GEOTHERMAL POWER PLANT COMPETITIVENESS IN INDONESIA: ECONOMIC AND FISCAL POLICY ANALYSIS

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This paper assesses geothermal power plant (GPP) competitiveness through evaluating its production costs and the application of government incentives, i.e. the Clean Development Mechanism (CDM) and the implementation of carbon tax. Then the GPP competitiveness is compared to coal power plant. The results show that the effect of duty free, value added tax free (VAT), implementation of investment tax credit, and pre survey government incentive can decrease the geothermal selling price by US 0,75 ¢/KWh, 0,91 ¢/KWh, 0,23 ¢/KWh and 0,69 ¢/KWh, respectively. Implementation of CDM and carbon tax on coal also improves GPP competitiveness. Geothermal can compete with coal in the year 4.

Keywords: geothermal electricity price, fiscal policy, carbon tax, competitiveness

Introduction

Indonesia is ranked the fourth, after USA, Philippines, and Mexico, among countries that utilizes geothermal energy to generate electricity eventhough she has the largest potency in the world, i.e. 27.169 MW or approximately 30 to 40% of world geothermal potency. The potency spreads along the volcanic belt from the island of Sumatra to Timor (Figure 1). Of 27,169 MW, only 1052 MW or less than 5% of the capacity have been used. One reason why geothermal utilization has not been used optimally is Indonesia still depends heavily on fossil based fuels as primary energy resources for electricity generation and the competitiveness of geothermal plant.

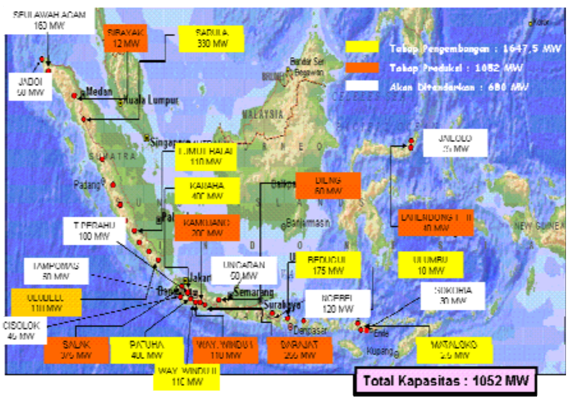

Figure 1. Indonesia Geothermal Potency

Electricity demand in Indonesia increases with the rate 5.9%. This rate is bigger than the electricity supply growth. This situation turns out to be an electricity crisis. Scheduled black out occurs in many places including at the industrial areas.

Depending on notorious fossil based fuels to fulfil electric energy is not a sustainable policy due to the fuels are not renewable, means their deposit is diminishing by time, and they are also not environmentally friendly. The government proposed National Energy Mix 2025 to reduce the dependency on fossil fuels and at the same time to promote the utilization of renewable energy including geothermal (Figure 2). It is projected that geothermal will contribute 5% to total energy source at the time of 2025.

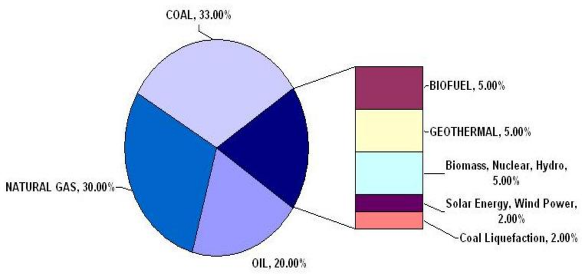

Figure 2. National Energy Mix 2025

As addition to its scarcity and environmental impact, another issue is the price of fossil fuels is not stable. The price volatility generates doubt about long term stability of the energy in the future. In contrast, geothermal energy is pollution free and environmental friendly. Its fuel cost is relatively stable during the whole period of a GPP. The issue related to its utilization is exploration and drilling costs which are quite high. Could the low and stable price of GPP set off its high exploration and drilling costs? What is the impact of taxation schemes to GPP competitiveness? How competitive is the GPP compare to coal fired power plant? Those are some questions that will be addressed here.

Research Methodology

This study is based on the profitability indicator theory. Profitability indicators indicate the level of taking an investment decision from the investor standpoint. Investment decision is a decision to procure fixed assets which include resources and funds at the present time to obtain series of long-term profitability in the future. Three indicators, net present value, internal rate of return, and payback period are used on this study.

