the usual finance from commercial banks is considered as one of incentives.

(e) Subsidy for Construction

Geothermal power plant needs a large amount of initial investment. For this reason it could be one of incentives that the government gives subsidy for a part of the construction of the power plant. In this analysis the effect of governmental subsidy of a certain percent of construction cost is examined.

(f) ODA Finance for Construction

In the case of state company, ODA finance from donor countries or international donor organization such as World Bank is available for construction stage. Generally the loan conditions are very soft and will alleviate the burden of interest payment in normal finance for construction. In this study, Japanese Yen Loan is taken as an example of ODA loan, and the effect of Yen Loan is examined.

8.4.3 Effect of VAT Exemption on Steam Sales

First of all, the effect of exemption of 10% VAT on the steam price in the case of joint projects is examined in the 55 MW model power plant case. Fig.8.4.3-1 shows the influence of VAT in the case of private company's development. This model power plant is assumed to be developed as a total project by a private company. Therefore, VAT is not applied in this case, and the selling price is calculated as 8.7 cents/kWh. However, if the development is done as a joint project by two private companies, then VAT on steam sales between them is applied and the selling price will increase to 9.2 cents/kWh or increase by about 5.7%.

Moreover, Fig.8.4.3-2 shows the results of the rough development cost estimation for 38 fields which are classified as non-PERTAMINA field. The estimation was done on the condition that they will be developed as a private company's total project. However, if they will be developed as a joint project by two private companies, the graph moves to the right side by the influence of VAT and implies the amount of development will decrease.

Fig. 8.4.3-3 shows the influence of VAT in the case of state company's development. In Indonesia, it is general that PERTAMINA, a state company, develops steam and sell it to PLN, another state company, for power generation. In this case, 10% VAT is applied to the steam sales, and the selling price is 7.4 cents/kWh in this model case. However, if VAT is exempted, the selling price will decrease to 7.0 cents/kWh and the reduction effect is about 5.4% .

Moreover, Fig. 8.4.3-4 shows the results of the rough development cost estimation for 11 fields which are classified as PERTAMINA field. The graph shows that all the capacity will be developed even at 7 cents/kWh buying price, if VAT is exempted.

8.4.4 Effect of Tax Credit

Next, let examine the effect of tax credit in corporation tax in the case of 55 MW model plant. Fig. 8.4.4-1 shows the effect of tax credit in the case of private company's development. The examined tax credit is to reduce tax rate from 34% to 20% or to 10% or to 0% in the first 10 years or in the first 7 years respectively. According to the price model, the effect of 20% of tax rate has an effect of 0.4 cents/kWh reduction of selling price, and 10% of tax rate has 0.7 cents/kWh reduction effect, and 0% tax rate has 1.0 cents/kWh reduction effect in the case of 10 year credit period. In the case of 7 year credit period, 20% tax rate has 0.3 cents/kWh reduction effect, and 10% rate has 0.5 cents/kWh effect, and 0% rate has 0.7 cents/kWh effect. The 10% tax rate for 10 years has the same effect as the 0% tax rate for 7 years.

Moreover, Fig.8.4.4-2 shows how tax credit increases the development amount in 38 fields of non-PERTAMINA field. The figure shows that the graph moves to the left side in accordance to the reduction of tax rates and implies the amount of development will increase.

Fig.8.4.4-3 shows the effect of tax credit in the case of state company's development. According to the figure, the effect of 20% of tax rate has an effect of 0.2 cents/kWh reduction of selling price, and 10% of tax rate has 0.4 cents/kWh reduction effect, and 0% tax rate has 0.5 cents/kWh reduction effect in the case of 10 year credit period. In the case of 7 year credit period, 20% tax rate has 0.1 cents/kWh reduction effect, and 10% rate has 0.2 cents/kWh effect, and 0% rate has 0.3 cents/kWh effect.

Moreover, Fig.8.4.4-4 shows how tax credit increases the development amount in 11 fields of PERTAMINA field. Similarly to the private company's case, the figure shows that the graph moves to the left side in accordance to the reduction of tax rates and implies the amount of development will increase.

Here let discuss the possibility of this tax credit realization. In the case of the 55 MW model plant, the 10% of tax rate, i.e. the tax reduction from 34% to 10%, for 10 years alleviates about 42 million US dollars from total tax payment if the selling price of 8.7 cents/kWh is accepted. This reduced amount is equivalent to about 30% of the total investment of 146 million USD. In Indonesia there is a tax credit up to 30% of investment amount for foreign direct investment which aims at export promotion. Since geothermal power plant saves domestic oil consumption and contributes to promote oil export as well, there is a large possibility of introducing the same kind of favorable tax credit for the investment in geothermal power plant.

Let see the examples in other countries. As a famous example of tax credit for the promotion of renewable energy, we can point out the Production Tax Credit in the Unite States. This is the system that the entrepreneur who constructs a renewable energy power plant and supplies electricity to electric power company is able to reduce their corporate tax by a fixed amount of "Production Tax Credit" for 10 years. In the cases of wind, geothermal and biomass the tax exemption is 1.9 cents/kWh, and in the cases of gas from reclaimed land, mini hydraulic power plant (smaller than 5MW) and garbage incineration power plant it is 0.9 cents/kWh. It is reported that this system enormously contributes to expand power generation by wind and others.

Other countries than United States also have the preferential tax system for renewable energy. For example, in Guatemala the corporate tax is 31%, but it has been ruled that the tax related to renewable energy development can enjoy tax exemption for 10 years since 2003. Also, in Nicaragua 30% of corporate tax has been exempted for 7 years for renewable energy development. In Panama as well, in the case of renewable energy power plant with less than 20MW, corporate tax is exempted up to the amount of 25% of total investment. In Asia, the Philippines are reportedly considering to introduce this kind tax credit system to promote renewable energy. From these examples, the proposed tax credit system is thought to be realistic enough (Table 8.4.4-1).

8.4.5 Effect of Government Preliminary Survey

Next, let discuss the effect of the preliminary survey by the government. Here we call such government survey as "Geothermal Development Promotion Survey (GDPS)". Fig.8.4.5-1 shows the function and significance of GDPS, which substitutes the initial survey of private developers. As the resource risk is the largest in the initial stage, the government survey has three effects; (a) risk reduction, (b) initial investment reduction, and (c) lead time reduction.

There are various ideas as for the scale of GDPS. According to the Indonesian geothermal law, the government has an obligation to implement a preliminary survey, and the exploration and the exploitation is done by private developers. However, the law allows the government to carry out the exploration and also allows private developers to carry out a preliminary survey. Here, the following 4 cases of GDPS are examined: (Table 8.4.5-2, Fig.8.4.5-2)

1) The government carries out a promotion survey which consists of only surface survey (GDPS-A), and the results of survey is transferred to private developers free of charge. (Case 1)

2) The government carries out a promotion survey which consists of surface survey

and drilling of 2 test wells (GDPS-B), and the results of survey is transferred to private developers free of charge. (Case 2)

3) The government carries out a promotion survey which consists of surface survey and drilling of 2 test wells (GDPS-B), and the results of survey is transferred to private developers with charge. In this case, the payment is done in 10 year installments after 4 year grace period[2]. During the payment period the interest rate is 4% annually. (Case 3)

4) The government carries out a large-scale promotion survey which consists of surface survey and drilling of 5 test wells (GDPS-C), and the results of survey is transferred to private developers with charge. The payment conditions are same as the above case. (Case 4)

The price mode of a 55 MW model geothermal power plant shows that the effect is hardly observed in Case 1, in which GDPS-A is carried out. This is because the cost of surface survey is not so large and the support to surface survey only is insufficient. In the case of GDPS-B, the effect of 0.2 cents/kWh reduction in the selling price is observed if the results of GDPS-B are transferred free of charge (Case 2), and the effect disappears if the results are charged (Case 3). However, it should be noted that the effect of resource risk reduction by GDPS in the initial stage is very large for private developers even if the selling price reduction effect disappears. In the case of GDPS-C, a very large effect of 0.9 cents/kWh reduction in the selling price is observed even if the results are charge (Case 4). Therefore, the effect of GDPS-C on the resource development in 38 fields is also expected very large, as shown in Fig.8.4.5-3.

The promotion survey of the government is very attractive scheme for private developers because the survey reduces the initial survey cost, the development lead time, and the initial resource risks. Even in the Case 3 where no price reduction effect is seen, the risk reduction effect is very appreciated from the private developers view point. In addition, a large-scale government survey like GDPS-C has an extremely large effect on geothermal development. From the government view point, this scheme is also attractive because the survey cost is recovered from private developers by charging them on the survey results, i.e. data and drilled wells. (Fig. 8.4.5-4)

By the way, this kind of preliminary survey by the government has been performed as the Promotion Survey in Japan since 1980. Specifically, New Energy Development Organization (NEDO) carries this survey, and the promising results are provided for private companies. The details are shown in Annex 8.4.5-1 in the end of this report.

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[2] The grace period is set considering the necessary period until power plant operation.

8.4.6 Effect of Low Interest Rate Loan to Development

Fig.8.4.6-1 shows the effect of low interest rate loan to development, which is calculated by price model of 55 MW model plant, in the case of private company's development. Five cases of interest rate, i.e. 7%, 6%, 5%, 4%, and 3%, are examined. The repayment year is 12 years with 3 year grace period in addition. Since the expenditure of this stage is covered by the developer's own fund if there is no incentive of low interest rate loan to this stage, the 0.4 cents/kWh selling price reduction effect and the 0.5 cents/kWh selling price reduction effect are observed in 7% rate case and from 6% to 3% rate cases respectively.

Fig.8.4.6-2 shows the effect of low interest rate loan to development in the rough development cost estimation of 38 fields of private company. The effect of loan to increase the development amount can be observed. From these charts, it can be said that the provision of loan has a certain effect regardless of interest rate.

Fig.8.4.6-3 shows the effect of low interest rate loan to development in the case of state company's development. Compared with the no incentive case, the 0.1 cents/kWh selling price reduction effect and the 0.2 cents/kWh selling price reduction effect are observed in 7% rate case and from 6% to 3% rate cases respectively.

Moreover, Fig.8.4.6-4 shows how the loan increases the development amount in 11 fields of PERTAMINA field. Similarly to the private company's case, the development promotion effect is seen at the selling price of 7 cents/kWh.

8.4.7 Effect of Low Interest Rate Loan to Construction

Fig.8.4.7-1 shows the effect of low interest rate loan to construction, which is calculated by the price model of 55 MW model plant, in the case of private company's development. Similar to the case of loan to development, five cases of interest rate, i.e. 7%, 6%, 5%, 4%, and 3%, are examined. The repayment year is 12 years with 3 year grace period in addition. Since the money source of this stage is the loan with commercial interest rate of 8.5% if there is no incentive of low interest rate loan to this stage, the 0.1 cents/kWh selling price reduction effect is observed in the case of 7% interest rate. Similarly in accordance to interest rate the progressive selling price reduction results such as 0.2 cents/kWh, 0.3 cents/kWh, 0.4 cents/kWh and 0.5 cents/kWh of price reduction effect are observed in 6%, 5%, 4%, and 3% interest crate case respectively.

Fig.8.4.7-2 shows the effect of low interest rate loan to construction in the rough development cost estimation of 38 fields of private company. The effect of the loan to increase the development amount can be also observed.

Fig.8.4.7-3 shows the effect of low interest rate loan to construction in the case of state company's development. Compared with the no incentive case, the 0.1 cents/kWh, 0.2 cents/kWh, 0.3 cents/kWh, 0.4 cents/kWh and 0.5 cents/kWh of selling price reduction effects are observed in 7%, 6%, 5%, 4% and 3% interest rate cases respectively.

Moreover, Fig.8.4.7-4 shows how the loan increases the development amount in 11 fields of PERTAMINA field. Similarly to the private company's case, the development promotion effect is seen.

Examples of this kind of governmental loan at lower rate than commercial loan for the construction of renewable energy power plants are seen in Japan and Germany. In Japan, in order to promote renewable energy development and to promote energy saving investment, special long-term loan at lower rate than commercial loan is available to these projects from Japan Investment Bank, a governmental financial institution. In case of renewable energy projects, the loan period is generally between 13 and 15 years, longer than the commercial one, and the interest rate is fixed at lower level than commercial one during that period. The loan can cover the maximum of 40% of the construction cost. The interest rates, the loan period and other conditions are decided case by case, considering the level of commercial interest, the years of life of equipment, profitability of the project and others. In Germany, Deutsche Ausgleichsbank (KfW) also gives special long-term loan to the construction of renewable energy power plants. Like Japan's case, the interest rate of this loan is fixed at the lower level than commercial one but the loan period is 20 years at maximum, much longer than Japan's case. In both Japan and Germany, the purpose of this kind of special loan from governmental finance institution is, generally, to provide finance in longer term with fixed and lower interest rate than commercial one, in order to promote projects in the following fields where it is difficult to obtain loan from commercial banks; (i) fields where projects face high risks, (ii) fields where it takes long time for recovering the investment, (iii) fields where the governmental policy puts high priority. This loan is highly appreciated by entrepreneurs who need a large up-front investment for renewable energy development in construction stage.

8.4.8 Effect of Construction Subsidy

In order to alleviate large initial investment of geothermal power plants, the effect of subsidy for construction cost is examined. Fig.8.4.8-1 shows the effect of subsidy for construction, which is calculated by the price model of the 55 MW model plant, in the case of private company's development. Three cases of subsidy rate, i.e. 10%, 20% and 30%, are examined. Compared with no incentive case, the 0.1 cents/kWh selling price reduction effect is observed in the case of 10% subsidy rate. Similarly the 0.3 cents/kWh selling price reduction effect and 0.6 cents/kWh effect are observed in the case of 20% subsidy rate and 30% subsidy rate respectively.

Fig.8.4.8-2 shows the effect of the subsidy in the rough development cost estimation of 38 fields of private company. The effect of the subsidy to increase the development amount in accordance to the subsidy rate increase can be observed.

Fig.8.4.8-3 shows the effect of the subsidy in the case of state company's development. Compared with the no incentive case, the 0.2 cents/kWh, 0.4 cents/kWh and 0.6 cents/kWh of selling price reduction effect are observed in 10%, 20% and 30% subsidy rate cases respectively.

Moreover, Fig.8.4.8-4 shows how the subsidy increases the development amount in 11 fields of PERTAMINA field. Similarly to the private company's case, the development promotion effect is seen at the selling price of 6 cents/kWh and 7 cents/kWh.

The typical examples of this kind of subsidies to the construction of renewable energy plants are seen in Denmark and Japan. In Denmark subsidies for the construction of wind power plant were supplied between 1978 and 1989. The rate of subsidies was 30% in the beginning. Denmark changed the system later and the new system is that the government provides subsidies of 0.10DKK (Danish Krone)/kWh, 1.6 US cents/kWh at the rate in 1992, to wind power energy production. Thanks to these subsidies for plant construction and energy production, the capacity of the wind power plant increased rapidly and the percentage of the wind power energy goes up to 21%, which is the highest ratio in the world today. In Japan, in order to promote solar power generation, subsidies have been given to the person who installs solar power system on his house roof since 1994. The subsidies contributed to reducing the installation cost of solar power system and expanded the market to reduce production cost of photovoltaic panel. Between 1994 and 2002 this system contributed to subsidize 115,000 cases, 421MW capacity of solar power system. In Japan, thanks to this system, solar power system has quickly spreaded and the capacity of equipment expanded from 19MW in 1992 to 635MW in 2002, making the country the number one country in terms of solar power usage. As described above, the governmental subsidies are greatly contributing to the expansion of renewable energies.

8.4.9 Effect of ODA Finance for Construction

Fig.8.4.9-1 shows the effect of ODA finance for construction, which is calculated by the price model of the 55 MW model plant, in the case of state company's development. In this analysis, Japanese Yen Loan is considered as an example of ODA finance. The conditions of Yen Loan[3] for geothermal projects are so soft that interest rate is 0.65% and repayment period is 40 years with 10 year grace period included. Generally Yen Loan is applied to the construction stage. First let's see the case where Yen Loan is applied to the construction stage of steam facilities (production wells, steam gathering system etc.) The effect of Yen

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[3] The interest rate of Yen Loan for geothermal projects has been lowered from 0.75% to 0.65% since April 2007.

Loan in this case is calculated as 0.8 cents/kWh price reduction. In the case where Yen Loan is applied to the construction stage of power plant facilities (turbine, generator, and transformer etc.), the effect Yen Loan is calculated as 1.2 cents/kWh price reduction. Further, in the case where Yen Loan is applied to the construction stage of both steam facilities and power plant facilities, the effect reaches 2.0 cents/kWh. Since a considerable amount of money is spent before construction stage of steam section, the effect of Yen Loan on steam facilities is less than that of power plant facilities. In the case where Yen Loan is applied to the development stage and construction stage of steam facilities, the effect becomes almost same as Yen Loan on power plant facilities.

Fig. 8.4.9-2 shows how Yen Loan increases the development amount in 11 fields of PERTAMINA field. The remarkable development promotion effect is seen.

8.4.10 Overlapping of Incentives and their Effects

Based on the above mentioned discussions, the following incentives are adopted (Table 8.4.10-1).

- VAT on steam sales:	Exempted for all operation year period
- Tax credit for corporation tax:	Reduced to 10% tax rate for 10 years
- Governmental preliminary survey:	GDPS-B (Surface survey & 2 test wells) Results are free of charge
- Low interest rate loan to development:	5% interest rate, 12 repayment years
- Low interest rate loan to construction:	5% interest rate, 12 repayment years
- Subsidy for construction:	20% of subsidy rate
- Yen Loan for construction:	Applied to steam field and power plant （for state company）

The effects of overlapping these incentives in the 55 MW model plant are shown in Table 8.4.10-2, Fig.8.4.10-1 and Fig. 8.4.10-2. Fig. 8.4.10-1 shows the case of private company's development and Fig.8.4.10-2 shows the case of state company's.

In the case of private company, 18% of expected profitability rate should be secured. On the other hand, VAT of steam sales is not applied because private company develops steam field and generate power by itself on the basis of total project. Therefore, the necessary selling price is calculated as 8.7 cents/kWh in no incentive case. Comparing with this price, when the incentive of tax credit is applied, the selling price becomes 8.0 cents/kWh, and the effect of 0.7 cents/kWh of the selling price decrease is seen. When the incentive of government promotion survey is added further, the necessary selling price goes down to 7.7 cents/kWh. This means the promotion survey by the government has the effect of 0.3 cents/kWh of the selling price decrease. In the same way, when the incentive of low-interest rate loan to development stage is added further, the selling price decreases to 7.3 cents/kWh (effect of

0.4 cents/kWh reduction). Similarly when the low interest loan to the construction of steam field is added further, the selling price goes down to 7.0 cents/kWh (effect of 0.3 cents/kWh). It can be decreased to 6.6 cents/kWh by incentives of construction subsidy to the steam development construction (effect of 0.4 cents/kWh reduction).

On the other hand, in the state company's case, the expected rate of profit is 15%. However, in such a case, PERTAMINA develops steam and sells it to PLN for power generation, and in this process, 10% of VAT is applied on steam price. Therefore, the necessary selling price is calculated as 7.4 cents/kWh when there are no incentives. In this case, when the incentive of VAT exemption is applied, the selling price decreases to 7.0 cents/kWh. The effect of 0.4 cents/kWh of the selling price decrease is seen. From this state, when the incentive of tax credit is applied to PERTAMINA and PLN for 10 years, the necessary selling price goes down to 6.7 cents/kWh (effect of 0.3 cents/kWh reduction). In addition, when government carries out promotion survey even within the PERTAMINA's development area, the selling price decreases to 6.2 cents/kWh (effect of 0.3 cents/kWh). Further, when government provides PERTAMINA with low interest loan for its development activity, the selling price goes down to 6.2 cents/kWh (effect of 0.2 cents/kWh). In addition, when government provides PERTAMINA with low interest rate loan for construction of steam field facilities, the selling price decreases to 5.9 cents/kWh (effect of 0.3 cents/kWh). In addition, when government provides PERTAMINA with 20% of construction subsidy, the selling price decreases to 5.6 cents/kWh (effect of 0.3 cents/kWh reduction). The cumulative effect of all incentives is 1.8 cents/kWh decrease of selling price. By the way, the effect of Yen Loan is so large that the selling price plunges from 7.4 cents/kWh to 5.4 cents/kWh by as much as 2.0 cents/kWh. This effect is much larger than the cumulative effects of above-mentioned incentives by government.

Fig.8.4.10-3 and Fig.8.4.10-4 show how these incentives improve the profitability of project. In these figures, the horizontal axis shows the profitability of the project (project IRR), and the vertical axis shows the funding margin (Project IRR - weighted average capital cost (WACC)). The incentives of tax credit, the promotion survey by government, and the construction subsidy have the effect of improving the project profitability directly, and the incentives of low-interest loan for development and low-interest loan for construction have the effect of improving the funding margin through the offer of the low-interest fund.

Next, the effect of incentives on how much capacity of geothermal resources will be developed is examined using the results of the simple resource evaluation in Indonesian 49 geothermal areas. Fig.8.4.10-5-Fig.8.4.10-8 and Table 8.4.10-2 show the results. First of all, let us see the results of 49 development areas as a whole (Fig.8.4.10-5). The development capacity is estimated to about 8,200 MW. Indonesia has a policy target of 9,500 MW development by 2025. To attain this target, buying of 10 cents/kWh or more is necessary if there is no government support.

Let us divide this graph into two areas, i.e. the development area of Non PERTAMINA and the development area of PERTAMINA. In the Non PERTAMINA development areas, about 5,000MW development is expected. (Fig.8.4.10-6) In order to develop this entire amount, the buying price of 12 cents/kWh is needed. Considering the shape of the graph, 10 cents/kWh is at lease necessary to develop a considerable amount, if not to say the whole amount. If the buying price is 9 cents/kWh at most, the favorable treatment in tax system is needed to compensate the price gap. In case of 8 cents/kWh buying price, favorable tax system and the promotion survey of government is necessary. In case of 7 cents/kWh price, four measures of incentives, which include the preferential treatment in tax system, the government survey, the low-interest loan to development, and the low-interest loans to construction, are needed.

In the PERTAMINA development areas, about 3,200 MW development is expected (Fig.8.4.10-7). From a similar analysis, the buying price of 8 cents/kWh is needed to develop this entire amount. If the buying price is 7 cents/kWh, VAT on steam sales should be exempted. In case of 6 cents/kWh buying price, three measures of incentives, which include the preferential treatment in tax system (VAT exemption and 10% tax rate for 10 years), the government survey, the low-interest loan to development, and the low-interest loans to construction, are needed.

The results are shown in Table 8.4.10-2.

The use of ODA finance from donor countries is also possible for PERTAMINA. ODA finance is extremely soft condition and the effect is very large. For instance, when Yen Loan is applied to both the steam facilities and power plant facilities, about 80% of resources will be developed even if the buying price of PLN is at the current level (5 cents/kWh) (Fig.8.4.10-8). It is recommendable to utilize these ODA finance positively.

8.4.11 Effect of CDM

The use of “Clean Development Mechanism (CDM)" scheme is an effective method to improve the profitability of geothermal power plant. CDM scheme is a scheme of Kyoto Mechanism, which was introduced to reduce greenhouse effect gas under the United Nations Framework Convention of Clime Change. More concretely, this is a scheme in which developed countries are able to utilize the amount of CO_2 reduction produced as a result of a joint project between the developed countries and developing ones. Certified Emission Reduction (CER) credit is issued, depending upon the amount of greenhouse effect gas reduction, and it is possible to share this CER credit between the participating countries. CER credit can be traded in the market and entrepreneurs are able to utilize it for improving the profitability of project. Since CER is not for the reduction of green house gases in developed countries, in the issue of CER credit, strict examination is performed in the CDM board. In order to be approved as CDM project, it must be proved that it is not business as usual (BAU) project. However, as we have already seen, the project of geothermal energy development in Indonesia is not well advanced at all, mainly because the purchase price of PLN is very low. This fact points out the existence of a big barrier in the financial area. Therefore geothermal project is not BAU project at all, and is eligible for CDM project. In fact, In fact, five (5) geothermal projects have already been registered as CDM project in UNFCCC and two (2) more projects are in validation process. Among these geothermal projects, Darajat No3 project was approved as CDM project (Table 8.4.11-1).

The price of CER credit is not finalized yet. However, in the advancing examples in World Bank and Dutch scheme, CER is traded at the price of around 5 US$/ton of CO_2. Since geothermal power plant is able to supply large volume of energy, the amount of CER in a year reaches about 350,000 ton in the case of 55 MW plant, for example. If the price of CER is 5 US$/ton, revenue of 3.5 million US dollars is expected annually. This is equivalent of the purchase price increase by 0.4 cents/kWh. At the moment, the issue of CER is limited to 21 years, but it has a big effect for improving profitability.

In this section we see the effect of CDM scheme under the assumption of 5 US$/ton of CER price for 21 years. Table 8.4.11-2, Fig.8.4.11-1, and Fig.8.4.11-2 show the effects of incentives when the CER credit of 5 US$/ton is considered. The CER credit of 5 US$/ton has the effect of the selling price decrease of 0.4 cents/kWh for private company, and has the effect of 0.3 cents/kWh decease for state company. Fig.8.4.11-3 shows how geothermal development will be promoted in case of 5$/t CER and 10$/t CER.

At present the reduction obligation of greenhouse effect gas of the industrial countries is limited between the year of 2008 and 2012, and the prospect after 2013 of the CDM system is not clear. Therefore, the analysis in paragraph 4.10 set aside the effect of CDM from discussion of incentives. However, as the reduction of greenhouse effect gas is an urgent matter, some institutional framework of this kind may continue.

8.4.12 Influence of Drilling Expense Rise

Recently, the oil exploration activity in Indonesia has been activated by the sudden rise of an international oil price. Therefore, the utilization rate of the oil well drilling rig equipment rises, and the procurement cost also rises. As oil well drilling rigs are also used in geothermal well drilling, the procurement cost of drilling rigs is increasing, too. This section examines the influence of the drilling expense increase to 4 million US dollars.

Fig.8.4.12-1 shows the change of necessary selling price when the drilling expense rises from 3 million US dollars to 4 million US dollars in the model 55 MW power plant. According to this, the necessary selling price rises from 8.7 cents/kWh to 9.8 cents/kWh in private company's development case, and it rises from 7.4 cents/kWh to 8.3 cents/kWh in state company's case. Fig.8.4.12-2 shows how geothermal development will be delayed in case of 4 million drilling cost. From these charts, about 1 cent/kWh increase in the buying price is necessary to off set the drilling cost increase of 1 million dollar per one well.

8.5 Conclusion

In this chapter we have discussed the characteristic of geothermal energy, the challenges and promotion methods for geothermal energy development. They are summarized in the following way.

First of all, the selling price of geothermal energy becomes 8.7 cents/kWh in private company's development case and 7.4 cents/kWh in state company's development case, which seem relatively high selling prices compared with that of coal power plant, because geothermal development needs larger up-front investment and longer development lead time than coal power plant development. However, can we immediately conclude that geothermal energy is expensive energy compared with coal from only this selling price viewpoint? As pointed out in the section 8.1, geothermal energy is an energy source which has extremely a lot of values. For instance, if we pay much attention to the fuels of thermal power plants, we can say that thermal power plants are losing very important opportunities of export fossil fuels and earn foreign currency by consuming these valuable fuels by themselves. Moreover, the influence on the environment must be considered more as a social cost, although this environment cost is considered as an external economy which the operators don't need to pay. Therefore if we evaluate each energy source from the viewpoint of generation operator, the selling price may be one of the indexes of judgment. However, if we evaluate them from the viewpoint of government or society, the socio-economic cost which includes the loss of opportunity cost and the environmental cost should be considered.

Table 8.5-1 shows the socio-economic cost of each energy source from such a viewpoint. The selling prices, which are calculated by the price model in 15% IRR case and 18% IRR case, are shown in the first line. The loss opportunity cost of fuel export is shown in the second line. This cost, the same cost as the fuel cost of each generation cost, represents the cost of losing the opportunity of exporting fuel by consuming it in stead. The third line is environmental cost. The calculation of this cost is difficult, but here it is calculated as the value of the pollutant volume multiplied by the emission trade market price from each power plant. The emission trade market price of sulfur dioxides (SOx) and nitrogen oxides (NOx) are assumed to be 700$/ton and 2,500 each$/ton respectively referring to the prices of the transaction in the United States emission trade market. The price of carbon dioxides is assumed to be 10$/ton referring to the transaction price in the European emission trade market. It is true that these prices reflect the environmental values in the developed countries and not the situation of Indonesia. However, as the environmental value in Indonesia will also increase in the future, these prices are used in the calculation. According to Table 8.5-1, it is understandable that geothermal energy has the competitiveness even if it is compared with coal power plant[4]. The table shows that geothermal energy is worth while development from the view point of the government or the national social economy.

As for the development style of geothermal energy in Indonesia, there are two kinds of players in Indonesian geothermal development; namely they are the state companies (PERTAMINA, PLN, and GeoDipa, etc.) and private companies. The characteristic of them is as follows.

< State companies >

(a) They can raise fund at inexpensive cost with mortgage of the government.

(b) They can utilize ODA scheme in introducing inexpensive capital and sophisticated technology

(c) They hold many promising areas in the matter of fact.

(d) They can develop plural areas and distributes the development risks.

(e) They can continue steady development regardless of Indonesian economy.

(f) They can contribute Indonesian economy through employment, tax payment, and the re-investment of the profit etc.

(g) On the other hand, they have disadvantages such that (i) there are some possibilities to fall into the sloppy management, (ii) the government needs to allocate fund for them from limited financial chest.

< Private companies >

(a) They expect high profitability and require high selling price to compete with other investment projects. (Their opportunity cost is high.)

(b) They have a tendency to keep high risk development projects away.

(c) They can utilize the latest and the sophisticated technology.

(d) They raise necessary fund by themselves and the governmental money can be saved.

(e) On the other hand, they have disadvantages such that (i) theirs activities are likely to influenced easily by Indonesian economy and political stability. (ii) they have difficulty to carry out the parallel development of plural areas due to the limited fund and manpower.

[4] In case of coal power plant which uses exportable coal as its fuel.

When such characteristics of the players are considered, it is necessary to recognize the importance of state company’s functions in the geothermal development. The reasons are as follows.

(a) There are strong relations in the selling price of electricity and the expected profitability in a geothermal energy development project, which needs a large up-front investment and a long lead-time before the profit returns. In such situation, an inexpensive selling price can be expected in the state company's development case.

(b) It is important to develop a central technology institute of the local to promote geothermal development. Such a technological institute has the following advantages,

  (i) it may be able to carry out geothermal development inexpensively by knowing domestic circumstance well and by utilizing the learning effects,

  (ii) it may be able to distribute development risks by parallel development of plural areas,

  (iii) it may return the development profit to domestic economy through employment and reinvestment.

  (as a mater of fact, a strong central state-run organization of technology is playing the important role in the geothermal advanced countries (for example, Philippines, Mexico, and Kenya, etc.).)

(c) State companies are eligible for the support of technology and fund by ODA. They can localize these technologies and, through piling the experience, they can grow up to the central technological organization which bears future development.

(d) There are actually a lot of promising areas in Petamina's concession area. To promote geothermal development, the development of these promising areas is the first task as a matter of fact.

From these perspectives, it is important and effective to support geothermal development by state companies. The geothermal development by state companies is concretely the development by the combination of PERTAMINA and PLN, and, according to circumstances, the development by GeoDipa Company, which is the subsidiary company of PERTAMINA and PLN.

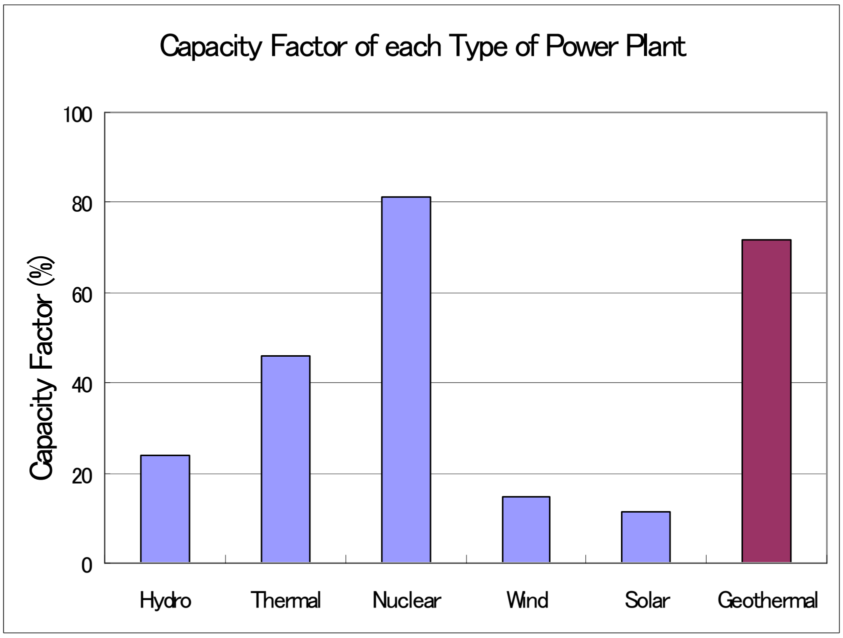
On the other hand, as the geothermal development target of Indonesia is set considerably high, the participation of private companies is also necessary to accomplish this target. The private participation is expected from the following aspects, (i) the private fund can be mobilized, (ii) the number of developers can increase, and (iii) the competition by large number of developers leads to the cost-down competition of development. In order to encourage private companies, the strong policy to assist them is necessary.

Indonesia has a development target of 9,500 MW geothermal energy by 2025. To attain this ambitious target, it is necessary for PLN to review and revise the purchasing price policy of less than 5 cents/kWh. In addition, it is important for the government to provide the geothermal developers with a set of appropriate incentives. When there is no incentive, the purchase price of PLN should be 8 – 10 cents/kWh. When the purchase price of PLN can not be raised to that level, a certain set of incentives of government is needed to fill the price gap.

These measures need the incentives costs of government and the cost of purchase price increase of PLN. Therefore, to work out an appropriate combination of the incentives and purchase price increase is necessary. The design of this combination, or the design of the above-mentioned policy option, is a question of philosophy how to harmonize the energy diversification policy and the least electric tariff policy. It is necessary to find an appropriate harmony which is suitable for Indonesian society.

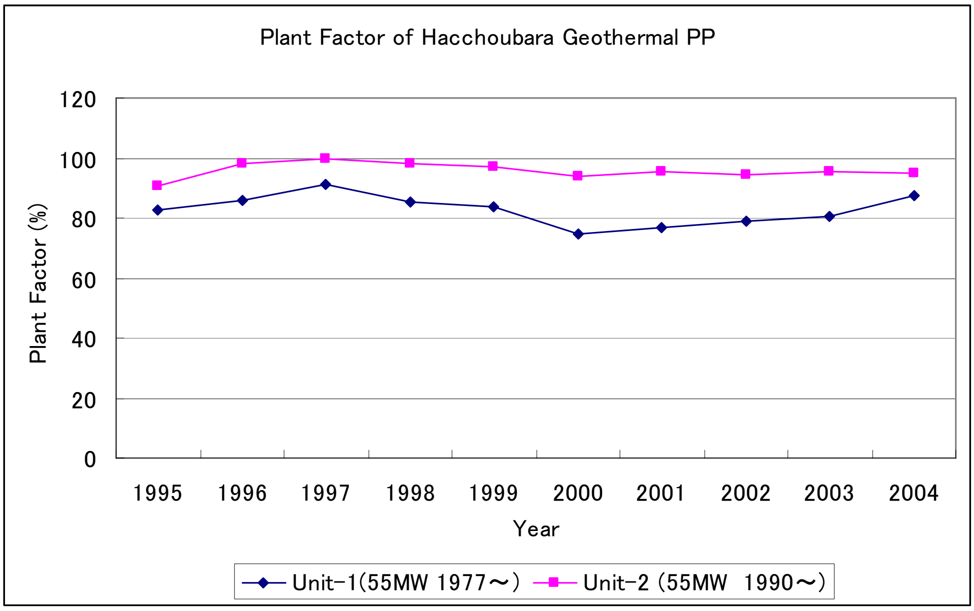
Table 8.1-1 Values of Geothermal Energy

Value	Explanation	Value evaluation
Reliable source	Geothermal energy can be used all year around, day and night, and is independent of weather conditions.	Plant Factor of power sources; - Geothermal 80-100% - Hydropower 30-60% - Wind 20-30% - Solar 10%
Indigenous energy	Geothermal energy is indigenous energy source and thus avoids imports of fuels and saves foreign money.	A 55 MW geothermal plant will produce 11,550 GWh and will save 925 million US$ of oil, 696 million of natural gas, or 204 million of coal during 30 year operation. (Under an estimation of 50$/BBL oil price or 35 $/ton coal price.)
Stable energy source	Geothermal energy needs no fuel cost and therefore will be little affected by fuel price increase or devaluation of exchange rate.	Energy mix with geothermal power will be less vulnerable not only in fuel increase but also in severe drought.
Environmentally friendly energy	Geothermal energy is environmentally friendly energy from local and global viewpoint, with little emission of SOx, NOx, soot and CO2.	A 55 MW geothermal plant will save 315,000 ton CO2 per year, and its value will be 1.8 million US$ per year under an estimation of 5$/ton CO2 value.)
Multiple use for local society	Geothermal energy can be used not only for electricity generation but also for heat source for agriculture or local industry.	



(Source: Japan Electric Power Utility Data book)

Fig. 8.1-1 Capacity Factor Comparison



(Source: Japan Thermal & Nuclear Generation Association; Japan Geothermal Data Book 2005)

Fig. 8.1-2 Example of Plant Factor in Hacchoubaru Geothermal Power Plant

Table 8.1-2 Oil Equivalent Value of Geothermal Energy

The Value of 55 MW Geothermal Power Plant

Condition 696 millionUSD (@			
Capacity	55 MW		
Operation Years	30 Years		
Plant Factor	85 %		
Auxiliary ratio	6 %		
Heat Rate of Thermal Power Plant	50 % (Natural Gas CC PP)	38 % (Diesel PP)	38 % (Coal PP)
Auxiliary ratio of Thermal Power Plant	2.5 % (Natural Gas CC PP)	4 % (Diesel PP)	10 % (Coal PP)

Generated Energy by Geothermal PP

Generation Energy 385.0 GWh/yr
(55MW * 8,760h/yr * 85% * (100%-6%) = 385.0 GWh/yr)

Generation Energy in Lifetime 11,550 GWh
(385.0 GWh * 30 Yrs = 11,550 GWh)

Value of Energy compared with Alternative Source

Natural Gas Combined Cycle Power Plant

Natural Gas Saved 2,620 million c.f./yr 78,700 million c.f. for 30 yrs.
(385.0 GWh/yr /(100%-2.5%) / 50% * 3,412 BTU/kWh / 1,027 BTU/cubic feet = 2,620 million c.f./yr)

Value in Dollar terms 23.2 million US$/yr 696 million US$ for 30 yrs.
(Fuel price 8.6 $/MMBTU or 8,832 $/million c.f)

Diesel Power Plant

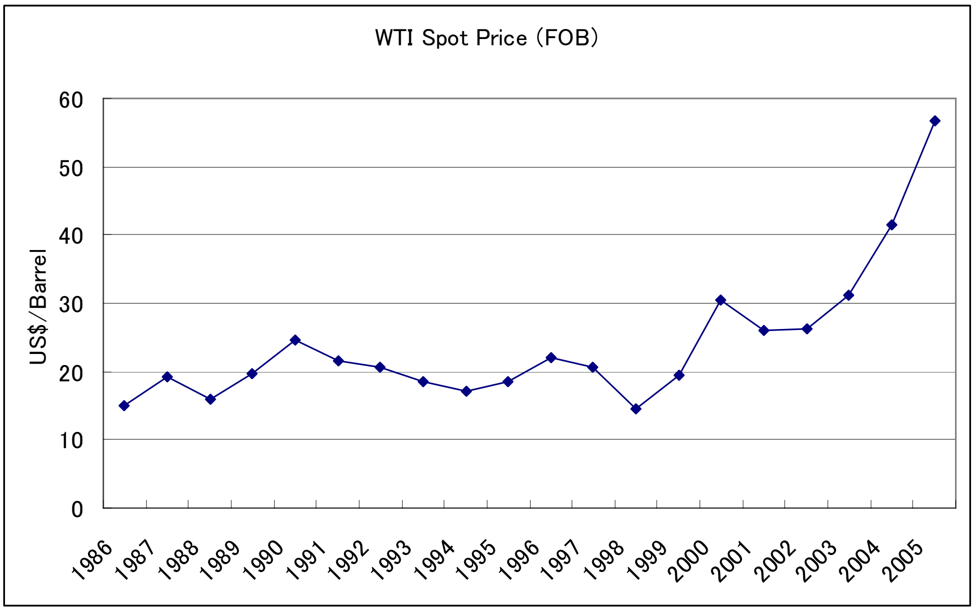
Oil Saved 617.0 '000 Barrel/yr 18.5 million Barrel for 30 yrs.
(385.0 GWh/yr /(100%-4%) / 38% * 3,412 BTU/kWh / 5.84 MMBTU/Barrel = 616,500 Barrel/yr)

Oil Equivalent Value 30.8 million US$/yr 925 million US$ for 30 yrs.
(Fuel price 50 $/Barrel)

Coal Power Plant

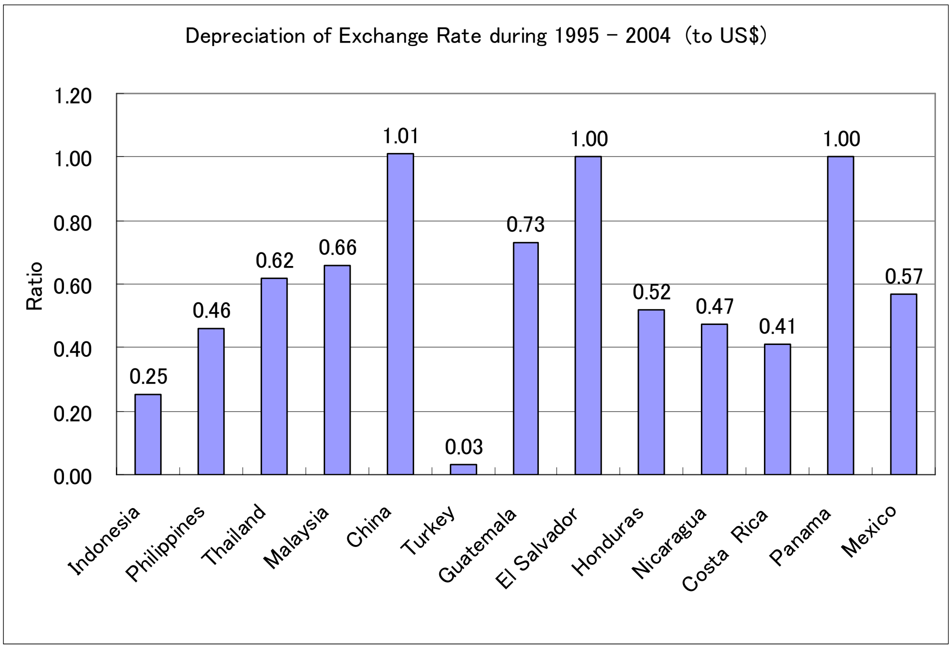
Coal Saved 194.0 '000 ton/yr 5.82 million ton for 30 yrs.
(385.0 GWh/yr /(100%-10%) / 38% * 3,412 BTU/kWh / 19.8 MMBTU/ton = 193,990 ton/yr)

Coal Equivalent Value 6.79 million US$/yr. 204 million US$ for 30 yrs.
(Fuel price 35 $/ton)



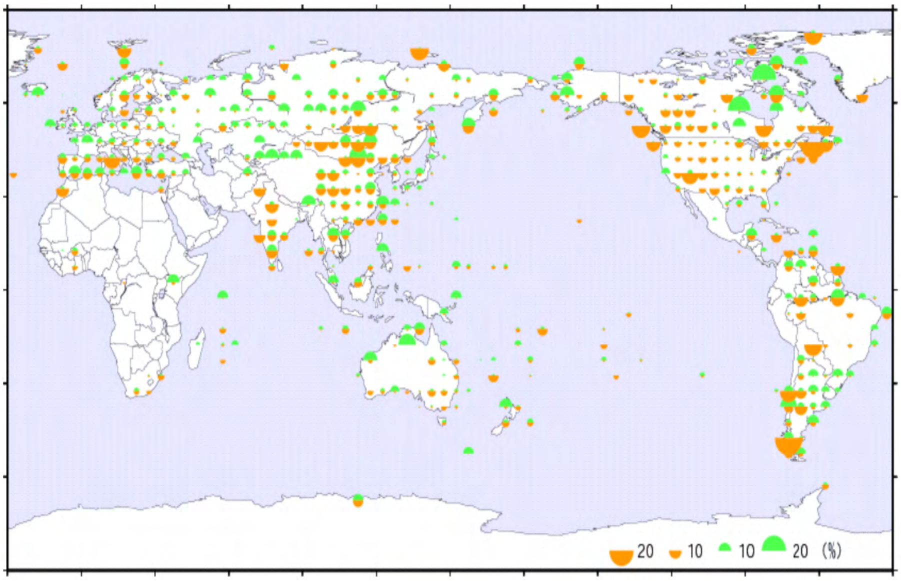
(Source: EIA; http://tonto.eia.doe.gov/dnav/pet/hist/rwtca.htm)

Fig. 8. 1-3 International Oil Price Increase



(Source: JBIC; ODA Handbook 2005/2006)

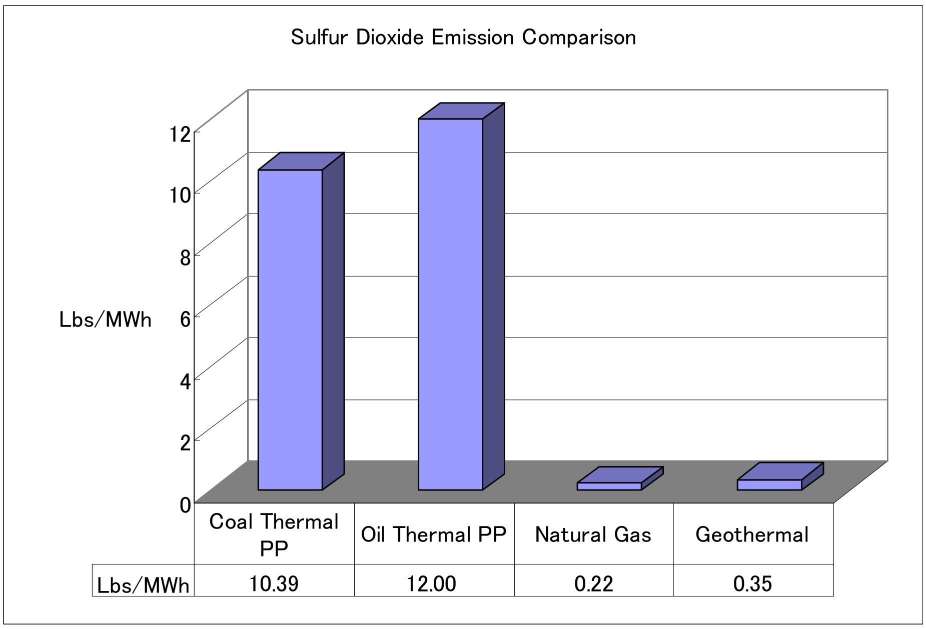
Fig. 8.1-4 Depreciation of Exchange Rate of each Currency during 1995-2004



(Note) Green (orange) color shows the frequency of abnormal heavy rain (abnormal draught) during the period. The larger semicircle radius is, the larger the appearance frequency is.

(Source: Meteorological Agency of Japan: Abnormal Weather Report 2005)

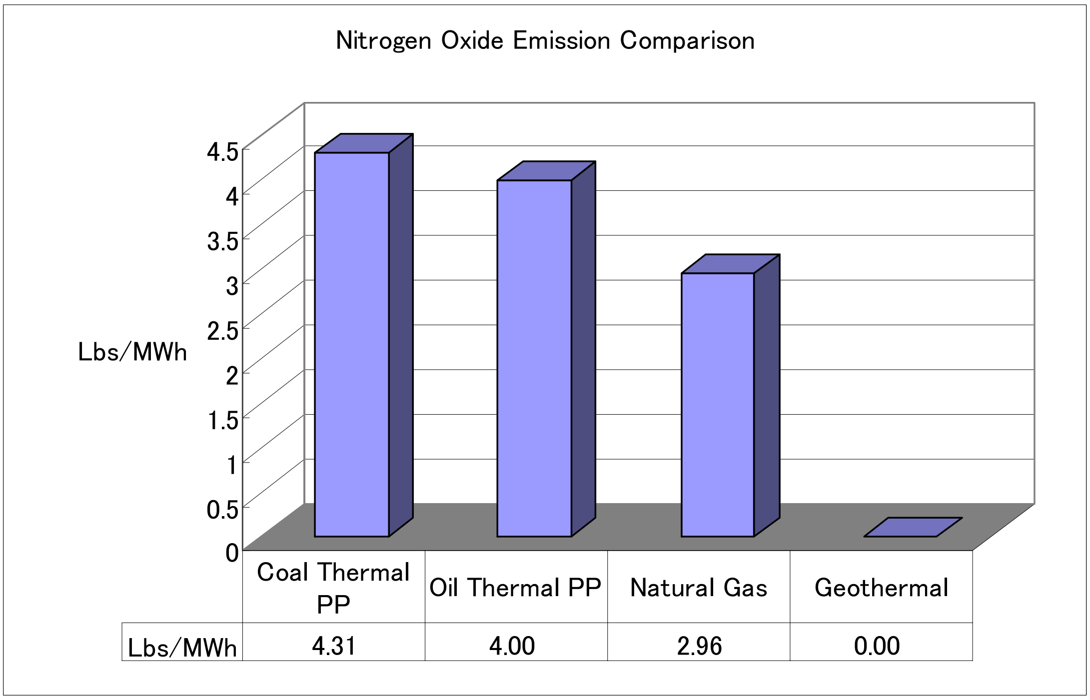
Fig. 8. 1-5 Frequency of abnormal heavy rain and abnormal draught appearance (1998 - 2004)



	Coal Thermal PP	Oil Thermal PP	Natural Gas	Geothermal
Lbs/MWh	10.39	12.00	0.22	0.35

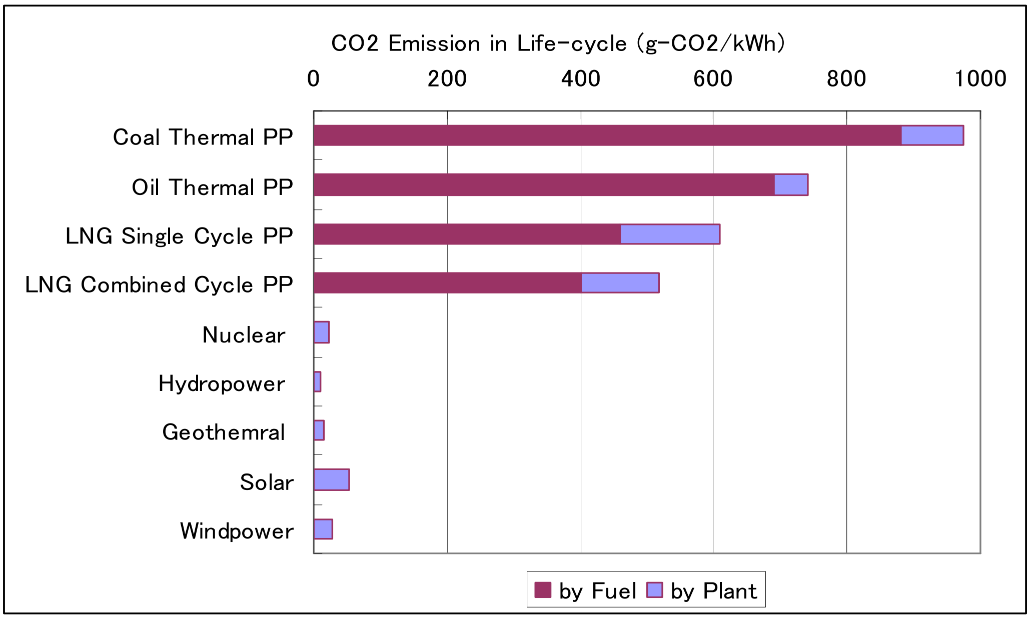
(Source: A Guide to Geothermal Energy and the Environment; Geothermal Energy Association USA, 2005)

Fig. 8.1-6 Sulfur Dioxide Emission Comparison in Electric Power Generation



(Source: A Guide to Geothermal Energy and the Environment; Geothermal Energy Association USA, 2005)

Fig. 8.1-7 Nitrogen Oxide Emission Comparison in Electric Power Generation



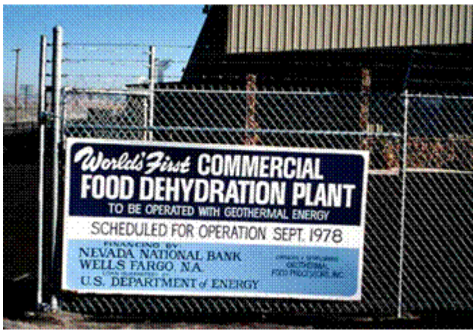
(Source: Central Research Institute of Electric Power Industry, Japan; CRIEPI Review No.45, 2001 Nov.)

