EVALUATION OF THE STRATEGIC AND REPLICABLE ASPECTS OF THE IDB – ITDG FUND FOR THE PROMOTION OF MICRO HYDRO PLANTS IN PERÚ (MPF)

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ITDG - Practical Solutions

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EXECUTIVE SUMMARY

National Regulatory Framework (Chapter I)

Some of the features of the General Power Concessions Law are described. In Chapter IV it is suggested that the tariff regulated according to this law is significantly lower than the tariff that would be needed for financial sustainability of the local public service power companies – LPEs (see previous page with acronyms and abbreviations) being promoted by ITDG, probably because the size of these systems is much smaller, which results in higher costs, than those which served as a basis for the calculation of the official regulated tariffs. Travelling OSINERG officials have taken note of this fact, which suggests the need to make a special effort to have get access to the Power Social Compensation Fund (FOSE), established by Government to cross-subsidise tariffs in favour of the poorer consumers. Finally, the lack of specific laws to promote rural electrification in Perú and mini hydro (MH) is stressed, although legally-approved technical standards for these activities exist.

Promotion and Management Models (Chapter II)

The ITDG Micro Hydro Promotion Fund (MPF) Programme has followed an interesting development path over the years:

1) *Initial MPF Promoción Model.* Its main objectiv e was to demonstrate an appropriate technology package to install social infrastructure (chiefly household and public lighting). It was based on the leadership of the municipality because this made it easier to obtain co-financing for the MH projects.

2) *Municipal Management Model.* With this model, the municipality delegates or entrusts the power service to a Committee, although it can also decide to take on the administration of this service directly for political reasons. In both cases, and for the same reasons, power management tends to become economically and administratively unsustainable because it leads to “votes for volts”, to administrative inefficiency, to the subsidisation of tariffs and to the neglect of maintenance. It also becomes socially unsustainable when the inhabitants lose faith in their municipality.

3) *Micro-enterprise Management Model.* This model was developed by ITDG after the failure of the municipal model, and is based in clearly delimiting the participating actors and making their respective responsibilities explicit: (a) The Owner of the MHP, usually the municipality, althgh making clear that that this body will not interfere in favour of any user; (b) The Assembly of Users, which will have an elected committee to monitor service quality; (c) The Local Power Enterprise (LCE), chosen by a special process of local tender and given the concession of the management of the local power service by the MHP’s owner, with the approval of the Assembly, and after a period of promotion and
training activities by ITDG; and, finally, (d) The User, who signs a service contract with the LPE, by which he or she accepts the obligation to pay for the service at the established tariff rates and to accept the sanctions specified in this contract, for failure to effect these payments.

4) Social Management Model. It is not enough to define the actors’ responsibilities. It is also necessary to identify all social groups in the community and to drum up their support for the LPE. A transition from a community-type of consciousness to an entrepreneurial mindset needs to be effected, seeking the support of the Mayors whenever these have a favourable vision of the Project. Everything indicates that this model, after a few adjustments discussed in the body of this work, has a good chance to be administratively, financially and socially sustainable.

5) Promotion of Productive Uses. It is very important to have many productive uses for the power produced because it achieves a load diagram with a less-pronounced peak, and higher power consumption– and sales – of electricity with the same installed capacity, which improves the financial sustainability of the LPE. Thus, since the year 2003, ITDG’s MHP management model aggressively includes the promotion of productive uses: initially for the local market.

Economic Aspects (Chapter III)

1) Energy Demand. Data on the monthly expenditure on candles, dry batteries, kerosene for lamps and for the charge of truck batteries is analysed as a function of income. It is obvious that there is a significant opportunity cost for the rural inhabitant if he fails to, or is unwilling, to pay a similar amount for mini hydro power, when this source of energy is available. The problem is how to get this inhabitant to acquire the willingness to pay this tariff.

2) Preinvestment Costs. This often-omitted, but important, aspect is analysed – including the cost of promoting the Project, the preliminary study, the executive design and the preparation and approval of a loan – as it has been estimated that such costs accounted for about 12% of total investment costs in the ITDG MFP sample.

3) Working Capital. This cost is also often neglected, even though it is important in any long lead-time project, such as mini hydro. An indicator of this item is total interest during construction, which was estimated to reach 7% of total sample investment costs.

4) Fixed Investment Costs. The available information was reviewed and found to be substantially consistent, although some missing items and inconsistencies were observed which would need to be corrected. Fixed investment accounts for 81% of total investment costs. Conventional ratios, such as Investment/installed kW, Investment/Household, Loan/Household and Power/Household, were calculated.

5) Operating and Maintenance Costs. Monthly operating costs are fixed costs of about S/. 1.000 (US$ 300), over the whole range of MHP sizes in the sample. Maintenance costs – both routine / preventative and periodic overhauls – are
calculated as a percentage of fixed costs. The larger the MHP, the lower the Investment/installed kW, and the higher the number of beneficiaries. Hence, operating and maintenance costs per household tends to diminish with larger MHP. This implies that a lower tariff per household would be required to cover these costs, as the size of the system grows.

**Financing (Chapter IV)**

A number of credit lines are analysed: the COFIDE – Holland Renewable Energy Promotion Credit Line (PROER), the National Housing Fund (Fondo Nacional de Vivienda - FONAVI), the FPM and the proposed World Bank – Ministry of Energy and Mines Rural Electrification Fund (FONER). It is concluded that the design of these credit lines was not always technical, but that theoretical and even ideological criteria intervened in their design.

1) **PROER.** We show why this credit line was inapplicable because of the insistence of channelling the funds through banks and other similar institutions, whose transaction costs, under the prevailing Peruvian legal conditions, are very high, especially with respect to the rural market for renewable energy. The PROER consultants suggested entrusting the administration of these funds to suitably-qualified, and lower-transaction cost - NGOs, but this was not accepted by COFIDE. Nevertheless, a significant number of solar PV and other systems were sold through hire-purchase by small-scale local firms, not through the banks. The risk perception of banks led them to fix repayment periods too short, and repayment instalments too high, for the purchasing power of potential interested rural buyers.

2) **FONAVI.** This line of credit had a low interest rate (12% in Peruvian soles) and long repayment times, but it was never a serious commercial line, in that no local enterprises were established to administrate the systems, nor was any collateral demanded. Thus, delinquency rates were very high and, finally, the State condoned all of these credits. However, even this did not make the resulting investment sustainable.

3) **Micro Hydro Promotion Fund (MPF).** Generally speaking, the MFP credit experience has been positive. Loans totalling US$ 783.718 were made to partially finance the construction of 31 MHP up to January 2005. However, Annex 1 shows that the repayment of some of the loans has been delayed and, in a few cases, it has been necessary to start lawsuits to execute loan collateral. The MPF only lends up to US$ 50.000 per project (about 25 – 30 % of the average MHP investment cost), and the repayment period is up to 5 years: too short, compared with the MHP’s operating life (30 years). Average payback times were about 3 years, which results in high monthly instalments, averaging about 13 – 14 % of current municipal revenues (mainly the Fondo de Compensación Municipal, a transfer from the National Budget). It is shown that a longer repayment period substantially reduces the value of these instalments and their incidence on current revenues. The reasoning is that, in the case of MH, the longer period may reduce the risk of loan default, because the technology and market are fairly stable, as opposed to the case of industry or commerce, where frequent technological and
market variations occur. A second hypothesis is that there is a small risk that a new Mayor will repudiate a loan undertaken by his predecessor, whenever the social management of the MH project leads to a widely-accepted LPE.

4) **FONER.** This is mainly a fund to subsidise rural electrification projects presented by existing power distribution concessionaires, which makes it difficult, but not impossible, for ITDG to have access to in the future. It also has a loan component to be channelled through COFIDE for the financing of the preparation, construction and putting in operation of MHP. However, the owner of these MHP, once running smoothly, would have to obtain a normal bank loan to replenish the COFIDE fund. This second component is seen to suffer from the same problems as the PROER fund, and for the same reasons.

5) **Self-financing Possibilities.** Under the premise that villagers would be willing to pay the same amounts for MH electricity than what they used to pay for before the arrival of these systems, it would be possible to cover all operating and routine / preventative costs of an average-sized MHP, but not all of its periodic overhaul costs. This calculation does not include the willingness to pay of small businesses, which is probably greater than of households. In conclusion, the higher the villagers’ incomes, the greater the possibility of self-financing though the payment of their electricity bills; and that, the greater the MHP size, and of the number of persons being served by it, the lower the operating and maintenance costs per person, and the greater the possibilities of self-financing. Thus, the promotion of productive uses, which would lead to higher incomes, should be strengthened, as they would increase the willingness to pay of the population.

**Impact of the MPF Programme (Chapter V)**

1) **Sustainable livelihood Means Methodology.** In a recent evaluation of the impact of the MPF Programme, an attempt was made to apply this methodology, which is receiving the support of the UK’s DFID, and which integrates the social, economic, institutional and environmental elements.

2) **Economic Impact.** After about 5 years of the installation of a MHP, incomes appear to have increased approximately 33 % in the sample villages: chiefly through the establishment of small businesses and an increase in production and sales of some existing businesses. However, these activities – whether generated spontaneously or through the efforts of the Programme – look basically to the local market which, due to its small scale, would not be able to sustain this growth of incomes in the future. Therefore, products would need to be developed for the wider regional and national markets. Opportunities for simultaneous use of water resources for irrigation and power generation to improve the load factor should also be sought.

3) **Social Impact.** The ways in which the promotion and management of a LPE can strengthen a community’s social capital are analysed. This arises through:
• A better access of the community’s members to local organisations and to their participation in these bodies.
• An increase in the villagers’ intensity of association and in their capability to cooperate in favour of their common welfare.
• An increase in the degree of trust, and a reduction in conflicts, between villagers.
• The punctual payment of established power and other tariffs.

**Strategies for Sustainability**

1. Prepare an inventory of possible MHP projects, together with existing power distribution concessionaires. Develop contracts between LPEs and such concessionaires as a means to ensure access to the FOSE tariff cross-subsidisation fund.
2. Co-ordinate proposals for legal and regulatory changes with Central Government bodies for the adequate treatment of small, isolated communities.
3. Prioritise target communities as a function of their population, income and hydro resources.
4. Co-ordinate available resources at the municipal and regional levels with those available through the MPF, and ensure that long-enough repayment times are granted so that the incidence of repayment instalments do not exceed 6 or 7% of the municipalities’ current incomes through FONCOMUN. Ensure that total finance includes periodic overhaul costs and repairs for a number of years, giving time for the LPE to develop and consolidate.
5. Directly link the preparation of the socio-economic study to the process of social management of a LPE in those villages whose incomes and willingness to pay will at least cover operating and routine/preventative maintenance costs.
6. Strongly promote the development of productive uses in parallel with LPE development, especially for products directed to regional and national markets, and seeking the multiple use of water.
EVALUATION OF THE STRATEGIC AND REPLICABLE ASPECTS 
OF THE IDB –ITDG FUND FOR THE PROMOTION OF 
MICRO HYDRO PLANTS IN PERÚ (MPF)

I. BACKGROUND

1.1 First Agreement with the Inter-American Development Bank (IDB)

On the 17.11.92 ITDG signed and agreement\(^1\) with the IDB, by which ITDG 
received funds from the Small Projects Programme (SP/SF-92-42-PE), which 
included a reimbursable amount of US$ 400 000 to constitute the MHP Revolving 
Fund and a grant of US$ 120 000 for institutional strengthening.

According to the terms of reference of this agreement, two interim evaluations 
were to be carried out: the first, upon disbursement of 25 % of the revolving 
fund, which occurred in August 1995; and the second, when a disbursement rate 
of 60 % had been reached, which took place two years later. The criteria which 
were to be used in these evaluations were six: a) focus on the target group, b) 
technology transfer, c) system of financing, d) operational efficiency, e) impact of 
the programme on the target population, and f) prospects for future success. A 
final study was also carried out\(^2\).

The conclusions of these evaluations are that the MPF Programme has produced 
positive impacts on the target communities. However, the sole installation of a 
MHP was not enough to endure that the systems would be well-administrated nor 
that the beneficiaries would take maximum advantage of their new source of 
energy. It was recommended that ITDG establish new management models and 
promote new productive and commercial activities that would bring higher 
incomes and more jobs through the use of electricity.

1.2 Second IDB Agreement

Towards the end of June, 2000, a second agreement was signed between ITDG 
and the IDB\(^3\), through which the IDB would contribute US$ 200 000 for technical 
assistance and US$ 300 000 for the revolving fund. To these amounts, ITDG co-
financed US$ 50 000 for the former and US$ 191 000 for the latter components. 
This agreement received an interim evaluation\(^4\) at the end of 2003 and, in 
December of 2004, the Project continues its execution at a limited rate and must 
oficially conclude in December 2005\(^5\).

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\(^1\) Technical Co-operation and Financing Agreement between the IDB and ITDG of 27.11.92.
\(^2\) The two interim evaluations were performed by the consultants Miguel Aréstegui (1995) and 
Alfredo Oliveros (1997), and the final evaluation was carried out by the first author in the year 2000 
(see Bibliography).
\(^3\) Technical Co-operation and Financing Agreement Nos. SP/EM-00-03-PE and ATN/EM-6922-PE.
\(^4\) The consultant was Homero Miranda (see Bibliography).
\(^5\) Execution deadline: 28 June, 2005; and last disbursement: 28th December, 2005.
All together, 29 loans totalling more than US$ 800 000 have been to co-finance an equal number of MHP. Five MHP are under construction or are not working, while the remaining 24 are operating.

1.3 Impacts of the Project “Micro Hydro Promotion Fund”

In this work we show that the Project has generated a significant and positive impact on the inhabitants, localities and small-scale enterprises in which it has operated, which can be described as follows:
1) Direct net benefits, in the form of electricity for multiple uses, for over 2,000 households in 21 populated centres.
2) Increase of the order of one-third in the income of the beneficiaries, after the setting up of a MHP, through the establishment of new businesses and an increase in the production and sales of existing activities.
3) Favourable impact on social capital: defined as a community’s capacity to act in an organised and co-operative way. This was especially true in those where the new ITDG Social Management Model for MHPs was put into practice.
4) In such communities the adoption of socially-accepted tariffs in line with willingness to pay of its inhabitants is allowing the coverage of operating and routine/preventative maintenance costs of MHPs, which tends to ensure those plants’ sustainability.
5) MPF loans stimulated a financial leverage of nearly 2:1 for investment in MHPs. The adoption of certain recommended financial policies in the future would ensure the financial sustainability of the MPF.

1.4 Objectives and Criteria of this Evaluation.

This work intends to identify the direct and indirect impact of the MPF and arrive at conclusions on the intervention model that was followed.

Regarding the definition of “Micro Hydro”, although it is common in international literature to read that Micro hydro describes the category of hydroelectric plant whose installed capacity lies between 10 and 200 kW \(^6\), in this study it will also be convenient to include some plants below 10 kW, but over 1 kW.

In this work, the evaluation criteria followed are considerably wider in scope and more detailed than those followed in earlier evaluations, which undoubtedly reflects the progress attained in Project management by ITDG.

The terms of reference for the evaluation of the strategic and replicable aspects of the MPF Project have been interpreted in the following way in this work:

- **Chapter II.** The analysis of the Project’s approach and methodology will be treated together with the management models, including the promotion of productive end-uses.

\(^6\) Smail Khennas y Andrew Barnett, p.1

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• Chapter III. Various economic aspects are analysed, such as electricity demand and the kinds of MHP costs: pre-investment, investment and operation and maintenance.

• Chapter IV. The options of financing the investment and the operation and maintenance of MHP are analysed. We conclude with the prospects for internal and external cross-subsidies.

• Chapter V. The impact of the Programme is analysed, from the social and economic points of view.

• Chapter VI. Strategies to ensure the sustainability of the programme are suggested.

The relevant legal and regulatory material on rural electrification in Perú is now briefly analysed.

1.5 Legal Framework

The regulatory framework for public service electricity appears in the General Electricity Concessions Law and its by-laws. A concession granted by the Ministry of Energy and Mines (MEM) is required for the performance of the following activities:

• Power generation using hydroelectric and geothermal resources, when the installed capacity is more than 10 MW. If it is less than 10 MW, but greater than 500 kW, only the authorisation of the MEM is required.

• Power transmission, whenever the installations affect State property or require the State’s right of way to lay power lines or primary and secondary distribution lines.

• Public distribution of electricity, whenever the demand is over 500 kW.

• Generation, transmission and distribution activities that do not require either a concession or an authorisation may be freely carried out so long as existing technical, environmental and cultural heritage conservation regulations are followed.

These rules imply that an MHP-based LPE can legally operate without a concession or an authorisation provided its total power is below 500 kW and the its demand is also below this limit, provided existing technical, environmental and cultural heritage conservation regulations are followed.

However, there is currently no specific legislation applicable to rural electrification nor for MHP, despite the approval and publication of Law Number 27744, “Rural Electrification and of Isolated and Border Localities” on 31.05.02. The main features of this law were:

1) Rural areas, isolated localities and border areas are those where the financial profitability of rural electrification investments are not attractive to the private sector, and which, therefore, require State subsidies because of the high social profitability of these investments.

7 Articles 3, 4, 6, and 7 of Decree-Law N° 25844. By-laws were approved by Supreme Decree Num. 009-93-EM
2) A Rural Electrification Fund is hereby created (REF) by earmarking 2% of the profits of generation, transmission and distribution corporations, out of the income tax proceeds from these companies. In the case of Hydroelectric concessionaires, this 2% will be levied additionally to the existing percentage paid as hydraulic levy (according to Law Num. 27506). The REF will also receive up to 25% of all resources obtained from the privatisation of State power companies, plus all proceeds from fines levied by OSINERG on electricity concessionaires. In total, the REF may not have less than 0.85% of the total Public Sector Budget, and if necessary, the Treasury will supply the balance if the other sources do not reach this target.

3) The FER will be administrated by the Executive Directorate of Projects (EDP) of the MEM, but the Projects must follow the guidelines of the National Public Investment System (NPIS).

4) A Rural Electrification Plan will be approved. where the year in which each project will begin is established.

5) The by-laws of this Law will specify the technical standards to be followed in the design, construction and operation of these projects, and tariff calculation procedures.

6) EDP will transfer the property of all completed works to the State “Empresa de Administración de Infraestructura Eléctrica (Enterprise for the Administration of Power Infrastructure) – ADINELSA”. In turn, the latter corporation will give the operation and maintenance of these works in concession or privatise them.

This Law was never applied, not only because the by-laws were never written, but because it would have conflicted with the more-or-less simultaneous approval of a new Organic Law of Decentralisation (Law Num. 27867 of 16.11.02, modified by Law Num. 27902 of 20.12.02).

