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FROM CARBON FINANCING IN THE CONTEXT OF GEOTHERMAL DEVELOPMENT TOWARDS ADAPTATION TO CLIMATE CHANGE

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ABSTRACT

The concern on the effects of climate change is global. Scientific evidence has shown that its origin is the increasing greenhouse gas emissions from anthropogenic activities. The international community agreed that the solution is to mitigate climate change and adapt to this change.

The Clean Development Mechanism (CDM) contributes to the mitigation and provides opportunity for promoting the development of geothermal energy utilization in developing countries. Twelve geothermal projects have been registered in the CDM and four of them are from Central America. El Salvador has registered two geothermal electricity projects as CDM projects with about 212,881.0 Certified Emission Reductions per year (CERs/yr), which represent 96.5% of the total offer.

The main benefits identified in the CDM geothermal projects are: a) the contribution to mitigate climate change, b) contribution to sustainable development in the host country, c) improvement in project profitability, d) positive environmental publicity for the company, e) strengthening of the competitiveness of the company, f) reduced dependence on oil, g) contribution to fund adaptation, h) access to investment funds and i) capacity building in CDM.

Central America has low emissions of gases (0.08% of CO_2 in the world) and has high vulnerability to climate change; and hence, the main issue should be the adaptation to climate change. Geothermal project developers should include in their environmental management plan (EMP) measures that contribute to the reduction of the vulnerability in the local area of the project. In this way, geothermal projects not only would contribute to sustainable development but also to adaptation to climate change.

1. INTRODUCTION

The effect of climate change is a global problem. The international response provides two paths of solution: the mitigation of greenhouse gas emissions and the adaptation to its effects. This paper presents the potential for geothermal projects to participate in the CDM. At the same time, it presents the experience of El Salvador and the lessons learned from CDM. Finally, it gives the opportunity on how the developer of geothermal projects can contribute to the local adaptation to climate change.

2. GLOBAL EFFORTS TO CLIMATE CHANGE MITIGATION

Scientific evidence shows that increasing greenhouse gas (GHGs) emissions from anthropogenic activities is causing dramatic climatic changes such as elevating temperatures, rising sea levels, alterations in precipitation patterns and evolving of extreme climate events. There is more than 90% of certainty that global warming in the 20th century was due to the observed increase in these anthropogenic GHGs concentrations (IPCC, 2007).

According to the Intergovernmental Panel on Climate Change reported in its Fourth Assessment Report, the main greenhouse gases in the atmosphere are water vapour, carbon dioxide, methane, nitrous oxide, and ozone. The rise in carbon dioxide (CO_2) concentrations is mainly due to the use of fossil fuels; and increased concentrations of methane (CH_4) and nitrous oxide (N_2O) due to agricultural activities.

The international response to mitigate climate change began in 1992, where different governments in the world adopted the United Nations Framework Convention on Climate Change (UNFCCC). The main objective of the Convention is to achieve stabilization of atmospheric concentrations of greenhouse gases (GHGs) at levels that would prevent dangerous anthropogenic interference with the climate system, by an average of 5.2% in the period 2008-2012.

The Convention divides countries into two main groups:

- *Annex I Parties*: include the relatively wealthy industrialized countries that were members of the Organization for Economic Co-operation and Development (OECD) in 1992, as well as countries with economies in transition; and
- *Non-Annex I Parties*: mostly the developing countries.

In 1997, the Kyoto Protocol was adopted and gave new vision, with its legally binding constraints about reduction GHGs emissions, primarily through national measures. As an additional means of meeting these targets, the Kyoto Protocol introduced three flexible market-based mechanisms, which are:

- Emissions Trading (ET);
- Joint Implementation (JI); and
- The Clean Development Mechanism (CDM).

Under Article 12 of the Kyoto Protocol, the CDM is a mechanism which has two purposes:

- Assist non-Annex I Parties in achieving sustainable development and in contributing to the objective of the climate change convention; and
- Assist Annex I Parties in achieving compliance with their quantified emission limitation and reduction commitments under the Kyoto Protocol.

The CDM projects are designed to reduce GHGs emissions, as well as to transfer environmental protection technologies and promote these technologies to the host countries, see Figure 1.