Fig. 8.1-8 Carbon Dioxide Emission Comparison in Electric Power Generation

Contribute to Local Community

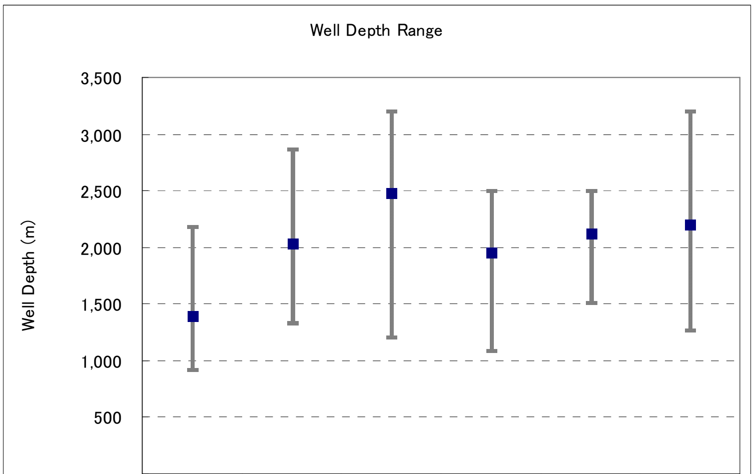
Hot water from geothemal power station can be used for

- Greenhouse,
- Aquaculture,
- Local Industry
- Swimming Pool, Hot springs.



2000 Geothermal Education Office
http://geothermal.marin.org/GEOpresentation/sld088.htm

Fig. 8. 1-9 Geothermal Contribution to Local Host Community



	Field A	Field B	Field C	Field D	Field E	Field F
Average (m)	1,400	2,040	2,480	1,960	2,120	2,210

Fig. 8.2.2-1 Well Depth Distribution of Geothermal Power Plant in Indonesia

Table 8.2.2-1 Well Depth of Geothermal Power Plant

	Average	Minimum	Maximum
Field A	1,400	930	2,190
Field B	2,040	1,330	2,870
Field C	2,480	1,210	3,210
Field D	1,960	1,090	2,500
Field E	2,120	1,510	2,500
Field F	2,210	1,270	3,210

(Source: Processed from Geological Agency Database)

Table 8.2.2-2 Examples of Well Productivity in Indonesia

Geothermal Power Plant		Kamojang		Salak		Wayang Windu	
Output (MW)	(a)	140		377		110	
No. of Units		3		6		1	
No. of Wells		26		58	(*1)	31	(*1)
No. of Production Wells	(b)	26	(*1)	44	(*1)	12	(*1)
No. of Reinjection Wells				14	(*1)	5	(*1)
Output per Well (MW/well)	(a)/(b)	6.7MW (50.6t/h)	(*2)	8.6		9.2	
Steam Water Ratio		Steam Dominated		Steam 30%:Water 70%	(*2)	Steam 70%:Water 30%	(*2)
Remarks & Source		*1 As of 1987 *2 26wells produced 1,315t/h steam. Steam consumption of turbine is 7.6t/h/MW. *3 "6th IGA Annual Meeting & Conference" P. 201 (2003)		*1 Explanation paper of Salak GPP *2 Hearing at site visit (May 2006)		*1 Explanation paper of Wayang Windu GPP *2 Hearing at site visit (Sep. 2006)	

Table 8.2.2-3 Development Cost for 55MW Model Geothermal Plant

Stage	Content	Cost (m$)
1. Surface Survey	Wide-area Surface Survey	2
2. Exploratory	2 Exploratory Wells (success rate 50%) etc.	10
3. Cinfirmation (Development	3 Production Wells (success rate 70%) etc.	10
4. Construction		
4.1 Steam Field	7 Production Wells (success rate 80%), P/L et	42
4.2 Power Plant	Power Plant	65
5. Others		7
Total		136

Table 8.2.2-4 Condition of Cost Analysis

Field Condition	Production Well Drilling Cost (m$/well)	3
	Steam Productivity (MW/well)	8
Plant Condition	Plant Life (Years)	30
	Plant Factor (%)	85
	Axially rate (%)	6
Financing Condition	Interest rate (%)	8.5
	Repayment (Years)	12
	Grace Period (Year)	3
Business Condition	Depreciation Method	Straight line
	Depreciation Period - Wells	7
	- Machinery	15
	Tax rate (%)	34

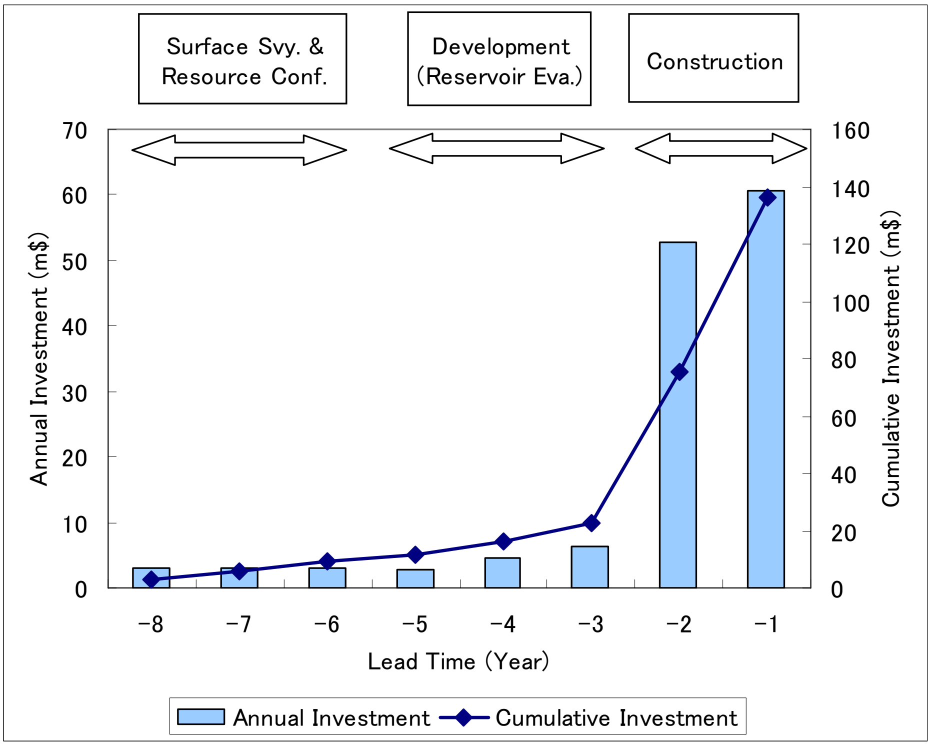


Fig. 8.2.2-2 Lead Time for Developing 55MW Model Geothermal Plant

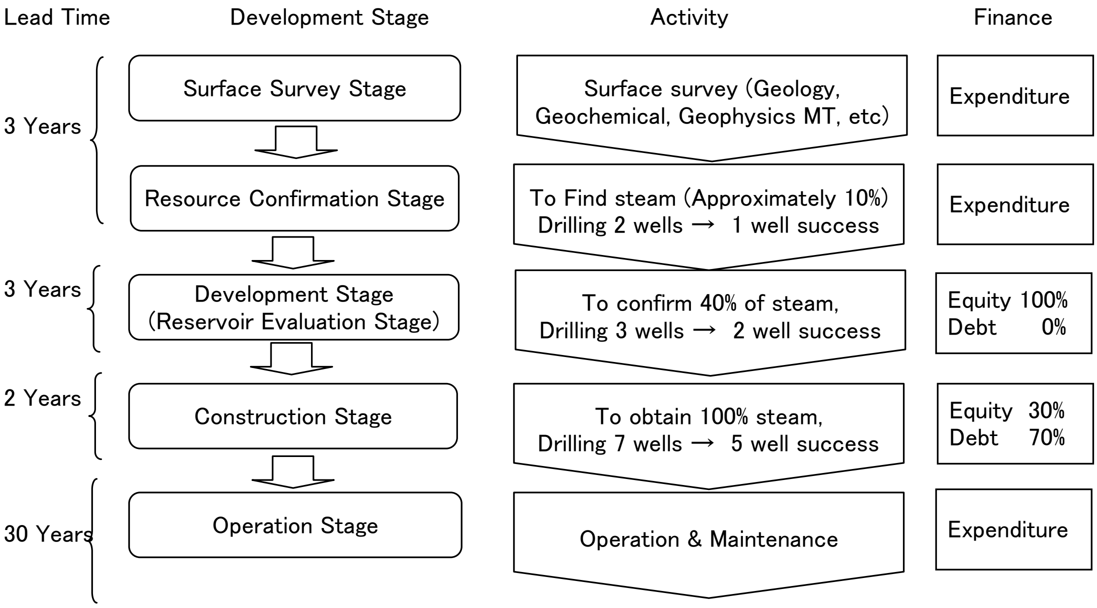


Fig. 8.2.2-3 Development Process of 55MW Model Geothermal Plant

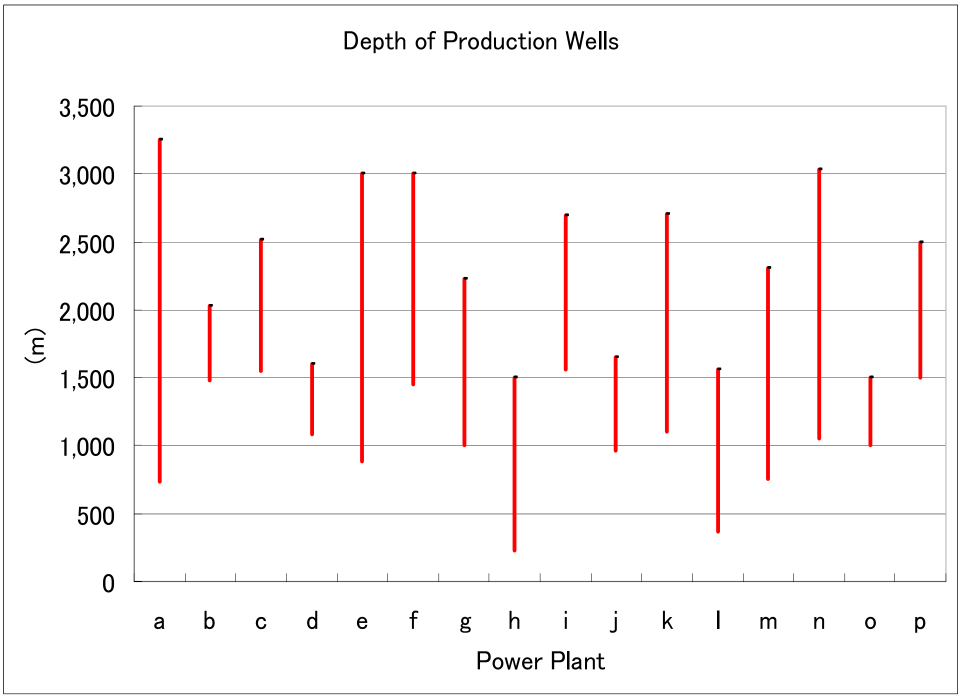


Fig. 8.2.3-1 Depth of Production Wells at Geothermal Power Plants in Japan

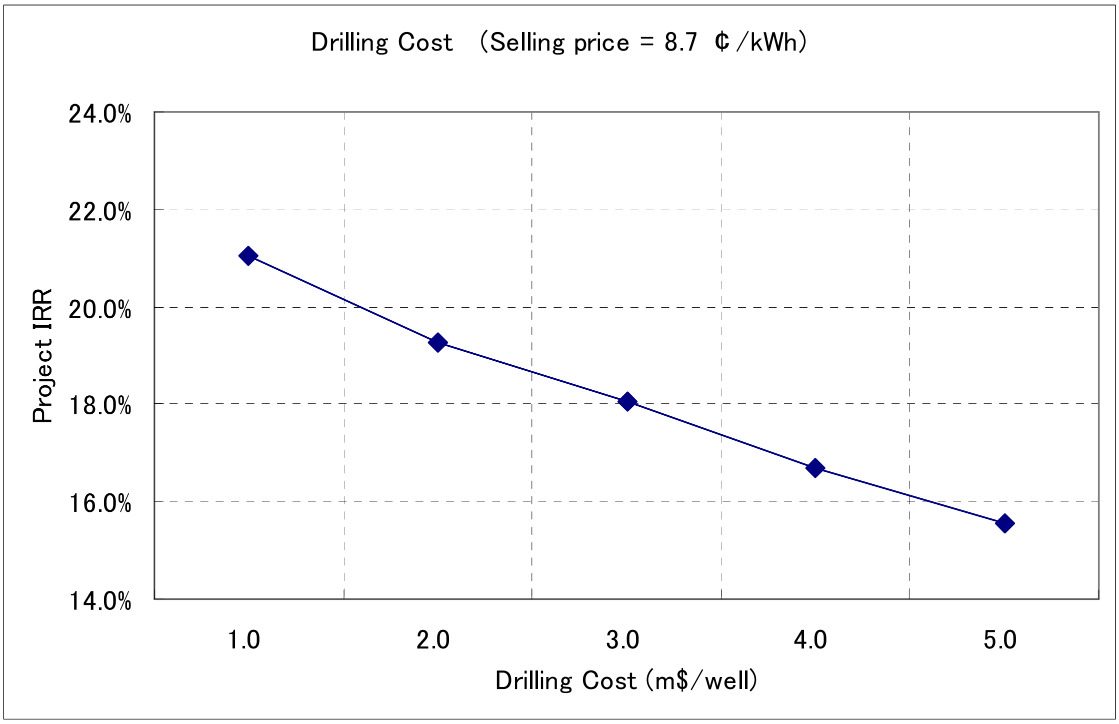


Fig. 8.2.3-2 Effect of Drilling Cost on Project IRR

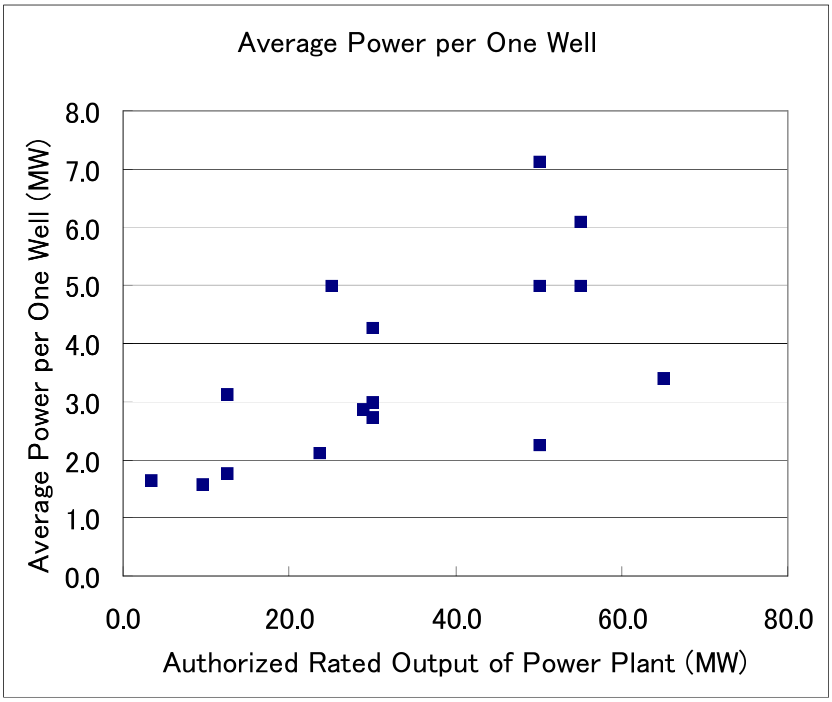


Fig. 8.2.3-3 Average Power Output of Wells at Geothermal Power Plants in Japan

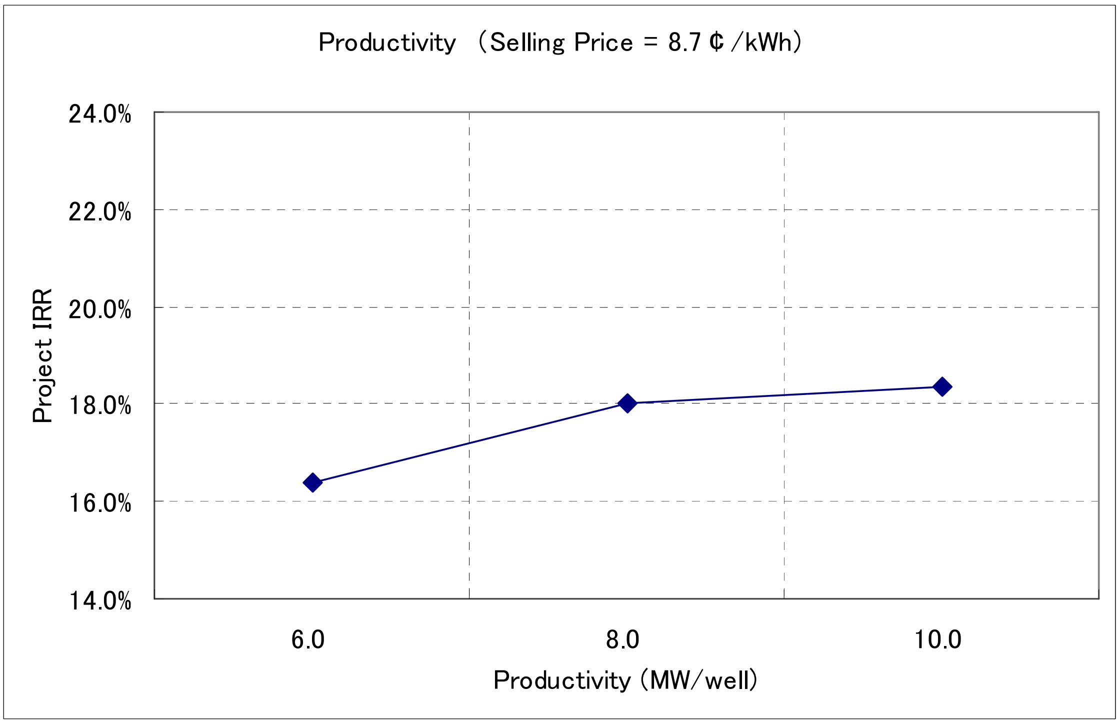


Fig. 8.2.3-4 Effect of Productivity of Wells on Project IRR

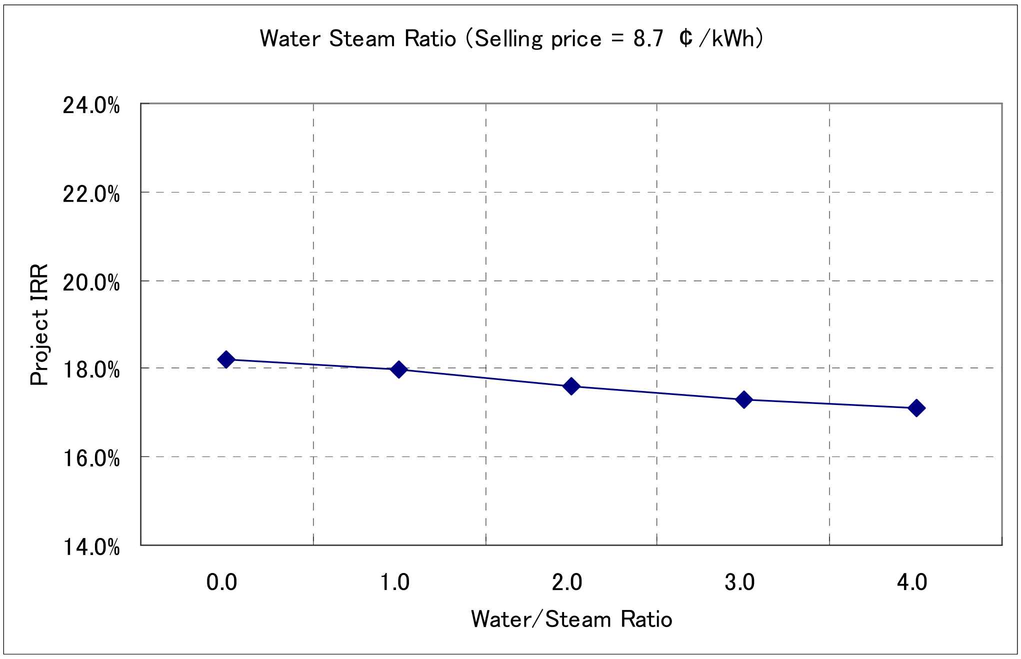


Fig. 8.2.3-5 Effect of Water Steam Ratio on Project IRR

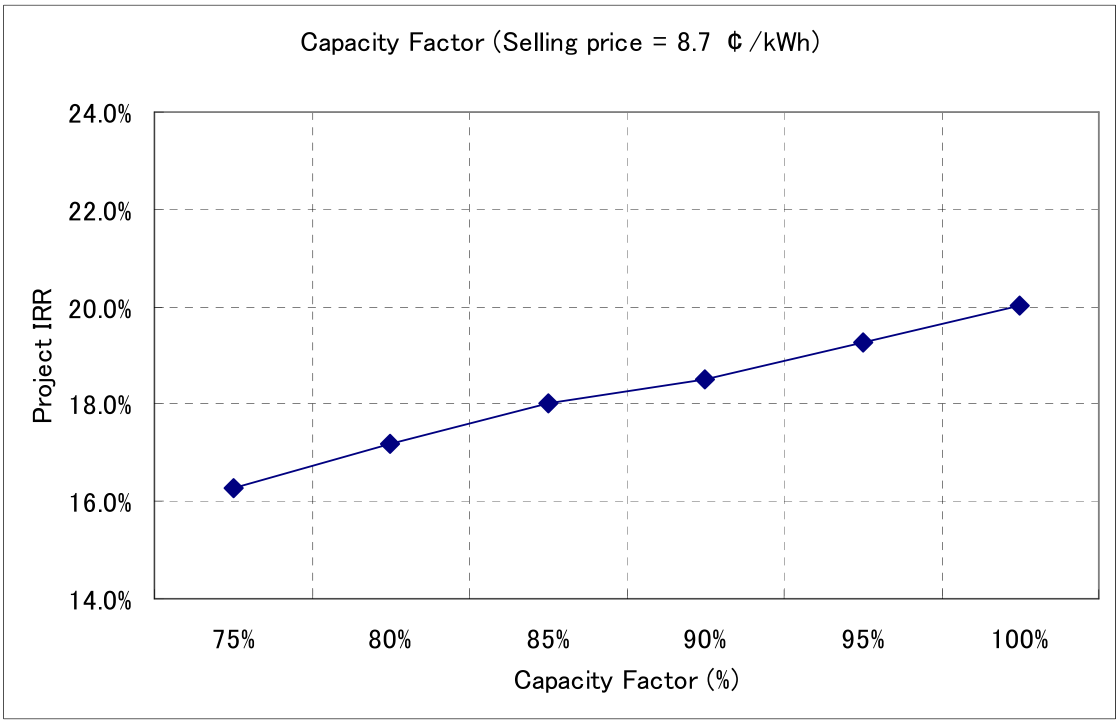


Fig. 8.2.3-6 Effect of Capacity Factor on Project IRR

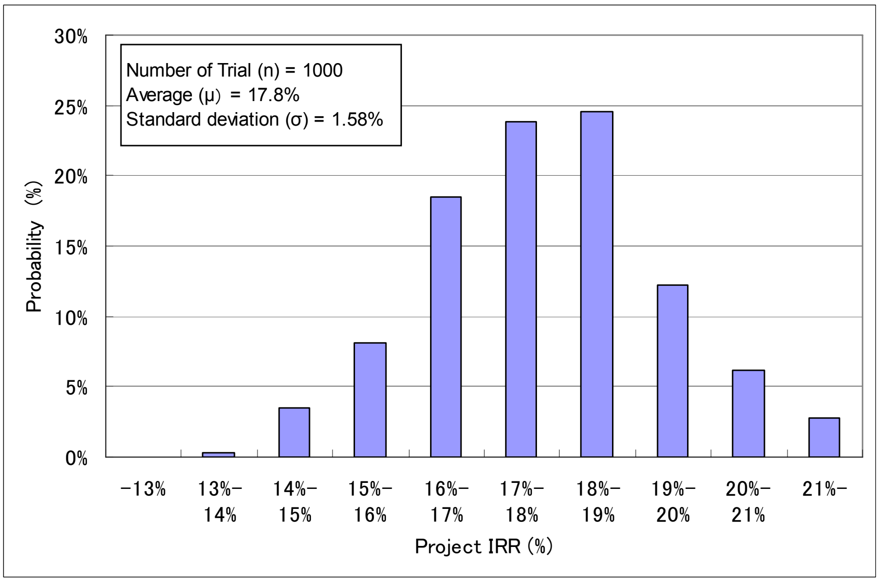


Fig. 8.2.3-7 IRR Distribution of Model Project (Selling price = 8.7 ¢ /kWh)

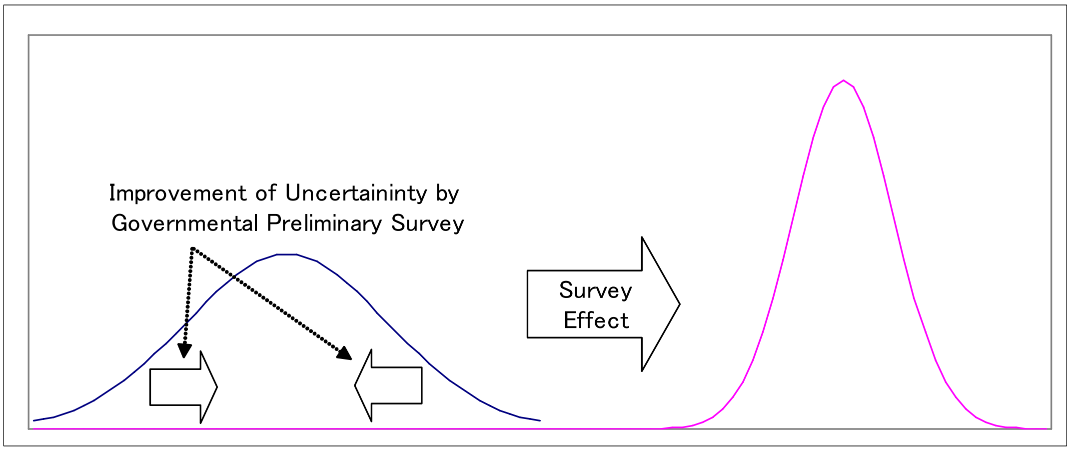


Fig. 8.2.3-8 Risk Mitigation by Improvement of Accuracy (Governmental Preliminary Survey)

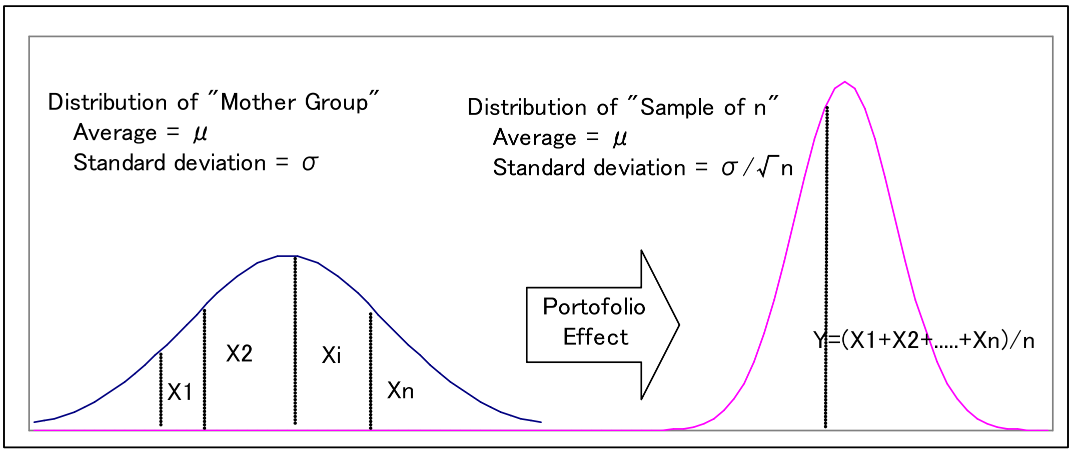


Fig. 8.2.3-9 Risk Mitigation by Portfolio Effect (Multi-fields Development Effect)

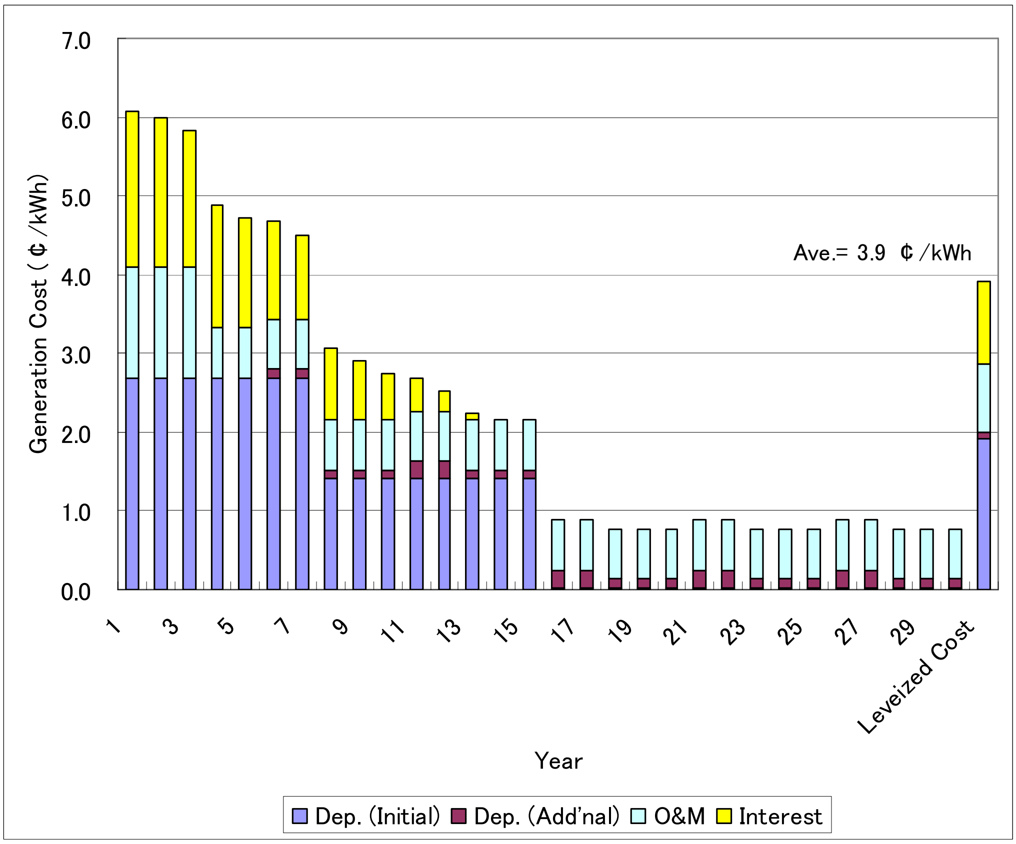


Fig. 8.2.4-1 Generation Cost of Geothermal Power Plant

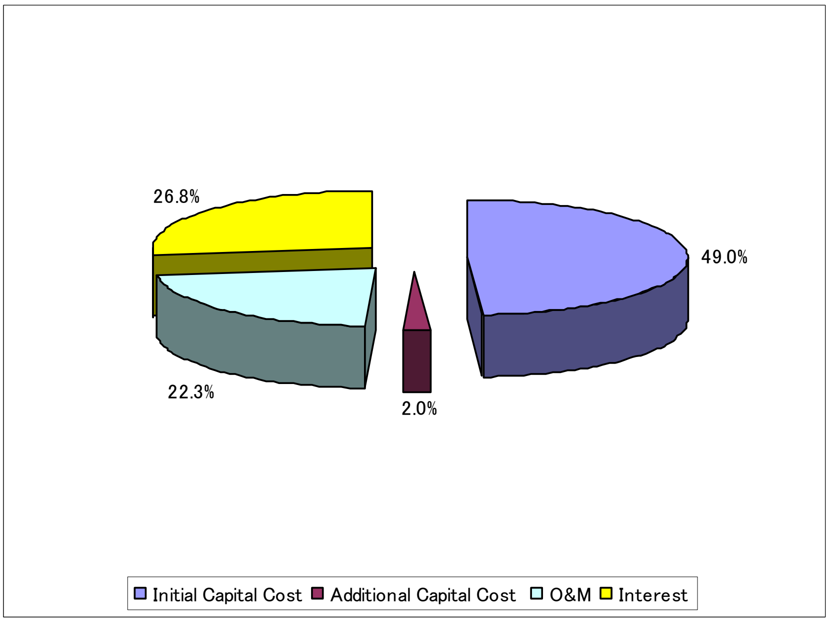


Fig. 8.2.4-2 Cost Structure of Geothermal Power Plant

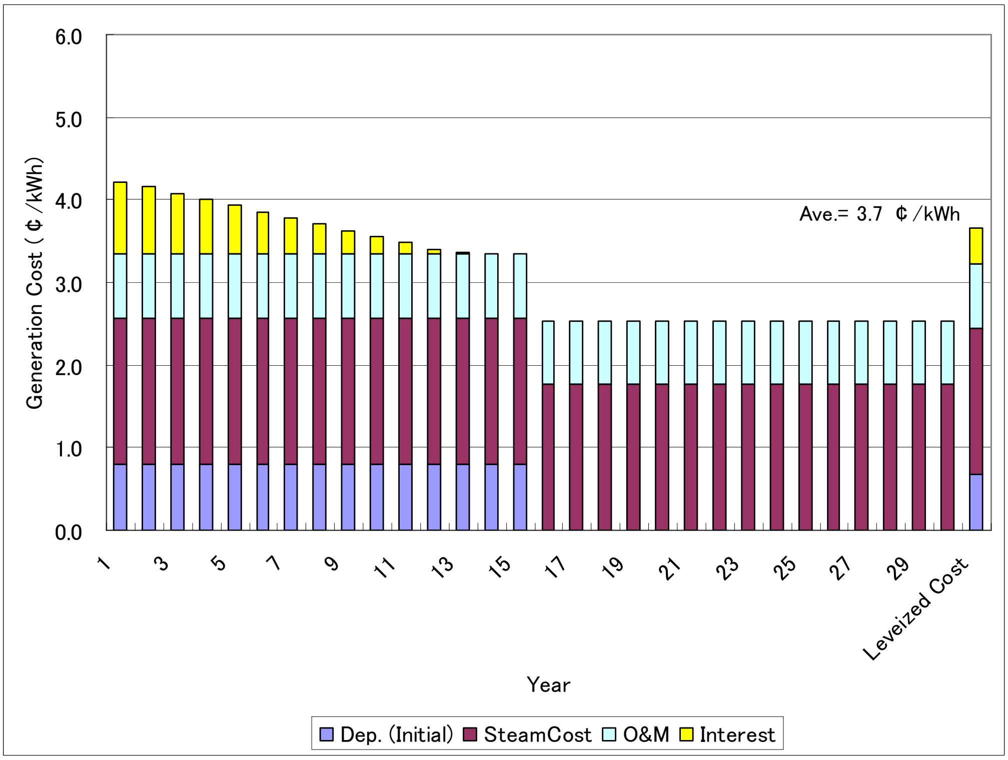


Fig. 8.2.4-3 Generation Cost of Coal Power Plant

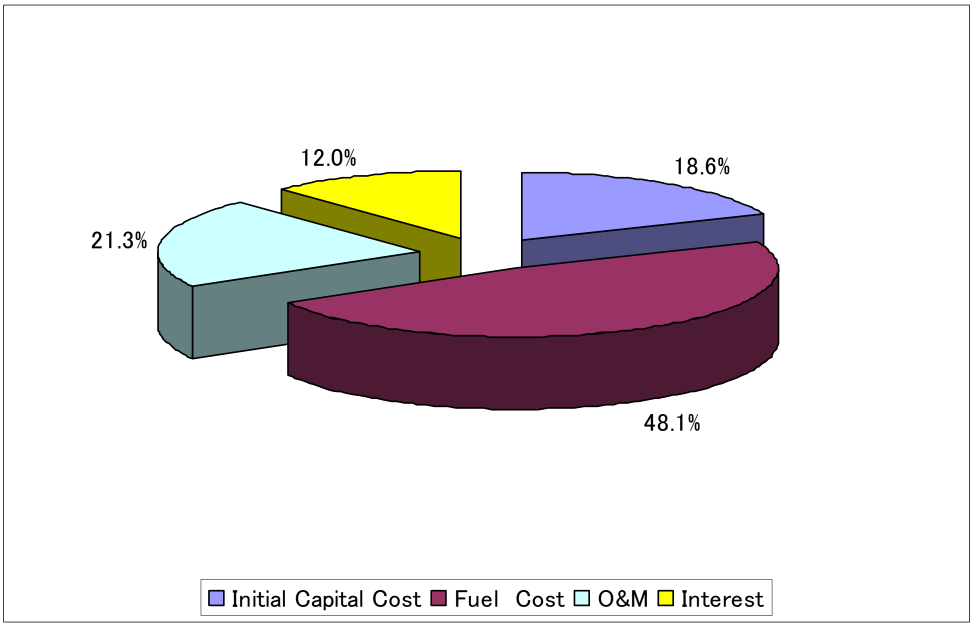


Fig. 8.2.4-4 Cost Structure of Coal Power Plant

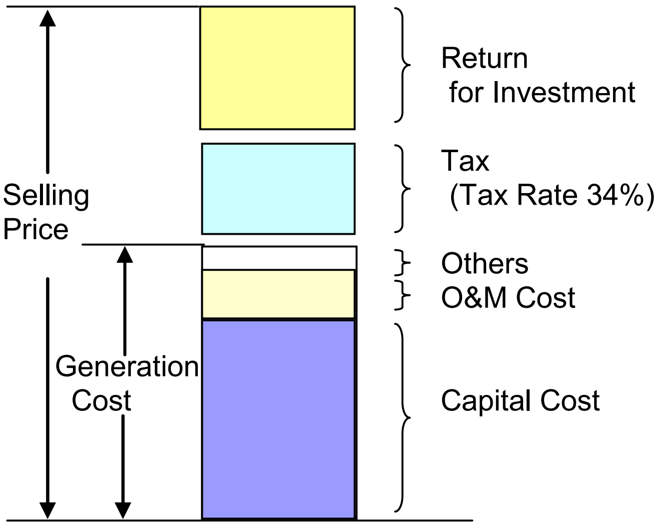


Fig. 8.2.4-5 Structure of Generation Cost and Selling Price

Table 8.2.4-1 Specification of each Energy Source

Power Source	Plant Capacity (MW)	Initial Investment (m$)	Unit Cost ($/kW)	Construction Years (Yrs.)	Plant Factor (%)	Fuel Price ($/MMBTU)	Heat rate (%)	Remarks
Geothermal	55	136	2,500	5	85	–	–	
Coal	600	500	850	3	85	1.8 (35$/t)	38	include port, coal yard, ash disposal pond etc.
Coal	100	160	1,600	3	85	1.8 (35$/t)	38	– dtto –
Natural Gas CC	600	300	500	3	85	8.6 (50$/B)	50	not include gas pipeline
Diesel	10	16	1,550	2	85	12.9 (50$/B)	38	
Hydropower	20	44	2,200	4	60	–	–	

(Note) Initial investment does not include Interest during Construction (IDC).

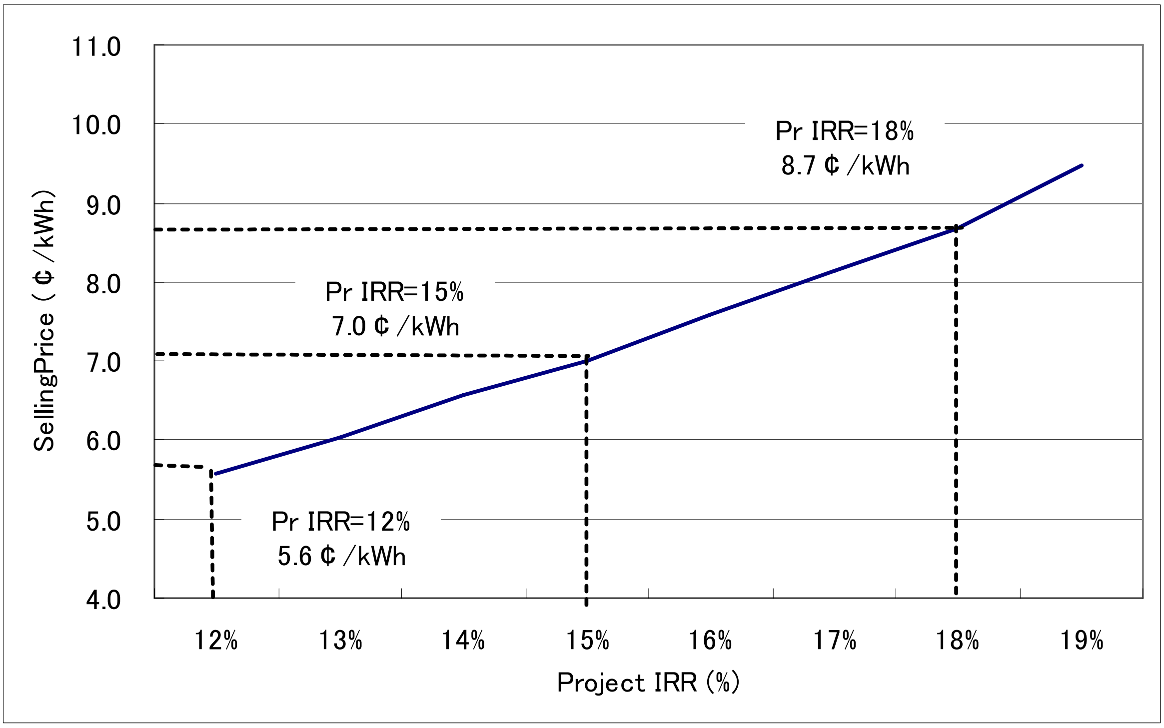


Fig. 8.2.4-6 Selling Price and Project IRR in Geothermal Power Plant

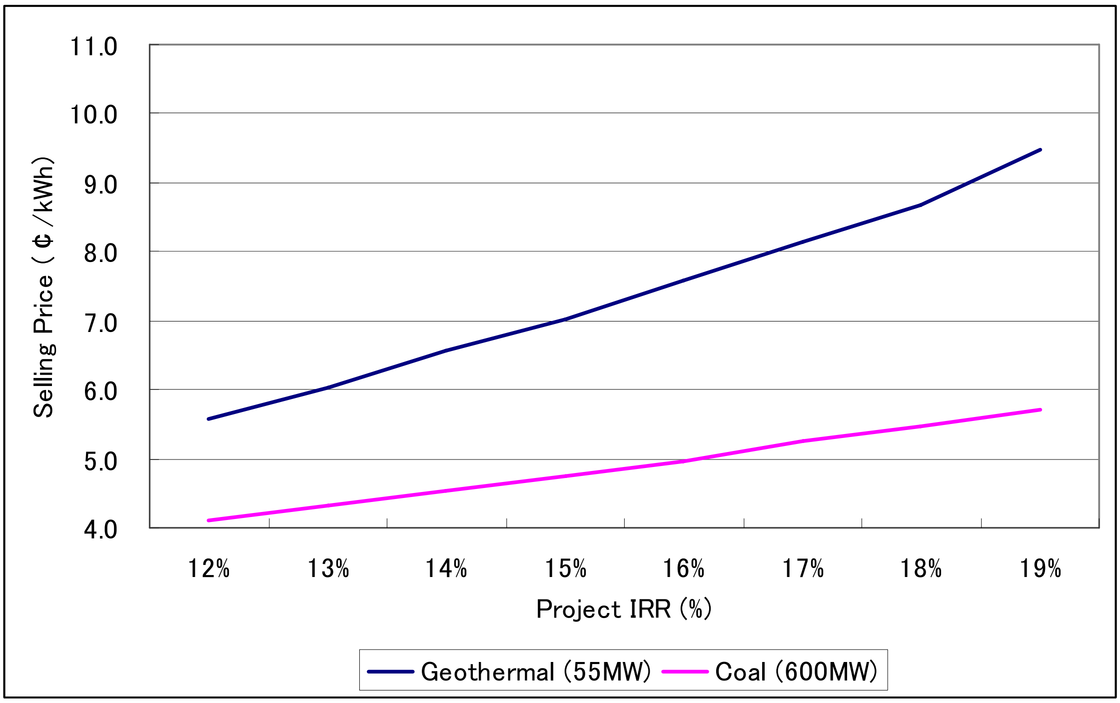
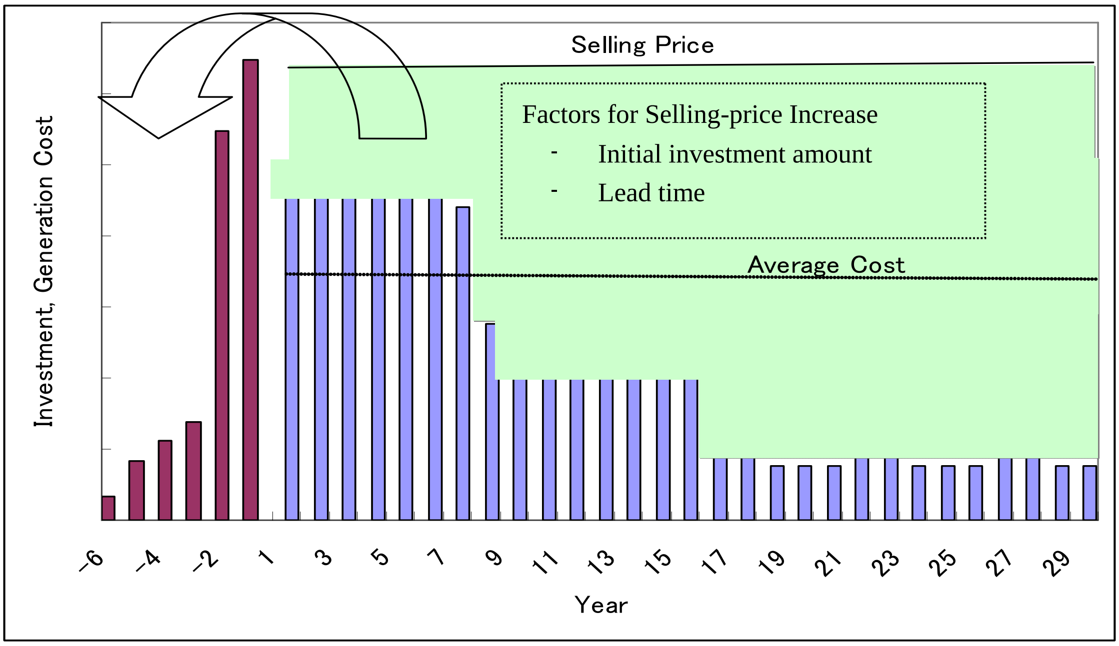


Fig. 8.2.4-7 Selling Price and Project IRR in Geothermal and Coal Power Plant



(cf. Coal Power Plant)