On the other hand, there exists a system of cross-subsidies from medium and large urban consumers in favour of rural and urban-rural household consumers. Thus, Law Num. 27510 of 24.08.01 established the Electricity Social Compensation Fund – FOSE, which would receive surcharges on consumers being served by the national grid, and whose monthly consumption exceeds 100 kWh. FOSE will then reduce the tariff of households whose consumption is less than 100 kWh per month who are currently being billed under residential tariff BT5.

This Fund allows the subsidisation of users’ bills whose consumption is below the above limit. OSINER manages the Fund and the surcharges on the larger consumers that feed into it.

The FOSE law was originally intended to be valid for only 30 months, but this was extended first for one year by Law Num. 28213 of 07.04.04; and later, for an indefinite time, by Law Num. 28307 of 28.07.04.
II. PROMOTION AND MANAGEMENT MODELS FOR MINI HYDRO

2.1 Types of Models for the Promotion of MHP

Before analysing the promotion models actually used during the IDB/ITDG MPF FPM Programme, we review some types of these models\(^8\), which depend on the approach or starting point taken.

From the point of view of their **objective**, programmes can be motivated by:

- **Technical Push.** This model has the rationality of development, demonstration and diffusion of appropriate hydro generation technology for small, isolated, rural populations.
- **Social Infrastructure.** The objective is to provide lighting to improve the quality of life of people and to satisfy one of their basic needs, in a similar way as with health and water programmes.
- **Economic Development.** Tries to identify opportunities for new income-earning activities and to promote the good use of these opportunities through the setting up and training of small enterprises.

Secondly, an approach based on the **type of leader, promotor or owner of the system**, would lead to the following kinds of programmes:

- Community Leadership.
- Leadership by the Public Service Power company.
- Leadership by a private self-producing entrepreneur.

Thirdly, we have the approach based on the **type of use for the energy**:

- Only mechanical energy transmitted by the turbine shaft to the end-use equipment by means of belts.
- Electricity for residential, commercial and services only.
- Lighting and productive uses in general.

Finally, in a recent study on rural electrification in Perú\(^9\), three kinds of management models for this activity are mentioned as having been tried by the EDP/MEM, under the heading **privatisation of rural electrification approach**:

1) **Investment Obligations.** The private concessionaire is obliged to invest in grid extensions to rural areas. An example was the Sur Medio Concession, South of Lima, where the investor extended service to the Ica Valley, where it was profitable; and also to isolated communities in Huancavelica, where it was not. Because of this problem, the concession eventually reverted to the State.

2) **Beneficiary – Shareholder Enterprise.** This was a kind of local public service electricity corporation whose shareholders were the power users or beneficiaries themselves. This model was tried out in two localities: San Francisco (PV system), in Ayacucho; and in the Santa Leonor MHP, in the Lima Region.

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\(^8\) Khennas & Barnett (2000), pp. 1 – 5

\(^9\) ESMAP (2001), p.8

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3) *Minimum Subsidy Concession*. This consists in giving a private entrepreneur a concession in an existing public power system under a minimum-subsidy condition. This model is in the process of being developed.

### 2.2 Initial Approach and Methodology

#### Initial Approach

A review of the management of MH projects during the First Agreement with the IDB suggests that the approach was a hybrid between *technical push* and *social infrastructure*, from the point of view of the Programme’s objective; together with a *purpose* of providing energy basically for *domestic and public lighting* and, finally, where the preferred *leader* was the *Municipality*.

Perhaps the technological aspect weighed more during the first years of the agreement, because an appropriate technology for the electrification of isolated communities was being developed and adapted for Perú. As this technology matured, the social aspect started to gain ground. Thus, the focus of the promotion methodology seems to have suffered an evolution with distinct phases in time: first, a technological phase, and later, a social phase.

Clearly, this does not mean that the ITDG staff who were working so intensely in the promotion of MH were not thinking in the development possibilities offered by this technology. During this period, ITDG financed and installed MHP for a number of entrepreneurs. However, it seems that the prevailing view was that economic development would be induced little by little in localities with MH power.

The implicit premise\(^{10}\) of this hybrid approach was, therefore, that the supply of the technology tends to create its own demand: initially, for domestic lighting and, with time, commerciales and productive activities. In fact this did occur, to some extent, as will be described in Chapter IV on the impact of the MPF Project. The question is whether this spontaneous development can, on its own, ensure the sustainability of the Project.

#### Working Methodology

The following steps were followed, as a consequence of the hybrid approach of the ITDG energy programme:

- Development of MH technology and its transfer to regional and national manufacturing companies to produce components and services for these plants.
- Development of MH demonstration projects for the target population.
- Training of members of this population in the operation and management of MH systems.

\(^{10}\) Aréstegui (1995), p.8; y Oliveros (1997), p.4 y 5

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• Diffusion of results to influence the adoption of national policies in favour of MH; and
• The establishment of a Revolving Fund to assist in the financing of these systems.

The following concrete activities, called the MH Operational System, were carried out11:

1) Promotion and diffusion of MH technology.
2) Reception of requests from community organisations, such as development committees and local municipalities.
3) Technical visit to evaluate water resources, possible location of power-house and other aspects.
4) Preparation of a preliminary study and its delivery to the community for their approval.

However, this methodology did not explicitly emphasize the organisation, training, tariff regulation nor the final uses of electricity, as will be seen later on.

Promotion and Diffusion of the Technological Package

In analysing the first step in the so-called Operational System it is worth-while to briefly describe this technological package, because it is an important achievement that resulted by the work and devotion of many ITDG scientists and engineers in Perú and other parts of the world. This package has the following components12:

• The construction of water channels using wooden inverted arch center ribs as a kind of template13.
• Innovative design of the water intake with movable barrages.
• Use of PVC instead of steel of iron in the penstock.
• Innovative turbines with a standardised design: Pelton turbine with multiple flows, Michel-Banki cross flow turbines and axial turbine for low heads.
• Adaptation of generators from standard electric motors (motors as generators).
• The substitution of electronic load regulators, for the traditional manual or oil-hydraulic regulators, simplifies turbine design and reduces maintenance costs.
• The use of belts for the alternator enables a single standardised turbine to be adapted to a range of heads and installed capacities.

Reception of Requests from Potential Beneficiaries

In practice, efforts were concentrated more on certain kinds of beneficiaries than on others. The following groups of beneficiaries were identified and analysed:

11 Aréstegui (1998), p.9
12 Aréstegui (1995), pp. 6 y 7
13 Armazones de madera trapezoidales, iguales a la sección transversal del canal, con cuyo uso se puede acelerar y abaratar la construcción del mismo hasta en un 50% respecto a un sistema convencional.
• Local Governments.
• Private Enterprises.
• Community Organisations.
• Organisations of producers.

Priority was given to the first group, under the assumption that local governments could co-finance investment costs directly or offer guarantees for loans. This is important when investment costs for a typical public service MH plant is of the order of US$ 150.000, but the maximum loan allowed under the MPF rules was of US$ 50.000. There was also the expectation that municipal organisations could be put to work in the management of MH projects. However, projects for private entrepreneurs were also promoted, whenever these could demonstrate the required financial capacity. Hence, attention to the other two groups of beneficiaries was only viable if they were somehow backed by the relevant municipal government.

The Co-financing Assumption

In Anexo 2, summary files are presented on 20 specific MH projects promoted by ITDG during the First Agreement with IDB. Of this total, 14 MHPs were promoted by municipal councils (MC); 6 correspond to private entrepreneurs and 1 to a cooperative. These files show that 2 of the 14 projects led by MC had also received co-financing from PRONAMACHCS; and that a Framework Agreement existed between RENOM, ITDG and several municipalities for the execution of MH plants with co-financing by MPF, RENOM and the municipalities, under which the latter were required to finance a formal final location and design study for each project. Later, RENOM was replaced by its corresponding CTAR. Four of the 14 projects led by MCs received this co-financing, while 2 more received co-financing from FONCODES. There remaining 6 projects received co-financing only from the MCs and MPF.

Although this model succeeded in co-financing the execution of many projects, all project components were not always covered, nor were the funds always disbursed in the required amounts and times. Thus several projects suffered delays or could not be concluded at all.

However, the assumption that MC support would lead to project co-financing was in fact justified. Now we analyse the second assumption, namely, that the organisation of the MCs could be used in project management.

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15 RENOM= Región Nor-Oriental del Marañón (North-East Marañón Region) which was comprised of the departments of Lambayeque, Cajamarca, Amazonas and San Martín until its dissolution in 1994. CTAR= Consejo Transitorio de Administración Regional (Transitory Regional Administration Council). One was set up for each department, starting in 1994.
2.3 Direct Municipal Management Model

This model has a public character, in any of its 3 variants: Communal Committee, Administration Committee promoted (but independent) of the Municipality or direct municipal administration. In the first case, committee members are not directly involved with the municipal government, although they are supposed to represent the community. This organisation is compatible with Peruvian Law\(^\text{17}\), because the municipality’s responsibility for the administration of public services within its jurisdiction is delegated to this Committee.

However, the Communal Committee is not an independent legal entity, and so has no access to formal credit; although it can receive funds from NGOs and State institutions. Such committees are also exempt from tax returns and payment.

On the other hand, as the origin of the Committee lies in the assignment or delegation by the municipal government its functions, the Committee is totally under the control of the MC: at any time the MC can dissolve the Committee and decide to carry out its functions directly. Thus, in both cases, this kind of organisation has the disadvantage of being subject to political pressures.

These pressures can take the form of interference by municipal authorities in the naming or replacement of the Committee’s staff, or to decide the conditions of electricity supply on the basis of political and even personal considerations—such as giving preference to certain persons or extending the service beyond what is technically possible— or attempting to subsidise the service to such a high degree that the MH system becomes unsustainable: direct municipal subsidies of operating and maintenance costs could prove difficult to maintain whenever any unexpected problem arises in another area of municipal responsibility, considering the scarcity of resources, especially in rural municipalities, whether internally generated or received by transfer from the national budget (FONCOMÚN\(^\text{18}\)). And even if the Municipality should receive natural resource rents, known in Perú as the Canon\(^\text{19}\), these resources can only be applied to investment, but not to current expenditure.

Thus, the least desirable way to subsidise the local public electricity service would be the fixing of tariffs below O&M costs, and that the power of users who do not pay is not cut off: on one hand, no consciousness on he need for energy saving is raised and, on the other hand, a culture of irresponsibility is fostered. This leads to a vicious circle of low receipts, a lack of maintenance of the system and, eventually, to increasing operating problems which will be rejected by the population.

\(^{17}\) According to the Ley Orgánica de Municipalidades (Organic Municipality Law).

\(^{18}\) FONCOMUN = Fondo de Compensación Municipal (Municipal Compensation Fund) is financed by two percentage points of total VAT tax receipts. This is then divided amongst municipalities according to population and other criteria.

\(^{19}\) Peruvian Law establishes that a certain percentage of total production (in the case of oil and gas) or of income tax generated by natural resources must be paid as Canon to the regions and municipalities where these resources are produced, according to special formulas.

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Under this model, tariffs for households, commercial and industrial users are normally differentiated. In the first group, tariffs are set according to the number of lights installed, rather than on actual metering of consumption\footnote{Aréstegui (1998), p.17}. This system is undesirable, even if the Municipality is not subsidising the tariff, because the number of lights and the times during which they are on can vary without any control by the system’s administration, and because no incentives are in place to encourage energy consumption. Generally, in such cases there is no cost study.

Information\footnote{Calderón (2005), pp. 7 - 15} exists on the working of some communal and municipal administration committees which illustrate the principles outlined above. To the extent possible, this information was analysed using the sustainable living means methodology outlined in Section 5.1 of Chapter V.

Huarango.

- Located 3.5 hours North of Jaén by rough feeder road, but cut off by a river from the main Jaén - San Ignacio road, which leads to the Border with Ecuador. In spite of this, Huarango has links with other neighbouring towns and has a steady flow of passengers.
- The District Municipality directly administrated a MH plant at first, until complaints by the inhabitants due to poor service led to the creation of a community Monitoring Committee and, in September 2004, a CASEP\footnote{Comité de Administración de Servicios Eléctricos y Productivos (Committee for the administration of electric power and productive activities)} was formed. At the time, ITDG was attempting to establish a local public service electricity enterprise (ESPEL), but the process stalled due to the lack of support of the local authorities, a lack of finance to improve existing civil works and because no decision was taken to install meters.
- A monthly tariff of S/. 5 is charged per household, S/. 10 per grocery and other stores and S/. 15 for photocopiers and other services and workshops. Receipts barely cover operating costs. Failure to pay the tariff leads to the user being cut off after the second month, but only one example of this was reported.
- Despite this apparent compliance with payment obligations there may be future conflicts: there is no public lighting, except for the main town square, which causes the discontent of outlying households.
- The same occurs with the population of the surrounding hillsides, who provided their labour during the MH plant construction, but receive no power whenever the plant is overloaded, something which occurs both during the dry season and when there is too much rain. Despite this, except during a month when these inhabitants received no electricity, they are obliged to pay the same tariff as other residents who get a better service.
- There are also complaints that businesses that consume much more power than households pay proportionately much less for their consumption.
Chugur

- Isolated community in Hualgayoc Province (Cajamarca).
- The MH plant was co-financed by the Provincial Council of Chota through a PRONAMACHS (civil works and equipment) and ITDG (meters). The latter were paid for by the consumers. No outstanding debts remain.
- The administration was directly handled by the District Council from 1998 to 2000, with a uniform tariff of S/. 15 without meters. Due to the poor administration and political interference of the municipality the population established a CASEP in the year 2000. Its unpaid Board was headed by a nun.
- In 2004, ITDG started negotiations with the municipality to establish an ESPEL. Meters were installed and a new tariff based on metering was introduced. However, the process was interrupted.
- Today most users are metered and the minimum monthly payment is S/. 6 (up to 10 kWh) and is S/. 0,50/kWh between 10 and 30 kWh, being reduced to S/. 0,40 for larger consumers. There is a 6% non-payment rate and the service is cut off after the second month without payment. Monthly receipts are S/. 650 and the operator costs S/. 400 per month. The remainder is saved towards maintenance.
- However, there is now a malfunction which would cost US$ 4,000 to repair. The Committee has asked the Municipality for assistance. Despite the Municipality’s initial reticence, this authority now agrees to cover 50% of this cost, but the remaining 50% is yet to be financed.
- During winter (the rainy season), the MH plant operates properly with a flow of 100 lt/seg, but this flow drops to only a 30 lt/seg during the dry season, and then the service can only be provided between 7 and 10 pm.
- With the distribution lines financed by FONCODES the service could be extended to 104 additional households, on top of the current 98, but the installed generation capacity would also need to be expanded.
- This case is exceptional because it is unusual to find an institution with well-defined responsibilities and an unpaid staff that, nevertheless, operates as well as it does. However, the Committee and the Municipality both wish to create an ESPEL, which tends to confirm our hypothesis that CASEPs are not sustainable in time.

Chetilla

- Lies about 1 hour away from the city of Cajamarca, but in an isolated area which hardly has any public transport to this city, the Regional Capital.
- The existing 80kW MH plant which serves 89 households was built with CTAR and Municipal co-financing. ITDG has only provided technical assistance.
- The plant was administrated by the Municipality since 2001. There are no meters and fixed tariffs are charged per household and a higher one for businesses. Operating, but not maintenance, costs are covered. The small savings are to be saved in a special bank account solely for this purpose.
- The inhabitants doubt that an ESPEL could work in such a poor locality.
- However, currently the MH plant is out of commission. Despite this, the Mayor would like to increase its size to 280 kW in order to provide electricity to the surrounding communities. The inhabitants are discontented with this interruption and complain that they have not been informed about its causes.

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Incahuasi

- Located 2 hours by surfaced plus 6 hours by unsurfaced dirt roads from the main Chiclayo – Ferreñafe road. Despite these poor roads, the village has a twice-daily lorry service.
- The municipality obtained an ITDG loan in 1998 and the 50 kW MH plant, serving 150 households, was completed the following year. The loan has been repaid.
- The plant is under direct municipal administration. There are no meters, and each household pays S/. 5 per month and businesses pay S/. 10. Clients are disconnected at the third month without payment and a reconnection fee of S/. 5 is charged. There are few households in this condition. About S/. 700 a month is collected, but operating costs are S/. 960. The municipality puts up the difference.
- The municipality is introducing energy-saving lights.
- However, the plant is out of commission at times, without anyone knowing the cause. During the dry season only domestic demand can be satisfied, not public lighting.
- Despite these shortcomings, the municipality is running the service reasonably well, in addition to subsidising it. Hence, no problems between the population and the municipality have arisen as yet.

Chalán

- Located near Celendín (Cajamarca), it has road connection with this town and the town of Chumus, on the border of Amazonas Department. There is a daily mini-van service linking these towns.
- The plant has 25 kW and serves 87 households since 1994, whose construction was financed with a US$ 19.218 ITDG loan, US$ 17.400 from the municipality and US$ 35.182 by the Region.
- En 1994 the administration was by CASEP, but its shortcomings caused the municipality to take over the administration directly after only a few years. However, this administration was characterised by political favouritism and by charging below-cost tariffs. In addition the municipality did not cover the deficit and maintenance was neglected. The plant is out of commission.
- In 2004 the people took over the control of the plant once more, but it still only operates part-time. There are mechanical and electric problems, despite the presence of the advice of hired engineers.
- Many people are indifferent because they expect to be connected to the National Grid soon.
- Only a few of the town’s inhabitants are connected, and only a few of these have meters. Installed capacity is inadequate and several small businesses have left the town.

Annex 2 shows summary information on a total of 20 projects, including details of the preceding examples and additional projects. In 8 out of 14 projects promoted by municipal councils (MCs), the administration has remained in municipal hands, either directly or indirectly through a CASEP; in 3 cases there is no established
administration and in the remaining 3 cases an ESPEL has been established or is in process\textsuperscript{23}.

In conclusion, the Direct Municipal Management model has many reasons why it can become unsustainable, even if the municipality should carry out a relatively efficient administration and fulfills its MPF loan repayment obligations. Unsustainability can result form a combination of any of the following:

- **Committee instability.** The Mayor can name or change committee staff or can even decide to operate the plant by himself or by his aldermen.
- **Granting favours either by not collecting service bills or extension of the service beyond its technical possibilities.**
- **Change of Mayor, after municipal elections, as in 1999 and 2003.** The new Mayor either takes time to take charge of the system administration or, if his predecessor was a political rival, may question the project and even try to repudiate the MPF loan.
- **Temptation to subsidise tariffs, by way of “volts for votes”.**
- **Lack of discipline by not disconnecting clients who are not up to date in their payments.**
- **Not performing the needed maintenance of the system, which sooner or later leads to its deterioration and collapse.**

Now we see why this model is called the “Direct Municipal Management Model”, to distinguish it from the very different case where the municipality promotes the construction of the MH plant and receives loans and other public funds for this purpose, but does not intervene in its management and administration, once built.