Net present value (NPV) of a project is the total cash flow per each unit of time that has been charged to the present value of the investment that have been cashed. NPV is calculated by adding up all the cash flows occur from period of zero, so-called as investment, to the last period of the project.

$$NPV = I + \sum_{n=1}^{n} \left(\frac{An}{L(1+r)^n} + \frac{Vn}{L(1+r)^n} \right)$$

where:
I: investment
r : rate of return
An: cash flow / proceed
n: economic value of investments
Vn :salvage value of investments at the end of economic period

If NPV turns out to be positive, then the project is feasible to run. Positive NPV indicates the investment has achieved favourable condition.

Internal rate of return (IRR) is a percent increase in the value of money contained in the current cash flow. IRR can be interpreted also as the discount rate that produces zero NPV.

$$IRR = \frac{An}{(1+r)^n}$$

In general, investment decision based on NPV and IRR will give a consistent result which mean if an investment proposal is considered feasible based on the NPV, the proposal assessed based on IRR is also feasible.

Payback period (PBP) is the time needed to fully recover the costs and liabilities incurred in a project.

$$PBP = m + \frac{0 - CCFm}{CCF_{m+1} - CCF_m}$$

Where:
PBP: Payback Period, years
m: Year of the CCF negative after a positive CCF
m+1: Year of the CCF positive after a negative CCF
CCF_m: Cumulative Cash Flow in *m* (<0)
CCF_{m+1}: Cumulative Cash Flow in *m*+1 (>0)

Although PBP does not reflect profitability indicator of an investment proposal and the calculation does not consider time value of money, but it is often used to complement the feasibility analysis of investment proposals. PBP may reflect the liquidity of an investment proposal.

Profitability indicators also consider investor required rate of return (RRR). RRR is influenced by two main factors, risk free rate and risk premium project with relationship as RRR = risk free rate + risk premium project. RRR is defined by the investor. The higher the risk of a project, the higher the RRR is. Geothermal electric prices are considered feasible if they can generate an IRR more than RRR. In this study, RRR is set as 16%. In Indonesia, government regulations limit the sale price of geothermal electricity not exceeding US 9.7 ¢/KWh. Geothermal electricity price is considered competitive if the price does not exceed 9.7 ¢/KWh.

Input Factors

Government policy on tax and incentives influence the competitiveness of GPP. In Indonesia, government policy on tax includes investment tax credit, duty-free import, free value added tax, and government initial survey. While incentives include clean development mechanism and carbon tax.

Investment tax credit

Business tax rate for GPP is 30%. Investment tax credit is assumed to reduce the basic tax rate to a certain extent, up to 5%, over six year period.

Duty-Free Import

Through import duty policy, the government frees the import duty that used to be 5 percent to 0 percent.

Free Value Added Tax (VAT)

PMK 24/PMK.011/2010 policy states that geothermal exploration activities are borne by the government. With his policy, the government bears the VAT payable on the importation of goods that are used for geothermal exploration activities.

Government Initial survey

Preliminary survey conducted by the government in the early stages of GPP development is an effective way to reduce the risk of developing geothermal resources. The survey includes surface surveys and drilling of two test wells. All survey results are transferred to private developers at no cost.

Implementation of Clean Development Mechanism

Clean development mechanism (CDM) scheme is a scheme in which developed countries are able to use the amount of carbon dioxide (CO_2) reduction as a result of joint project between developed and developing countries. Certified

Emission Reduction Credit (CER) is issued depending on the amount of greenhouse gases reduction. CER credit can be traded on market thus can be used to improve the profitability of the project. CER value is assumed to be US$ 10 per ton CO_2 and the emission factor is 0.819 ton CO_2 per MWh.

Application of Carbon Tax

Carbon tax applied to fossil fuel plants will make some changes in the structure of energy prices thus will make geothermal more attractive (Table 1).

Table 1 Average price impact of Rp 80.000 carbon price, projected revenue, and possible revenue uses

	Price increase	Tax/levy revenue	Possible use of revenues
Electricity Diesel/kerosene Gasoline	Rp 60 per kWh Rp 235 per liter Rp 190 per liter	Revenue would rise to around Rp 95 trillion by 2020 per year. Additional permit export revenue of several billion dollars per year may be available	Government free to decide on revenue use. Proposed strategy: Offset the impact of price rises on households and on businesses; reduce other taxes; support additional abatement initiatives.

