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CLEAN DEVELOPMENT MECHANISM, CARBON FINANCE AND GEOTHERMAL APPLICATIONS

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ABSTRACT

The Kyoto Protocol, entered into force on 16 February 2005, commits many developed countries, defined as Annex I countries, to reduce their greenhouse gas (GHG) emissions to specific targets. The Protocol defined the Clean Development Mechanism (CDM) as a mechanism to help these industrialized countries to reduce the costs of meeting their targets by buying certified emission reductions (CERs) generated from projects implemented in developing countries.

The quantification of the CERs, generated by different projects, is made using a methodology that provides all the steps to determine the emissions reductions in an accurate and conservative way. Nowadays, geothermal energy can claim CERs when it is used for electricity generation. A new methodology for the use of geothermal sources for heating purposes is required; the methodology for geothermal heat generation has to follow the same guidelines as any other methodology: define the project boundary, guidelines to prove the additionality of the geothermal project, and provide procedures to estimate the baseline, project, and leakage emissions.

1. INTRODUCTION

It is a fact that the atmospheric build up of CO_2 and other GHGs have been changing the composition of the earth's atmosphere since pre-industrial times, there is no doubt that this is largely the result of human activities.

With the launch of the Kyoto Protocol on 16 February 2005, more than 140 countries agree to work together to fight global climate change. The 36 industrialized countries that ratified the Protocol - namely Canada, Japan, members of the European Union, as well as economies in transition from Central and Eastern Europe agreed to put in place policies and measures to collectively reduce 5 percent of their emissions by 2008 – 2012, as measured against 1990 levels. To meet this binding commitment, industrialized countries have the option to reduce part of their emissions domestically, and they can also obtain emission reductions from developing countries through the CDM.

The CDM represents an opportunity to attract investments, from the public and private sectors, in climate-friendly technologies, like the ones that use geothermal energy, and to contribute to the global combat on climate change. In order to be eligible, CDM projects have to be above and beyond business-as-usual, and must contribute to sustainable development as defined by the host country (developing country).

2. THE KYOTO PROTOCOL AND THE CLEAN DEVELOPMENT MECHANISM

Scientific evidence of impact of the anthropogenic emission of greenhouse gases (GHGs) in global warming along with the increase of public awareness about the environment drove climate change onto the political agenda in the 1980's. In 1988 the United Nations Environment Programme (UNEP) and the World Meteorological Association (WMO) established the Intergovernmental Panel on Climate Change (IPCC) to provide objective scientific information to the policymakers. In 1990, the IPCC in its First Assessment Report concluded that the growing accumulation of human-made greenhouse gases in the atmosphere would "enhance the greenhouse effect, resulting on average in an additional warming of the Earth's surface" by the next century, unless measures were adopted to limit emissions.

2.1 The United Nations Framework Convention on Climate Change

In 1992 at the United Nations Conference on Environment and Development, the Earth Summit in Rio de Janeiro, Brazil the United Nations Framework Convention on Climate Change (UNFCCC) was opened for signature and finally entered into force in 1994. The ultimate objective of the Convention is to stabilize atmospheric concentrations of greenhouse gases at safe levels. The objective should be reached in a sufficient time frame to allow ecosystems to adapt to climate change, to ensure food production and to enable economic development. To achieve this objective all countries have the commitment to address climate change, adapt to its effects and report the implemented actions to the Convention.

The Convention establishes commitments for the parties taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances. The Convention divides the countries in: a) Annex I parties, which includes industrialized countries that have historically contributed the most to climate change, and b) non-Annex I Parties, which primarily includes the developing countries. Annex I Parties have to reduce their greenhouse gas emissions in around 5% compared with 1990 levels by 2008 - 2012. They must also submit regular reports, known as national communications, detailing their climate change policies and programs, as well as annual inventories of their GHG emissions.