### 2.4 Social Management of the Community Entrepreneurial Model

During the Second Agreement with IDB, a new management model for MH development was started, known as the “MH Micro enterprise Model” or, to be more exact, the “Small Isolated Power Systems Management and Promotion Services Model”, which was designed to overcome the main problem identified in the preceding model: namely, the lack of local capacity for sustainably managing local power generation and supply systems.

The new approach consists in generating a sense of responsibility in the fulfillment of duties, and in the exercise of rights, of: users, managers and owners of the systems, without losing the sense of community belonging of all these stakeholders. The question now arises: how was this management methodology arrived at?

To answer this question, one must first consider the actors that intervene and the working mechanisms of the model, which are as follows:

\textsuperscript{23} CASEP = Comité de Administración del Servicio Eléctrico Público; ESPEL = Empresa de Servicios Públicos de Electricidad Local.
1) **Assembly of Users.** Comprised of all system users. This body appoints a monitoring committee to exercise social vigilance on the quality of service. This committee can also act at the request of any of the other actors.

2) **Owner.** Usually the municipality, but it could also be the National Government, the Church or indeed a private entrepreneur. The important thing is that ownership be clearly defined. Also, that it be clearly established that the owner is not allowed to interfere in favour or against any current or future users.

3) **Local Power Enterprise.** It is a local private enterprise hired by the owner through a special local public tender, whose responsibility is the management of the local power system. The relationship with users must be straightforward: they must request the service and agree to pay the established tariff, through a signed agreement – identical for all users – with the company, which establishes the obligations of each party and the penalties for not honoring these obligations.

4) **User.** He must sign a service agreement with the company, through which he undertakes to pay for the service and agrees to accept the penalties mentioned therein for failure to do so.

However, it is not sufficient to identify the actors and to describe their main functions and inter-relationships within the model. We now need to address how the social management of this model took place.

ITDG’s experience in social management methodology is now described and analysed\(^{24}\).

**Role of the Mayors and Civil Society**

The support of the Mayors is necessary and desirable, given the fragility and even total absence of communal organizations, many of which were destroyed during the long internal conflict of the years 1980 – 2000\(^{25}\). However, the support of the local Mayor has not always been positive. For example, the Mayor of Chalán thought that he, being an Engineer, could personally manage the MH system. As was described above, this effort failed because of the politisation of the Electricity Committe, which led to the taking of many wrong economic and administrative decisions. For this reason a distinction is made between the Direct Municipal Management and the Micro Entrepreneurial Models.

In both cases the active participation of the Mayor is desirable: but only if he does not try to interfere directly in the administration of the project. To ensure this, the ITDG promotor must get the support of some representative of civil society, distinct from ITDG, with a significant local presence – or train one of these institutions or local leaders – since existing laws do not formally limit the power of the Mayor, except through the aldermen and local civil society, to the extent that the latter is organised and active.

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\(^{24}\) Interviews in Lima on May 20\(^{th}\) and 21\(^{st}\), 2005, with Sociologist Rafael Escobar, former promoter of the community management of MH systems and, later, developer of the development of the corresponding Micro Entrepreneurial Model.

\(^{25}\) See the recent analysis by Martín Tanaka, researcher at the Instituto de Estudios Peruanos (IEP).
Other Social and Political Aspects

1) In the social management of the micro entrepreneurial model, it is essential to consider the former community leaders, since they usually still retain some of their influence and leadership among their followers and sympathisers. If these leaders are not willing to collaborate with the process of Project establishment, they may become an opposition to this process and lead it to failure. Obviously, current leaders need to be considered for the same reasons. This may be difficult, to the extent that both belong to different power groups.

2) For this, it is vital that the ITDG promoter consider the “living means methodology” to analyse these social group and dilucidate the differences in the access to power of the same to promote the strengthening of cooperation in the community to sendure the success of the enterprise and also achieve a very important, though intangible, benefit: an increase in the social capital of the community.

3) One strategy that has worked is to start the promotion effort precisely with a “communal” discourse. This always generates enthusiasm initially. The problem then becomes one of effecting the conceptual leap from the community to the entrepreneurial view-point later on.

4) If the Mayor supports this transition, the process can be greatly facilitated, but this would usually happen only at the beginning of his term for objective political calculation reasons: having time enough to demonstrate that the project is successful.

5) There is a strategically key technical decision in favour of the adoption of the micro entrepreneurial model: the decision to install household power meters. This decision can mark the transition form the communal to the entrepreneurial focus of the project. Thus, in Chugur, Las Juntas, Tamborapa Pueblo and Conchán, where such meters were installed under municipal management, Local Power Enterprises (LPE) were established in the three latter localities. This aspect is so important, that ITDG should evaluate whether it is worthwhile to proceed in the promotion of a MH plant if there is no consensus on the need for meters.

6) Once the LPE is established, it may happen that the municipality does not wish to continue repaying its ITDG loan; or the inhabitants, to continue paying their electricity bills. Perhaps a rumour starts that the LPE is benefitting only two or three persons who are possibly getting rich at the expense of the people; or, in any case, the rest of the people are not getting the same benefits. Often the community members think that the staff working in the LPE should do so as volunteers, and do not always understand that their work is like any other: that must be paid.

26 There are exceptions: the Mayor of Conchán gave his support at the end of his term; but, at the time, the MH plant built with PRONAMACHCS / FONAVI funds was not operating, so the Mayor asked ITDG for a loan to install a new load regulator and household meters. As this corrective measure could be taken in a short time, it was to the Mayor’s political advantage to support the creation of a Local Power Enterprise, something he might not have done otherwise.
7) This is not the only irrational attitude: no matter how much it is explained to the villagers that, if they formerly spent an average of S/. 15 per month on candles, kerosene and the charging of truck batteries, and that the LPE needs to charge this same amount to offer a vastly superior service permanently, some villagers do not necessarily accept this. First, because they formerly made their energy expenditures in small amounts in accordance with their receipt of income. Second, because of the prejudice that, as electricity is a right, it should be provided free, something which is often associated with social claims promoted by politicians, and strengthened by the perception that, as the water is communal, it should not cost anything to tap its energy.

8) What has been described in the few lines before is only the symptom of the oposition to the model, which now must be analysed carefully. Sometimes politicised school-teachers\(^\text{27}\) try to denounce the promotors as outsiders who have come to exploit the villagers through their project. For example, in Conchán, the teachers created a “Committee to Defend the User”, saying that the LPE was unduly benefiting its community workers and outside owners, even though the selection of this LPE was carried out by local public tender.

9) A strategy to combat this type of argument is to publicise the fact that the ownership of the LPE is local: the municipality, an NGO, a religious congregation. Total transparency on this subject would make it difficult for the opposition to try to sell the idea that the MH plant is a personal venture of the ITDG promotor (possibly in collusion with the Mayor) and that he will become rich at the expense of the people.

10) Another strategy to route the opposition is to appeal to and stimulate the people’s self-esteem. The key question, then, may be: “Do you want someone from outside to come and administrate the MH plant or do you think that you are capable of doing it yourselves?” , obviously, after many motivating and training sessions that show how the village can manage its LPE.

11) Transparency criterios: it is important to always deliver the same message to all key stakeholders in the process: a) the Mayor, b) the community organisations, c) the people in assemblies, and d) the opposition to the MH project.

12) The promotion work does not end with the construction of the MH plant and the setting up of the LPE. It is necessary to accompany the LPE from its initial establishment until its full acceptance by the community.

2.5 The Promotion of Productive Uses

As we explained in the preceding sections, during the First Agreement there was no real model to promote productive end uses for MH plant power. However, during the first years of the Second Agreement there was an increasing awareness of the necessity to carry out this kind of promotion as part and parcel of overall MH promotion in order to increase the odds in favour of MH plant sustainability. Thus the second agreement included the target\(^\text{28}\) - which was fulfilled in excess - of promoting and training staff in 150 small-scale rural enterprises.

\(^{27}\) It is common knowledge that the National Teachers' Union – SUTEP – is directed by, and has many members belonging to, Patria Roja and other revolutionary left-wing organisations.

\(^{28}\) Miranda (2004), p.12
Training of MH Micro enterprises

Between January 2003 and March 2004, ITDG has trained 212 rural micro-entrepreneurs (59% men and 41% women; 17% formally constituted) within the surrounding of 13 localities with a MH plant. Subjects covered include the following:

1) Administration.
2) Accounting.
3) Enterprise formalisation.
4) Marketing.
5) New business ideas. This subject uses the pamphlets on specific economic activities developed for this purpose.

The material prepared for the training was improved and tested with the comments and suggestions of the micro-entrepreneurs themselves during training sessions, individual advisory meetings and in followup training and supervision activities, in coordination with community promoters.

The main lessons that emerge from this training effort are:

a. Most micro-entrepreneurs do not see themselves as entrepreneurs. They therefore do not see the need for following formal administration methods, as opposed to what should be the case in large enterprises. Their low self-esteem also contributes to such disorderly administrative practices. They are more worried about access to finance than about training. Attempts have been made to show that, on the contrary, tools such as strategic analysis (FODA) and development plans can be very useful. It is, however, less whether existing training programmes put enough emphasis on market studies and business plans.

b. Even though micro-entrepreneurs often record purchases and accounts receivable, they rarely have a sales registry book nor calculate daily sales. ITDG has attempted to show that these instruments can save time and avoid confusions and error, when adopted.

c. Most rural enterprises are informal because of the lack of presence of SUNAT in rural areas. The potential advantages of micro-enterprise formalisation was stressed during training activities. However, it is not clear whether the possible higher initial costs associated with this step have also been addressed.

30 Por ejemplo, Soldadura y cerrajería, elaboración de yogur, carga de baterías, molinería, videos, ilantería, juguetería, carpintería de madera y peluquería, desarrollados por el Consultor Miguel Aréstegui en 2003.
31 FODA – fortalezas, oportunidades, debilidades y amenazas (strengths, opportunities, weaknesses and threats).
32 Superintendencia Nacional de Administración Tributaria (National Superintendency of Tax Administration – Government entity in charge of tax collection, including social contributions, nationwide).
d. Rural micro-entrepreneurs do not usually adopt a marketing plan, but rely on their direct experience and intuition. The concept of attention to the client was stressed in the training programmes.

Although most of the micro-enterprises that received training operate in areas served by public service MH plants, and carry out activities such as retail commerce and restaurants, the case of self-generating small enterprises is also important in that they illustrate several aspects of the promotion of productive activities that were perhaps insufficiently addressed in the training programmes.

**Self-generating Micro-enterprises**

We now study the following private MH plant projects:

1. *Trinidad*, used to charge truck batteries, grain milling, video projection and the sale of surplus energy to third parties.
2. *Yumahual*, for the heating of chicken incubators.
3. *El Tingo*, for carpentry by direct mechanical, not electric, power.
4. *Toraya*, for the lighting of fish farms, grain milling, battery charging and radio communications.

The summary files of Anexo 2 show that, while the profitability of some of these businesses was adequate to ensure project sustainability, this was not always the case. Also, some entrepreneurs failed to come up with the required co-financing in production equipment.

This last problem occurred in the case of *Trinidad*, for example, even though the MH plant was built without any problem. The plan was to generate surplus revenue through the sale of electricity to third parties and thus finance the grain milling and video equipment. It seems that the local market for Trinidad’s products was not big enough for the surpluses to materialise or the entrepreneur was not well-enough trained to quantify and save these surpluses: whatever the reason, the investment never took place. There may also have been design errors, since the MH plant consisted in two turbines: a 3 kW turbine for the rainy season and a 500 W turbine for the dry season, which would appear to be uneconomic in that the majority of total capacity would inevitably remain idle for over 6 months. Currently this entrepreneur is being sued for not even starting loan repayment. Obviously such remedies are always available. However, the lengthy procedures and uncertain results of lawsuits in Perú will probably not result in a full recovery of the US$ 12,000 lent to this client. Hence, a better strategy might be to analyse the problem in greater detail and see if alternative solutions could be found.

In *Toraya*, the business was grain milling and battery charging, as in *Trinidad*. However, after a few months activities were halted because they were apparently not profitable enough, possibly because of insufficient local market. Fortunately it was possible to shift to fish farming, and 6 units were built that required lighting. This activity appears to have a profitable market external to the immediate
locality, so that the entrepreneur has managed to repay his loan. Once more, it appears that the first business plan was not thorough enough.

*El Tingo* illustrates two types of risks: natural disaster and market risk. In January 2001 a natural dam that formed on the Utubamambu river after a major landslide suddenly collapsed and the resulting flood totally destroyed the MH plant and the sawmill. ITDG condoned 50% of the debt and immediately started a new MH plant in the same place. It is not known whether any evaluation of the probability of repetitions of this phenomenon was made. Regarding commercial risk, it seems that the entrepreneur was unable to finance a new sawmill and chose the alternative of ice-making. However, after a year, a competitor appeared who, despite generating his power with a diesel engine, was apparently able to sell his ice at half the price of El Tingo’s. It is not clear whether the competitor was actually covering his costs. What is clear is that the decision on the second business activity was taken without sufficient evaluation.

Finally we mention the *Manantial Eterno* MH plant, owned by a Lima resident, not a local entrepreneur, who runs a hotel and offers tours in the area, wanted the MH plant to improve the quality of the services he offered. First, it seems that ITDG only financed the civil works due to the loan limit of US$ 50,000 imposed by the MPF statutes, trusting that the entrepreneur would be able to buy the equipment. But this has taken longer than expected and loan repayment has also been delayed. Secondly, the entrepreneur requested a change in his payment schedule, from monthly to six-monthly, as the latter is better attuned to the two yearly seasons of his business. However, for reasons unknown, the entrepreneur suddenly decided to abandon his property and has not been heard of since.

The lessons of the experience in promoting MH plants for rural entrepreneurs is that, in addition to training in administration and accounting, it is essential to prepare a detailed market study and a clear business plan, regardless of whether the business in question is aimed at the local, regional or national market.

**Conditions and Opportunities for the Promotion of Production**

The main problem for the development of micro-enterprises for the local or micro-regional market is the small size of this market, due to the small number of potential customers and their low incomes. Nevertheless, in Chapter 4 we demonstrate that a significant number of such small businesses were induced by the presence of a MH plant: mainly service activities such as grocery shops, restaurants, barber shops, battery charging; and productive activities such as carpentry and metal working. While the initial impact of these activities was significant, their potential for growth is limited by local market size: to a greater degree in isolated communities, and to a lesser extent, in localities that serve as a link between other localities in the same micro-region.

Part of the difficulty in promoting productive activities for the external market lies precisely in the isolation of most localities that require a MH plant, in the sense of distance from the existing national grid and of its probable extentions. Moreover,
these localities are also poorly connected to the existing National Road Network, having only dirt feeder roads or mule trails, which are often impassable during the rains. These conditions make it difficult for the products of such regions to compete in the regional and national markets. However, the costs of some products may become competitive thanks to a MH plant.

One possibility that should be considered is the joint use of water resources for power generation and irrigation, with which it should be possible to increase productivity and reduce costs, thereby enabling produce to compete in outside markets. Obviously this implies a much greater effort in investment, training and organisation than for a MH plant alone. However, if the overall package’s profitability increases, the problem is reduced to one of financing.

The preceding analysis shows that not all productive activities are feasible. To reach this objective, the following aspects need to be taken into account:
1) Natural resources must exist that can be competitively transformed into products which have a market, as it is unlikely that the local market would be big enough. Information on the availability of such resources and their potential markets is needed.
2) Competitive marketing channels for these products must exist, including all-weather roads or rivers.
3) There should also be a coincidence between the season of greatest power supply and greatest demand for these products, if these cannot be stored for long periods.
4) Alternatively, it would be necessary to invest in water regulation, if the products can bear the cost.
5) There must exist sufficient local or regional investment capacity. The regional aspect is emphasized because, when a locality within a region has a MH plant, it becomes possible to attract small investors to the region.
6) Investment in some productive uses of power is relatively low: about US$ 500 to 4,000 for grain milling, rice polishing, coffee shelling, fruit juice extraction, wood carpentry, metal working, baking, ice and ice-cream making, welding, etc.33 However, as local financial capacity is also likely to be limited, private MH plant promoters should ensure that beneficiaries have enough financial capacity before financing such plants.

Regarding productive end-uses of MH public service plants, the following aspects should also be considered:
1) The development of manufacturing and services tends to improve the load factor of the MH plant, because productive uses tend to take place at different hours from household services: mainly during the day and during the evening and early night, respectively. Hence, a greater effective demand can be satisfied with the same installed capacity, resulting in a higher profitability for the MH project.
2) Nevertheless, competition for water can arise between power generation and irrigation and, also, between irrigation and other productive uses, especially

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33 Aréstegui (1998), pp. 56 y 57.
during the dry season, because both of the latter activities are normally carried out during the day.

3) In any case, it is usually preferable to plan and promote productive uses at the onset of a MH project because generation capacity and a high load factor are developed simultaneously, which improves project profitability and sustainability. For a full demand to develop by induction, as in the traditional management model, a long time is needed and the results are also uncertain.

In conclusion, the greater the number of sustainable productive and service activities in a locality, the greater the sustainability of the MH plant it serves.

2.6 Tariff Systems and Productive Uses

This section serves as a bridge between this Chapter on promotion and management models and the next Chapter on economic and financial aspects.

Under the Direct Municipal Management Model, tariffs were quite arbitrary: normally just two or three different prices according to the kind of client. For example, S/. 10 per month for households, S/. 15 for commercial establishments and S/. 20 for productive establishments. There is no relationship between the actual electricity consumed and these tariffs, nor any meters to register consumption. In addition, high delinquencies were tolerated, and direct tariff subsidies were provided by the municipality, neither of which is conducive to sustainability.

The tariff system evolved substantially after 1998 together with the MH Micro-enterprise Management Model, according to which 3 decreasing tariffs are set for an equal number of increasing consumption blocks. The tariff blocks in this model are:

1) **Block I**: This is planned for the 60 – 70 % of the population whose consumption is limited to two or three lights, a black and white TV and a small radio set that, jointly, represent a consumption of up to 20 kWh / month. This block has the highest price, in soles per kWh.

2) **Block II**: Refers to the consumption of households and commercial and service establishments, consisting in a refrigerator, colour TV, video or DVD, sound equipment and lighting. The level of consumption of this block is over 20 and up to 60 KWh/month. The price per kWh is lower than in the first block. In other words, after paying the total for the first 20 kWh at the Block I price, additional consumption is paid at the lower second Block at a lower tariff.

3) **Block III**: This tariff is set significantly lower than the previous two blocks with the intention of stimulating the investment in productive activities.

In conclusion, this new tariff model has served as an incentive for the installation of new productive activities. There are even examples of the migration of some enterprises from neighbouring towns to a locality that has a MH plant and has adopted a decreasing block tariff system.