3. PROBLEMS OF THE CLIMATE CHANGE IN C.A. REGION

The Central American region is located in a strategic position, which provides a natural link between North America and South America and separates the Pacific Ocean with the Caribbean Sea. The region is composed of seven relatively small countries: Guatemala, Belize, Honduras, El Salvador, Nicaragua, Costa Rica and Panama, which base their economies on agriculture and use of natural resources (Leonard, 1987). The biological richness of Central America is manifested in 20 lifezones,

ranging from semi-desert to cloud forest, and with 8% of the world's known plant species and 10% of its vertebrates. The region has extremely steep terrains, ample variety of climate and perhaps a higher propensity for natural disasters than any other territory on the planet (Leonard, 1987).

Historically, the region has been identified by their socioeconomic vulnerability that is affected by droughts, cyclones and the El Niño/La Niña-Southern Oscillation (ENOS). The climate change is intensifying and expanding these vulnerabilities, and can cause an increased impact on the main economic activities in the region; such as agriculture and tourism, which are climate-dependent. These economic activities are representing a major proportion of income and employment in all the countries in the region (CCAD and SICA, 2010).

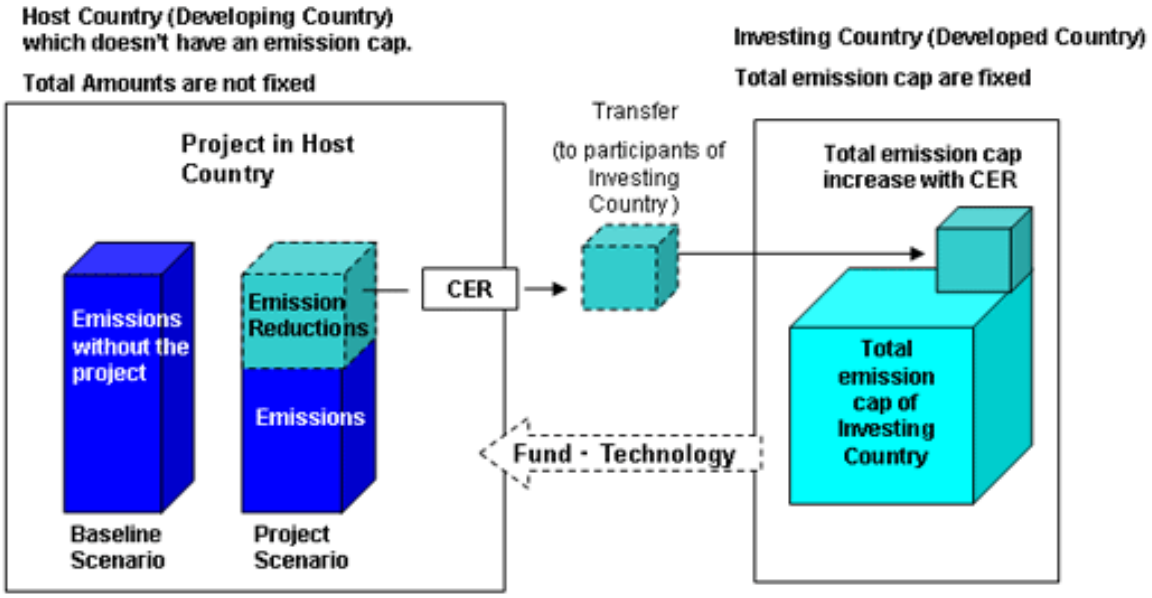


FIGURE 1: Clean Development Mechanism (JQA, 2007)

It doesn't matter that Central America continues to have one of the lowest shares of the GHG global emissions (0.08% of CO_2 in the world in 2007) as the effects of climate change will continue to increase in the region. In the past three decades, the number of disasters has grown at an estimated annual rate of 5% compared to the levels recorded during the 1970's. There is a consensus that the increasing intensity of hurricanes and other storms is related to climate change (United Nations, 2010 and The Word Bank, 2007).

According to GERMANWATCH (Harmeling and Eckstein, 2013; Kreft and Eckstein, 2014), the most affected countries in the world by the impacts of weather-related loss events in 2011 were Thailand, Cambodia, Pakistan and El Salvador. Between 2002 and 2011, El Salvador was affected by seven cyclones and two low-pressure systems, three of these extreme event caused losses of approximately 1,300 millions of dollars (equivalent to 6% of its Gross Domestic Product) (MARN, 2013). Furthermore, for the period of 1993 to 2012, Honduras, Myanmar, Haiti, Nicaragua, Bangladesh, Vietnam, Philippines, Dominican Republic, Mongolia, Thailand and Guatemala ranked the highest. Unfortunately, three of these countries belong to the Central American region and four have geothermal projects in the CDM.