Assumptions on GPP project used in this study:

- Type of project: The total project (project downstream + upstream)
- Scale of project: 110 MW which consisted of two units of 55 MW
- Period of contract: 35 years (5 years for pre production and the rest for production)
- Capacity Factor: 90%
- Success Ratio:
  - exploration wells: 50%, production wells: 80%
- Decline Rate 3% per year
- Steam Production
  - exploration wells: 8 MW, production wells: 12 MW
- Income Tax Rate: 30%
- Depreciation Method: Declining Balance with 8 years
- Investment Tax Credit 5% per year for 6 Years
- Free Value Added Tax: 10%
- Duty-Free Import

Summary of GPP costs is shown in Figure 3:

Project Capital	Cost
Exploration	
Initial Survey	$1,200,000
Access Roads, Pads, Land	$4,000,000
Logistic Support and Facilities	$1,000,000
Rig Mobilization incl. Upgrade Roads	$1,500,000
Exploration Well Drilling	$6,360,000/well
Well Testing	$680,000
FS (NORC, Env. Permits)	$1,500,000
Steam Field Development	
Production Well Drilling	$5,861,250/well
Well Testing	$1,750,000
Injection Well Drilling-Brine	$5,300,000/well
Injection Well Drilling-Condensate	$3,313,000/well
Steam Field Facilities	
Access Roads and Well Pads	$4,819,000
Piping and Production Facilities	$33,647,000
General facilities	$4,518,000
Permits, Land, etc.	$4,217,000
Power Generation Facilities	$143,000,000
Operation and Maintenance Cost	
Steam Field (cent/KWh)	0.55
Power Generation Facilities (cent/KWh)	0.65
Overhead Cost	0.05
Work Over sumur (well/3 yrs)	$1,200
Major Overhaul PP (per 3 yrs)	$1,500
Make Up Well	$5,023,000/well

Figure 3. Geothermal Power Plant costs

The number of wells drilled in the pre production is 20 wells. Among them nine make up wells for a 30-year production periods (year of production 2, 5, 9.12, 15, 18, 21, 24, 27).

Result and Discussion

The calculation result for 110 MW GPP found that using the price of US 9.70 ¢/KWh, the IRR, NPV, and PBP are 15.16%, US$ 17,570, and 10 years, respectively. The IRR is slightly less than developer's RRR, which is 16%. Meanwhile, when using developer's RRR the electricity price will be a bit higher than 9.70 ¢/KWh, i.e. 10.07 ¢/ KWh. the NPV is US$ 30,578 and nine years PBP.

A 10% reduction on capacity factor and electricity price causes a decrease in IRR of 1.68%, while on the other side a 10% addition of capacity factor and the price of electricity increases 1.22% of IRR. Reduction of investment costs by 10% leads to an increase of IRR by 1.51%, while the addition cost of investment with the same amount causes a decrease in 1.28% IRR (Figure 4)

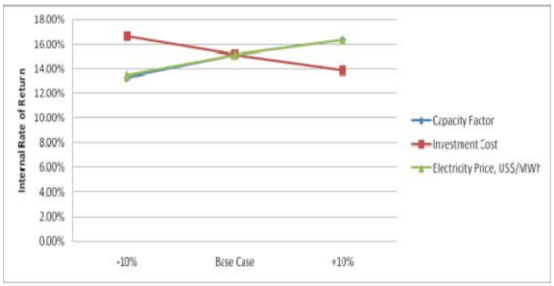

Figure 4. Capacity Factor, Investment Costs and Price of Electricity; Sensitivity Analysis on IRR

Toward the NPV, a 10% reduction of capacity factor and electricity price causes the NPV decreases of $27.83, while the 10% addition causes an increase of $19.32. Reduction of investment costs by 10% leads to an increase NPV of $ 19.63, while the addition decreases NPV of $ 19.59 (Figure 5).

