

PROJECT EVALUATION

CAPACITY STRENGTHENING IN GEOTHERMAL ENERGY

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1. Introduction

The Nicaragua office of the Icelandic International Development Agency (ICEIDA) engaged the services of Epsilon 3, S.A. de C.V. to evaluate the progress made in the project titled “Capacity Strengthening in Geothermal Energy” (PFCG, acronym in Spanish), to which the governments of Iceland, through ICEIDA, and Nicaragua are signatories, in the latter case through the Ministry of Energy and Mines (MEM) as main counterpart, and the Ministry of the Environment and Natural Resources (MARENA). The project began in early 2007 and includes three components, as follows: short and medium-term technical assistance, capacity strengthening and training, and endowment with equipment.

The Government of Nicaragua has identified the need to reduce dependence on imported energy resources as a national strategic objective. It intends to achieve this aim by developing autochthonous and renewable sources of energy, among which geothermal energy production plays a prominent role. In this context, the PFCG is well positioned, as it focuses on a priority area for Nicaragua, which seeks to reactivate and grow its economy in a sustainable manner, while reducing poverty. According to the Nicaragua Geothermal Resources Master Plan (2002), at least ten areas of geothermal interest have been identified, with a total energy generation potential of some 1,200 MW. This constitutes an enormous opportunity for development and to attract investment in a strategic area.

In view of the fact that geothermal projects in Nicaragua are carried out by private companies, it was correctly identified that there is a need to strengthen the capacities for supervision and regulation on the part of government agencies charged with promoting and guiding national geothermal development. However, and notwithstanding having implemented the PFCG, electricity generation based on geothermal resources continues to represent a low percentage of the total injections of electricity to the Nicaraguan system, and the objectives set forth in the “2008-2014 Indicative Energy Generation Plan” will not be reached in the short or medium term, at least not as far as geothermal energy generation is concerned.

While this evaluation focuses mainly on the PFCG, in order to obtain a proper perspective it is necessary have an overview of the overall context in the country's geothermal sector. It is worth mentioning that currently Nicaragua generates approximately 40 MW of geothermal energy, but that as it develops the fields for which concessions are currently being granted, and if to those fields are added the areas for which tenders are underway, it may be possible to reach a production level of around 300 MW over the next six years. This would be a major achievement for Nicaragua. It is an achievable goal and within the range of possibility. If this can be done, Nicaragua would, by 2015, be the country in Central America with the highest production of electricity using geothermal resources.

2. Summary: the current state of geothermal energy production in Nicaragua

There are currently two geothermal power plants producing electricity in Nicaragua. Concessions have been granted to private developers for three additional fields, which are now in the exploration phase. The Ministry of Energy and Mines has begun a tendering process for three additional fields.

2.1 Momotombo

The first of the already built power generation plants, Momotombo, has an installed capacity of 70 MW from a steam condensation plant and 7.5 MW from the binary cycle power plant. The exploitation concession belongs to the Nicaraguan Electricity Company (ENEL), which in 1999 signed a contract with Ormat International Inc. for the rehabilitation and operation of the plant over a 15-yr period, during which time it must sell the energy produced to ENEL. Of the 77.5 MW installed, approximately 32 MW are actually produced, with most of the deficit to be found in the steam condensation plant. This contract gave rise to accusations on the part of ENEL and MARENA, to the effect that Ormat was not complying with a number of contractual obligations. Eventually MARENA filed suit against Ormat, but the Constitutional Division of the Supreme Court of Justice ruled in favour of Ormat, stating that the company had complied with the energy supply and purchase contract, the association in participation contract, and the conditions set forth in the environmental permit. In

addition, the Court found that MARENA had invaded the competencies of other state institutions.

While the work relation between Ormat and MEM has been harmonious, in the opinion of officials from both institutions, those interviewed at Ormat and ENEL described the relationship between these two as tense, and on occasion openly hostile. As a consequence of these confrontations, and considering that both ENEL and MARENA are state institutions, Ormat management portrayed its relations with MEM as fragile, and there is an ambience of mistrust that hinders the developer from collaborating openly with MEM beyond that which is specifically stipulated in the contract.

In view of the fact that compliance with certain aspects of Component 1 (see indicator 12.1.7-2 of the PFCG) require collaboration between MEM and Ormat, and given the recent history of conflicts between Ormat and other state institutions, the poor relations with Ormat, and the difficulty in determining the competencies of state institutions (as noted by the Supreme Court of Justice), there are a number of obstacles to the proper development of this cooperation project. An independent evaluation of the Momotombo reservoir model could contribute to solve perhaps the most controversial aspect of the conflict, namely the demand that Ormat deliver 70 MW to the system, which continues to stand at technical level, even after the Supreme Court ruling, and despite the apparent physical impossibility that the resource could sustain a production of that magnitude. If it is indeed impossible to produce 70 MW, then the real amount of power that can be generated should be established. Then it can reasonably be demanded that Ormat maintain that level of output. An adequate strategy should be designed to achieve and maintain this realistic level of production. The existing contracts should be modified in such a way that they are brought into line with reality. Technical intervention by ISOR would be very valuable in such an evaluation.

As will be seen further on, there are parallel situations currently in more incipient stages at the other geothermal projects, which may also end up facing obstacles in terms of the proper development of the PFGC.

2.2 San Jacinto - Tizate

The San Jacinto – Tizate geothermal field was explored in the early nineties, but did not reach the development stage until 2003, when the Polaris company (formerly San Jacinto power) was granted a concession to exploit the resource. The objective of the concession was to establish a 66 MW steam condensation plant, with a temporary permit to operate a 10 MW counter-pressure plant that would produce energy until the necessary wells were drilled necessary to increase capacity and build the steam condensation plant.