The climate simulation for Central America under scenario B2 (medium-low global emissions) of the IPCC generated the mean annual temperature, stating that by 2020 and 2050, increase in temperature is up to 0.5°C and 1.3°C respectively, compared to the average annual temperature for 1980-2000. The region had suffered the impacts (shown in Figure 2) within the range of 0.5°C to 2°C (United Nations, 2010).

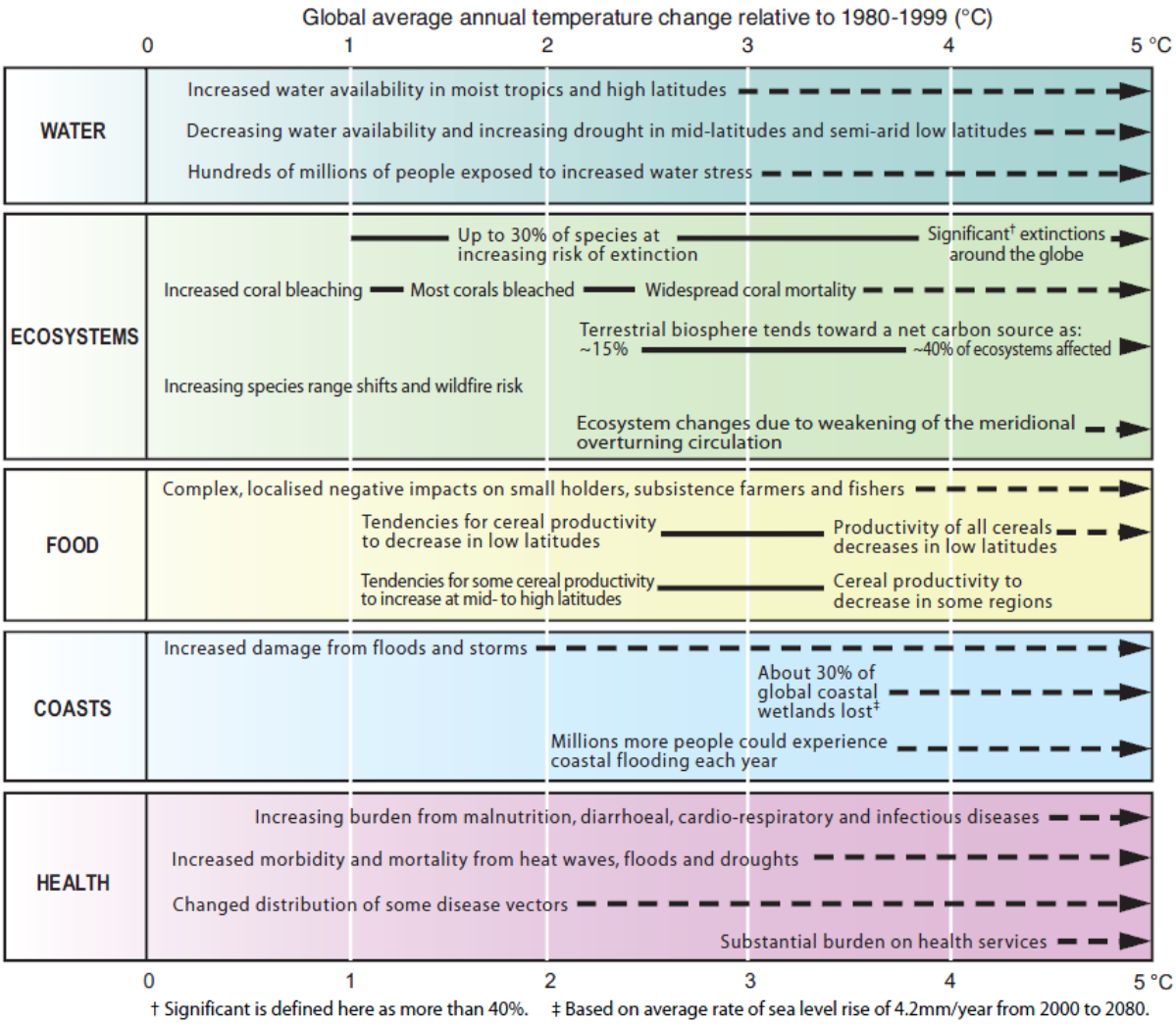


FIGURE 2: Impacts associated with global average temperature change (Bernstein et al., 2007)

