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GEOTHERMAL TRAINING PROGRAMME

ENVIRONMENTAL STUDIES AND MONITORING FOR GEOTHERMAL DEVELOPMENTS

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ABSTRACT

The environment is an integral component of a country´s heritage, its culture, its lifestyle, its potential for growth, and its legacy for future generations. Environmental damage may have long-lasting, severe, even irreversible or catastrophic effects that may not be immediately obvious to the lay observer. Modern philosophies of development recognize these facts, and organisations worldwide are sensing pressure to protect and preserve the environment as a part of any countries' development goals. In the recent past, power generation projects have been proven to be a main contributor to environmental degradation, and as a result have endured increasing public scrutiny that has obliged power companies to seek out alternative, clean sources of energy.

Geothermal power projects are widely believed to be an environmentally friendly alternative for electricity generation, in particular because they emit only small amounts of greenhouse gases. However, in practice, some geothermal projects receive very strong opposition from local and environmental groups, to the point where some projects have been held up for years, or sometimes even scrapped altogether. For successful development of a geothermal project to move forward smoothly, the legitimate concerns of the local communities and environmental groups must be addressed to their satisfaction, even though, sometimes this means going beyond the mandates of law.

A comprehensive environmental and social management program for geothermal projects is essential to comply with local legislation, and avoid conflicts with neighbouring communities and environmental organisations. Such a program must include activities at every stage of a geothermal development project.

1. IDENTIFYING A BASELINE

Before any excavation, indeed before the project begins, the state of the local environment must be documented thoroughly, in the form of an environmental and social baseline study, verified by the local authorities where possible. The baseline study should document every aspect of the surroundings of the projects: number and species of flora and fauna, microclimate, groundwater sources and quality, air quality, number of inhabitants and their social and economic status, and any

other data that may be considered relevant. The documentation should be in various forms: written, photographic, video, geographic, etc. A good baseline study will go a long way in managing conflicts with authorities and/or neighbours if and when they arise during the construction or operation stages.

The geothermal developer must correctly identify legitimate stakeholders in each project along with the issues that are critical to each one of these. Normally, every corporation will identify three stakeholders: clients, shareholders, and employees. Often it is believed that if the interests of these three groups are satisfied, and the geothermal developer observes the local legislation, creates jobs, pays taxes, and reduces carbon emission, then a project should move ahead without difficulty. Developers are then surprised to see opposition from local groups whose concerns were overlooked, and most often this opposition is dismissed as coming from the "radical fringe".

However, local communities may have legitimate claims that a large geothermal project will significantly alter their way of life, certainly during construction, and further during the project´s life. In developing nations, areas with geothermal potential are often situated in the middle of very poor communities who may resent the impact of access roads, well pads, pipelines, and a power plant in their neighbourhood and their environment. It requires some research, understanding, and negotiation, to be able to address their genuine concerns – beyond strictly legal compliance – before a project can move ahead without problems.

In practice, the first people to do reconnaissance work in a new geothermal prospect should be those in charge of environmental and social issues (even before the geologist sets foot on site!). The first order of business is to establish an environmental and social baseline in the project area, and identify potential points of conflict for the early exploration phases. This involves discussing with local leaders and organisations, and compiling existing information on the socioeconomic status of the neighbouring communities. Local leaders are thus informed of the exploration program, and educated about the basics of geothermal development.

The final product at this stage is an Environmental Impact Assessment (EIA), an extensive document normally required by the authorities in order to extend an environmental permit.

2. INCORPORATING ENVIRONMENTAL CONCERNS INTO THE DESIGN

Once a project is deemed technically and economically feasible, the next stage is critical: construction. In a geothermal development, this stage will have the most significant environmental and social impact during the life of the project. Any mistakes at this stage may take years to correct, if at all possible. Neighbouring communities or authorities may never forget careless impacts that were overlooked at this stage, and they may be the source of decades-long conflicts.

Each major component of the project – civil works, well drilling, pipeline construction, power plant construction, and transmission line construction- should identify the environmental impacts associated with its construction, and care should be taken to avoid, mitigate, or compensate each impact. This task is too large and important to delegate to a small group of Company environmentalists, so the engineers and scientists in charge of each activity must be conscious of the concerns, and must incorporate the environmental measures into the design. The environmental and social compensation and mitigation measures should be incorporated into the project budget from the beginning as part of the design and as part of the contractual requirements. As an example, environmental and social protection and mitigation measures for projects in El Salvador usually accounted for 2-3% of the total project budget, and were recouped through the price of the kWh.