Polaris put the counter-pressure plant into operation in July of 2005, but the development of the steam condensation plant has suffered considerable delays, to such a degree that it is not yet under construction. Some of the wells intended to increase capacity were drilled, including one with very good production capacity (SJ6-2, at 22.8 MW), but Polaris reports that the financing structure it had planned for and negotiated over a year ago (with the Central American Bank for Economic Integration, CABEL, the Brazilian Banco Nacional de Desenvolvimento Econômico e Social, BNDES, and shareholder capital from the Toronto stock exchange) evaporated with the 2008 world economic crisis, even though it had over 75% of the necessary volume of steam available. It thus became necessary to restructure the financing in its entirety, both as regards shareholders and the banks. Polaris officials now declare that the situation is about to be solved, this time with Canadian financing and capital. If this were to become a reality in the short term, the delay in the project due to the international financial crisis will have had almost a one-year impact. An examination of the value of Polaris shares on the Toronto stock exchange (GEO.TO), compared to the general market as represented by SP 500, indicates that the value of the company is recovering more quickly than the market at large since March 2009, which augurs real possibilities of success as regards obtaining the needed financing.

Staff at Polaris expressed their appreciation for the patience and forbearance shown by MEM officials regarding this situation, which was truly beyond the company's control. They say they are very much willing to collaborate with MEM and ICEIDA consultants by providing any data or information that may be useful in understanding the field's geoscientific model, including beyond that which is set forth in the concession contract.

Another important aspect is that LaGeo of El Salvador, which had thus far carried out the geochemical samples and analyses at San Jacinto – Tizate, has informed Polaris that it will no longer be making analyses in that field. This means that the company needs to find a laboratory able to undertake the necessary samples and analyses for monitoring of the reservoir, as well as calculating the certificates for emissions reduction within the clean development mechanism. Polaris may well become a client of the MEM laboratory, as well as a concessionaire very much willing to collaborate openly with the Ministry.

Due to the fact that Polaris has had a series of delays in developing the resource, comments are heard in the sector to the effect that “Polaris hasn’t done anything”, and that it is “wasting the resource by using inefficient turbines”. This is incorrect. Currently Polaris has available a substantial portion of the steam production and injectivity needed to operate a steam condensation plant. This is a significant achievement that should not be underestimated. The counter-pressure plant currently in operation, although inefficient, does generate early cash flow and serves to test the reservoir. These types plants have been or are being used in the early stages of several geothermal development projects, usually for a period lasting from three to five years, while a steam condensation or combined cycle plant is built. Indeed, the engines in question were used previously (1992 to 1998) in the geothermal field at Berlín, El Salvador, while feasibility studies were completed and the steam condensation plant currently in operation was being built. This engine should, however, be removed when the larger plant is installed at San Jacinto – Tizate. It could then still be used at a different field, or in another area of the same field, but always as a substitute for use in an early stage of development. To publicly disparage the contribution made by Polaris could, in fact, scare off potential investors and delay even further the entry into operation of a steam condensation plant. Taking this into account, the government of Nicaragua should ascertain that the financial problems are being adequately overcome (by means of documents and communications from shareholders and bankers). The construction of a new plant should begin this year, and to that end the government should keep up the pressure on the developer.

2.3 El Hoyo – Monte Galán and Managua – Chiltepe

The concessions for operating these two fields were both granted to GeoNica S.A., an Italian-Salvadoran company. The surface exploration stage has concluded in both fields, and exploratory drilling is now underway.

At El Hoyo – Monte Galán six sites for the perforation of deep wells of commercial diameter were located, and the first of these is now being drilled. On Saturday 23 May 2009 the second stage to 466 m had been completed, and it was estimated that at 430 m the temperature was of 230⁰C. At these depths and temperatures, if a permeable zone is found in the third stage, as expected in accordance with a fault system that cuts across the zone, it is likely that the well will be productive, and could thereupon be considered a “discovery well”. The drilling platform for the second well has made substantial progress, and will very likely be ready when needed. It can be observed that the quality of the civil works is adequate, and environmental protection and mitigation works are underway. The on- site staff at the drilling and civil works mentioned that they had been the object of visits by the La Paz Centro municipality environmental supervisors, and the contents and technical expectations of the supervision exerted were well-focused, probably as a result of the training received by staff in the framework of the PFCG.

One aspect that affects the development of the PFCG is that GeoNica has not provided MEM with the comprehensive model resulting from its surface exploration activities, and has only delivered data, unaccompanied by an interpreted model. This hampers the adequate development of the respective PFCG component, and Icelandic experts should review the data delivered and communicate their opinion to MEM. The staff at GeoNica had two comments in this regard. For one, in the case of El Hoyo – Monte Galán, the data allowed for reaching relatively obvious conclusions as concerns where to drill the wells. The locations were therefore selected and physical works began without ever having documented a comprehensive model. In any case, the technical staff charged with preparing the document instead spent their time on other, more urgent matters, and thus the final document to be submitted to MEM was not prepared. Secondly, clause 12 of the exploration concession contract requires the concessionaire to deliver the geoscientific information to MEM at the end of the concession period, and it is not required to present the models in a series of stages based on milestones in the

development of the project. In this regard, the partial information introduced was submitted in good faith, and not in strict compliance with a contractual obligation. This is a difficulty for the PFCG and MEM, given that it would be extremely beneficial for the adequate capacity strengthening and training of MEM staff to be able to count on assistance from ISOR in the analysis and interpretation of the data available at this point in time, before receiving the drilling results. This is so because it would provide an opportunity for MEM to learn about the differences in the quality of surface and well information, and be able to experience first-hand an exercise in the adjustment, validation and updating of a geoscientific model when receiving and incorporating information from the wells. In this regard, it is recommended to modify the aforementioned contractual clause in all future tenders for concession areas. In the case of San Jacinto – Tizate, it would be worthwhile to appeal to good faith and attempt to obtain the information, in order to be able to have an open discussion among Icelandic experts, the developer (GeoNica) and MEM staff regarding the model that is being used “de facto” to locate sites for the drilling of wells.

The surface studies carried out at the Managua – Chiltepe geothermal field have also been concluded, and GeoNica delivered a complete study to MEM, although this was not strictly required in the concession contract. The comprehensive geoscientific model prepared by GeoNica for the area does not foresee a high potential for production in this concession area. Therefore GeoNica has adopted the more conservative exploration strategy of drilling small-diameter continuous core wells, in order to study the surface geology and measure the temperature gradients. This will contribute to a more accurate determination of the productive potential in the area before going on to drill deep wells, and could help to locate better sites for drilling wells with commercial diameters. GeoNica has already contracted small-diameter well-drilling services, and this activity is expected to get underway shortly. Much as in the case of El Hoyo – Monte Galán, it would be helpful if MEM staff were to review the preparation of a comprehensive model, together with the project developer and Icelandic experts.