In summary, the Central American region faces climate change with a high sensitivity to its impact and reduced resilience and adaptation capabilities. In this context, it is worth remembering the following definitions presented in the IPCC TAR (McCarthy et al., 2001):

- *Sensitivity*: The degree to which a system is affected, either adversely or beneficially, by climate related stimuli;
- *Resilience*: Amount of change a system can undergo without changing state; and
- *Adaptive capacity*: The ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

The report by CCAD and SICA (2010) indicates that the response of the Central American region to face this problem is based on the Regional Strategy on Climate Change (RSCC).

This Regional Strategy contemplates actions to be taken in the following strategic and programmed areas:

- Mitigation;
- Vulnerability, adaptation to climate change and variability and risk management;

- Capacity building;
- Education, awareness, communication and citizen participation;
- Technology transfers; and
- Negotiations and international support.

4. SUSTAINABLE ENERGY AND CLIMATE CHANGE

The concept of sustainable energy can be defined as the provision of energy services affordable, accessible and reliable to meet the economic, social and environmental needs of society with an equitable distribution to meet these needs (Davidson et al., 2006).

In 2009, in Central America, there existed about 7.4 million of people without electricity access and this unsatisfactory situation is clearly a considerable constraint to its social-economic development (WEO, 2011; OFID, 2010); moreover 38% of electricity generation comes from fossil fuel (Montalvo, 2011). The dependence on fossil fuels not only increases the cost of electricity, but also is one of the main responsible for the global GHGs emissions. This fact allows to identify that there is a long way to go in the struggle against climate change and the urgent need to switch to an energy model to a low-carbon economy, in order to resume the path towards sustainable development.

Renewable energy projects and energy efficiency programs are making significant contributions in programmed area of Mitigation (reducing dependence on fossil fuel use and associated GHG emissions). Geothermal energy is one of the most promising among renewable energy sources, and has proven to be reliable and clean energy source compared to nuclear and fossil fuels. Therefore, its utilization for power generation and direct uses is increasing (Kömurcu and Akpinar, 2009). According to Bertani (2009), by 2050, geothermal electricity generation will be about 1000 TWh/yr and could be mitigated up to 1000 of million tons of CO_2/yr (calculation made based on the replacement of coal).

Central America has a total estimated geothermal potential of about 3500 MWe, which has an installed capacity of 506.8 MWe to date and by 2015 it is forecasted to increase to 885 MWe (Montalvo, 2011 and CEPAL, 2010). An opportunity for promoting and accelerating the development of geothermal energy utilization in developing countries is the CDM (Mutia, 2010). At present, Central America has already begun to benefit this mechanism.

According to the website of UNFCCC (2014), 12 countries (Chile, China, El Salvador, Guatemala, Honduras, Indonesia, Kenya, Malaysia, Mexico, Nicaragua, Papua New Guinea, and Philippines) are taking advantage of the Clean Development Mechanism (CDM) to generate an additional source of income to contribute to the economic viability of 29 geothermal power projects and 2 geothermal space heating projects. Of these 31 projects, it is expected to have an annual reduction near of 11 million tonnes of CO_2 equivalent. But only 10 have already received 7,227,982.0 of Certified Emission Reductions (CERs) in the period from 2005 to 2012 (which represents 8.0% of the offer). Five of these projects belong to the Central American countries indicating that the region has good participation in the CDM for geothermal projects and generated 19.6% of the CERs issued.