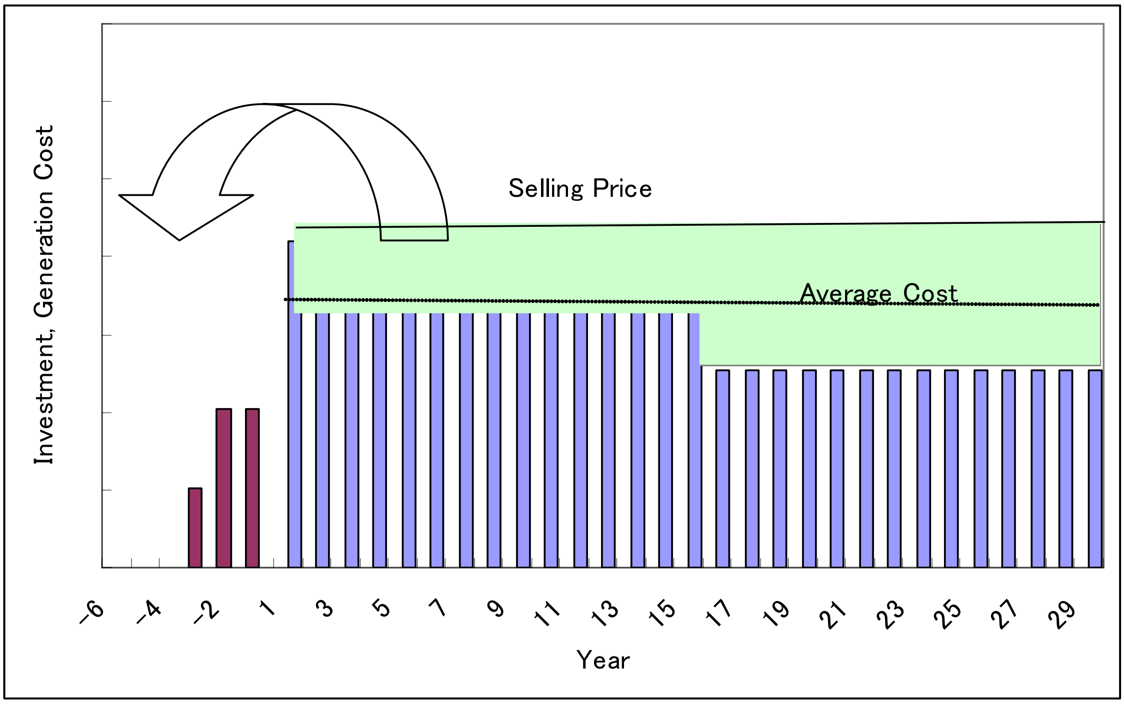


Fig. 8.2.4-8 Factors for Selling Price Increase in Geothermal Power Plant Case

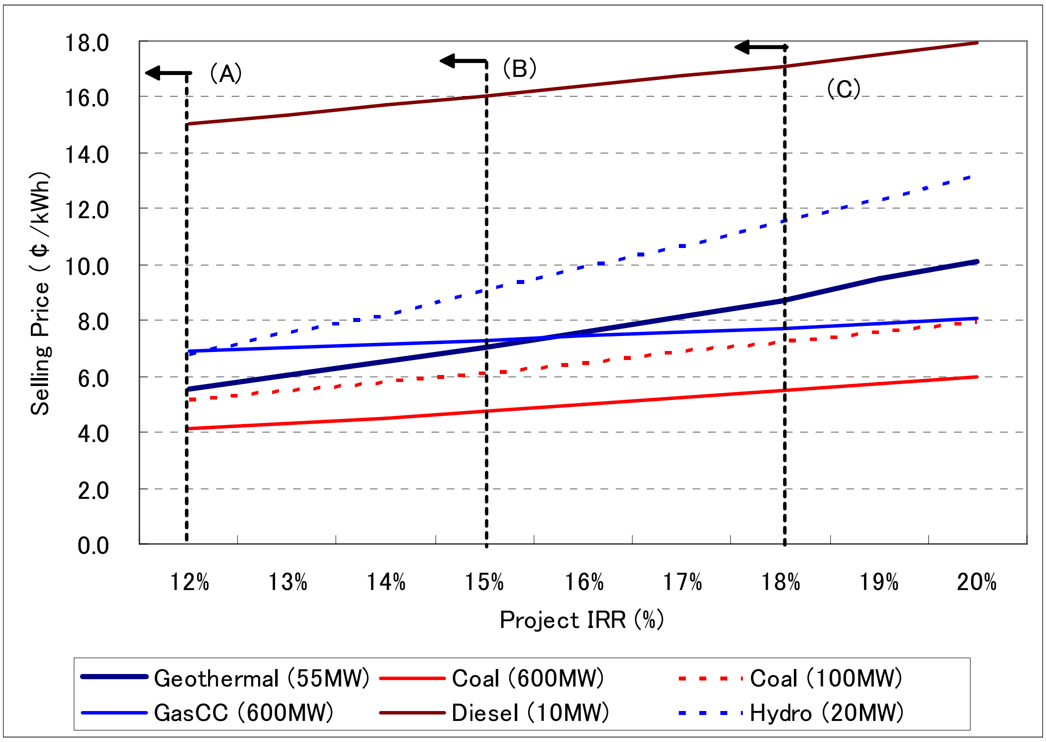


Fig. 8.2.4-9 Selling Price and Project IRR of each Energy Source

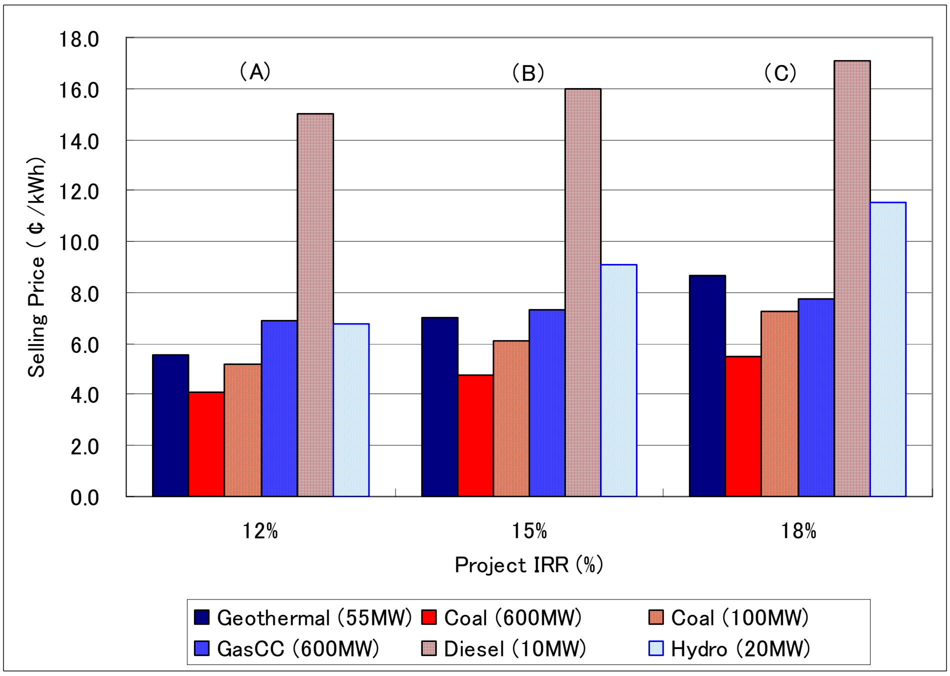


Fig. 8.2.4-10 Selling Price of Energy in Different Project IRR

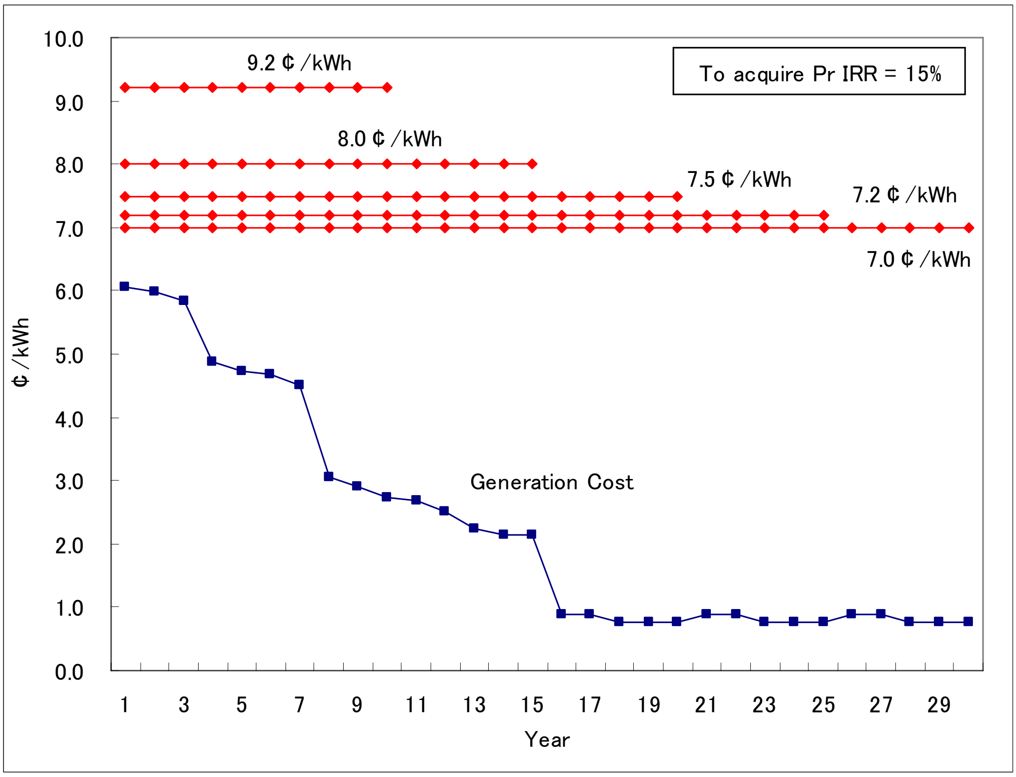


Fig. 8.2.4-11 Selling Price to Recover Investment in Short Period (Geothermal Plant)

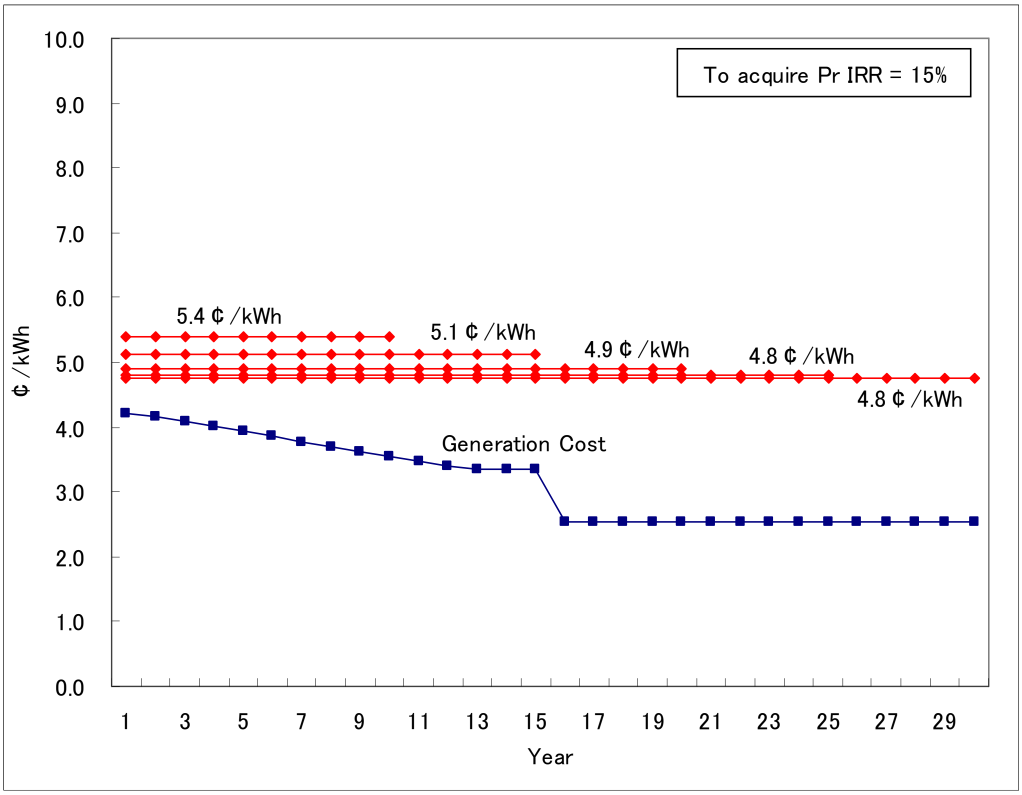


Fig. 8.2.4-12 Selling Price to Recover Investment in Short Period (Coal Plant)

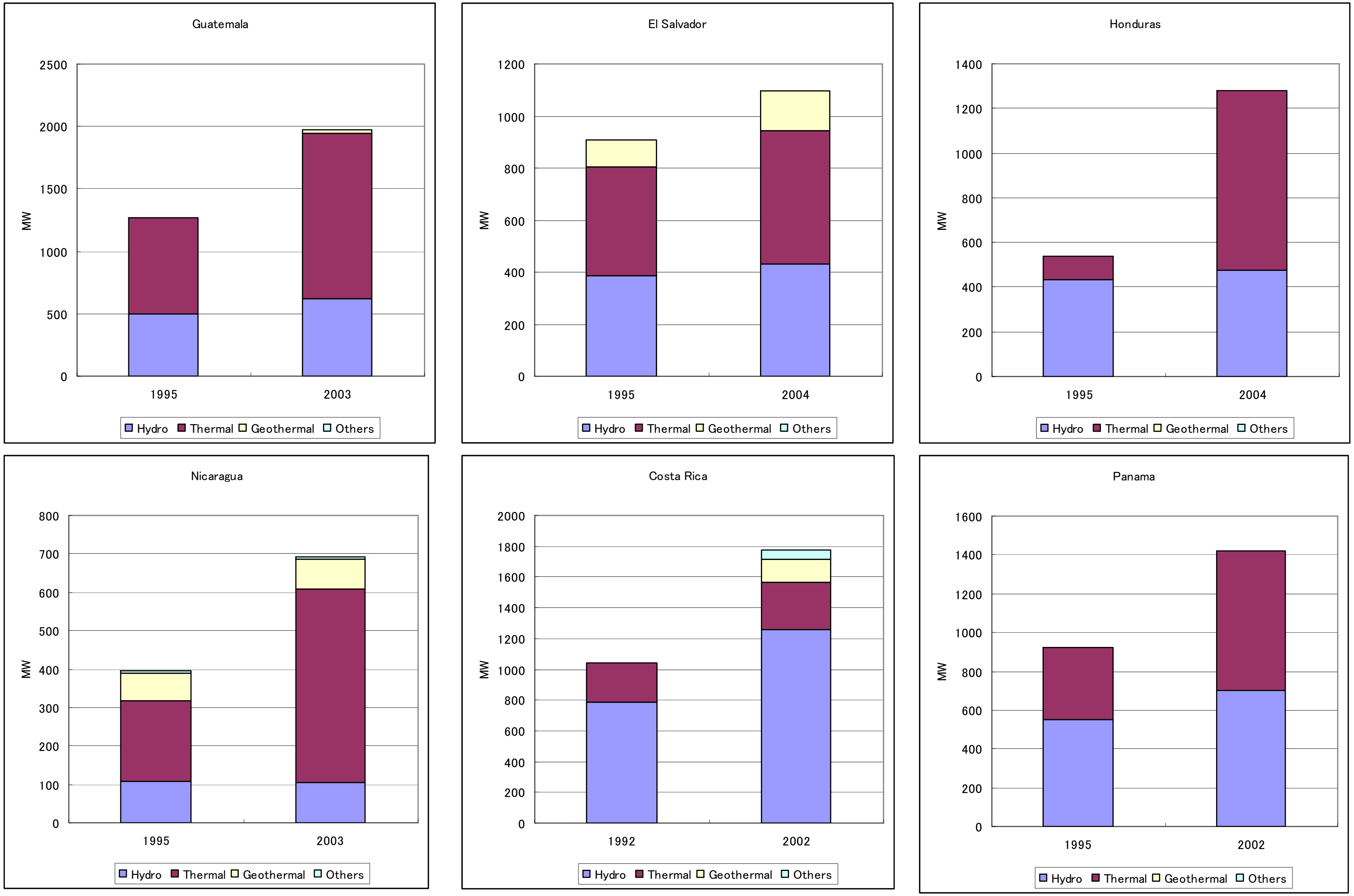


Fig. 8.2.4-13 Electric Power Sector Reform and its Impact on Energy Mixture in Central American Countries

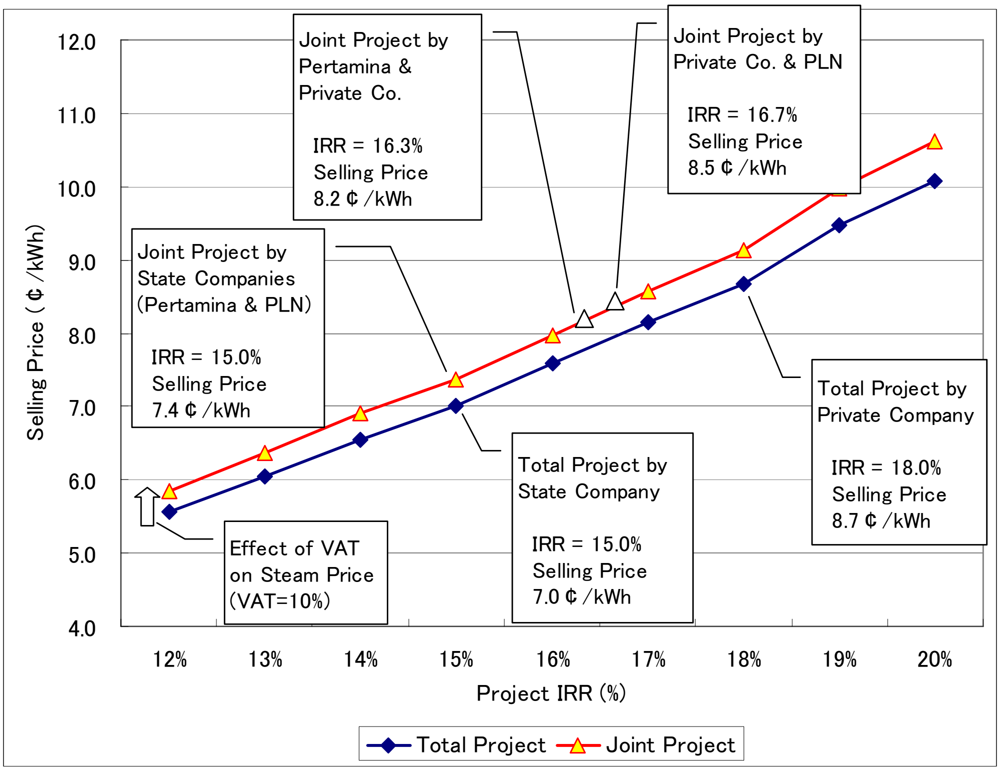


Fig. 8.2.4-14 Selling Price in Different Development Style

Table 8.3.1-1 Price Change before and after Economic Crisis

Power Plant	Selling Price (¢/kWh) Original (*1)	After Renegotiation
Bedugul, Bali	7.15	
Chibuni, west Java	6.90	
Darajat, West Java	6.95	4.20 (*2)
Dien, West Java	9.81	
Kamojang, West Java	7.03	
Patuha, West Java	8.46	
Karaha Bodas, Java	7.25	
Salak (unit 4-6), West Java	8.46	
Sibayak, North Sumatra	7.10	
Wayang Windu, West Java	8.39	4.90 (*3)
Wayang Windu (unit2)	-	4.94 (*4)
Sarulla	-	4.64 (*5)

(Source)

*1, *2: Indonesia's geothermal development (Embasy of USA in Indonesia)

*3: Energy Highlight Oct.2005 Embassy of USA in Indonesia

*4: Tempo Interaktif 15 Aug. 2006

*5: Antara NEWS, 19 June 2006

Table 8.3.2-2 Selling Price of Coal Power Plant (Example)

Comp	Price (c$/kWh)	Abb.	Appendix G
A	3.00	CCR	2,496,600 Rp/kw year
B	0.30	$FOMR_l$ $FOMR_f$	142,500 Rp/kw year 142.500,- Rp/kw year
C	1.61		152.95 Rp/kwh 2300 kcal/kWh Fuel Price 35 US$/ton HHV 5000 kcal/kg
D	0.10	$VOMR_l$ $VOMR_f$	7,13 Rp/kwh 2,37 Rp/kwh
Total	5.01	$VOMR_l$ $VOMR_f$	475.95 Rp/kWh
B and D escalated according to CPI Coal price is passthrough to PLN			Base Exchange Rate 9500 Rp/USD

(Source: CDM Seminar by World Bank, Jakarta (Sep.2006))

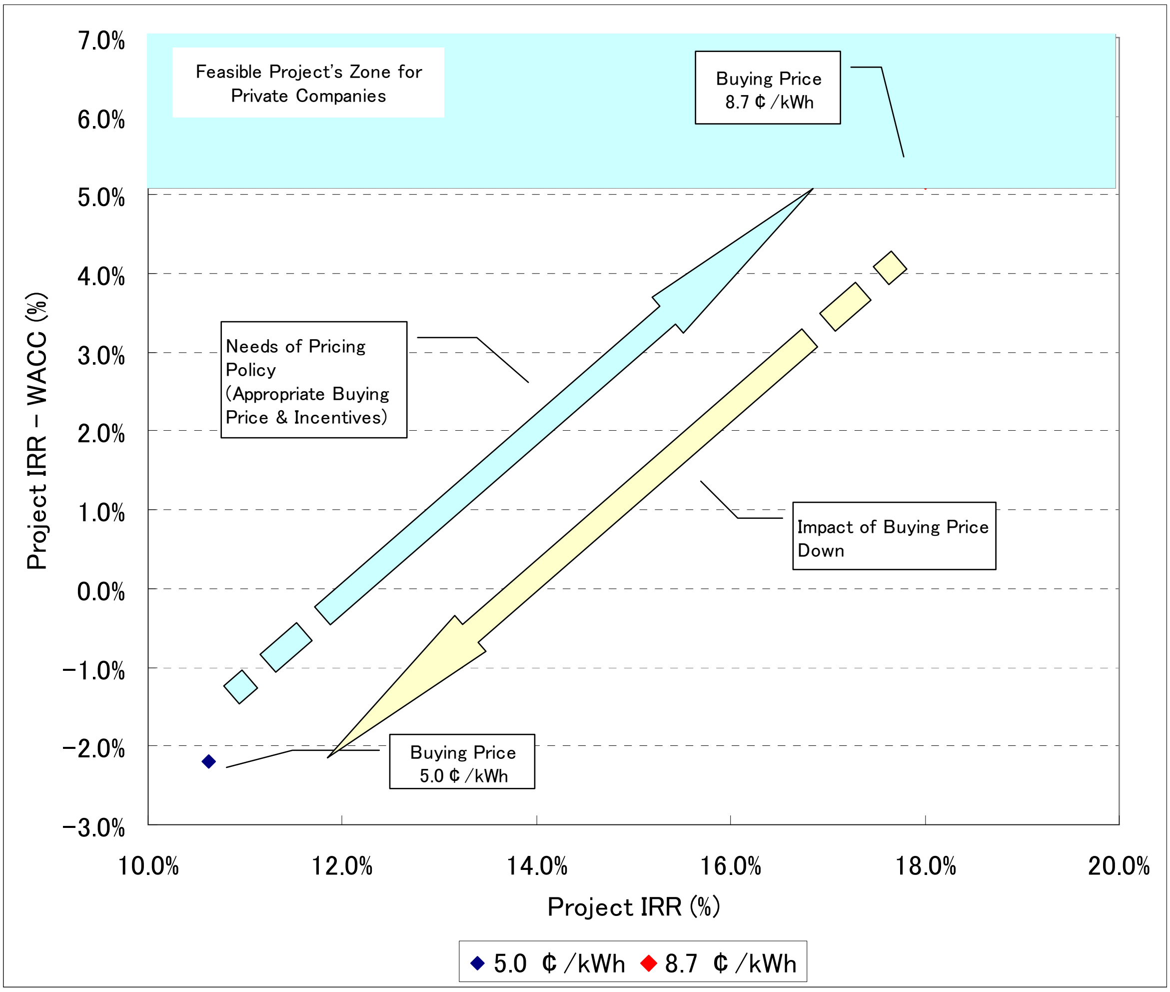
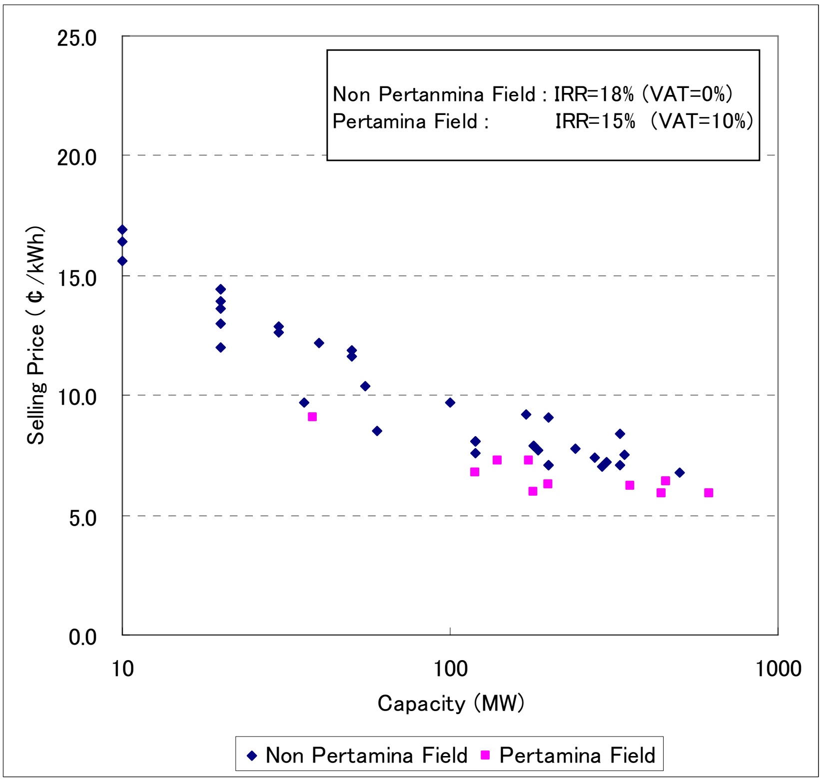
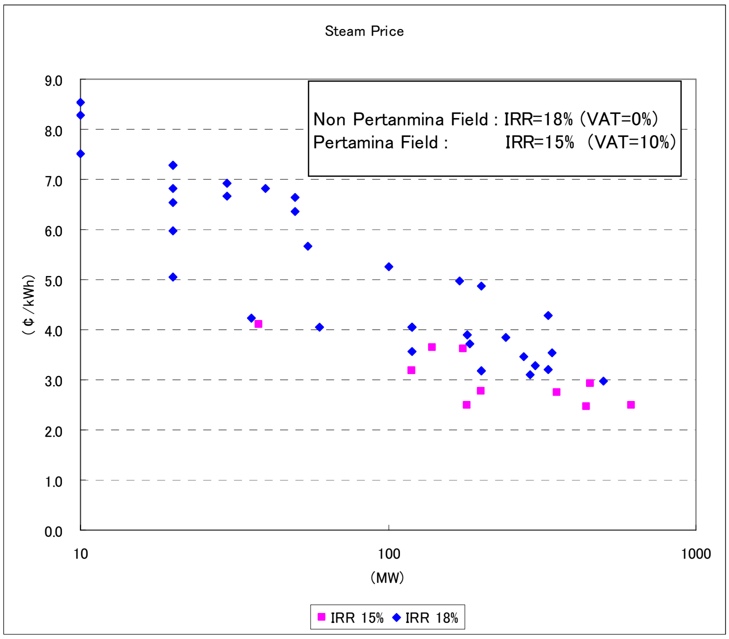


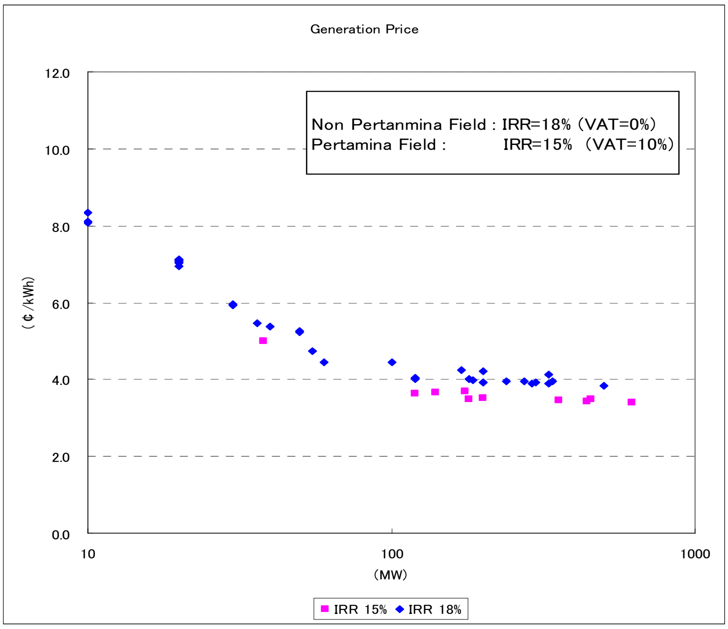
Fig. 8.3.1-1 Profitability Deterioration by Price Change



(Total Price)



(Steam Price)



(Generation Price)

Fig. 8.3.1-2 General Economic Estimates of Geothermal Fields

Table 8.3.1-3 Possible Development Capacity by Buying Price

Selling Price ¢/kWh	No Incentives <IRR15%> MW	No Incentives <IRR18%> MW	Total MW	Total (%)
5	0	0	0	0.0%
6	1,240	0	1,240	15.1%
7	2,370	790	3,160	38.5%
8	3,140	3,340	6,480	79.0%
9	3,140	4,090	7,230	88.2%
10	3,178	4,596	7,774	94.8%
11	3,178	4,651	7,829	95.5%
12	3,178	4,771	7,949	97.0%
15	3,178	4,991	8,169	99.6%
20	3,178	5,021	8,199	100.0%

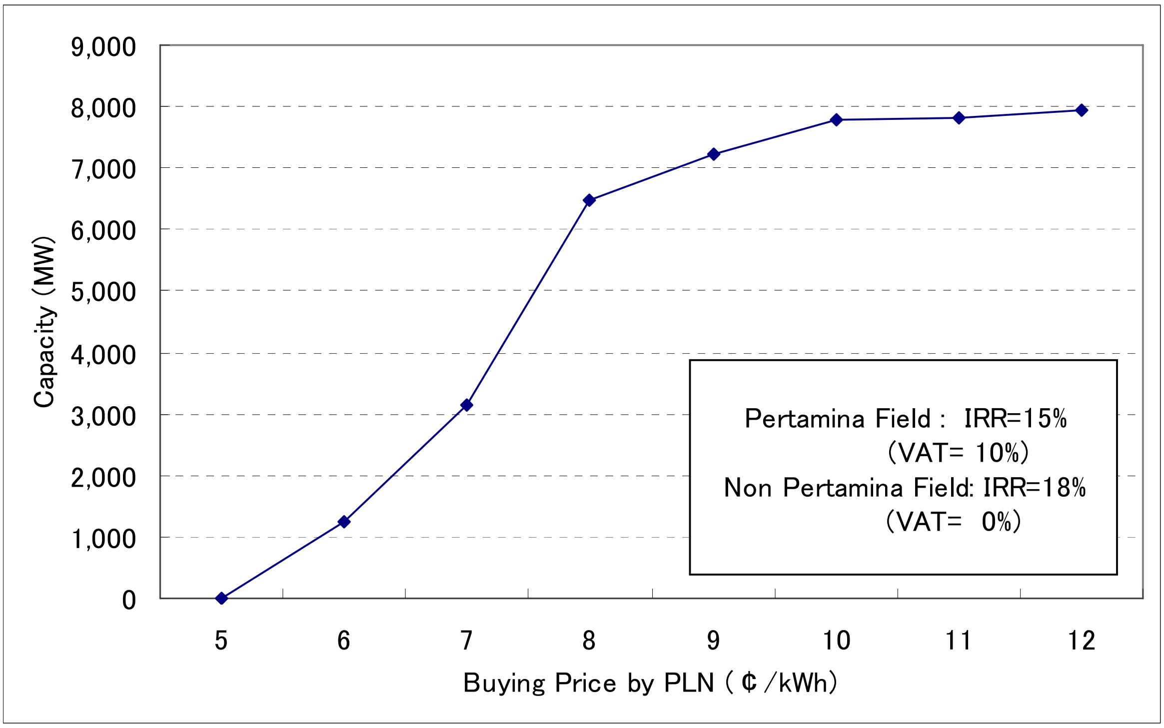


Fig. 8.3.1-3 Possible Development Capacity by Buying Price

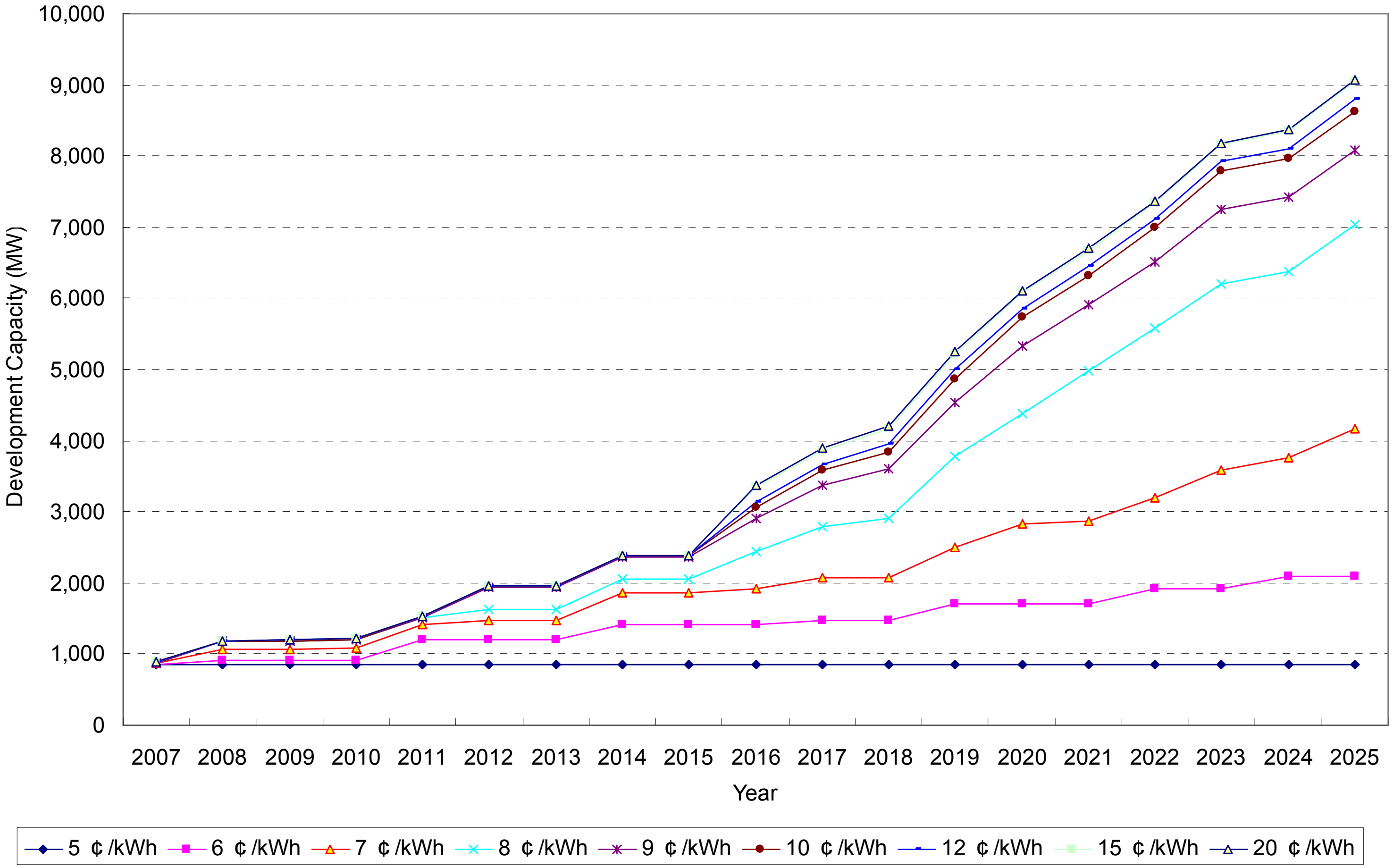


Fig. 8.3.1-4 Different Development Scenario by Buying Price

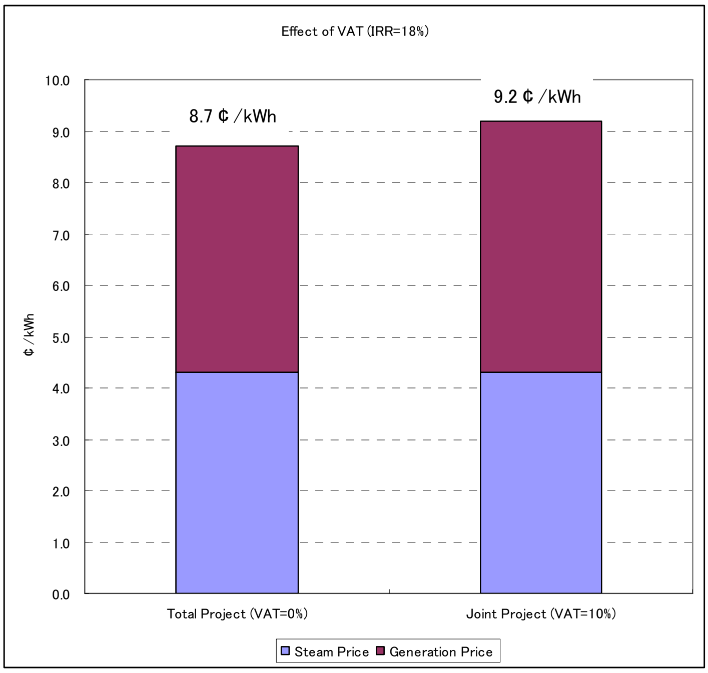


Fig. 8.4.3-1 Effect of VAT on Steam Sales (Selling Price Increase Effect in 55MW Model Plant when VAT is applied in Private Company's Case)

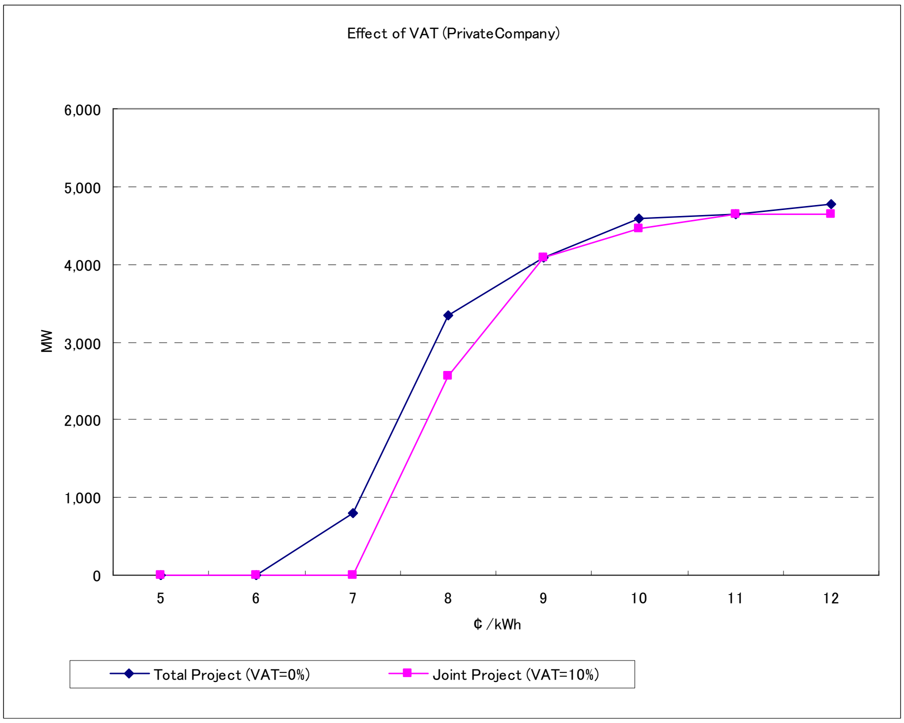


Fig. 8.4.3-2 Effect of VAT on Steam Sales (Development Amount in 38 Field Estimation) (Private Company's Case)

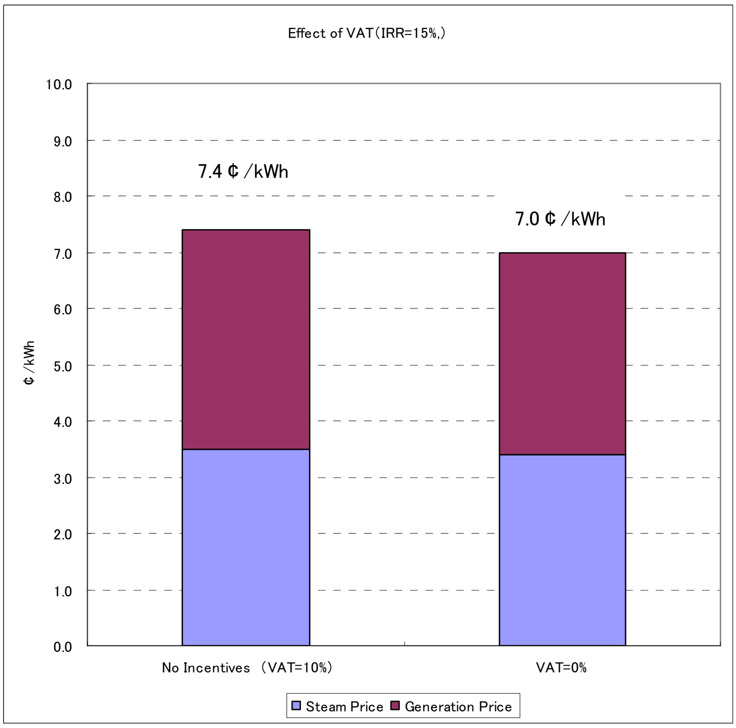


Fig. 8.4.3-3 Effect of VAT on Steam Sales (Selling Price Decrease Effect in 55 MW Model Plant when VAT is applied in State Company's Case)

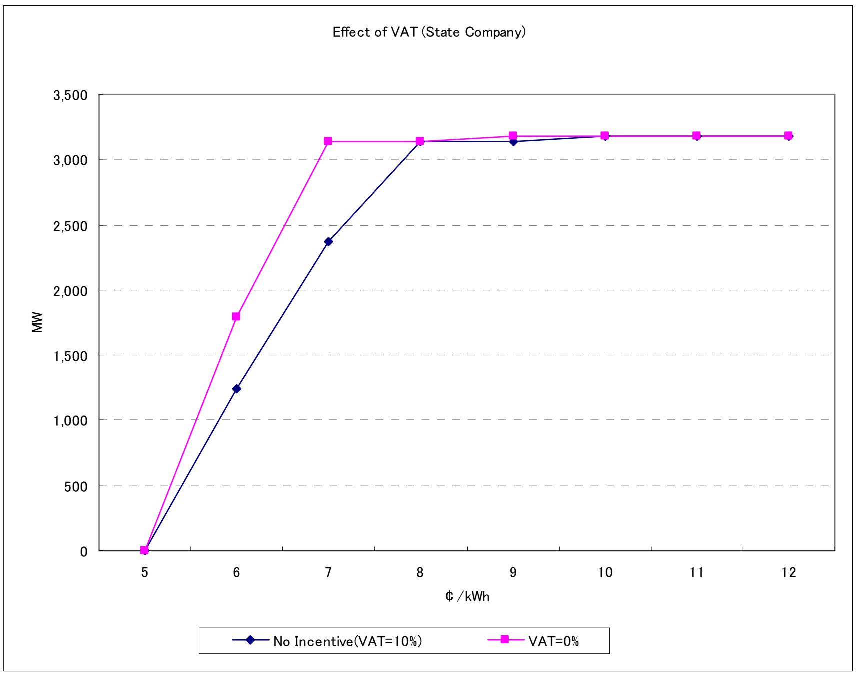


Fig. 8.4.3-4 Effect of VAT on Steam Sales (Development Amount in 11 Field Estimation) (State Company's Case)

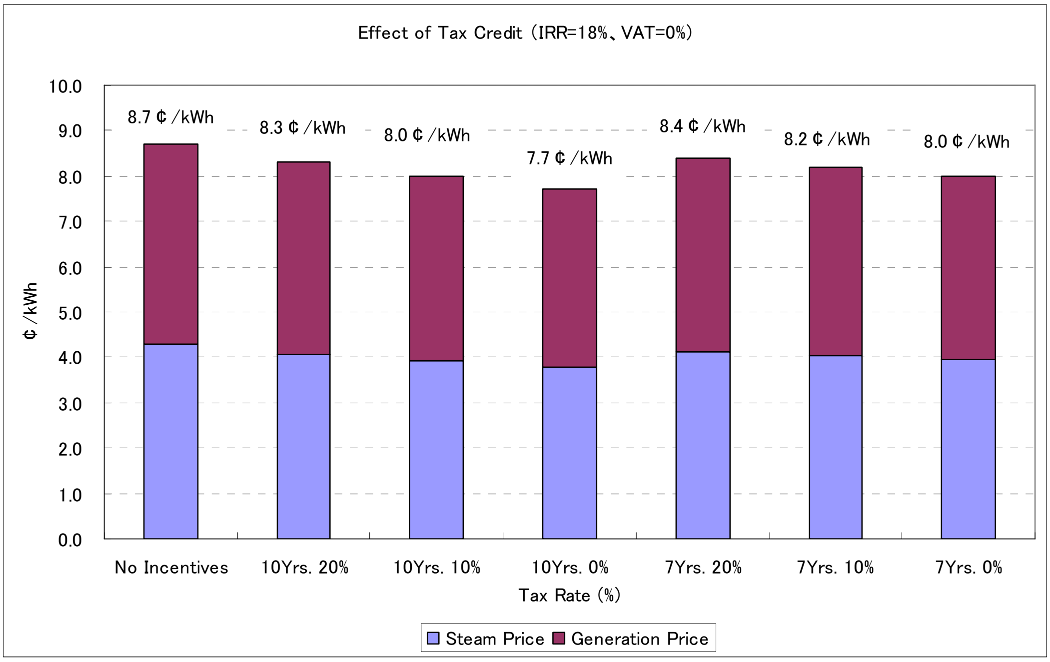


Fig. 8.4.4-1 Effect of Tax Credit (Selling Price Reduction Effect in 55 MW Model Plant)（Private Company's Case）

Fig. 8.4.4-2 Effect of Tax Credit (Development Promotion Effect in 38 Fields)（Private Company's Case）

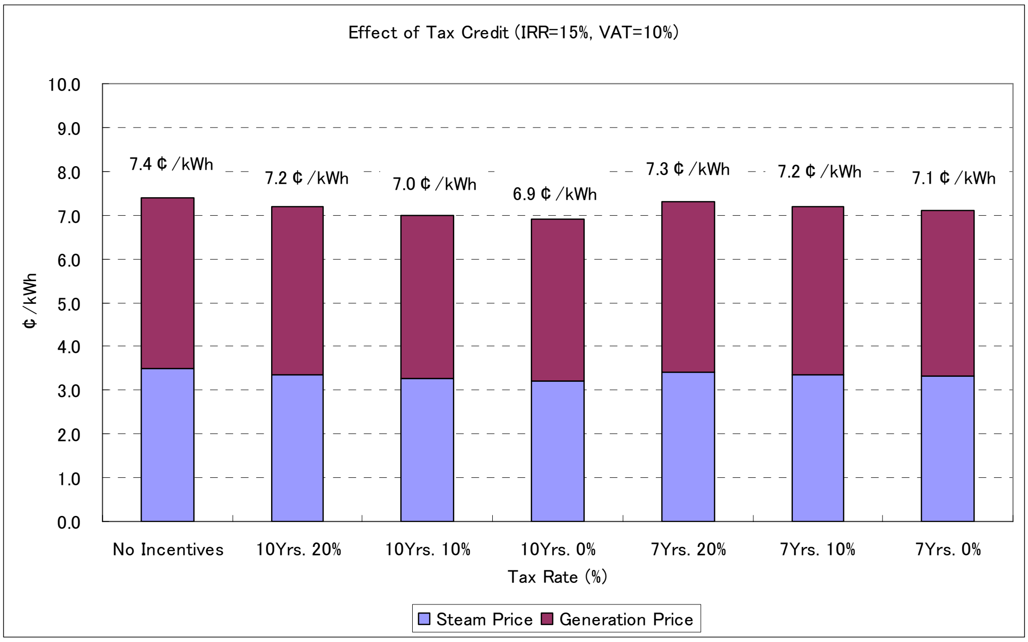


Fig. 8.4.4-3 Effect of Tax Credit (Selling Price Reduction Effect in 55 MW Model Plant) (State Company's Case)

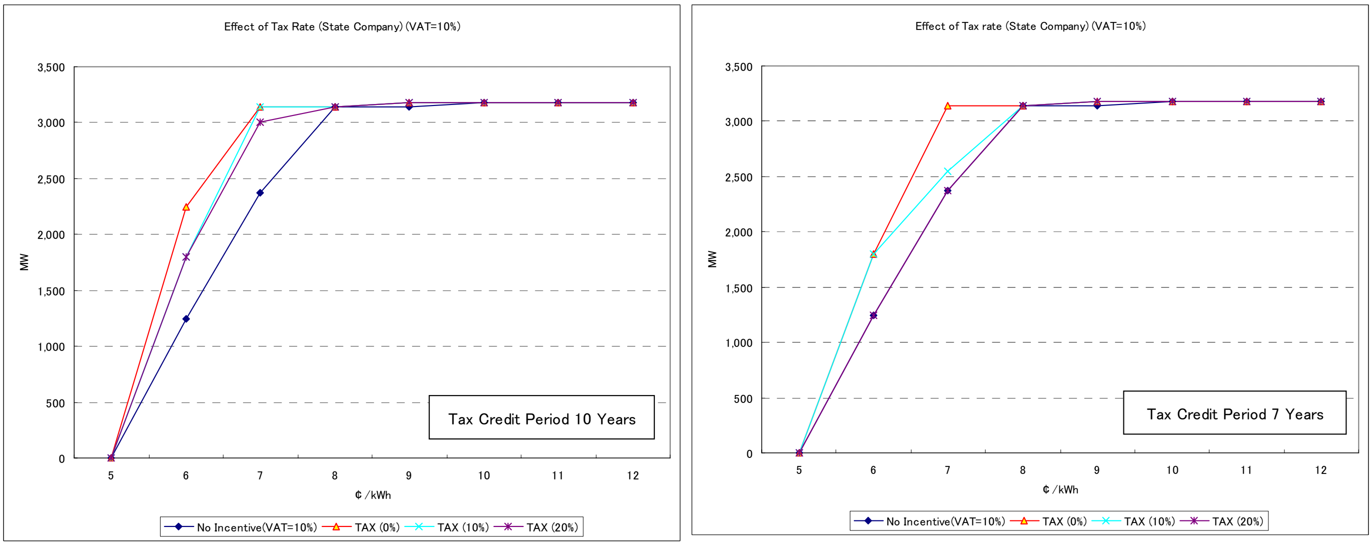


Fig. 8.4.4-4 Effect of Tax Credit (Development Promotion Effect in 11 Field Estimation) (State Company's Case)

Table 8.4.4-1 Tax Exemption Incentive in Central American Countries for Renewable Energy

Country	Guatemala	Nicaragua	Panama
General Tax Rate	31%	30%	30%
Tax Holiday Term	10 yrs	7 yrs	up to 25% of Direct Investment
Base Law	Law on the Development of New and Renewable Energy	Law for Promotion of Electricity Generation with Renewable Energy	Law 45 of August 2004
Start year	2003	2005	2004

(Source: Economist Intelligence Unit, Country Commerce 2005)

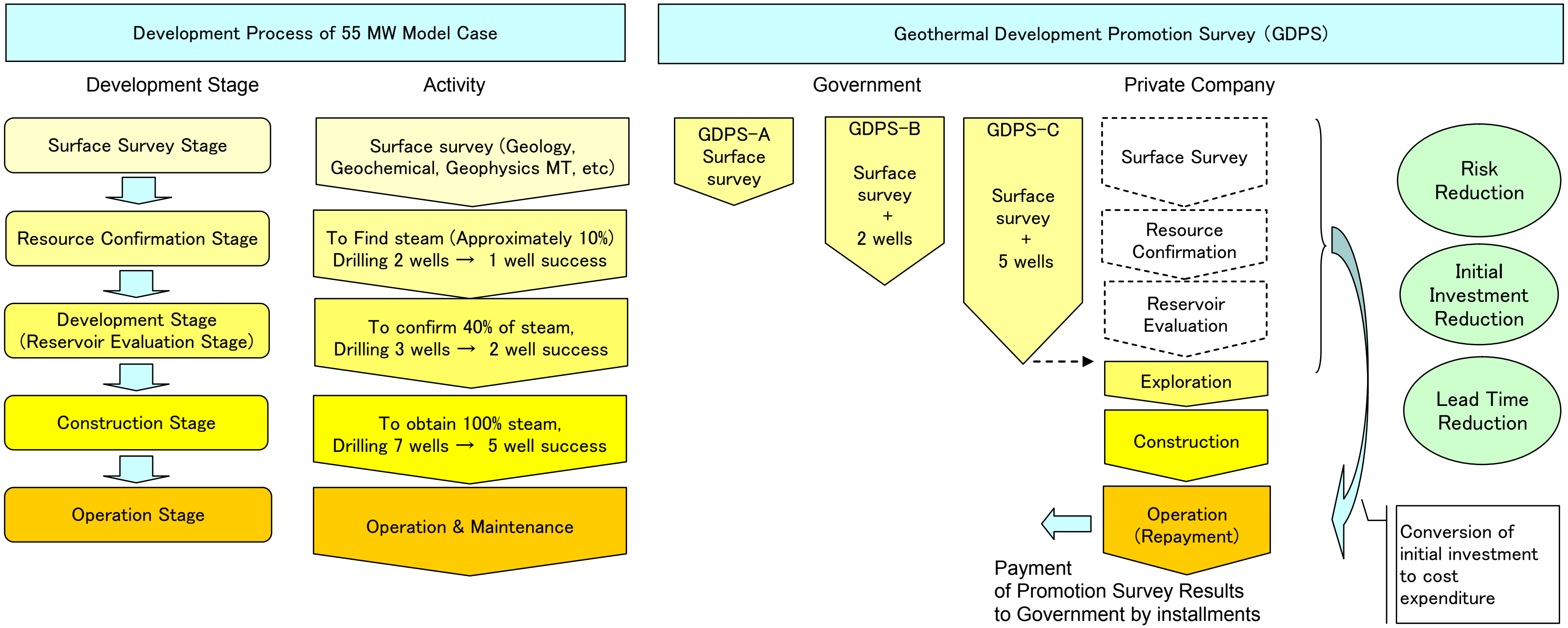


Fig 8.4.5-1 Geothermal Development Promotion Survey by Government and its Effect

Table 8.4.5-1 Scale and its Effect of Geothermal Development Promotion Survey

Case	Case 0	Case 1	Case 2	Case 3	Case 4
Type		GDPS (A)	GDPS(B)		GDPS(C)
Survey		Surface survey	Surface survey 2 Test wells Pre F/S		Surface survey 5 Test Wells F/S
Cost		2m$	9m$		30m$
Price of Results		Free	Free	10 yr installments (Int. rate 4%)	10 yr installments (Int. rate 4%)
Selling Price	8.7 ¢/kWh	8.7 ¢/kWh	8.5 ¢/kWh	8.7 ¢/kWh	7.8 ¢/kWh
Effect	—	0 ¢/kWh	0.2 ¢/kWh	0 ¢/kWh	0.9 ¢/kWh