2.2 The Kyoto Protocol

The Kyoto Protocol was adopted in 1997 and shares the Convention's objective, principles and institutions, but significantly strengthens the Convention by committing Annex I Parties to individual, legally-binding targets to limit or reduce their GHG emissions. Only Parties to the Convention that have also become Parties to the Protocol (i.e. by ratifying, accepting, approving, or acceding to it) will be bound by the Protocol's commitments. The Kyoto Protocol entered into force on 16 February 2005.

The emission reduction targets cover the six main greenhouse gases:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_20);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs);
- Sulphur hexafluoride (SF_6).

2.3 The Clean Development Mechanism

The Protocol has established three mechanisms designed to help industrialized countries (Annex I Parties) reduce the costs of meeting their emissions targets by achieving emission reductions at lower costs in other countries than they could domestically; these are the CCDM, Joint Implementation and Emission Trading.

The CDM allows an Annex I Party to obtain emission reductions from a project that reduces greenhouse gas emissions in the territory of a non-Annex I Party. The resulting CERs can then be used by the Annex I Party to help meet its emission reduction target.

The aim of the CDM is described in the Kyoto Protocol Article 12.2 "The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3."

3. UNFCCC EMISSION BASELINES

The CDM establishes that a project which wants to be included under the mechanism has to have "additional" emission reductions. To determine the amount of reductions a project can generate, an indication is needed of which GHGs would have been emitted in the absence of the project. The amount of GHG emitted in the hypothetical non-project scenario is referred to as a project's baseline. The baseline is the quantification of the hypothetical emission levels and may be used to prove if a project is additional or not. CDM projects will qualify for CER units if they are additional relative to the baseline.

There are previous experiences in the development of baseline scenarios; most of them draw on a project specific basis. Scenario analysis involves the creation of a set of scenarios that reflect what would happen in the absence of the CDM project; this baseline identification can be done following a regulatory assessment, investment analysis, market barrier analysis, risk analysis and conservatism principles.

Since baseline methods determine how many emission credits a project will accrue, systematic error in baseline estimation could result in a variety of unwanted outcomes. Lax baselines will increase global emissions and stringent baselines will reduce crediting and the economic incentive of GHG projects.

The Executive Board (EB) of the CDM must balance these concerns, while ensuring reliability, consistency and transparency with manageable transactions costs. As a way to address these issues the idea of standardized baselines has gained attention and support. Standardized methodologies can ensure project consistency and reduce transaction costs (Table 1).

TABLE 1: Number of approved large scale methodologies per sectoral scope (April 2008)

Scope	Number Of Methodologies
Energy industries (renewable - / non-renewable sources)	30
Energy distribution	1
Energy demand	5
Manufacturing industries	14
Chemical industries	10
Construction	0
Transport	1
Mining/mineral production	1
Metal production	5
Fugitive emissions from fuels (solid, oil and gas)	5
Fugitive emissions from production and consumption of halocarbons and sulphur hexafluoride	4
Solvent use	0
Waste handling and disposal	6
Afforestation and reforestation	11
Agriculture	1

4. CURRENT STATUS OF GEOTHERMAL ENERGY EXPLOITATION UNDER THE CDM

Currently the CDM only considers geothermal energy for electricity generation; it is included in the methodology ACM0002 "Consolidated methodology for grid-connected electricity generation from renewable sources". This methodology allows renewable energy projects, like geothermal, to claim emission reductions, and consequently earn money on the displacement of energy generation from fossil fuel power plants (e.g. natural gas, coal or diesel).

When analysing the emission of GHGs from geothermal project activities, the methodology ACM0002 takes into account fugitive emissions of carbon dioxide and methane due to release of non-condensable gases from produced steam and carbon dioxide emissions resulting from combustion of fossil fuels related to the operation of the geothermal power plant. Table 2 shows the existing geothermal energy projects that are registered under the CDM.