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III. ECONOMIC ASPECTS

3.1 Energy Demand

Demand Analysis

The available information shows that there was no explicit demand analysis, during the First Agreement. Demand was simply calculated from assumptions on the average number of family electric appliances and their total consumption. This method is therefore called the *fixed electricity needs* method. MH plant installed capacity was chosen according to technical possibilities and the needs thus calculated of as many dwellers as possible were satisfied considering this capacity. This measurement of demand is consistent with the adopted promotion methodology, based on the hybrid *technical push* and *social infrastructure* approaches analysed above.

Socio-economic studies

However, in spite of this limited approach to demand estimation, much useful information was collected during the socio-economic diagnosis stage of project promotion 35.

First of all, families were classified according to their social category, defined by land ownership:
- Below subsistence (up to 4 H.)
- Self-sufficient (more than 4 and up to 10 H.)
- Surplus (more than 10 H.)

There is information available on the number of families for each category and the distribution of the size of their plots.

Secondly, the amount spent in traditional energies such as candles, kerosene lamps, dry batteries and lorry batteries that are recharged by users is shown, which allows this expenditure to be related to average income. However, no models were developed to draw quantitative conclusions about the willingness to pay for electricity taking into account its price, income level, final use and the availability and the cost of substitute energy supplies.

In addition, towards the end of the First Agreement, towns were classified according to their average income: low, average and high 36. Although the implicit supposition that higher incomes translate into greater spending capacities and therefore higher electricity demand is reasonable enough, no model was developed to relate these variables to tariff levels. Nevertheless, we will see that this is a pertinent classification for the proposal of different sustainability and replication strategies.

35 Three examples are given in the Bibliography: Las Juntas (Jaen), Tambopara (Tabaconas) and Incawasi (Ferrenafe).
36 Arestegui (1998), p.10
Supply and demand curves

As with most goods, power demand as a function of its price is probably a negatively-sloped curve: the greater the level of consumption, the lower the price consumers are willing to pay.

However, whereas normally supply curves follow increasing marginal costs, the opposite frequently occurs in the case of hydropower: marginal costs are lower the greater the output. Due to technical reasons, hydro power has large economies of scale owing to the combined presence of technical indivisibilities that lead to high fixed costs, and the presence of low variable costs. This property of MH supply curves is the foundation for the decreasing block tariff model discussed in the previous section. The fact that these blocks are discrete quantities relating to specific types of demand, while marginal costs usually follow a continuous curve, does not contradict this statement. The general agreement between the shape of both curves - supply and demand - argues in favour of the adoption of this tariff system because it satisfies both sides of the market.

Opportunity Cost of Traditional energies

Even though knowing average expenditure on candles and other types of traditional energy does not allow us to determine the demand for MH electricity, it does help us to estimate the opportunity cost of these energy forms. The opportunity cost of the investment in a resource is the amount sacrificed when not invested in an alternative, more productive or satisfactory use. So, if people are already spending a certain monthly amount on candles, lamps and in recharging lorry batteries, when they could be consuming MH power - a more productive and satisfactory good - at a similar cost, they would be sacrificing this higher value, which would then be the opportunity cost of continuing to use traditional sources of energy. Hence, gathered socio-economic information can lead to an estimate of this opportunity cost.

Table 1 below shows the results of a sample obtained in 1996 by the ESMAP study in 8 different towns, which although different from those mentioned in Annex 2, we assume to be representative of at least some of the villages that have received ITDG attention and now have a MH plant. We observe that a monthly income of S/. 168, 445 and 853 at current prices, corresponds to the three socio-economic categories based on land ownership. We can also be observed that as expected, that of the total income, the spending rate on energy products is the highest in the lowest income category (8% of total income) than in the categories with higher income (rates of 5 and 3% for the other two levels). However, the total consumption value is very close amongst the last two categories, but approximately 60-70% higher than in the poorest category.

37 Energy Sector Management Assessment Program (ESMAP) (2001) pp14-17. Socio-economic data has not been considered for the localities mentioned in the Bibliography-Tambopara, Inkawasi and Las Juntas- because their incomes are fairly high due to commercial activities that correspond to their strategic geographical location near the Perú-Ecuador Border, and are thus not representative.
Table 1 - Selected Socio-economic Data of a Sample of Localities in 1996

<table>
<thead>
<tr>
<th>Locality</th>
<th>Families Interviewed</th>
<th>% Fam. Below sub</th>
<th>% Fam. Self-suff</th>
<th>% Fam. Surplus</th>
<th>Monthly expend on energy - US$</th>
<th>Yearly Income - US$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Below sub</td>
<td></td>
</tr>
<tr>
<td>Chetilla</td>
<td>80</td>
<td>85</td>
<td>13</td>
<td>2</td>
<td>1.61</td>
<td>2.88</td>
</tr>
<tr>
<td>Tumbadén</td>
<td>55</td>
<td>71</td>
<td>20</td>
<td>9</td>
<td>2.56</td>
<td>5.55</td>
</tr>
<tr>
<td>Tongsod</td>
<td>98</td>
<td>59</td>
<td>31</td>
<td>10</td>
<td>5.17</td>
<td>7.67</td>
</tr>
<tr>
<td>Pipus</td>
<td>22</td>
<td>73</td>
<td>18</td>
<td>9</td>
<td>6.00</td>
<td>15.2</td>
</tr>
<tr>
<td>Moyán</td>
<td>20</td>
<td>40</td>
<td>50</td>
<td>10</td>
<td>5.12</td>
<td>4.80</td>
</tr>
<tr>
<td>Palca</td>
<td>39</td>
<td>74</td>
<td>26</td>
<td>0</td>
<td>6.30</td>
<td>9.14</td>
</tr>
<tr>
<td>Ushcamarca</td>
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<td>94</td>
<td>4</td>
<td>2</td>
<td>4.52</td>
<td>3.80</td>
</tr>
<tr>
<td>Casacalla</td>
<td>44</td>
<td>39</td>
<td>41</td>
<td>20</td>
<td>3.52</td>
<td>9.88</td>
</tr>
<tr>
<td>TOTALS</td>
<td>411</td>
<td>69</td>
<td>23</td>
<td>7</td>
<td>4.02</td>
<td>5.40</td>
</tr>
</tbody>
</table>

Yearly expend on energy and yearly income S/. 159.06 261.14 277.34 2,011 5,342 10,242

Monthly expend on energy and monthly income S/. 13.25 21.76 23.11 168 445 853

Percentage of energy expenditure in income 8 5 3


Note 1. US$ have been converted conservatively to soles (S/) at the rate S/. 3.30/US$.

Note 2. Families below subsistence had 0 to 3 Ha of land. Self-sufficient families had plots between 4 and 10 Ha, and surplus families had 12 or more Ha. There are therefore discontinuities between categories.

Note 3. Data on Tamborapa, Las Juntas and Inkawasi were not incorporated because their incomes appear to be much higher than in the ESMAP sample, possibly because the former’s location near the Peru-Ecuador border may make commerce a more important source of income than agriculture.

As Table 1 shows, the population spends a significant amount on candles, kerosene lamps, batteries for portable radios, and in charging lorry batteries for home use. If they spent the same sum in power from a MH plant, they would obtain a service of far greater value. Then, the cost of opportunity of continuing to spend in traditional sources would mean sacrificing this higher value. The problem is how to make the population conscious of this additional value. One way would be to remind them of all the many end-uses they could conveniently have access to with a good electricity service, that cannot be accessed with traditional energies.

On the other hand, when we compare the cost of electricity with traditional energies, we must bear in mind that the latter are bought with small cash outlays of S/.2 or 3 each time, according to each family’s available cash at a given moment. This spending pattern contrasts with the normal practice of paying electricity bills once a month: even these are no higher than what is spent each month on traditional energies, the fact that payment of electricity is required in monthly lumps might be felt as too high by the population and, therefore, rejected. In other words, the willingness of the population to spend between S/.10 to 20 a month, a little at a time, does not automatically mean that they will be willing to come up with one equal lump monthly payment. This important aspect - that has not been addressed in the literature reviewed as part of these evaluations - would need to be included in project design and practice.

Another aspect is the transition between the pre and post - MH situation: since these projects take more than a year to materialise, in some cases the population is asked to make payments - for example, to install secondary networks, home appliances and internal cables- before the actual electricity service is running in their homes, a fact that could be rejected or, at least, affect the project’s cash flow. One option, which will be addressed in the next chapter, is to incorporate these costs in the project’s initial investment.

By: DONALD TARNAWIECKI
3.2 Pre-investment costs

The documents reviewed do not have much information about this important but frequently overlooked aspect. We therefore present a bench-mark estimate of the cost of each of the pre-investment phases:

1) Promotion and diffusion of the project. Evidently we are talking about an overhead-type cost that relates to the whole MPF project. It would be necessary to calculate this total and divide it between the number of projects. Because we lack this information, we assume that this activity requires an average of 4 people per month per approved project. At a rate of US$ 800 / person.month the total average cost would be of US$ 3.200 for each MH plant.

2) Technical visit to the town, preliminary study and approval by beneficiaries. According to ITDG38, two professionals are in charge of the technical visit, which consists of information-gathering during 3 days. Each professional is paid US$100 daily plus US$150 for travel expenses. Both professionals, and an additional electric or mechanical engineer, will work 5 more days to prepare their report. The total cost would then be US$2.400 per approved MH plant.

3) Preparing the final location and design study. An estimated cost of US$12.000 (see below) is contemplated. According to ITDG, systems over 20 kW generally require co-financing and therefore need a complete final location and design study. This requirement, established in the national public investment law, are also applied to local council investments even if they do not require co-investment. On the other hand, in general private clients are satisfied with a less complete study rather, to reduce investment costs. For this reason, Table 2 shows pre-investment costs that include the proportion of municipal MH plants in the sample studied: that is, 16 out of 28 MH plants.

4) Payment capacity analysis, preparation of loan request, loan evaluation and approval and the drawing up of the respective legal documents. According to ITDG39, these activities need the participation of a sociologist and an economist during approximately 3 weeks, at a cost of US$ 1.200. Including the credit operator’s fee of US $700 per loan request40, the total cost would come to US$1.900 per MH plant.

Through the RENOM-ITDG-Municipalities Agreement, municipalities are obliged to finance final location and design study costs. However, the amount charged by ITDG for this purpose, at only US$5.000 per study41, is clearly insufficient.

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38 Interview with Engineer Saul Ramirez, ITDG.
39 Ibid
40 According to the contract between ITDG and the credit operator CONSULRED
41 Oliveros (1997), p17

By: DONALD TARNAWIECKI
Cost of final location and design studies

Normally this cost would be considered as part of investment and not of pre-investment because such studies are not undertaken until economic viability is proven. However, for practical reasons this aspect is analysed in the pre-investment section.

A final location and design study for an MCH often requires the following staff:

1) A civil or geological engineer with experience in evaluating soils and slopes.
2) Hydraulic engineer with experience in evaluating small hydraulic resources.
3) Civil engineer or economist with experience in unit costs of small-scale projects.
4) Civil or agricultural engineer with experience in design and construction of channels.
5) Mechanical-electrical engineer.

Let us suppose for simplicity that 3 persons.month from each field are needed, which would mean a total of 15 persons.month. At a conservative average cost of US$800 per person per month, total cost would be US$12.000, without considering social overhead and other indirect costs. Obviously, this estimate is imprecise because the characteristics of each specific project site can differ widely but, nonetheless, it gives us an idea of the gap between the rate charged by ITDG and the real cost.

To sum up, our estimate of the average cost for the pre-investment of an MH plant amounts to about US$14.885, a considerable percentage of total investment cost. But this should not surprise us because it is difficult to achieve scale economies in the pre-investment of small-sized projects.

<table>
<thead>
<tr>
<th>Table 2 - Estimated Preinvestment Costs in the Analysed Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>1. Public Service MH Plant with MPF Credit</td>
</tr>
<tr>
<td>Project promotion and diffusion</td>
</tr>
<tr>
<td>Preliminary technical visit and study</td>
</tr>
<tr>
<td>Final location and design study</td>
</tr>
<tr>
<td>Analysis of borrower’s creditworthiness</td>
</tr>
<tr>
<td><strong>Preinvestment Costs per MH Plant</strong></td>
</tr>
<tr>
<td>Number of Public Service MH Plants</td>
</tr>
<tr>
<td><strong>Total Public Service Plant Preinvestment Costs</strong></td>
</tr>
<tr>
<td>2. Private MH Plant with MPF Credit</td>
</tr>
<tr>
<td>Preinvestment Costs without Final Study</td>
</tr>
<tr>
<td>Number of Private MH Plants</td>
</tr>
<tr>
<td><strong>Private MH Plant Preinvestment Costs</strong></td>
</tr>
<tr>
<td><strong>Total MH Programme Preinvestment Costs</strong></td>
</tr>
<tr>
<td><strong>Average Preinvestment Cost per Plant</strong></td>
</tr>
</tbody>
</table>

**Source:** Author’s calculations based on ITDG information
Alternative calculation of promotion and study costs

Another way of calculating the cost of these studies is to link the total administration and technical assistance costs of projects that were developed during a certain time. So, between 1993 and 1998 US$333,045 was spent on the above items\footnote{Arestegui (1998), p 63} for 10 public service MH projects and 4 private projects, which would mean an average of US$23,575 per project: a much higher value than our earlier estimate. No equivalent information is available for the remaining MH plants that were built up to today (18 public service and 10 private or co-operative plants). However, on the one hand, the total costs above may include non-project costs. On the other hand, it would be logical that a new calculation with complete data would be closer our first estimate, because fixed pre-investment costs would be spread out among a greater number of MH plants. Hence, we therefore prefer to continue working with our first estimate in the remainder of this book.

3.3 Investment costs

Disaggregation of investment costs

\textbf{Table 3} gathers and organises available investment information on a sample of 26 MH plants out of a total of 28 that were installed up to the year 2004 by ITDG\footnote{Table 3 does not show the Las Colmenas, Nuevo Progreso and Calabazas MH plants cofinanced with MPF loans that were granted on January 2005 for a total of US$21,000. Also, no information is available on investments before 2005 for Las Juntas (ITDG donation) and Chetilla MH plants, cofinanced by CTAR and the Municipal Council with ITDG technical advise and training.}. Total fixed investment and its financing is shown.

The breakdown by cost category is also shown: a) Civil works (33\% of total fixed investment), b) electromechanical equipment (35\% of total), c) transmission network (14\%), secondary network (14\%) and others (3\%). These proportions are within normal ranges in MH works, although significant discrepancies are found in specific projects. We proceed to comment on some of these categories.

Civil works

The percentage of local labour and raw materials is not known in the sample of MH works shown in \textbf{Table 3}. It is not even clear whether, if the beneficiaries indeed contributed with labour or materials, the equivalent value is included in total investment of \textbf{Table 3}. It is important to clarify this point because usually it is assumed that the population has the obligation to provide these inputs, or at least offers to do so during the project’s promotional phase. Even though this input was given, the opportunity cost of the work done by the population should be considered: even if it is low during certain months of the year, it is never completely zero. Hence, this calculation should be made independently of whether the local work force was paid or if it was provided as part of the community’s voluntary work.
<table>
<thead>
<tr>
<th>Municipal Councils and Villages</th>
<th>Name of Date of Civils</th>
<th>Number of Investm.</th>
<th>Electric-mechanical equipment Investm.</th>
<th>Other Items Investm.</th>
<th>Total Investm.</th>
<th>Financially funded by</th>
<th>Financed by others</th>
<th>Total Invested cap kW</th>
<th>Investment per kW in US$</th>
<th>% of MPF in investm.</th>
<th>Number of Users</th>
<th>Investm. in $ per user</th>
<th>Credit in $ per user</th>
<th>Power (W) per user</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colayac</td>
<td>Feb-97</td>
<td>2,400</td>
<td>4,500</td>
<td>1,770</td>
<td>3,016</td>
<td>11,736</td>
<td>11,000</td>
<td>738</td>
<td>3,912</td>
<td>90</td>
<td>1,174</td>
<td>1,140</td>
<td>478</td>
<td>2,945</td>
</tr>
<tr>
<td>Colayac</td>
<td>Jan-96</td>
<td>82,000</td>
<td>125,000</td>
<td>40,865</td>
<td>12,800</td>
<td>240,360</td>
<td>236,900</td>
<td>99</td>
<td>4,344</td>
<td>16</td>
<td>160</td>
<td>1,962</td>
<td>218</td>
<td>458</td>
</tr>
<tr>
<td>La Peca</td>
<td>Mar-97</td>
<td>75,000</td>
<td>51,000</td>
<td>24,850</td>
<td>12,500</td>
<td>160,250</td>
<td>157,500</td>
<td>84</td>
<td>4,752</td>
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<td>1,829</td>
<td>480</td>
<td>385</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
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<td>Mar-97</td>
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<tr>
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</tr>
</tbody>
</table>

**Table 3 - MICRO-HYDRO FIXED INVESTMENT, MPF PROGRAMME**

Source: Dávila (2002) and original ITDG files. Organisation and calculations by the author.

**Electromechanical Equipment**

For the same reasons, it is necessary to know whether the local population supplied any materials or labour. It is known that all MPF turbines were manufactured in Peru and that generators and electronic load regulators are a combination of domestic manufacture and imports, it would be interesting to have greater details regarding the origin of the inputs used in power lines and secondary lines: local, regional, national or imported manufacture.

**The “Others” Item**

According to some of the project files reviewed, this item is comprised of:
- Skilled labour.
- Technical direction, work supervision or work foreman.
- Supervision, monitoring and loan recovery.
- Freight costs of de materials and electro-mechanical equipment.
- Erection and installation of equipment and operating trials.
- Training in operation and maintenance.

Obviously this list is not homogeneous. For example, the freight cost of transporting cement to the work site should be included in the cost of the civil works, not in “other items”. Similarly, the skilled labour – including technical direction and supervision - required by these works should likewise be included.

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**Notes:**
- The files reviewed include: El Pululo, El Punre, Santo Tomás II, El Progreso, Buenos Aires, Sondor and Manantial Eterno MH plants.
under this item. Equally, freight costs to transport, erect and test the electro-
mechanical equipment should be included under this item.

The item “others” should only include indirect fixed investment costs, such as 
training in operation and maintenance, overall supervision, project monitoring, 
loan recovery and the supervision of construction. Training in O&M is an indirect 
cost because it is not incorporated into the MH plant, even though it is vital to 
ensure project technical sustainability. The second items are indirect costs for 
the same reason, and because if loan recovery is not ensured, the financial 
sustainability of the MPF is put at risk, thereby preventing the financing of future 
projects or even the provision of additional finance for the current project. This 
could be necessary, for example, to replace the MH plant after a natural disaster.45 
The third item mentioned ensures the quality control of the execution of the work 
using the minimum standards needed to ensure technical sustainability.