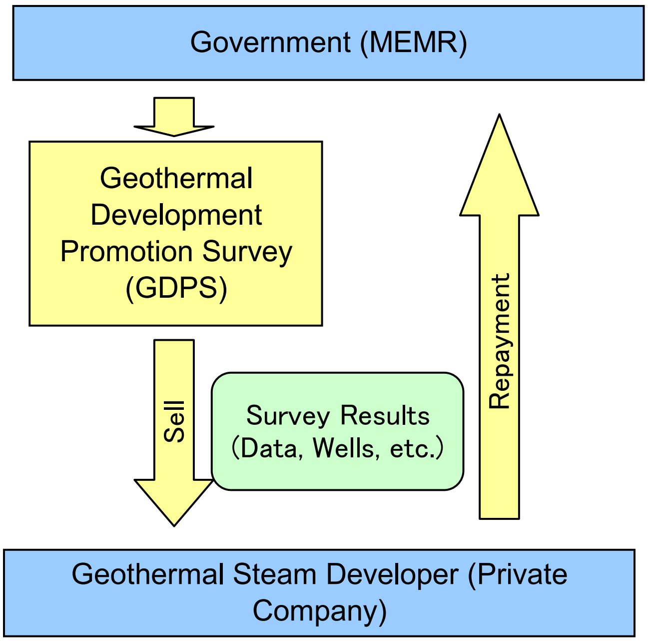


Fig. 8.4.5-2 Geothermal Development Promotion Survey Scheme

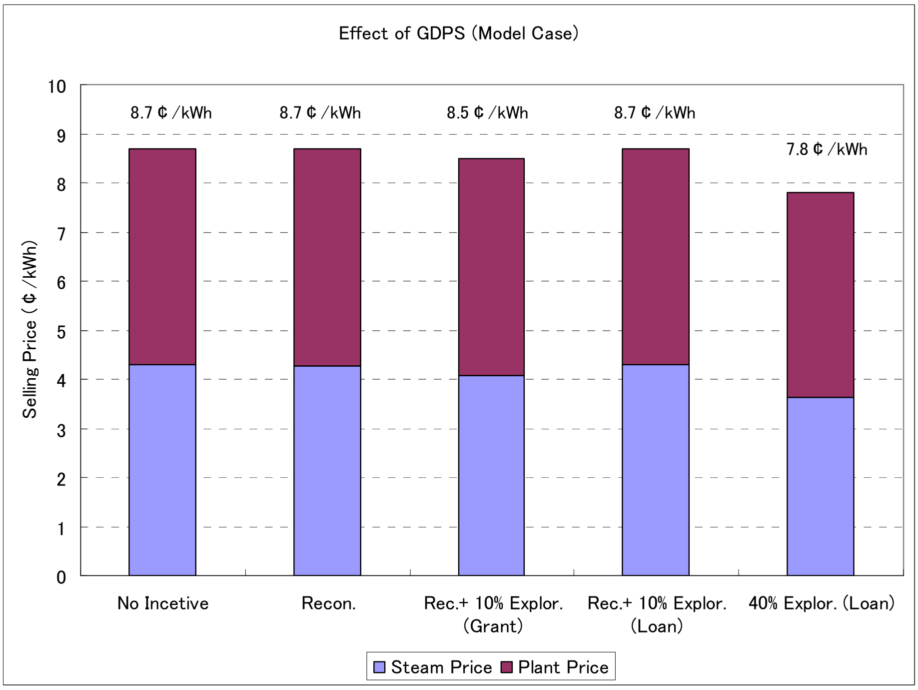


Fig. 8.4.5-3 Effect of Government Survey (Selling Price Reduction Effect in 55 MW Model Plant)（Private Company's Case）

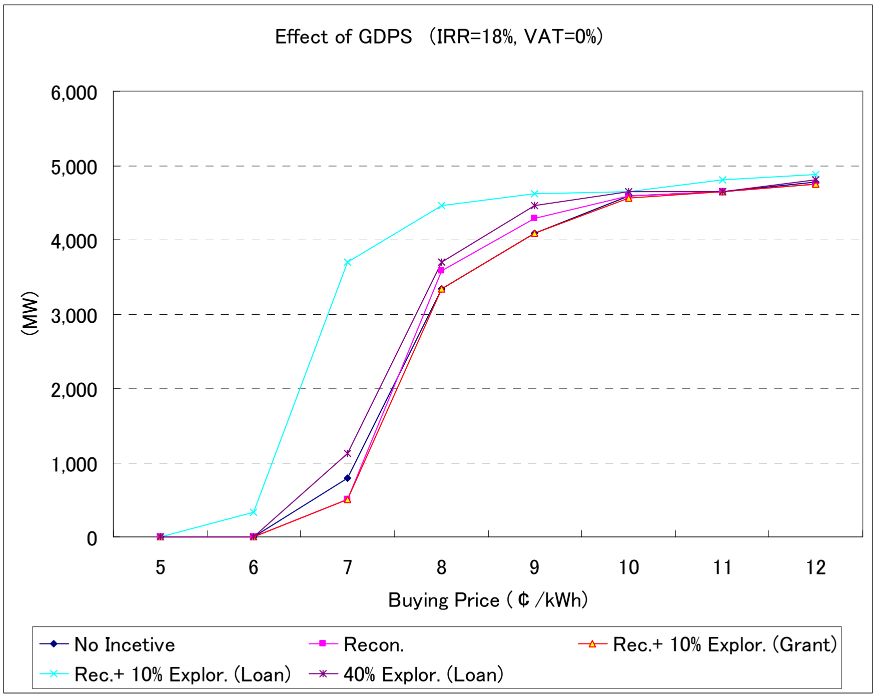


Fig. 8.4.5-4 Effect of Government Survey (Development Promotion Effect in 38 Field Estimation) (Private Company's Case)

Fig. 8.4.6-1 Effect of Low Interest Rate Loan to Development for Private Company (Selling Price Reduction Effect in 55 MW Model Plant)

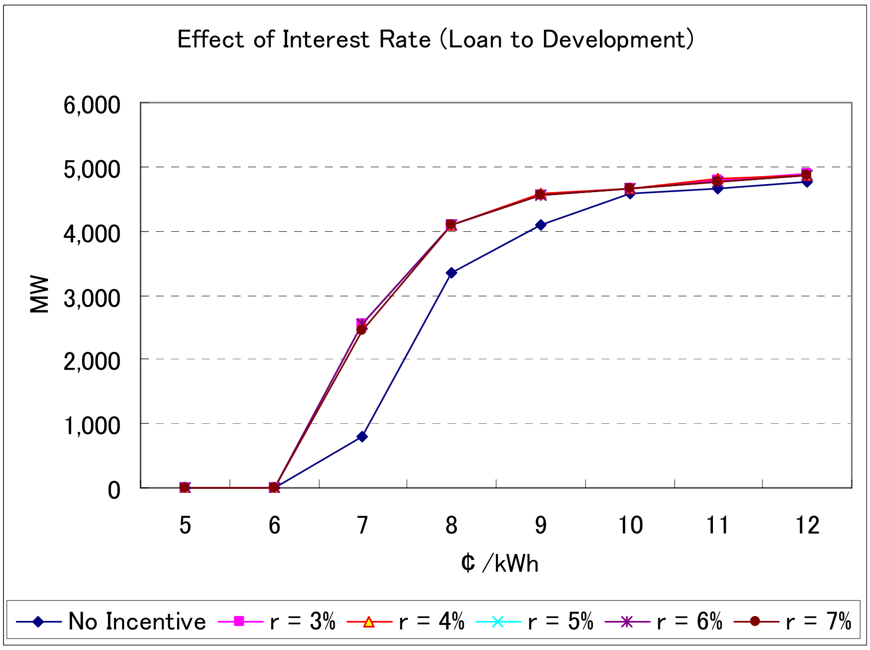


Fig. 8.4.6-2 Effect of Low Interest Rate Loan to Development for Private Company (Development Promotion Effect in 38 Field Estimation)

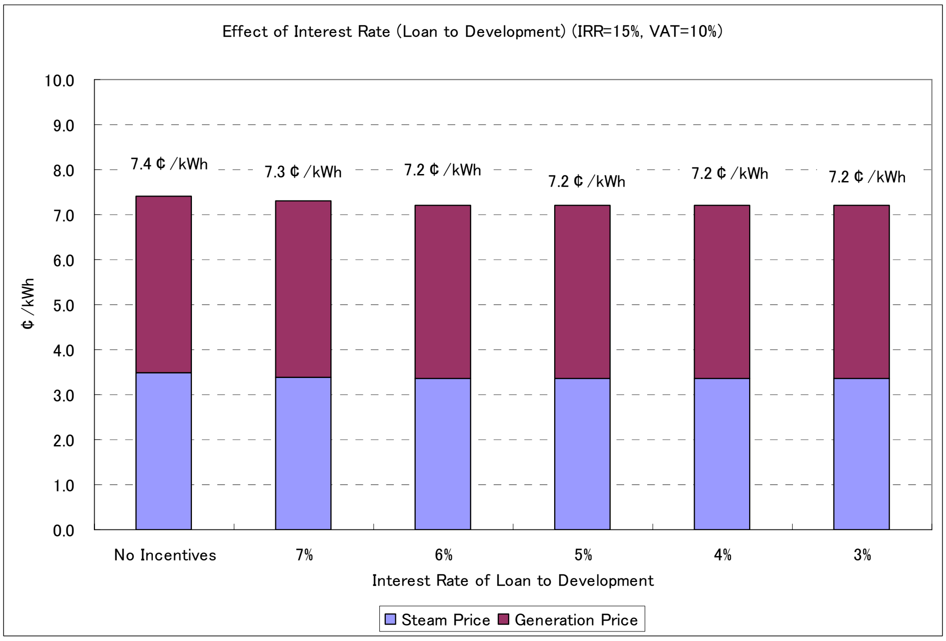


Fig. 8.4.6-3 Effect of Low Interest Rate Loan to Development for State Company (Selling Price Reduction Effect in 55 MW Model Plant)

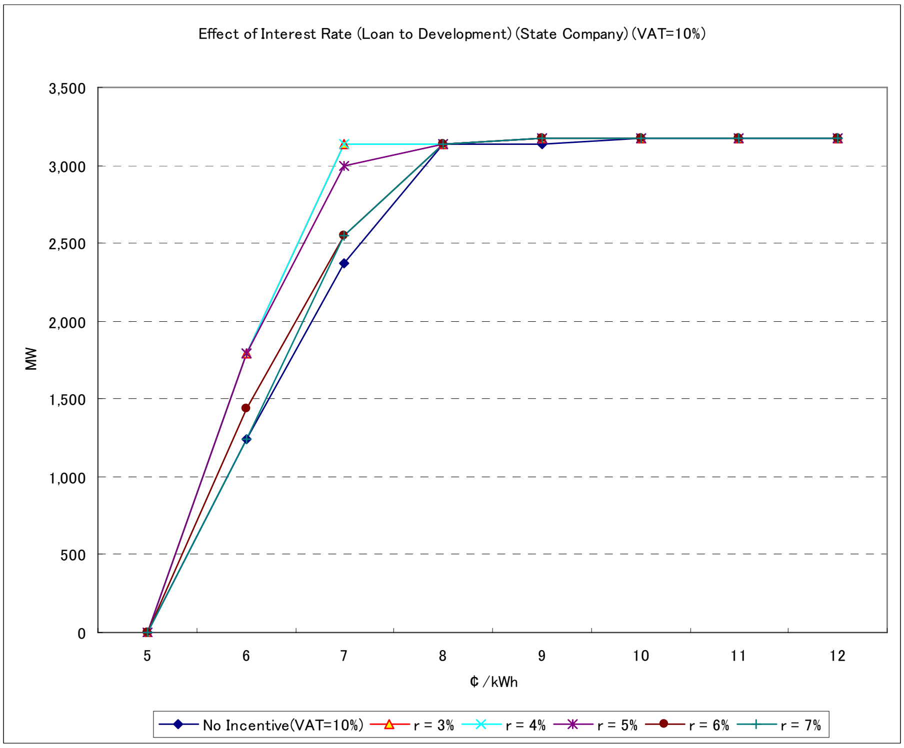


Fig. 8.4.6-4 Effect of Low Interest Rate Loan to Development for State Company (Development Promotion Effect in 11 Field Estimation)

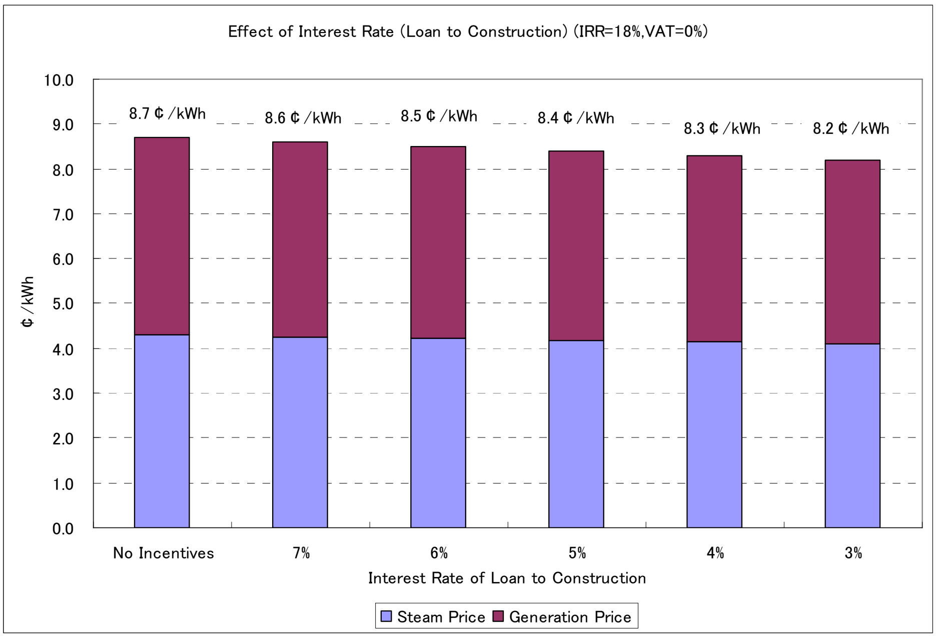


Fig. 8.4.7-1 Effect of Low Interest Rate Loan to Construction for Private Company(Selling Price Reduction Effect in 55 MW Model Plant)

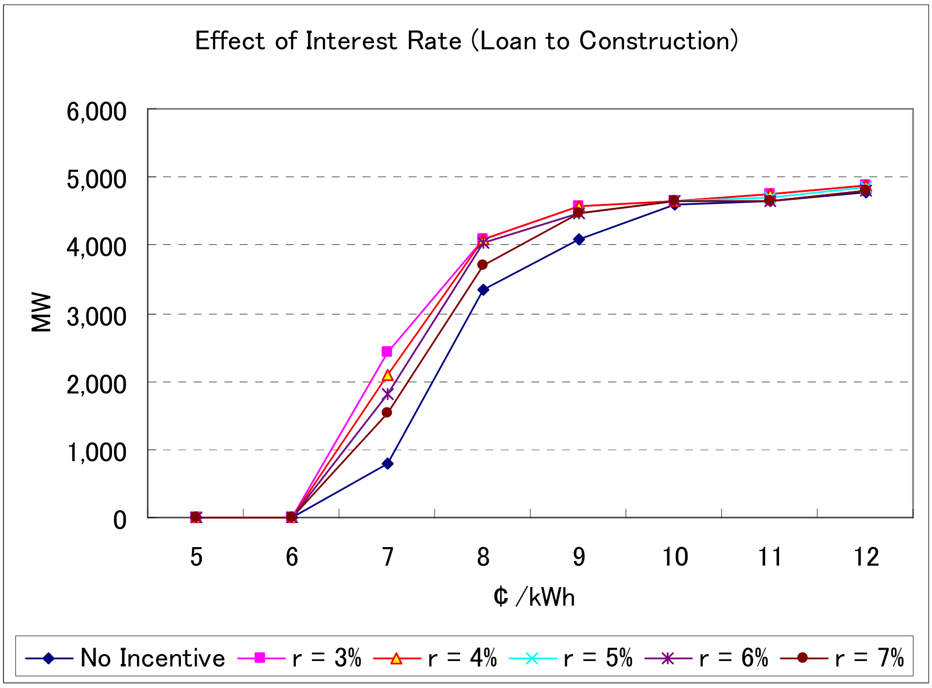


Fig. 8.4.7-2 Effect of Low Interest Rate Loan to Construction for Private Company (Development Promotion Effect in 38 Field Estimation)

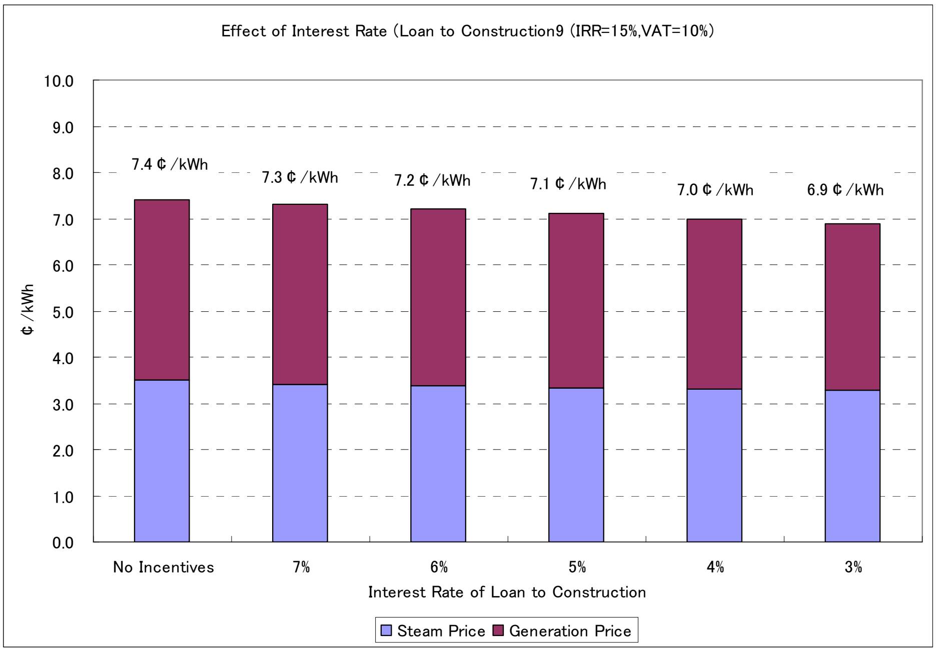


Fig. 8.4.7-3 Effect of Low Interest Rate Loan to Construction for State Company (Selling Price Reduction Effect in 55 MW Model Plant)

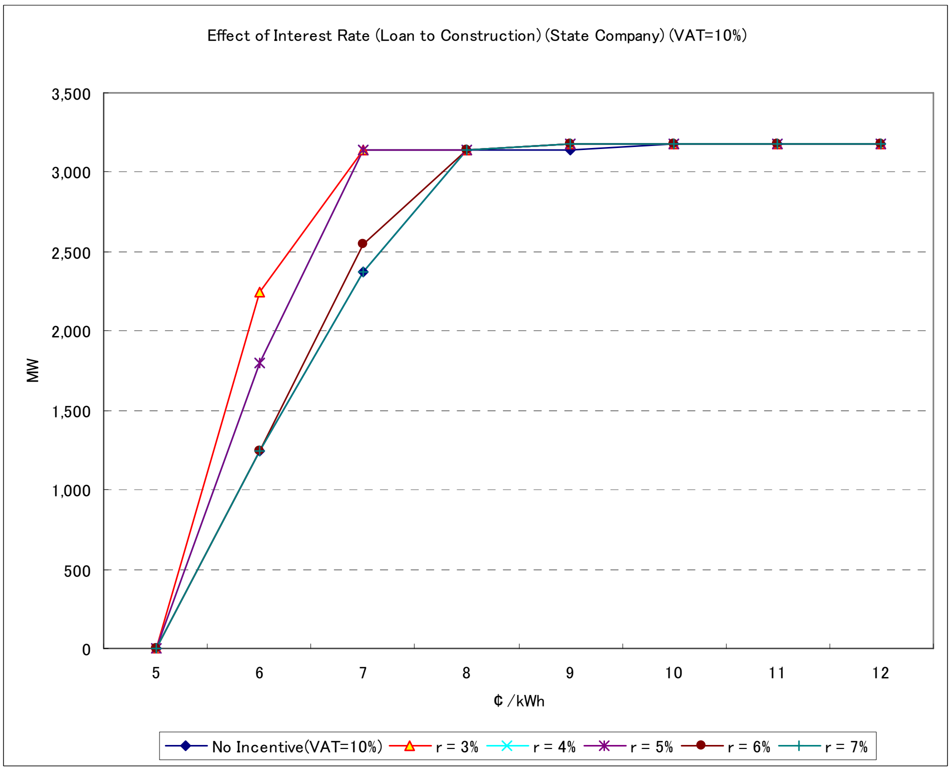


Fig. 8.4.7-4 Effect of Low Interest Rate Loan to Construction for State Company (Development Promotion Effect in 11 Field Estimation)

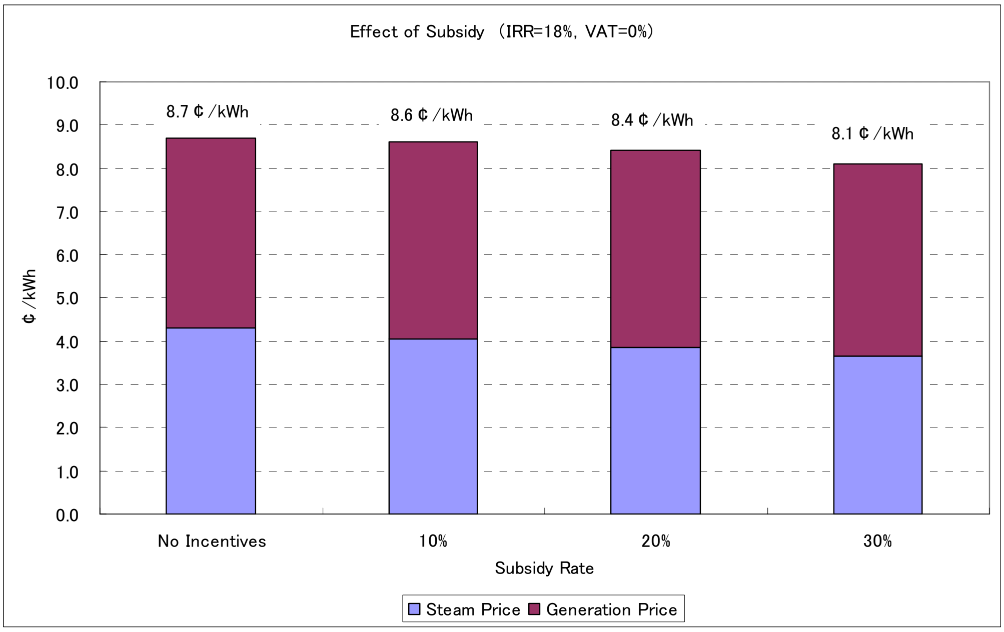


Fig. 8.4.8-1 Effect of Subsidy for Private Company (Selling Price Reduction Effect in 55 MW Model Plant)

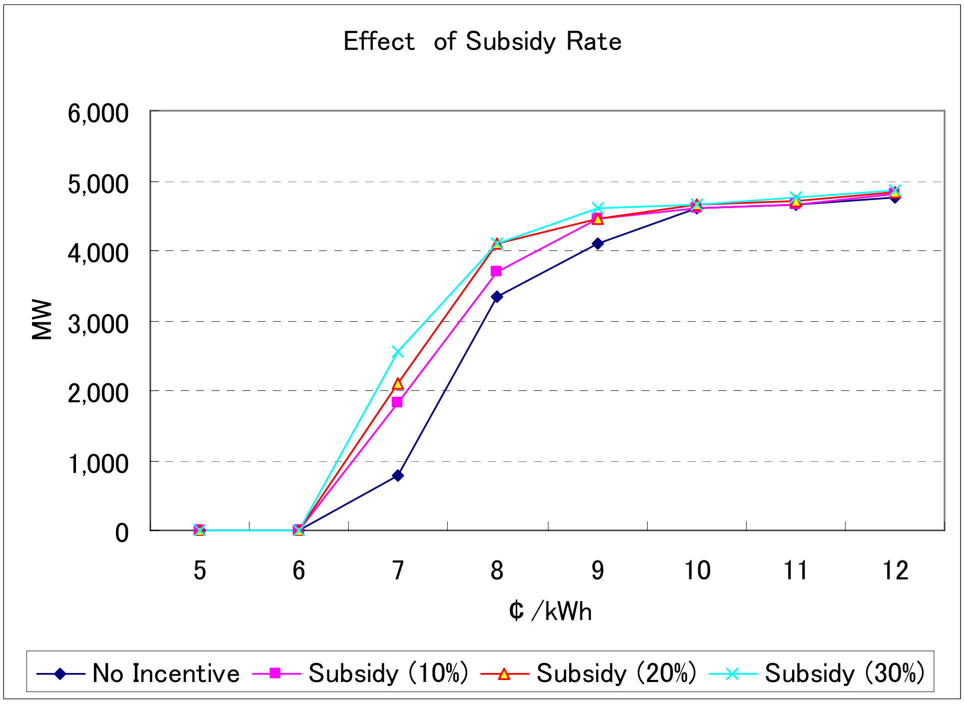


Fig. 8.4.8-2 Effect of Subsidy for Private Company (Development Promotion Effect in 38 Field Estimation)

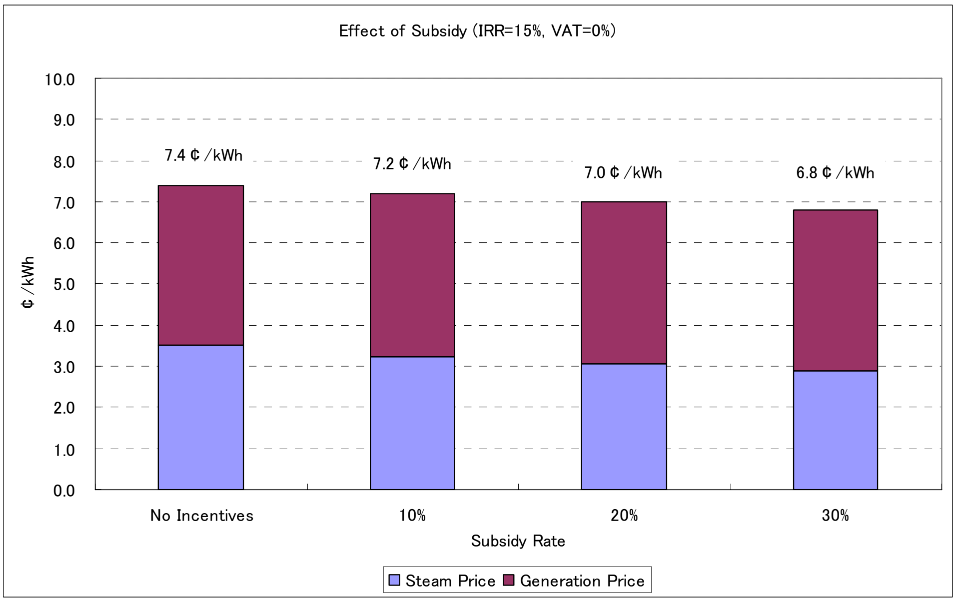


Fig. 8.4.8-3 Effect of Subsidy for State Company (Selling Price Reduction Effect in 55 MW Model Plant)

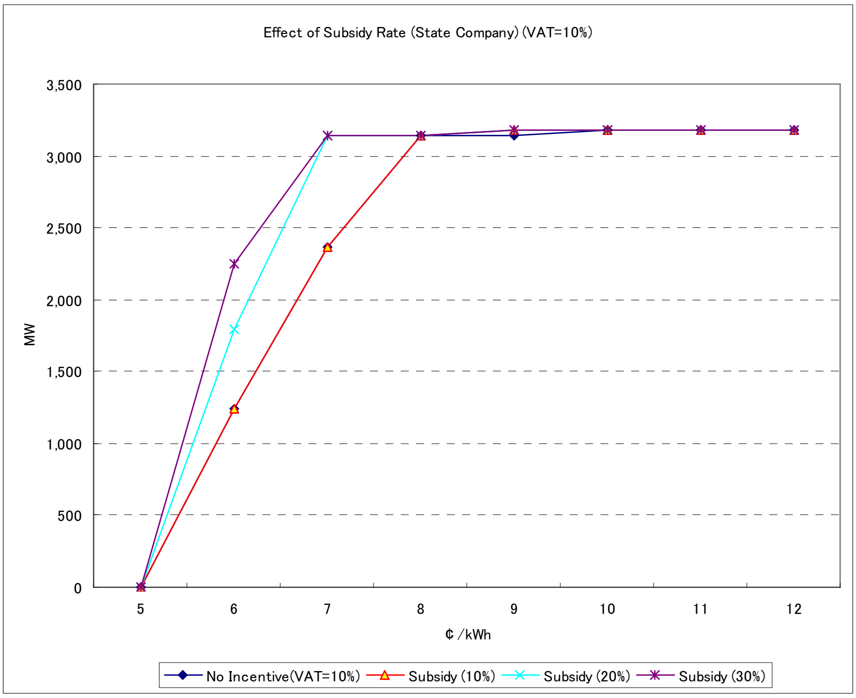


Fig. 8.4.8-4 Effect of Subsidy for State Company (Development Promotion Effect in 11 Field Estimation)

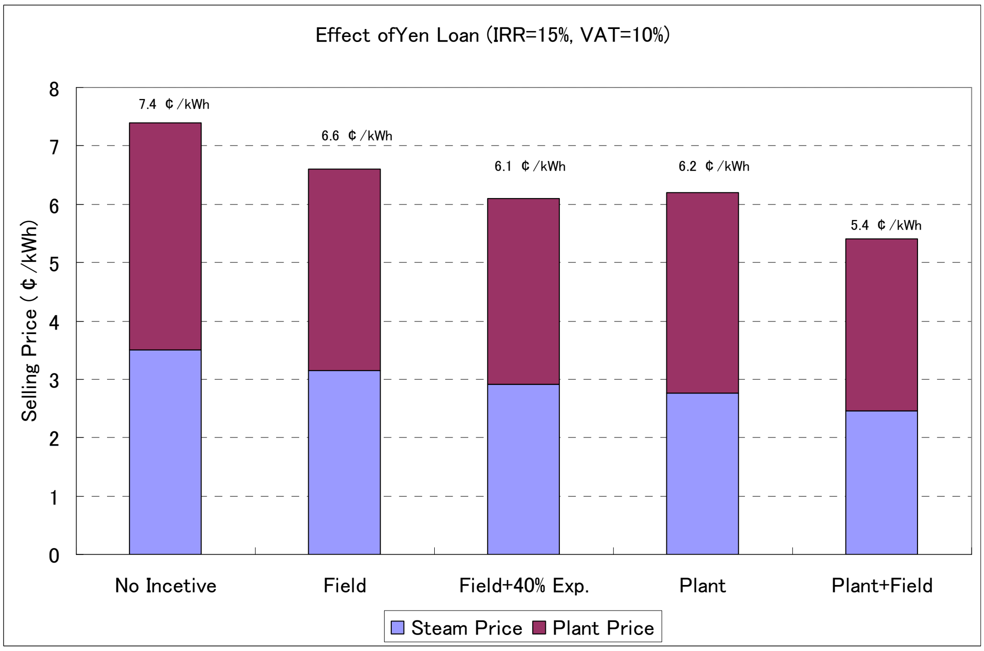


Fig. 8.4.9-1 Effect of ODA Loan to Construction for State Company (Selling Price Reduction Effect in 55 MW Model Plant)

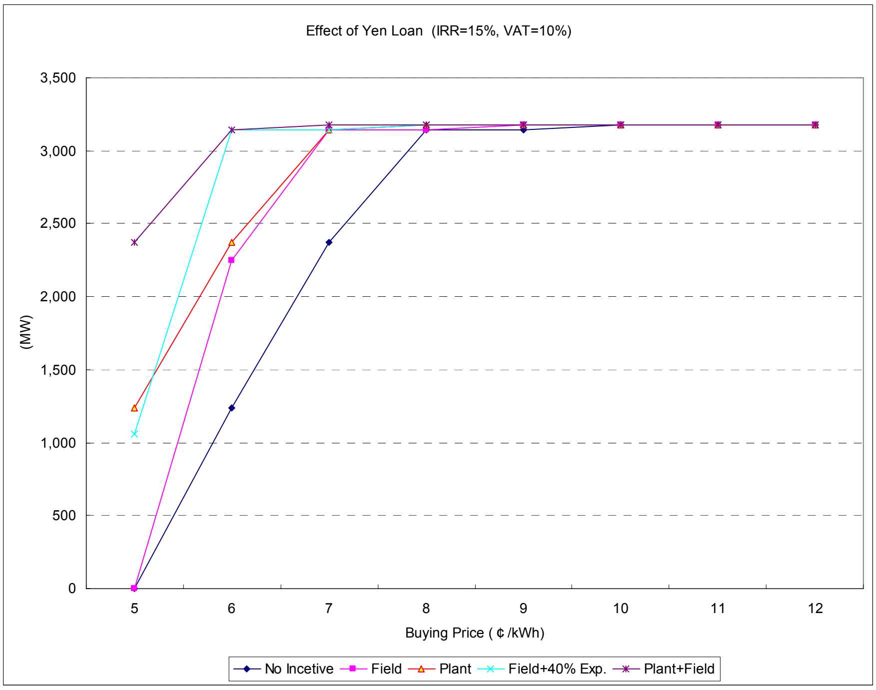


Fig. 8.4.9-2 Effect of ODA Loan to Construction for State Company (Development Promotion Effect in 11 Field Estimation)

Table 8.4.10-1 Possible Incentives for Geothermal Development

Incentive	Tax Credit (10 years)	Preliminary Survey by Government	Low Interest Finance for Development Stage	Low Interest Finance for Construction Stage	Subsidy to Construction Cost	Support by Yen Loan (Support for public entity's project)
Content of incentive	The corporate tax (34%) will be reduced to 10% for 10 years after operation for the geothermal power generation business by private companies.	In the promising geothermal potential area, the government executes preliminary survey to reduce initial resource development risks, and thus, to attract private developer's interest.	For the private company's geothermal development activity, which is not eligible for a commercial loan at present, governmental investment bank extends a loan of 50% of necessary fund with a special low interest rate. (The interest rate is 5.0%, while 8.5% is a usual rate. Loan repayment period is 12 years with 3 year grace period.)	For the private company's geothermal power plant construction activity (construction of wells, steam supply facilities), governmental investment bank extend a loan of 80% of necessary fund with a special low interest rate. (The interest rate is 5.0%, while 8.5% is a usual rate. Loan repayment period is 12 years with 3 year grace period.)	The government delivers the subsidy to geothermal construction cost (steam section). (subsidy cover ratio is 20%)	For projects executed by public entity such as PLN, Pertamina, GeoDipa, or regional government, government extend low interest loan using Yen Loan. (In a case of Emvironmental Yen Loan, interest rate is 0.65%、repayment period is 30 years with 10 year grace period.)

Table 8.4.10-2 Effect of Incentives

			No Incentives (VAT=0%)	Tax Credit (10yrs)	Gov's Svy.	Loan to Dev. (r=5%)	Loan to Const. (r=5%)	Sub. To Const (20%)	
Private Company's Case	Steam Price (￠/kWh)		4.3	3.9	3.6	3.4	3.3	2.9	
	Generation Price (￠/kWh)		4.4	4.1	4.1	3.9	3.7	3.7	
	Electricity Price (￠/kWh)		8.7	8.0	7.7	7.3	7.0	6.6	
(IRR=18%)	Price Down Effect (￠/kWh)		-	△ 0.7	△ 0.3	△ 0.4	△ 0.3	△ 0.4	
		No Incentives (VAT=10%)	VAT (0%)	Tax Credit (10yrs)	Gov's Svy.	Loan to Dev. (r=5%)	Loan to Const. (r=5%)	Sub. To Const (20%)	ODA Loan (VAT=10%)
State Company's Case	Steam Price (￠/kWh)	3.5	3.4	3.3	3.0	2.9	2.8	2.5	2.5
	Generation Price (￠/kWh)	3.9	3.6	3.4	3.4	3.3	3.1	3.1	2.9
	Electricity Price (￠/kWh)	7.4	7.0	6.7	6.4	6.2	5.9	5.6	5.4
(IRR=15%)	Price Down Effect (￠/kWh)	-	△ 0.4	△ 0.3	△ 0.3	△ 0.2	△ 0.3	△ 0.3	△ 2.0

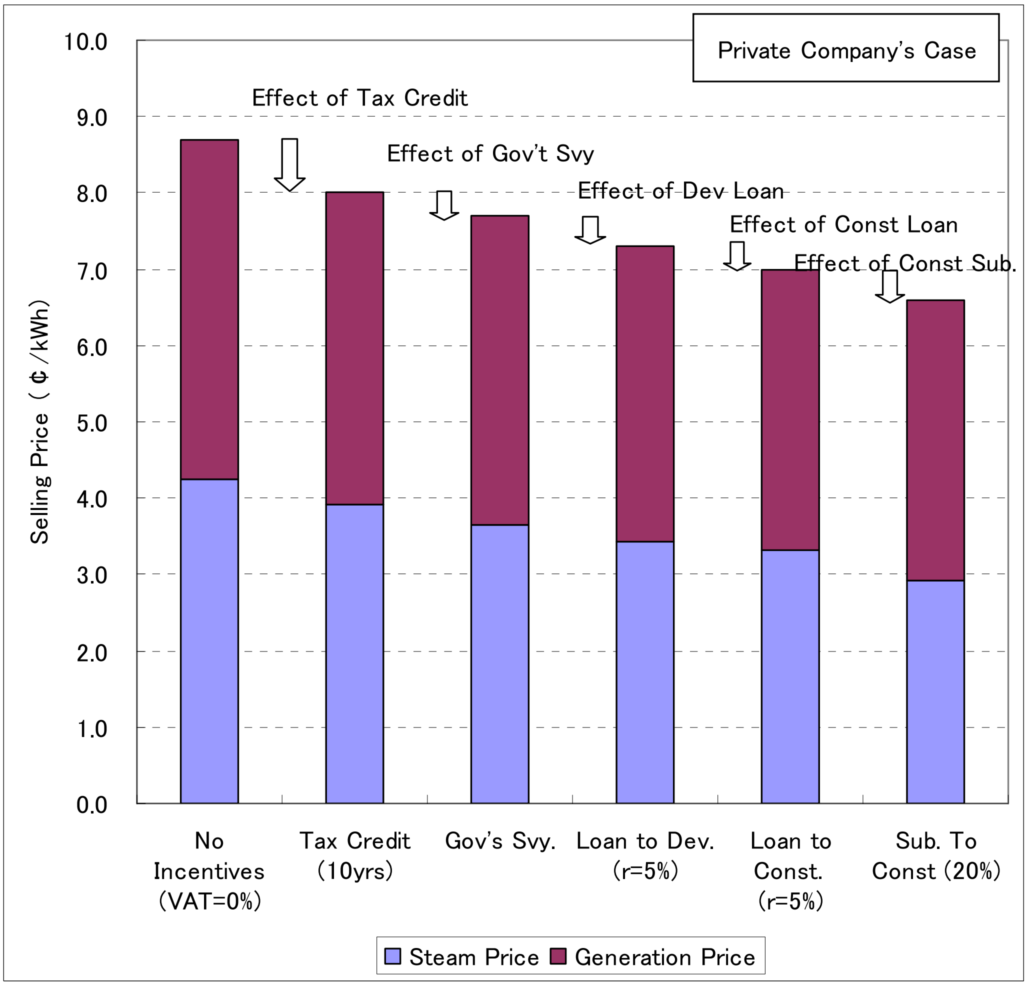


Fig. 8.4.10-1 Effect of Incentives (Selling Price Reduction Effect in 55MW Model Plant in Private Company's Case)

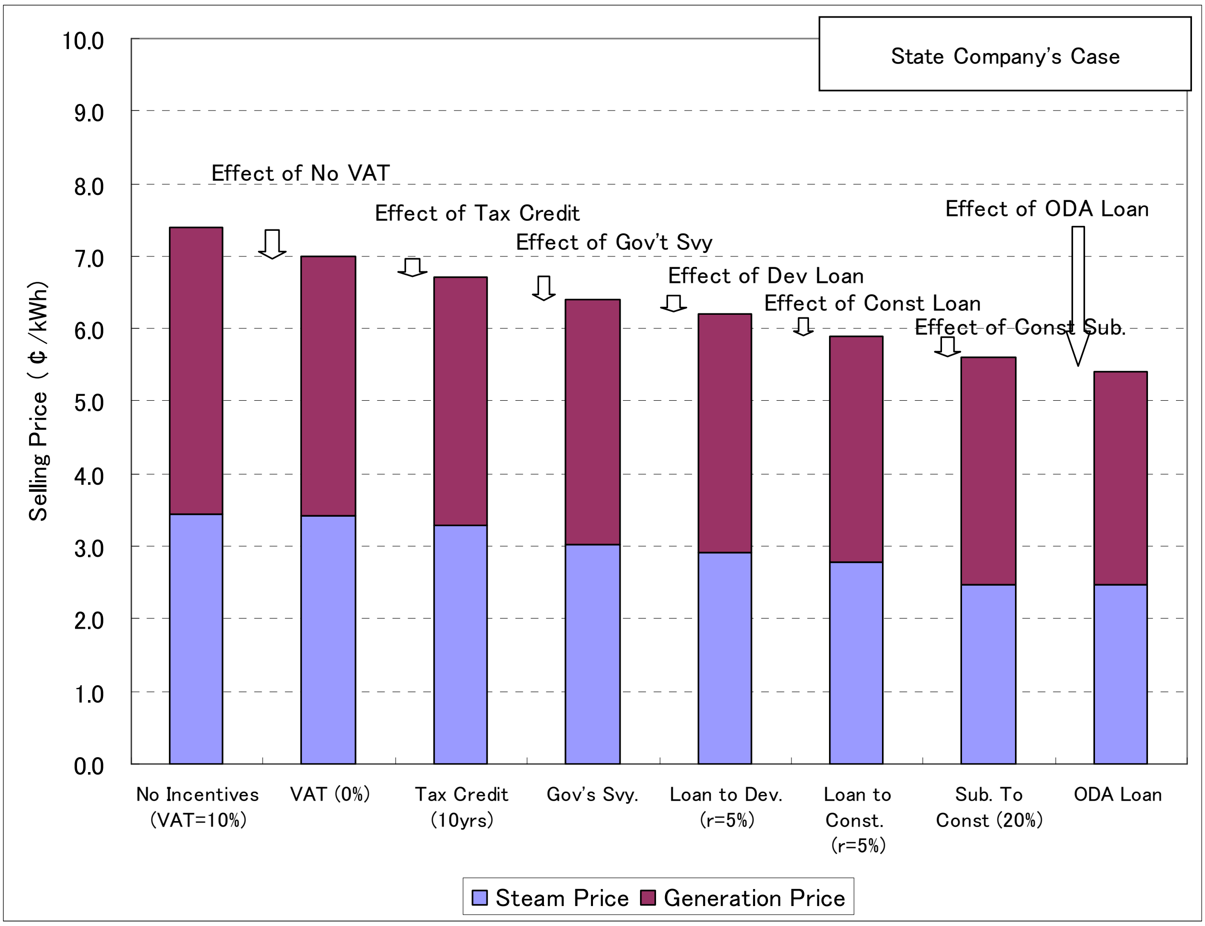


Fig. 8. 4.10-2 Effect of Incentives (Selling Price Reduction Effect in 55MW Model Plant in State Company's Case)

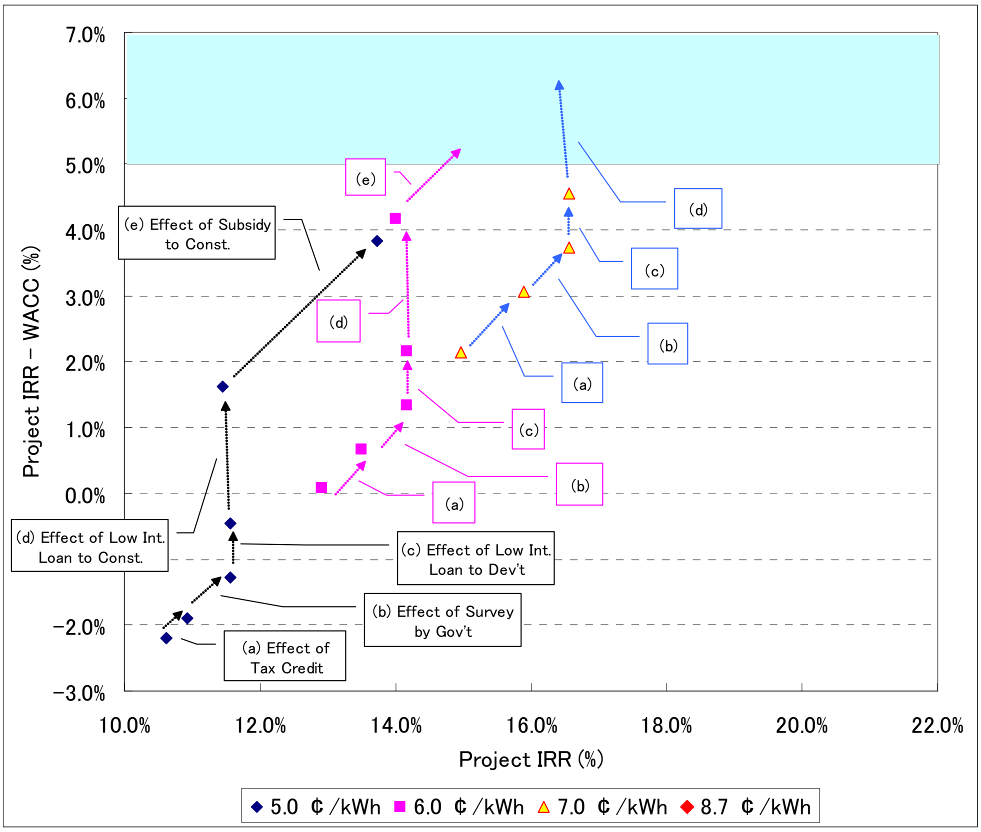


Fig. 8.4.10-3 Effect of Incentives (Private Company's Case)

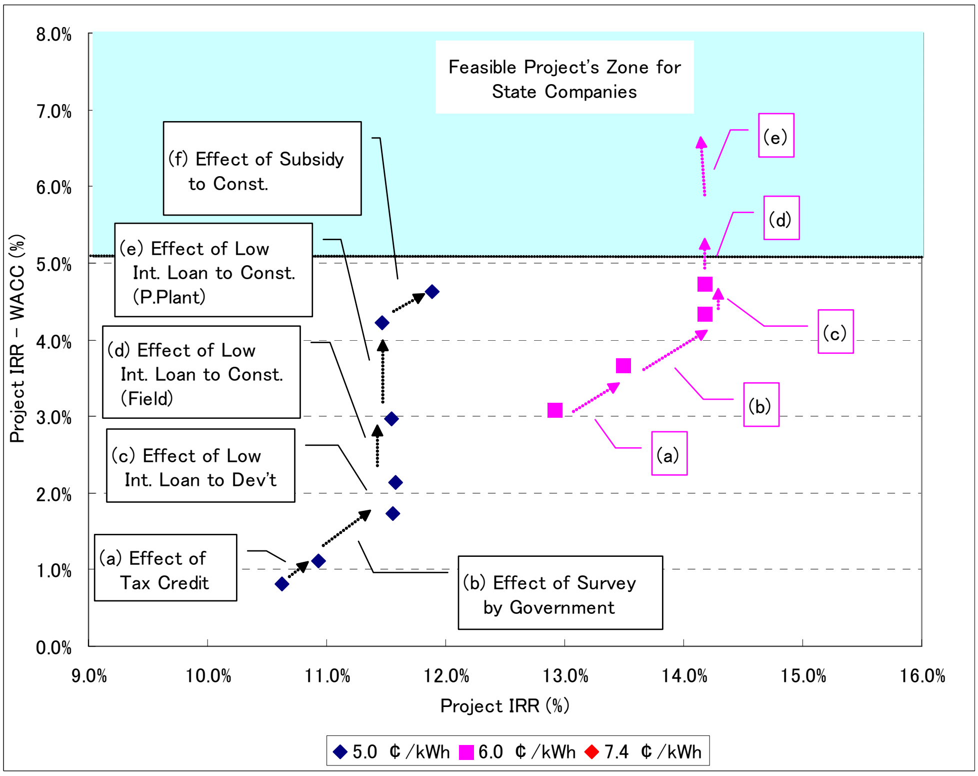


Fig. 8.4.10-4 Effect of Incentives (State Company's Case)

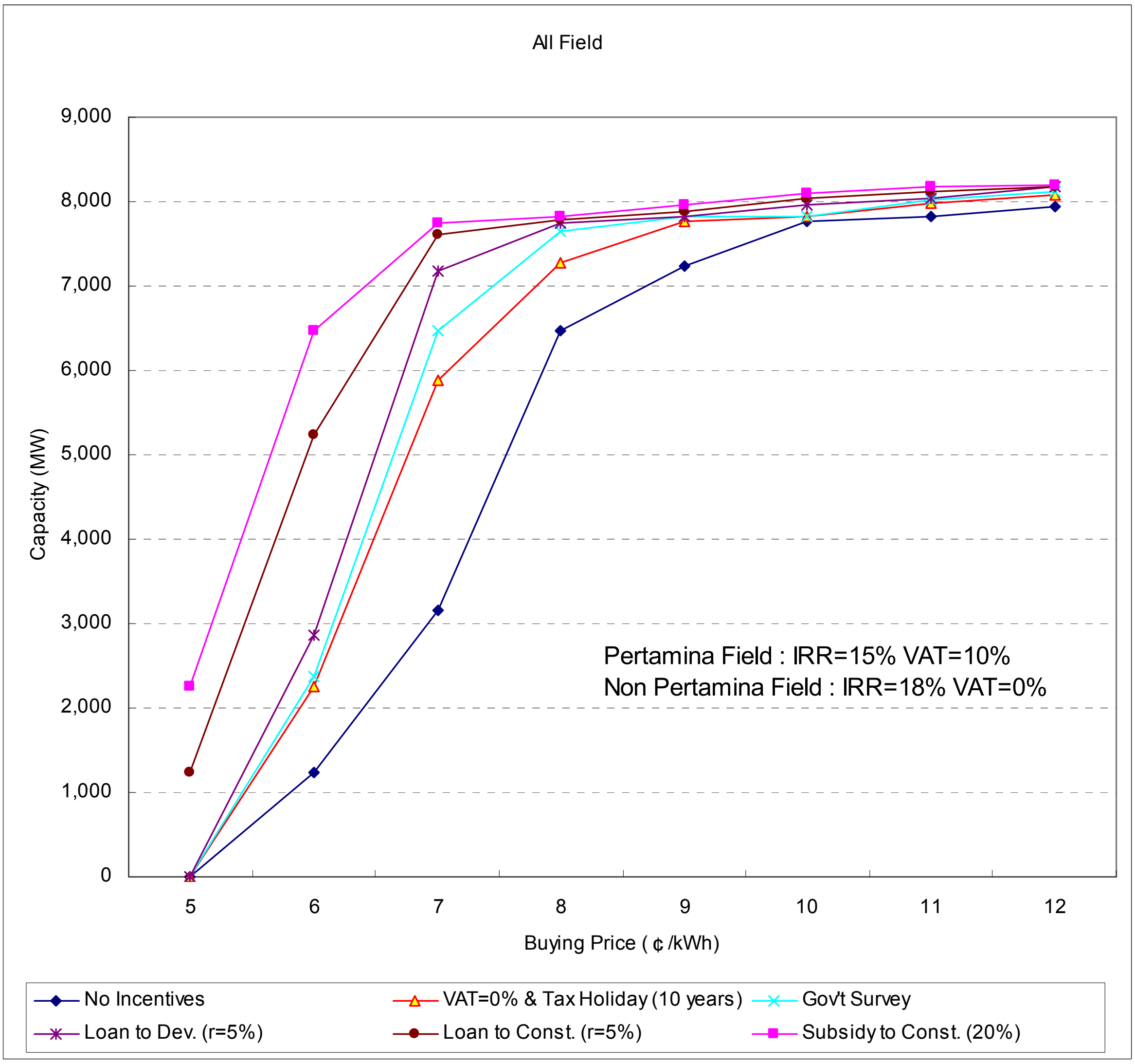


Fig. 8.4.10-5 Effect of Incentives (Development Amount in 49 Field Estimation) (Private Company & State Company Total)

