POTENTIAL AND OBSTACLES FOR USING THE CDM TO PROMOTE GEOTHERMAL ENERGY

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ABSTRACT

The CDM has the potential to become a powerful incentive for geothermal projects. Many countries with an attractive geothermal potential and geothermal expansion plans have already started to prepare themselves for CDM implementation. However, geothermal energy has not figured prominently in their CDM plans. Thus the geothermal community should enhance its presence in the development of national CDM strategies and in the international climate negotiations. Baseline rules and CER prices have a crucial impact on the attractiveness of CDM projects to geothermal developers. At high CER prices and baselines, geothermal projects can cover a significant share of the investment costs through CER sales. At current low prices and grid benchmarks, revenues cannot affect the overall investment decision. While forestry projects can help the developers to safeguard water recharge, they do not yield enough CERs to have a real impact on revenues.

1. INTRODUCTION

The Kyoto Protocol allows for project cooperation on greenhouse gas (GHG) reduction between industrial and developing countries in the framework of a so-called "Clean Development Mechanism" CDM). It builds on a pilot phase of such projects ("Activities Implemented Jointly", AIJ) that started in 1995. The CDM has only been defined in vague terms in Art. 12 of the Kyoto Protocol. It states in paragraph 3 that investing countries get credit for certified emission reductions from CDM projects provided "benefits" accrue to the host country (Art. 12 (3a)). Besides countries, companies are allowed to invest and execute projects (Art. 12 (9)). The CDM could provide a powerful incentive for geothermal projects as geothermal energy production only releases a tenth to a twentieth of GHG emitted by fossil fuel power stations (Thain and Dunstall 2001). This paper looks at the international institutional settings currently discussed for the CDM and their implications for geothermal projects and then discusses geothermal activities and the policy framework in potential host countries.

2. IMPLICATIONS OF INSTITUTIONAL SETTINGS ON THE INTERNATIONAL LEVEL

2.1. General institutional features

There are different design options for the CDM that have been advanced in the international discussion on the climate policy regime:

1) Developing countries can supply permits through certified emission reduction/sequestration projects*: "Unilateral CDM"* (Stewart et al. 1999, TERI 1999). Costa Rica has pioneered this approach with the creation of "Certified Tradable Offsets" (CTOs, Roveda/Merenson 1999, p. 22f). The advocates of Unilateral CDM argue that this approach could minimize transaction costs due to the fact that barriers are better known to the domestic actors than to foreign investors and can be overcome more easily by the former. The opponents of unilateral CDM criticize that there is a higher risk of non-additional reductions as countries could now sell "business-as-usual" projects. This risk, however is not higher than in other approaches where the investors also have an incentive to maximize (ficitious) credits. If a country sees geothermal energy as a priority sector, the unilateral approach would allow it to develop a sectoral strategy, especially if the country is not very attractive for foreign investors. A drawback would be the need for domestic financing that penalizes capital-intensive projects. The Philippines would be a good case.
2) As 1, but only countries with caps can invest in emission reduction/sequestration projects and trade in certified credits from these projects: *"Bilateral CDM"* (Goldemberg 1998, Stewart et al. 1999). The bilateral option would be helpful in the case where a investor country has a strong geothermal industry (e.g. the U.S., Iceland, Italy or New Zealand) that has enough clout to get a priority treatment in the investment strategy.
3) As 2, but countries may only use certified credits to reach their target and cannot sell them*: "Coupon CDM"* (TERI 1999). The idea of non-tradeability of CERs has been strongly put forward by China. A Coupon CDM does not make much sense as the investing country can sell Assigned Amounts and base its compliance on CERs (thus circumventing the sales restriction). Only in the case of a stringent cap on both sales and acquisitions the "laundering" of CERs would pose problems.
4) As 3, but countries can only invest in a multilateral fund: *"Multilateral CDM"* (Mintzer 1994, Goldemberg 1998, Stewart et al. 1999). In this option investing countries make contributions to the fund (Yamin 1998, p. 55f). Other countries can now offer projects and so compete for the fund's resources. Projects are selected according to their emission reduction efficiency, with positive externalities being taken into account in the case of equally efficient projects. For the duration of the project, each investor country receives a credit proportional to its share of the project portfolio. Project risks would also be pooled with the investor countries being required to pay a corresponding insurance surcharge. Geothermal energy could profit from a fund approach if it was linked to existing structures at the World Bank that have already collected experience with the financing of geothermal power.