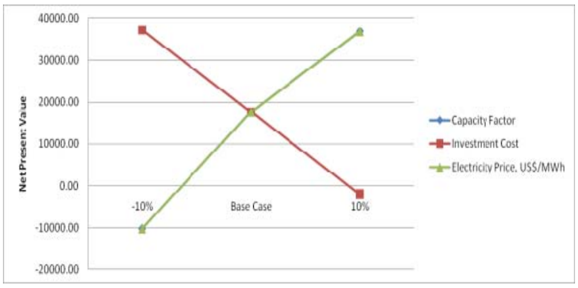

Figure 5. Capacity Factor, Investment Cost and Price of Electricity; Sensitivity Analysis on NPV

For the PBP, a 10% reduction in capacity factor and electricity price causes a slower PBP with one year, while the 10% addition causes the payback period a year earlier. Reduction of investment costs by 10% causes PBP a year earlier, while the addition causes a slower PBP by one year (Figure 6).

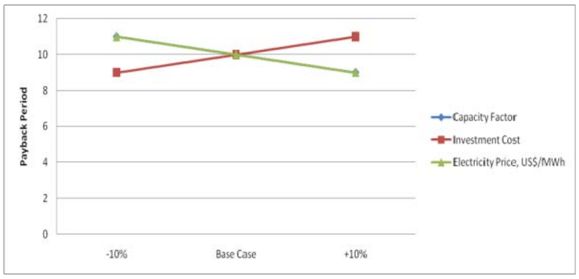

Figure 6. Capacity Factor, Investment Cost and Price of Electricity; Sensitivity Analysis on PBP

With the governments' geothermal electricity price of US 9.70 ¢/KWh, with a capacity factor of 90% (base case, CF 90%), the IRR will be less than 16%. If the capacity factor reduces to 80%, with geothermal electricity prices of US 7 ¢/KWh, 9.70 ¢/KWh and 12 ¢/KWh, the IRR will fall by 1.55%, 1.87% and 2.13%, respectively. In the base case (CF 90%) with IRR 16%, geothermal electricity price is feasible if it is above 10.2 ¢/KWh (Figure 7).

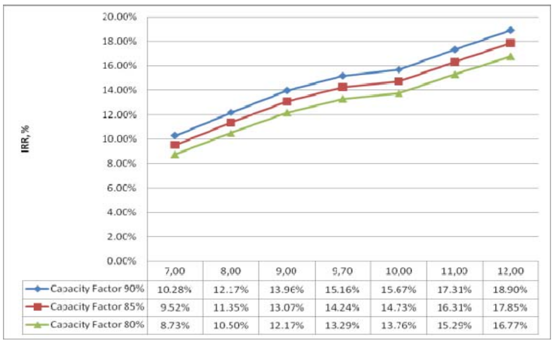

Figure 7. IRR Profile at Different Capacity Factor

At government electricity price of US 9.70 ¢/KWh, the IRR may be more than 16% if the investment cost can be pressed not less than 10%. If the investment cost reduces by 10%, the IRR would increase by 1.18%, 1.51% and 1.76% on the geothermal electricity prices of US 7 ¢/KWh, 9.70 ¢/KWh and 12 ¢/KWh, respectively. On the contrary, If the investment costs increases by 10%, the IRR will drop by 1%, 1.28% and 1.51% on the geothermal prices of 7 ¢/KWh, 9.70 ¢/KWh and 12 ¢/KWh, respectively. If the investment costs decreases by 10%, then the feasible geothermal electricity price at 16% IRR will not be less than $ 9.5 ¢/KWh (Figure 8).

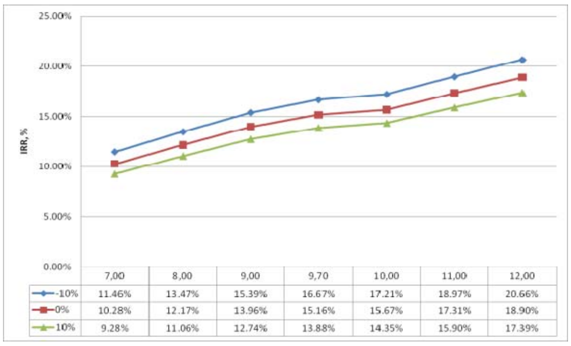

Figure 8. Profile of IRR at Different Investment Costs

The most influential incentive improving the project IRR is the 10% VAT-Free incentive followed by import duty-free incentive, government preliminary survey, and investment tax credit (Figure 9).