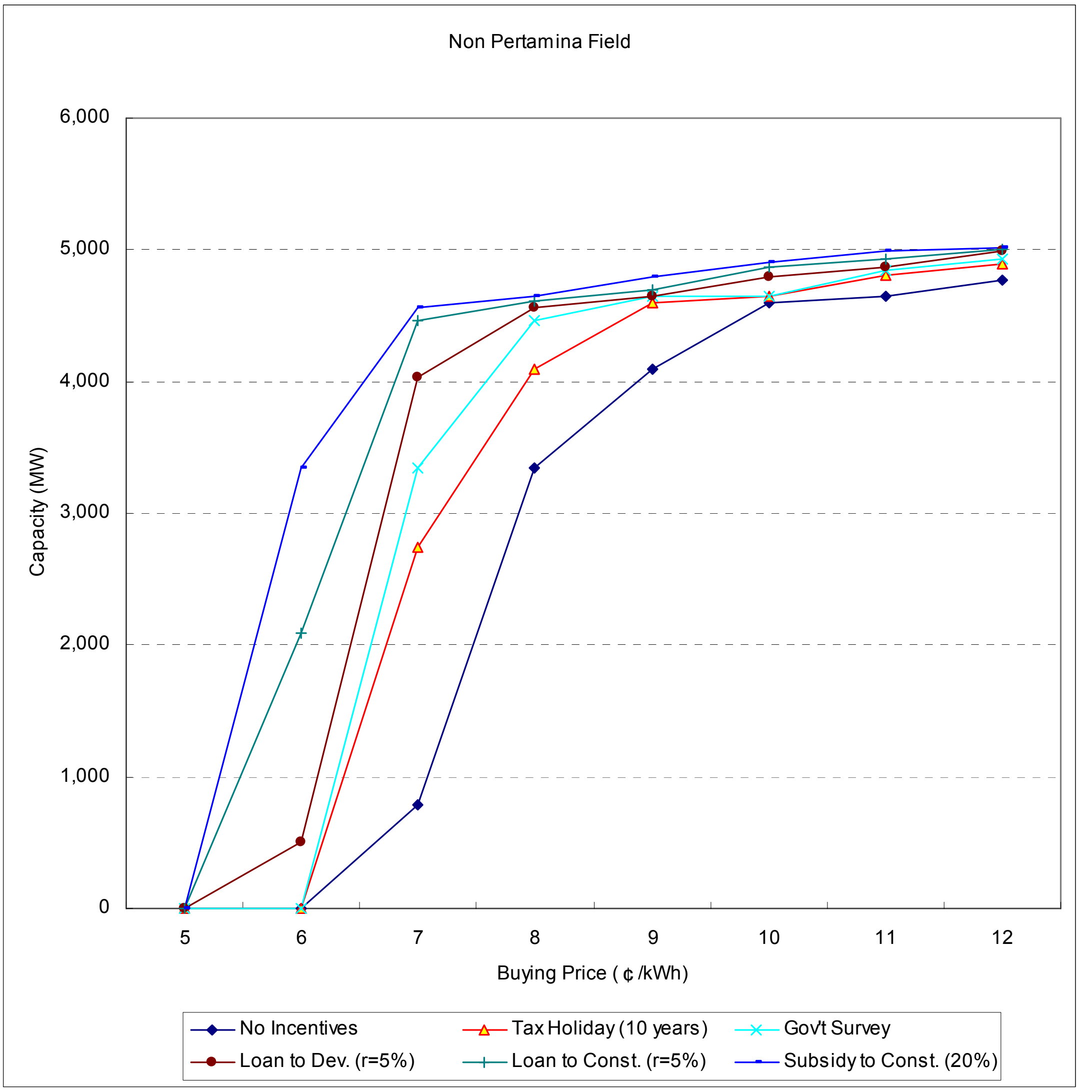


Fig. 8.4.10-6 Effect of Incentives (Development Amount in 38 Field Estimation)
(Private Company's Case)

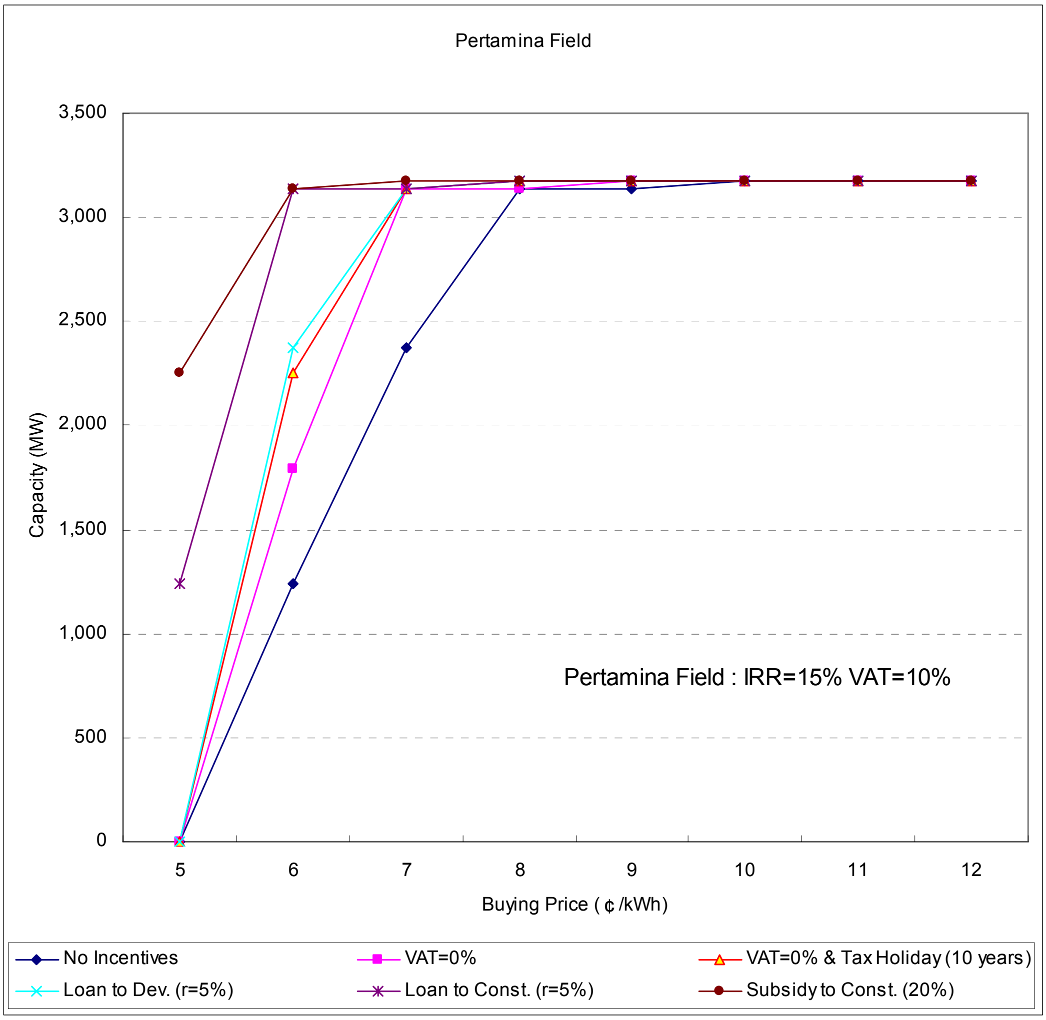


Fig. 8.4.10-7 Effect of Incentives (Development Amount in 11 Field Estimation)
(State Company's Case)

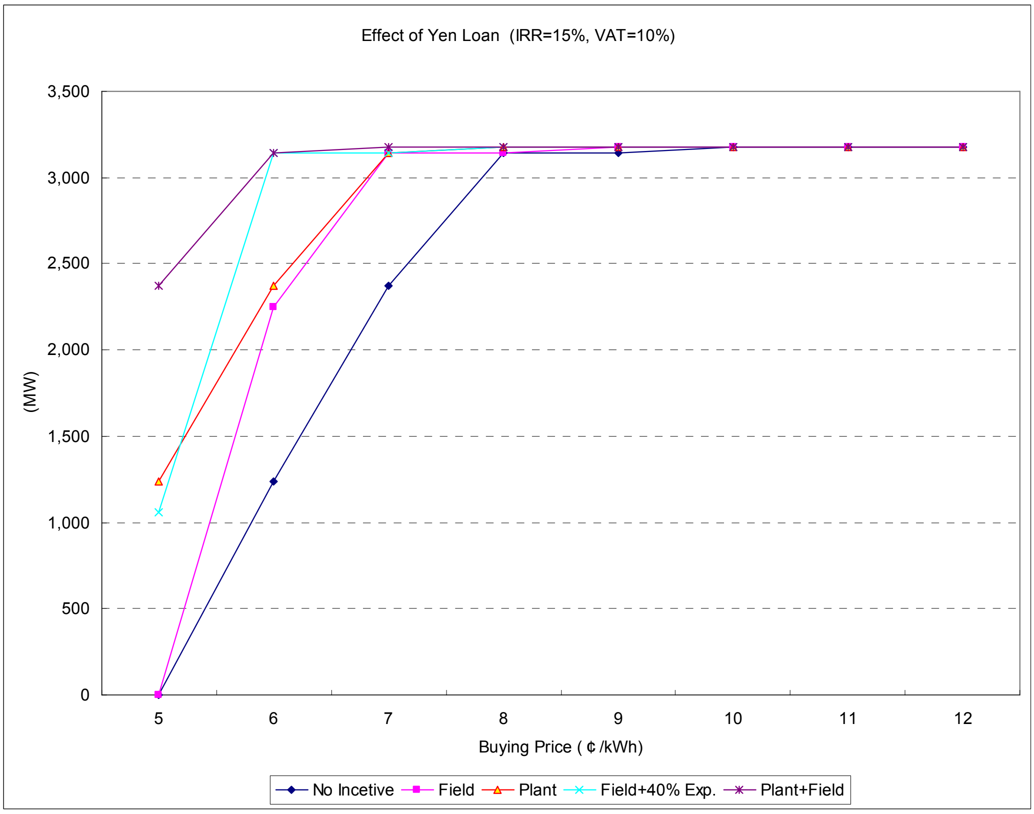


Fig. 8.4.10-8 Effect of ODA Loan (Development Amount in 11 Field Estimation)
(State Company's Case) (Fig.8.4-26 Re-posted)

Table 8.4.10-2 Options of Incentive Combination

Options	State Company's Case		Private Company's Case	
	Buying Price of PLN	Incentives of Government	Buying Price of PLN	Incentives of Government
No Incentive Case	8 Cents/kWh	-	10 Cents/kWh	-
Option 1	7 Cents/kWh	- VAT Exemption	9 Cents/kWh	- Tax Holiday (10 years)
Option 2	6 Cents/kWh	- VAT Exemption - Tax Holiday (10 years) - Loan to Development (r=5%) - Loan to Construction (r=5%)	8 Cents/kWh	- Tax Holiday (10 years) - Government Survey
Option 3			7 Cents/kWh	- Tax Holiday (10 years) - Government Survey - Loan to Development (r=5%) - Loan to Construction (r=5%)

Table 8.4.11-1 Geothermal CDM Projects

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	output	remarks
29-May-06	Lihir Geothermal Power Project	Papua New Guinea		ACM0002 ver. 4	278,904	55MW	registered
11-Dec-06	Darajat Unit III Geothermal Project	Indonesia	United Kingdom of Great Britain and Northern Ireland	ACM0002 ver. 6	652,173	110MW	registered
10-Dec-06	20 MW Nasulo Geothermal Project	Philippines	Netherlands	ACM0002 ver. 6	74,975	20MW	registered
8-Apr-06	San Jacinto Tizate geothermal project	Nicaragua	United Kingdom of Great Britain and Northern Ireland	ACM0002 ver. 4	280,703	66MW	registered
25-May-06	LaGeo, S. A. de C. V., Berlin Geothermal Project, Phase Two	El Salvador	Netherlands	ACM0002 ver. 4	176,543	66MW	registered
	AMATITLAN Geothermal Project	Guatemala		ACM0002 ver. 6	99,251	28MW	validation
	40 MW Northern Negros Geothermal Project	Philippines		ACM0002 ver. 6	174,899	40MW	validation

* AM - Large scale, ACM - Consolidated Methodologies, AMS - Small scale
** Estimated emission reductions in metric tonnes of CO2 equivalent per annum (as stated by the project participants)
(Source: UNFCCC home page http://cdm.unfccc.int/index.html)

Table 8.4.11-2 Effect of Incentives (CDM=5$/t)

			No Incentives (VAT=0%)	CDM (5$/t)	Tax Credit (10yrs)	Gov's Svy.	Loan to Dev. (r=5%)	Loan to Const. (r=5%)	Sub. To Const (20%)	
Private Company's Case (IRR=18%)	Steam Price (¢/kWh)		4.3	4.1	3.7	3.5	3.3	3.1	2.8	
	Generation Price (¢/kWh)		4.4	4.2	3.9	3.8	3.6	3.5	3.4	
	Electricity Price (¢/kWh)		8.7	8.3	7.6	7.3	6.9	6.6	6.2	
	Price Down Effect (¢/kWh)		-	△ 0.4	△ 0.7	△ 0.3	△ 0.4	△ 0.3	△ 0.4	
		No Incentives (VAT=10%)	VAT (0%)	CDM (5$/t)	Tax Credit (10yrs)	Gov's Svy.	Loan to Dev. (r=5%)	Loan to Const. (r=5%)	Sub. To Const (20%)	ODA Loan + CDM (5$/t) (VAT=10%)
State Company's Case (IRR=15%)	Steam Price (¢/kWh)	3.5	3.4	3.3	3.1	2.8	2.7	2.6	2.3	2.3
	Generation Price (¢/kWh)	3.9	3.6	3.4	3.2	3.2	3.1	2.9	2.9	2.7
	Electricity Price (¢/kWh)	7.4	7.0	6.7	6.3	6.0	5.8	5.5	5.2	5.0
	Price Down Effect (¢/kWh)	-	△ 0.4	△ 0.3	△ 0.4	△ 0.3	△ 0.2	△ 0.3	△ 0.3	△ 2.4

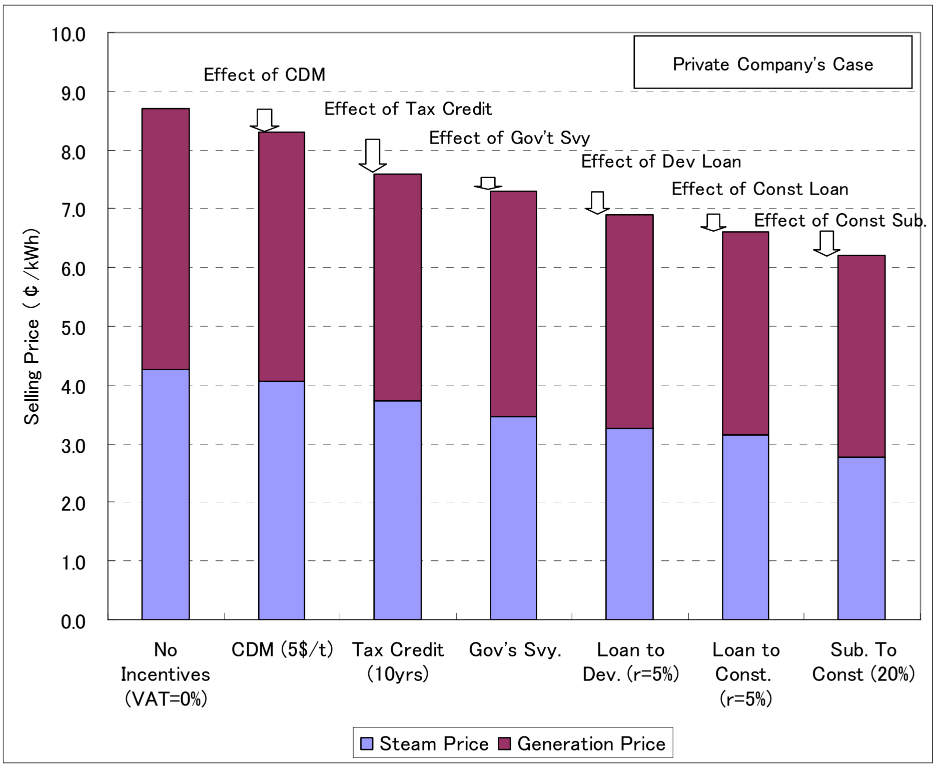


Fig. 8.4.11-1 Effect of Incentives (55MW Model Plant Case, Private Company's Case, CDM=5$/ton)

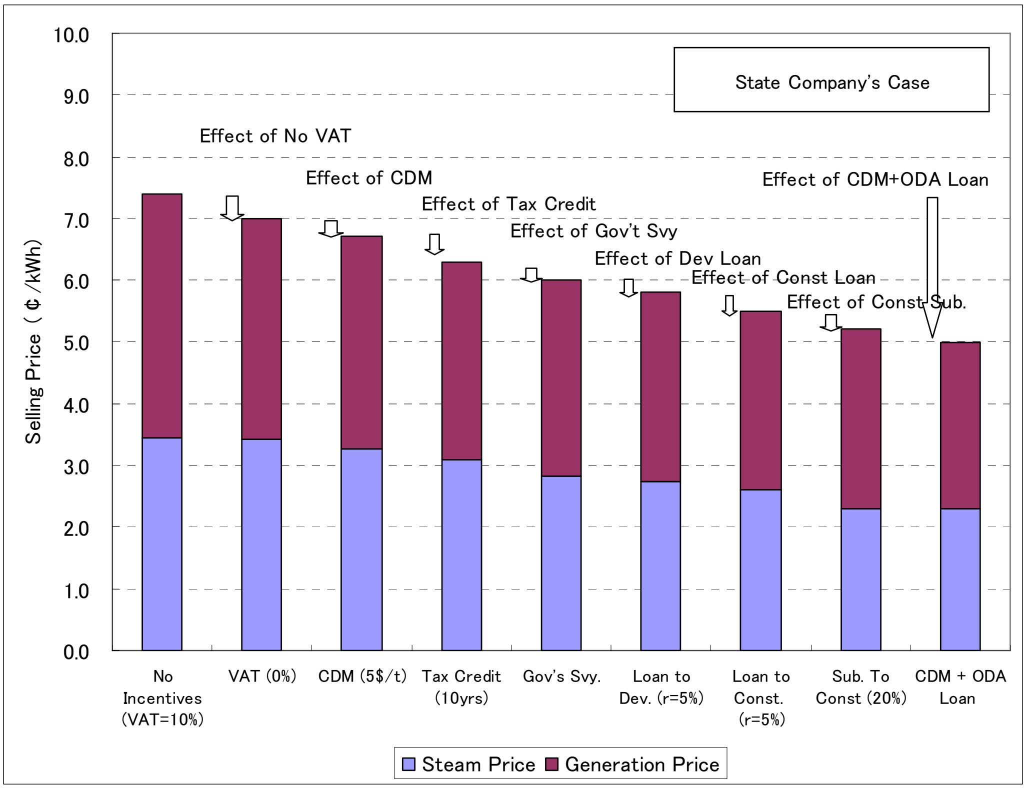


Fig. 8.4.11-2 Effect of Incentives (55MW Model Plant Case, State Company's Case, CDM=5$/ton)

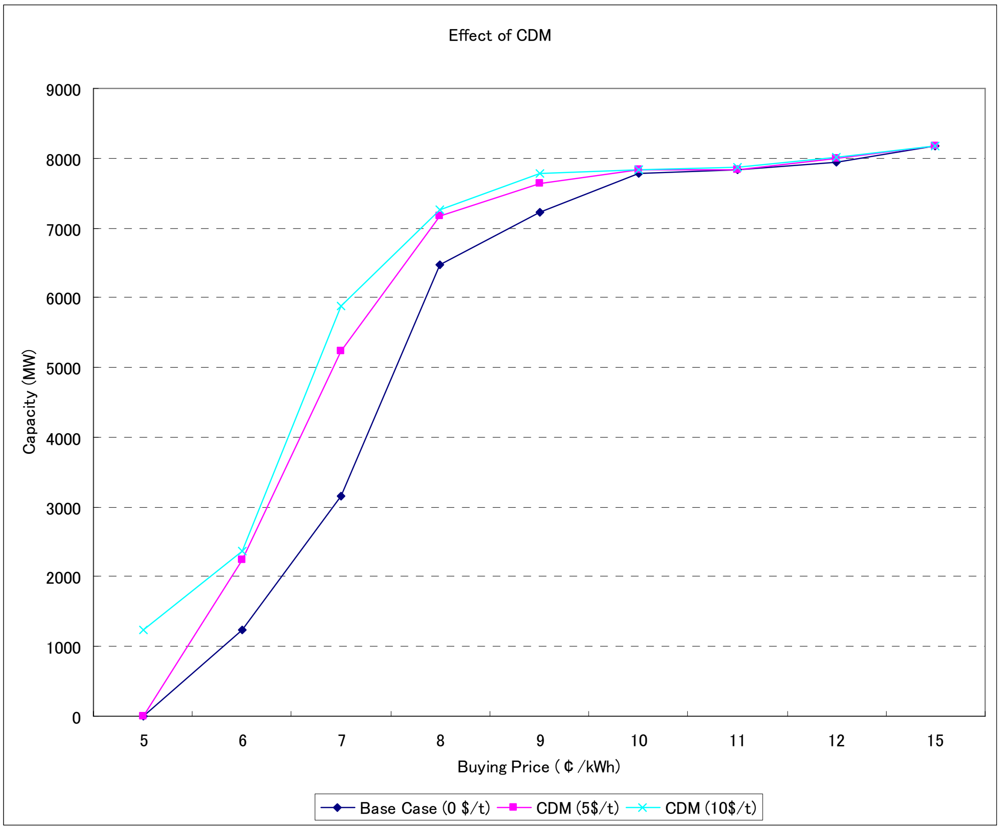


Fig. 8.4.11-3 Effect of CDM (Development Amount in 49 Field Estimation)
(Private Company & State Company Total)

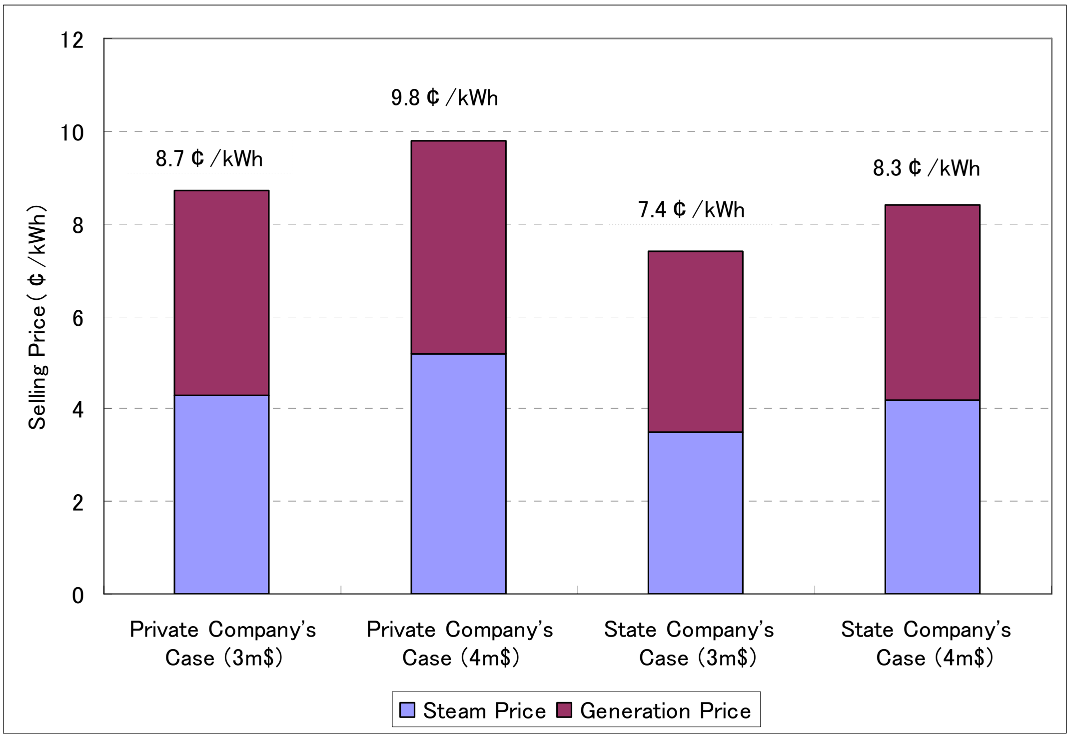


Fig. 8.4.12-1 Effect of Drilling Cost Increase on Selling Price (55MW Model Plant Case)

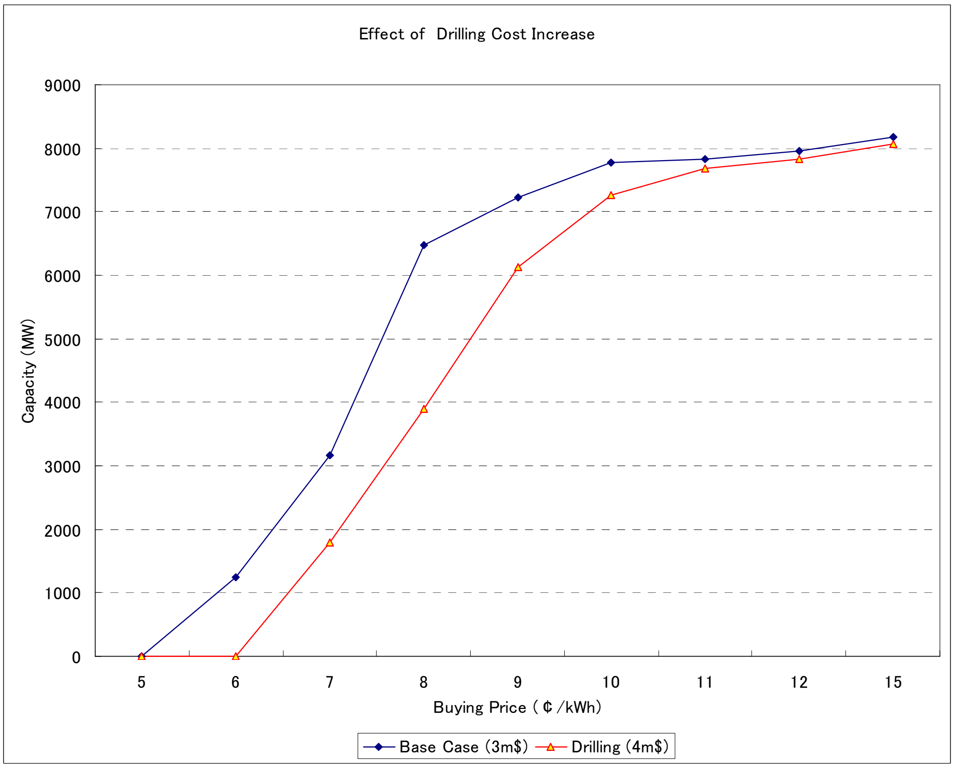


Fig. 8.4.12-2 Effect of Drilling Cost Increase (Development Amount in 49 Field Estimation) (Private Company & State Company Total)

Table 8.5-1 The Scio-economic Cost of Energy Source considering Loss of export fuel opportunity cost and Environmental cost

Item		Geothermal (55MW)		Hydro (20MW)		Coal (600MW)		Natural Gas (600MW)		Oil (Diesel) (10MW)		Remarks
Selling Price	(¢/kWh)	7.4	8.7	9.1	11.5	4.8	5.5	7.1	7.6	16.0	17.1	In case of IRR=15% / 18%
Loss of fuel export opportunity cost	(¢/kWh)	-		-		1.8		5.9		11.6		Oil 50$/BBL, Coal 35$/ton, LNG 8.6$/MMBTU
Environmental cost	(¢/kWh)	0.0		0.0		1.8		0.9		1.6		
(Sulfur dioxide)	(¢/kWh)	(0.01)		(0.00)		(0.33)		(0.01)		(0.38)		from table below
(Nitrogen oxide)	(¢/kWh)	(0.00)		(0.00)		(0.49)		(0.34)		(0.45)		ditto
(Carbon dioxide	(¢/kWh)	(0.02)		(0.01)		(0.98)		(0.52)		(0.74)		ditto
Total	(¢/kWh)	7.4	8.7	9.1	11.5	8.4	9.1	13.9	14.4	29.2	30.3	

Emission of Pollutants		Geothermal	Hydro	Coal	Natural Gas	Oil (Diesel)	Price of emission
Sulfur dioxide	(lb/MWh) (*1)	0.35	0.00	10.39	0.22	12.00	'@700$/ton (*4)
Nitrogen oxide	(lb/MWh) (*2)	0.00	0.00	4.31	2.96	4.00	'@2,500$/ton (*4)
Carbon dioxide	(kg/MWh) (*3)	15	11	975	519	742	'@10$/ton

(Source)

*1 A Guide to Geothermal Energy and the Environment: Geothermal Energy Association USA (2005) (See Fig.1.6)

*2 A Guide to Geothermal Energy and the Environment: Geothermal Energy Association USA (2005) (See Fig.1.7)

*3 Central Research Institute of Electric Power Industry, Japan CRIEPI Review No.45,2001 Nov) (See Fig1.8)

*4 US Emission Market 2006 April

(Note)

Coal power plant (600MW) is the case where exportable coal is used as its fuel.

Chapter 9　Proposal for Geothermal Development Promotion

Chapter 9 Proposal for Geothermal Development Promotion

9.1 Basic Strategy for Geothermal Development

The objective of “Geothermal Development Master Plan”, which is worked out in Chapter 7, is to attain development target of 9,500 MW in 2025 indicated in "Presidential Decree on National Energy Policy (PD. No.5/2006)", although the projected development amounts in 2012 and in 2016 are less than the interim development target of “Geothermal Development Road Map”. It is true that the development target of 9,500 MW is a considerably high target. However, the utmost effort of the government to attain this ambitious target is highly expected.

In Chapter 7, the 73 fields which had been surveyed in this study were classified into the following categories in consideration of such factors as the existence of developers and development plan, the progress of development activities, the possibility of promising resources and so on.

Classification Criteria for 73 Fields

Rank	Progress of Development	Possibility of Promising Resources	Number of Fields	Expected Amount of Development by 2025
A	WKP has been set. Developer is designated.	Estimated as very high.	22	6,556 MW
B	WKP has not yet set. Developer is not yet designated.	Estimated as very high. No existence of well data. Existence of geochemical data.	9	1,250 MW
C	- ditto -	Estimated as very high. No existence of well data. No Existence of geochemical data.	16	1,150 MW
L	- ditto -	Less expectation of high temperature resources.	3	120 MW
N	- ditto -	No estimation due to insufficient information.	23	424 MW
Total			73	9,500 MW

The expected development amounts by ranks are as follows.

Development Amount by Ranks

(MW)

	Existing	2012		2016		2020		2025		Total	
A	857	1,097	(98.2%)	645	(67.2%)	1,713	(58.7%)	2,245	(61.5%)	6,556	(69.0%)
B		20	(1.8%)	315	(32.8%)	535	(18.3%)	380	(10.4%)	1,250	(13.2%)
C		0	(0.0%)	0	(0.0%)	670	(23.0%)	480	(13.2%)	1,150	(12.1%)
L		0	(0.0%)	0	(0.0%)	0	(0.0%)	120	(3.3%)	120	(1.3%)
N		0	(0.0%)	0	(0.0%)	0	(0.0%)	424	(11.6%)	424	(4.5%)
Total	857	1,117	(100.0%)	960	(100.0%)	2,918	(100.0%)	3,649	(100.0%)	9,500	(100.0%)
(cum.)	857	1,974		2,934		5,851		9,500			

Based on this classification, the basic strategy for geothermal development is proposed as follows.

9.1.1 Basic Strategy for Rank A Field Development

In rank A fields, Geothermal Working Area (WKP) has already been designated and the developer has also been decided. Each developer has its development plan in the WKP. In rank A fields, some fields are under steady development; they are Darajat (No.34), G.Wyang-Windu (No.37), and Lahendon (No.61), etc. However, the development of many other fields has not well progressed although the development plan exists. It is true that some fields have their own peculiar reasons of development suspension. For instance, in Bedugul (No.52), the main reason of suspension is the delay in forming a consensus among the local people for geothermal development. In Kamojang (No.32), the main reason of development delay is difficulty of using the forest conservation area for geothermal development. However, a common reason which disturbs the smooth development can be observed in many fields. That is the lack of attractiveness in PT.PLN's buying price for geothermal electricity. Because of this lowness of buying price, many developers are facing the difficulty of envisioning the success of their projects and are hesitant to promote the project. The resources of rank A fields account for almost all the development target in 2012. It is indispensable to resolve this problem and to promote development in rank A fields to accomplish the target of 2012.

To promote rank A fields, the economic incentive policy which bridges the gap between the buying price which PLN offers and the selling price which the developer requests. As shown in Chapter 8, the most concise policy is to raise the buying price of PLN to a certain level. If it is difficult because of maintaining the PLN's financial soundness, the government policy to fill the gap is necessary. The examples of this policy are; the tax incentives, the low interest loan for geothermal exploration and/or exploitation from the governmental banks, and subsidy for geothermal power plant construction cost. Moreover, it is recommendable to utilize the ODA funding such as the Yen Loan for the projects of PERTAMINA, GeoDipa, and/or PT. PLN, as the effect of the ODA funding is considerably large.

[The fields to be promoted urgently by providing economic incentives (Rank A fields)]

No.	Region	Field No	Field name	WKP	Concession	Developer
1	N.Sumatra	8	SARULA	○	PLN	MEDCO/C.ITHO
2	N.Sumatra	9	SIBUAL BUALI	○	PLN	MEDCO/C.ITHO
3	Lampung	27	ULUBELU	○	Pertamina	Pertamina
4	W.Java	32	KAMOJANG	○	Pertamina	Pertamina
5	W.Java	33	G. SALAK	○	Pertamina	Cheveron
6	W.Java	34	DARAJAT	○	Pertamina	Amoseas
7	W.Java	36	G. PATUHA	○	Pertamina	Geo Dipa
8	W.Java	37	G. WAYANG - WINDU	○	Pertamina	MNL
9	W.Java	38	G. KARAHA	○	Pertamina	KBC
10	W.Java	39	G. TELAGABODAS	○	Pertamina	
11	C.Java	44	DIENG	○	Pertamina	Geo Dipa
12	N.Sulawesi	61	LAHENDONG	○	Pertamina	Pertamina
13	N.Sulawesi	63	TOMPASO	○	Pertamina	Pertamina
14	Bali	52	BEDUGUL	○	Pertamina	Bali Energy
15	N.Sumatra	7	LAU DEBUK-DEBUK / SIBAYAK	○	Pertamina	Pertamina
16	E.Nusa Tenggara	55	ULUMBU	○	PLN	MEMR
17	E.Nusa Tenggara	56	BENA - MATALOKO	○	PLN	MEMR
18	Jambi	17	SUNGAI PENUH	○	Pertamina	Pertamina
19	S.Sumatra	25	LUMUT BALAI	○	Pertamina	Pertamina
20	Bengkulu	21	B. GEDUNG HULU LAIS	○	Pertamina	Pertamina
21	Bengkulu	22	TAMBANG SAWAH	○	Pertamina	Pertamina
22	N.Sulawesi	62	KOTAMOBAGU	○	Pertamina	Pertamina

The analysis of Chapter 8 is a very rough one based on limited data. It is extremely important for the government to design the incentive policy which suits for the realities of each project through the hearing and the data collection from the developers.

In addition, it is also important to resolve the individual problems of each project such as the adjustment of interests between forest reservation and geothermal development, the adjustment of interests between PT.PLN and the developers, the formation of consensus among the local people, and so on. To resolve these problems, the developers should exert maximum effort of their own. However, the government is also expected to support developers efforts for the solution.

9.1.2 Basic Strategy for Rank B and Rank C Field Development

Currently no working area (WKP) has been set in rank B and rank C fields. Moreover, the surveys with exploration drillings have not been done in these fields. Therefore, rank B and rank C fields have larger risks concerning the resource development than rank A fields, although the surface data indicate the existence of promising resources. As rank B fields account for about 30 percent of the development amount between 2012 and 2016, the development promotion in these fields is indispensable for the target of 2016. Also as rank

C fields play the key role in the target of 2020 and 2025, the development of these fields are also expected from a long-term viewpoint.

[The fields to be promoted urgently by the government survey (Rank B and Rank C fields)]

No.	Region	Field No.	Field name	Rank
1	Jambi	15	LEMPUR / KERINCI	B
2	W.Sumatra	13	MUARALABUH	B
3	Lampung	28	SUOH ANTATAI	B
4	W.Java	35	CISOLOK - CISUKARAME	B
5	C.Java	47	UNGARAN	B
6	Lampung	29	G. SEKINCAU	B
7	E.Java	50	WILIS / NGEBEL	B
8	N.Sumatra	10	S. MERAPI - SAMPURAGA	B
9	E.Nusa Tenggara	57	SOKORIA - MUTUBUSA	B
10	Aceh	3	SEULAWAH AGAM	C
11	Lampung	30	RAJABASA	C
12	Lampung	31	WAI RATAI	C
13	S.Sumatra	24	MARGA BAYUR	C
14	C.Sulawesi	65	MERANA	C
15	Golontaro	73	SUWAWA-GOLONTALO	C
16	Aceh	1	IBOIH - JABOI	C
17	W.Sumatra	14	G. TALANG	C
18	W.Java	40	TANGKUBANPERAHU	C
19	E.Java	51	IJEN	C
20	W.Nusa Tenggara	53	HU'U DAHA	C
21	E.Nusa Tenggara	54	WAI SANO	C
22	E.Nusa Tenggara	58	OKA - LARANTUKA	C
23	E.Nusa Tenggara	60	ATADEI	C
24	Maluku	69	TULEHU	C
25	N.Maluku	70	JAILOLO	C

In order to develop these fields, the working area (WKP) should be set at first. For this, an enough survey of resources by the government is necessary to set an appropriate working area. It is true that the working area may be set from the results of surface surveys alone. However, the precise information on the existence of resources is more desired to invite private developers into the development of the area. From this viewpoint, the promotion survey with drilling test wells (Geothermal Development Promotion Survey (B) or Geothermal Development Promotion Survey (C) mentioned in Chapter 8) is necessary.

The rank B fields are expected for the high temperature resources from the data of geochemical analysis. The rank C fields are expected for the high temperature resources from the other data Therefore it is recommendable that the surveys of rank B fields be done first and the surveys of rank C fields be done next. The order of rank C survey is their estimated economic order.

Moreover, it is necessary to apply the economic incentives described above to rank B and rank C fields. The rank B and rank C fields have the problem both in the resource risk aspect and in the project economy aspect. The resource risk problem should be decreased by the surveys of the government and the project economy problem should be improved by the economic incentive policy.

9.1.3 Basic Strategy for Geothermal Field Development in Remote Islands

There are some geothermal fields in remote islands in rank A, B, and C. These fields are listed in the following table. In these fields, development of geothermal resources will be small-scale because the power demand in the system is not so large. In such small systems, geothermal power plant is the most economic advantageous power source, as already shown in Chapter 7, because other power plants can not utilize the scale-merit in construction cost. Therefore, geothermal development in such small systems should be positively promoted in order to decrease the generation costs. Moreover, the geothermal development is also desired to promote rural electrification in such small islands, as the National Energy Plan aims at 90% of nationwide electrification or more by 2020. However, in such remote islands, the development by private developers cannot be expected because the project scale is too small for business scale.

In such remote islands where private sector is unlikely to participate, the government should play the central role of development. In such fields, as the development scale is small, there is a possibility of converting succeeded exploration wells into production wells. Therefore, the construction of a small power plant by PT. PLN or by local government company may be easy if government succeeds to drilling steam wells in the survey and transfers the wells to the power plant operator. The governmental survey is highly expected in the fields in the table below.

[The fields to be promoted by the government from the viewpoint of rural electrification]

	Region	No	Field name	Remarks
1	E.Nusa Tenggara	55	ULUMBU	Rank A
2	E.Nusa Tenggara	56	BENA - MATALOKO	Rank A
3	E.Nusa Tenggara	57	SOKORIA - MUTUBUSA	Rank B
4	Aceh	1	IBOIH - JABOI	Rank C
5	W.Nusa Tenggara	53	HU'U DAHA	Rank C
6	E.Nusa Tenggara	54	WAI SANO	Rank C
7	E.Nusa Tenggara	58	OKA - LARANTUKA	Rank C
8	E.Nusa Tenggara	60	ATADEI	Rank C
9	Maluku	69	TULEHU	Rank C
10	N.Maluku	70	JAILOLO	Rank C

9.1.4 Basic Strategy for Other Field Development

Rank L fields come to the result that the resources may not be high temperature ones from existing data analysis. However, this conclusion is a judgment based on the existing data. It is recommendable that the review of resources be properly done after new data is obtained or the new technology has been developed in the future.

The resources of rank N fields were not evaluated due to the lack of information. However, development in these fields is also expected to attain the 2025 development target. Although the development will be concentrated on rank A, Band C fields for the time being, the development in this rank is also necessary in the future.

9.2 Proposals for Geothermal Development

As already discussed, a long lead-time is required for geothermal development. For this reason, immediate action is required toward the accomplishment of the target of 2012. It is also necessary to take immediate measures to start operations in new fields by 2016.

On the other hand, there is also a time lag in several policy measures for producing their respective effects. Some policies produce an immediate effect, while other policies will require a certain period of time to produce an effect. In view of these points, the following proposals have been listed up toward accomplishment of the Geothermal Development master Plan.

<Short-term Policies>

These are policies that are mainly designed to promote the development of rank A fields, and do not require much time in policy implementation and are expected to produce an immediate effect.

Proposal 1 Providing economic incentives

Proposal 2 Establishment of enforcement system for Geothermal Law

Proposal 3 Establishment of rules for coordination among the parties concerned

Proposal 4 Promotion of private developers participation

<Mid-term Policies>

These are policies that are mainly designed to promote the development of rank B and C fields, and can expect an immediate effect but require some time for policy implementation.

Proposal 5 Promotion of resource survey by the government

Proposal 6 Capacity building of geothermal engineers

Proposal 7 Promotion of reducing development costs

Proposal 8 Securing financial resource for the government policy

<Long-term Policies>

These are policies that are mainly designed to promote the development of new fields, and require a relatively long time to produce an effect.

Proposal 9 Promotion of human resources supply in higher education institutions

Proposal 10 Nationalization of technologies and development of related industries

As shown in Chapter 8, the main obstacles for geothermal development lie in the (a) resource development risk and the (b) huge amount of initial investment cost. These policies work on the above two obstacles. These policies approach from the aspects of institutional system, finance and technology. These relationships are shown in Fig. 9.2-1.

Among these proposals, both mid-term and long-term policies require mid-term and long-term activities. As they need some time to produce their respective policy effects, it does not mean that they may be implemented in later years, but mean that an immediate start is desirable for good results.

9.2.1 Proposal 1 Providing Economic Incentives

The main obstacles against geothermal development lie in (a) the resource development risk and (b) the huge amount of initial investment cost. However, currently the Indonesian government has adopted a policy to purchase electric power from geothermal plant at 5 cents/kWh or less, which is the same level of the price of coal-fired thermal power. By this low purchasing price, geothermal development is hardly progressing.

As reported in Chapter 8, the result of rough economical evaluation of geothermal resources shows that no development can be expected if the purchasing price is 5 cents/kWh or less. To cope with this problem, some incentives by the government are necessary.

Currently, various economic incentives are provided in many countries for the development of renewable energy including geothermal energy. These incentives for renewable energy can be classified into three major categories. That is, (i) a voluntary type, where consumers who put high values on renewable energy pay for it voluntarily, (ii)a compulsory type, where electric power companies are obligated to develop and use renewable energy to some extent, and (iii) a support type, where the government takes various measures to support development of renewable energy (see App.9.2.1-1).

An example of the voluntary type of incentives is “Green Electricity Contribution” and “Green Electricity Certificate” which are seen in Japan. This is a system in which consumers of electric power who desire the supply of renewable energy pay a charge (green charge) higher than ordinary electricity charges or cash contributions (green contribution) and such funds are used to promote the development of renewable energy. A Green Electricity Certificate is issued to certify the use of renewable energy. This is a system supported by the voluntary actions of consumers who have a high environmental consciousness. This system has an advantage that consumers can make direct and positive contributions to the promotion of renewable energy, but participants are few, because it involves voluntary cost sharing. In the case of Japan, the adoption rate is less than 0.01%. However, the number of environmentally-conscious companies will increase in the future. It is conceivable that voluntary type support incentives may be taken, focusing on such companies.

There are two types in the compulsory type of incentives that enforce electric power companies to use renewable energy: a type that enforces a purchase price and a type that enforces a quantity. An enforced price type is a system that enforces electric power companies to purchase renewable energy from a renewable energy generation company at a price designated by the government. Such a designated price is set at a fixed rate (for ex. 90%) of electricity charges or an absolute price (for ex. 7 cents/kWh). As introduced in Chapter 8, a famous example of this purchase price type was the PURPA Act which was implemented in the U. S. A. in the 1980s and the Electricity Feed Law which is currently being implemented in Germany. These incentives enable rapid popularization in a short time, if a purchase power pricing level is appropriate. On the other hand, there is a report of examples where development did not make progress sufficiently due to inappropriate designated pricing. It should be noted that setting an appropriate pricing level is very difficult. A type that enforces quantity is a system that obligates electric power companies to generate a certain amount by renewable energy or purchase renewable energy from outside. In particular, a method to set a rate of renewable energy in total output is called an RPS System (Renewable Portfolio Standard). In this system, a method to issue a Certificate of Renewable Energy and to obligate companies to hold more than a certain amount of the certificates is often used. Such certificates can be transacted on the market, and the price of the certificates is determined by the market of the certificates. In this system it is expected that development will make progress in the order of low development cost of renewable energy. A typical example of this type is the RPS system in the U. S. A., England and Japan. This offers the advantage of activating price competition among renewable energies and brings about an incentive for cost reductions. This has also an advantage that clarifies the relationship with the government's target and policies for the introduction of renewable energy.

The government's support types are incentives of taxation system, budgetary system and finance system for renewable energy promotion. Various incentives have been adopted by many countries. As an example of taxation system, the Production Tax Credit in the U.S.A. can be named. As an example of budgetary system, the subsidy system for renewable energy that is implemented in Denmark and Japan can be named. As an example of financing system, a low interest rate loan from governmental banks can be seen in Japan and Germany.

It is necessary to consider geothermal incentives that are suitable for Indonesia, taking into consideration the features, the effects and the costs of these incentives. There is a strong demand from the geothermal developers in Indonesia for purchasing at a price compatible with resource risks and burdens of initial investment. In view of these demands, an effect of increased purchase prices was considered in Chapter 8. Since the ratio of geothermal power generation in all power generation is not so large, an influence of price hike on the financial base of PT. PLN can be almost negated. However, theoretically the increase of purchase price may be detrimental to the financial base of PT. PLN. For this reason, a combination of purchase price increase and the government's economic incentives is a realistic option. In Chapter 8, an analysis for this combination was also attempted.

The strongest method for geothermal promotion may be to introduce the obligatory quantity of geothermal power generation to PT. PLN, such as RPS method. However, this method exerts a great impact on the financial base of PT. PLN. On the contrary, a voluntary type of incentives may be the softest method for PT. PLN and the effect on geothermal development may be very limited. Any incentives have a promotional effect and require the costs. With consideration of these factors, an effort to work out geothermal promotion incentives which are most suitable for the social climate of Indonesia is desired.

In order to realize the governmental incentive measures, a considerably large effort and a long time is forseen. The governmental incentive measures are indispensable by all means to achieve Road Map. Therefore a strong effort of government to realize the measures is desired. However, other two incentives which can be used under the current conditions are also recommendable until government realizes the measures. They are the use of CDM scheme and the use of ODA finance. As already seen in paragraph 8.4.11, CDM has a strong selling price decrease effect of about 0.4 ¢ /kWh in private company's development case if the CER credit price is 5$/ton. The effect increases to about 0.8 ¢ /kWh if CER price increases to 10$/ton. That means the effect of CDM is equal to the effect of purchase price increase. It is strongly desired that the government positively support geothermal CDM projects. Moreover, it is also desired that PLN positively provide necessary information to geothermal developers so that they can easily form their Project Design Documents (PDD) for CDM projects.

The second realistic measure is to use ODA finance. The ODA finance is extremely concessionary finance. As geothermal power generation projects need a large amount of initial investment, such concessionary finance has an extremely large effect. As seen in paragraph 8.4.9, a big development promotion effect is seen even in 5 ¢ /kWh purchase price case if Yen Loan of JBIC, one of examples of ODA finance, is utilized. Such concessionary ODA finance is available not only in JBIC but also in World Bank, Asian Development Bank, and KfW (the ODA bank of Germany) and so on. Positive use of finance from these organizations is expected.

Proposal 1.1 It is necessary to increase the purchase price of electricity from geothermal power plants up to the level that can pay off development efforts in order to ease the two obstacles, that is, the resource risks and the burden of huge initial investment.

Proposal 1.2 If it is difficult to increase the purchase price to a large extent, it is necessary to promote development by combining an increase in the purchase price and various promotion incentives.

Proposal 1.3 The economy of geothermal power plant is different the field by the field. Therefore, it is necessary to obtain enough information and data from the developers and to reflect the realities appropriately in the formation of incentives.

Proposal 1.4 It is also recommendable to study a method that enforces the obligatory quantity of geothermal power generation and/or a method of voluntary type incentives, if necessary.

Proposal 1.5 CDM is one of the realistic incentives which can be used under the current conditions. The government is expected to strongly support CDM projects of geothermal energy developers.

Proposal 1.6 The ODA finance is another realistic incentive which can used under the current conditions until government realizes its incentives. The government is expected to use ODA finance from the World Bank, Asian Development Bank, and the bilateral assistance organizations such as JBIC and KfW.

9.2.2 Proposal 2 Establishment of Enforcement System for Geothermal Law

More than 3 years and half have passed since the Geothermal Law (Law No.27, 2003) was enacted in October, 2003. In the meantime, however, not a single geothermal development has been started by private developers in a new field. One of the reasons for this is that the enforcement system of the geothermal law has not been sufficiently established, including no establishment of implementation rules and regulations of the geothermal law, confusion resulting from empowerment to local governments and inadequacy in the taxation system on geothermal business.

One of the clear examples the lack of implementation rules and regulations brought about is that there has been no tenders for a new field. In the tender system, a working area is set out for new geothermal development, and a private developer which undertakes development is selected by bidding in tender. However, it is still unknown how this tender is implemented. The delay of establishing the implementation rules and regulations disables the development process of geothermal law, and causes the fact that not a single private developer has participated in geothermal development.

The geothermal law stipulates that geothermal resources reserved in a local government area (Regency/City and Province) shall be managed by the head of the local government (Regent/Mayor and Governor) and geothermal resources existing across several local governments areas shall be managed by the upper government (Province in the case of multiple regencies and cities and the central government in the case of multiple provinces). This comes from the trend of decentralization of authority from the central government to the local governments, starting with the Local Autonomy Law (Law No. 22, 1999) enacted in 1999. However, it is said that there are 33 provinces and more than 300 regencies and cities in Indonesia. It is highly likely that licensing operations vary depending on administrative authority's judgment. The geothermal law also stipulates national revenue (tax and non-tax revenue) from geothermal business, but some province governments demand their own local taxes and annoy geothermal developers. In addition, there are various opinions from local government officials[1]. For example, there are inconsistencies between their way of enforcement of the law and the central government's concept. Not only necessary information is insufficiently provided to local government officials, but also they lack necessary knowledge and experience in geothermal power. As such, a lot of confusions are observed in the enforcement system of the geothermal law in the midst of the decentralization trend. To solve these problems is an urgent task. Moreover geothermal resources are underground resources and the precise location is hardly known in advance. Geothermal law stipulates that the management of a geothermal resource depends on the location of resources. Therefore, there is a concern that the legal manager of geothermal resources is not confirmed until the location of resources are surveyed and confirmed.

Also, at the central government level, a new tax rate on geothermal business is not yet determined after the geothermal law is enforced. As a result, there is a complaint in business society that operating revenue cannot be estimated in their business plan[2].

