30 April 2010

To:

Signor Rafael Escobar
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Cc: A. Carrasco
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Warwick Franklin
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Dear Rafael,

RE: CHAMBAMONTERA PROJECT, REPORT TO MARCH 2010

Thank you so much for the detailed report on the background and deficiencies at Chambamontera. Warwick Franklin, various senior directors and I all have long been awaiting such a detailed statement about the regrettable deficiencies that have occurred in the Chambamontera micro hydro scheme.

You mentioned under paragraph 1 background that there were problems with the owners of land, which caused delays to the construction of the weirs and the powerhouse and regrettably in my opinion the powerhouse was badly sited and it would have been well worthwhile paying some extra money to have it sited more conveniently near the roadway and in a protected position. The present siteing of the powerhouse in my opinion left it highly vulnerable to landslide and flooding from the slopes above and of course the access was difficult, which was why immediately in February 2009, I recommended certain remedial drainage works which were only partially carried out, some shrub and tree planting to secure the subsoil, both above and below the hut and, above all, a retaining wall to deflect any landslide and water run-off. These works have been partially carried out, but still require completion.

At our visit at the beginning of February 2009, I immediately noticed that the generator was not running smoothly and that the diodes were likely to blow at any moment, something that nobody else seemed to be paying any attention to, and in fact, I was proven correct subsequently.

It seems therefore, if one reads through the entire catalogue of breakdowns that the quality of the equipment supplied locally in Lima was highly suspect and substandard and, indeed, this was confirmed to me and the transformers had twice to be returned to Lima and were finally replaced. I would comment here that there seems to be a serious lack of supervisory care in the purchase stage, which regrettably for Soluciones Practicas has resulted in a great deal of unnecessary additional cost in removing the defective equipment from Chambamontera back to Lima and back to Chambamontera on several occasions and consequently a lot of this inconvenience and expense might have been avoided with more careful specification and oversight.

When it was reported to me that there was a substandard earth return circuit, I drew attention to the fact that I had noted during my brief visit that the subsoil contained

very high ferric oxide content and that quite possibly this was causing earthing dispersion. I made several recommendations based on a little bit of research and found a similar problem in Australia in the Hamersley area where iron ore is mined and suggested triple earthing circuits, at both the sending and receiving end, buried to a greater depth, preferably two meters and this appears to have solved this problem satisfactorily I am glad to read.

During my visit in February 2009 I drew Warwick Franklin's attention to the fact that I noted that the quality of the connections in the few houses that we visited was exceedingly poor and that it was quite evident to me that the villagers (Camposinas) had not been properly trained or instructed as to the dangers and requirements of household electrical wiring. I noted that both some external connections and, above all, the internal connections were inevitably going to short-circuit in the near future and in addition I noted that there was no earthing circuit or three core wiring to the domestic dwellings, which I felt was highly inadvisable, since this could cause a fire risk or electrocution in the case of short-circuits. In consequence, when I reached Lima, I discussed these matters with Javier, Celso and Alfonso and I made the suggestion, followed up in writing, that it would be a very cost effective promotion to issue each household with a small illustrated cartoon pamphlet showing the dangers of bad wiring, electrocution, fire, etc. I put Soluciones Practicas in touch with the cartoonist who did the drawings for ANIA. I also suggested on that occasion, before funding the additional El Eden scheme that this was conditional upon the quality of the installation at El Eden being decidedly superior to what it had been in Chambamontera. If this stipulation, which I made was followed out, this could well be yet another reason why El Eden has not had the same ratio of breakdowns as we have seen in Chambamontera. I suggested that each household should be given a safety instruction pamphlet, and a plastic bag containing a number of cable connectors, which would cost less than a dollar and a sample of the quality of wiring, preferably three core, which they would be able to obtain in Jaen. This would encourage them to use proper specification wiring and not the vast assortment of cheap cable, many of which which have been banned in most parts of the world for the past fifty years. I also said that a bag should contain a packet of cable clips so that one would not see cables nailed to the wall with metal nails leading to further short circuiting. An additional recommendation I made, which I do not believe would lead to additional major expense, is that when the electricity meters are installed that there should be an earth circuit to each meter, for obvious reasons.

At a subsequent meeting in Lima, I drew attention to the fact that as these installations were in the high mountains, they would be liable to lightning strikes, which would, at the very least, burn out the windings in the generator, or destroy the transformers, and I therefore suggested that there should be lightening ground protection in the vicinity of this equipment and this was agreed with Soluciones Practicas although I have heard or read nothing to the effect that it has in fact been installed. I would draw your attention to the fact that the scheme that we visited in the high mountains near Cajamarca had been struck by lightning twice, knocking out the generator, which had to be trucked all the way to Lima for repair, thereby underlining the point I was trying to make.