The social and environmental projects associated with a large-scale geothermal development project are defined in the EIA in part, and also negotiated with the local communities. They can be quite

varied, and target the physical, chemical, and biological environmental impacts, as well as socioeconomic and cultural aspects.

2.1 The physical environment

The construction of well pads, pipelines, access roads, and a power plant impacts the natural flow of rainwater, and can cause disturbances downhill from where the infrastructure is built (erosion, flooding, etc.). The design of the civil works must take these impacts into consideration, and measures to solve potential problems must be taken. The noise levels are a nuisance to neighbours, especially during drilling, well tests, and pipe blow-outs. Care must be taken in the project construction stage to build adequate sound barriers and mufflers to minimise the noise impact. Projects may include a reforestation component, that actually improves the original environment around the wells and power plant.

2.2 The chemical environment

The main impacts come from odours during well tests and power plant operation. The H_2S levels are monitored to ensure that they are held below acceptable levels, as defined by the environmental authority. Well discharges are announced publicly days before, and programmed jointly with neighbours, when people are living near the well. This gives people a chance to get away if they are bothered by the sound or odours. Other impacts come from possible brine or mud spills. These must be foreseen during the design stage, and there must be monitoring of contaminants to ensure compliance with legal and moral obligations. Adequate disposal of drilling mud and adequate reinjection infrastructure should ensure that all effluents are properly contained.

2.3 The biological environment

The impacts to the local flora and fauna come from cutting trees and reducing wildlife habitat to make way for infrastructure. However, as some areas have very little original forest cover left as a result of centuries of subsistence-level agriculture, geothermal projects can actually help improve conditions from what was found in the baseline study. Native species of trees can be planted along pipelines and around well pads and power plants. There is now denser tree cover in the area of influence of the Ahuachapan and Berlin geothermal projects in El Salvador than there was ten years ago. The main threat to wildlife in El Salvador is the local population, who hunt species to extinction. In order to address this, an employee awareness program for wildlife conservation has been maintained for several years, and agreements have been worked out with the Ministry of the Environment and the Zoology Foundation to construct and maintain a large animal shelter around the geothermal installations. This is becoming a small tourist attraction.

2.4 Integration with communities

If the relationship with local communities is not managed properly, the locals will see the geothermal developers as invaders who exploit “their” subsurface for profit, give nothing in return to the community, and damage the environment. News of bad experiences with one project, even one by another developer in a neighbouring country, will spread quickly, and spark resistance to all geothermal developments. Helping the local communities with their development is therefore not only a fair and just action, but also good business practice to ensure sustainability.

3. MONITORING AND FOLLOW-UP

The EIA document submitted to the environmental authorities must contain observations by the company’s environmental and social teams, plus the baseline studies, and the impact of mitigation/compensation measures that the company deems necessary and adequate for at least the

first stages of the project. The social and environmental teams must take charge of internal follow-up and evaluation of the developer's compliance with the obligations acquired with both the environmental authorities and the local communities.

In many countries, the developer is required to present a bond to ensure compliance with the environmental mitigation/compensation measures included in the EIA. The developer should program periodic follow-up audits jointly with the authorities and neighbours in order to document the progress and compliance. The documents should be produced at least twice yearly, and may contain technical, photographic, and video evidence.

The developer's high-level management must be committed to the compliance with the environmental and social measures, so it is of utmost importance that they be copied on the monitoring and progress reports elaborated by the environmental and social teams, and informed immediately of any problems, as they may have to face legal consequences derived from any demonstrated non-compliance.

4. EXAMPLES FROM EL SALVADOR

Geothermal projects in El Salvador are situated around volcanic areas with communities living in extreme poverty. There is widespread unemployment, and roughly half of the young men emigrate North in search of better opportunities, even if it means to risk illegal entry into the United States. Incomes are as low as $6/day for a farmer/labourer. Social services, such as access to clean water and health and education services, are scarce. There is a very serious problem with delinquency, especially among gang members that are deported from the U.S. In areas around Berlin power plant, there are also very serious seismic and landslide risks, which the local population associate with geothermal development. The aim of the social programs and the environmental mitigation/compensation programs are often to help alleviate poverty and reduce the geological risk in neighbouring communities. This is seen in LaGeo (the local developer) as more than a legal obligation, a moral imperative, corporate social responsibility, and just good business practice.

Initially, when LaGeo was created, projects with neighbours were mainly for assistance with minor community problems (paving parts of roads, supporting local sports teams, etc.). With time, work with the communities has become more focussed, and much more effective. The basis for support programs has been development plans of the locals, where major problems are identified, and actions are planned to resolve these issues. LaGeo can contribute to development of areas by supporting local plans. Small assistance projects are still carried out, but the main focus now is for deeper solutions for health and education programs, and self-sustaining productive projects. Because the needs are so many, the social assistance projects now number near one hundred and fifty around Ahuachapan and Berlin. The funds are taken from both the investment budget and the operating budget.