To address these problems, the following measures are proposed.

Proposal 2.1 The implementation rules and regulations of Geothermal Law is urgently to be issued.

Proposal 2.2 With respect to the articles of Geothermal Law which entrust the authority to local governments, it is necessary for the central government to draw up and publish the guideline for the local governments to standardize the administration of the geothermal law.

Proposal 2.3 It is necessary to provide training to the officials of local governments concerning knowledge about geothermal resources and geothermal business as well as the spirit of the law to ensure unified and effective enforcement of the geothermal law.

Proposal 2.5 It is necessary to establish a system to provide information on geothermal resources to local governments.

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1 Remarks of an official in Tohomon City, North Sulawesi Province at the Geothermal Seminar sponsored by BAPPENAS (January 30, 2007)

2 Remarks of a geothermal business entity in the CDM Seminar sponsored by The World Bank

Proposal 2.6 It is necessary to set and announce a new tax rate on geothermal business.

9.2.3 Proposal 3 Establishment of Rules for Coordination Among the Parties Concerned

Geothermal business has many stakeholders. Recently there are some problems reported that the coordination among these stakeholder become rather difficult. For example, there are some cases where permissions of Forest Law are not given for geothermal development in forestry areas. In the case of joint business between PERTAMINA and PT. PLN, it takes longer time than before to conclude a basic development agreement between the parties. As such, difficulties in coordination between the parties involved in geothermal development become an obstacle to the promotion of development.

In 1999, the Indonesian government enforced the new forest law (Law No. 41, 1999) as a replacement for the old forest law (Law No. 5, 1967) with a view to developing the forest industry as well as protecting forests. Behind this, there is a sense of crisis for accelerating a reduction in forest area and a trend toward protection and expansion of local residents' rights to use forests. In the new law, forests are classified into (a) production forests, (b) conservation forests and (c) protected forests, and its method of use is defined. By this categorization, cutting of trees is prohibited in principle and, as a result, geothermal development becomes impossible in a protected forest. However, the permission of cuttings tress is issued if plantation is done in an adjacent area with the width of twice of the cutting area. Currently, the problem in geothermal development and operation of the forest law is, for example, that a forest where geothermal development is already in process is designated afterward as a protected forest and permission for deforestation cannot be given, or that it is difficult to find an alternative area in an adjacent area. Behind these problems, it can be pointed out that authority in the operation of the forest law is transferred to the provincial government in the midst of the decentralization trend and operation of the law differs depending on the local government and an appropriate judgment cannot be made, as human resources and a budget for forest administration are not sufficient.

Both economic development through stable energy supply and environmental protection through forest reserve are important political goals of the government. Therefore, it is necessary to strive for simultaneous attainment of both goals by flexible operation in the law system instead of a simple either-or logic to approve or not to approve development. A flexible response should be more easily taken by recognizing an isolated place as an alternative area, in case that it is not obtained in an adjacent area. Furthermore, it is also necessary to coordinate in advance the forestry plan and the geothermal development plan in designating protected forests. It is necessary to make such coordination in the central government level and to provide its guidelines to local governments. Establishment of rules for such coordination between ministries and agencies are desired.

A conclusion of a basic development agreement as seen in the joint project between PERTAMINA and PT. PLN is another problem that requires such coordination rules between the parties concerned. The geothermal development business involves the risk of underground resource development. For this reason, there is a problem of how this risk is shared between a geothermal developer and an electric company which is an undertaker of electricity. Generally, a geothermal developer desires to conclude a Power Purchase Agreement (PPA) with an electric company as early as possible, because it is advantageous for the developer to obtain the financing for the business. On the other hand, an electric company desires to conclude a PPA as late as possible, because it is necessary for them to know the exact quantity of a resource to decide the capacity of power plant appropriately. This is the same pattern as the "theory of speculation" of a producer and the "theory of postponement" of a retailer in marketing theory (Fig.9.2.3-1). In the case of a geothermal developer, however, the problem is totally different from the case of distribution of goods in terms of magnitude in its investment amount and risk. In addition, electric companies have an overwhelmingly greater voice than geothermal developers, as there is no effective method of use other than the transformation of geothermal steam into electricity on the spot and electric companies are a single buyer of electricity. Also, the fact that all information on steam development is in the possession of a steam developer wraps an electric company up in suspicion and makes them further conservative. For this reason, the negotiation of PPA is often done under the initiative of an electric company and its timing is likely to be delayed. However, in these circumstances, smooth geothermal development cannot be expected. Some corrective measures by the government's intervention are required to correct the imbalance in voices of both parties, to let them negotiate on equal terms with each other, to share necessary information, and to consequently promote geothermal development as a national policy.

Proposal 3.1 It is necessary to make a coordination in the operation of the geothermal law and the forest law between the ministries and agencies on the central government level and to set out rules and guidelines for the operation.

Proposal 3.2 In particular, as for geothermal development in protected forests area, it is necessary to coordinate geothermal development and forestry reservation by taking flexible measures such as forestation in an alternative area.

Proposal 3.3 It is necessary to establish guidelines for PPA negotiation between geothermal developers and electric companies. If negotiation between both parties is deemed not to make smooth progress, it is necessary for the government to intermediate the negotiation to promote it, if necessary.

9.2.4 Proposal 4 Promotion of Private Developers Participation

A considerable amount of funds is required to promote geothermal development according to the geothermal development master plan (Table 9.2.4-1). Accordingly, it will be difficult to accomplish the goal due to limitations of financial power, if development relies on only state-owned enterprises such as PERTAMINA and PT. PLN. Therefore it will be necessary to encourage private developers to participate in the geothermal development business.

Since the Indonesian economy has recovered from the Asian economic crisis of 10 years ago and stability in its macro economy and political situation has improved, major international credit-rating agencies have raised Indonesia's rating to a higher status. Moody's raised Indonesia from B2 to B1 in May, 2006, while Standard & Poor's raised the country's rating from B+ to BB- in July of the same year. These results have been received favorably by private investors, but many problems still remain in order to attract full-fledged investment from the private sector.

Fig.9.2.4-1 shows the items to which investors attach importance in the power generation business in developing countries in a poll conducted by The World Bank in 2003. Those ranked in a high position are items related to legislative protection of investment. However, in Indonesia there are some cases where cancellation of an IPP agreement after the economic crisis developed into international lawsuits. As a result, investors are still mistrustful of Indonesia's attitude toward investment protection. It is urgently necessary to remove the international mistrust by developing legislative protection for investment. The biggest concern of investors in the electric generation business is the government's guarantee on default in payment by PT. PLN. Currently the Indonesian government refuses to provide any direct guarantee. However, according to the agreement made between the Indonesian government and the Japan Bank for International Cooperation (JBIC) in 2006, the Indonesian government is reported to provide financial assistance to the IPP business which is financially supported by JBIC. This is interpreted among the parties interested as a substantial measure by the government to guarantee the performance of obligations of PT. PLN[3]. To expand private investment in geothermal development business, it is desired to expand such a measure to general investment.

Investors also pay attention to the financial base of PT. PLN as a condition IPP agreement. Actually, this is ranked second in the above-mentioned poll conducted by The World Bank. Generally, electricity charges attract great attention from people. Therefore governments are likely to repress electricity charges at a low level in many developing countries. However, the policy to keep electricity charges excessively low will cause great damage to the financial base of electric companies. It will delay the necessary capital investment and has a harmful effect on the maintenance and development of the electric power facilities. It also

[3] News letter No. 6 of Herbert Smith (February, 2007)

will lose attractiveness of private investors who are concern about the performance of electric power companies. In order to avoid such situation, it is necessary to maintain electricity charges at a level to enable the electric power company to develop soundly at all times. In Indonesia, electricity charges are also an extremely important matter of politics. In fact, the government has raised electricity charges every quarter since July, 2001 in order to strengthen the financial base of PT. PLN. However, in September, 2003, the scheduled increase was suspended in view of the sentiment of the people, and the electricity charges have been frozen since then. However, the electricity charges of Indonesia are not very high, when compared with those of neighboring countries (Table 9.2.4-1, Fig.9.2.4-2). The percentage of electric charges as a portion of the income of the people is not necessarily so high compared to countries placed under similar economic conditions. Therefore, it is necessary to make efforts to adjust the electricity charges at an appropriate level at all times for a stable supply of electric power, sound development of the electric power industry and attraction of private investment, though it is fully understandable that a rate increase in electricity charges will lead to a political problem.

There is a problem unique to geothermal power generation; a problem of resource risk. This resource risk is not only considerably a large barrier for private developers, but also is a major obstacle to general investors. For example, the biggest risk in coal-fired thermal power project is unexpected increase in the price of coal in the future. However, in an IPP agreement of coal-fired thermal power in Indonesia, there is a clause that recognizes a markup on the electric power selling price, if the price of coal is increased in the future[4]. Consequently, coal-fired thermal power project has almost no risk. On the other hand, in a geothermal power generation project, there is no mechanism to cover risks of the project, while the project risks are larger than that of coal-fired power plant project. Judging from this difference, general investors will choose coal-fired thermal power without question, when they compare geothermal power generation project and coal-fired thermal power project. Therefore, some measures are required to direct the general investor’s attention to geothermal power generation project and gather significantly more funds.

To address these challenges, the Philippine National Oil Company-Energy Development Corporation (PNOC-EDC) has worked out a unique system. So far, PNOC-EDC has been engaged in the development of steam, while the National Power Corporation (NPC) has been engaged in power generation (Fig. 9.2.4-3 upper part). From the late 1990s, PNOC-EDC began to provide steam to the private company which undertakes the power generation business. The generated electric power is taken back by PNOC-EDC and PNOC-EDC sells it to NPC (Fig. 9.2.4-3 lower part). As a result, the supplier of steam and the receiver of electric power become the same person for the private power generator, and the risk of interruption in the steam supply is eliminated. Consequently, it becomes an almost risk-free business (Fig. 9.2.4-4). Furthermore the investment becomes smaller; the

[4] This is called the “Pass Through” clause.

private company needs to invest only for the power generation section. It becomes an attractive business for private companies to enter into. In this scheme, PNOC-EDC and the private company have a BOT[5] contract for a period of 10 years, under which PNOC-EDC shall supply steam free of charge during the period and shall buy electricity while the private company shall build power plant and generate electricity and shall transfer the power plant free of charge at the end of the contract period. This is a scheme which encourages private companies to enter into the power generation business. This scheme also enables PNOC-EDC to enter the electric power generation business in which PNOC-EDC has no experience before. In Indonesia, generally PERTAMINA takes charge of steam development, while PLN takes charge of power generation. It is necessary to study this kind of scheme to facilitate private participation in geothermal development business.

Proposal 4.1 In order to activate foreign investment in Indonesia, it is necessary to improve the legal environment for investment protection.

Proposal 4.2 In order to attract private investment in the electric power generation sector, to secure the stable supply of electric power, and to promote sound development of the electric power industry, it is necessary to make efforts to adjust electricity charges at an appropriate level at all times.

Proposal 4.3 In order to activate private investment in geothermal development, it is necessary to work out various schemes which enable private companies to enter into the geothermal power generation business with less risks.

9.2.5 Proposal 5 Promotion of Resource Survey by the Government

Generally geothermal development starts with a wide area survey and proceeds, focusing on a promising area gradually. Therefore the biggest resource risk lies in the early stage of survey, and such a risk largely surpasses a private company's ability to bear. In addition, an initial survey also has a meaning of an inventory survey that grasps the amount of resources in the country. For this reason, an initial survey is generally conducted by the government.

Also in Indonesia, an initial survey is to be conducted by the central and local governments, although the developer decided by a bid tender is in charge of development in a geothermal development working area (Fig. 9.2.5-1). However, it is very much a situation in which sufficient surveys are not necessarily carried out due to budget shortages in the central and local governments and lack of equipment and materials for the survey. In the future, however, participation of private developers is essential to accomplish geothermal

[5] Build, Own and Transfer

development master plan, and the leading surveys by the central and local governments are essential to induce such participation.

As introduced in Chapter 8, there are three kinds of leading surveys (Geothermal Development Promotion Survey, GDPS) by the central and local governments. One is a simple survey comprised of surface survey only (GDPS-A). Another one is a survey comprised of surface survey and a few test well drillings (GDPS-B). The third one is a large-scale survey comprised of surface survey and some test well drillings (GDPS-C). In Japan, such surveys for geothermal development have been positively conducted by the government since the first oil crisis. Also in Indonesia these kinds of leading surveys by government are expected.

In the case of GDPS-A, it is recommended that geologic, geochemical and geophysical surface surveys are conducted in an area of 20-30 km^2 to estimate the existing location and rough amount of resources. In this survey, it is desirable to use efficient electromagnetic exploration methods such as MT (Magnetotelluric Method) and CSAMT (Controlled Source Audiofrequency Magnetotelluric Method). About one year is required to conduct this survey in a field, but it is possible to conduct the survey in multiple fields in parallel, as data can be obtained in about one month.

In the case of GDPS-B and GDPS-C, it is recommended to conduct the survey that involves some exploration well-drillings in an area of 20-30 km^2 or slightly narrower, in addition to geologic, geochemical and geophysical surface surveys. It is possible to directly check the existence of steam by exploration wells and furthermore make a reservoir evaluation by checking the property of steam and the amount of its blowout, which makes it possible to develop a highly accurate development plan. About 2 to 3 years are required to conduct this survey in a field, as it involves exploration well-drillings, but it is possible to conduct the survey in multiple fields by adjusting a drilling plan.

In Indonesia, such leading surveys are conducted by the Geology Agency of the Ministry of Energy and Mineral Resources. However, surface surveys have been conducted annually in only a few fields due to the budget shortages. The number of surveys which involve a slim-hole drilling has been only one or so in 2 or 3 years. State-of-the-art exploration methods such as the MT method are not used in a surface survey due to the lack of equipment and materials. As a result, the responsibility of the government is not fully fulfilled. It is strongly desired that such a situation will be improved and full-fledged leading surveys will be conducted by the government. If any funds and technology are required for these surveys, it is desirable to utilize the ODA programs of bilateral aid scheme and/or of The World Bank.

Here let's assume an example of the scheme of GDPS using the Yen Loan as a money source. In this case, let’s take GDPS-B, which includes two exploration well-drillings, to attract private company's participation (Fig. 9.2.5-2). As the cost of GDPS-B for one field is about 10 million U.S. dollars, the total cost of GDPS-B for 10 fields is about 100 million U.S. dollars. It is assumed that this money is procured by the Yen Loan. The government will collect the survey cost (10 m$ per a field) from a private developer who wishes to succeed the development afterwards. In that case, let's make the payment scheme as a 10 year installment payment after five year grace period, in order not to make a large burden of the private developer. In this scheme, when the government survey succeeds and a private developer appears, the government can collect the survey cost. However, when the survey fails and a private developer does not appear, the government can not collect the cost. To prepare such case, the government adds some risk premium (χ%) on the price. By the way, , the interest rate of Yen Loan is 0.65% annually and the repayment period is 40 years with 10 year grace period. This condition is so soft that there will be the surplus money between the collection of the survey cost and the repayment of the Yen Loan. When this surplus money is deposited to a bank, the interest is generated (let's assume 4% interest, for example.). By this effect, the risk cover ratio is calculated as roughly 60% even when the risk premium is 0%. That means, even if private developers appear only in six (6) fields among the ten (10) fields surveyed, the government can secure the repayment money of the Yen Loan (100 m$ plus interest rate). In addition, when the 20% of risk premium is added, the risk cover ratio will fall down to about 50% levels. By the way, the risk premium makes the selling price of electricity higher one. However, it can be judged that the influence is not large in case of 20% risk premium. On the contrary, the effect that the government takes the development risk in the initial stage is much greater for private companies. (Fig. 9.2.5-3)

In this example, we assume the surplus money is able to be deposited in a bank. There is a question here whether it is possible or not. There are some other assumptions to be considered further. However, this example shows that there is possibility to devise a scheme to attract private developers into geothermal business with reducing the financial burden of the government, if ODA money is well utilized. Such scheme may be the so-called Public-Private-Partnership (PPP) scheme for geothermal development. The efforts to work out such an effective scheme by the people concerned are desired.

Proposal 5.1 In order to encourage the participation of private developers, it is essential to conduct Geothermal Development Promotion Survey by the government. It is necessary for the government to carry out the survey with exploration well-drillings under the well prepared plan. The results are expected to be announced to the public.

Proposal 5.2 When technology and monetary resources are needed for the governmental survey, it is recommendable to consider to utilize the ODA programs. There is a possibility of devising a scheme to attract private developers with little financial burden of the government.

9.2.6 Proposal 6 Capacity Building of Geothermal Engineers

As mentioned above, in Indonesia the Geology Agency of the Ministry of Energy and Mineral Resources takes charge of surveys of underground resources in the whole country. Surveys of geothermal resources are also conducted by the geothermal survey team of the Geology Agency, and the results are input into a database. However, it is difficult to say that surveys of promising fields are fully carried out, due to the shortages of budget, human resources and technical abilities.

Generally, a geothermal survey consists of a geological survey, geochemical survey, geophysical survey, drilling of exploration wells, well logging, blowout test and reservoir evaluation. A geological survey is the most basic survey, which captures the entire picture of a development field and provides basic information in interpreting data obtained by their respective exploration techniques. A geochemical survey is a surveying technique to estimate the temperature and chemical properties of the underground resources based on the components of hot springs discharged to the ground. A geophysical survey is a survey to look into the physical data of underground rocks such as temperature, electric conductivity and mass density from the ground. In particular, electromagnetic exploration methods such as the MT method and CSAMT method are expensive but an effective surveying technique for searching drilling sites of exploration wells, since they are highly sensitive to the existence and temperature of fluid compared to other exploration methods. Drilling of an exploration well is a sole means to directly check the temperature, pressure, water permeability of the underground as well as the existence, properties and productivity of steam. Even if the existence of steam cannot be confirmed through an exploration well, it is a fully meaningful survey, as the data of the exploration well makes it possible to verify and correct an underground structural model. Many of the exploration well drilling techniques are diverted from the oil-drilling techniques. In the case of an oil well, it is drilled up to 6,000 meter deep, while in the case of a geothermal well, it is drilled up to 4,000 meter deep or so. In the case of a geothermal well, however, it is necessary to take measures against high temperature. In an oil well, it is 200°C or less, but in a geothermal well, there is a record that it is 500°C at the highest. Various drilling techniques are required to drill safely and securely in such an environment. A survey to obtain physical data from an exploration well, such as temperature, mass density and specific resistance, is called well logging. It is said that skill and experience are required to obtain data in a high temperature environment and analyze and interpret such obtained data. A blowout test is carried out in an exploration well that is capable of producing steam. In this test the temperature, pressure and output (flow volume) of steam are measured. There is a blowout test that is conducted for each exploration well and a simultaneous blowout test that is conducted all at once for all exploration wells. A reservoir evaluation is made based on this data. Generally, the underground construction is divided into a three dimensional mesh, and data such as temperature, pressure and water permeability is simulated by means of a computer. If a natural state and the results of a blowout test can be explained by simulation, future behavior (changes in reservoir and stability of output after the start of operation of an electric power plant) can be predicted based on this simulation. This reservoir evaluation is an integration of survey results conducted so far, and it requires a wide range of knowledge and experience to construct its model.

Indonesia is also a country with geothermal resources and has long experience and technologies of a geothermal survey. Among others, the Geology Agency of the Ministry of Energy and Mineral Resources has played a leading role as a research agency of the government. However, it is difficult to say that sufficient activities have been carried out due to limitations of human resources and budget. For example, the drilling rigs owned by the Geology Agency are small diameter rigs for a survey, and it is difficult to use them for drilling a very deep exploration well due to small drive power. It also does not have sufficient ground survey instruments, and especially does not have equipment and materials for the MT survey which is recently said to be an effective survey method. Geothermal surveying techniques have developed with ingenuity exercised in analyzing and interpreting data based on experience. Under these circumstances, limitations on equipment and materials make it impossible to conduct the latest survey and consequently cause delay in technical capabilities such as data interpretation ability. The Geology Agency of the Ministry of Energy and Mineral Resources is expected to play a big role in promoting geothermal development in Indonesia in the future as an implementing agency of the government's leading surveys as well as a body to provide technical guidance to private developers and universities. Therefore, it is an urgent issue to improve the technical capabilities of the agency.

The technical fields, for which the improvement of the technical capabilities of the Geology Agency of the Ministry of Energy and Mineral Resources is especially needed, range from visualization technology on geothermal resources data (GIS technology), and the latest geophysical exploration techniques (electromagnetic exploration techniques such as MT method), to the latest drilling technologies (directional drilling technology), the latest well logging technologies and the reservoir evaluation techniques (3 dimensional simulation technique).

Proposal 6.1 It is necessary to enhance the technical capabilities and update equipment and materials of the Geology Agency of the Ministry of Energy and Mineral Resources. For this purpose, it is necessary to work out and implement a human resource development plan and equipment and materials expansion plan.

Proposal 6.2 It is recommendable for the government to consider to utilize ODA programs in implementing the above plans, when it is necessary to introduce funds and technologies. Specifically, it is also recommendable to consider the use of the technical co-operation program of Japanese

Government (JICA) for the above-mentioned capacity buildings.

9.2.7 Proposal 7 Promotion of Reducing Development Costs

As discussed in Chapter 8, the power generation cost in geothermal power plant is not so different from the cost of coal-fired thermal power plant, but its selling price is higher than that of coal-fired thermal power plant, since its initial cost is large and its development lead-time is long. In the future, however, it is necessary to make efforts to decrease the selling price of geothermal power generation to expand geothermal energy use. The factors to decrease its selling price include a reduction in drilling cost of wells, reduction in the number of failed wells through improvement in survey accuracy, reduction in development lead-times by efficient surveys, reduction in construction cost by standardization of power plant facilities.

Taking a 55MW model geothermal power plant in Chapter 8 for example, the drilling cost of wells reaches a total of about 40 million U.S. dollars, which accounts for about 30% of the construction costs. For this reason, the drilling cost has a great influence on economic efficiency of a power plant, and if the drilling cost per well increases by one million U.S. dollars, the selling price of electricity increases by about 1 cents/kWh (Fig. 9.2.7-1). Accordingly, if the buying price of PT. PLN remains unchanged, the potential amount of development decreases to a large extent (Fig. 9.2.7-2). At present in Indonesia, oil prices are increasing, and oil field exploration activities are much activated. As a result, the drilling rigs for oil exploration are in full operation, and usage charges for rigs are sharply increasing. Since the drilling rigs for geothermal power and the drilling rigs for oil are basically the same, arrangement of the drilling rigs for geothermal power became very difficult, and the usage charges are considerably increasing. The measures are necessary to mitigate this situation.

In the case of PERTAMINA Geothermal Energy Company (PGE), it does not possess drilling rigs of its own. The company procures drilling services from PERTAMINA subsidiaries (PERTAMINA Drilling Company and USAYANA Company) or from private drilling companies (Appexind Company, etc.) according to their availability. For this reason, the procurement is very much influenced by oil exploration activities, and currently it became very difficult. The charges of rigs are also increasing sharply under the direct influence of oil exploration boom. To address these circumstances, it is appropriate for PGE to own rigs for itself. Otherwise, it is desirable to take measures by which some sets of rigs in the possession of PERTAMINA Drilling Company and USAYANA are ear-marked for geothermal use and can be used at a reasonable price by PGE. In particular, the parent company of PGE, i.e. PERTAMINA, will reportedly transfer its own rigs to USAYANA when it will be transformed into a holding company in the near future. On this occasion, it is desirable that some sets of rigs are made available for exclusive use for geothermal energy development.

In addition, the government is required to take some measures to increase the number of drilling rigs for geothermal use in the market. These measures may range from the granting of subsidies to drilling companies for the acquisition of rigs for geothermal use to the favorable taxation system such as the accelerated depreciation system for geothermal rigs. Through the introduction of these government supports, the number of rigs for geothermal use will increase and the drilling costs will decrease.

The utilization of small-scale wellhead generator can be proposed as another measure for a reduction in development costs. Currently, even if an exploration well succeeds in blowout of steam, construction of a power plant is not started until a certain amount of steam is obtained. As a result, long-awaited steam that has been developed by spending a large amount of money remains trapped underground and not utilized for some years. But in Mexico, if an exploration well succeeds in blowout of steam during the development period, electric power is generated by using a wellhead generator with about a 5 MW back-pressure type steam turbine. This generation also serves as a long-term blowout test to evaluate reservoir capacity, while recovering and utilizing energy. In Indonesia, it is also recommendable to use this kind of small-scale wellhead generator. It may contribute to a long-term blowout test for reservoir evaluation, to supply electricity to the surrounding community, and to collect money to recover some portion of development costs; it is a kill-three-birds-with-one-stone effect.

Proposal 7.1 It is recommendable to take some measures to make some rigs owned by PERTAMINA available for exclusive use for geothermal development to alleviate the difficulty of drilling service procurement.

Proposal 7.2 It is recommendable for the government to take some measures to increase the number of geothermal rigs in the market. Such measures include the grant of subsidies to private drilling companies for the acquisition of geothermal drilling rigs and application of tax incentives to geothermal drilling rigs.

Proposal 7.3 It is recommendable to consider the utilization of small-scale simplified wellhead generator in order to decrease the development cost.

9.2.8 Proposal 8 Securing Financial Resource for the Government Policy

Any government policy requires its cost for implementation. Stable financial resources are necessary for the government to execute energy policies steadily.

Currently, the Indonesian government delivers a large amount of subsidies to soften the oil price increase. It also pays subsidies to PT. PLN to fill the gap between the fuel procurement cost and revenue of electricity charges. The amount of subsidies paid to PT. PLN by the government will reach 27.9 trillion rupiah in 2007[6], and these subsidies will cause a great burden on the government. Table 9.2.8-1 is a provisional estimate of the Ministry of Finance which shows that even if electric power produced by geothermal power plant is bought at 7 cents/kWh, a subsidy of 763 rupiah/kWh for fuel costs can be reduced. This means that if a 55MW geothermal power plant is operated for one year and replaces diesel electric power generation, a subsidy of about 305 billion rupiah will be saved. For this reason, it is the first option to utilize these subsidies to promote geothermal development.

Another option to secure the financial resources of government chest on a long-term basis is to impose a special tax[7] on oil, natural gas and coal sold in the domestic market in order to collect necessary money for energy policy. The imposition of a tax on energy sold in the domestic market has an effect of reducing energy consumption and promoting energy savings. Consequently, a double effect can be expected, that is, rationalization of energy use and promotion of energy policy.

An example of imposing a special tax on the domestic sale of energy and using the tax revenue for energy policy as financial resources can be seen in Japan. As Japan is an importing country of energy, the government imposes a tax of ¥2,040/kl on oil, ¥800/ton on LPG, ¥840/ton on LNG and ¥230/ton on coal at the time of import. It also imposes a special tax of ¥375/MWh on electric power sales. The tax revenue thus collected is used for the energy policies of ministries such as the Agency for Natural Resources and Energy, METI. In 2007, the tax revenues from oil, LPG, LNG and coal is estimated to be 462 billion yen, while the tax revenues from electric power sales is forecasted to be 195.4 billion yen. These financial resources will be allocated to policies for supply and demand of fuel energy worth 535.3 billion yen and to policies for promotion of electric power development worth 226.8 billion yen (Fig. 9.2.8-1).

The necessity to secure stable financial resources for the government will also occur in Indonesia in the future to promote energy policies such as rationalization of energy use and development of alternative energy. For this reason, it is recommendable to study the feasibility of a special taxation system on energy sales.

Proposal 8.1 It is recommendable to study the feasibility of utilizing current subsidies to promote geothermal energy development.

Proposal 8.2 On a long-term basis, it is recommendable to study the feasibility of a

6 According to the materials of the Ministry of Finance on the Geothermal Talk Show held on June 12, 2007

7 This is called a special tax, as the use of a collected tax is limited to the special purpose, the energy policy.

special taxation system on energy sales for financial resource of energy policy.

9.2.9 Proposal 9 Promotion of Human Resources Supply in Higher Education Institutions

According to a research paper[8], there were 526 geothermal-related professionals with university background in Indonesia as of 1999, out of which 90 professionals worked for PERTAMINA. Having majored in Earth Sciences and Mineral Technology or Petroleum and Natural Gas Technology in universities, most of these geothermal professionals are said to have acquired geothermal energy technology in in-house on-the-job-training (OJT) or overseas training under ODA programs. According to the same paper, to develop a 150-200 MW geothermal field, about 25-30 professionals are needed and the technician needs are about 2.5 to 3 times higher than professionals. Based on this estimation that 25 professionals and 60 technicians are required for a 200MW development, it is estimated that about 1,200 professionals and about 2,400 technicians totaling about 3,600 human resources are required to accomplish the goal of 9,500 MW in 2025 (Table 9.2.9-1). This number is about 7 times of the number of at present. How to develop these human resources is a current problem.

In Indonesia, main universities such as the Institute of Technology Bandung (ITB), Gadjiah Mada University (UGM) and University of Indonesia (UI) have the faculty of Earth Sciences and Mineral Technology or the department of Petroleum and Gas Technology in the faculty of Engineering. For example, the Faculty of Earth Sciences and Mineral Technology of ITB offers a curriculum like that in Table 9.2.9-2. Training under the ODA program also has played a major role in capacity building of geothermal energy professionals in Indonesia. Training programs have been provided by the Geothermal Institute of Auckland University as the assistance of the New Zealand government (4-5 trainees annually), by the United Nations University located in Iceland (1-2 trainees annually) and by Kyushu University as the assistance of the Japanese government (1 trainee annually). These ODA programs are large contributions to the fostering of geothermal professionals.

However, training opportunities under ODA programs of these countries are decreasing on the contrary. For example, JICA training course in Japan has been suspended, though it is anticipated that a large number of geothermal professionals are required in the future. It is a big problem in Indonesia on how to develop geothermal professionals.

Under these circumstances, the University of Indonesia has started to provide a Geothermal Research and Education Program specialized in fostering geothermal professionals in the

8 "The needs of a professional course in geothermal energy technology in the development of geothermal industry in Indonesia" Yunus Daud et al. (2000),

Department of Physics, Faculty of Mathematics and Natural Sciences[9]. The program provides education and research concerning geothermal energy like that in Tables 9.2.9-3 and Table 9.2.9-4. In Gadjiah Mada University (UGM), the Comprehensive Academic-Industrial-Regional Cooperation Project has been implemented since 2006 with support from JICA. This is a project to enhance the function of universities in local society, designed for make more contributions in the "education" and "research" fields to the regional needs. Specifically, an academic-industrial-regional cooperation center has been established at Gadjiah Mada University, and the activities to strengthen its function are started. Kyushu University is extending its full cooperation in this project with the aim of promoting geothermal utilization technology there. Like this, various attempts are being made by universities under circumstances where it is anticipated that many geothermal professionals are required in the future. The Indonesian government is expected to provide its positive support for such attempts from financial and institutional aspects.

Also, attention should be paid to the role played by training courses under ODA programs. For example, Kyushu University started an international geothermal group training course in 1970 and invited engineers from developing countries with support from UNESCO and JICA to provide education on geothermal energy for a period of about 3 months. Since 1990, it has leveled up its content and provided education and training as an advanced course with a training period of 6 months, adopting a system in which each trainee conducts research under his or her own theme. A total of about 380 trainees from 36 countries completed this training course from 1970 to 2000[10]. These trainees have played an important role in promoting geothermal development in their home countries. Also in Indonesia, trainees who participated in this training course use their training results for the promotion of geothermal development in main organizations such as the Ministry of Energy and Mineral Resources and PT. LN. However, in the case of JICA, this training course terminated in 2002 due to ODA budget elimination. It is expected that the training course will be revived in the near future.

Proposal 9.1 The government is expected to support universities to their attempts to foster geothermal professionals to meet the large demand in numbers in the future.

Proposal 9.2 In order to foster a large number of geothermal engineers, it is recommendable that the government request donor countries to provide ODA training programs of geothermal technology or to provide financial and technical assistance to universities.

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9 The same paper as the previous foot note.

10 Based on the web site of Kyushu University (http://museum.kyushu-u.ac.jp/MINE2001/04/04-12.html)

9.2.10 Proposal 10 Nationalization of Technologies and Development of Related Industries

A geothermal power plant consists of production/reduction wells, steam-water separator, steam pipe line, power plant building, turbine/generator, cooling tower, transformation/transmission facilities and so on. Geothermal power generation does not require fuel costs, but instead requires a large initial investment costs. In order to expand geothermal generation capacity in the future, it is desirable to gradually nationalize geothermal generation facilities and related technologies so that the investment in geothermal development creates domestic employment and added-values within the country.

Currently, when a geothermal power plant is built in Indonesia, production/reduction wells can be drilled by a domestic contractor. But drilling rigs themselves cannot be manufactured domestically. Most of materials used in drilling (bids, casing, drilling pipes, special cement and mud water, etc.) also have to depend on imported goods, as they are used in a high temperature environment. In addition, steam turbines and generators also rely on imported goods, since they are precision machines and require sophisticated manufacturing technologies such as anti-scale and anti-corrosion measures for example. On the other hand, steam-water separators, steam pipelines and vessels made by Indonesian makers become useful gradually, as they are relatively simple in structure. Power plant buildings can also be built by domestic technologies nowadays, although they require more strength than general buildings to install heavy equipments such as turbine, generators and working cranes. In the future, it is expected to gradually expand the scope of products that can be made by domestic technologies, focusing on peripheral equipment such as piping, containers, valves and electric cables, with the view of expanding market.

Taking into consideration the increase in demand in the oil sector as well as geothermal sector, it is recommendable to improve the quality of domestic products so that they will be used instead of imported products. Some of steel products such as casings and drilling pipes for well-drilling, which are used in less severe environment, can be replaced by domestic products gradually. For this purpose, domestic manufacture's efforts are required to enhance the quality of their products by introducing technologies such as license production with foreign manufacturers, for example.

Lastly, we would like to propose to expand direct-use of geothermal energy for local industry. In cold climates such as Japan or Iceland, hot water from geothermal power plants is actively used. Hot water is used for greenhouse cultivation of flowers and vegetables, for hot swimming pool, and for house warming, thus adding values to local products and providing benefits for the local residents. Even in a warm country such as Indonesia, hot water could be used for mushroom growing and coconut milk drying, and such research is being conducted positively. A sugar factory which utilizes geothermal water actually has been realized. Such attempts are expected to expand in Indonesia to increase the quality of agriculture, forestry and fisheries products and to create employment opportunities in local community. In order to realize the wide use of geothermal hot water, the technology to utilize hot water is expected to develop.

Proposal 10.1 It is desirable to gradually nationalize geothermal generation facilities and related technologies so that the investment in geothermal development creates domestic employment and added-values within the country. For this purpose, it is recommendable to select strategic products and enhance the quality of them through introduction and/or innovation of technology.

Proposal 10.2 It is recommendable to develop hot water utilization technologies from geothermal power plants which are suited for the actual situation of Indonesia. The positive use of hot water for the agriculture, forestry and fisheries industry is highly expected to add values to local products and to increase income of local people.

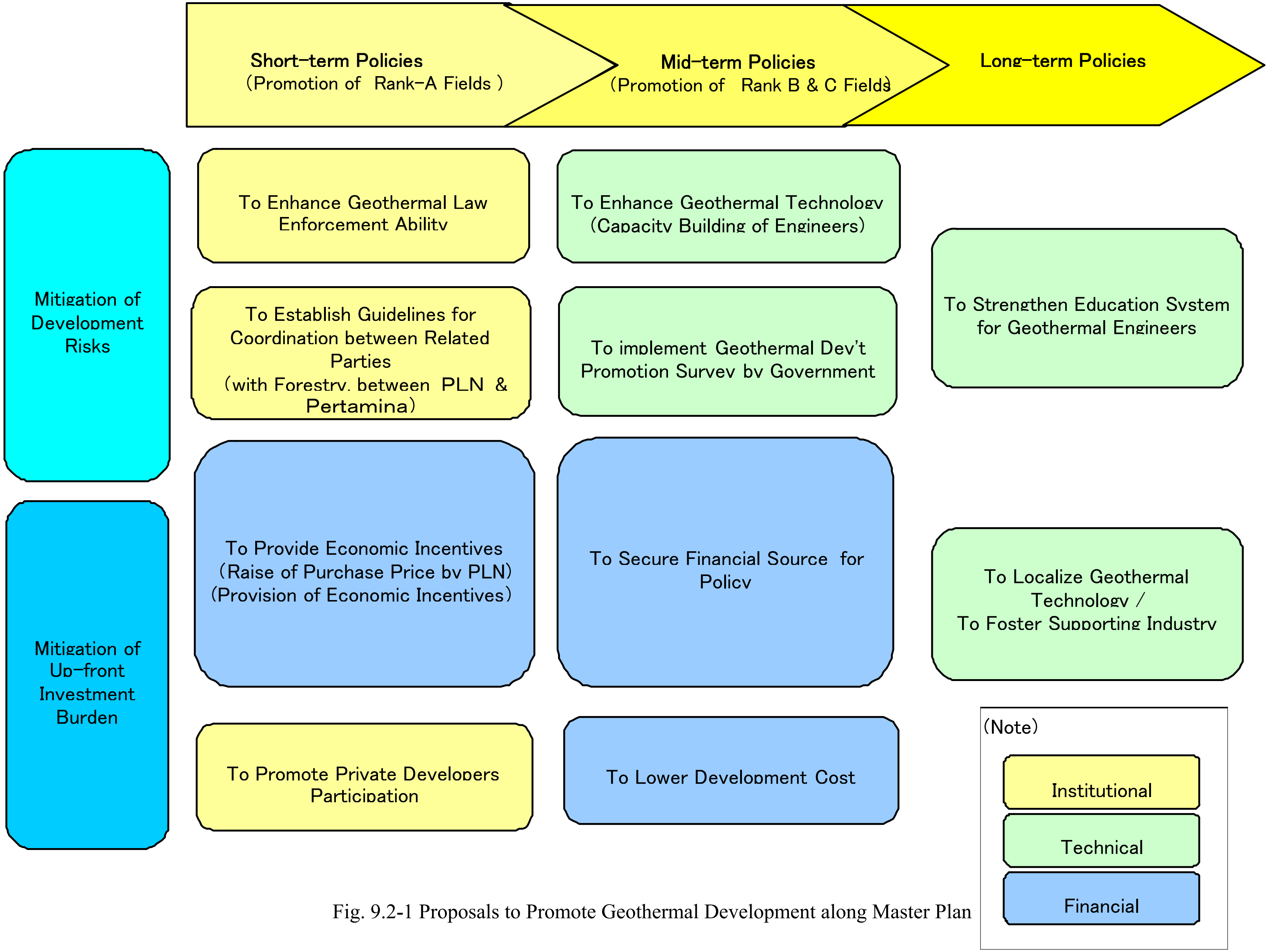


Fig. 9.2-1 Proposals to Promote Geothermal Development along Master Plan

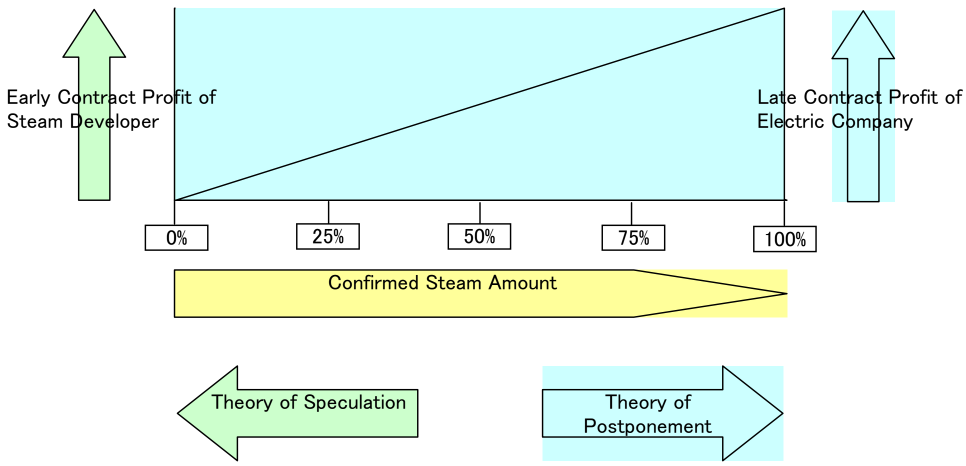


Fig. 9.2.3-1 Geothermal developer's Theory of Speculation and Electric Power Company's Theory of Postponement

Table 9.2.4-1 Estimation of Required Money for Development according to Mater Plan (M-US$)

Surface Svy.	Explo. Drill	Steam Plant	Power Plant	Total
100	500	8,200	9,800	18,600

(Source) Calculated by Rough Economic Evaluation Model

Fig. 9.2.4-1 How Investors Rank Priorities When Investing in a Developing Countries
(Source: "The Challenge of Financing Power Project," Hardiv H Situmeang, PhD, PLN (2005))

Table 9.2.4-2 Basic Electricity Tariff in Neighboring Asian Countries (2005)

Country	Electric Tariff (US ¢ /kWh) (a)	GDP per Capita (US$/capita) (b)	Ratio of Electric tariff and GDP per Capita (10^-3 US ¢ /kWh/US$/capita) (a)/(b)
Indonesia	6.00	1,262	4.75
Cambodia	12.24	320	38.25
Lao PDR	4.22	390	10.82
Malaysia	6.17	4,998	1.23
Myanmar	139.56	167	835.69
Philippines	12.98	1,159	11.20
Singapore	8.29	26,833	0.31
Thailand	7.41	2,721	2.72
Vietnam	4.94	550	8.98
Korea	7.37	16,309	0.45
China	6.00	1,742	3.44
Japan	13.38	35,734	0.37

(Source: Japan Electric Power Information Center, Inc.)

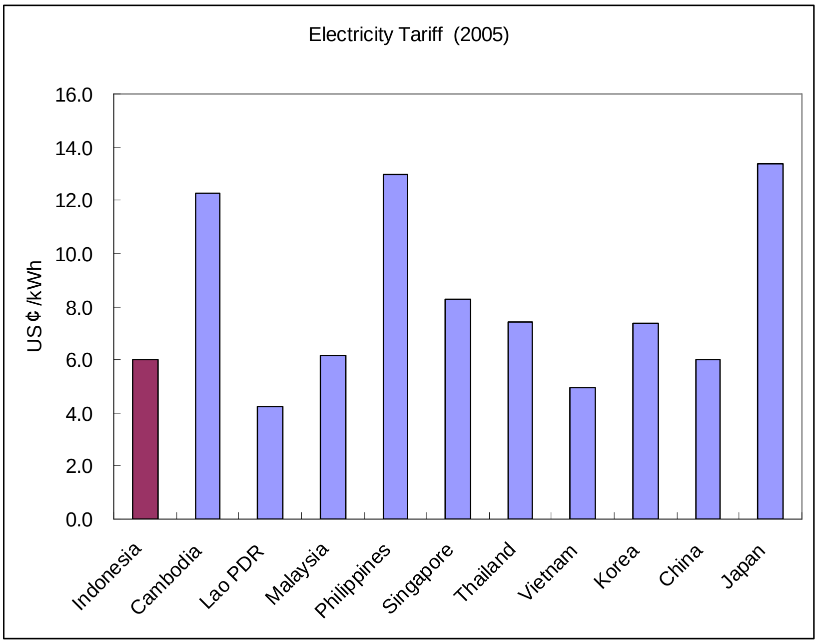


Fig. 9.2.4-2 Basic Electricity Tariff in Neighboring Asian Countries (2005)

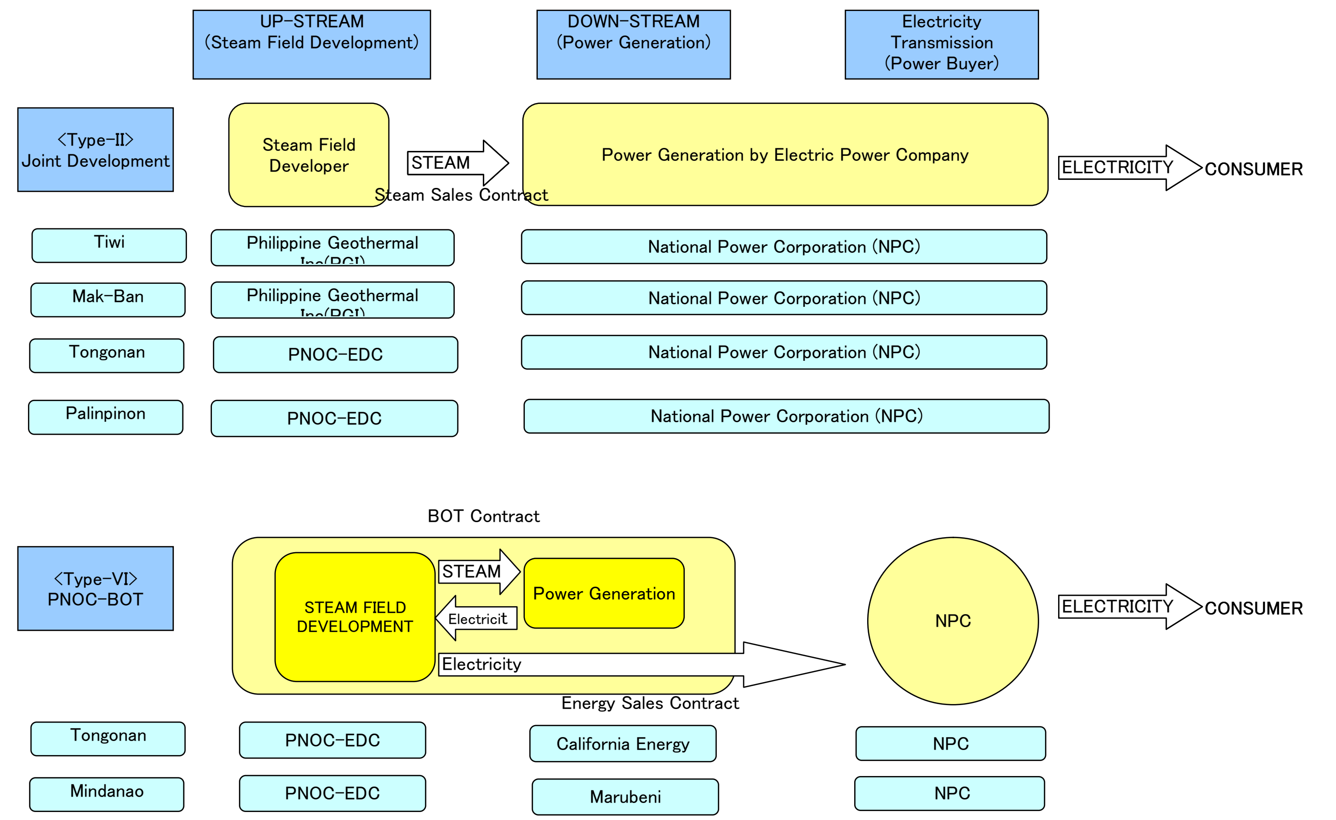


Fig. 9.2.4-3 Geothermal Development Scheme in the Philippines

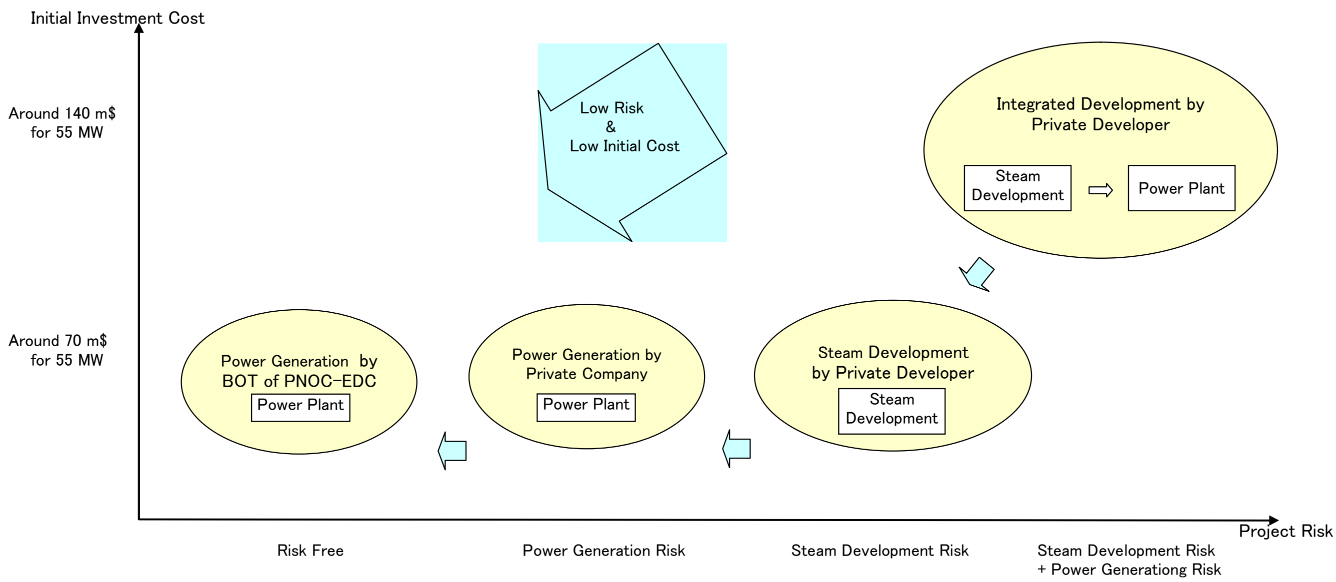


Fig 9.2.4-4 Easiness of Private Participation in Geothermal Development

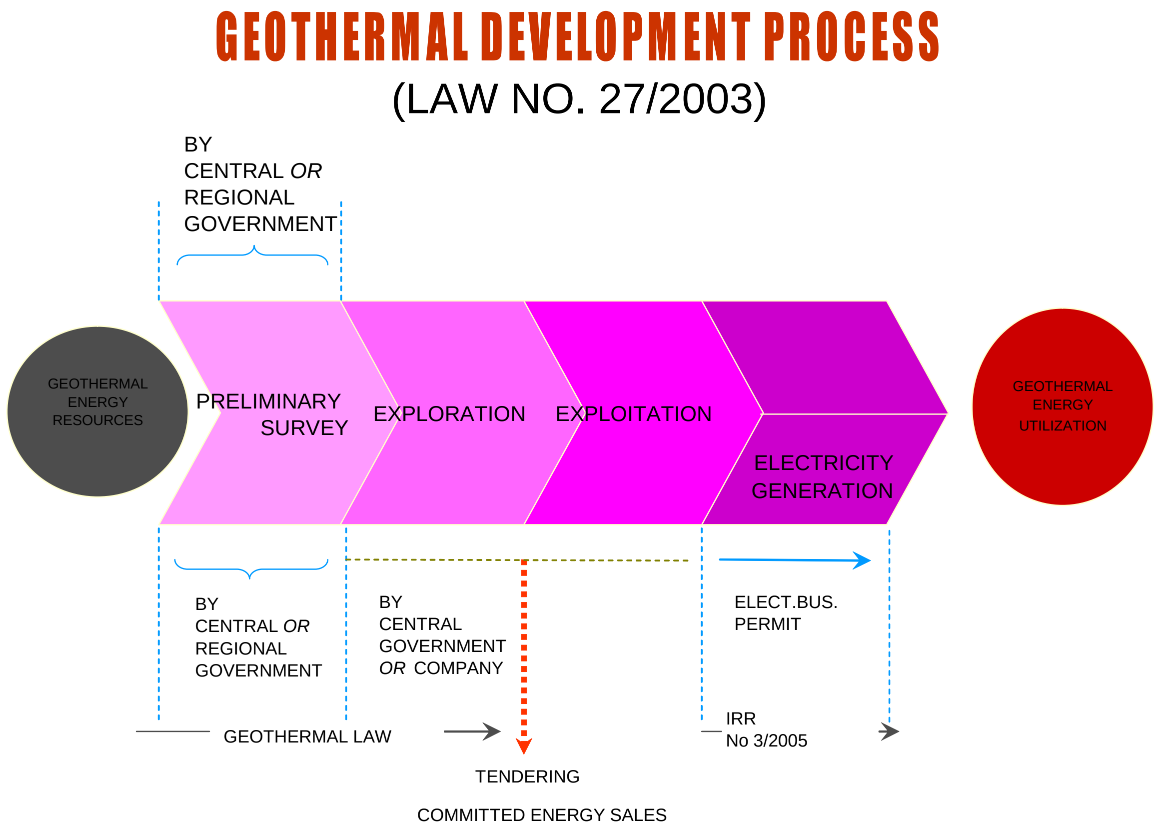


Fig. 9.2.5-1 Geothermal Development Process in Indonesia

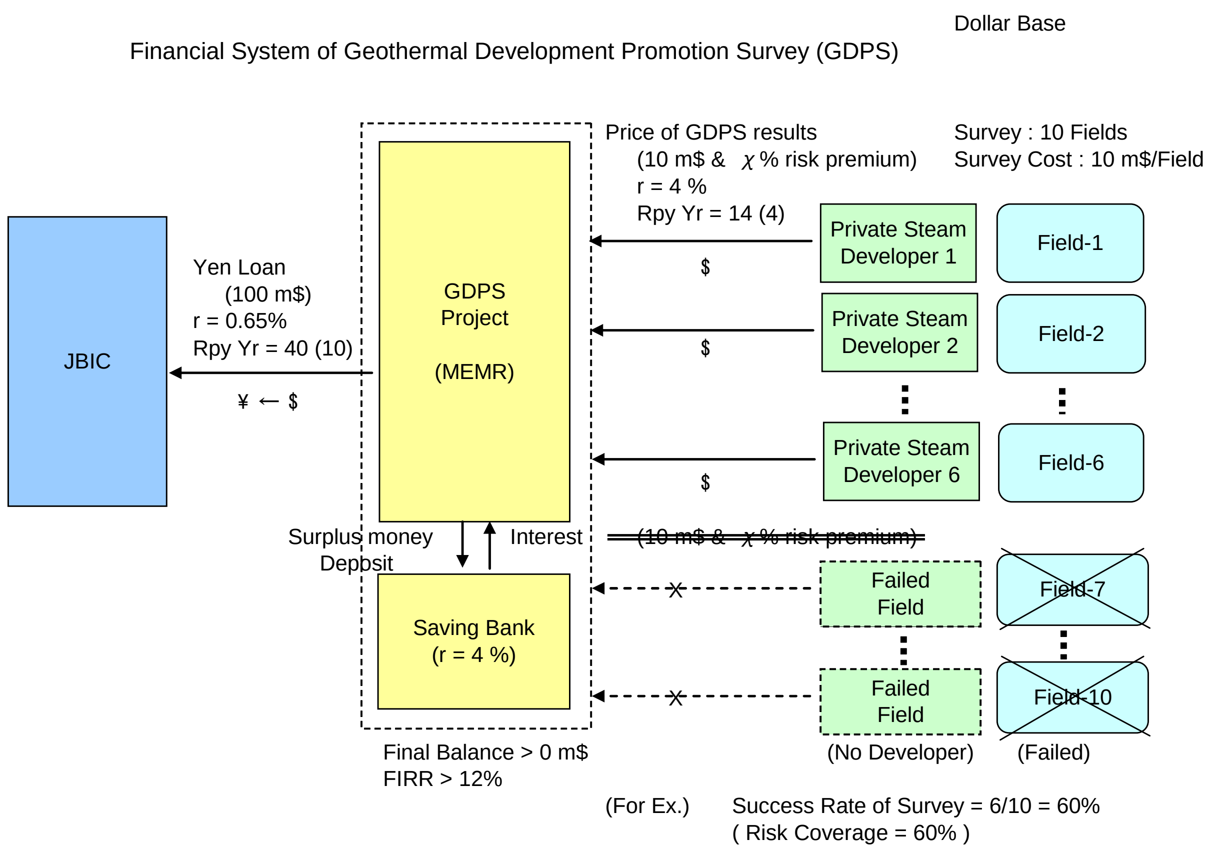


Fig. 9.2.5-2 A Scheme of Geothermal Development Promotion Survey (GDPS) using Yen Loan (Draft)