One hurdle mentioned by GeoNica officials was that they had encountered difficulties being allowed the VAT tax exemption to which they are entitled, especially as they have expert subcontractors that only provide services to geothermal companies that are exempt from paying VAT in the third or fourth link in the services chain (geothermal

well-drilling activities, among others). If the exemption from paying the VAT cannot be made effective and expedite in the chain of services, the formalities take too long to process and the cost of the project may increase, given that the subcontractor will simply add the cost of the VAT to the service.

Another difficulty reported by GeoNica at Managua – Chiltepe is that lands within the project area recently changed owners, and there have been difficulties contacting the new owners to negotiate the purchase of the properties.

2.4 Casita – San Cristóbal

The geothermal field at Casita – San Cristóbal was granted in exploration concession to the Cerro Colorado Power company (CCP). This company operates two relatively small thermal plants in Nicaragua, and the directors have been providers of goods and services for geothermal projects in Nicaragua and El Salvador for over a decade. In order to penetrate the geothermal energy market, CCP has engaged technical support from the New Zealand firm SKM and obtained financing for the exploration phase from North American risk capitalists. The geoscientific data being used to plan the exploratory drilling were originally acquired by Triton Energy corporation, which subsequently sold these to CCP when it lost the concession. Because the latter is using a business model similar to that of Polaris, the company expects to learn from the difficulties faced by other developers. It therefore does not anticipate financial problems, having already engaged in preliminary contacts with several financial institutions. At this point, CCP is in the civil works design stage (access streets / roads and platforms), before proceeding to drill the exploratory wells.

As is the case with other concessions, MEM staff needs to understand the geoscientific model the company is using in order to locate sites for exploratory wells. No difficulty is expected in obtaining the technical documentation from CCP, which has indicated it is willing to collaborate, even though its concession contract, as with the other companies, does not obligate it to submit documentation until the conclusion of the concession period.

In this geothermal field, the government has required that ENEL be granted 15% of the concessionary society's shares. CCP officials consider this to be a simple financial operation (known as "free-carry"), for which they expect to be economically compensated through the energy sales contract (price of electricity) arising from the exploitation concession.

Possibly because this concession contract is recent and the geoscientific data being used were gathered in the field some years ago, technical staff at MEM and MARENA do not mention this project much, and tend to concentrate their attention on Momotombo, San Jacinto Tizate and El Hoyo – Monte Galán. This project too, however, can serve as schooling for Nicaraguan geoscientists.

2.5 Apoyo Caldera, Mombacho Volcano, Ometepe Island

In April 2009 the Ministry of Energy and Mines announced the sale of tendering documents for the geothermal fields at the Apoyo Caldera, Mombacho Volcano and Ometepe Island geothermal fields. At the deadline for purchasing these documents, thirteen companies had done so, which demonstrates a healthy interest in geothermal energy production in Nicaragua.

The technical information section regarding the geothermal fields to be tendered contain very little information, and most of it is taken from the Geothermal Master Plan. This would oblige the developer to assume a substantial mining risk, greater than that taken by the operators at Momotombo and San Jacinto–Tizate and Casita–San Cristóbal and similar to that assumed by the concessionaires at El Hoyo–Monte Galán and Managua–Chiltepe. Because in Ometepe there are technical difficulties as concerns the acquisition of geophysical data, and there is a logistical problem with transporting drilling equipment, materials and heavy machinery to the island, this would be a particularly complex project by Central American standards. However, the president of Cerro Colorado Power is currently generating 2.5 MW on the island using diesel, and has expressed an interest in converting the island's source of electricity into a clean and renewable energy. There thus exists this special incentive.

MARENA staff reports that of the three geothermal fields, only Mombacho has an Environmental Management Plan (EMP). Work on the EMP for the Apoyo Caldera has already begun, while that for Ometepe Island has not. It was pointed out that MARENA staff had no knowledge of the tender until the sale of documents had been closed and the field visits concluded. A similar experience occurred with El Hoyo – Monte Galán and Managua – Chiltepe, where MARENA, declaring that it would only make such ToRs available once the EMP was completed, refused to deliver the Terms of Reference (ToRs) to the developer so he could engage a firm to carry out an environmental impact study (EIA) before beginning exploration activities. In these cases, the impasse caused delays of approximately 10 months. MEM staff, for their part, are of the opinion that no EMP is necessary to obtain the ToRs and proceed to prepare the EIA, and that therefore there should be no delay in the implementation of the concession contracts for reasons related to environmental permits. According to MARENA, however, there will again be a delay, as happened with the earlier concessions. It is recommended that these two government agencies reach an agreement and clarify the situation and inform the bidders of the solution found to the difficulty.

The new concessions will require that the concessionaire give 10% of the shares in the concessionary's society to ENEL, and allow it one seat on the Board of Directors. The exact function such a board member might have is not specified, and it is obvious that should difficulties arise between a regulating entity (MEM, MARENA or the Nicaraguan Energy Institute, INE) and the concessionaire, the state would have interests on both sides of such a conflict. Similar situations have occurred in other countries in which the state holds a stake in geothermal development (including Iceland), so in this sense the Nicaraguan case is hardly unusual. It is simply being pointed out here that it is necessary to be aware of this state of affairs, and that more thought should be given to the actual function of ENEL in its role as shareholder in the different geothermal concessionaire societies. The ENEL geothermal staff talks of "safeguarding the interests of the state", but that would seem to be a role better played by MEM, MARENA and INE, with ENEL in a more entrepreneurial role.

The reactions of the companies that purchased the tendering documents to the requirement of handing over 10% of shares to ENEL are mixed. Some, such as Polaris and CCP consider that "free-carry" is an economic requirement of the developer, and

have no problem with this so long as the value of the shares is recognised in the electricity sales price. Others, however, such as Ormat and GeoNica are of the opinion that “free-carry” could lead to difficulties, unless ENEL were willing to shoulder certain responsibilities in return for its participation, such as facilitating certain formalities regarding tax exemptions, for instance.