5. GEOTHERMAL PROJECTS AND CDM BENEFITS IN EL SALVADOR

Geothermal projects could be considered a potential CDM project and to qualify, these projects must meet the following requirements:

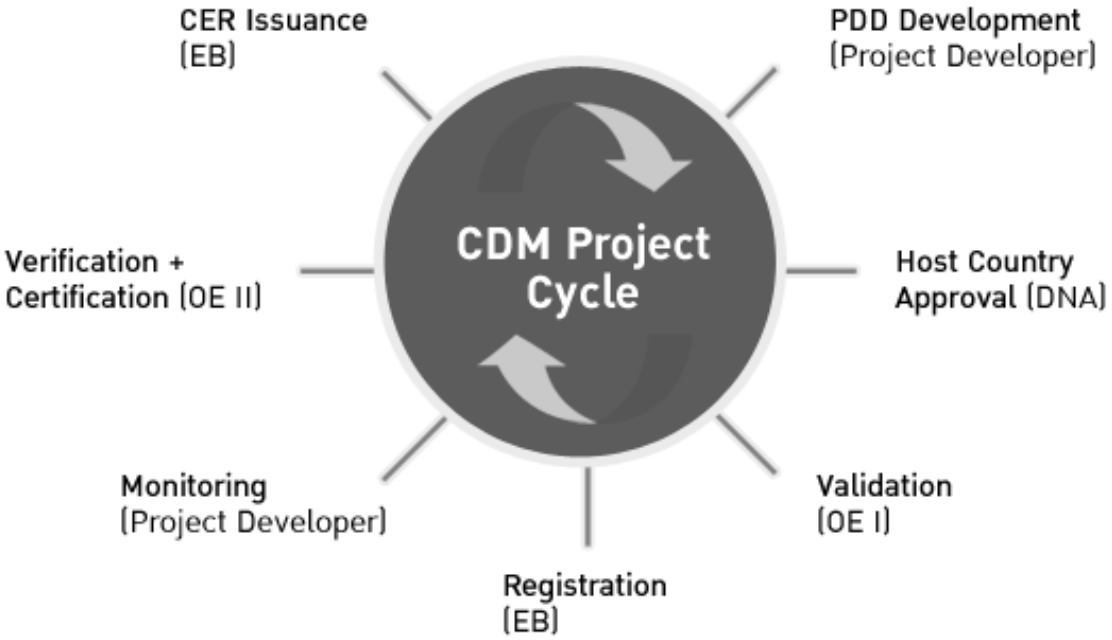
- The project host country must have ratified the Kyoto Protocol and a Designated National Authority (DNA);

- A letter of approval from DNA stating that participation of the project is voluntary, and that the project activity assists in achieving sustainable development of the host country;
- The project activity must demonstrate to have real, measurable and long-term benefits related to the mitigation of climate change;
- Early consideration of the project activity is to implement the CDM;
- The emission reductions must be additional;
- Does not give significant environmental impacts and undertakes public consultation; and
- Does not result to the diversion of official development assistance (ODA).

According to Loy (2008), in late 1999, LaGeo contracted consulting services to incorporate the geothermal projects to the CDM, which included the Berlin Geothermal Project Phase One and the Stabilization Project Ahuachapán, operating since 2000 and with an installed capacity of 66 and 23 MWe respectively. The study concluded that these projects were not eligible under the CDM because they did not meet the additionally requirements.

LaGeo attempted again to include another project called HFR (Hot Fractured Rock) and it was placed to validation in the CDM project cycle as it was already in the advanced stage (Figure 3). However, the project did not generate the required results so neither Emissions Reduction Purchase Agreement (ERPA) was signed nor it was registered in the CDM project.

El Salvador has registered two geothermal electricity projects as CDM projects, with about 165,000.0 CERs/yr and represents 74.8% of the offer. These are a) Berlin Geothermal Project, Phase Two and b) Berlin Binary Cycle power plant; both are already contracted until 2012. The general information of these projects is shown in Table 1.



CER: Certified Emission Reduction
DOE or OE: Designated Operational Entity (Independent agency that acts as a validator or verifier of CDM Projects)
DNA: Designated National Authorities
PDD: Project Design Documents

FIGURE 3: Clean Development Mechanism Project Cycle

TABLE 1: Geothermal CDM projects in El Salvador (UNFCCC, 2012)

Registered	Title	MWe Installed	Ref.	CERs Issued	CERs Awaiting issuance request	Period of monitoring reports issued
25 May 06 Ref. 297	Berlin Geothermal Project, Phase Two	44.0	0297	882,857	167,143	01 Jan 07 to 31 Dec 12
30 Nov 07 Ref. 1218	Berlin Binary Cycle Power Plant	9.2	1218	154,474	38,760	31 Nov 07 to 31 Dec 12