TABLE 2: CDM Geothermal electricity generation projects

Name of the project	Capacity	Country
San Jacinto Tizate geothermal project	100 MW	Nicaragua
Berlin Geothermal Project, Phase Two	44 MW	El Salvador
Lihir Geothermal Power Project	55 MW	Papua New Guinea
20 MW Nasulo Geothermal Project	20 MW	Philippines
Darajat Unit III Geothermal Project	110 MW	Indonesia

To broaden the options for geothermal energy, the Asian Development Bank has proposed a new methodology to use geothermal energy for space heating (households and commercial building). This proposal will be discussed next June, 2008, and if approved it will allow other geothermal projects to apply to the CDM and consequently obtain CERs.

The proposed methodology refers to a project to be implemented in Baoding city in Hebei province,the specific CDM project activity includes four separate heat exchangers supplying heat with a total rated capacity of 90 MW_{th}.

The proposed project will replace the current coal fired boilers and room heaters and provide geothermal space heating for urban areas. The proposed geothermal space heating project envisages extending space heating to an area of 1,650,000 m^2. It will exploit 4.5 million m^3 of geothermal water annually from 11 new wells, with re-injection of return water to 10 wells. A total of 4 heating stations with 55,000 m of transmission lines and 18,140 m of supply pipelines will be necessary for the proposed project activity.

5. THE CDM AND THE HEAT GENERATION USING GEOTHERMAL ENERGY

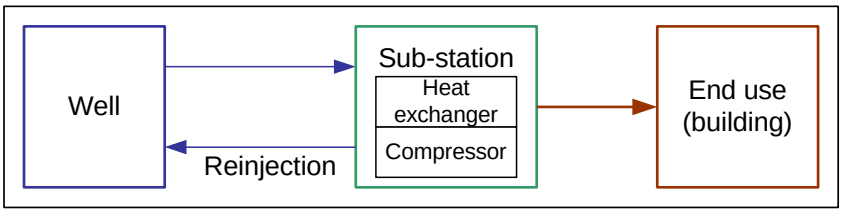
The scope of this section is to discuss the main issues to take into consideration when developing the CDM component of a geothermal heating project. The analysis includes the following steps:

5.1 Project boundary

The methodology has to identify the main components that constitute the project (Figure 1). The project boundary in a geothermal project will include:

- Sources of energy: wells, storage tanks;
- Heating systems: stations, sub-stations;
- Transmission and final users: buildings, stoves, pipes.

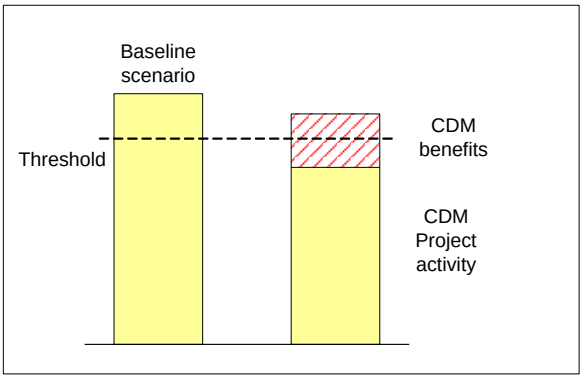
FIGURE 1: Possible project boundary for space heating systems using geothermal energy



5.2 Additionality

Additionality is a key element of the CDM. A project is additional if the benefits from the CDM help it to overcome certain barriers (e.g. technological, financial), or make it more competitive when compared with other technologies that provide the same service. Figure 2 shows the impact of the CDM.

FIGURE 2: Impact of the CDM



The UNFCCC has developed two tools to determine the additionality of a proposed CDM project. The main components of these tools are described below.

5.2.1 Identification of baseline scenario

The baseline scenario is defined as the situation that will occur if the proposed CDM project is not implemented. It could be the case that there is already a technology supplying the same service as the CDM (e.g. district heating system) which means that the baseline scenario is the continuation of the current activity; and it may also be possible that the project can be implemented without requiring the help of the CDM.

To identify the baseline scenario it is necessary to elaborate a list of possible technologies/options that can supply the same quality of service as would be provided by the CDM project activity.