Training in operation and maintenance strats at the beginning of the work and, for 
MH plants built in the Cajamarca region, were initially carried out in this city.46 
According to ITDG47, the future operators and administrators of MH plants have an 
active participation during the whole construction phase of the plant, in order to 
learn about the characteristics and technical requirements of the plant for its 
optimal operation in the future. After the plant is built, this same staff receives 
specific training on operation and maintenance on site, plus a booster course after 
a short period of about 30 to 45 days.

Little information is available on the cost of these items of indirect investment. 
Their calculation though important, lies outside the scope of this study. For the 
moment, we accept the value of 3% of total fixed investment, as shown in Table 3.

**Working Capital**

It is possible that interest during construction constitutes an important financial 
cost, to the extent that the grace period before loan repayments are 
approximately equal to real construction times. To the extent that grace periods 
are shorter than construction times, these financial costs are reduced; and if no 
grace period is established, then such financial costs would be zero. In most MH 
projects funded with MPF loans the grace period is usually short, so that interest 
during construction is also small. In fact, some loans were repaid before the 
corresponding work was concluded and put on stream.

Nevertheless, there is always an economic cost associated with a construction 
period, which is the working capital cost of the work. This can be approximately 
measured by the value of interest during construction, under the assumption that 
the grace period equals total construction and commissioning times. Table 4

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45 This contingency already occurred in the MPF Programme with El Tingo I MH plant. 
46 Training is carried out in the "Centro de Demostración y Capacitación en Energías Renovables de 
ITDG (CEDECAP)", and lasts 3 days. It is unclear whether only 3 persons, or if a pool that can 
allow for staff rotations, are trained. See Oliveros (1997), p.12 
47 Interview of Engineer Saúl Ramírez
shows this calculation: the time effectively taken to build and commission MH plants is recorded and an interest rate of 8% per annum is applied to one-half the value of total fixed investment, as an indicator of the average amount of capital used during this time. This simplifying assumption implies that capital is being allocated at a uniform rate over time.\(^{48}\)

<table>
<thead>
<tr>
<th>Name of MH Plant and type of owner</th>
<th>Date of Project approv.</th>
<th>Total Fixed Investmt.</th>
<th>Constr time in months</th>
<th>IDC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Municipal Councils and Villages</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chalán</td>
<td>May-94</td>
<td>71,800</td>
<td>10</td>
<td>2,393</td>
</tr>
<tr>
<td>Incahuasi</td>
<td>Jul-96</td>
<td>236,433</td>
<td>38</td>
<td>29,948</td>
</tr>
<tr>
<td>Chugur</td>
<td>Nov-96</td>
<td>240,360</td>
<td>6</td>
<td>4,807</td>
</tr>
<tr>
<td>Kañaríis</td>
<td>Mar-97</td>
<td>190,200</td>
<td>42</td>
<td>26,628</td>
</tr>
<tr>
<td>Colasay</td>
<td>Feb-97</td>
<td>11,736</td>
<td>6</td>
<td>235</td>
</tr>
<tr>
<td>Combayo</td>
<td>Sep-97</td>
<td>160,231</td>
<td>28</td>
<td>14,955</td>
</tr>
<tr>
<td>Tamborapa</td>
<td>Sep-97</td>
<td>119,900</td>
<td>11</td>
<td>4,396</td>
</tr>
<tr>
<td>Cortegana</td>
<td>Sep-97</td>
<td>122,973</td>
<td>33</td>
<td>13,527</td>
</tr>
<tr>
<td>Huarango</td>
<td>Feb-98</td>
<td>105,251</td>
<td>42</td>
<td>14,735</td>
</tr>
<tr>
<td>Conchan</td>
<td>Abr-99</td>
<td>161,000</td>
<td>10</td>
<td>5,367</td>
</tr>
<tr>
<td>Sondor</td>
<td>May-00</td>
<td>226,350</td>
<td>16</td>
<td>12,072</td>
</tr>
<tr>
<td>Sillangate</td>
<td>Jun-00</td>
<td>116,417</td>
<td>10</td>
<td>3,881</td>
</tr>
<tr>
<td>Santo Tomás</td>
<td>Jun-00</td>
<td>196,580</td>
<td>22</td>
<td>14,416</td>
</tr>
<tr>
<td><strong>TOTAL IDC PUBLIC SERVICE MH PLANTS</strong></td>
<td></td>
<td></td>
<td></td>
<td>147,360</td>
</tr>
<tr>
<td><strong>AVERAGE IDC, PUBLIC SERVICE PLANTS</strong></td>
<td></td>
<td></td>
<td></td>
<td>11,335</td>
</tr>
<tr>
<td><strong>Private enterprises and Cooperatives</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>El Tinte</td>
<td>Ene-95</td>
<td>42,531</td>
<td>12</td>
<td>1,701</td>
</tr>
<tr>
<td>El Tingo I</td>
<td>Feb-97</td>
<td>21,080</td>
<td>37</td>
<td>2,600</td>
</tr>
<tr>
<td>Yumahual</td>
<td>Ene-95</td>
<td>36,513</td>
<td>15</td>
<td>1,826</td>
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<tr>
<td>Trinidad</td>
<td>Ago-96</td>
<td>14,876</td>
<td>11</td>
<td>545</td>
</tr>
<tr>
<td>Toraya</td>
<td>Ago-96</td>
<td>24,450</td>
<td>11</td>
<td>897</td>
</tr>
<tr>
<td>El Tingo II</td>
<td>Feb-01</td>
<td>18,362</td>
<td>4</td>
<td>245</td>
</tr>
<tr>
<td>Manant.Eterno</td>
<td>Nov-00</td>
<td>82,159</td>
<td>10</td>
<td>2,739</td>
</tr>
<tr>
<td><strong>TOTAL IDC PRIVATE &amp; COOP MH PLANTS</strong></td>
<td></td>
<td></td>
<td></td>
<td>10,552</td>
</tr>
<tr>
<td><strong>AVERAGE IDC, PRIVATE &amp; COOP PLANTS</strong></td>
<td></td>
<td></td>
<td></td>
<td>1,507</td>
</tr>
<tr>
<td><strong>TOTAL IDC IN MPF SAMPLE</strong></td>
<td></td>
<td></td>
<td></td>
<td>157,912</td>
</tr>
<tr>
<td><strong>AVERAGE IDC IN MPF SAMPLE</strong></td>
<td></td>
<td></td>
<td></td>
<td>7,896</td>
</tr>
</tbody>
</table>

Source: Investment figures from Table 3. Construction times, from Dávila (2002)

In the case of the MPF Programme a number of different sources of finance have been used, in addition to the MPF. Experience has shown, however, that the concurrence of these different sources has caused delays in the execution of works because funds have not always been forthcoming at the required times. In Annex 2 several examples of these delays are shown: in 9 out of 14 public service MH projects\(^{49}\) there were construction delays, of which 2 cases were due to delays in regional and national cofinancing, 3 to delays in municipal cofinancing and 4 to technical problems or delays in the supply of parts and equipment.

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\(^{48}\) In fact capital expenditure in a MH plant usually has one or two “humps” in time.

\(^{49}\) Including ElTinte Cooperative, where the main end-use is the domestic use by members of the cooperative. La Peca MH plant is not included because the project only consisted in the rewiring of the generator.
Intangible Costs

This item usually includes the cost of technology used in the Project and other similar costs. The successful development and adaptation of MH technology has required significant outlays by ITDG in Peru and other countries. As these costs have already been incurred they are sunk costs and, anyway, as ITDG is a non-profit institution, the financial recovery of these costs is not being suggested.

However, there are aspects where future investments in technology appear to be warranted as, for example, improvements in civil works so that they are less vulnerable to serious damage during each rainy season. It is therefore proposed to include a small item in the tariff to contribute to a Technical Development and Training Fund to help ensure the long-term sustainability of the Programme. This Fund would have a transparent and participatory character, where representatives of all communities and ESPELs contributing to it would decide jointly with ITDG staff on how the Fund would be used.

Investment according to the kind of ownership

The data in Table 3 has also been classified according to the ownership of the plants: of the 28 projects, 18 are public service plants owned by municipal councils, 2 are owned by cooperatives and the remaining 8 are private. The cooperative examples can be seen as hybrids, because although the main function of the plant is to supply energy to a productive unit, it also satisfies the cooperative members’ domestic needs. Also, many private projects sell surplus energy to neighbouring households.

Total Investment

Table 5 shows the investment that was required by the MPF Programme to build a public service MH plant, including preinvestment and working capital. Table 6 shows the same data for private and cooperative projects.

Table 5 - Total Investment in MPF

<table>
<thead>
<tr>
<th>Public Service MH Plants (US$)</th>
<th>Fixed Investment</th>
<th>2,077,260</th>
<th>81.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preinvestment</td>
<td>312,000</td>
<td>12.3</td>
<td></td>
</tr>
<tr>
<td>Working capital</td>
<td>147,360</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>Total Investment</td>
<td>2,536,620</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Num.of Publ.Serv.MH Plants</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total investment per plant</td>
<td>169,108</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average installed capacity</td>
<td>69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Investment / kW</td>
<td>2,448</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average num.of households</td>
<td>134</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment / household</td>
<td>1,263</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Tables 3 and 4
We conclude that the fixed investment in an average public service MH plant was approximately 82% of total investment. The remaining 18% is comprised of preinvestment and working capital. Seen differently, total investment is 22% greater than fixed investment.

The incidence of preinvestment in private MH plant investment costs is higher than in public service plants because of the diseconomy of scale of the smaller private plants. This can be seen in Table 6. In contrast, in private plants, working capital costs were relatively lower because, as 86% of the finance was provided by ITDG, there were fewer construction delays. In public service plants, ITDG was only 27% of total finance. We recall our earlier finding that, having several sources of finance that do not disburse their funds on time, was a major cause of construction delays and thus higher costs.

Representative Ratios in Public Service MH Investment

Table 3 also shows installed capacity of the MH plants and the number of users of these plants. The following representative ratios were calculated from this data:

- **Unit Investment.** Fixed investment per installed kW (US$/kW).
- **Installed capacity per user.** Measured in kW/user, it indicates the intensity of potential consumption per user. As most users are households, it gives a rough indicator of kW/household.
- **Investment per user.** It roughly indicates the investment per household (US$/household).
- **Borrowing per household.** It measures what would have been the average amount borrowed per household (US$/household), if indeed households would have received MPF loans, instead of the municipality.

These indicators are now analysed in the case of public service systems:

1) **Unit Investment.** In Table 3 average fixed investment of the MPF Programme was US$ 2.005 / kW, which would appear to be significantly lower than the average value of US$ 3.095 calculated for a sample of countries\(^\text{50}\). It is possible that, as the summary files of Annex 2 suggest, some of the projects

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\(^\text{50}\) Khennas and Barnett (2000), p. 9. However, this source does not indicate whether total cost or only direct fixed investment was included.
already had partial civil works or a part of the equipment before the MPF entered the scene - or simply could not be completed because a supplementary source of finance did not materialise – and that these missing components did not enter into investment calculations, hence leading to this total being underestimated. It is also possible that supplies in kind by the beneficiaries have not been considered. If we consider the total investment of Table 5, we arrive at an average of US$ 2.448/kW: closer, but still significantly lower than the international value quoted above. For these reasons, it would be desirable to review the investment costs of all MPF projects to date and verify that the investment costs have been correctly accounted for, a task which however escapes the scope of this work.

In Graph 7 investment per kW is shown as a function of installed capacity in kW (both public service and private MH data have been pooled). As expected, the data show a high degree of dispersion, due to the site-specific nature of MH costs. However, there is a decreasing trend in unit investment as the size of the MH plant increases, which probably reflect the economies of scale that can be gained in the larger plants. We recall from Tables 5 and 6 that average

MH size was only 69 kW for public service, and 11 kW for private plants. We do not have data on the preinvestment costs of individual MH plants, which would allow the preparation of a similar graph to Graph 7 for total unit investment (including preinvestment and working capital) versus size. But probably a similar decreasing function would be obtained: to the extent that preinvestment is a fixed cost, its unit value would decrease sharply with size. On the other hand, it is not clear whether working capital has any significant economies of scale, since its value is proportional to fixed investment and also depends on the construction process. However, preinvestment costs are more important than working capital costs, so the former would probably have a greater effect on the resulting trend.

2) *Inverstment per Household.* This indicator gives a value of US$ 1.034/household in Table 3, which considers only fixed investment. Once

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51 For the sake of continuity, tables and graphs use the same numbering order.
again, with data in Table 5 this figure is adjusted for total investment, with which the indicator rises to US$ 1.263/household. This indicator is useful to compare it with average annual incomes and get a preliminary idea on whether the population would be able to repay a 100% loan for the investment. If we compare the latter value with the average incomes shown in Table 1, this investment would be equivalent to the following multiples of yearly incomes per social category: 2.1 (below subsistence), 0.8 (self-sufficiency) and 0.4 (surplus). These results suggest that, provided adequate financial conditions are offered, beneficiaries could – at least in theory - pay for MH investment. In Graph 8 the investment per household is shown as a function of the number of households. As expected, the average investment goes down as the size of the village served by the MH plant increases. To complement our analysis, we show in Graph 9 MH installed capacity as a function of the number of households. The resulting correlation is positive, as expected. In both cases, however, there is a considerable degree of dispersion in the data.

Clearly the above discussion on investment/household should not only deal with the issue of the beneficiaries' ability to pay, but on whether this would be fair, since urban dwellers have by and large never had to pay for any investments in power infrastructure enjoyed by them today. But this topic also lies outside the scope of this book.
3) **Loan per household.** This indicator shows what would have been the debt burden if the current beneficiaries were expected to repay the MPF loans actually given. The result, from Table 3, US$ 280 / household, and would not change regardless of whether fixed or total investment were being considered as the loan amount does not change in either case. This level of debt would be obviously much more manageable than if beneficiaries were expected to repay a 100% investment loan.

4) **Installed capacity per household.** The value of 516 W emerges from Table 3, significantly higher than the average value of approximately 300 W quoted in the literature. This could indicate that many households have established small businesses as soon as they have access to electricity, as we discuss in Chapter V.

**Investment in Household Connection Equipment**

The figures in Tables 3, 5 and 6 do not include any calculation of the real cost of household or business connection to the local grid. In the review of Conchán MH plant52 a charge of S/. 91 per household for its meter is mentioned, but no connection cost information is given. According to ITDG sources53 the cost of the meter, plus the internal wiring, is an average of S/. 150 per household. If we adopt this value and apply it to a village with 134 households, the average size in our MPF sample, the total needed investment would be approximately US$ 6.085.

Pre payment meters could also be installed54 or, in small systems where demand often exceeds supply, power limiting devices have been used (usually just fuses that limit current intensity) and a fixed tariff is charged. For example, in Buenos Aires MH plant, with 5 kW for 30 families, only up to about 160 W can be distributed to each family simultaneously. The introduction of energy-saving measures is especially critical here to ensure that, even with such constraints, welfare is maximised.

The investment in connection to the power system is not included in Project investment because of national rules that oblige users to pay for these connection costs – which is indeed correct in principle – because the respective investment is for private, not public, use. However, as we are dealing with poor and isolated localities, it would not be out of place if these charges could be subsidised, together in the same way that the remainder of MH investment is usually funded. Moreover, if we compare the required investment in metering and wiring estimated above, with the investment in Tables 5 and 6, we see that the former cost is only a small fraction of the latter, a fact that would facilitate including the smaller sum in project finance. Such a policy could also increase the population’s willingness to pay for electricity consumption.

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52 Sánchez (2004), p. 34
53 Entrevista al Ing° Saúl Ramírez
54 Existe un proyecto piloto de Hidrandina para introducir sistemas prepago que podría tener aplicaciones prácticas en proyectos de MCH.
On the other hand, its exclusion might delay the incorporation of customers to the new system, until households and businesses have managed to gather the necessary cash, and this delay would delay the enjoyment of the Project’s benefits, and certainly hurt its cash-flow.

**Investment in Efficient Light Bulbs and Other End-Use Equipment**

The unit retail price of efficient light-bulbs is about S/. 10-20\(^55\). Considering a wholesale unit price of S/. 10 and 3 units per family, the required investment in lights would amount to approximately US$ 1.217 for the average village in our MPF sample. In conclusion, as with meters and wiring, the incorporation of this item in Project investment would not alter the economic nor financial figures significantly. Moreover, the purchase and installation of these efficient units can be justified on social investment grounds: to improve the social and educational possibilities of the population.

These items should be included in the overall investment of the Project and should be financed as one package, because this would ensure a desirable energy saving practices from the outset; and would also allow more families to receive electricity from the same installed capacity and, moreover, at a low marginal cost. Finally, the financing of this package may well facilitate the acceptance of an entrepreneurial management system by the beneficiaries, which would lead to prompt payment of energy bills and project sustainability.

The community may also want to provide appropriate quarters for the village teacher, consisting in the teacher’s lodging and perhaps a community computer, telecommunications and internet centre. Decentralised telecommunications and Internet are both technically possible and low cost\(^56\). In addition, IP phone protocol, which allows voice conversation by Internet, is becoming more and more competitive, and does not require any physical telephone wires. These solutions are low cost, so long as a reliable and economic source of electricity is available, such as a MH plant. They can also be included in the subsidised investment package, on the grounds that telecommunications and internet are socially valuable facilities. Obviously a charge for the use of these services would need to be set.

Depending on the will and possibilities of the villagers, there would be no need to stop there: in principle, other household and business equipment could be financed, such as microwave ovens, B/W and colour TVs, and PCs. Obviously these items could not be included in the package mentioned above, which receives municipal and other subsidies. But this does not necessarily preclude a second credit line direct to the beneficiaries.

\(^{55}\) Aréstegui (1998), p.17

\(^{56}\) According to the draft (unpublished) “Study to Define a Strategy of Strengthening and Expansion of the Rural Telecommunications and Info-Centres Programme in Perú” (D.Tarnawiecki, J.Távara, C.Wendorff – PUCP y R.Valdivia – VALTRON, Sept. 2003), a micro-region with several villages and about 4.000 inhabitants could have rural internet systems including a VSAT, local WiFi and antenna and 14 PCs with an investment of about US$ 11.200, or US$ 14 per household, considering 5 persons/household.
Opportunity Cost of Water Resources

In the cost-benefit evaluation of MH power, a zero opportunity cost of the water resources is often assumed, on the basis of the non-consumptive use of water for power generation, which means that the water can be used after leaving the turbine. However, it may well occur that the opportunity to use the water between the intake and tailrace elevations might be lost because of the MH plant. For example, lands between these two levels could not be irrigated, unless it were economic to pump water back up again during off-peak hours. This aspect should be considered in future MPF projects; and which cannot be accomplished in this evaluation because of the lack of data on energy generation and load diagrams in existing MH plants.