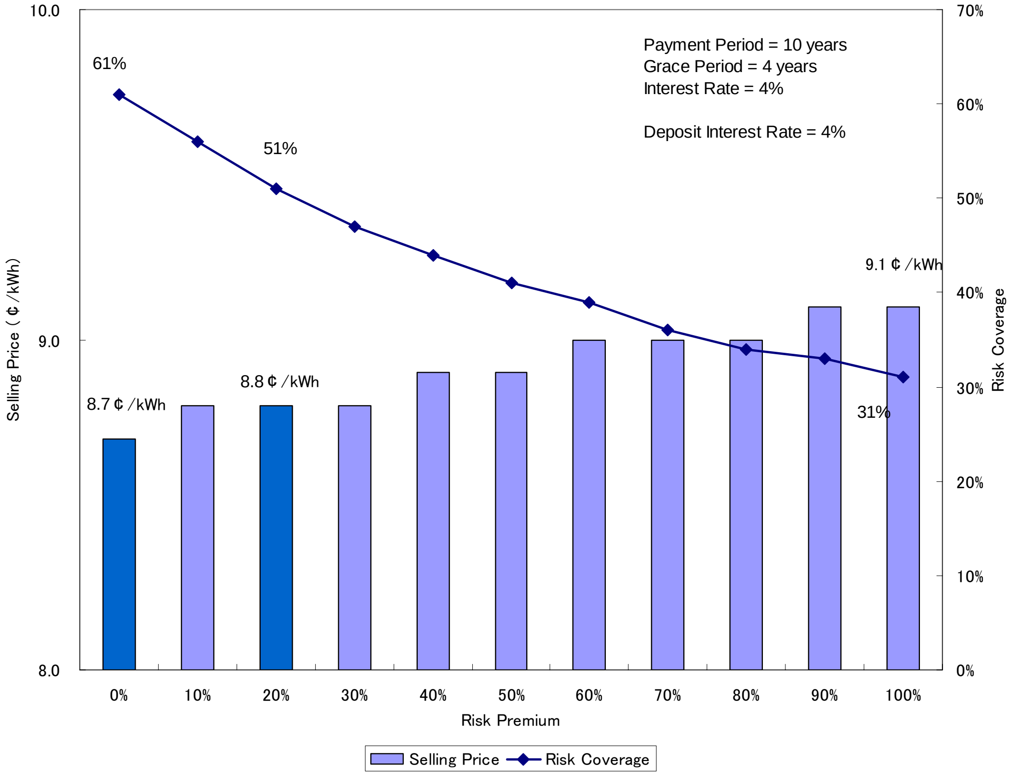


Fig. 9.2.5-3 Risk Premium Effect on Risk Coverage and Selling Price

Technical Transfer Items	1st Year	2ndYear	3rd Year
I. Field Selection Technology GIS Mapping Technology			
II. Advanced Surface Survey Technology MT Survey Technology			
III. Advanced Well Logging Technology Advanced Well Logging Technology			
IV. Resource Evaluation Technology Resource Simulation Technology			
Total			

Fig. 9.2.6-1 Proposal of Technical Transfer Program under ODA Scheme

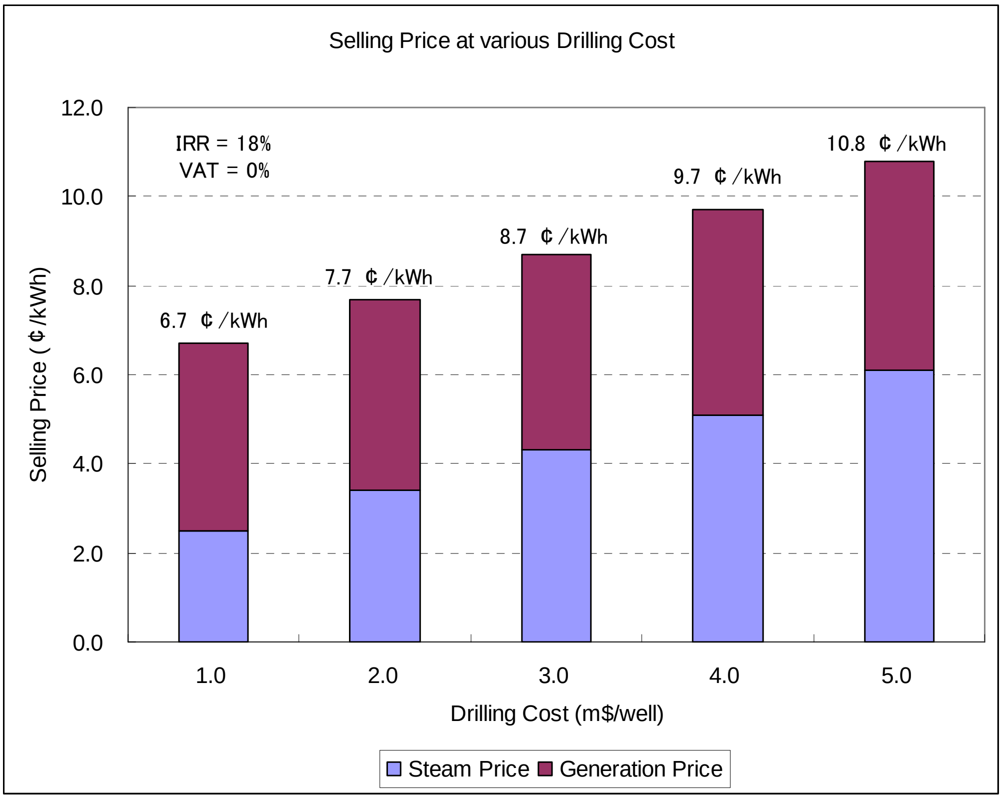


Fig. 9.2.7-1 Effect of Drilling Cost on Selling Price

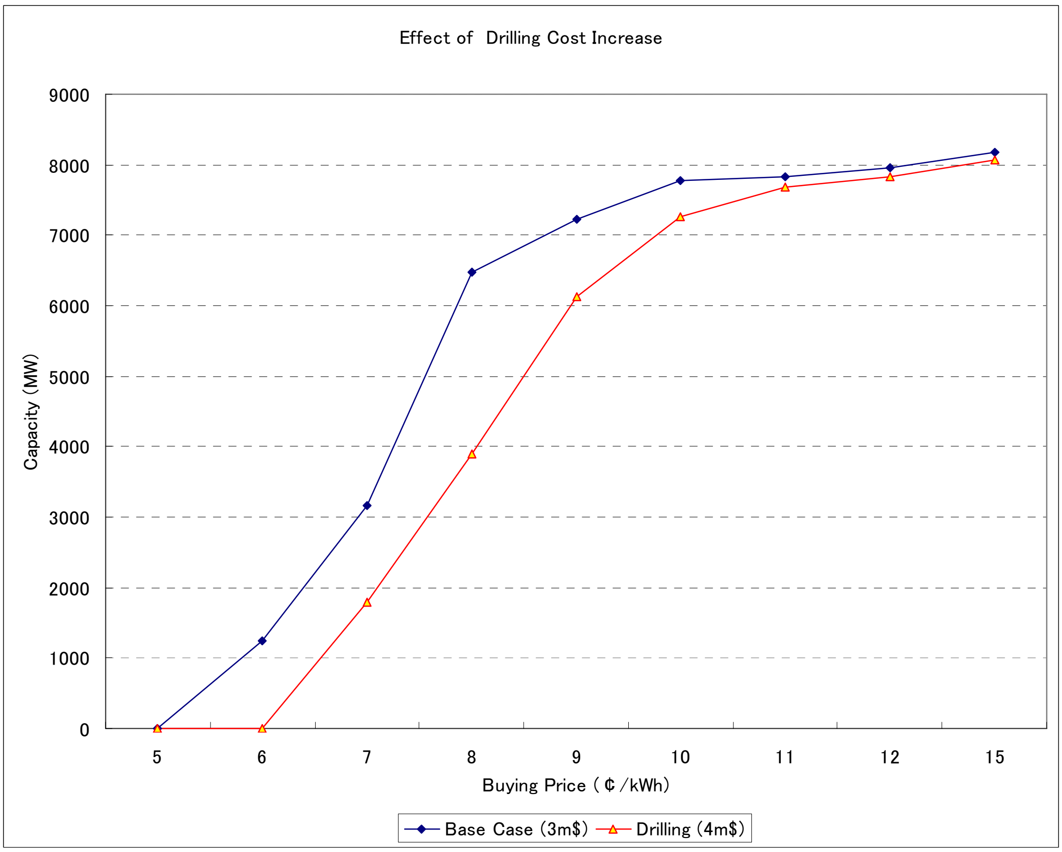


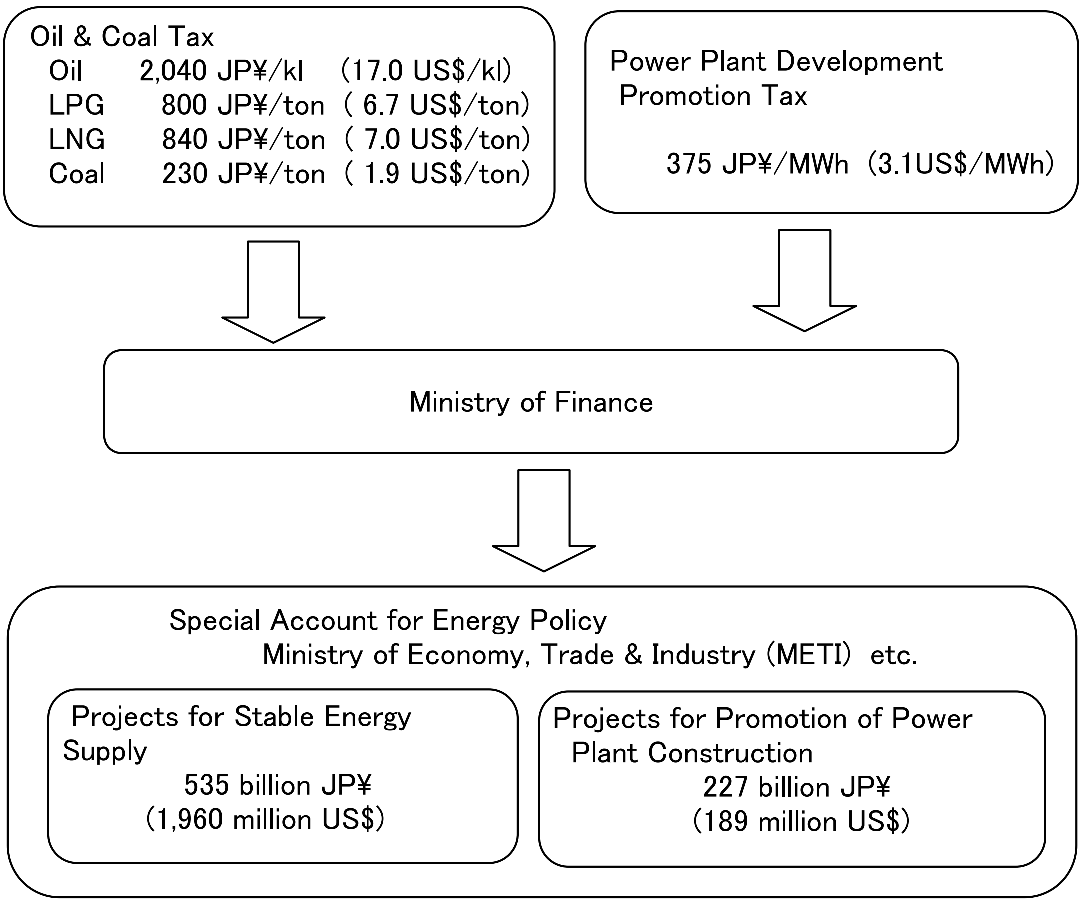
Fig. 9.2.7-2 Effect of Drilling Cost on Development （Fig. 8.4-39 Re-posted）

Table 9.2.8-1 Estimation of Saving Electricity Subsidy by Geothermal Power Plant

Fuel Oil				
Volume	Ltr Needed	Cost/Ltr	Cost (Rp)	Remarks
1 kWh	0.28	5,000	1,400	(a)
400 GWh	112,000,000	5,000	560,000,000,000	(b)
Geothermal				
Volume	Cost (US$/kWh)	Exc Rate (Rp/$)	Cost (Rp)	Remarks
1 kWh	0.07	9,100	637	(c)
400 GWh			254,800,000,000	(d)
Average retail Price			622	(e)
Subsidy (Fuel)			778	(f)=(a)-(e)
Subsidy (Geothermal)			15	(g)=(c)-(e)
Saving			763	(h)=(f)-(g)
In case of 400 GWh				
Subsidy (Fuel)			311,200,000,000	(i)=(f)*400GWh
Subsidy (Geothermal)			6,000,000,000	(j)=(g)*400GWh
Saving			305,200,000,000	(k)=(h)*400GWh

Note : 400 GWh is annual energy produced by 55 MW geothermal power plant.
cf. 55 MW x 8,760 x 0.85 = 409.5 GWh

(Source) Slightly modified from Ministry of Finance's material presented to "Geothermal Talk Show" on 12, June, 2007.



(1US$=120JP¥)

Fig. 9.2.8-1 Special Energy Tax and Energy Policy Budget System in Japan (FY2007)

Table 9.2.9-1 Estimation of Required Number of Engineers and Technicians for Geothermal Development Master Plan

		2012	2016	2020	2025
Geothermal Capacity	(MW)	2,000	2,900	5,900	9,500
Professional	(person)	250	370	730	1,200
Technician	(person)	490	730	1,460	2,400
Total	(person)	740	1,100	2,190	3,600

(Note)

1. The number of professionals is estimated by 25 person at 200MW power plant capacity
2. The number of technicians is estimated by 50 person at 200MW power plant capacity.
3. These assumptions are based on the paper of "The need of a professional course in geothermal energy technology in the development of geothermal industry in Indonesia". (2003) Yunus Daud et al.

Table 9.2.9-2 Example of Study Course in Institute of Technology in Bandung (ITB)

Subject	Course
Mining	Bachelor
Mining	Masters
Mining	Ph.D.
Petroleum Engineering	Bachelor
Petroleum Engineering	Masters
Petroleum Engineering	Ph.D.
Geophysical Engineering	Bachelor
Applied Geophysics	Masters
Applied Geophysics	Ph.D.
Geological Engineering	Bachelor
Geology	Masters
Geology	Ph.D.
Geophysics	Bachelor
Oceanography and Athmosperic Science	Masters
Earth Science	Masters
Meteorology	Bachelor
Oceanography	Bachelor

（Source） ITB Website

Table 9.2.9-3 Example of Lectures being Conducted in the UI Geothermal Program

No	Lectures
	Geothermal Education Program for Bachelor Course
1	Geothermal Energy Systems and Technology
2	Geophysical Methods (Gravity, Magnetic, Resistively and Electromagnet
3	Geothermal Exploration (geophysics, Geology and Geochemistry)
4	Introduction to Geothermal Reservoir Engineering
5	Volcanology
6	Field Trip to Geothermal Area
7	Field Measurements for Geothermal Exploration
8	Undergraduate Research Project in Geothermal Exploration
9	Internal Seminar
	Geothermal Education Program for Mater Course
1	Geothermal Energy System and Technology
2	Advanced geothermal Exploration
3	Advanced Exploration Geophysics
4	Reservoir Engineering
5	Hydrogeology
6	Thesis Project

Table 9.2.9-4 Example of Research Topics being Conducted in the UI Geothermal Program

No	Research Topic
1	Development of Permeability Imaging technique by using Surface and Borehole-to-surface geophysical Measurements
2	Development of 2-D inversion technique of MT data for delineating reservoir structure
3	Reservoir Boundary Delineation by using Controlled Source Audio Magneto-Telluric (CSAMT) Technique
4	Re-injection Monitoring by using Fluid Flow Tomography (FFT)
5	Fracture Delineation by using Micro Earth Quake (MEQ) Study
6	Integrated geophysical techniques for investigation various geothermal settings (including resistively, gravity, MT, CSAMT, SP techniques)
7	Study about the success and failure of the geophysical techniques applied in geothermal exploration in Indonesia

(Source) "The needs of a professional course in geothermal energy technology in the development of geothermal industry in Indonesia" Yunus Daud et al. (2000),

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Attachment

Project Design Document (PDD)

No. 13 MUARALABUH

CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

SECTION A. General description of project activity

A.1 Title of the project activity:

Muaralabuh 55 MW Geothermal Project ("the project")
Version: 03
Date: 27 July 2007

A.2. Description of the project activity:

Indonesia has a huge geothermal energy resource as much as 27,000 MW, but up to present there is only 857 MW (3%) that is being produced as an electricity generation plant, and there is no exploitation for the power generation yet in Sumbagsel Grid System. Sumbagsel Grid System consists of an interconnection grid of transmission lines of 70 kV and 150 kV which covers Lampung, South Sumatera, Jambi, West Sumatera and Riau Provinces. Currently, the total installed capacity of the Sumbagsel Grid is 1,583 MW, consisting of hydro power plants (390 MW), oil-fired power plants (362 MW), coal-fired power plants (460 MW) and gas-fired power plants (371 MW).

The proposed project is to develop a 55MW Geothermal Power Plant by a geothermal IPP (Independent Power Producer) in Muaralabuh geothermal "green" field in West Sumatera Province. The plant will supply 407,707 MWh electricity per annum to the Sumbagsel Grid to meet the electricity demand in West Sumatera region, with the objective as follows:

a. To displace electricity generation from fossil fuel based source with an indigenous and environmentally friendly renewable energy resource (ie. geothermal), resulting in the avoidance of approximately 326,001 tCO_2e per annum.
b. To contribute to sustainable development in the West Sumatera region.

Contribution of the project activity to sustainable development :
In addition to the electricity generation, the project activity must fulfill criteria for the national sustainable development as indicated by the National CDM Comission (http://dna-cdm.menlh.go.id/en/susdev/) (see Annex 5 for the details) through the followings :

Environment :

The use of geothermal energy for electricity generation will contribute to environmental sustainability through the reduction of fossil fuel use in the Sumbagsel Grid System. Geothermal is a very friendly to the environment, with unsignificant gas emissions. In the absence of the project activity the system will likely be dominated by fossil fuel based power generations, especially coal-fired power plants, which exhaust a large amount of green house gases. Therefore, the project activity will contribute to the improvement of local and national environment conditions through the application of much cleaner power generations.

Economy :

The additional electricity supply to the Sumbagsel Grid will contribute to the local economy improvement due to a more secure access of local community to electricity. This will also lead to an enhanced development of infrastructures that would improve the local economy growth.

The utilization of indigenous energy source such as geothermal energy will protect PLN from fossil fuel price fluctuation, thereby the electricity generating cost in the system. The Government of Indonesia will be benefited by the reduction of fossil fuel import and by reducing the country's dependence on the use of fossil fuel in power generation.

Social :
The project activity will create employment opportunities in the project area, either skilled or unskilled laborers during the construction and operation of the project.

Technology :
The project activity will demonstrate the application of cleaner and proven technology, and contribute to the national capacity building and technology development. This kind of project can further stimulate initiatives for investors to develop geothermal energy in Indonesia.

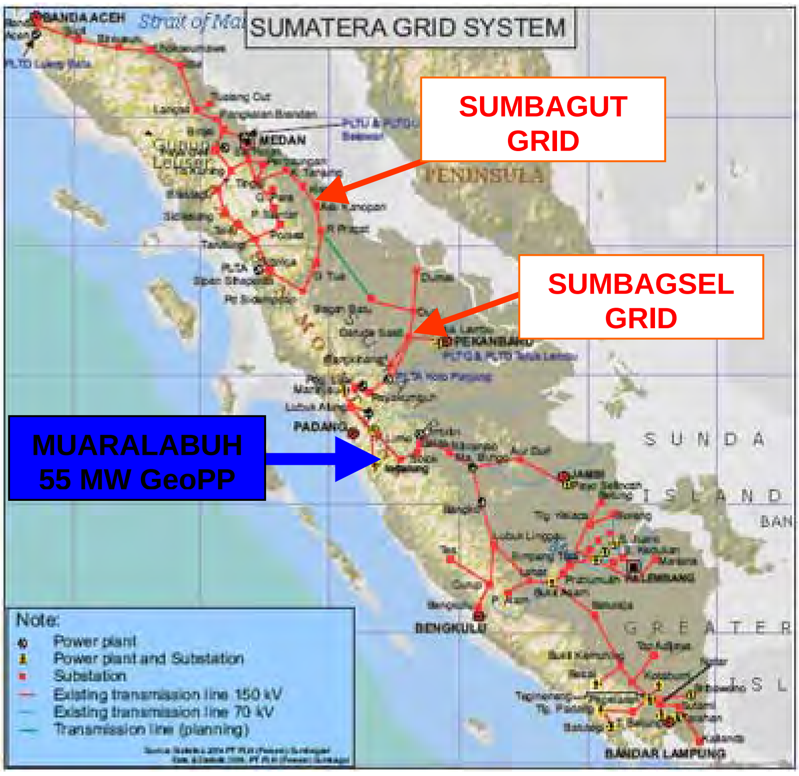

Figure 1. Map of Sumbagsel Grid and Location of the Proposed Project

A.3. Project participants:

Name of Party involved ((host) indicates a host Party	Private and/or public entity(ies) project participants (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)

Republic of Indonesia (host) …..	 …..	No ..…
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required. Note: *When the PDD is filled in support of a proposed new methodology (forms CDM-NBM and CDM-NMM),* at least the host Party (ies) and any known project participants (e.g. those proposing a new methodology) shall be identified.		

The Official Contact Person for the Clean Development Mechanism ("CDM") project activity will be:

…..
…..

Contact information is listed in Annex 1.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Republic of Indonesia

A.4.1.2. Region/State/Province etc.:

West Sumatera Province

A.4.1.3. City/Town/Community etc:

Muaralabuh village, Sungai Pau district, Regency of Solok

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

The project is located approximately 160 km southeast of Padang City, the capital city of the West Sumatera Province, at an altitude of roughly 900 m above sea level. The area is surrounded by forest area. Figure 2 shows the location of the Muaralabuh project.

Figure 2. Location of Muaralabuh Project in West Sumatera Province

A.4.2. Category(ies) of project activity:

Sectoral Scope: Renewable Energy
Project Activity: "Renewable electricity generation for a grid (geothermal)"

A.4.3. Technology to be employed by the project activity:

Geothermal fluid for the Muaralabuh Geothermal Power Plant will be produced by production wells drilled into the geothermal reservoir. As shown in Figure 3, the 2-phase geothermal fluid is separated into steam and hot water (ie. Brine) in a separator, and the steam is directed to a 55MW turbine coupled with a generator to generate electricity, whereas the brine is injected back into the earth in order to avoid environmental pollutions as well as to maintain the life of the reservoir.

Exhaust steam coming out of the turbine is condensed in a direct contact condenser by circulating a cooling water through a mechanical draught cooling tower. The condensate is then reinjected into the earth, while very small amount of non-condensable gases will be rejected to atmosphere. This is the most common technology in the world, including Indonesia, which is technically sound and environmentally safe.

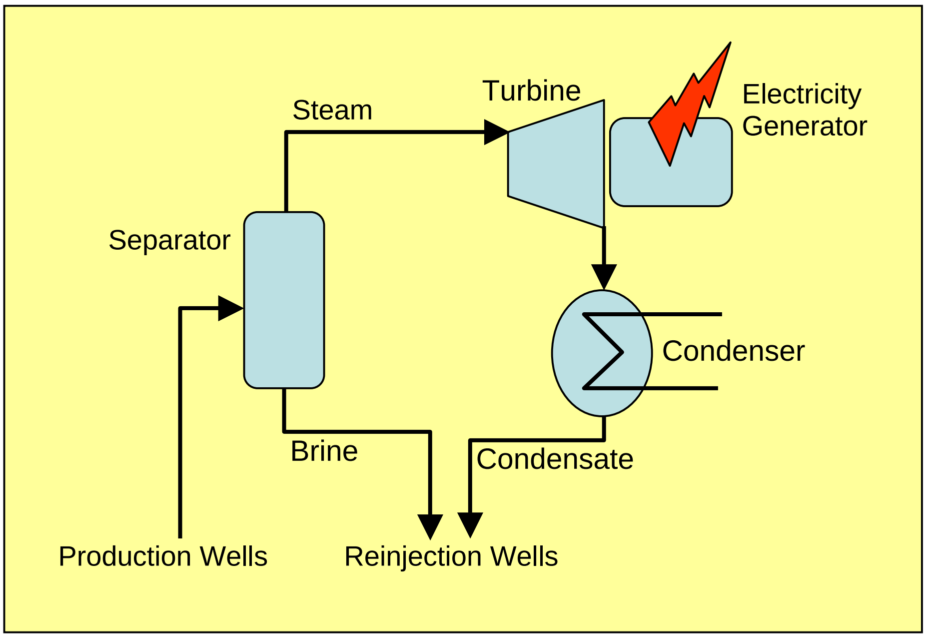

Figure 3. Schematic Diagram of Muaralabuh Geothermal Power Plant

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

Once implemented, the project is expected to yield annual emission reductions (ERs) of 326,001 tCO_2e per annum and a total of 2,282,007 tCO_2e for the duration of the initial 7-year renewable crediting period.

The project estimated annual ERs, over the first 7-year crediting period, are as follows:

Years	Annual Estimation of Emission Reductions in tonnes of CO_2 e
Year 2009	326,001
Year 2010	326,001
Year 2011	326,001
Year 2012	326,001
Year 2013	326,001
Year 2014	326,001
Year 2015	326,001
Total estimated reductions (tonnes of CO_2 e)	2,282,007
Total number of crediting years	7 x 3 years
Annual average over the crediting period of estimated reductions (tonnes of CO_2 e)	326,001

A.4.5. Public funding of the project activity:

.....

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

"Consolidated baseline methodology for grid-connected electricity generation from renewable sources ACM0002 Version 6". This methodology is hereafter referred to as the "Baseline Methodology".

The Baseline Methodology will be used in conjunction with the approved monitoring methodology ACM0002-Version 6 ("The Monitoring Methodology").

B.2 Justification of the choice of the methodology and why it is applicable to the project activity:

The project complies with the Applicability Criteria of ACM0002, as follows:

- The project supplies electricity with the capacity of 55 MW from a geothermal source;
- The project is not an activity that involves switching from fossil fuels to renewable energy at the project site;
- The electricity grid is clearly identified (so called SUMBAGSEL (it means "Southern Sumatera") Grid System) and the information on grid characteristics is also available.

B.3. Description of the sources and gases included in the project boundary

Project Boundary

As per the approved methodology, ACM0002, *“the **spatial** extent of the project boundary includes the project site and all power plants connected physically to the electricity system that the CDM project power plant is connected to.”*

The project boundary is defined as the notional margin around a project within which the project’s impact (in terms of GHG reduction) will be assessed. According to ACM0002/Version 06/Sectoral Scope (19 May 2006) the spatial extent of this project activity includes the project site and all the power plants connected physically to the electricity system that the CDM power project is connected to. Thus, it is essentially the zone encompassing the Muaralabuh Geothermal Plant installations to the nearest grid interconnection point.

Muaralabuh project is located in the West Sumatera Province. The spatial extent of the project boundary includes the project site and all power plants connected physically to the Sumbagsel Grid. The Sumbagsel Grid consists of an interconnection grid of transmission lines of 70 kV and 150 kV which currently covers Lampung province, South Sumatera Province, Jambi Province, West Sumatera Province, and Riau Province. Currently, the grid mix is composed of steam coal power plant, steam gas power plant, diesel power plants fuelled by High Speed Diesel (HSD), hydro and combustion gas turbine and combustion oil turbine power plants. The total installed capacity of the Sumbagsel Grid is 1,658 MW. In keeping with ACM 0002, the baseline emission factor is estimated based on the fuel composition of Sumbagsel Grid and does not include any non-grid connected power plants.

	Source	Gas	Included?	Justification/Explanation
Baseline	Operating and Build Margin of Sumbagsel Grid	CO_2	Yes	Included as per ACM0002 methodology
		CH_4	No	Excluded as per ACM0002. This is conservative
		N_2O	No	Excluded as per ACM0002. This is conservative
Project Activity	Fugitive emissions from Non Condensable Gas (NCG)	CO_2	Yes	Included as per ACM0002 methodology
		CH_4	Yes	Included as per ACM0002 methodology
		N_2O	No	Excluded as per ACM0002 This is conservative

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

According to ACM0002, for project activities that do not modify or retrofit an existing electricity generation facility, the baseline scenario is the following:
“*Electricity delivered to the grid by the project would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources.*”

For a geothermal IPP, there are two choices for the project activity, one is to develop geothermal power plant, and the other is not to do.
Therefore, the following alternatives are possible to be the baseline scenario except the proposed project:

Alternative 1: Continuation of the current situation, where there is no proposed project activity and electricity is delivered to the grid by the operation of grid-connected power plants and by the addition of new generation sources;

Alternative 2: The proposed activity is implemented without the CDM incentives;

The results of the barrier analysis in the section B.5 indicate *Alternative 1* is only the scenario to be the baseline for the proposed project because *Alternative 1* has no barrier against the realization. Detailed explanation is described in section B.5.

The project baseline is calculated on the combined margin approach (CM). The CM, consists of the weighted average of the operating margin emission factor calculated with dispatch data (OM) and the build margin emission factor (BM), weights being default values 50% and 50%, respectively All margins are expressed in tCO_2/MWh. The project boundary is the Sumbagsel Grid.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

The proposed CDM project is justified to have additionality or not by applying "the tool for the demonstration and assessment of additionality (version 03)", which provides a procedure for the additionality demonstration. This approach is executed with the following step:

Step 1: Identification of alternatives to the project activity;
Step 2: Investment analysis to determine that the proposed activity is not the most economically or financially attractive;
Step 3: Barriers analysis; and
Step 4: Common practice analysis.

STEP 1. Identification of alternatives to the project activity consistent with current laws and regulations.

Step 1 includes two sub-steps as follows:

Sub-step 1a. Define alternatives to the project activity

For a geothermal IPP, there are two choices for the project activity, one is to develop geothermal power plant, and the other is not to do.
Therefore, the following alternatives to the project activity are identified:

Alternative 1: Continuation of the current situation, where there is no proposed project activity and electricity is delivered to the grid by the operation of grid-connected power plants and by the addition of new generation sources;

Alternative 2: The proposed activity is implemented without the CDM incentives;

Sub-step 1b. Consistency with mandatory laws and regulations

The realistic and credible alternatives mentioned above are in compliance with all applicable legal and regulatory requirements.

STEP 2. Investment analysis

Not Applied.

STEP 3. Barrier analysis

This step determines whether the project activity faces barriers that:
(a) prevent the implementation of this type of proposed project activity; and
(b) do not prevent the implementation of at least one of the alternatives.

The following two sub-steps are used for the barrier analysis:

Sub-step 3a. Identify barriers that would prevent the implementation of the proposed project activities

In this section, barriers that would impede the implementation of the Muaralabuh Project are identified, and such barriers include:

i) Investment Barrier;
ii) Technological Barrier; and
iii) Barriers due to prevailing practice.

i) Investment Barrier

The regulatory management of the geothermal resource in Indonesia is under the Ministry of Energy and Mineral Resources, split into upstream management by the Directorate General of Minerals, Coal and Geothermal, and downstream management by the Directorate General of Electricity and Energy Utilization. In the past, the development of geothermal energy in Indonesia involved two Indonesian state-owned companies, that is, PT PERTAMINA (the Indonesian state-owned oil and gas company) in the upstream of the geothermal resource management, and PT PLN (the Indonesian state-owned electricity grid operator, retailer and majority generator) in the downstream of the geothermal resource management. A private company which has an interest in geothermal energy business had to make a Joint Operating Contract (JOC) with PERTAMINA and an Energy Sales Contract (ESC) with PLN. This condition caused complexity and bureaucracy to geothermal power development in Indonesia.

As the Geothermal Energy Law (No.27/2003) came into effect in 2003, the separated upstream and downstream regulatory management of the geothermal resource management remains, but PERTAMINA is no longer required as a partner in the development of new geothermal projects. However, up to present, four years after the Geothermal Energy Law came into effect, its implementing regulations such as presidential and ministerial decrees are not issued yet, causing a stagnancy in the geothermal power development.

In the downstream management, PLN is the single sole electricity buyer with no open market competition. With the state power monopoly under political and commercial pressure, the current electricity purchase price is kept low. The GOI provides a huge amount of subsidy to PLN annually. PLN has an overall net loss (as of 2006) due to the addition of interest on loan, exchange rate loss, etc. In addition, Article 16 of PLN Law (No.15/1985) on Basic Tariff of Electricity (Indonesian abbreviation: TDL), regarding "The Government shall stipulate power selling price" policy, has not only economical aspect but also political and social aspects and thus the company is requested to provide electricity to consumers under a uniform tariff set in local currency as determined by the Government. The company is also required to maintain electricity in a condition of Rupiah depreciation against US dollar as well as an increase in world petroleum price. Therefore, this condition causes hesitancy in investing in power generation businesses.

ii) Technological Barrier

As mentioned above, Muaralabuh Geothermal Power Project is a "green field" geothermal development project. The development is started from the very beginning stage, and the primary technological barrier lies in the significant risk of finding the availability of the fuel source, i.e. steam. A geothermal project is totally reliant on the steam produced from the reservoir deep below the earth. Comparing with conventional fossil fuel based power projects, a geothermal project needs significant capital cost and faces risks associated with drilling wells to both confirm and understand the geological setting of the geothermal system to ensure the steam delivery. In addition, the uncertainty regarding the steam availability still remains during the operation phase of the geothermal power plant, where the determination of the number, location and timing of wells required to maintain the steam supply is critical.

iii) Barriers due to Prevailing Practice

Indonesia is a country blessed with a huge fossil based fuel resources, and is fully relying on them accordingly. The Indonesia's oil resources reached around 86.9 billion of barrels, natural gas around 384.7 TSCF, and coal around 50 billion tons. According to the Presidential Decree No.5/2006 on the National Energy Policy, the contribution of coal in the national primary energy mix is targeted to increase from 14% at present to more than 33% in 2025. In addition, as mentioned above, the GOI has a "Crash Program" to develop 10,000 MW of additional coal-fired power generation capacity by 2010. Thus, it is obvious that the national preference for the primary energy source is coal. This impedes the development of renewable energy resources, including geothermal. The fuel pricing approach indicating that coal to be the least cost power option supports this condition.

Sub-step 3b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity)

This section shows how the main barriers identified above will affect the three realistic and credible alternatives defined in the Sub-step 1a (*Alternative 1 and 2*).

1) *Alternative 1:* Continuation of the current situation, where there is no proposed project activity and electricity is delivered to the grid by the operation of grid-connected power plants and by the addition of new generation sources

i) *Investment Barrier*: There is no investment barrier in continuation of the current situation.

ii) *Technological Barrier*: There is no technological barrier in continuation of the current situation.

iii) *Barriers due to Prevailing Practice*: There is no barrier due to prevailing practice in continuation of the current situation.

2) *Alternative 2*: The proposed activity is implemented without the CDM incentives

i) *Investment Barrier*: The investment issue are the same whether the project activity is implemented with or without the CDM incentives.

ii) *Technological Barrier*: The technological issue are the same whether the project activity is implemented with or without the CDM incentives.

iii) *Barriers due to Prevailing Practice*: The barriers due to prevailing practice are the same whether the project activity is implemented with or without the CDM incentives.

STEP 4. Common practice analysis

The existing common practice of geothermal power generation is identified and discussed through the following sub-steps:

Sub-step 4a. Analyze other activities similar to the proposed project activity
Sub-step 4b. Discuss any similar options that are occuring

Indonesia has a huge geothermal energy resource as much as 27,000 MW, but up to present there is only 857 MW (3%) that is being produced as an electricity generation plant, and more than 97% of it is in the Java-Madura-Bali (JAMALI) System. There are 48 geothermal fields with the potential capacity of 8,810 MW in the Sumbagsel Grid, but there is no exploitation for the power generation yet. Therefore, the proposed activity will be the first geothermal power plant in the Sumbagsel Grid.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The estimation of emission reduction follows ACM0002, version 6, the consolidated baseline methodology for grid-connected electricity generation from renewable sources. Version 06 (19th May, 2006), Sectoral scope: 1. The consolidated baseline methodology for grid connected electricity generation from renewable sources (ACM0002) describes a stepwise approach to apply the methodology to the project activity.

The baseline emission factor (EF_y) is calculated as a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) factors. The OM method selected is the Simple OM with *ex-ante* calculation. The BM selected is option 1, *ex-ante* calculation. The weights for calculating the Combined Margin are the default 50% for each of the margins.

STEP 1. Calculate the Operating Margin emission factor ex ante

The Operating Margin emission factor is calculated *ex-ante* based on one of the following four methods:

(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch data analysis OM, or
(d) Average OM.

Simple OM is selected among the four methods above for the following reasons:

1. There is not a half hourly MWh data sheet for individual power plant at PLN Statistics data.
2. The data for the Dispatch Data Analysis Emission Factor is not available to public
3. In addition, it is also difficult to determine λ in simple adjusted OM because of difficulty in determining total annual generation from low-cost must-run resources.
4. Total annual electricity generation from the low-cost must-run resources which includes hydro and geothermal constitutes less than 50% of the total grid generation in Sumbagsel Grid.
5. The low-cost must-run resources (hydro and geothermal power plants) in average of the five most recent years is 32.49% (less than 50%) of the total Sumbagsel Grid generation (see Table 1 below).

Table 1. Electricity Generation of Power Plant for Sumbagsel Grid (MWh)

		2001	2002	2003	2004	2005	2001-2005
Type of Power Plant	Fuel type						
Hydro		1,679,483	1,683,932	2,405,772	2,226,603	2,265,701	10,261,491
Geothermal		0	0	0	0	0	0
Steam - Oil	MFO	97,452	106,988	160,686	993	0	366,119
Steam - Gas	Natural Gas	45,155	99,656	77,829	140,231	125,254	488,125
Steam - Coal	Coal	2,741,448	2,713,276	2,378,787	2,618,576	2,932,329	13,384,416
Diesel	HSD	524,179	503,439	480,800	477,702	301,976	2,288,096
Diesel	IDO	86,266	121,928	91,549	115,943	66,887	482,573
Combustion Turbine - Oil	HSD	378,044	589,351	378,318	517,026	192,818	2,055,557
Combustion Turbine - Gas	Natural Gas	153,804	185,784	354,991	812,025	747,000	2,253,603
Combined Cycle - Oil		0	0	0	0	0	0
Combined Cycle - Gas		0	0	0	0	0	0
Total		5,705,831	6,004,354	6,328,732	6,909,099	6,631,965	31,579,980
Total Low Cost Must Run		1,679,483	1,683,932	2,405,772	2,226,603	2,265,701	10,261,491
% of Low Cost Must Run		29.43%	28.05%	38.01%	32.23%	34.16%	32.49%

Source: Statistik 2001-2005PT PLN (Persero) Pembangkitan Sumbagsel

The Simple OM emission factor is calculated using following data vintages for years(s) *y*:

- (*ex-ante*) the full generation-weighted average for the most recent 3 years (2003-2005) for which data are available at the time of PDD submission.

The Simple OM emission factor ($EF_{OM, simple,y}$) is calculated as the generation-weighted average emissions per electricity unit (tCO_2/MWh) of all generating sources serving the grid system, including low-operating cost and must-run power plants:

$$EF_{OM,simple,y} = \frac{\sum_{i,j} F_{i,j,y} \bullet COEF_{i,j}}{\sum_{j} GEN_{j,y}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Where

$F_{i,j,y}$ is the amount of fuel i (in a mass or volume unit) consumed by relevant power sources j in years y (2003-2005), j refers to the power sources delivering electricity to the grid (Sumbagsel Grid), including low-operating cost and must run power plants, $COEF_{i,j\ y}$ is the CO_2 emission coefficient of fuel i (tCO_2 / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power sources j and the percent oxidation of the fuel in year(s) y, and $GEN_{j,y}$ is the electricity (MWh) delivered to the grid by source j. Description on fuel type and carbon emission factor is given in Table 2 below.

Tabel 2. Fuel Specifications

Fuel Type	Density [kg/kl]	NCV [TJ/Nm^3]	NCV [TJ/kt]	Carbon Emission Factor [tC/TJ]	Oxidation Factor
Data Source	PERTAMINA	PERTAMINA	Coal Statistics	IPCC	IPCC
Coal			23.86	25.80	1
Natural gas		4.27779E-05		15.30	1
HSD	850			20.20	1
IDO	880			20.20	1
MFO	990			21.10	1

Source: Bahan Bakar Minyak, Elpiji dan BBG untuk kendaraan, rumah tangga industri dan perkapalan, PERTAMINA 2003

The CO_2 emission coefficient $COEF_i$ is obtained as:

$$COEF_i = NCV_i \cdot EF_{CO2,i} \cdot OXID_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

where:

NCV_i is the net calorific value (energy content) per mass or volume unit of a fuel *i*,
$OXID_i$ is the oxidation factor of the fuel (see page 1.29 in the 1996 Revised IPCC Guidelines for default values),
$EF_{CO2,i}$ is the CO_2 emission factor per unit of energy of the fuel *i*.

Where available, local values of NCV_i and $EF_{CO2,i}$ should be used. If no such values are available, country-specific values (see e.g. IPCC Good Practice Guidance) are preferable to IPCC world-wide default values.

STEP 2. Calculate the Build Margin emission factor ($EF_{BM,y}$)

The Build Margin emission factor is calculated as the generation-weighted average emission factor (tCO_2/MWh) of a sample of power plants *m*, as follows:

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y} \bullet COEF_{i,m}}{\sum_{m} GEN_{m,y}} \quad \text{………………………….. (3)}$$

where

$F_{im,y}$, $COEF_{i,m}$ and $GEN_{m,,y}$ are analogous to the variables described for the average OM method above for plants *m*.

Option 1. Calculate the Build Margin emission factor $EF_{BM,y}$ *ex-ante* based on the most recent information available on plants already built for sample group *m* at the time of PDD submission. The sample group *m* consists of either the five power plants that have been built most recently or the power plant capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently. It is required to select from those two options that sample group that comprises the larger annual generation.

Option 2. For the first crediting period, the Build Margin emission factor $EF_{BM,y}$ must be updated annually *ex-post* for the year in which actual project generation and associated emissions reductions occur. For subsequent crediting periods, $EF_{BM,y}$ should be calculated *ex-ante*, as described in option 1 above. The sample group *m* consists of either the five power plants that have been built most recently or the power plant capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently–Project participants should use from these two options that sample group that comprises the larger annual generation.

Among the two options available for calculating the build margin, the choice is on the first option or calculation of the build margin emission factor as an *ex-ante* based on the most recent information available on plants already built for sample group m at the time of PDD submission.

The sample group m is the capacity addition of power plants in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently. In this case the 20% of the most recent power plant built had given the larger annual generation over the five plants that have been built most recently in the Sumbagsel grid system from the most recent available data, year 2005.

The 20% of the most recent power plant built comprises 18 power plants (Tabel 3), exporting electricity to the Sumbagsel grid system considered as a subset data points m.

Tabel 3. The Last 18 Power Plant Connected to Sumbagsel Grid

NO.	Description	Unit	Installed Capacity	Start of Operation	Production in 2005 (kWh)	Fuel	Volume	Unit
1	PLTG Inderalaya II	kw	40,000	2004	235,374,704	Gas	2,941,744	mscf
2	PLTG Truck Mounted 1	kw	20,000	2004	109,551,361	Gas	1,209,974	mscf
3	PLTG Truck Mounted 2	kw	20,000	2004	121,387,361	Gas	1,359,928	mscf
4	PLTG Apung	kw	33,600		81,775,808	Gas	883,590	mscf
5	PLTG Rental Inderalaya	kw	50,000	2003	-	-	-	
6	PLTG Rental Tl. Duku #1	kw	20,000	2004	79,683,666	Gas	1,467,382	mscf
7	PLTG Rental Tl. Duku #2	kw	14,000	2004	-		-	
8	PLTA MUSI #1	kw	73,600	2006	-	-		
9	PLTA MUSI #2	kw	73,600	2006	-	-		
10	PLTA MUSI #3	kw	73,600	2006	-	-		
11	PLTA BESAI #1	kw	45,000	2001	154,074,800	-		
12	PLTA BESAI #2	kw	45,000	2001	209,659,200	-		
13	PLTA BATUTEGI #1	kw	14,000	2002	75,240,600	-		
14	PLTA BATUTEGI #2	kw	14,000	2002	69,895,700	-		
15	PLTA SKRK #1 [VOEST ALPN]	kw	43,750	1998		-		
16	PLTA SKRK #2 [VOEST ALPN]	kw	43,750	1998	190,101,502	-		
17	PLTA SKRK #3 [VOEST ALPN]	kw	43,750	1998		-		
18	PLTA SKRK #4 [VOEST ALPN]	kw	43,750	1998		-		
					1,326,744,702	20.0%		

Source: Statistik 2005 PLN Pembangkitan Sumbagsel

Note:

PLTA : Hydro Power Plant

PLTD : Diesel Power Plant

PLTG : Gas Thermal Power Plant

PLTU : Coal Thermal Power Plant

PLTGU: Combined Cycle Gas Thermal Power Plant

Since ACM0002 baseline methodology calculation does not state the years from which the data should be included for calculating the build margin, the most recent available data (year 2005) is used.

The Build Margin Emission Factor ($EF_{BM,y}$), in tCO_2equ/MWh, is the sum of the carbon dioxide emissions 2005 of the set of *mi* generators selected for the year *i* =2005, in tonnes, divided by the sum of all electricity dispatched onto the Sumbagsel Grid for the same year in MWh by this set of generators.

STEP 3. Calculate the Combined Margin Emission Factor EF_y

The Combined Margin emission factor EF_y is calculated as the weighted average of the Operating Margin emission factor ($EF_{OM,y}$) and the Build Margin emission factor ($EF_{BM,y}$):

$EF_y = w_{OM}\, EF_{OM\,,\,y} + w_{BM}\, EF_{BM\,,\,y}$ ………………………….. (4)

where

the weights w_{OM} and w_{BM}, by default, are 50% (i.e., $w_{OM} = w_{BM} = 0.5$), and $EF_{OM,y}$ and $EF_{BM,y}$ are calculated as described in Steps 1 and 2 above and are expressed in tCO_2/MWh

STEP 4. Calculate the project emissions

In this project, the following emission sources are considered:

a) Fugitive Emissions from Non-Condensable Gases

Fugitive carbon dioxide and methane emissions due to release of non-condensable gases (NCG) from the produced steam are estimated based on data from the adjacent Lempur-Kerinci geothermal field (*PESy*):

$PESy = w_{NCG}\,(w_{Main,CO2} + w_{Main,CH4} * GWP_{CH4}) * M_{S\,,\,y}$ ………………………….. (5)

where *PESy* are the project emissions due to release of carbon dioxide and methane from the produced steam during the year y; w_{NCG} is the average mass fraction of non condensable gas in the produced steam; $w_{Main,CO2}$ and $w_{Main,CH4}$ are the average mass fractions of carbon dioxide and methane in the non condensable gas; GWP_{CH4} is the global warming potential of methane and $M_{S\,,\,y}$ is the quantity of steam produced during the year *y*.

In ex-ante calculation, the CO_2 content of non-condensable gas is 0.317% by weight and the CO_2 content in steam is about 0.26% by weight. CH_4 content in steam is about 0.1% by weight.

b) Carbon dioxide emissions resulting from fossil fuels related to the operation of the geothermal power plant (PEFFy)

The CO_2 emissions resulting from electricity consumption required for the operation of the geothermal power plant will be as follows:

b-1) Electricity consumption for producing steam to be supplied to the geothermal power plant. Steam production requires electricity at a facility located outside of the power plant to run the equipments such as pumps and valves, and because of its location, electricity will be supplied from the Sumbagsel Grid.
This electricity consumption is estimated to be small because the electricity is used to meet the small-scale demand, such as a pump for reinjection of hot water. As this consumption is estimated to be less than 1 % of the total demand from the experience of the other existing unit, it can be considered negligible.

b-2) Electricity generation of the power plant itself
This activity requires internal use of electricity by the project plant such as the running of motors. This activity consumes the power generated from the plant itself. Therefore, the greenhouse gas emissions are considered zero since it is generated from geothermal steam and not by fossil fuel combustion.
Carbon dioxide emissions resulting from fossil fuel consumption related to the operation of the geothermal power plant are considered and expected to be 0.

STEP 5. Calculate Leakage

Leakage emissions are considered and expected to be 0.