5.1 CDM benefits in El Salvador

The main benefits of CDM projects are listed in Article 12 of the Kyoto Protocol and related to the mitigation of climate change and contribution to sustainable development in the host country. The following are other benefits identified for these projects:

a) *Improvement of project profitability:*
The sale of CERs improves the feasibility of the project by providing additional revenue for the Project Proponent (PP). According to Rodriguez and Henríquez (2007), roughly 5-7% of the revenue streams can be accrued from a CDM certification of a geothermal project, having an impact of 1-2% on the internal rate of return.

b) *Positive environmental publicity for the company:*
The CDM provides an incentive not only economic but also an international recognition to the project by contributing measurable and long-term to climate change mitigation voluntarily. There are many publications which refer to CDM projects and their environmental achievements.

c) *Strengthening of the competitiveness of the company:*
The Project Proponent must implement control processes that should be verified by a third party (Designated Operational Entity - DOE) to ensure accuracy in the delivery of CERs on offer. This helps in identifying and incorporating improvement in the process.

d) *Reduction in dependence on oil:*
The energy generated by the geothermal projects helped reduce dependence on oil. Only in 2011, the geothermal CDM projects in El Salvador have prevented the purchase of 465,000 barrels approximately, and its respective impact on the national economy.

e) *Contribution to adaptation fund :*
Contribution to the adaptation fund for developing countries with 2% of total Certified Emission Reductions (CERs) issued on CDM project. Currently 7,356.0 CERs for adaptation fund have been given by the geothermal projects of El Salvador.

f) *Access to investment funds:*
Access to green or social responsibility funds has provided the search for investment opportunities in Latin America.

g) *Capacity Building in CDM:*
Training of staff involved in the CDM project has emphasized in global processes and methodologies.

5.2 Lessons learned from CDM

- Invest the time necessary to prepare and review the Project Design Document (PDD), if it meets the requirements and does not commit more than the required information. Does PDD correctly describe the actual project? Does PDD meet the CDM requirements?

- For geothermal projects, it is necessary to calculate project emissions due to release of CO_2 and CH_4 from the produced steam (PESy) to avoid offering of more emission reduction (ERy). In the case of "Berlin Geothermal Project, Phase Two" about 10% of the tons of emission as baseline is the project emission.

- During validation or verification process, most of the time depends on DOE, therefore Project Proponent should have an open communication with DOE (validator or verifier), and must have all the information. The Project Proponent must provide all information even confidential, so that the DOE could evaluate all the hypotheses.

- The monitoring report must follow the approach provided in the methodology and PDD. Communicate with your consultant if any deviation is detected. A deviation in the PDD could delay the verification process up to 3 months.

- The monitoring plan described in the PDD should be implemented by a team. The training of the team responsible for implementing the monitoring plan is essential in order to quantify correctly each of the variables to be used in the calculation of the emission reduction.

- The processes and methodologies are becoming increasingly complex with time. The project proponent should be aware of the changes and should be prepared to meet them.

- Identify gaps and opportunities for improvement before the actual validation or verification is pre-audited (pre-validation and pre-verification).

6. TOWARDS ADAPTATION TO CLIMATE CHANGE IN GEOTHERMAL FIELDS

Progress in the utilization of geothermal energy for electricity generation contributes to the significant reduction of the national emission factor in developing countries, which allows these projects to have a real contribution and measures related to the mitigation of climate change. Reduction in greenhouse gas emissions along with socio-economic and environmental benefits has helped identify geothermal projects that can contribute to sustainable development in the host country and be eligible for CDM.

Under Article 12 paragraph 8 of the Kyoto Protocol and the Marrakesh Accords, the Conference of the Parties (COP) shall ensure that a share (2%) of Certified Emission Reductions (CERs) issued for a CDM project activity is used to assist developing countries, which are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation. It is here where the CDM could contribute most significantly to meet the challenges of adaptation to climate change in developing countries.

In practice, UNFCCC has created the adaptation fund to finance concrete adaptation projects and programs that are driving developing countries. However, the CDM levy of 2% will not suffice to cover the growing adaptation needs in these countries; therefore the adaptation fund should also receive funding from other sources. According to The Adaptation Fund (until February 23, 2012), only 17 projects in different countries are receiving adaptation funds, of which just two projects (Honduras and Nicaragua) belong to the Central American region. The above is very small compared to the urgent adaptation needs of the region.