Comparison Between MPF and DEP Mini-Hydro Programmes

Many of the rural electrification projects developed by the DEP formerly had an investment cost of about US$ 1.100 – 1.200 per household. However, this cost has risen recently, as the electrification of the more accessible and thus cheaper areas was concluded: in many new projects, average investment costs are 2.000 to 3.000 US$/household. In either case, these averages do not include either preinvestment nor primary nor secondary distribution networks, and so cannot be directly compared with the investment per household data in Table 3. In addition, DEP grid extension projects appear to be over-sized in that the installed capacity per household reaches 3 kW, which makes these systems unsustainable.

In Table 10 data on a recent sample of mini-hydro plants built by DEP/MEM is shown. The investment cost is disaggregated according to the plant construction itself and the various power lines and networks.

Unit investment costs of DEP mini hydros appear to be more than double the cost of ITDG's MH plants: US$ 5.184/kW in the sample of Table 10 (versus US$ 2.448 for MPF public service plants). This cost gap is even wider if we consider that the average size of the DEP plants is 269 kW, much larger than the average MPF size of 69 kW.

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57 DEP = Dirección Ejecutiva de Proyectos (Project Executive Directorate) of the Ministry of Energy and Mines (MEM) has been building Mini and Micro hydro plants and grid extension projects to rural communities and small towns for over 10 years.

58 Interview of DEP / MEM staff.

By: DONALD TARNAWIECKI
### Table 10: Investment by the Ministry of Energy and Mines in Mini-Hydro Projects

<table>
<thead>
<tr>
<th>Name of Project:</th>
<th>Catilluc-Tongod</th>
<th>Santa Leonor</th>
<th>Nuevo Seasme</th>
<th>Valle Aco-bambilla</th>
<th>San Balvin</th>
<th>Totales Values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ITEMS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installed Capacity (kW)</td>
<td>70</td>
<td>726</td>
<td>210</td>
<td>60</td>
<td>280</td>
<td>1,346</td>
</tr>
<tr>
<td><strong>Investment in MH Plant</strong></td>
<td>1,569</td>
<td>6,894</td>
<td>4172</td>
<td>656</td>
<td>1323</td>
<td>14,614</td>
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<td>Civil Works</td>
<td>1,261</td>
<td>2765</td>
<td>391</td>
<td>1060</td>
<td>5,477</td>
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<tr>
<td>Work supervision</td>
<td>67</td>
<td>86</td>
<td>34</td>
<td>32</td>
<td>219</td>
<td></td>
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<tr>
<td>Machinery and equipment</td>
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<td>4043</td>
<td>150</td>
<td>147</td>
<td>4,486</td>
<td></td>
</tr>
<tr>
<td>Studies</td>
<td>76</td>
<td></td>
<td>66</td>
<td>68</td>
<td>210</td>
<td></td>
</tr>
<tr>
<td>Study supervision</td>
<td>19</td>
<td></td>
<td>15</td>
<td>16</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td><strong>Investment in Network</strong></td>
<td>517</td>
<td>5,050</td>
<td>1519</td>
<td>293</td>
<td>1729</td>
<td>9,108</td>
</tr>
<tr>
<td>Transmission line</td>
<td>112</td>
<td>2037</td>
<td>279</td>
<td>1660</td>
<td>4,088</td>
<td></td>
</tr>
<tr>
<td>Primary network</td>
<td>84</td>
<td></td>
<td></td>
<td></td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>Secondary network</td>
<td>184</td>
<td>2932</td>
<td></td>
<td>69</td>
<td>3,185</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>57</td>
<td>81</td>
<td>14</td>
<td></td>
<td>152</td>
<td></td>
</tr>
<tr>
<td>Contractor’s overheads</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
<td>80</td>
<td></td>
</tr>
<tr>
<td><strong>Total Investment</strong></td>
<td>2,086</td>
<td>11,944</td>
<td>5,691</td>
<td>949</td>
<td>3,052</td>
<td>23,722</td>
</tr>
<tr>
<td>Investment per kW</td>
<td>29,800</td>
<td>16,452</td>
<td>27,100</td>
<td>15,817</td>
<td>10,900</td>
<td>17,624</td>
</tr>
<tr>
<td>Investment per kW (in US$)</td>
<td>8,765</td>
<td>4,839</td>
<td>7,971</td>
<td>4,652</td>
<td>3,206</td>
<td>5,184</td>
</tr>
<tr>
<td>Beneficiary households</td>
<td>266</td>
<td>1667</td>
<td>516</td>
<td>239</td>
<td>2,688</td>
<td></td>
</tr>
<tr>
<td>Power / household (W)</td>
<td>263</td>
<td>436</td>
<td>407</td>
<td>879</td>
<td>501</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Respective DEP Project Files, arrangement and calculations by the author.

**Note:** All monetary values are in thousands of Peruvian Soles (S/.), at December 2000 prices, unless otherwise indicated.

### 3.4 Costs of Operation and Maintenance

In principle, operating costs of MH plants are low, and this is precisely one of the main advantages of this technology versus thermal plants.

**Operating Costs**

This cost is mainly comprised of the payment of the ESPEL’s operating and administrative staff. Usually 3 employees are needed: an administrator who also bills clients and collects receipts, and two plant operators who work by shifts. This staff must be paid a representative local wage, of about S/. 300 per month for the administrator and S/. 250 per month for each of the plant operators. Total monthly costs would therefore reach about S/. 1,000, including stationery and cleaning materials, transport and sundries. This means that operating costs are fixed costs, whose value per household falls sharply as the number of households served increases.

**Routine and Periodic Maintenance**

It is necessary to distinguish between routine or *preventative maintenance* and periodic overhauls or *periodic maintenance*. The former is also a fixed cost, and its steps are described in the “Operation and Maintenance Manual” developed by ITDG. In this manual the appropriate times to check or change certain parts and components are indicated, as are the appropriate tools. Existing operating.
staff can carry out this type of maintenance as part of their activities, while the administrator can also order the required spares or travel to purchase them, in addition to billing clients and collecting payments from them. In sum, routine maintenance has a fixed staff cost which is included in the operating cost of approximately S/. 1,000 per month, but obviously does not include the cost of parts and components changed during this activity.

The other component is periodic maintenance, an activity not carried out every month but once a year: usually after the end of the rainy season. Periodic maintenance is not a fixed cost, since system deterioration due to the rains is as variable as the weather which causes it. However, it is also not a typical variable cost, i.e. one that varies as a function of a variable, say, energy production or the age of the plant. For simplicity we will assume that this cost has a fixed annual value.

**Maintenance Costs**

How can we best calculate the cost of the materials and parts in routine maintenance and the cost of periodic maintenance? One way to approach an answer to this question is to consider the operating life of a typical MH plant. From the technical and physical points of view, this life can reach up to 30 years. For the purposes of this book, we assume that the cost of the materials and parts in routine maintenance and the cost of periodic maintenance is equivalent, on average, to the linear depreciation of the MH plant over its operating life, which then results in a yearly cost equivalent to 3.33% of fixed investment. We further assume that 40% of this depreciation (equivalent to 1.33% of fixed investment) is reflected in the cost of the materials and parts in routine maintenance, while the remaining 60% (2% of fixed investment) reflects the cost of periodic maintenance.

**Post-investment Costs**

This cost is comprised of the cost of the ITDG technical staff that provides specific technical assistance to ESPELs and constantly monitors project development. The finance provided by IDB did not cover these costs, most of which was used in developing and adapting the technology. There is no information regarding the size of this cost item, so we assume that it is included in periodic maintenance costs, for the moment.

**Major Repairs**

Periodic maintenance should not be confused with major repair work, needed after severe damage to a MH plant after a landslide or flood. This cost item must therefore be regarded as an additional, contingent, fixed investment cost. The MPF has refinanced several loans to MH plants as a result of such events.

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59 Most MH plants do not have large dams that silt up, a problem which plagues large hydro systems having such dams. On the other hand, metal parts begin to exhibit brittleness after 30 years.
It must be stressed that ITDG, between 1992 and 1995, transferred appropriate technology for the construction of turbines and other parts to three industrial firms in Lima, Cuzco and Cajamarca, and in the case of the Lima company, the technology for the manufacture of electronic load regulating equipment was also transferred. Therefore, sufficient capacity to support MH maintenance and repairs exists in Perú. Periodic maintenance and repair services can therefore be requested by ESPELs: either directly or through ITDG to any of these firms; additionally to technical staff of other firms in Chiclayo and Cajamarca or the National Capital, Lima.
IV. FINANCING AND SUBSIDIES

4.1 Agreement between COFIDE and The Netherlands

Before we begin to analyse the system of loans offered by MPF it would be desirable to consider the experience of previous similar programmes. Of these, one of the most interesting, was the co-operation between the Ministry of Economy and Finance (MEF) through COFIDE, the State second-tier bank, and the Netherlands, in which the author of this document was involved as a promoter and consultant.  

Conditions of the Dutch donation

The Dutch government offered Peru the sum of US$ 5 million dollars to finance, thorough COFIDE, an effort to promote the use of renewable energies, including a line of credit called PROER that COFIDE was to channel through financial entities such as banks, rural and municipal savings banks and other financial institutions supervised by the Peruvian Superintendency of Banking and Insurance (SBS).

In the programme’s agreement Memo the following conditions were established:

a) Only renewable energy projects could be financed.

b) The beneficiary had to provide a 20% down payment.

c) The maximum limits for loans were:
   1) US$ 1.000 for households, 2) US$ 10.000 for micro and small-sized enterprises; and 3) up to US$100,000 for communities; exceptionally US$200,000.

d) The loans channelled through any financial institution could not exceed 30% of the total loans.

e) There was no specific regulation regarding loan repayment times nor interest rates. These would be fixed by each financial institution according to market conditions.

Some of the conditions stated above turned out to be inappropriate. In fact, some of the project’s problems were identified almost immediately and were reported to COFIDE by the promoters-consultants. However, it was not possible to change these conditions because there was only one evaluation meeting scheduled per year and one three-party (The Netherlands-MEF-COFIDE) meeting two years after the starting date of the project.

For example, if the cost of a basic 48 W peak PV module was US$1.200, the user had to come up with a down payment of 20% (US$240). The intention was undoubtedly to ensure the user’s commitment, but this was almost certain to be difficult for the targeted beneficiaries, mostly poor and rural, to comply with.

60 The other promoter was the Engineer Ricardo Giesecke Sara-Lafosse.
Competition between PROER and other credit lines

Another example was that PROER was competing at a disadvantage against MICROGLOBAL, another COFIDE credit line, which did not require any down payment and which had higher maximum limits (US$5,000) for family, small and informal enterprises. Prospective clients, as well as the financial institution itself, would logically choose this line of credit over PROER.

In spite of the fact that the funds originated in a Dutch grant, the agreement stipulated that no distortions to the credit market were going to be introduced by PROER. This meant that PROER was not to charge interest rates that were lower than those offered by other COFIDE credit lines. But the PROER promoters recommended that financial conditions that were visibly lower than other lines were necessary to promote PROER because the goods and services that were supposed to be financed by this line were not well known to the market; and moreover, such more favourable conditions would not distort the market. Finally, after much debate, in 01.10.96 COFIDE board meeting, the interest rate which PROER funds would be made available to financial institutions was fixed at TIPMEX\textsuperscript{61} + 2%, then equivalent to 8% per annum in US$. The banks would then fix interest rates and loan repayment times for users of the PROER funds at their discretion. At first the lowest interest rate offered was 12% per year and the longest repayment period was 5 years, including a grace period of one year.

The promoters recommended extending repayment times, especially for high investment cost infrastructure, such as mini hydro plants or solar water heating systems, but the financial institutions did not agree because they thought that longer periods increased credit risks. Although this might be true for industrial and commercial activities, where swift changes in market conditions or technology are common, it does not necessarily apply to goods with a more stable technology and market, as is the case with infrastructure in general, and renewable energy in particular. In this case, the extension of repayment periods may actually lessen credit risks because it lowers repayment instalments (see ahead).

Another line of credit that competed with PROER was FONAVI\textsuperscript{62}, specially in the MH market, offering interest rates of just 1.5% per month in soles and a 12 year repayment period: ideal for financing a MH plant. These loans were made possible under such soft conditions because FONAVI was not really a commercial credit line, because it was based on funds withheld from payrolls and because it did not require require borrowers to put up collateral. It also did not require the creation of independent, local, companies to meter consumption, bill clients and collect receipts, as well as manage maintenance. Hence FONAVI was not

\textsuperscript{61} TIPMEX = Tasa de Interés Pasiva Promedio en Moneda Extranjera, or average yearly interest rate paid to depositors in US$ savings accounts.

\textsuperscript{62} The Fondo Nacional de Vivienda (FONAVI) or National Housing Fund was established with financial support from individual worker’s salaries. This was done even though the Ministry of Housing and the Central Mortgage Bank were shut down during president Fujimori’s government. Government passed a bill that allowed it to use FONAVI to finance the construction of roads and general infrastructure.
sustainable: loan delinquency was rampant and, finally, in 1998 the Government wrote off all FONAVI loans for electoral reasons, before discontinuing the line.

Financial institutions and their legal and operational inflexibility

Another reason why PROER did not succeed was that few financial institutions were interested in promoting a credit line that was mainly destined for owners of small and medium sized agricultural businesses, i.e. ranging from 5 to 15 Ha. The cost of running this promotional campaign from the headquarters of these institutions was too high. For example, the decentralised branches of some financial institutions were not allowed to grant credit, even for small amounts such as US$1,000, without first consulting with the main branch.

Also, few farmers were willing to take out a mortgage on their whole property, since mortgages are not legally divisible, in order to acquire a PV system worth only a fraction the land’s value. The other alternative would have been to pawn the renewable energy equipment being purchased by the loan, but the repossession of this equipment by the bank, in case of default, can only be completed through a lawsuit – an always complicated, long and uncertain process in Perú – made even less attractive by the fact that the repossessed item would not always have a ready market value. Thus the PROER promoters suggested that the line be channelled thorough NGOs having low access costs to the potential beneficiaries as well as a solid institutional reputation, such as ITDG, CIPCA (Piura) and others. The selected NGOs could then promote joint guarantees from groups of beneficiaries or establish a guarantee fund with banks to back the loans made to individuals. Unfortunately COFIDE did not accept these recommendations, even though PROER was a pilot project financed by a grant, in which the degree to which credit can stimulate the market for renewables could have been tested.

PROER results

Despite the many identified obstacles, the efforts in promoting renewable energy resulted in modest sales: about 60 solar PV panels and a smaller number of solar heaters. But these were not achieved through PROER financing but through the direct financing by small provincial companies (Piura, Puno, Arequipa and Junin), run by lecturers at local universities and other entrepreneurs, who toured the nearby rural areas and installed renewable energy systems by informal hire-purchase, where the company maintained its ownership of these systems until payment was completed. This system was successful in having a low delinquency rate because the equipment doubled up as its own guarantee. It was also sustainable because the payment included maintenance.

This initial success, which was especially marked amongst Jaen and Chanchamayo coffee growers during 1996 and 1997, when international coffee prices soared, was halted in 1997 by the El Nino weather phenomenon. By 1999 the Peruvian government assured the programme’s demise by giving PV panels away. No credit line could possibly compete against that.
In conclusion, even though there were important achievements, the COFIDE-Netherlands programme was not successful because of its inappropriate design, which in turn was derived from theoretical and even ideological thinking rather than from pragmatic considerations.

4.2 MPF Credit: Rules and regulations

The MPF rules and regulations have a substantial problem: there is a lack of consistency between the maximum loan amount and repayment time and the object of the offered credit.

Initially, the maximum amount was just US$ 30,000; but this was raised to US$ 50,000. In both cases, the amounts were far below the average cost of the public service MH plants promoted by MPF (US$ 169,108, in Table 5).

MPF was conceived as a rotary fund with repayment periods of up to 5 years, which would have been suitable to finance machinery and equipment for industry or services: not for infrastructure projects, such as MH plants which have long construction and operating times, as we have seen earlier. The argument frequently heard in financial circles is that lengthening repayment times increases the project’s risk because technology or the market can change dramatically. Undoubtedly this may happen with machinery and industrial equipment and with consumers’ tastes; but not with MH plants, whose technology will probably not suffer radical changes. Moreover, nobody expects the appearance of a source of energy that would replace electricity any time soon.

There is also fear that because Mayors are elected for a period of 4 years, the incoming authority might decide not to recognize the debt his predecessor acquired for political reasons. And, as loan repayments need to be made with the municipality’s limited current income, new Mayors could also be tempted to default because of cash shortages, a situation that has already occurred (see summary files in Annex 2).

<table>
<thead>
<tr>
<th>Name of MH Plant</th>
<th>Repayment period, in months</th>
<th>Instalment, in US$/month</th>
<th>FCM in US$/month</th>
<th>Repayment as % of FCM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sto. Tomás II</td>
<td>36</td>
<td>1,656</td>
<td>12,105</td>
<td>13.68</td>
</tr>
<tr>
<td>El Progreso</td>
<td>12</td>
<td>1,331</td>
<td>10,211</td>
<td>13.04</td>
</tr>
<tr>
<td>Sondor</td>
<td>30</td>
<td>800</td>
<td>12,308</td>
<td>6.50</td>
</tr>
</tbody>
</table>

**N.B:** In Sondor, a low incidence is due to the monthly positive income of US$ 1,044 that is generated by electricity bills.
Table 11 illustrates cases where the incidence of repayments on current municipal incomes are about 13 -14%. The Sondor case is atypical because in this community almost 57% of the loan repayment has been charged to the electricity bills of consumers. The potential danger that a newly elected authority could be tempted to ignore the acquired debt in order to win votes, would be minimised, to the extent that the ESPEL has been effective in bringing the community to a consensus about the benefits of the company and of the need to fulfil payments to ensure sustainability.

Table 12 - Monthly Instalments for a Municipality for Various Interest Rates and Repayment Periods

<table>
<thead>
<tr>
<th>Loan ($)</th>
<th>169,168</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest Rate</td>
<td>0.50%</td>
</tr>
<tr>
<td>Period (months)</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>144</td>
</tr>
<tr>
<td></td>
<td>156</td>
</tr>
<tr>
<td></td>
<td>168</td>
</tr>
<tr>
<td></td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>192</td>
</tr>
<tr>
<td></td>
<td>204</td>
</tr>
<tr>
<td></td>
<td>216</td>
</tr>
<tr>
<td></td>
<td>228</td>
</tr>
<tr>
<td></td>
<td>240</td>
</tr>
</tbody>
</table>

Source: The amount of the loan was taken from the average total investment costs of MH plants in Table 3.