2.2. Renewable and small scale priorities

The recent climate negotiations have focused on fast track procedures for small scale or renewable projects. Due to its modular nature, geothermal energy would profit from special rules for small scale projects. It would also benefit from a positive list approach that excludes fossil fuel and nuclear power as demanded by many environmental NGOs (Greenpeace 1998). However the rules are still under negotiation and no estimates of their economic impact can be given.

2.3. Actors

There are different groups of actors that influence the design of the CDM and are active in international climate negotiations. Each one is defined by its own set of interests, including the CDM as an institution. There are different rewards for the actors that could be classified as follows:

1. global climate change mitigation benefits through emission reduction or sequestration. This applies primarily to NGOs.
2. individually creditable emission reduction or sequestration. This currently only applies to emitters in some industrialized countries which are subject to domestic policy instruments that penalize emissions. In the future, a global market in emission permits
3. positive externalities, such as formation of human capital, transfer of technology, capital transfer, foreign currency transfer, job creation, improvement of distribution, reduction of local pollutants, protection of biodiversity for the host country part (Michaelowa 1997) and market entry, product diversification or publicity gains on the investing country's side. Last not least, CDM projects offer the opportunity of microeconomic profits if additionality is defined loosely.

Compared to other renewable energy types, geothermal energy has so far not been promoted actively as means to reduce greenhouse gas emissions. This is due to the absence of groups stressing the geothermal potential at international climate negotiations. Even if wind energy on a global scale has a lower impact on emission reduction than geothermal energy, it is far more discussed and promoted.

3. CDM STANCE OF POTENTIAL GEOTHERMAL PROJECT HOST COUNTRIES

High-temperature geothermal energy resources suitable for electrcity generation can be found in volcanic areas, particularly the “ring of fire” around the Pacific ocean and the rift valley in Eastern Africa. Global resources are estimated at 50-100 GW (Energy and Geoscience Institute at the University of Utah, 1998). Low temperature resources for hot water and heat pump use exist almost anywhere in the world.

Of the current installed world total of almost 8 GW with 48 TWh electricity production and 51 TWh thermal use, 47% of electric capacity, 46% of electricity production and 30% of heat production is situated in countries without emission targets under the Kyoto Protocol, thus potential CDM host countries (see **Table-1**).

Several of the developing countries with an active use of geothermal energy belong to the small group that has actively participated in the AIJ pilot phase and developed institutional capacities that can become very useful for using the CDM. Costa Rica has been a forerunner of AIJ and been very creative in developing new ideas of project development (Dutschke and Michaelowa, 2000). Many countries have participated in the World Bank’s programme of National CDM Strategy Studies (NSS) (Klarer et al. 1999). Of the 18 countries with relevant geothermal activities, seven have high AIJ/CDM-related activity levels, four a medium level, 3 a low level and only four have not been active at all. According to IGA secretariat (2000b), seven of the 18 countries have plans to expand their geothermal electric capacity. (see **Table-2**). However, so far only one AIJ project out of 144 is a geothermal plant (El-Hoyo/Monte Galan in Nicaragua), and this project so far has not found an investor.

The challenge for the geothermal community in countries with high geothermal potential is thus to direct the existing interest in CDM development towards geothermal development. In the context of the NSS done so far, geothermal energy has been sidelined. Only in the context of the Indonesian NSS it has explicitly been considered in the project pipeline. This may be due to the active role of the Indonesian geothermal society which prepared a document clearly showing the potential of goethermal CDM projects (API 2000).

Another sensible strategy might be to enlist the support of strong investor countries. The U.S., New Zealand and Japan are likely to have a high demand for CERs. They may be willing to promote exports of their domestic geothermal industry in the CDM context.