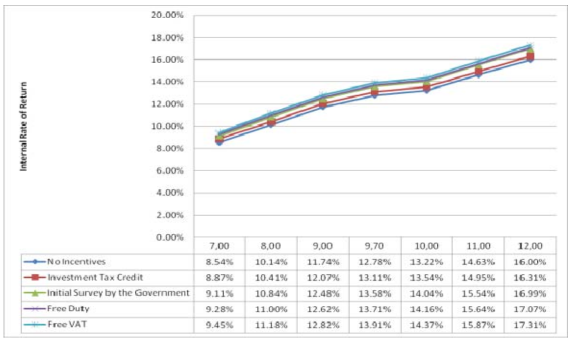

Figure 9. Analysis of the effect of Government Incentives on IRR and Electricity Prices

The effect of free duty, free VAT, the implementation of investment tax credit, and the preliminary survey incentive reduces the geothermal electricity price by $ 0.75 ¢/KWh, 0.91 ¢/KWh, $ 0.23 ¢/KWh and $ 0.69 ¢/KWh, respectively (Table 2).

Table 2. Effect of Government Incentives on Electricity Prices

Incentives	Electricity Price At IRR=16%
No Incentives	12
Investment Tax Credit	11.77
Initial Survey by the Government	11.25
Free Duty	11.31
Free VAT	11.09

The effect of the implementation of CDM reduces the electricity price by 0.82 ¢/KWh and increases the IRR to 16.53% which is a bit above the desired RRR (Figure 10).

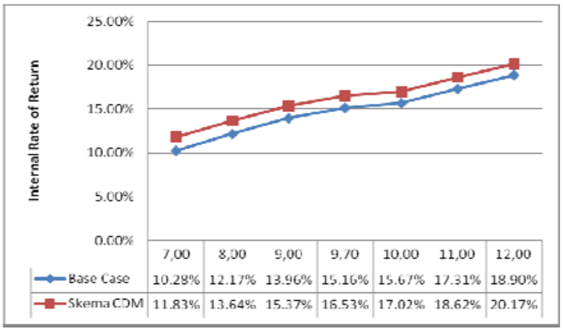

Figure 10. Analysis of the effect of CDM on IRR and Electricity Price

Table 3 below lists 6 scenarios of implementing combination of government tax and incentives.

Table 3. List of Scenarios

Scenario	Fiscal Policy
1	Duty Free
	VAT Free
	ITC 5% for 3 years
	No Survey Incentives
	No CDM Scheme
2	Duty Free
	VAT Free
	ITC 5% for 8 years
	No Survey Incentives
	No CDM Scheme
3	Duty Free
	VAT Free
	ITC 5% for 5 years
	Survey Incentives
	No CDM Scheme
4	Duty Free
	VAT Free
	ITC 5% for 5 years
	No Survey Incentives
	CDM Scheme
5	Duty Free
	VAT Free
	ITC 5% for 5 years
	Survey Incentives
	CDM Scheme
6	Duty 5%
	VAT 10%
	No ITC 5% for 5 years
	No Survey Incentives
	No CDM Scheme

In scenario 1, at the electricity price of 9.70 ¢/KWh, the IRR only reaches 14.66%. Electricity prices that feasible at IRR 16% is 10.54 ¢/KWh (Figure 11).

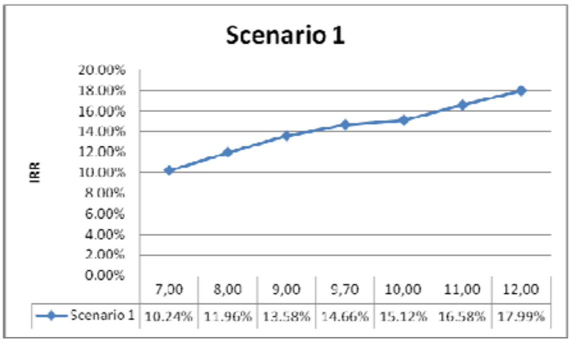

Figure 11. Analysis of the effect of Scenario 1 on IRR and Price

Results of scenarios 1 to 6 are summarized at Table 4 bellow:

Table 4. IRR and Geothermal Electricity Price

Scenario	**IRR (%)** when electricity price is set as 9.70 cents/KWh	**Electricity Price (cents/KWh)** when IRR is set by 16%
1	14.66	10.54
2	15.29	10.23
3	16.02	9.6
4	16.53	9.26
5	18.72	8.68
6	14.53	10.5

According to National Energy Mix 2025, coal will still play as primary energy source, but it role will be reduced. As substitution, geothermal will contribute 5% of total energy source (Figure 2). It is imperative to check GPP competitiveness toward coal power plant

The assumptions used in calculating the cost of coal fired power plant are as follow:

- Capacity: 300 MW
- Capital Cost: US$ 2,500/MW
- O & M Cost: US$ 88/KW
- Operation time: 7000 hours a year
- Carbon Tax: Rp 60/KWh
- Fuel Consumption: 0.439 Kg/KWh

The fact that geothermal fuel cost is quite stable during the life time of GPP, while on the contrary coal fuel cost is increasing by time. Using US$ 24.76/MWh for geothermal energy cost for 30 years, geothermal cost will be less than coal in year 14. At the time coal fuel cost is US$ 24.78 (Figure 12).

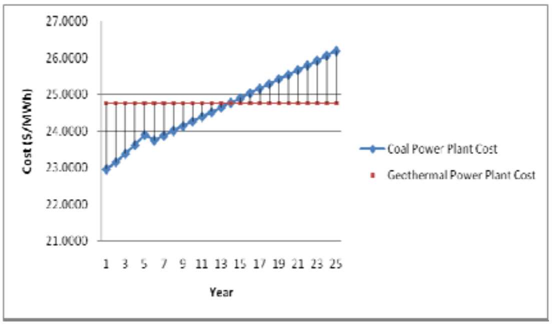

Figure 12. Levelized Cost Comparison Between Geothermal and Coal

Meanwhile, when applying carbon tax, geothermal will outperform even earlier, i.e. in fourth year, where the cost of coal is $ 24.88. Application of carbon tax adds to the cost of coal Power Plant to $ 1.26/MWh (Figure 13).

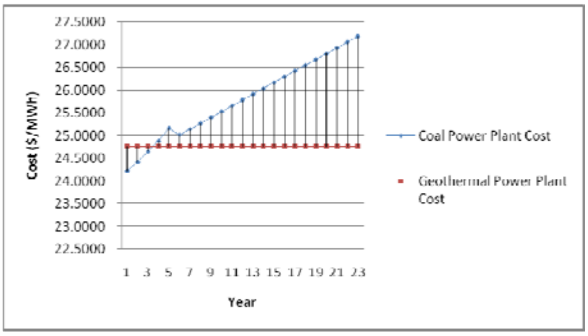

Figure 13. Levelized Cost Comparison Between Geothermal and Coal with Carbon Tax

Conclusion

The current policy, refers to PMK No. 21/PMK.011/2010 with the highest geothermal price US 9.70 cent/KWh, is not able to provide the investor desired IRR, i.e.16%. To fulfil the investor IRR with the government electricity price, the investment costs must be reduced to at least 10% or increase the capacity factor by 10%.

Free VAT apparently has the most significant influence on the IRR and the geothermal electricity price followed by free import duty, initial survey by government incentive, and investment tax credit. The effect of those policies can lower the selling price by US 0.91 cent/KWh, 0.75 cent/KWh, 0.69 cent/KWh, and 0.23 cent/KWh, respectively. The effect and the implementation of CDM reduces the price by US 0.82 cent/KWh and increases the IRR to 16.53%.

From the six scenarios studied, only scenario 3 (combination of Duty-Free, Free of VAT, the ITC is 5%, and government pre survey), scenario 4 (Duty-Free, Free of VAT, the ITC is 5%, application of the CDM) and scenario 5 that can enhance GPP competitiveness . Among these three scenarios, scenario 5 (Duty Free, free of VAT, ITC is 5%, government survey and the application of the CDM) is the best scenario to promote GPP. Without implementation of carbon tax, the cost of geothermal electricity can compete with coal in the year 14. The implementation of carbon tax to coal plant improves the competitiveness of GPP. Geothermal can compete with coal in the year 4.

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