Table 13 - Six-monthly Instalment per Household, for Various Interest Rates and Repayment Periods

<table>
<thead>
<tr>
<th>Loan ($)</th>
<th>1,263</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest Rate</td>
<td>3.0%</td>
</tr>
<tr>
<td>Period (semesters)</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>40</td>
</tr>
</tbody>
</table>

Source: The loan amount was taken from the average investment per household, from Table 3.

High repayment instalments have also led to attention being centred on the possibility of reducing MPF interest rates. However, this perspective overlooks a key feature of finance: that repayment instalments are far more sensitive to the amount of time given to repay a debt than to the interest rate.

In order to illustrate this, Tables 12 and 13 show the calculation of instalments under two scenarios: 1) a Municipality takes out a loan to cover total investment cost of an average MH plant in equal monthly instalments, suitable to the
periodicity with which a municipality receives FCM funds from the Treasury; and 2) the beneficiaries commit themselves to repay this loan with equal six-monthly instalments, suitable to farmers and stockbreeders, who usually receive incomes twice a year during harvests and livestock sales.

In Table No. 13 we can see that when the repayment period is doubled from 10 to 20 half years, the instalment falls from US$149 to US$86 when the interest rate is 3% per six months, a 42% drop. On the other hand, lowering the six-monthly interest rate from 6% to 3% would only lower the instalment from US$173 to US$149 for a period of 10 half years, a drop of only 14% of the original instalment. Hence, a longer repayment period would place a lesser burden on municipal income and would reduce the temptation or need to repudiate MPF loans. Thus, an appropriate repayment period could prove financially sustainable.

Tables 12 and 13 showed average instalments for municipalities and families in case any of the two were to become debtors. However, we have to take into consideration that both municipalities and households have very different income levels. This is why the level of required subsidy (co-financing of the investment) is also different.

4.3 Other Possible Sources of External Financing

A financial intermediary

The possibility exists that ITDG could tap resources from international development institutions, such as the World Bank’s IFC and the corresponding IDB private-sector institution. In this way, ITDG would operate as a kind of second-tier bank, initially specialising in MH development and connected development projects. For this to work, a guarantee fund would have to be set up. In future, this possibility should be studied, and the conditions under which it would be feasible, identified. However, this subject goes beyond the scope of this study.

Financing through the Sale of Carbon Bonds

Although the small size of MH projects would make it difficult and costly to sell each project’s carbon bonds separately, the bundling of several projects in one region might make this sale possible.

Both possibilities will have to be addressed in detail in a future study, as this aspect also lies outside the scope of this report.

4.4 The Rural Electricity Fund (FONER)

This project is run and co-financed by the Ministry of Energy and Mines, the World Bank and the Global Environmental Fund (GEF). The project has two components: a) A GEF grant of US$10 million for I) studies regarding productive uses of electricity; II) technical assistance in the development of renewable energy
projects and III) a Financial Facility of up to US$5 million placed in trust with COFIDE; and
b) US$100 million to finance rural electrification projects on a minimum subsidy basis: 50% provided by the World Bank and 50% provided by the Government.

Component 1

1. The management is similar to that of the Carbon Fund, which would also be tapped. The idea is to finance MH plants smaller than 10MW and costing up to US$2 million during the construction period and the first year of operation (a total of 3 years).
2. After this period, the project’s promoter must undertake to obtain a conventional bank loan to substitute the GEF-financed loan and commit himself to repay the bank, under whatever financial conditions are agreed between the promotor and the bank.
3. The promoter can use part of the energy produced for his own productive activities, but the bulk is expected to satisfy local household and commercial demand: that is, for public service and not private production only.
4. The advantage of this bridge-type loan would be to ensure the construction and full functioning of the MH plant for a year and allow time for demand to develop and to establish the local administration of the company.
5. However, a longer repayment period than that which a bank would normally grant is not considered. This period normally spans only up to about 5 years or maybe 8 years if dealing with an investment bank. Likewise, the promoter will have to come up with a solid collateral if the bank is to grant the loan. Apparently the World Bank staff that participated in the preparation of this project did not think that there is a way of shortening the gap between the working life of a MH plant and the period of private financing63.
6. The problems with this approach has already been encountered in the previous PROER project, as commented above.

Component 2

1. This subsidy component does not work like FITEL64, where businessmen compete to operate a pre-established concession area on a least subsidy basis.
2. In this Project, existing (or future) distribution and concession-holding companies or private promoters are asked to identify and evaluate the projects. Each year (or any other set period), they must create a portfolio of projects that have been adequately assessed at the technical, economical and financial levels.

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63 In financial circles there is the fear that a long repayment period will mean a high delinquency rate and that the Government would end up covering this debt like it did in previous cases (e.g. FONAVI’s MCH loans through PRONAMACHCS ). However, as discussed earlier, there are mechanisms for reducing this risk.
64 FITEL = Fondo para la Inversión en Telecomunicaciones, a State Fund to subsidise the installation of rural or otherwise less economic communication systems. This Fund is fed by a percentage of gross sales of existing telecommunications companies in Perú.

By: DONALD TARNAWIECKI
3. The projects in each portfolio are ranked in reverse order to the amount of subsidy that would need to be covered from Project funds. Subsidies are intended to cover investment only, not O&M costs. If operating subsidies should be required, recourse to the existing Government FOSE cross-subsidy mechanism can be made (see Section 1.4).

4. In each case the beneficiary must provide at least 20% of total investment, and this amount must be recovered through the established electricity tariff, including a 12% rate of return.

5. Any businessman or promoter can also develop a project and submit it to an existing distribution company or apply for a new distribution concession, before applying for an investment subsidy through the Project.

6. The money will be granted through a financial institution and not through the DEP.

Periods and timetables

The project is still in its formulation phase. Changes in the design may still occur. The Bank’s Board of Directors may approve the loan in November 2005, at the earliest, although it will probably have to wait until early 2006. Actual disbursements would not be forthcoming much before the middle of 2006 so that, in practice, the Project will be started by the next Government.

4.5 Self-financing possibilities

In the previous Chapter we analysed investment, operating and maintenance costs. In previous sections, we looked into the external financing of investment costs. In this section we look into the possibility of financing operating and maintenance costs by charging an adequate power tariff.

Evidently this option will depend on the population’s willingness to pay, which in turn depends on its income level and on how highly they value electricity, among other factors. We adopt the simplifying assumption that this willingness to pay is related to the average expenditure on traditional energy forms, weighted according to the proportions of the three socio-economic levels of Table 1. Table 14 shows this weighted average.

<table>
<thead>
<tr>
<th>Household (HH) characteristics</th>
<th>% HH</th>
<th>S/./month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below subsistence</td>
<td>69</td>
<td>13.25</td>
</tr>
<tr>
<td>Self-sufficiency</td>
<td>23</td>
<td>21.76</td>
</tr>
<tr>
<td>Surplus</td>
<td>7</td>
<td>23.11</td>
</tr>
<tr>
<td>Weighted average expenditure</td>
<td></td>
<td>15.77</td>
</tr>
</tbody>
</table>

The weighted average monthly traditional energy expenditure shown in Table 14 is equal to S/. 15.77 a month.
On the premise that this population is willing to pay the same monthly amount to have access to electricity, we can determine the potential this community has for self-financing the operational and maintenance costs through power tariffs. Table 15 shows how these costs would be met by setting a succession of higher tariffs for an MH plant that serves an average sized population, that is to say of 134 families (refer to Table 6).

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Costs in US$</th>
<th>% fixed investment</th>
<th>Monthly payment in S/.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only Running costs (O)</td>
<td>2.26</td>
<td>0</td>
<td>7.47</td>
</tr>
<tr>
<td>Routine Maintenance (MR)</td>
<td>1.41</td>
<td>1.33333</td>
<td>4.64</td>
</tr>
<tr>
<td>Periodic Maintenance (MP)</td>
<td>2.11</td>
<td>2</td>
<td>6.97</td>
</tr>
<tr>
<td>O+MR</td>
<td>3.67</td>
<td></td>
<td>12.11</td>
</tr>
<tr>
<td>O+MR+MP</td>
<td>5.78</td>
<td></td>
<td>19.08</td>
</tr>
</tbody>
</table>

The layers of coverage for the resulting costs are as follows:
1) Only operating costs. In this case the average monthly payment needed is S/. 7.47.
2) Operating and routine maintenance (O+MR). The average monthly payment needed is S/.12.11 soles.
3) Total running and maintenance (routine and periodical), that is O+MR+MP. The average monthly payment needed is S/.19.08 soles.

Note that these calculations only consider household willingness to pay. However, it seems reasonable to suppose that small businesses would have a higher willingness to pay: one, whose upper bound would be the cost of electricity from a diesel generator. Indeed, many of these businesses are only feasible by having access to the low-cost energy of a MH plant.

Hence, while households in an average community would cover all running and routine maintenance costs, but not all periodic maintenance costs, the consideration of businesses’ willingness to pay might ensure full O&M cost coverage. However, this would still not solve the problem of the smaller-than-average communities.
Importance of the size of the MH and beneficiary population.

Recalling Section 3.3, where investment per installed kW and per household was found to decrease with the size of the MH plant. Let us consider the importance of these trends for self-financing.

The cost of running the plant is fixed and independent of plant size, costing an estimated S/ 1.000 per month. So, the bigger the population, the lower the monthly cost needed to finance this layer of costs. The same can be said about the financing of maintenance costs: to the extent that these are a percentage of fixed investment, the larger the size of the community, the lower the investment per household and, therefore, the lower the monthly maintenance cost, thus tending to facilitate self-financing and reducing the need to cover deficits with subsidies.

Implications of the MH Micro enterprise Model self-financing tariff system

We consider two examples of Local Power Enterprises (LPE) operating under the MH Micro enterprise Model: Tamborapa Town and Conchan, based on information of March 2005\textsuperscript{65} that is not systematic nor complete. In the first case, the average income is known, but not the tariffs; in the second case, the opposite occurs. We compare these cases regarding the potential for self-financing of running and maintenance costs.

Tamborapa Pueblo

- The town of Tamborapa is part of the Jaen-San Ignacio corridor. It is near the road to Chiclayo, about 12 hours away from this city, including 6 hours on a dirt road. It is an important link to other communities in the same corridor.
- The population’s average monthly income considering the 3 social and economic categories in Table 1 are: S/.498 (below subsistence), S/.1.096 (self-sufficiency) and S/.1.531 (surplus)\textsuperscript{66}. These incomes are more than double those shown in our sample.
- The MH plant was built with donations by FONCODES and the NGO FRONTIER. The Municipal Council guaranteed the MPF loan, used to purchase the power regulator and meters for the 178 registered users\textsuperscript{67}.
- There is an ESPEL (or Local Power Enterprise). Without meters the tariffs were S/.10, 15 or 25 per month per family. Now, with meters, most pay as little as S/. 6 but those who paid S/.10 now pay S/.15. It is not known whether these payments include street lighting.
- Paradoxically the lowest electricity bills are lower than the expenditure on traditional energies by the lowest socio-economic category shown in Table 1, even though income levels were more than double our sample’s average.

\textsuperscript{65} Calderon (2005), p.9
\textsuperscript{66} Index cards No. 1, 2, and 3 from “Socio-economic diagnosis of the Jaen Caserio Juntas. ITDG without date.
\textsuperscript{67} According to Davila (2002) there were 105 beneficiaries, according to Calderon (2005) they are 140 in p.7 and 178 in p.9
• There are 20 clients whose payments are in arrears (more than 10% of the beneficiaries). Electricity is disconnected after the second month without payment and S/. 10 is charged for reconnection of service. The high index of arrears payments may be due to the fact that part of the population travels from January to March of each year, and are therefore not consuming electricity during this period. This seasonal aspect could help explain our paradox.
• Average monthly receipts from tariffs are about S/. 1.800, of which S/. 750 is used to pay for the operator and manager, S/. 250 for maintenance costs and S/.20 in taxes\textsuperscript{68}. The balance is then deposited in a bank account in Jaen to cover repair and replacement of equipment. By March 2005 savings were of S/.13.000.
• The MH plant is running at full load, with restrictions during peak hours. Many 100 W light-bulbs have been installed, hence ITDG is advising the population on energy saving. At present there is no spare capacity to serve villagers living in the surrounding hillsides.
• In conclusion, the ESPEL's receipts allow it to cover operating but, despite the bank savings, maybe not all maintenance costs. It may be that the percentage of households paying only S/. 6 per month is too high to ensure the financial sustainability of this ESPEL in the long run.

Conchán

Of all the MH projects promoted by ITDG\textsuperscript{69}, this is probably the most successful, from the point of view of the social and financial sustainability. The MH is owned by the Municipality, but the ESPEL is a private company that gets a fixed payment for its services from the Municipality of S/. 1.000 a month, plus 20% of total receipts from users, provided the debtor index does not exceed 6%. On average, current monthly receipts are S/. 2.700, and staff costs are S/. 1.100 \textsuperscript{70} plus other running and maintenance costs. The balance is deposited in a bank account that by March 2005 had S/. 7.000 in savings.

Tariff structure in Conchán

There are three different progressively lower tariffs for increasing consumption blocks. The numbers shown refer to July 2001 prices, when S/.3,45 = US$ 1,00:

\textit{Block I}: S/. 0,54 / KWh (US $0,15), up to 20 kWh a month. This is planned for the 60 - 70% of the population whose end-use equipment is limited to two or three lights, a black and white TV and a small radio that represent a joint consumption of up to 20 kWh a month.

\textsuperscript{68} Despite being a small rural company, the fact that it is formal legally obliges it to declare incomes monthly and pay a minimum 2% retention towards annual income tax.
\textsuperscript{69} Sanchez (2004), pp 33-37
\textsuperscript{70} MH Operator S/. 400, Manager s/.370 and an Operations Assistant S/.330.
Block II: S/. 0,12 / kWh (US $0,03), for consumption higher than 20 and up to 60 kWh / month. This applies to household, commercial and small service end uses such as a refrigerator, Colour TV, video or DVD, sound system and lights. This Block is set for consumption higher than 20 and up to 60 kWh / month, and its tariff is lower than in Block I to stimulate investment in commercial activities and small services.

Block III: S/.0,02 / kWh (US$ 0,006), for consumption levels higher than 60 kWh / month. A significantly lower tariff than in the previous Block is set to stimulate the development of productive activities, such as the transformation of raw materials or services that require more power, such as welding.

In addition to these tariffs, the possibility of charging a fixed monthly fee for the right of access to the service is mentioned. This fee would equal the average cost of the first 8 -10 kWh delivered, that are evidently the ones with the highest marginal cost. However, there is no mention that this fee was actually charged. A S/. 98,32 connection fee for new clients, a monthly charge of S/. 1,00 for public lighting and a S/.2,00 reconnection fee, whenever a client is disconnected for lack of payment, were also mentioned; as well as a 2% monthly penalty on all outstanding debts71.

Tariffs and willingness to pay

In Conchán, 60% of users pay an average of S/. 9,66 a month, equal to an average consumption of 16 kWh / month: 35 % less than the fixed rate of S/.15 previously charged by the Municipality, which, however, cannot be related to consumption because of the former lack of meters. It is also noteworthy that this average payment is significantly lower than the average amount spent by the poorest families in traditional energies, according to Table 1. However, the significance of this is not clear, as we do not have income data for Conchán.

On the other hand, the relationship between the consumption block a particular consumer belongs to and his income level is not necessarily direct: for example, the population in Block I are not necessarily the poorest in the community. They might even be relatively wealthy, but work intensively away from their homes72. This situation might contribute to a higher willingness to pay by many families than what is shown in Table 14, a fact that does not seem to have been taken into consideration by the ESPEL.

Possibilities of the tariff block system

Note the strong lowering of the tariffs from the first to the third Block: the second Block pays only 22% of Block I tariff, and Block III, as little as 4% of the same tariff. This strongly decreasing progression is intended to encourage the establishment of commercial, productive and service businesses, thus increasing

71Sanchez et al. (2004), p.36. The exchange rate in July 2001 was S/.3.45.
72Sanchez et al. (2004), p.16.
the load factor of the MH plant: be it by residents’ investment or by migration of businesses from other towns. This increase tends to make the MH plant more sustainable.

There is no existing study relating these tariffs to marginal generation costs of either diesel engines or MH, that would allow us to analyse whether tariffs as low as those of Blocks II and III are really necessary.

On the one hand, it seems likely that these marginal costs are higher than the tariffs in Blocks II and III, which would imply that an excessive incentive is being given to production. Besides, the cost of electricity is not always the main production cost, so the same promotional effect could be achieved with higher Block II and III tariffs: maybe even above marginal generation costs of MH (but obviously significantly below that of diesel). On the other hand, it is likely that the willingness to pay, especially by the wealthier families, may also be higher than the tariffs in any of the three Blocks.

These considerations suggest that it would be worthwhile for future tariff schemes (it would be difficult to change the scheme in Conchán) to explore the possibility of charging a higher tariff in the three Blocks than those charged in Conchán, and thus achieve a degree of self-financing that allows full coverage of running and maintenance costs.

Cross Subsidies

There may also be some scope for adopting a policy of cross subsidies, where higher Block II and III tariffs allow a reduction in Block I tariffs. Productive activities could still be encouraged by setting decreasing block tariffs, but in a less pronounced way than they are now. However, the scope for doing so would be limited since a high percentage of users (approximately 70% in Conchán) are limited to Block I, only 25% reach Block II and only 5% reach Block III.

If, for reasons of financial sustainability, it were not possible to apply this cross subsidy scheme, then setting higher tariffs for the two last two consumption blocks would at least generate more profit.

In conclusion, there is no doubt that Conchán’s tariff system is socially and economically superior to the previous scheme, even though current average monthly bills are lower than during previous Municipal administration. In addition, the debt index is lower (5% compared to 25% with the MC) and the number of users is greater (from 120 to 140), which has increased monthly income significantly, from a maximum of S/. 1,800 to an average of S/. 2,700 at present.

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73Sanchez et al. (2004), p.38 refers to the case of an ice and ice-cream maker that transferred his business from Tacabamba to Conchan because of better tariffs.
74 Refer to p.43 about Chugur where a decreasing order of tariffs is applied but less pronounced than in Conchan.
75 No exact figures are available as to how much the Municipality collected previously, but the highest amount, not frequently met, was of S/.15 times 120 = 1,800 soles.
National Tariff Regulation Framework

In this section tariffs in Conchán are compared to the official, regulated, tariffs. Table 16 shows the current pertinent Residential BT5B tariff\textsuperscript{76}.