3. Evaluation of Component 1: Technical Assistance

The first PFCG component consists of technical assistance, and is the one with least elements implemented thus far. The main aspects of the Agreement that are reported to be under execution are identified and briefly discussed immediately below.

3.1 Studies of Momotombo

The Agreement includes an evaluation of the Momotombo reservoir, for the purpose of recommending activities that could be undertaken with a view toward increasing production. This component suffered as a result of the legal dispute between MARENA and Ormat. MARENA opened an administrative procedure without having sought an independent expert opinion on certain very complex issues, and therefore arrived at the hasty conclusion that Ormat was not complying with its contractual obligations. The company took the case all the way to the Supreme Court of Justice, which ruled in its favour, and in addition declared that MARENA had taken on competencies that were outside its sphere of competence. The conflict with MARENA (which also extends to ENEL), and the judicial process itself, caused Ormat to restrict the degree to which it was willing to share information on the reservoir and its operation. Therefore MEM lacked the information it should have been reviewing together with Icelandic experts. Although this component is now very much delayed, it continues to be a critical element in geothermal development in Nicaragua. Now that the lawsuit has been resolved in favour of Ormat, and the operator is no longer in danger of being penalised, Ormat has declared its interest in extending the contract. This more favourable situation could be used to renegotiate the contracts with Ormat in such a way that it reflects the physical reality of the resource, based on the knowledge gathered thus far. The fact that the component is part of the Agreement could be used to ensure that MEM, with the support of at least one Icelandic expert, discusses the current state of the geothermal

resource with Ormat, including the real possibilities of increasing production and extending the life of the exploitation contract. The opinion of the external expert would bolster the technical foundation of the agreements that may be reached. This is one of the most useful elements the PFCG could have. Serious obstacles could be the refusal to participate on the part of ENEL, which doesn't consider itself part of the PFCG, as well as reservations MEM might have concerning the negotiation of a contract with a private company without having undergone a public process. Notwithstanding such potential difficulties, the positive impact a renegotiation might have could be so important that this activity deserves to be given top priority.

3.2 Review of the geoscientific information

The PFCG contained activities involving a joint review with MEM of the geoscientific reports produced by GeoNica at the El Hoyo-Monte Galán and Managua-Chiltepe geothermal fields. In the latter case, GeoNica prepared and submitted a full report of the result of its surface explorations. At El Hoyo – Monte Galán, the conclusions of the surface studies were rather obvious, and GeoNica proceeded to locate the sites for drilling the wells, without having submitted a formal report to MEM. It is worth noting that the concession contract does not obligate GeoNica to submit such a report until the conclusion of the exploration concession. Thus GeoNica has not failed to comply with the contract. That said, there is no reason why GeoNica and MEM could not have a confidential discussion on both geoscientific models (every developer has its own criteria for locating the well site it considers ensures success, and will want to keep it confidential). Such an act of goodwill would no doubt contribute toward reaching the aims set forth in the Agreement. It can be noted that this technical assistance component also serves the purpose of transferring knowledge / training. The important thing is that MEM staff have available the assistance of experts as it moves through the cycle of obtaining and interpreting geoscientific surface data, the formulation of a comprehensive model, the location of sites and subsequent drilling of wells, and finally the inclusion of the information from the wells to the model, in order to update it. Although implementation is a responsibility of the developer, MEM staff needs to understand the logic behind each step of the process, and how each of the different elements are integrated among each other. In other fields, MEM will have to supervise this process without external support, and it is thus important that on this occasion, with

these first fields, the Ministry have on hand the support of independent experts. It is important to move through every step of a full process at one of the fields, whether this be El Hoyo – Monte Galán, Managua – Chiltepe or even Casita – San Cristóbal. This is therefore another very important component of the PFCG that must be complied with. It is recommended that, instead of seeing this as a situation in which the experts will review a document and then issue a report on the contents of the model, the data and the models be discussed in dynamic fashion at a workshop with the developer. This would be far more enriching. What needs to be documented, more than any external comments on a particular model, is the process being followed in the exploration cycle during the life of the concession.

3.3 Preparing environmental regulations and setting standards

PFCG technical assistance activity 4.1 contemplates the formulation of rules and regulations for the exploitation of geothermal resources, and activity 15.1 deals with assistance in the preparation of environmental standards. The results of the assistance provided thus far in these areas has not met expectations. What has been delivered is a comparison of legal frameworks in various countries, which while interesting as such, does not cover the needs of MEM and MARENA. Rather, the expectations were that forms would be obtained (in essence, a checklist) of the technical aspects that needed to be looked after by the authorities charged with oversight during the development of state resources by private companies. For instance, it was expected to identify what the environmental impact would be that might require oversight during the well-drilling activities, and which mitigation or compensation measures should be demanded from the project developer. Another example is that it was hoped there would be recommendations as concerns the frequency of sampling in productive wells located in geothermal fields under operation, as well as what species should be monitored in waters and gases. In view of the fact that this type of information was not forthcoming, but are still needed, renewed efforts should be made to obtain such forms. Some examples of regulations, standards and procedures at geothermal fields in neighbouring countries can be acquired and would be useful, as the ecology and geothermal resources being exploited are similar. Given that on the other hand the environment in Iceland, as well as its geological location, are so different from Nicaragua, the work done on this issue in the Nordic country would be of only limited use in tropical Nicaragua.

