Potential Clean Development Mechanism Incentives for Geothermal Power Projects in Developing Countries

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ABSTRACT

The Clean Development Mechanism (CDM), promoted by the Kyoto Protocol, encourages developed countries to invest in renewable energy projects based in developing countries and receive credit for the carbon emissions saved by these projects for use to offset the greenhouse gas emissions in their own countries. The aim of the mechanism is to foster financial partnerships that provide access to affordable low-greenhouse gas emitting commercial energy technologies for developing countries.

This paper examines the financial incentives, which could be realized for geothermal power projects in developing countries using the CDM for two levels of carbon tax.

1. INTRODUCTION

Renewable energy continues to make inroads on the world's energy industries but progress has been slower than many expected. At the 6th World Renewable Energy Congress, held from 1 to 7 July 2000 at Brighton, UK, it was estimated that the global renewable energy market would be worth US$11 billion over the next five years. At the Congress the merits of wind, solar and biomass renewable energy systems were fully debated, however, there seems to have been little said about the merits of renewable geothermal energy (WREN, 2000) despite it appearing as a topic in the pre-congress advertising.

The Clean Development Mechanism (CDM), promoted by the Kyoto Protocol, encourages developed countries to invest in renewable energy projects in developing countries and receive credit for the carbon emissions saved by these projects to offset the greenhouse gas emissions in their own countries.

The aim of the mechanism is to foster financial partnerships that link access for developing countries to affordable low-greenhouse gas emitting commercial energy technologies. As yet, the rules for the Clean Development Mechanism have not been set, and no decision was taken on this matter at the COP6 meeting 13-24 November 2000

In January 1999, the New Zealand Ministry for the Environment released a domestic policy options statement to discuss options for addressing the issue of climate change. In this discussion document figures of between US$6 and US$15/tonne were used as a likely value of trade able emissions. (MfE, 1999). These values have been used to assess the potential emissions credit which could be realized by trading CO_2 emission savings from a geothermal power project..

In this paper the present worth of the reduction in CO_2 emission which would arise if a geothermal power plant replaced: -

(a) natural gas fired combined cycle plant
(b) fuel oil fired conventional thermal plant
(c) coal fired conventional thermal power plant;have been calculated.

2. GREENHOUSE GAS EMISSIONS

Geothermal fluids contain minerals leached from the reservoir rock and variable quantities of gas, mainly carbon dioxide and a smaller amount of hydrogen sulphide. The gas composition and quantity depend on the geological conditions encountered in the different fields. Virtually the entire mineral content of the fluid and some of the gasses are reinjected back into the reservoir. Most of the non- condensable gasses are released to the environment, although some plants remove the H_2S in a gas treatment process.

The International Geothermal Association is in the process of carrying out a detailed assessment of CO_2 emissions from global geothermal power plants. To date (Jan 2001) the results for approximately 4,325 MWe of operating power plants have been obtained. The average CO_2 emission level from these power plants is 110g/kWh. (IGA 2001)

The average emission level for 580MW of operating Indonesian geothermal power plants is 69.2g/kWh and for 1124 MW of operating Philippines geothermal power plants the average CO_2 emission level is 94.1g/kWh.

It is anticipated that the average global geothermal power plant CO_2 emission level will be less than 100g/kWh. However for the purpose of this study the 115g/kWh has been used.

The following CO_2 emission data for fossil fueled power plants were obtained from the New Zealand Energy Efficiency and Conservation Authority:

- Combustion of coal in a power plant operating at 35% efficiency =915g/kWh
- Combustion of fuel oil in a power plant operating at 35% efficiency = 760g/kWh
- Combustion of natural gas in a combined cycle power plant at 55% efficiency = 345g/kWh.

Replacing a combined cycle natural gas fired plant with a geothermal power plant (110g/kWh) would give a net saving of 235g/kWh of generation. Similarly, if a fuel oil plant is replaced the net saving would be 650 g/kWh, and for a coal-fired plant the saving would be 805g/kWh.

In Indonesia the savings in CO_2 emission, if a geothermal power plant replaces a:

- Natural gas combined cycle power plant operating at 55% efficiency = 275 g/kWh
- Fuel oil fired power plant operating at 35% efficiency = 690 g/kWh
- Coal fired power plant operating at 35% efficiency = 845 g/kWh.