4. OVERALL CO2 REDUCTION POTENTIAL OF GEOTHERMAL CDM PROJECTS AND RELATED REVENUES

According to Thain and Dunstall (2001) the average CO_2 emission level from 50% of the global geothermal power plants is 110g/kWh, all Indonesian plants 69g/kWh and for about 50% of Philippines plants 94g/kWh. However, the level can differ by a factor of 40 even within one country (New Zealand Geothermal Association, no date)! In contrast, fossil fuel power stations emit around 900 g/kWh for coal and 400 g/kWh for natural gas. It is thus clear that geothermal plants can considerably reduce greenhouse gas emissions.

The creation of emission credits under the CDM (“Certified Emission Reductions”, CERs) depends on the baseline chosen for the calculation. As the data listed above show, it makes a decisive difference if the baseline is a coal-fired station, a gas fired or even a hydropower station. CERs per kWh would be about 800 g in the first case, 300 in the second and 0 in the third. In the international climate negotiations so far no consensus on baseline rules has been found. Thus there are the following possibilities:

- Top-down baseline derived from national energy systems modelling
- Project-by-project baseline
- Benchmark, i.e. a fixed emission factor for all projects of a specific technology in a specific country or the average of the grid for all electricity supply projects

In a country with a high share of fossil fuels, the benchmark approach would give high incentives for geothermal projects. This would be the case for the project-by-project approach if project proponents can show that a fossil fuel plant with high carbon intensity would have been used in absence of the project. A grid benchmark in countries with a high share of hydro would however only give a small incentive.

Another factor concerning the attractiveness of CDM projects is the price of the CERs. On the current grey market, a t CO_2 trades at 0.5-1 $. Prices after entry into force of the Kyoto Protocol are estimated at 5 – 10 $. In the long run, however, they may be much higher. Long-run prices depend, however, on future emissions targets and cannot be predicted to any extent. The CER revenue from a 100 MW geothermal power plant under different assumptions can be found in **Table-3**. It can become quite substantial if high baselines and CER prices coincide with high capacity factors. Under a coal baseline and 10 $/CER the CER revenue per kWh would be 0.8 cents which would be enough in some circumstances to make geothermal plants viable compared to fossil fuel alternatives, whereas under a gas baseline and 1 $/CER it would only be 0.3 mills, i.e. negligible. Assuming constant CER prices of 10 $, discount rates of 10% per year and a plant lifetime of 25 years, NPV of CERs per kW under a 89% capacity factor would amount to 587 $, i.e. 29% of the investment cost of 2000 $/kW (assumptions taken from Thain and Dunstall 2001). For a gas baseline, a CER price of 1 $ and a 47% capacity factor, the NPV would fall to 11.4 $, i.e. only 0.5% of the investment cost.

The discussion shows that there is a lot of factors that can influence the attractiveness of CDM to promote geothermal energy. Many of them depend on the outcome of international climate negotiations.

5. LINKING GEOTHERMAL AND FORESTRY CDM

Geothermal power stations need undisturbed areas of land for infiltration of water to recharge the reservoirs. This allows to link two types of CDM projects: the geothermal energy production and the protection of forests/afforestation. However, the CER yield of the forestry part would be several orders of magnitude lower than the one of the energy production. An afforestation programme of 185 ha such as the one implemented by Amoseas at the 125 MW Darajat field (Amoseas 2000) would annually yield 925 to 2775 CERs at sequestration rates of 5 to 15 t CO_2 per ha and year, i.e.more than 100 times less than the CERs created by the power station. Moreover, it is still doubtful whether forestry projects will be at all eligible under the CDM.