3.4 Determining good practices for regulation and supervision

During discussions with staff at both MEM and MARENA there was talk of requiring training and assistance on a number of highly specialised and diverse issues. It is praiseworthy that the curiosity and desire to learn is clearly present, but the PFCG should focus its efforts on supporting the government in its supervisory and regulatory functions. The responsibility for implementing and developing geothermal resources belongs to the developers, who also have an interest in seeing the projects advance as smoothly as possible, while aware that occasional problems may be inevitable. Thus government supervision should be keyed to, for instance, avoiding that due to some poorly understood notion of savings the developer build deficient environmental mitigation works, or that there are no adequate controls over the exploitation of a reservoir that ensure its operation over the long term, or even that the concessions become the object of financial speculation. The desire to know everything would also appear to reflect the idea of regulating or controlling everything (known as *micromanagement*). Such an approach would not allow for the proper development of geothermal resources. Government officials that receive technical assistance and training must be quite clear regarding what it is exactly they are expected to do with the knowledge they are being provided with. It is recommended to add a technical assistance component that defines good practices concerning supervision and regulation, together with the forms containing regulations (component 4.1) and environmental standards (15.1) of the PFCG. These should determine the details of what is to be supervised. A good and clear demarcation of functions would facilitate the work of both government officials and developers.

4. Evaluation of Component 2: Training

Thus far the PFCG training component has been the most visible and the one that has reached the most people. Except for a few complaints concerning coordination between government institutions, it is recognised and celebrated that both MEM and MARENA now have a deeper understanding of geothermal issues, and that this expands their capacities in terms of follow-up, monitoring, supervision, management and environmental control over development projects. The ongoing series of workshops and seminars has also served as a space at which those in attendance have gotten to know

each other and have the opportunity to share opinions and work together toward common objectives. The very fact that several Nicaraguans have had the opportunity see geothermal projects firsthand in both Iceland and El Salvador, and have studied how these are operated, has contributed to the absorption of their theoretical study of geothermal energy production, while generating confidence in the technology. Many of the obstacles to geothermal development are in the minds of people who are opposed to its use, often due to mistrust born of a lack of knowledge. The broad-based workshops and training sessions, which have including persons from universities and staff from private developers, has contributed and continues to contribute to increasing the level of trust among the various entities involved.

Some private developers have expressed they have noticed the difference in the supervisory work, especially as concerns the environment. In particular, the mayor's office at La Paz Centro was mentioned as a case in which environmental oversight used to be rather diffuse, but has now become much more sharply focused on those aspects that may lead to environmental problems. Participants in the training workshops also mention that their level of knowledge has multiplied, something which will surely have a positive effect on project development.

The complaints heard concerning the training can be summed up in three categories: (i) workshops have been keyed mainly to public officials, and on occasion have overlooked the universities or private developers; (ii) attendance at workshops has been deficient, as too many people show up irregularly, thus undermining continuity of discussions on important issues; and (iii) there are unsolved differences of opinion among MEM and MARENA officials, and these have on occasion been vented at the training sessions, as occurred for example at the EIA workshop held in Managua during the week from 18 to 22 May.

As regards comments of the first type (i), it must be noted that the PFCG contemplates that training is aimed specifically at public officials, and the fact that members of universities or staff from private companies sometimes participate is a sign of openness, flexibility and goodwill on the part of the project coordinators. Complaints of this nature arise rather from lack of information regarding the Agreement. That said, it is worth mentioning that on those occasions when persons sent by private developers

participated, their presence has been considered positive. The most immediate case is that of the person charged with environmental affairs at San Jacinto – Tizate. She has been able to forge positive relations with all institutions, and is widely respected. Anyone who visits the geothermal field she works at can see that the environmental aspects have been well identified and are under control. The workshops, therefore, while correctly keyed to build capacities among public officials, do stand to gain from the presence of private sector representatives. This opening contributes to consolidating better understanding and could result in improved implementation.

Comments of the second type (ii) appear to reflect a reality, an outcome of the informal manner in which some participants approach the issue. Indeed, the negative side of opening the courses for broad-based participation – and in particular to the universities – is that persons may attend who do not have a strong commitment to the subject at hand. In any case, this problem can be solved by asking the organisers to take a firmer stand with the institutions interested in sending personnel for training.

Finally, it is unfortunate that complaint (iii) also reflects a reality, but one that goes beyond the PFCG, is outside its scope, and is due mainly to differences in attitudes that are deeply entrenched at some government institutions. Its solution would require that top-level officials at MEM and MARENA (and even ENEL) hold open discussions at which controversial issues are freely discussed, without the presence of persons who do not hold a position in government. A prior and very general understanding among ministers, accompanied by instructions to mid-level officials to seek understandings at a level of detail satisfactory to all, would go a long way towards solving their difficulties, both in PFCG training as well as in the remainder of the sector. MARENA staff has requested its inclusion to the PFCG steering and coordination committees, but it should be noted that if attitudes don't change, all that would be accomplished by this is to raise the conflict to another level.

5. Evaluation of Component 3: Endowment with technical resources, infrastructure and equipment

The endowment with technical resources and equipment took place at the MEM laboratory installations. To that end a building was refurbished (rearrangement of

spaces, electrical systems, chimneys, and so on). Most of the equipment is already in place, and a large part has been approved. The technical staff engaged by MEM is well suited to handle the equipment, and it is expected that the laboratory will be operating sometime in August 2009. There was a two-month delay while it was determined whether to adapt and rehabilitate the ENEL geothermal laboratory or to build a new one, but the delay has not had a major impact on the work. State-of-the-art equipment has been selected, with technical support available locally, and there is an interest on the part of all developers to use the laboratory services for sampling and analysis. This will unquestionably be a valuable source of support for national geothermal development.

Of all the equipment that was delivered to the laboratory – and it is a considerable amount – thus far only one piece appears not to function adequately, namely the geological microscope. Technical staff at MEM reported that the microscope's objective lenses were not properly centred, and that there is not enough space between the thin blades that are the subject of analysis and the extreme end of the objective lens. The guaranty accompanying the equipment should be used to have the manufacturer repair it. Otherwise, it should simply be replaced with a microscope in good working condition.

Two recommendations are made related to the sustainability of the laboratory in general, rather than the equipment per se. At government offices, which depend upon the national budget for funding, it is very common that the product from sales services be included as an income to the national treasury. If this is the case here, the budget for the functioning of the laboratory would depend upon a far broader discussion on the budget allocated to MEM and indeed how to distribute said budget. This could lead to scarcities or delays in the purchase of materials, reagents or replacements necessary to the proper functioning of the laboratory.