Space heating technologies that can provide the same service as the geothermal are:

- Continuation of current situation;
- Implementation of the project activity without the benefits of the CDM;
- New centralized/decentralized fossil fuel supply systems;
- New centralized/decentralized renewable supply systems;
- Combination of renewable and fossil fuel energy to satisfy heat demand.

The scenarios that do not comply with certain national, regional norms or regulations (legal barriers) have to be eliminated from the list of possible baseline scenarios.

5.2.2 Barrier analysis

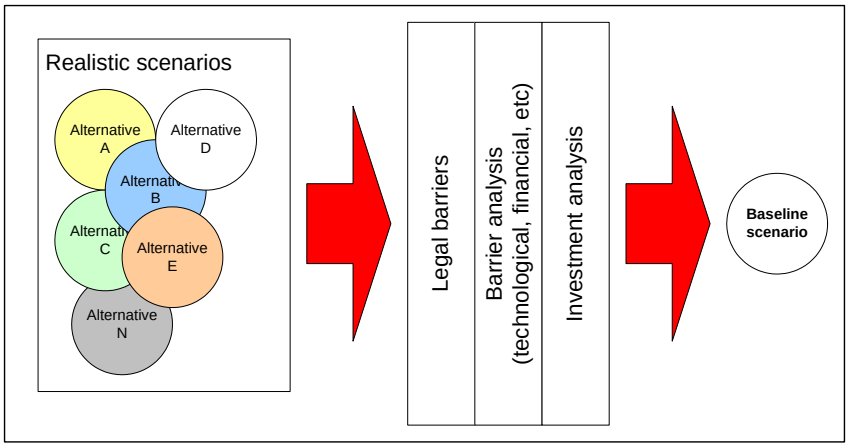
The list of potential baseline scenarios has to be narrowed down eliminating the options that face some barriers. These barriers can be technological barriers, financial barriers, etc.

5.2.3 Investment analysis

If there is more than one option available after the barrier analysis, then it is necessary to carry out the investment analysis of the remaining options in order to determine which ones are the most attractive. The comparison among the possible options can be based on the Internal Rate of Return (IRR), or on the Net Present Value (NPV).

The scenario that faces no barriers or the scenario that is the more economically attractive could be defined as the baseline scenario (Figure 3).

FIGURE 3: The process to identify the baseline scenario



If the identified baseline scenario is the implementation of the geothermal space heating project without the benefits of the CDM then the project is not additional.

5.3 Baseline and project emission factors

To determine the total emission reductions it is necessary to calculate the emissions that will occur in the baseline scenario and then discount the emissions caused by the project activity and the possible leakage emissions. The difference represents the total emission reductions generated by the implementation of the project activity.

5.3.1 Baseline emissions

The baseline emission can be determined if the historical fuel consumption is known. An average consumption of the last three to five years prior the implementation of the project could be used as a reference to estimate what the fossil fuel consumption would be if the geothermal CDM project is not implemented. If the fuel consumption history is not available (i.e. in the case of new installations) then a series of parameters should be defined and monitored in order to estimate the fossil fuel consumption:

- Heat demand (based on building characteristics and climate of the region, or sampling in a control group);
- Transmission losses (pipe supplier information or control group);
- Thermal efficiency of the space heating technology (standard efficiency in the country, best available technology, or recommended default values).

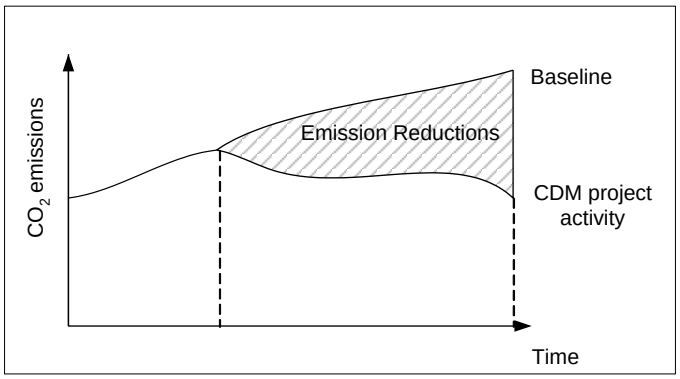
5.3.2 Project emissions

Project emissions can be calculated taking into consideration fugitive carbon dioxide and methane released from geothermal vents, electricity consumption from the use the pumps to extract the geothermal water and fossil fuel used to operate the geothermal facility.