As the catalogue of breakdowns documented in your report and on my website mounted, I made the further suggestion that I found it incredible that some form of

basic fuse protection had not been budgeted into the system and I pointed out that if for maybe less than a dollar per household a sealed fuse had been included at the meter at each household, then if that household short-circuited it would blow the fuse and therefore safeguard the system without causing any further damage. Think of the cost advantage in view of what has happened. I further asked as to whether there were any electro-mechanical breakers to safeguard the transformers and particularly the generator and in view of the comparatively limited output of this system I suggested that a 100 amp circuit breaker would probably be sufficient for the entire output of the system, which would protect against load surges and I actually gave the costing of that equipment obtained off ebay!

In my original discussions in Lima after visiting Chambamontera I stated that I was surprised that the system was being installed as a single phase system and not as a two phase system, but was assured that this was the norm in Peru and indeed I know that it has worked for distances even up to two or three hundred kilometres in certain remote parts of the world, but in Chambamontera it seems to have been a problem from the start.

There would appear to be no reason why a properly installed SWER system should not function in Chambamontera at 380v providing all the equipment is properly calibrated and maintained and matched. SWER systems[1[1]] are reliable and have been used well over distances of 100 kms but in our case the distance is substantially less than one kilometre. The load densities are usually below 0.5 kVA per kilometer of line. Any single customer's maximum demand will typically be less than 3.5 kVA, and in our case less than O.4 but larger loads up to the capacity of the distribution transformer can also be supplied. **Grounding is critical.** Significant currents on the order of 8 amperes flow through the ground near the earth points. Duplication of the ground points assures that the system is still safe if either of the grounds is damaged. A good earth connection is normally a **6 m stake of copper-clad steel driven vertically into the ground**. A good ground resistance is 5–10 ohms. Other standard features include **automatic reclosing circuit breakers**.[2[2]] Reclosers may cooperate with down-stream protective devices called "sectionalizers", which present disconnectors or cutouts equipped with a reclosing mechanism with a counter or a timer. A sectionalizer does not interrupt fault current. It observes fault current and circuit interruption by the autorecloser. If the autorecloser cycles and the fault persists, the sectionalizer will open its branch circuit during the open period of the autorecloser, thereby isolating the faulty section of the circuit. SWER's main advantage is its low cost at roughly 50% of dual phase. It can also be upgraded and

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[1[1]] Rural Power Supply Especially in Back Country Areas, L Mandeno, B.E., M.I.E.E. Proceedings of the New Zealand Institute of Engineers, 1947, Volume 33, Page 234. This states: SWER is a good choice for a distribution system when conventional return current wiring would cost more than SWER's isolation transformers and small power losses. Power engineers experienced with both SWER and conventional power lines rate SWER as equally safe, more reliable, less costly, but with slightly lower efficiency than conventional lines

[2[2]] With a conventional circuit breaker or fuse, a transient fault would open the breaker or blow the fuse, disabling the line until a technician could manually close the circuit breaker or replace the blown fuse. But an autorecloser will make several pre-programmed attempts to re-energize the line. If the transient fault has cleared, the autorecloser's circuit breaker will remain closed and normal operation of the power line will resume.

has been known to carry as much as 35Kv. whereas in Chambomontera we are talking about a little over 100 amps.

It would be interesting therefore to see a cost analysis comparing upgrading the present SWER system with a complete rebuild as a two phase system

My own feeling is that the present SWER system can be made to work at economical **cost if properly installed and protected with lightning insulators and 'reclosers'. I am still not satisfied that the ground stakes are sufficient or set sufficiently deep. The absolute minimum should be 2 meters but four meters is better and the steel stakes should be wrapped in copper wire. If the system of distribution cannot be sectionalised so that each group of houses is protected by a recloser or resettable breaker then the individual houses should be fused at the meter with a 5 amp fuse. THE INTERNAL WIRING AND CONNECTION QUALITY AS WELL AS THE TRAINING OF AND EDUCATION OF THE INHABITANTS REMAINS PARAMOUNT. EACH HOUSEHOLDER SHOULD BE TOLD HE MAY USE *NOT MORE* THAN 3 OR 4 20w CIRCULAR NEON TUBES FOR LIGHTING, and A RADIO**. It should be noted that the power available per household is roughly 300/400w. The introduction of a black and white TV per house in the future is acceptable but the generalized introduction of refrigerators would require more output as this would exceed load capacity.

In conclusion it seems hard to believe that the inhabitants of Chambamontera can be so different from Camposinos in other locations in Peru and this therefore rather begs the question as to why would the problems that have occurred domestically within the village of Chambamontera be so much aggravated whereas the claim is that in the other fifty or sixty locations in Peru this kind of problem has never been encountered before. If this is the case then the preliminary training must surely therefore be considered faulty?