It is recommended that any income generated through the sale of services be used mainly to purchase materials and replacements that allow for keeping the laboratory in optimum conditions. Staff salaries are usually not a problem, and may depend upon the MEM budget without thereby risking sustainability.

The second recommendation related to the laboratory is that the initial number of staff operating the equipment (4 professionals) is adequate only for the purpose of carrying out the routine analyses required by the two geothermal fields currently in operation. The number of analyses required will depend upon what is determined in the forms mentioned earlier in the section above on “regulations and standards”, but it will probably be beyond the ability of a four-person staff to undertake the necessary analyses once two fields are operating at full capacity (most likely Momotombo and San Jacinto - Tizate). Further, an additional well is in the testing stage. The equipment can handle far more than this, but in order to operate it and carry out the work that will be needed, an additional shift (or at least half-shift) will be required. This need for additional staff will not occur immediately, but rather gradually, meaning in approximately two years. Still, the need for more office space and a higher budget is already foreseeable.

Finally, it is noted that the National Autonomous University at León (UNAN) has good capabilities for carrying out chemical analyses that could be used in geothermal research, specifically atomic absorption, gas chromatography, conductivity measurement, pH analyses and so on. It is therefore recommended to coordinate efforts and be prepared to overcome any temporary difficulty or sudden work overload at the MEM laboratory by using the laboratory at UNAN León. This may possibly require that some of the equipment be the target of some investment, for instance in order to complete the gas chromatograph and purchase sampling equipment, but this is a far less costly option than buying entirely new equipment.

6. General conclusions

Overall, it can be said that the three components of the Agreement show some significant achievements. The persons charged with supervising and regulating geothermal development in Nicaragua today have a deeper knowledge of geothermal science and technology than before. This will allow them to do a better job, and will boost project implementation. As mentioned above, there are a number of projects currently underway and in different stages of development. It is therefore realistic to expect that in a few more years Nicaragua will be the largest producer of geothermal energy in Central America. There are many reasons why those who work in the sector feel optimistic.

One aspect that would help to obtain cooperation from private developers and universities would be to disseminate the Project Document more widely. None of the private company representatives had seen a copy of the PFCG document, nor did those in charge at UNAN León have a copy, although they knew of the part of its contents that makes reference to the University. It is thought that receiving information of the cooperation with ICEIDA on geothermal energy generation issues would in general be well received as a gesture of transparency and good will, above all considering that they are on occasion asked for information that is to be analysed in the context of the PFCG.

Communication and coordination between government institutions and indeed within MARENA itself needs to improve, both for the sake of proper development of the PFCG, as well as the adequate promotion and supervision of geothermal development. Situations such as the difference of opinion between MEM and MARENA regarding the need for environmental management plans (EMPs) for the new geothermal areas that are being tendered are causing confusion, mistrust and could possibly lead to delays. Further, to discuss these differences at training workshops is not the solution. MARENA's request to be included in the steering and coordination committees should be considered, although always keeping in mind that if attitudes don't change, a structural modification alone won't solve the underlying problems.

After completing most of the main objectives in terms of training, advisory services and the equipping of Nicaraguan government institutions, the PFCG provides for maintaining a certain level of support for technical assistance in the follow-up to the development of the geothermal fields, specifically as concerns resource and environmental management. It also covers accompaniment to universities in research activities regarding high and low enthalpy resources. Over the long term emphasis should be placed on establishing a group of local professionals that are in a position to manage their own resources with some specifically oriented external support. Professionals at MEM and MARENA need to be trained so they can adequately carry out supervisory activities, even if it will continue to be necessary to engage external experts for opinions on certain highly specialised aspects (such as for example the interpretation of seismic data, the mathematical modelling of reservoirs, or the electronic geophysical records that are kept on wells). This requirement of external support on specific issues is quite normal and will always exist, considering that the

supervisory work usually requires a broad-based vision of the development and operation process, and only occasionally the tapping of in-depth knowledge on particular aspects.

In view of the fact that geothermal developers in Nicaragua are private enterprises, and that they do not enjoy the backing of international geothermal schools, the Nicaraguan staff that will be directly developing and operating the resources needs to be educated at universities and then be selected and contracted by these companies. In this regard, the work planned at the universities is the guaranty that geothermal development in Nicaragua can be maintained over the long run. In fact, the number of days scheduled for technical assistance to MEM and MARENA over the long term (in particular the years 2011 and 2012) can probably be reduced without thereby undermining the achievement of the main objectives – given that the professionals at the ministries can do the work by themselves. Assistance could then be geared toward establishing a regional geothermal department at he UNAN in Nicaragua. In view of the fact that the traditional international training programmes in New Zealand, Italy and Japan have been closing down or reducing their outreach, the opportunity to train professionals in geothermal energy generation is becoming more limited over time. Nicaragua could easily become a regional leader on the subject.

One aspect that had not been identified as a risk factor for the ultimate PFCG objective – namely to increase the use of geothermal energy in Nicaragua – is the financial situation of the electricity distribution companies owned by Unión Fenosa (DISNORTE and DISSUR). If the geothermal development projects are successful (which thus far they are, albeit with some difficulties) it will become necessary that several private companies request financial support from international financial institutions (IFIs), in order to implement approximately USD 1 billion in projects over the next five or six years. For IFIs to approve amounts in that order of magnitude, they need to have a relative degree of certainty that Unión Fenosa will be able to pay the energy generators, and they are aware that there have in the recent past been difficulties on that score. This is a national situation that is of course entirely beyond the scope of the PFCG, but it is mentioned here because this may become a constraint when developers seek financing for geothermal projects in Nicaragua.

The international financial crisis calls for a period of patience and understanding, and should be seen as something that is temporary. Any hasty action taken against a company that faces more obstacles obtaining financing than was originally anticipated may lead to additional delays in project implementation. In any case, it would appear that the international financial system is slowly stabilising, and that in a few more months funding for projects of this nature will begin to flow again.

Finally, it is worth mentioning that the climate of confidence among Nicaraguan government officials and the members of the private sector will improve as the projects advance and the regulators note that the supervision system functions adequately and developers are complying with their contractual obligations, while exercising their rights. As the benefits to be derived from geothermal development become clear and are visible to all, including the fact that environmental management is proceeding without too much difficulty, and that the interests of the developers and the state coincide in many aspects, future development will be facilitated further.