6. CONCLUSIONS

The geothermal industry should see the CDM as chance, but not as panacea that will achieve an overall market breakthrough. Many countries with an attractive geothermal potential and geothermal expansion plans have already started to prepare themselves for CDM implementation. However, geothermal energy has not figured prominently in their CDM plans. In such countries, the geothermal community should bundle its forces to guarantee a presence in the development of national CDM strategies. Moreover, overall awareness of participants in international climate negotiations concerning the potential of geothermal energy for greenhouse gas reduction has to be strengthened. The geothermal trade associations should thus develop a strong presence at the negotiations, particularly as decisions on baseline rules have a crucial impact on the attractiveness of CDM projects to geothermal developers. At high CER prices and baselines, geothermal projects can cover a significant share of the investment costs through CER sales and may thus make projects attractive that have hitherto been uneconomic. At current low prices and grid benchmarks, revenues cannot affect the overall investment decision. While forestry projects can help the developers to safeguard water recharge, they do not yield enough CERs to have a real impact on revenues.

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Table-1
Geothermal capacity in CDM countries 2000

Country	Electric capacity (MW)	Electricity generation (GWh)	Heat use (GWh)	Total (GWh)
China	29	100	10531	11531
Philippines	1909	9181	7	9188
Mexico	755	5681	1087	6768
Indonesia	589	4575	12	4587
Georgia	0	0	1752	1752
El Salvador	161	800	0	800
India	0	0	699	699
Costa Rica	142	592	0	592
Nicaragua	70	583	0	583
Israel	0	0	..476	476
Algeria	0	0	441	441
Jordan	0	0	..428	428
Kenya	45	366	3	369
Korea	0	0	299	299
Guatemala	33	216	30	246
Argentina	0	0	125	125
Colombia	0	0	74	74
Tunisia	0	0	56	56
Developing country total	**3742**	**22124**	**16067**	**38191**
World total	**7947**	**48545**	**51428**	**99973**

Source: IGA Secretariat (2000b), Lund (2000)

Table-2
Participation of geothermally active countries in AIJ and preparations for CDM

Country	AIJ projects approved	Dedicated AIJ/CDM office	NSS*	Overall activity**	Expan-sion till 2005 (MW)
China	4	-	N	High	
Philippines	-	-	-	Low	764
Mexico	5	-	-	Medium	325
Indonesia	2	-	I	High	1398
Georgia	-	-	-	Low	
El Salvador	1	-	N	High	39
India	1	-	-	Medium	
Costa Rica	9	X	-	High	19
Nicaragua	1	-	-	Medium	75
Israel	-	-	-	None	
Algeria	-	-	-	None	
Jordan	-	-	-	None	
Kenya	-	-	-	Low	128
Korea	-	X	-	Medium	
Guatemala	3	X	I	High	
Argentina	2	X	C	High	
Colombia	-	X	C	High	
Tunisia	-	-	-	None	

* C: completed, I: currently being elaborated, N: under negotiation, A: application pending

** High: two or more entries, Medium: one entry, Low: no entry, but known in-country activities on AIJ/CDM (e.g. workshops), None: No known activity

Sources: UNFCCC (2000), IGA Secretariat (2000b), NSS Program (2000)

Table-3
Annual revenue impact of CERs under different baselines, capacity factors and prices for a 100 MW geothermal power station with a CO_2 emission of 100 (upper line) and 70 g/kWh (lower line)

a) CER generation (1000)

Baseline	Capacity 48% (Costa Rica)	Capacity 74% (Guatemala)	Capacity 89% (Indonesia)
Coal-fired plant[1]	336 349	519 538	624 647
Gas fired plant[2]	126 139	194 214	234 257
Respective grid average[3]	- 4	64 84	425 448

[1] 900 g/kWh
[2] 400 g/kWh
[3] 80 g/kWh (Costa Rica), 200 g/kWh (Guatemala), 645 g/kWh (Indonesia)

b) Range of annual revenue (1000 $) depending on CER prices

Price per CER	Costa Rica	Guatemala	Indonesia
1 $	0-349	64-538	234-647
5 $	0-1749	320-2690	1170-3235
10 $	0-3490	640-5380	2340-6470

Sources: Own calculation on the basis of data on
- capacity factors from IGA Secretariat (2000b),
- electricity mix for 1998: Indonesia: API (2000), Costa Rica and Guatemala: U.S. Energy Information Administration, emission factors for thermal power stations: diesel= 900 g CO_2/kWh, oil = 750 g CO_2/kWh