The Central American countries have such low emissions that should not be the main issue of the mitigation but should be the adaptation to climate change. The developments of geothermal projects are of great importance that should be executed even without CDM support; and many developing countries are making these efforts. Even without the CDM support, the geothermal projects must invest in adaptation to climate change in its geothermal fields. This is the way that Project Proponent should follow in order to give a greater contribution to sustainable development and climate change in the local area of the project.

In El Salvador, the Ministry of Environment and Natural Resources (MARN) has incorporated into its National Environmental Policy the reduction of vulnerability to climate change. It has also created National Strategy for Climate Change with three main areas:

a) National program priorities mitigation co-benefits;
b) Mechanisms to address recurring losses and damage from climate change; and
c) Adapting to climate change.

LaGeo has already started its studies in the Chinameca Geothermal Project and the environmental studies have incorporated greater emphasis on the evaluation of the social-economic and environmental sensitivity in order to identify vulnerability to climate change. This information has identified some measures that could contribute to reducing vulnerability and increase the resilience in the local people to climate events.

Some of the measures are listed below:

- Maintenance of existing ecosystems. The drilling pads are constructed in terrains that are usually coffee farms, therefore owners sell it completely. In practice a small portion is used for geothermal development and most can be allocated to the current ecosystem conservation.

- Restoration of damaged forest systems. All geothermal projects should make compensatory measures for the impacts generated such as planting 10 trees for every affected tree. This measure could be focused on the restoration of damaged forest systems.

- Construction of conservation work for soil stabilization and storm water management that works with a dual purpose: to protect the infrastructure of geothermal projects and reduce the vulnerability of the area to landslides and floods.

- Installation of a weather station in order to identify relevant information to be integrated into risk management of the area.

- Construction of rainwater infiltration systems on drilling pads to reduce runoff in the lower basin.

- Implement a wood-saving stove project to reduce deforestation and respiratory diseases in the area.

- Construction of individual rainwater- capturing systems to supply water the people in the rural area that are deprived of public water supply.

- Construction of storage tanks and distribution of spring water to supply water to rural communities in the area which have no public supply.

The above measures have been included in the Environmental Management Program (EMP) to be considered from the design of the project. As a result, the project will not only have a contribution to sustainable development, but also will include a local adaptive approach.

7. CONCLUSION

- Based on scientific evidence, it can be said that the problem of climate change has its origin in increasing greenhouse gas emissions from anthropogenic activities. The international community agreed that the solution is to mitigate climate change and adapt to this change. The Clean Development Mechanism (CDM) is a flexible mechanism of the Kyoto Protocol that contributes to the mitigation.

- The CDM is an opportunity for promoting the development of geothermal energy utilization in developing countries. Twelve geothermal projects have been registered in the CDM; seven have already received 2,610,299.0 CERs and short-term projects are waiting 1,826,367.0 CERs. Central America has 4 projects registered with an average of 285,000.0 CERs/yr.

- Developing CDM project requires the services of a professional with experience in the field. It should be kept in mind that each CDM project is different. By the lessons learned in this paper, it can help a project developer to reduce errors during the CDM project cycle.

- El Salvador has registered two geothermal electricity projects as CDM project activities with about 165,000.0 CERs/yr which represents 74.8% of the offer. The main benefits identified of the CDM geothermal projects are: a) contribution to mitigate of climate change, b) contribution to sustainable development in the host country, c) improvement of project profitability, d) positive environmental publicity for the company, e) strengthening of the competitiveness of the company, f) reduction in dependence on oil, g) contribution to adaptation fund, h) access to investment funds and i) capacity building in CDM

- Central American countries have such low emissions (0.08% of CO_2 emissions in the world in 2007), but they are very vulnerability to climate change, which should not be main issue for the mitigation but should be the adaptation to climate change.

- The project developer should give a greater contribution to sustainable development and climate change in local area of the project. One way is that the geothermal project developers should include in their environmental management plans (EMP) measures that contribute to the reduction of vulnerability in the local area. In this way, measures could be considered during the design of the project. As a result the project will not only have a contribution to sustainable development, but also will include the local adaptive approach.

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