If Low-heat geothermal capacities are below the gaseous point of water then it may not be necessary to calculate fugitive emissions (i.e. Geothermal water less than 100°C at standard temperature and pressure)

Figure 4 shows a simplified graph of how the emission reductions are estimated.

FIGURE 4: Identification of emission reductions as the difference between baseline and project emissions

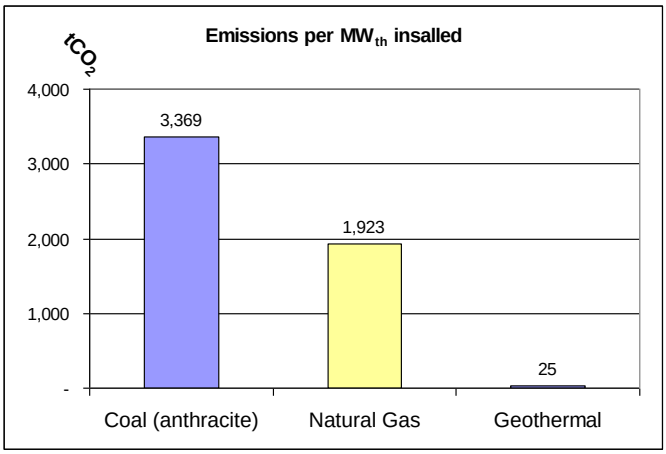


6. POTENTIAL BENEFITS OF THE CDM

Figure 5 shows the CO_2 emissions generated by the use of different fuels to produce $1MW_{th}$. As it can be expected, the use of coal will produce the largest amount of emissions (3369 $tonCO_2/MW_{th}$); the use of natural gas, which is one of the most common fuels used for space heating, will produce around 1900 $tonCO_2/MW_{th}$ and finally geothermal heating will generate only 25 $tonCO_2/MW_{th}$ from the electricity consumption (from the grid).

It is important to see that the emissions due to geothermal heating generation represent less than 1% of the emissions generated by the use of coal.

FIGURE 5: GHG emissions from different sources



The difference between the emissions from the use of fossil fuels (i.e. coal) and the use of geothermal energy means that the geothermal heating project can receive an extra income for selling the CERs generated by the activity. Table 3 is an example on the total benefits that can be obtained per MW_{th}

installed. Assuming a conservative price of EUR 10 per ton CO_2 it is possible to have an additional income of EUR 33,400 per year, but if the price per ton CO_2 is EUR 24 then the income per each MW_{th} installed could be of the order of EUR 80,000 per year.

This possible income may help to make the project more financially attractive and also can help to overcome possible barriers faced in the implementation of the project. It can, for example, be used for training purposes, market development, etc.

TABLE 3: Possible revenue for geothermal heating projects from the CDM

Potential CERs income per MW_{th} installed	**EUR**
Price of EUR10	33,439.12
Price of EUR24 (Point Carbon)	80,253.88

7. CONCLUSIONS

The CDM is a mechanism created with the objective to help developed countries to achieve their emission reduction targets established in the Kyoto protocol as well as to contribute to the sustainable development of the developing countries. It can allow projects that use geothermal energy for space heating to receive an extra benefit because it will generate CERs due to displacing fossil fuels like coal, LPG or natural gas.

Currently the UNFCCC is evaluating a methodology to estimate emission reductions from geothermal space heating projects submitted by the Asian Development Bank that will allow geothermal heating projects to apply to the CDM and claim the CERs. In order to qualify to the CDM a geothermal project has to demonstrate that it is additional and the potential CDM benefits will help to overcome possible barriers that hamper its implementation.

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