7. Summary of recommendations

With the aim of simplifying the reading of this document, the recommendations made earlier are summed up below by each of the components of the PFCG Plan of Operation, and include some more general recommendations.

7.1 Activity 1.1: Evaluation of Momotombo

This is considered to be a critical activity, and cannot be substituted for. It must take place. In order for this to occur it will be necessary to appeal to the good relations that have existed between MEM and Ormat in order to allow MEM, with the support of experts from Iceland, to evaluate the Momotombo reservoir, based on the data provided by the company. A Plan of Action should be prepared to increase field production in a sustainable manner, based on real data regarding the status of the reservoir. If such a Plan requires substantial additional investments, the possibility could be discussed with Ormat of extending the duration of its contracts to allow for enough time to execute its investment and make a return thereon. It is recommended that the contracts with Ormat

be modified in such a way that they reflect the current knowledge on resource availability.

7.2 Activity 2.1: Evaluation of El Hoyo – Monte Galán and Managua – Chiltepe

It is recommended that this evaluation take place in two workshops, with the presence of those technicians from GeoNica charged with preparing the geoscientific models, MEM staff and Icelandic experts. At the first workshop the discussion would concentrate on the surface data that was gathered, the reasons for which this and not another type of data was selected, how the model and other data available were integrated, and the rationale for locating the wells in the places decided upon. At a second workshop, once data from the deep well drilling has been gathered, the information obtained and results from these wells would be discussed, including the model, and how the new data may be incorporated to said model in such a way as to update and enrich it. Components 2.1 c and d could remain as originally planned, with adjustments made only as concerns the timetable.

It is considered important that MEM staff, which will in the future be carrying out this type of evaluation, be guided at least once through the entire process that takes place once a concession is granted. The advisory services provided in the evaluation of a geothermal field can be seen as a transfer of knowledge, so that eventually MEM staff can itself carry out these evaluations, with outside assistance on only certain very specific issues, as needed. If at a workshop it were possible to discuss both concessions granted to GeoNica, that would be beneficial, but the most important thing is that MEM staff understand the pattern they can use as a guide with which to evaluate the development of future concessions.

Another field that is in condition to be included in a similar activity is that of Casita – San Cristóbal. Surface information is already available, apparently in sufficient quantity to proceed and hold the first workshop on this field, even if there is difficulty obtaining information from GeoNica. However, because the El Hoyo – Monte Galán geothermal concession is already in the deep well drilling stage, it should be afforded priority.

7.3 Modification of contractual clause on tenders

It is recommended to modify the twelfth clause of the exploration concession contracts in such a way that it is established that the information gathered by the developer is to be submitted to MEM at two points in time: at the conclusion of the geoscientific model once surface data has been included, and at the conclusion of the geoscientific model once deep drilling data has been incorporated.

7.4 Definitive interpretation of ENEL's role as shareholder

Private developers interpret the requirement in Chapter 6 (Basis for Tendering), article 3 (State Participation) of the law on new exploration concessions, which orders that 10% of the shares of the society charged with exploration must be granted to ENEL (15% in the case of Casita – San Cristóbal) as a purely financial operation, and assume that the cost of delivering a percentage of its profits to ENEL as a “free carry” will be eventually be recognised as an energy sale once the exploitation concession is in hand. No documents were found to back up this interpretation. If it is correct, this should be clarified to bidders in writing. If it is incorrect, note should be taken that this may cause problems further on during the exploitation phase.

7.5 ENEL as a minority shareholder representing the state

It is not clear what function ENEL will have as a minority shareholder and member of the boards of directors of the concessionary companies. The role of safeguarding the interests of the state falls to MEM, MARENA or INE, depending upon the issue at hand. This would seem to indicate that ENEL should play an entrepreneurial role in the concessionary society. However, the tendering documents specify that ENEL “for no reason assumes any risk, debt or responsibility of any kind”. It is hereby suggested that the role of ENEL be better defined and further clarified, for the sake of better understanding thereof on the part of investors, as well as the other state institutions.

7.6 Environmental management plans in the new areas open for tender

There are two interpretations possible regarding the issue of environmental management plans (EMPs). MARENA officials are of the opinion that the EMPs for a protected zone

should be prepared first, thus placing the ministry in a position to deliver Terms of Reference (ToRs) to the developer regarding the EIA the company must engage. For their part, MEM personnel considers that the developer can be given ToRs even without there being an EMP for the protected area. This is a difference between the two ministries that needs to be cleared up, and the companies bidding for exploration concessions should be informed on whatever agreement is reached. Preferably, in the future, the EMPs for protected areas should be included in the tendering materials as part of the technical information, and could thus be taken into account by bidders as they prepare their offer.

7.7 Activities 4.1 and 15.1: formulation of regulations and standards

The activities were implemented, but the forms that MEM and MARENA expected were not obtained. Considering that these are an essential part of the regulation procedures, and that those existing in Iceland are likely to be very different from regulations in Nicaragua, it is recommended to establish contact with developers and / or institutions in neighbouring countries, in order to obtain the environmental and operational forms needed for geothermal projects. For instance, in El Salvador, geothermal concessionaires must periodically submit a report to the General Superintendency of Electricity and Telecommunications (SIGET) that contains the information necessary for supervising and monitoring geothermal resources. Environmental forms are also used for purposes of supervision and monitoring on the part of the Ministry of the Environment and Natural Resources (MARN). It would most likely be easy to access this information, as well as to enlist the support of neighbouring countries whose environmental and geological situations are fairly similar to those in Nicaragua.