I have made as many suggestions as it is possible to make from a such a long distance and if I had not received this report now, I would have felt morally obligated to program in a visit to Chambamontera personally sometime later this year in company of an independent electrical engineer because both Warwick Franklin and myself feel, as does Practical Action in the UK, that we have a moral obligation to the villagers at Chambamontera and El Eden to ensure that the investment that has been made there does produce the requisite results and that they do get the promised electricity which, over a year ago we personally ourselves gave our word would be supplied.

Warwick, Warwick's colleagues and I look forward very much to hearing your proposals as to how we resolve these problems and how we insure a fully trouble-free and guaranteed operating system for the villagers.

PATRICK MATTHIESEN
THE MATTHIESEN FOUNDATION
APRIL 10TH 2010

Report on the "Chambamontera" Micro Hydroelectric Power Plant

Report on activities at March 2010

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1. BACKGROUND

The micro hydro power scheme was built at the request of residents of the community, organised in a Farmers' Association. The project was co-financed mainly by the Mathiessen Foundation of the UK, with the participation of the population through a supervised loan granted to the association.

The project encountered several problems from the very beginning. First of all, obtaining the necessary authorization from the owners of the land chosen as the site for the civil works proved to be complicated, causing the locations of the intake weir and the powerhouse to be changed on more than 2 occasions, until the authorization was finally obtained. Secondly, the target population had a limited participation in the construction work and thirdly, the transport of material and personnel to the worksite was delayed because access to the area was restricted by heavy rain. Based on our experience in similar projects, problems of this kind are common and are no impediment for continuing the anticipated actions. In actual fact, the activities continued until the implementation of the system was completed in March last year.

2. CHRONOLOGY OF THE INSTALLATION PROCESS (PROBLEMS ENCOUNTERED/IDENTIFIED)

February 2009:

- The installation of the electromechanical equipment was completed and then tested, although the results were not as good as expected as the generator was causing problems. This was observed by Mathiessen and Franklin Warwick, who happened to be in the community at the time. These observations to the system were gradually lifted.
- The generator was returned to the supplier for the necessary adjustments and repairs.

March 2009:

- The installation of both medium and low voltage electricity grids and household connections was completed. After the corresponding

tests, it was observed that one of the transformers (powerhouse output) was badly made, so it was returned to the manufacturer to be repaired.

- The problem continued and the faulty transformers created problems with both the generator and the regulator, a situation that had to be improved.
- Changing and repairing the transformers has been a persistent problem, to the extent that technicians had to be hired to rewind the transformers as a quick solution. Both the power house output and town input transformers were changed.

August 2009

- As a result of the recommendations made by Mathiessen and the evaluation made by the team, the earth system for the secondary grid was improved and the exclusive earth system for the primary grid (earth return) was implemented for the output sub-station (transformer), obtaining values of 2 Ω and 8 Ω, respectively, thus substantially improving the previous readings.
- Household installations were inspected (although this work may not have been too thorough), the thermo-magnetic switches on the general switchboard were checked and changed, as were the protection systems in the transformers. However, after working for three consecutive days, the system collapsed, apparently due to a short circuit in one of the homes.

December 2009

- After evaluating the faulty transformers, the team decided to switch to another manufacturer. Once installed, tests were carried out again on the system as a whole: power generation in the powerhouse, transformers, primary grid, secondary grid, household connections and public lighting, obtaining values of 448 V between phases and 224 between a phase and neutral. Values of 220 and 222V were obtained in the households. Once the service was established in the Chambamontera and El Eden communities and in agreement with the users, it was decided that the service would be provided from 17:00 to 23:00 hours from Monday to Saturday and from 10:00 until 22:00 hours on Sundays. Meanwhile, those responsible for the operation and maintenance of the system were trained and the users' organization was consolidated.
- It is worth mentioning that the service for the El Eden sector (low voltage) was working well and this service was expected to continue as soon as the problem in Chambamontera was solved.

To complement the actions related to the system itself, the relevance of planning other important activities was evaluated, with a view to regaining the confidence of the community and ensuring the sustainability of the project. In that respect, the following activities were planned:

- Hire the services of an operator from Jaen for the operation and maintenance of the system, who at the same time could train the people selected by the users to fulfil that job in the future (a quick but more reliable transfer process).
- Resume the implementation of the management model, with specific tasks such as setting rates, establishing rules for service users, contracts, etc.
- Hold training events for users and operators, in order to reinforce issues like service payment agreements (rates), entities involved in the management and operation, revenue management mechanisms and the efficient and rational use of energy, etc.
- Help prepare the first economic reports on the service and build trust among users.

After working normally for four days, the system shut down again due to failures in the transformers caused by a power cut in a household in El Eden. As the transformers were under a one year guarantee, they were returned to the manufacturer to be checked and repaired.

Due to the above, the actions defined as complementary to the project were not carried out but will be resumed as soon as the whole system is working again.