3. CARBON VALUE

The Kyoto protocol provides for trading of emission allowances between countries, but individual governments will decide whether companies in their own countries are able to trade in an open market. Taxing the emission of CO_2 within their own countries is one mechanism available to governments to control emission levels.

The preferred mechanisms for meeting the Kyoto protocol commitments are still being debated within the international community, with the possible level of carbon tax and value of tradeable emissions generating considerable discussion. Figures quoted for carbon tax have ranged from as low as US$2.80/tonne to as high as US$15/tonne. The New Zealand Ministry for the Environment used figures of between US$6 and US$15/tonne for its assessment of the likely value of tradeable emissions. For the purpose of this exercise similar levels have been used to calculate the CDM financial incentive for geothermal power plants.

4. CDM CARBON VALUE

The Present Value of the CO_2 saving is calculated as follows…

Annual value = MW x hrs x LF x savedCO_2 x $/t

where MW = plant power capacity
hrs = 8760 hours per year
LF = plant annual load factor =90%
savedCO_2 = saving in CO_2 (kg/kWh)
$/t = CO_2 value ($/tonne)

Using carbon values of US$6/tonne and US$15/tonne, the net annual value of CO_2 emission credits per MW of geothermal developed to replace natural gas, fuel oil, and coal fired generation was determined using the above criteria.

Present worth of this annual CO_2 emission credit over a plant life of 25 years was calculated assuming a discount rate of 10% and a resultant "Unified series present worth factor " (USPWF) = 9.077.

The relative value of CO_2 emission credits for a MW of geothermal generation capacity replacing fossil fuels are shown in **Table-1**. These credits are estimated for both Global and Indonesian average CO_2 emission rates.

6. CDM IMPACT ON GEOTHERMAL DEVELOPMENT

Assuming a geothermal power plant cost of US$2 million/MW installed then the percentage of this cost, which could be met from CDM incentives arising from the saving of carbon emissions from the fossil fuels identified above, are shown in **Table-2**.

7. DIRECT USE SAVINGS IN CO_2

Substitution of fossil fuels by geothermal has the potential for a much greater relative advantage if the steam is used directly. A comparison can be made using the figures of Everett (1999) for CO_2 emissions from fuel assuming electricity is generated from geothermal steam at an efficiency of between 10 and 15%. Using this steam directly would result in the emission of about 15-20 g/kWh of heat supplied. This compares very favourably with coal (320g/kWh), fuel oil (265g/kWh), and even gas (190g/kWh).

The CO_2 saving over gas was in the range 45-65% for electricity generation whereas the saving is 90% or more for direct use. Replacement of coal or fuel oil would result in even greater relative savings.

Projects for the direct use of geothermal energy would probably be implemented in a similar manner to electrical developments using the Clean Development Mechanism.

8. CONCLUSION

From **Table-2** it can be seen that substantial CDM credit incentives for geothermal electrical development will only be realized if the carbon value is greater than US$6 per tonne of CO_2 released to the atmosphere and if fuel oil or coal fired fossil fuel generation are being replaced. A larger potential for savings exits in direct use projects.

9. REFERENCES

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Table-1
CDM incentive credit for replacing fossil fueled power plants with geothermal power plants

Fossil Fuel System being Replaced	Present Worth of CO2 Emission Credits for1 MW of Annual Geothermal Generation			
	Geothermal Global Average CO2 Emissions (110g/kWh)		Indonesian Geothermal Average CO2 Emission (70g/kWh)	
	US$6/tonne	US$15/tonne	US$6/tonne	US$15/tonne
Natural Gas Combined Cycle (55%) Efficiency	US$100,905	US$252,260	US$118,070	US$295,185
Fuel Oil (35%) Efficiency	US$279,095	US$697,740	US$296,270	US$740,680
Coal (35%) Efficiency	US$345,650	US$864,120	US$362,825	US$907,065

Table-2
Percentage of Geothermal plant installation cost that could be met from CDM incentive credits

Energy Source	Carbon Tax	
	US$6/Tonne	US$15/Tonne
Natural Gas	5%	13%
Fuel Oil	14%	35%
Coal	17%	43%