One example of a successful project in education is called "Window to the World". Children from neighbouring communities that have very limited access to education are provided with English language education to a basic level, and taught computer skills, including internet navigation. This opens young minds and gives new opportunities in a globalised world. As El Salvador has opted to open its economy to trade and commerce, these skills may prove useful for many young people in the near future. LaGeo provides teachers, computers that are taken out of the company´s inventory, physical space for the classroom, and an internet server (with filters).

An example of a successful productive project is the harvest of bananas in Ahuachapan. Some locals were invading LaGeo´s lands in Ahuachapan, and started setting up makeshift cardboard houses and planting subsistence-level crops (corn and sorghum). This posed a threat to LaGeo's legal tenure of the land, and ensured that these people would continue living in extreme poverty conditions for many years. A negotiation committee was set up jointly with the local municipality, and a solution was found: LaGeo would keep legal tenure of the land; the locals would be allowed to plant and harvest

non-subsistence level crops (bananas) on LaGeo's land at no additional cost, that would allow them to raise their quality of life in the future; condensate run-off would be used to irrigate the crops; the Government would provide an agricultural engineer to supervise the crops. The result was that thirteen families raised their standard of living from extreme poverty to non-poverty conditions. Their children can now attend school and do not need to look for income elsewhere. The people in charge have learned how to manage a small business. And, finally, the Ahuachapan power plant is seen as a source of wealth for the neighbours, and not as an invader.

5. THE CLEAN DEVELOPMENT MECHANISM

When a country has subscribed to the UN Kyoto Protocol to reduce greenhouse gas emission, the clean-energy projects within its borders that displace other, fossil-fuel projects, are candidates to be certified for emission reductions (CER's) within the framework of the Clean Development Mechanism (CDM) of the Kyoto Protocol. Industrialised countries seeking to reduce their emission may meet their targets in part by financing clean energy projects in developing countries by purchasing CER's from these projects. Geothermal developments are natural candidates to sell CER's (1 CER = 1 ton of CO_2 avoided) to interested buyers, as the energy produced is both clean and stable.

In order to be certified, a project must undergo a fairly lengthy process. First, the national government must produce a baseline study of how the developing country's emissions will grow in the future, assuming a business-as-usual scenario. Then it must be proved that a clean energy plant will avoid a fossil-fuel-fired plant from being built, or at least will displace the burning of certain amounts of fossil fuels. This displacement is then measured in terms of CO_2 emission displaced. For a project to be eligible, it must be marginally economical, and the sale of CER's must bring it above a threshold IRR. If the project is economical above threshold on its own right, then it is deemed business-as-usual, and does not meet the Kyoto Protocol´s "additionality" requirement. All this must be validated by independent auditors who are certified by the UN, and then the project must be registered at the UN, in order to be credited with a certain estimated amount of CER's per year, which can then be sold. Validation must be repeated every year, in order to certify that the underlying assumptions were correct. The sale of CER's adds about 3% to the IRR of a geothermal project in El Salvador.

Certification and yearly validation come with the requirements that the project is environmentally benign beyond just emission reductions, and that it is accepted by the community. A project that is rejected by the neighbours, or that pollutes the groundwater, will not be validated. In their contracts with LaGeo, the Governments of Holland and Belgium required that the social and environmental programs that were in place would continue, to which LaGeo responded with alacrity. It is, in fact, a way of rewarding good business practice to ensure its sustainability.

6. CONCLUSIONS

The environmental and social impacts of geothermal projects must not be overlooked, and indeed should be considered as an integral part of project design, in order to ensure that the facility can comply with legislation and is accepted by the neighbouring communities. This kind of development should be seen as compliance with legislation and international treaties, a moral imperative, and plain good business practice.

REFERENCES

Rodríguez, J.A., and Arévalo, A.S., 2007: Geothermal, the Environment, and Neighbouring Communities, UNU-GTP Guest lecture, 2007.

Arévalo, A.S., 1998: Environmental aspects of the Berlín geothermal power station in El Salvador, Report 2; Geothermal Training in Iceland, 1998-UNU-GTP, Iceland, 25-50.

Arévalo, A.S., 2006: Environmental and Social Issues in Geothermal in El Salvador, Workshop for Decision Makers on Geothermal Projects in Central America, UNU-GTP, 2006.

El Salvador Environmental Law, 2003

Valle, O.S., 2006: LaGeo Social Action 2005, internal report