STEP 6. Calculate Project Emission Reductions:

The project emission reductions are to be derived *ex-post* annually as follows:

ERs per annum (tCO_2e) = Combined Margin x (Muaralabuh electricity dispatched in MWh to the Sumbagsel Grid) – fugitive emissions

ERs per annum (tCO_2e) = EF_y x annual dispatched electricity in MWh - $PESy$ …………….. (5)

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	$EF_{OM,y}$
Data unit:	tCO_2/MWh
Description:	Operating Margin emission factor for Sumbagsel Grid
Source of data used:	Computed from data sourced from PLN Sumbagsel
Value applied:	1.269 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	Calculated as per ACM0002 with 3 years vintage (2003, 2004, 2005) data obtained from PLN Sumbagsel Annual Report.
Any comment:	

Data / Parameter:	$EF_{BM,y}$
Data unit:	tCO_2/MWh
Description:	Build Margin emission factor for Sumbagsel Grid
Source of data used:	Computed from data sourced from PLN Sumbagsel
Value applied:	0.403 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	Calculated as per ACM0002 with 3 years vintage (2003, 2004, 2005) data obtained from PLN Sumbagsel Annual Report.
Any comment:	

Data / Parameter:	EF_y

Data unit:	tCO_2/MWh
Description:	Combine Margin CO_2 emission factor for Sumbagsel Grid
Source of data used:	Calculated based on the statistics data from PLN Sumbagsel
Value applied:	0.836 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	Calculated as per ACM0002 with 3 years vintage data and option of ex ante calculation based on 50% of OM and 50% of BM values approach.
Any comment:	

Data / Parameter:	Amount of fossil fuel consumed per annum by Sumbagsel Grid
Data unit:	Mass or Volume
Description:	Quantity of fossil fuel consumed by each power plant
Source of data used:	Statistic data from PLN Sumbagsel
Value applied:	Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	This data is taken from publicly available data and not by direct measurement
Any comment:	Obtained from the latest statistics from PLN Sumbagsel, 2003-2005

Data / Parameter:	CO_2 emission coefficient of diesel
Data unit:	tCO_2e/GJ diesel
Description:	The coefficient for CO_2 emissions for combustion of High Speed Diesel in Indonesia power stations
Source of data used:	IPCC default value
Value applied:	74 tonnes of CO_2/TJ
Justification of the choice of data or description of measurement methods and procedures actually applied :	Considering that there is no actual measurement of emission factor, the default value of IPCC guideline 2006 is used.
Any comment:	In the absence of actual data, IPCC values are used

Data / Parameter:	CO_2 emission coefficient of MFO
Data unit:	tCO_2e/GJ diesel
Description:	The coefficient for CO_2 emissions for combustion of Marine Fuel Oil in Indonesia power stations
Source of data used:	IPCC default value
Value applied:	77.4 tonnes of CO_2/TJ

Justification of the choice of data or description of measurement methods and procedures actually applied :	Considering that there is no actual measurement of emission factor, the default value of IPCC guideline 2006 is used.
Any comment:	In the absence of actual data, IPCC values are used

Data / Parameter:	CO_2 emission coefficient of natural gas
Data unit:	tCO_2e/GJ natural gas
Description:	The coefficient for CO_2 emissions for combustion of natural gas in Indonesia power stations
Source of data used:	IPCC default value
Value applied:	56.1 tonnes of CO_2/TJ
Justification of the choice of data or description of measurement methods and procedures actually applied :	Considering that there is no actual measurement of emission factor, the default value of IPCC guideline 2006 is used.
Any comment:	In the absence of actual data, IPCC values are used

Data / Parameter:	CO_2 emission coefficient of coal
Data unit:	tCO_2e/GJ coal
Description:	The coefficient for CO_2 emissions for combustion of coal in Indonesia power stations
Source of data used:	IPCC default value
Value applied:	94.6 tonnes of CO_2/TJ
Justification of the choice of data or description of measurement methods and procedures actually applied :	Considering that there is no actual measurement of emission factor, the default value of IPCC guideline 2006 is used.
Any comment:	In the absence of actual data, IPCC values are used

Data / Parameter:	Electricity generation of each power source/plant
Data unit:	MWh/year
Description:	Electricity generation from each power source/plant of low cost must run power plant
Source of data used:	Statistic data from PLN
Value applied:	Annex 3
Justification of the choice of data or description of measurement methods and procedures	

actually applied :	
Any comment:	

Data / Parameter:	CVi
Data unit:	TJ/t
Description:	Net calorific value (TJ/t of fuel)
Source of data used:	Pertamina and Indonesian Coal Statistics
Value applied:	
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	Quantity of steam generated
Data unit:	t
Description:	The amount of steam
Source of data used:	PERTAMINA
Value Applied	385 t steam/h
Justification of the choice of data or description of measurement methods and procedures actually applied :	This is the data available to estimate the projection of power generation. The actual measurement of steam should be conducted on a continuous basis and should be based on international standard. The measurement results should be summarised transparently in regular production reports.
Any comment:	

Data / Parameter:	CO_2 project emissions in steam
Data unit:	tCO_2/ton steam
Description:	CO_2 Non Condensable Gases emissions from the wells
Source of data used:	PERTAMINA
Value Applied	0.26 t CO2/t steam
Justification of the choice of data or description of measurement methods and procedures actually applied :	Value measured in a well in the adjacent geothermal field (ie. Lempur-Kerinci) with laboratory screening for exact gas composition.
Any comment:	NCG sampling is carried out in a production well in Lempur-Kerinci geothermal field.

B.6.3 *Ex-ante* calculation of emission reductions:

Based on the *ex-ante* - the full generation-weighted average for the most recent 3 years (2003-2005) for which the most recent data are available, the value of the operating margin $EF_{OM,simple,y}$ calculated through a simple method using the data presented in Table 4 and 5 is 1.269 tCO_2/MWh in average.

Table 4. Total Fuel Consumption and Emissions

	Total Fuel Consumption and Emissions (incl. rental and IPP)					
	MFO	HSD	NG	Coal	IDO	Total
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2005	0.0	485,938.3	748,534.3	3,729,436.9	44,744.8	5,008,654.3
2004	1,294.4	1,307,835.3	923,007.9	3,317,439.6	78,131.2	5,627,708.4
2003	39,429.2	999,080.6	608,058.4	3,121,648.7	62,481.5	4,830,698.4
				Total		**15,467,061.1**

Tabel 5. EF_{OM} Calculation

Total Generation Capacity (2003-2005) incl. Must-Run				
Parameter	**Unit**	**2005**	**2004**	**2003**
Hydro	GWh	2,265.70	2,226.60	2,405.77
Thermal	GWh	4,286.58	4,018.08	3,626.79
Wind	GWh	0.00	0.00	0.00
IPPs thermal	GWh	0.00	264.48	0.00
Rental	GWh	79.68	399.94	296.17
Total Power Generated	GWh	6,631.96	6,909.10	6,328.73

Total Generation Capacity (2003-2005) excl. Must-Run				
Parameter	**Unit**	**2005**	**2004**	**2003**
Thermal	GWh	4,286.58	4,018.08	3,626.79
IPPs	GWh	0.00	264.48	0.00
Rental	GWh	79.68	399.94	296.17
Total	GWh	4,366.26	4,682.50	3,922.96

Total Emissions / Total Generation				
		2005	**2004**	**2003**
Total Emissions	tCO_2e	5,008,654	5,627,708	4,830,698
Total Generation	GWh	4,366	4,682	3,923
Parasitic power	GWh	272.9	271.6	217.7
Parasitic load in sub station	GWh	1.5	5.6	4.4
Net Generated Power	GWh	4,092	4,405	3,701
EF_{OM2005}	tCO_2e/GWh	1,224.04	1,277.48	1,305.28
EF_{OM2005}	tCO_2e/MWh	1.224	1.277	1.305

The calculation result of the build margin is presented in Table 6 below. The Build Margin Emission factor ($EF_{BM,y}$) in the Sumbagsel Grid calculated from the selected year is 0.403 tCO_2 equ/MWh.

Tabel 6. Calculation Result of the Build Margin

Power plant capacity additions in the electricity system that comprise 20% of the system generation

		2005
Total Generation	GWh	6,632
Last 18	GWh	1,327
Total / Last 18	%	20.0

Last 18 Total Emissions / Last 18 Total Generation

Parameter	Unit	2005
Total Power Generated	GWh	1,327
Fuel consumption	MMBTU	9,027,108
	TJ	9,524
Emissions	tCO2e	534,294
EF_{BM2005}	tCO2e/GWh	402.7
EF_{BM2005}	tCO2e/MWh	0.40

EF_{BM2005}	0.403	tCO2e/MWh	Building Margin

The value of $EF_{OM,y}$ *and* $EF_{BM,y}$ are 1.269 tCO_2/MWh and 0.403 tCO_2 MWh respectively, the baseline emission factor (EF_y) in the Sumbagsel Grid System is 0.836 tCO_2/MWh.

As shown in Tabel 7 below, the average emission reductions per annum are about 326,001 tCO_2e/year and 2,282,007 tCO_2e for the first 7 years.

Table 7. Baseline and Project Emissions and Emission Reductions

Description		Year						
Baseline Emissions	Unit	2009	2010	2011	2012	2013	2014	2015
Installed capacity	MW	55	55	55	55	55	55	55
Capacity factor	%	90	90	90	90	90	90	90
Gross generation	MWh/y	429,165	429,165	429,165	429,165	429,165	429,165	429,165
Auxiliary loss	%	5	5	5	5	5	5	5
Net electricity to grid	MWh/y	407,707	407,707	407,707	407,707	407,707	407,707	407,707
Baseline emission factor	tCO2/MWh	0.836	0.836	0.836	0.836	0.836	0.836	0.836
Baseline emissions	tCO2	340,770	340,770	340,770	340,770	340,770	340,770	340,770

Project emissions								
Steam flow rate/y	t	3,004,155	3,004,155	3,004,155	3,004,155	3,004,155	3,004,155	3,004,155
NCG content in steam	% weight	0.318	0.318	0.318	0.318	0.318	0.318	0.317778
CO2 content in steam	% weight	0.26	0.26	0.26	0.26	0.26	0.26	0.26
CH4 content in steam	% weight	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Project emissions	tCO2	14,769	14,769	14,769	14,769	14,769	14,769	14,769
Emission Reductions	tCO2e/year	326,001	326,001	326,001	326,001	326,001	326,001	326,001

B.6.4 Summary of the *ex-ante* estimation of emission reductions:

The summary of the *ex-ante* estimation of emission reductions is given in Table 8 below.

Table 8. Summary of *ex-ante* Emission Reductions

Year	Project activity emissions (t CO2e)	Baseline emissions (tCO2e)	Leakage	Emission Reductions (tCO2e)
2009	14,769	340,770	0	326,001
2010	14,769	340,770	0	326,001
2011	14,769	340,770	0	326,001
2012	14,769	340,770	0	326,001
2013	14,769	340,770	0	326,001
2014	14,769	340,770	0	326,001
2015	14,769	340,770	0	326,001

B.7 Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	Electricity exported to the Sumbagsel Grid by the project
Data unit:	MWh
Description:	Electricity exported by the project to the Sumbagsel Grid
Source of data to be used:	PLN - The electricity generation which is exported to the Sumbagsel Grid

<table>
<tr><td>Value of data applied for the purpose of calculating expected emission reductions in section B.5</td><td>
<table>
<tr><th>Year</th><th>Electricity delivered to Sumbagsel System (MWh)</th></tr>
<tr><td>2009</td><td>407,707</td></tr>
<tr><td>2010</td><td>407,707</td></tr>
<tr><td>2011</td><td>407,707</td></tr>
<tr><td>2012</td><td>407,707</td></tr>
<tr><td>2013</td><td>407,707</td></tr>
<tr><td>2014</td><td>407,707</td></tr>
<tr><td>2015</td><td>407,707</td></tr>
</table>
</td></tr>
<tr><td>Description of measurement methods and procedures to be applied:</td><td>The exported power will be measured by a digital kWh meter and recorded continuously.</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>The QA/QC will be performed through cross checking with receipt of electricity sales</td></tr>
<tr><td>Any comment:</td><td></td></tr>
</table>

Data / Parameter:	Quantity of steam produced during the year y
Data unit:	tonnes
Description:	The amount of steam that is discharged from the geothermal wells during the year y
Source of data to be used:	Daily recorded operation data which are reported monthly
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3,004,155 ton of steam/year. The value may follow to the actual annual amount of steam produced during validation.
Description of measurement methods and procedures to be applied:	The steam quantity discharged from the geothermal wells should be measured with a venture flow meter (or other equipment with at least the same accuracy). The calculation of steam quantities should be conducted on a continuous basis and should be based on international standard. The measurement results should be summarised transparently in regular production reports.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	Fraction of CO_2 in produced steam
Data unit:	tCO_2/t steam
Description:	CO_2 quantity of Non Condensable Gases (NCGs) in the produced steam
Source of data to be used:	The NCG data is taken from sampling as prescribed in the methodology AM0002 version 6, page 21, ID 17
Value of data applied for the purpose of calculating expected	0.26% by weight. This is currently taken based on well testing. This would also refer to data available during validation.

emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	NCGs sampling should be carried out in production wells and at the steam field-power plant interface using ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid for Purposes of Chemical Analysis. The NCG sampling and analysis should be performed at least every three months and more frequently, if necessary.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	Fraction of CH_4 in produced steam
Data unit:	tCH_4/t steam
Description:	CH_4 quantity in the Non Condensable Gases in produced steam
Source of data to be used:	the NCG data is taken from sampling as prescribed in the methodology AM0002 version 6, page 22, ID No 18
Value of data applied for the purpose of calculating expected emission reductions in section B.5	There is no CH_4 content in the Non Condensable Gas (NCG). Therefore, this is not taken into account. However, regular checking will be conducted during the project operation to verify the CH_4 content.
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	NCGs sampling should be carried out in production wells and at the steam field-power plant interface using ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid for Purposes of Chemical Analysis. The NCG sampling and analysis should be performed at least every three months and more frequently, if necessary.
Any comment:	

B.7.2 Description of the monitoring plan:

This section shows the steps taken to monitor on a regular basis the GHG emissions reductions from Mauralabuh project.

Approved consolidated monitoring methodology ACM0002 “Consolidated monitoring methodology for zero-emissions grid-connected electricity generation from renewable sources” , Version 6, is adopted for the project activity.

The power plant manager of the project will be responsible for the implementation of monitoring procedures.

The monitoring of the project activity will include :

1. Parameter to be monitored and how the data are obtained and recorded
   The parameter to be monitored and how the data will be obtained are presented in Section B.7.1. All data will be continuously recorded either electronically as well as on paper. All data will be kept for the full crediting period plus two years.

2. The equipment to be employed for monitoring purpose
   The power exported to the grid will be continuously measured using a kWh-meter and monitored using an integrated electronic system. The produced steam will also be monitored using an integrated electronic system continuously. NCG in this case CH_4 and CO_2 will be monitored through sampling every 3 months using glass flasks. All equipments used for monitoring purposes will be regularly calibrated and are subject to regular maintenance.

3. Quality assurance of data and operational procedure
   In order to maintain and upgrade the ability and skill of the operator, there will be training performed related to electrical engineering and operation of power generation. Regular training and quality control programs will ensure good management implementation of the project activity in term of overall maintenance and procedure for corrective action, recording and equipment calibration.

   The power plant manager will be responsible for the daily activities of the project and he/she should report the implementation to PLN monthly.

B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

Organization	
Street / Post Box	
City	
Postcode / Zip	
Country	
Telephone	
Fax	
E.mail	
URL	

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

January 2008

C.1.2. Expected operational lifetime of the project activity:

25 years

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

January 2009

C.2.1.2. Length of the first crediting period:

7 years 0 month

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>

C.2.2.2. Length:

>>

SECTION D. Environmental impacts

>>

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

>>

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

>>

SECTION E. Stakeholders' comments

>>

E.1. Brief description how comments by local stakeholders have been invited and compiled:

>>

E.2.	Summary of the comments received:

>>

E.3.	Report on how due account was taken of any comments received:

>>

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	
Street/P.O.Box:	
Building:	
City:	
State/Region:	
Postfix/ZIP:	
Country:	
Telephone:	
FAX:	
E-Mail:	
URL:	
Represented by:	
Title:	
Salutation:	
Last Name:	
Middle Name:	
First Name:	
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Annex 3

BASELINE INFORMATION

Source: Statistik 2005 PLN Pembangkitan Sumbagsel

Type of Power Plant	Fuel	MWh (2003)	%
Hydro		2,405,772	38.01%
Geothermal		0	0.00%
Steam - Oil	MFO	160,686	2.54%
Steam - Gas	Natural Gas	77,829	1.23%
Steam - Coal	Coal	2,378,787	37.59%
Diesel - HSD	HSD	480,800	7.60%
Diesel - IDO	IDO	91,549	1.45%
Combustion Turbine - Oil	HSD	378,318	5.98%
Combustion Turbine - Gas	Natural Gas	354,991	5.61%
Combined Cycle - Oil		0	0.00%
Combined Cycle - Gas		0	0.00%
Total		**6,328,732**	**100.00%**

Type of Power Plant	Fuel	MWh (2004)	%
Hydro		2,226,603	32.23%
Geothermal		0	0.00%
Steam - Oil	MFO	993	0.01%
Steam - Gas	Natural Gas	140,231	2.03%
Steam - Coal	Coal	2,618,576	37.90%
Diesel - HSD	HSD	477,702	6.91%
Diesel - IDO	IDO	115,943	1.68%
Combustion Turbine - Oil	HSD	517,026	7.48%
Combustion Turbine - Gas	Natural Gas	812,025	11.75%
Combined Cycle - Oil		0	0.00%
Combined Cycle - Gas		0	0.00%
Total		**6,909,099**	**100.00%**

Type of Power Plant	Fuel	MWh (2005)	%
Hydro		2,265,701	32.23%
Geothermal		0	0.00%
Steam - Oil	MFO	0	0.01%
Steam - Gas	Natural Gas	125,254	2.03%
Steam - Coal	Coal	2,932,329	37.90%
Diesel - HSD	HSD	301,976	6.91%
Diesel - IDO	IDO	66,887	1.68%
Combustion Turbine - Oil	HSD	192,818	7.48%
Combustion Turbine - Gas	Natural Gas	747,000	11.75%
Combined Cycle - Oil		0	0.00%
Combined Cycle - Gas		0	0.00%

Total	**6,631,965**	**100.00%**

Total Fuel Consumption in 2003

Type of Power Plant	Fuel	Quantity	Units
Rental			
Hydro		None	
Geothermal		None	
Steam - Oil	MFO	12,550	kiloliters
Steam - Oil	HSD	45,930	kiloliters
Steam - Gas	Natural Gas	1,412,105	MMBTU
Steam - Coal	Coal	1,382,725	ton
Diesel - HSD	HSD	21,871	kiloliters
Diesel - IDO	IDO	145,559	kiloliters
Combustion Turbine - Oil	HSD	162,019	kiloliters (HSD)
Combustion Turbine - Gas	Natural Gas	7,536,020	MMBTU
Combined Cycle - Oil		0	kiloliters
Combined Cycle - Gas		0	MMBTU

Total Fuel Consumption in 2004

Type of Power Plant	Fuel	Quantity	Units
Rental			
Hydro		None	
Geothermal		None	
Steam - Oil	MFO	0	kiloliters
Steam - Oil	HSD	0	kiloliters
Steam - Gas	Natural Gas	0	MMBTU
Steam - Coal	Coal	0	ton
Diesel - HSD	HSD	0	kiloliters
Diesel - IDO	IDO	13,616	kiloliters
Combustion Turbine - Oil	HSD	3,583,877	kiloliters (HSD)
Combustion Turbine - Gas	Natural Gas	4,765,960	MMBTU
Combined Cycle - Oil		0	kiloliters
Combined Cycle - Gas		0	MMBTU

Total Fuel Consumption in 2005

Type of Power Plant	Fuel	Quantity	Units
Rental			
Hydro		None	
Geothermal		None	
Steam - Oil	MFO	0	kiloliters
Steam - Oil	HSD	0	kiloliters
Steam - Gas	Natural Gas	2,324,832	MMBTU
Steam - Coal	Coal	1,651,943	ton
Diesel - HSD	HSD	15,662	kiloliters
Diesel - IDO	IDO	79,197	kiloliters

Combustion Turbine - Oil	HSD	85,678	kiloliters (HSD)
Combustion Turbine - Gas	Natural Gas	10,321,947	MMBTU
Combined Cycle - Oil		0	kiloliters
Combined Cycle - Gas		0	MMBTU

Annex 4

MONITORING INFORMATION

Annex 5

NATIONAL SUSTAINABLE DEVELOPMENT CRITERIA AND INDICATORS OF THE NATIONAL CDM COMMISSION

Annex 5

NATIONAL SUSTAINABLE DEVELOPMENT CRITERIA AND INDICATORS OF THE NATIONAL CDM COMMISSION (AS PER WEBSITE http://dna-cdm.menlh.go.id/en/susdev/)

The sustainable development criteria and indicators for assessing a proposed CDM project are categorised into four groups: environmental, economic, social and technological sustainability. The first three types of criteria concern local impacts of the proposed CDM project; therefore the evaluation boundary is local. Specifically, the scope of evaluation for environmental sustainability is the area having direct ecological impacts from the project. The scope of evaluation for economic and social sustainability is administrative border of regency. If the impacts cross boundaries, the scope of evaluation includes all impacted regencies. However, the scope of evaluation for technological sustainability is national.

A proposed project must pass all individual indicators that are applicable in order to be approved. The "checklist" method is used in the evaluation of CDM projects. Project Proponent has to provide explanation and justification that the proposed project fulfils all the indicators. Wherever possible the explanation in the application form should include comparison of the condition with and without the proposed project. The supporting data for justification can be qualitative or quantitative. The explanation may also refer to the current regulation related to the indicators, or refer to any supporting documents attached in to the application. The Technical Team, and

Expert Advisor(s) must tick each indicator with "yes", "no", or "not applicable". The proposed project will pass the sustainability criteria if "no" is never ticked.

Environment

The scope of evaluation is the area having direct ecological impacts from the project.

- Criteria: Environmental sustainability by practicing natural resource conservation or diversification
    - Indicator: Maintain sustainability of local ecological functions
    - Indicator: Not exceeding the threshold of existing national, as well as local, environmental standards (not causing air, water and/or soil pollution)
    - Indicator: Maintaining genetic, species, and ecosystem biodiversity and not permitting any genetic pollution
    - Indicator: Complying with existing land use planning

- Criteria: Local community health and safety
    - Indicator: Not imposing any health risk
    - Indicator: Complying with occupational health and safety regulation
    - Indicator: There is a documented procedure of adequate actions to be taken in order to prevent and manage possible accidents

Economy

The scope of evaluation is administrative border of regency. If the impacts are cross boundary, the scope of evaluation includes all impacted regencies.

- Criteria: Local community welfare
    - Indicator: Not lowering local community's income
    - Indicator: : There are adequate measures to overcome the possible impact of lowered income of community members
    - Indicator: Not lowering local public services
    - Indicator: An agreement among conflicting parties is reached, conforming to existing regulation, dealing with any lay-off problems

Social

The scope of evaluation is administrative border of regency. If the impacts are cross boundary, the scope of evaluation includes all impacted regencies.

- Criteria: Local community participation in the project
  - Indicator: Local community has been consulted
  - Indicator: Comments and complaints from local communities are taken into consideration and responded to
- Criteria: Local community social integrity
  - Indicator: Not triggering any conflicts among local communities

Technology

The scope of evaluation is national border.

- Criteria: Technology transfer
  - Indicator: Not causing dependencies on foreign parties in knowledge and appliance operation (transfer of know-how)
  - Indicator: Not using experimental or obsolete technologies

- - - - -

Project Design Document (PDD)

No. 57 SOKORIA-MUTUBUSA

CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
Version 03 - in effect as of: 22 December 2006

CONTENTS

Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.
03	22 December 2006	• The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM.

SECTION A. General description of small-scale project activity

A.1 Title of the small-scale project activity:

Sukoria Geothermal Power Plant
Document version: 1
Date: 27 July 2007

A.2. Description of the small-scale project activity:

The project activity is a small-scale CDM project activity developing Sukoria geothermal power plant (hereinafter referred as to "Sukoria GPP") in Nusa Tenggara Timur Province, Indonesia, exporting generated electricity to Ende-Wolowaru Grid System. The power plant will consists of two identical power generation units each with an installed capacity of 5 MW.

The net annual export of electricity to the system is estimated to be 20,779 MWh/year, an average electricity generated by the existing diesel power as shown in Table 4 in Section B.4. The project activity will export electricity to the system through a 20 kV transmission line of Ende-Wolowaru system owned by PT Perusahaan Listrik Negara (Persero), a state owned power company (hereinafter refer to as "PLN").

Currently, electricity in the Ende-Wolowaru system is supplied by diesel generator sets only. Sukoria GPP will mainly supply the electricity for the system's base load to substitute the existing inefficient diesel powers. Sukoria GPP employs backpressure steam turbines to transform heat energy in steam separated from a two-phase geothermal fluid into electricity. The project activity is estimated to reduce Green House Gases (hereinafter referred as to "GHG") emissions in the system of approximately 16,623 tCO_2 per year.

The purpose of the project activity :
The purpose of the project activity is to generate electricity by utilizing geothermal energy as fuel and export it to the Ende-Wolowaru system to meet electricity demand in Flores Island, thereby reducing the fossil fuel consumption in the system. The development of the project activity will reduce GHG emissions produced in the system and support sustainable development through the use of renewable energy.

Contribution of the project activity to sustainable development :
In addition to the electricity generation, the project activity must fulfill criteria for the national sustainable development as indicated by the National CDM Comission (http://dna-cdm.menlh.go.id/en/susdev/) through the followings :

Environment :

The use of geothermal energy for generating electricity will contribute to environmental sustainability through the reduction of fossil fuel use in the Ende-Worowalu system. In the absence of the project activity the system will likely be dominated by diesel power generations. Therefore, the project activity will contribute to the improvement of local and national environment conditions through the application of cleaner power generation than the existing condition.

Economy :

The project activity will contribute to the local economy improvement due to more secure access of local community to electricity. Besides, the development of Sukoria GPP will improve the energy supply in the system. This will lead to an enhanced development of infrastructures that would improve local economy growth. The utilization of local energy source such as geothermal energy source will protect PLN from fossil fuel price fluctuation, thereby the electricity generating cost in the system. The Government of Indonesia will be benefited by the reduction of fossil fuel import and by reducing the country's dependence on the use of fossil fuel in power generation.

Social :

In addition to assist improving the environment, the project activity will create employment opportunities in the project area, either skilled or unskilled laborers during the construction and operation of the project.

Technology :

The project activity will demonstrate cleaner technology application for electricity generation in a remote area. Apart from this, it will contribute to technology and capacity development. This kind of project can further stimulate initiatives for investors to develop geothermal energy in Indonesia.

A.3. Project participants:

Table 1 : Project participants of the CDM project activity

Name of party involved ((host) indicates a host Party)	Private and/or public entity (ies) project participants (as applicable)	Kindly indicate if the party involved wishes to be considered as project participants (Yes/No)
Indonesia (Host)		No
Japan		No

The contact information for project participants in the project activity is provided in Annex 1 in this PDD.

A.4. Technical description of the small-scale project activity:

A.4.1. Location of the small-scale project activity:

A.4.1.1. Host Party(ies):

The Republic of Indonesia

A.4.1.2. Region/State/Province etc.:

East Nusa Tenggara Province

A.4.1.3. City/Town/Community etc:

Ende Village, Ende District, Regency of Ende

A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity :

Sukoria GPP is located in Ende Village, Ende District, Regency of Ende, East Nusa Tenggara Province. The Sukoria GPP location is on south latitude 08.7917 degree and the east longitude 121.7667 degree. The map of the location is presented in Figure 1.

Figure 1. Location of the Proposed Project

A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:

Type I: Renewable Energy Project
Category I.D.: Grid connected renewable electricity generation

The project activity is a small-scale CDM project activity for a renewable energy generation project which will have a total installed capacity of 2 x 5 MW. Its annual estimation of electricity exported to Ende-Wolowaru system is 20,779 MWh. Since the total capacity of the proposed project activity does not exceed the eligibility limit of 15 MW, the project activity is qualified as a small-scale CDM project activity to which “Appendix B: Simplified Modalities and Procedures for Small-Scale CDM Project Activities” as indicated by UNFCCC is applicable. With regard to the project activity which involves energy generation from geothermal energy and exports the power to an electricity distribution system, based on small-scale CDM modalities, the project activity falls under Type I, Renewable Energy Project and Category I.D. Grid Connected Renewable Electricity Generation.

Technology of the small-scale project activity

The Sukoria GPP project will apply a conventional geothermal technology which employs back pressure steam turbines to generate electricity. A two-phase geothermal fluid supplied from geothermal production wells is piped into a separator to separate steam from hot water (or so called brine). The steam is delivered to a turbine with atmospheric pressure at the turbine outlet, and coupled with a generator to produce electricity. Meanwhile, the brine from the separator is reinjected back into the earth. This is a common technology to extract geothermal energy for small-scale capacity and has widely been used throughout the world, including some fields in Indonesia such as Sibayak in North Sumatera, etc. This kind of technology can be applied in a relatively short time and low investment cost, but consumes much higher steam flowrate compared to other geothermal power generation technologies.

Project description

Sukoria GPP mainly consists of production and reinjection wells, steam gathering system, a separator, a brine pipeline and back pressure turbines, with the specification as shown in Table 2.

Table 2 :The Nominal Data of Sukoria GPP

Item	Unit	Sukoria GPP
Total installed capacity	MW	10
Installed capacity of each unit	MW	5
Average annual export to Ende-Worowalu system	MWh	20,779
Steam flow rate	t/h	150
Number of units		2
Type of Turbines	-	Back Pressure

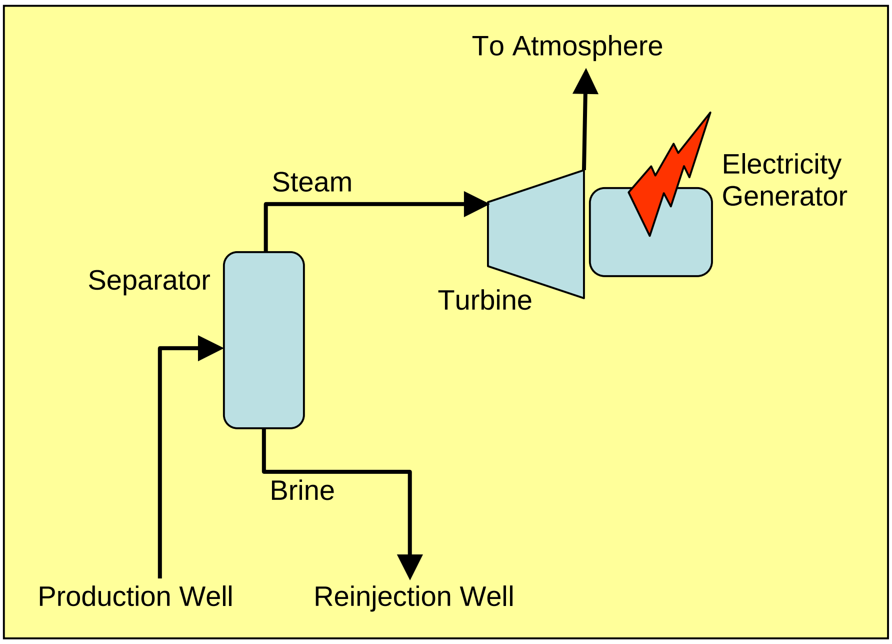

Figure 2. Schematic Diagram of Sukoria Geothermal Power Plant

A.4.3 Estimated amount of emission reductions over the chosen crediting period:

The total capacity of the geothermal power plant to be installed is 10 MW with its annual export to Ende-Wolowaru system of approximately 20,779 MWh. Since all power generations supplying the system are of diesel generators, according to AMS I.D, the emission factor in the system is 0.8 tonnes CO_2/MWh. The annual emission reduction of the project activity is estimated to be 16,623 tonnes of CO_2 e. The total

GHG emission reductions over one crediting period (7 years) estimated from the baseline analysis is 116,362 tCO_2 e.

Table 3: Estimated amount of emission reductions over the chosen crediting period

Year	**Annual estimation of emission reductions in tonnes of CO_2 e**
2009	16,623
2010	16,623
2011	16,623
2012	16,623
2013	16,623
2014	16,623
2015	16,623
Total estimated reductions (tonnes CO_2 e)	**116,362**
Total number of crediting years	7 years
Annual average over the crediting period of estimated reductions (tonnes CO_2 e)	16,623

A.4.4. Public funding of the small-scale project activity:

…..

A.4.5. Confirmation that the small-scale project activity is not a debundled component of a large scale project activity:

The project proponent confirms that the proposed project activity is not debundled component of a larger project activity. Moreover, there are no other small-scale CDM projects to be registered within 1 km of the project boundary of the proposed project activity.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the small-scale project activity:

Type: TYPE I - RENEWABLE ENERGY PROJECTS

Project category title: Category I.D. Grid Connected Renewable Electricity Generation.
Reference: Appendix B of the Simplified Modalities and Procedures (hereinafter referred to as “Appendix B”) for Small-Scale CDM project activities, Category I.D. taken from the document AMS-I.D., Version11, Scope 1, 18 May 2007.

B.2 Justification of the choice of the project category:

The project activity lies within the domain of Type I.D. as provided from Appendix B. This category comprises renewable power, such as photovoltaic, hydro, tidal/wave, wind, geothermal and biomass, which supply electricity to an electricity distribution system displacing fossil fuel or non-renewable biomass fired generating unit. In this case, the proposed project activity (ie. Sukoria Geothermal Power Plant) will utilize geothermal energy as a renewable energy source for electricity generation which will be connected to Ende-Wolowaru Grid System through a distribution grid of 20kV. The total capacity of the project activity is 10 MW (ie. 2 x 5 MW). The electricity output will not exceed the eligibility limit of 15 MW for a small-scale CDM project activity.

B.3. Description of the project boundary:

The project boundary specified in Type I.D. in Appendix B encompasses the physical, geographical site of the geothermal wells and power generation. According to the project boundary, the emission related to the construction of the project activity and transport of project equipment is ignored. Additionally, emission related to transmission and distribution losses, emission related to mining process, and emission related to the transport of materials to the project site are also excluded in the baseline scenario.

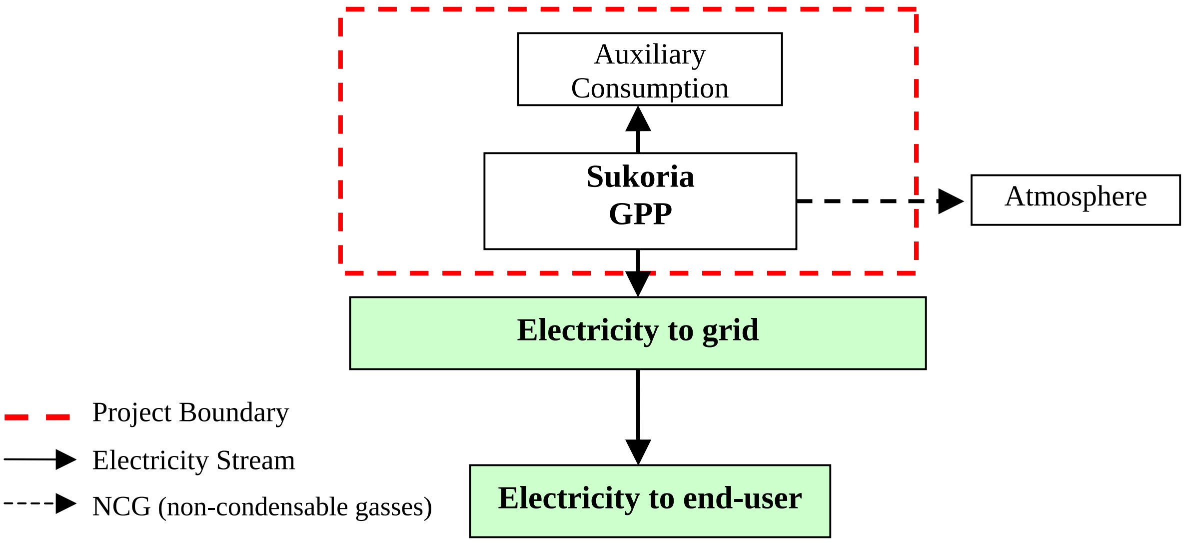

Figure 3. Project Boundary of the Project Activity

B.4. Description of baseline and its development:

The generated electricity from Sukoria Geothermal Power Plant is planned to substitute of all the diesel power plant installed in Ende and Wolowaru systems which is connected by a distribution grid of 20kV. As shown in Table 1, the averaged power generation of in the grid system during 4 years (2003, 2004, 2005 and 2006) is 20,779 MWh/year. In order to substitute all diesel power generators in the grid, the

Sukoria Geothermal Power Plant will produce electricity for at least equals to the average value of generation power from Ende-Wolowaru grid system.

Table 4. Electricity Power Generation in Ende-Wolowaru Grid System

Source: Statistik 2005 PLN NTT

Year	MWh Produced
2003	18,516
2004	20,079
2005	21,778
2006	22,741
Average	**20,779**

The latest version of the methodologies for small-scale CDM projects of Category I.D, Version 11, 18 May 2007, determines the emission factor for the system generated by diesel power generations. The baseline for this project has been estimated according to these methodologies. As a result, the baseline is the power generation by Geothermal Power Plant multiplied by an emission coefficient of the system generated by diesel generations (=0.8 tCO_2/MWh).

The baseline emissions are calculated by multiplying the baseline emission factor determined as above with the amount of electricity exported to the Ende and Wolowaru systems. The emission reductions (ER_y) by the project activity in year *y* is the difference between the baseline emissions (BE_y) in year y, project emissions (PE_y) and emissions due to leakage (L_y) in year y.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

The Appendix B of the simplified modalities and procedures for small-scale CDM project activities indicates that the project participants shall provide an explanation to show that the project activity would not have occurred anyway due to at least one of the following barriers:

a) Investment barrier: a financially more viable alternative to the project activity would have led to higher emissions;
b) Technological barrier: a less technologically advanced alternative to the project activity involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the project activity and so would have led to higher emissions;
c) Barrier due to prevailing practice: prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions;
d) Other barriers: without the project activity, for another specific reason identified by the project participant, such as institutional barriers or limited information, managerial resources, organizational capacity, financial resources, or capacity to absorb new technologies, emissions would have been higher.

a) Investment barrier:

Investment barrier of the project activity is demonstrated by analyzing the project's Internal Rate of Return (hereinafter referred to as "IRR"). It is a suitable financial indicator to measure the attractiveness of a project. IRR for the proposed project activity is calculated based on the indicated PLN purchased electricity price of 5 cents USD per kWh for a 25-year project life time without the CDM scheme, and the calculated result is 6.38%. This shows that the project activity is not attractive for the project participants, because as shown in Figure 1 below, the average lending rate for working capital and investment loans remained in the range of 14 to 16%. The project would be attractive when IRR is normally at least 2-3% above the lending rate.

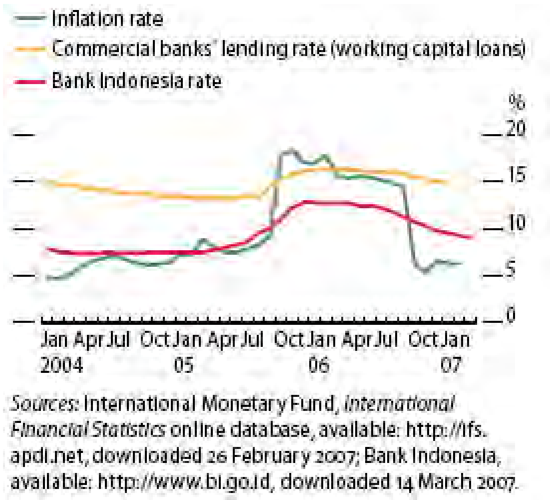

Figure 4. Commercial Banks' Lending Rate

A sensitivity analysis is simulated to figure out the effect of the project IRR without/with CDM scenario when the electricity selling price is varied. The result in Table 5 shows that the higher electricity selling price increases the project IRR, and this would still be feasible as the generating cost in Ende-Wolowaru system is 11.9 cent USD per kWh in average.

Table 5. Sensitivity Analysis of Electricity Selling Price vs Project IRR

Electicity Selling Price(¢ /kWh)	4.5	**5**	5.5	6	6.5	7
Project IRR without CDM Scenario	5.0%	**6.1%**	7.0%	7.9%	8.8%	9.6%
Project IRR with CDM Scenario*	6.6%	**7.6%**	8.5%	9.3%	10.1%	10.9%

*Assumption of CER's Unit Price 10US$/t-$CO_2$

b) Technological barrier:

Unlike fossil fuels such as oil, coal and gas, geothermal steam is a non-transportable fuel which requires a relatively more advanced technology to handle. The primary technological barrier in a geothermal project lies in the significant risk of finding the availability of the steam. A geothermal project is totally reliant on the steam produced from the reservoir deep below the earth. Technology to accurately determine the number and location wells is a critical aspect in the geothermal green-field development, and only limited companies have the capability to operate and maintain a geothermal reservoir.

c) Barrier due to prevailing practice:

As a country with huge fossil fuel resources such as oil, gas and coal, power generation for isolated areas and remote islands in Indonesia is relying on them, especially oil for the fuel of diesel generators because diesel oil generated power plants can be installed very quickly.

In addition, as the Presidential Decree No.5/2006 on the National Energy Policy stated that the contribution of coal in the national primary energy mix is targeted to increase from 14% at present to more than 33% in 2025, the development of small scale coal-fired power plants for isolated areas has been started, and some projects has signed PPA (Power Purchase Agreement) with PLN.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

In order to quantify emission reductions achieved by the project activity, procedures to calculate project emissions, baseline emissions, leakage and emission reductions set put in methodology are applied as follows:

<u>Project Emissions (*PEy*)</u>

For geothermal projects activities, project participants shall account the following sources:

a) Fugitive emissions of carbon dioxide and methane due to release of non-condensable gases from produce steam.

$$PES_y = (w_{Main,CO_2} + w_{Main,CH_4} xGWP_{CH_4})xM_{S,y} \text{ .... (1)}$$

where:
PES $_y$ are the project emissions due to release of carbon dioxide and methane from the produced steam during the year *y* (in tCO_2e), $w_{Main,CO2}$, $w_{Main,CH4}$ are the average mass fractions of carbon dioxide and methane in the produced (in tCO_2/tSteam and tCH_4/tSteam, respectively), GWP_{CH4} is the global warming potential of methane (default value = 21), $M_{s,y}$ is the quantity of steam produced during year *y* (in *tsteam/year*)

For the conservative consideration the amount of the fugitive emission is negligible.

$$PES_y = 0 \text{ .... (2)}$$

b) Carbon dioxide emissions resulting from combustion of fossil fuels related to the operation of the geothermal power plant.

$$PEFF_y = \sum_i F_{i,y} xCOEF_{i,j} \text{ .... (3)}$$

where,
$PEFF_y$ is the carbon dioxide emissions from fossil fuel combustion, $F_{i,y}$ is the fuel consumption of fuel type I during year y, $COEF_{i,j}$ is the CO_{2e} is the emission facto coefficient of the fuel type *i*.

In this project activity, there is no forecasted combustion of fossil fuels related to the operation of the project, then

$PEFF_y = 0$ ……………………………………………………………..(4)

Baseline Emissions (*BEy*)

According to AMS-I.D, the baseline emissions are calculated by multiplying the net electricity generation in the project activity by the baseline emission factor for the project grid.

The baseline emissions:

$BE_y\,(tCO_2\ e/year) = EG_y * EF_y$……………………………………………..……….. (5)

where,
BE_y is the baseline emissions (tCO_2 e) in year *y*; EG_y is the average of historical electricity (MWh) delivered by the existing facility to the grid in year *y*; EF_y is the emission factor (tCO_2 e/MWh) as the weighted average of the Operating Margin emission factor ($EF_{OM,y}$) and the Build Margin emission factor ($EF_{BM,y}$) in year y.

In this project activity, the generated electricity will be connected to Ende-Wolowaru Grid System. All power generation plants in this system are diesel generators. Therefore, according to AMS I.D, the EF_y in this project activity is equal to **0.8 t-CO_2/MWh**.

Baseline emission is calculated as follows:

$BE_y\,(tCO_2\ e/year) = EG_y * 0.8$…………………………...........………….. (6)

Leakage (L_y)

This is not applicable as the renewable energy technology used is not equipment transferred from another activity. Therefore, as per the Simplified Procedures for Small-scale CDM Project Activities, no leakage calculation is required.

Emission Reductions (ER_y)

In this project activity, project emission is zero due to a zero emission renewable generation power project and leakage is considered to be negligible. Therefore, emission reductions, ER_y is equal to the total baseline emission, BE_y (equation (4)).

$ER_y=BE_y-PE_y-Ly_y$…………………………...........……………………….... (7)

where $PE_y=0$ *and* $L_y=0$

$ER_y=BE_y$…………………………...........………………………………... (8)

B.6.2. Data and parameters that are available at validation:

Not Applied

B.6.3 Ex-ante calculation of emission reductions:

The emission reduction by the project activity (*ERy*) during given year (*y*) is the difference between the baseline emission (*BEy*), project emission (*PEy*) and due to leakage (*Ly*), as follows,

Project Emission

$PE_y = 0\ (tCO_2/year)$

Baseline Emissions (*BEy*)

$BE_y\ (tCO_2\ e/year) = EG_y * 0.8$………………………….........………….. (9)
$= 20{,}779\ MWh\ x\ 0.8\ (t\text{-}CO_2/MWh)$
$= 16{,}623\ \ t\text{-}CO_2e/year$

Leakage

$L_y = 0\ (tCO_2/year)$

Emission Reduction

$ER_y = BE_y$
$= 16{,}623\ \ t\text{-}CO2e/year$

B.6.4 Summary of the ex-ante estimation of emission reductions:

Table 6. Estimated Amount of Emission Reductions over the Chosen Crediting Period

Year	Estimation for Project Activity Emissions	Estimation of Baseline Emissions	Estimation of Leakage	Annual estimation of emission reductions in tonnes of CO_2 e
2009	0	*16,623*	0	*16,623*
2010	0	*16,623*	0	*16,623*
2011	0	*16,623*	0	*16,623*
2012	0	*16,623*	0	*16,623*
2013	0	*16,623*	0	*16,623*
2014	0	*16,623*	0	*16,623*
2015	0	*16,623*	0	*16,623*

Total estimated reductions (tonnes CO_2 e)	**0**	**116,362**	**0**	**116,362**

B.7 Application of a monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	Electricity exported to the Ende-Wolowaru Grid by the project
Data unit:	kWh (kilo Watt hour)
Description:	Electricity exported to the Ende-Wolowaru Grid
Source of data used:	PLN – The electricity generation which is exported to the Ende-Wolowaru Grid
Value of data applied for the purpose of calculating expected emission reductions in section B.5 :	Year / Electricity delivered to the Ende-Wolowaru Grid (MWh): 2009 – 16,623; 2010 – 16,623; 2011 – 16,623; 2012 – 16,623; 2013 – 16,623; 2014 – 16,623; 2015 – 16,623
Description of measurement methods and procedures to be applied:	The exported power will be measured by a digital kWh meter and recorded continuously.
QA/QC procedures to be applied:	The QA/QC will be performed through cross checking with receipt of electric sales.
Any comment:	

Year	Electricity delivered to the Ende-Wolowaru Grid (MWh)
2009	16,623
2010	16,623
2011	16,623
2012	16,623
2013	16,623
2014	16,623
2015	16,623

Data / Parameter:	Quantity of steam produced during year y
Data unit:	tonnes
Description:	The amount of discharged steam that from the geothermal wells during year y
Source of data used:	Daily recorded operation data which are reported monthly
Value of data applied for the purpose of calculating expected emission reductions in section B.5 :	328,000 tonnes steam/year. This value is estimated from the amount of electricity delivered to Ende-Wolowaru system. The value may follow to the actual annual amount of steam produced during validation.
Description of measurement methods	The steam quantity discharged from the geothermal wells should be measured with a venture flow meter (or other equipment with at least the same accuracy).

and procedures to be applied:	The calculation of steam quantities should be conducted on a continuous basis and should be based on international standard. The measurement results should be summarised transparently in regular production reports.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	Fraction of CO_2 in produced steam
Data unit:	tCO_2/tonne steam
Description:	CO_2 quantity in the Non Condensable Gases in produced steam
Source of data used:	The NCG data is taken from sampling as prescribed in the methodology AM0002 version 6, page 21,ID 17
Value of data applied for the purpose of calculating expected emission reductions in section B.5 :	0.57% by weight. This is currently taken based on well testing in the adjacent geothermal field (ie. Mataloko) with laboratory screening for exact gas composition. This would also refer to data available during validation.
Description of measurement methods and procedures to be applied:	NCGs sampling should be carried out in production wells and at the steam field-power plant interface using ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid for Purposes of Chemical Analysis. The NCG sampling and analysis should be performed at least every three months and more frequently, if necessary.
QA/QC procedures to be applied:	The QA/QC will be performed through cross checking with receipt of electric sales.
Any comment:	

Data / Parameter:	Fraction of CH_4 in produced steam
Data unit:	tCH_4/tonne steam
Description:	CO_2 quantity in the Non Condensable Gases in produced steam
Source of data used:	The NCG data is taken from sampling as prescribed in the methodology AM0002 version 6, page 21,ID 17
Value of data applied for the purpose of calculating expected emission reductions in section B.5 :	There is no CH_4 content in the Non Condensable Gas (NCG). Therefore, this is not taken into account. However, regular checking will be conducted during the project operation to verify the CH_4 content.
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	NCGs sampling should be carried out in production wells and at the steam field-power plant interface using ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid for Purposes of Chemical Analysis.

	The NCG sampling and analysis should be performed at least every three months and more frequently, if necessary.
Any comment:	

B.7.2 Description of the monitoring plan:

The project activity adopts Monitoring methodology as in Appendix B of the Simplified Modalities and Procedures (hereinafter referred to as "Appendix B") for Small-Scale CDM project activities, Category I.D. taken from the document AMS-I.D., Version 11, Scope 1, 18 May 2007.

The power plant manager of the project will be responsible for the implementation of monitoring procedures.

The monitoring of the project activity will include:

1. Parameter to be monitored and how the data are obtained and recorded
   The parameter to be monitored and how the data will be obtained are presented in Section B.7.1. All data will be continuously recorded either electronically as well as on paper. All data will be kept for the full crediting period plus two years.

2. The equipment to be employed for monitoring purpose

   The power exported to the grid will be continuously measured using a kWh-meter and monitored using an integrated electronic system. The produced steam will also be monitored using an integrated electronic system continuously. NCG in this case CH_4 and CO_2 will be monitored through sampling every 3 months using glass flasks. All equipments used for monitoring purposes will be regularly calibrated and are subject to regular maintenance.

3. Quality assurance of data and operational procedure
   In order to maintain and upgrade the ability and skill of the operator, there will be training performed related to electrical engineering and operation of power generation. Regular training and quality control programs will ensure good management implementation of the project activity in term of overall maintenance and procedure for corrective action, recording and equipment calibration.

   The power plant manager will be responsible for the daily activities of the project and he/she should report the implementation monthly.

B.8 Date of completion of the application of the baseline and monitoring methodology and the name of the responsible person(s)/entity(ies)

Date of completing the final draft of this baseline section *(DD/MM/YYYY)*

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

January 2008

C.1.2. Expected operational lifetime of the project activity:

25 years

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

January 2009

C.2.1.2. Length of the first crediting period:

7 years 0 month

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>

C.2.2.2. Length:

>>

SECTION D. Environmental impacts

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D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

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D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

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SECTION E. Stakeholders' comments

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E.1. Brief description how comments by local stakeholders have been invited and compiled:

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E.2. Summary of the comments received:

>>

E.3. Report on how due account was taken of any comments received:

>>

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	
Street/P.O.Box:	
Building:	
City:	
State/Region:	
Postfix/ZIP:	
Country:	
Telephone:	
FAX:	
E-Mail:	
URL:	
Represented by:	
Title:	
Salutation:	
Last Name:	
Middle Name:	
First Name:	
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Annex 3

BASELINE INFORMATION

Annex 4

MONITORING INFORMATION

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