7.8 New TA component: Good Practices Manual for Regulation and Supervision

Supervision and regulation of geothermal resources by the state should focus on those decisions or practices that affect the environment or electricity supply to Nicaraguans in the short or long term. Supervisors must not attempt to micromanage all of the day-to-day activities at the different projects or operations being carried out by companies, although they must be kept informed and satisfied that the works are being undertaken

according to the highest standards in the industry. In order to properly target the supervisory work and eliminate requests for training on highly specialised and diverse subjects, it is proposed to add a technical assistance component to the Agreement that could be included in activities 4.1 and 15.1, regarding the preparation of a Good Practices Manual for Regulation and Supervision of Geothermal Projects. As there is not sufficient experience on the subject in the Central American region, assistance from Iceland is of the essence (on technical, not legal matters). It is worth mentioning that the manual should be prepared locally in Nicaragua with external assistance, and it should not be expected that a consultant can work in isolation to prepare a full-fledged, comprehensive manual. The comparative work already done on regulations and standards in several countries could serve as an input to this activity.

7.9 Component 2: Participants at the training sessions

It has been observed that the training provided for in the PFCG geared specifically at public officials, and the fact that there has been participation by private developers or universities is rather a demonstration of openness, flexibility and goodwill on the part of PFCG coordinators. Nevertheless, considering that the participation of persons active in sectors outside government has been a success, it is recommended to allow private sector and university staff to participate more in these activities. Their participation has contributed and continues to contribute to good relations among institutions, and to reaching general understandings within the sector.

7.10 Component 2: Irregular attendance at training sessions

In view of the fact that attendance at some training events has been irregular, and that the list of participants tends to fluctuate from one day to the next, it is recommended that organisers take a firmer stand with the authorities at the institutions sending the trainees.

7.11 Component 2: Discussion on differences between MEM and MARENA

Training workshops are not the most adequate forum for the venting of differences of opinion between officials from the various ministries. It is recommended that personnel

involved in geothermal development at MEM, MARENA and possibly ENEL, hold a separate meeting in order to address those issues on which they hold divergent views, and make an effort to reach agreement on each point. A prior and very general understanding among the ministers, added to instructions to their delegates to work toward agreements on the various issues, should go a long way toward resolving the situation.

7.12 Activity 2.1 K: Geological microscope

It is recommended to make use of the guaranty to repair or replace the damaged microscope with one that functions properly.

7.13 Component 3: Sustainability of the laboratory

It is recommended that any income that may be generated by the sale of laboratory services be used primarily to purchase materials and replacements in order to keep the laboratory in optimal operating conditions.

7.14 Component 3: Laboratory staff

It is recommended to make the necessary preparations to increase the laboratory staff once two geothermal fields are operating at full capacity, and another one is in the well-drilling and testing stage (approximately two years hence). When this occurs, four professionals will not be sufficient to cover the needs for analyses. Therefore both physical space and budget should be planned for starting now.

7.15 Component 3: Equipment at UNAN León

Considering that a good part of the chemical analysis equipment at the UNAN León can be used for geothermal purposes, it is recommended to coordinate efforts in case it becomes necessary to supply a temporary deficiency or sudden work overload at the MEM laboratory. In addition, the equipment at the university needs little investment to complete the gases chromatograph and sampling equipment. Therefore this option

should be considered before purchasing additional equipment, although this may become necessary at some future point in time.

7.16 Long term considerations

Given that the development and operation of geothermal resources will be a direct responsibility of private operators, a local university-level training centre is required, for the purpose of educating professionals who can subsequently be selected and trained by individual companies. The time scheduled for technical assistance over the long term could profitably be reduced without thereby undermining the objectives of the Agreement, given that the staff at the ministries will have been trained and can undertake most of the supervisory work on their own. Thus the time allocated to expert assistance could be reoriented to building capacity and transferring knowledge to the universities by establishing a regional geothermal development department, headed by Nicaraguans. This would guarantee maximum sustainability to geothermal exploration and exploitation in Nicaragua.

7.17 Dissemination of the Agreement

Many of the actors active in geothermal development but outside government are unaware of the contents of the PFCG Agreement. It is recommended to deliver an electronic copy of the Agreement to those developers whose cooperation is being requested, as well as to the universities included in the Agreement. This would send a signal of openness, transparency and goodwill, and should facilitate relations with other institutions when data are requested for analysis in the framework of the PFCG, or personnel are called upon to attend workshops in order to review geoscientific or reservoir models.

7.18 The international financial crisis as a risk element

The international financial crisis exerts an influence on the possibility of obtaining financing for all projects, and may therefore affect the normal development of geothermal projects in Nicaragua. Indeed, the crisis has already affected financing for the project at San Jacinto – Tizate, and has led to additional delays in its development

plan. It is likely that the current situation will continue for at least a few more months. This is an element that must be taken into account as a *force majeure* external risk factor for these projects, as it is entirely beyond the control of developers or the government of Nicaragua. Therefore patience and understanding will be needed during the remainder of this year if there are delays due to difficulties encountered in obtaining the necessary financing. It is important, notwithstanding, to keep up the pressure as concerns implementation, within the boundaries of what is possible and realistic.

7.19 The solvency of the electrical distribution companies as a risk element

Investments in geothermal development projects over the coming years could be considerable. The return on said investments would take place by means of energy sales to the electricity distribution companies. The financial solvency of these distributors will be subject to examination by banks and international financial institutions, as a commercial risk element. In the recent past, problems with solvency have been reported at the two electricity distribution companies that belong to Unión Fenosa. The PFCG document should take this risk element into account among the external risk factors as regards financing for the geothermal energy development projects that are planned.

7.20 Administration of the Project with the closing of the Iceland Embassy

The Project has produced positive results so it is not necessary to make big administrative changes. However it is necessary that the coordinator of the project have all the support for the Icelandic offices. It can be necessary to consider one or two mission of the ICEIDA central offices to Nicaragua to evaluate the projects and monitoring of vice versa of the coordinator to Iceland. The coordinator can be provide with all the adequate technology and permits to keep a very broad and efficient remote communication with Iceland.

7.21 Facilitation of Informal communication

The Project has been managed with level of very high formalism which is necessary and must be continued. However especially with the imminent closing of the Iceland embassy in Nicaragua, the informal communication also will be important. It is

important that the coordinator of the project or a Nicaraguan functionary can clarify doubts by phone or by video conference even if not any document of support.. The result with that is that the functionary responsible for the projects could assume their own position even without the writing support from a consultant . In this way the responsibility about the decision and recommendation will be transfer gradually to the local functionary.