3. CURRENT SITUATION

The transformers and protection accessories were installed again on the 28th of February 2010 and the whole system was put into operation. The system worked normally from the 2nd until the 8th of March. After operating for 8 days, the power supply for Chambamontera and El Eden shut down unexpectedly.

The system is not working at the present time. Although the generator is in good condition, the Chambamontera population suggested that providing electricity only to the El Eden sector was not viable. Consequently, to be fair and on the safe side, it was decided to close down the operation altogether.

The ENISER technical team evaluated the incident, reaching the conclusion that problems occurred in the electricity grid, presumably because some beneficiary connected a high powered appliance that caused a power cut that affected the transformers. Unfortunately, this has not been verified, as some of the beneficiaries refused to have the internal connections in their houses checked.

It appears that this might have caused the sudden shut down of the system, which the operator[3] tried to restore a few minutes later, sending electricity into the system without positive results. Immediately after that and at the suggestion of some residents, new efforts were made to restore the service, an attempt that damaged the system's protection devices (thermo-magnetic switches).

To verify this, it was decided to reconsider the participation of outside experts to carry out an overall evaluation of the system, including the generator, transmission, distribution and internal connections in each household that forms part of the electricity service.

What is surprising is that this is an unusual case, as the power cut affected the transformers and not the equipment.

As mentioned above, a striking fact is that the generating system is working perfectly and could continue supplying electricity to the El Eden community. A determining factor may well be that this community has a low voltage transformer that has prevented any damage to the transformation system.

After the occurrence of this problem and the subsequent evaluation, the ENISER team held several working meetings to discuss the report and see what possibilities there are for resuming the work and restoring the service.

In this respect, several changes to the system were proposed in order to make it a safer and more reliable operation. In fact, this idea was discussed by the technical team, but unfortunately it was decided to continue with this design, although we believe there is no point in persisting with its restoration.

The idea discussed and evaluated involves making substantial technical changes in the system. The following proposals were evaluated: **1) Switch from the single phase system to a double phase system; and 2) switch to a single phase system with a 380 to 440/220 V transformer, similar to the one in El Eden.** This will be defined after one last evaluation visit, which includes the entire system as a whole. This change would require new investments initially, which we anticipate assuming as it is our responsibility and our desire to leave the system operating properly. This investment would have to be spent on changing the transformers and the type of transmission line.

On the other hand, the social aspect, which is crucial for the implementation of the system, must be boosted as there is a group of beneficiaries who have been unwilling to support the project from the start. Unfortunately and given the current state of the system, people in the community are feeling more disappointed and unwilling to help.

[3] The operator of the Cochalan MHPP, who had a certain amount of experience in the management of a similar system in his community and was therefore providing a reliable management service in the Chambamontera system.

Considering that after the technical evaluation some changes/adjustments will be made to the system so that it will operate under optimum conditions, the active participation of a sociologist is required to support organization and coordination actions with the community.

With these two activities, a report will hopefully be obtained suggesting the proposed modifications to the system, an aspect previously analysed by the ENISER programme. However, it is essential that this decision is corroborated with a technical evaluation conducted by an outside expert.

4. PROPOSAL FOR PUTTING THE SYSTEM INTO OPERATION

As mentioned in the previous item, a change in the design of the present system has been considered. To that end, the following activities are anticipated:

a) ***Evaluation of the system***.- An outside expert will be hired to evaluate the system as a whole and the corresponding TORs will be determined with a view to achieving the objective, identifying the problem in detail and finding a solution.

b) ***Installation of the renewed system***.- Based on the conclusions and recommendations resulting from the evaluation of the current system, the necessary changes will be made to the system in both technical and social terms. Apart from this, additional actions have been considered to help recover the population's confidence and consolidate the system as a whole. These actions were planned long ago, several of them at Matthiessen's suggestion, but unfortunately it was impossible to carry them out due to the failures in the operation of the system (not enough support from residents). Below is a summary of the actions to be carried out:

- Complete the construction of the wing walls of the retaining wall over the power house and, at the same time, make arrangements with the landowners to carry out reforestation activities, both in the upper and lower parts of the powerhouse.

- Hire the services of an operator from Jaen once again for a month, so that he can take charge of the operation and maintenance of the system and, at the same time, train the people selected by the users to fulfil that job in the future.

- Make regular visits to carry out a technical inspection of the installed equipment and accessories and make the necessary adjustments.

- Hold training events for users, as it is important for them to obtain detailed information regarding the organization of the system, the efficient and rational use of electricity, the rate system, etc.

5. ESTIMATED SCHEDULE

ACTIVITY	WEEKS							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1.- Prepare TORs for the consultant	X							
2.- Evaluation of the current system	X	X						
3.- Re-design of the system			X					
4.- Implementation of the new system				X	X	X	X	
5.- Operating tests								X