**Table 16 – Residential Tariff BT5B, valid as of June 4, 2005**

<table>
<thead>
<tr>
<th>Consumption, in kWh / month</th>
<th>Fixed Monthly charge, in S/. (Soles)</th>
<th>Variable Charge, Active Energy in ctv.S/. / kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 50</td>
<td>1,88</td>
<td>22,56</td>
</tr>
<tr>
<td>51 – 100</td>
<td>1,88 plus 6,77 for active energy for the first 50 kWh/month</td>
<td>45,12 (For more than 50 kWh/month)</td>
</tr>
<tr>
<td>More than 100 kWh/month</td>
<td>100</td>
<td>45,12</td>
</tr>
</tbody>
</table>

Source: OSINERG

The official tariff structure is also based on consumption Blocks but it differs from ITDG’s micor-enterprise model in that the tariff increased as consumption increases. Also, the definition of the various blocks differs from those in the ITDG model.

Finally, it is important to highlight that the official tariffs are lower that the ones applied by ESPEL and promoted by ITDG. For example, the average consumption by 60% of the users in Conchán (16 kWh / month) paid S/. 0,60 pero kWh, including the fixed payment for street lights. With the BT5B tariff the average payment , for an equal consumption, would have been S/.0.34 soles, just over 50% of the current tariff. One reason for this situation is that ITDG systems are smaller, and so higher cost, than those of the so-called “economically adapted” systems used to calculate regulated tariffs\textsuperscript{77}. This explains why OSINERG inspectors have reported no less than 21 violations regarding ITDG’s tariff system. This situation could complicate the future of ESPEL promoted by ITDG.

The financial sustainability of these businesses could also be affected, specially those serving smaller villages, whose costs are relatively higher. The tariff subsidies that could be obtained from the Social Electricity Compensation Fund (FOSE) require concessionnaires to comply with official rules, including tariff and technical specifications.

**Table 17** illustrates the subsidy levels that can be reached and shows FOSE’s current scale of tariff subsidies.

\textsuperscript{76}Tariff regulated by the Office of energy investment supervision or OSINERG for homes with a simple energy meter type 1E.

\textsuperscript{77}This refers to the optimum efficient system with a calculated cost that serves as reference for fixing tariffs
Table 17 - Current Tariff Reduction Factors, with respect to Energy Charges, with the FOSE (Fondo de Compensación Social Eléctrica).

<table>
<thead>
<tr>
<th>Users</th>
<th>Sector</th>
<th>For consumption of up to 30 kWh / month</th>
<th>For consumption from 30 to 100 kWh / month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interconnected System</td>
<td>Urban</td>
<td>25%</td>
<td>7,5%</td>
</tr>
<tr>
<td>Interconnected System</td>
<td>Urban-rural y rural</td>
<td>50%</td>
<td>15 %</td>
</tr>
<tr>
<td>Isolated Systems</td>
<td>Urban</td>
<td>50%</td>
<td>15%</td>
</tr>
<tr>
<td>Isolated Systems</td>
<td>Urban-rural y rural</td>
<td>62,5%</td>
<td>18,75%</td>
</tr>
</tbody>
</table>

**Source**: Law 28307 dated 28.07.04

An important consequence of FOSE, relevant to the present study’s main subject, is that household consumption of isolated urban-rural and rural systems has the right to an important tariff subsidy, granted by FOSE. Although it is likely that the procedures to have access to this benefit are not simple, it should be possible for ESPELs to achieve it with the advice and backing of ITDG.
V. IMPACT OF ITDG’s MPF PROGRAMME

5.1 Methodology of Sustainable Living Means

In order to study the socio-economic impact of ITDG’s MH programme we will use the Methodology of Sustainable Living Means proposed by the United Kingdom’s DFID. First we outline the traditional impact evaluation methodology.

Traditional approach

In order to measure the socio-economic impact of an MH project, the traditional approach establishes a direct link between electrification and rural development, according to which electrification brings about an increase in production levels, lowers emigration and creates new jobs. It can therefore be said that ITDG’s project promotion methodology had, until recently, this approach in mind.

However, the MH – economic development link is not a one-to-one relationship: even if new technology can bring about important changes in the production system and in social organisation, this economic and social structure defines the framework in which electricity may have certain impacts. Because of this, the results of an electrification project depend as much on the project itself as of the characteristics of the social system. In other words, the “project” should consider the characteristics of the social system in the area where it will work and have an impact.

Methodology of Sustainable Living Means

This methodology, used to assess the socio-economic impact of a development project, integrates the following analytical aspects:

- **Social**: This refers to the different needs and the different degrees of access to power mechanisms by families and gender, age and other kinds of social groups; also, to the different degrees of access to organisations and social participation. On the other hand it refers to social capital, a concept DFID associates to trust and reciprocity: the existing degree of trust among members of a population that reduces potential conflicts; together with civic behaviour that enhances common welfare: for example, the capacity to associate and collaborate, to form connections, to reach consensus and synergies. Therefore, this methodology must consider the strengths and creativeness of individuals and groups within the community as much as its needs.

- **Economic**: Measures the impact on income generation and the improvement of family budgets that have resulted from individuals’ strengths and creativeness. In turn, these components depend on the technical and educational capital possessed by each individual, on the location of their households within the micro-regional space; and also of this micro-region relative to surrounding regions and to the national economy. In this sense, the MH plant may generate an economic rent for some families, which can be seen by how these families value their assets.

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Calderón (2005), pp 4 - 6

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• **Institutional**: Analyses how structures work and the local impact of policies. Specifically, it analyses the government’s role regarding justice in its use of political power, the efficiency of social service providers and the honesty, efficiency and accessibility of government structures, specifically those of local authorities. It also assesses whether the responsibilities that come with granting a service are shared in a reasonable way within the Government structure, and between Government and the private sector.

• **Environmental**: It assesses the effect living means strategies has on the environment, considering both health as well as pollution issues; and the impact environmental factors have on living means and poverty.

**Practical Difficulties**

Evaluating the social impact of a MH plant, but not of other factors, presents a few practical difficulties because a comparison must be made between the current situation with MH and the one previous to the installation of the plant, which implies that a “control scenario” must be defined.

During March and April of this year, a study was undertaken on the social and economic impact of the MPF Programme in eight communities. Not enough prior information existed, nor was there time enough to collect it, to construct this scenario. As a result, the following tools were used:

- **Summary files**: One was prepared for each community, detailing the social impact of the Project.
- **Household Surveys**: To obtain information about the social impact at family and household level.
- **Partly-structured interviews**: Key informants were interviewed, such as ITDG local staff, Mayors, MH operators and community or social leaders.

**5.2 The Impact of Productive Uses of Electricity**

The impact of productive uses of electricity must be analysed in two areas: firstly, in communities where investment has been encouraged by the building of MH plant and secondly, when the MH project belongs to a private businessman.

**Impact on Communities**

Table 18 shows the impact that MH plants have on incomes, as perceived and declared by the population in these eight communities. The time between the year of plant commission (in brackets in column 1 of the Chart) and the present is of the order of 5 to 10 years, which can be considered time enough for the impact of the plant on incomes to materialise.

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79 Calderón (2005), pp15 and 16
80 Arestegui’s study: “The Impact of the MH Project Promotion Fund” (1998) and the socio-economic diagnosis applied in the communities between 1996-98 were not baseline studies, nor did they consider the sustainable living means methodology.
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The main conclusion in this Table is that 60% of the population believe that their incomes have increased after the commissioning of the MH plant: of which, 66% believe their incomes have increased by up to a third, while the remaining 34% believe their incomes have grown by more than a third. The weighted average of this increase in incomes is therefore higher than 33% for the 8 communities.

The second interesting conclusion of Table 18 concerns the main reasons the population give for the increase in their income, after the MH plant was built, which were:

a) It has allowed them to set up a business (60%)
b) The production and sales of existing activities has increased (26%)
c) The supply of jobs has grown (6%).

These numbers suggest the following:
1) New businesses are family owned (self-employment)
2) Not a lot of new jobs are generated; and
3) An increase in the production of traditional activities must have taken place, specially in small businesses and pre-existing services for which electricity is crucial. If this were not the case, an increase in income, production and sales would not have taken place.

In Table 19 we see that, in the surveyed communities, the number of new businesses is 216. This information and the fact that not many new jobs are created leads us to conclude that most businesses are family owned and run: a considerable number for a sample population of 990. This means that more than 20% of families set up new businesses: mainly grocery shops (25% of the total number of new businesses), bars, fruit shops and others (22%), restaurants (11%), battery charging (8%) and bakeries (7%). The towns with the most new businesses were: Tamborapa Pueblo (32%), Incahuasi (15%), Conchán (13%) and Chugur (12%). Of these the most important is the first, mainly due to its location in an area that serves as an economic link for neighbouring areas and is close to the Peru-Ecuador border.
These preliminary conclusions suggest that electrification and rural development are linked to each other to a degree; and that this is demonstrated by the opening of new businesses and the increase in production of existing productive activities, although not many new jobs are created. It is also worthwhile to note that the 40% of persons surveyed who felt that their incomes have not increased with the MH plants nevertheless believe that the local economy is doing better.

This conclusion must be read with caution, however, because the evaluation of the economic impact of MHs, and its differentiation of the possible impact of other factors, presents methodological difficulties. This is because a comparison would have to be made between the current situation and the situation before the installation of the MH plant so as to define a “control scenario” for which we do not have the required information. For example, it is possible that part of the increase in income is due to the macroeconomic growth of the whole country from 2002 on, or due to the location of some of these communities near the border with Ecuador, at a time that bilateral trade has improved after the peace treaty signed during the mid-90’s. All in all, it seems likely that the magnitude in income growth reported by the study is greater than what would have been the case solely as a result of macro-economic “trickle-downs” or other external effects.

In any case, these new businesses and the improvement of existing ones seems to have occurred spontaneously, 5 to 10 years after the construction of a MH plant. It is difficult to think that these businesses emerged mainly as the result of ITDG’s promotion of productive activities because the manuals for new businesses developed by this institution only started to be used from 2003 in its small business training activities.

Another conclusion suggested by Table 17 is that this impact only took place once. The activities shown in Table 19 are mostly to serve the small local market,
which quickly becomes saturated. To generate steady economic growth, activities serving regional and national markets would have to be encouraged.

A final aspect of the Calderón Report is analysed. The Report, source of the information analysed in this chapter, states that despite the positive impact of MH plants, there has basically been no reduction in emigration rates for work or education reasons. Because of the probable link between a community’s wealth and its propensity to undertake seasonal migrations, the continuing migrations show that there is no direct and immediate relationship between electrification and overcoming poverty. However, this conclusion does not appear to be warranted, given the other data drawn from the same Report. What may be happening is that the new businesses can be handled by a part of the owners’ families, while other family members continue to seek work and educational opportunities outside the community. Hence, the fact that migrations have not diminished need not imply that there was no economic growth induced by the MH projects.

The information given above refers to MH projects headed by the municipality or town council. While ITDG has also been involved in projects promoted by private businesses, the information on the economic impact of these activities is not available.

5.3 Social Impact

The available information does not allow us to assess the quality or quantity of the social impact of the MPF Programme. However, we submit preliminary evidence that this impact has been significant, but that it has depended on the degree of development of the social network at the time the MH plant was installed and, in particular, on whether an ESPEL was organised or not. These two variables are mentioned even though they are not independent: undoubtedly a solid social network aids the development of an ESPEL.

But first, we define the concept of social impact.

Social Capital

First of all, a project’s social impact should include an increase in the social capital of the community. This increase manifests itself in:

- Better access and participation by individuals in local organisations, considering the different needs of families, gender-based, age-based and other social groups; and of their access to power mechanisms.
- The development of degrees of associativity and the ability of individuals to collaborate with each other towards the common good based on needs; and also the strengths and creativeness of individuals and groups in the community to form networks, reach consensus and create synergies.
- An increase in the degree of trust and a reduction in conflicts between individuals and groups in the community.
- The punctual payment of public service bills, such as ESPEL tariffs.
Institutional Impact

Another important social impact linked with social capital refers to the working of institutions and the local impact of their policies. This implies improvements in:

- The working of general government functions, the operation of justice, the management of political power, the efficiency of social suppliers and the honesty, efficiency and accessibility of Government.
- The working of Local Government, with regards to the same issues as above.
- The sharing of service management responsibilities within Government and between the State and the private sector.

The social impact study of MCHs classifies communities according to the degree of development of their social structure:

1) **Developed social structure**: For example in Huarango there is a Rice Grower’s Committee, a Livestock Committee, an Irrigation Committee, School Parents’ Associations, subsidised public restaurants, a “glass of milk” Committee, a Mothers’ Association and a Sanitation Services Committee. In a similar way, Conchán has a Neighbour’s Association, 3 School Parents’ Associations, 1 “glass of milk” Committee, 1 Mother’s Association and 1 Service and Repairs Council.

2) **Intermediate social structure**: In Tamborapa Pueblo, for example, there is The Association of Producers of the Tabaconas Valley (APROVAT) that has 158 members that take care of selecting and processing coffee; a Livestock Committee, a “glass of milk” (Vaso de Leche) Committee and a Mother’s Association. In Incahuasi, there are 5 School Parents’ Associations, 1 Vaso de Leche Committee, 1 Mother’s Association, 1 Neighbour Association, 1 Weaver’s Association and 1 Producer’s Committee linked to soil preservation backed by PRONAMACHCS, INIA and the international NGO, Solidaridad.

3) **Weak social structure**: Churgur, Chetila, Chalan and Las Juntas are part of this category. All of them have only one or two organisations, in most cases related to the distribution of food donated by the State.

Two comments regarding this classification seem to be in order: the first is that although the number of social organisations in a community may be an indicator of its social cohesiveness, this is not necessarily true: we only have to take a look at the large number of ministries and other bodies of the Peruvian State to see how this does not ensure a high degree of organisation and capability. So it is possible that a community with fewer social and production organisations could have a more developed social structure than another community with more organisations. Thus, in order to establish the real degree of social structure development, a deeper analysis is needed: one that combines the qualitative and quantitative aspects of social organisation and functioning.

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81 Calderón (2005), p.23
82 National Agricultural Research Institute, a dependency of the Ministry of Agriculture.
Secondly, the Social Impact Study’s statement that the level of associativity, part of social capital, are low and remain much the same as before the appearance of the MH plants seems questionable because, at least in the case of Conchán, the establishment and apparently sustainable operation of its ESPEL has almost certainly strengthened the social capital of this locality.

We therefore put forth the hypothesis that the process of planning, executing and running a MH plant in an open, transparent and participatory way, with the permanent assistance of ITDG in all project phases, opens a unique opportunity for the strengthening of social capital in towns where such plants have been established.

For this to work it is necessary to consider the economic and social situation from the beginning of the process: for example, if trust has been lost between the community and the municipal authority, due to the political use of the MH plant by the Mayor and the low efficiency of the municipality when it was in charge of managing the plant. ITDG can assist in the social processing of this experience and, little by little, a consensus on the need to establish an ESPEL might emerge.

Evidently, special care should be taken in matching the presentation of this advice to the population’s real economic potential. In poorer areas, the seeking of subsidised tariffs through FOSE or other mechanisms must be sought.

Despite their ambivalence towards paying a reasonable tariff for electricity, in most cases villagers will pay these tariffs if these are within their means and they perceive quality, reliability and transparency in the service they receive. Local critics may feel that the ESPEL entrepreneurs have unfairly received their concession contract, but at least they are criticizing a business that is owned by the Community and is supervised by the Community Assembly. This very supervision can aid in the strengthening of local social capital, provided this function does not get politicized.

By: DONALD TARNAWIECKI
VI. STRATEGIES FOR THE PROJECT’S SUSTAINABILITY

Today Perú has two basic approaches to rural electrification: FONER and the MPF. The traditional approach run by DEP/MEM is neither efficient nor effective and will surely be discontinued in the short term.

FONER’s main objective is to achieve economic efficiency. Its core assumption is that rural electrification projects are not financially and, perhaps, economically, profitable. Therefore, it calls for project promoters who can finance at least 20% of the total investment cost, in exchange for receiving a subsidy to cover the balance. This approach demands that the tariffs that the final users pay will cover 100% of running and maintenance costs and allow the promoter-investor to recover his investment plus the rate of return allowed by law in electricity concessions, currently 12%. Otherwise, it is reasoned, there would be little an incentive to provide the 20% of investment costs in the first place. This programme prioritises projects that require the least possible subsidy but will not finance any that does not comply with the above mentioned requirements. In other words, it is a programme which is oriented towards generating and developing a market for rural electrification without specifically emphasising renewable energy: MH plants qualify as much as extensions of the existing national energy grid. Judging by the cost analysis of Chapters III and IV clearly larger projects than the ones promoted so far by ITDG would have an advantage because of economies of scale.

The ITDG model was different: its core objective was to develop a specific MH technology, and to replicate the largest possible number of cases where this can be done in a sustainable way. However, to achieve this, the programme does not seek to offer special incentives to private investors, but rather to seek political backing from local or regional government. This is necessary to guarantee access to public resources and guarantee the repayment of MPF credits, because the availability of this credit will encourage the use of other resources. This political backing is also important to bring about the management of an independent ESPEL but with the local consensus on the need to guarantee the payment of tariffs that cover at least routine running and maintenance costs. Without this it would be hard to guarantee the sustainability of the projects.

However, ITDG faces another specific problem: for populations smaller than 100 - 120 families it would not be easy to guarantee that maintenance is covered by a tariff that is matched by the population’s willingness to pay. For smaller communities there is therefore a special need to develop: a) sufficient productive activities to share the fixed costs that cannot be met by the small population or b) an efficient operating subsidy mechanism.

Not withstanding this, the FONER and ITDG models could complement each other, because they could be sustainable and between them they could offer the possibility to give access to electricity and modern educational and living facilities leading to social inclusion to virtually all of Perú’s rural population.

By: DONALD TARNAWIECKI
The development of ITDG’s future strategy should consider the following points that have been developed in this report:

1) **Legal considerations.** Legal amendment proposals need to be co-ordinated with the Ministry of Energy and Mining and OSINERG, in order to guarantee that small isolated towns have access to power services. Current laws do not address rural electrification nor MH specifically. A mechanism that guarantees that municipalities will punctually repay their loans also needs to be put in place, specifically when the credits originate in businesses or institutions that are independent from the State.

2) **Project Selection.** Prepare a list of possible projects with the aid of existing distribution concessionaires that have abundant information about the areas they work in.

3) **Promotion.** These activities should consider the Sustainable Living Means methodology.

4) **Preliminary Study.** List communities and their population. Obtain information on income levels, water resources, production potential and the amount of **social capital**. Prioritise those with sufficiently high incomes and willingness to pay, so that at least operation and routine maintenance costs of MH plants are covered. In these communities, it would be and advantage to start the process of social promotion of MH and the ESPEL at the same time as the execution of the preliminary socio-economic study. In the case of smaller and poorer localities, where it is not possible to guarantee running and maintenance costs with the set tariff, a mechanism should be established to ensure that existing FOSE subsidies reach these towns.

5) **Financing investment.** The funds coming from the regional and local governments and the MPF should be confirmed to ensure that the entire MH investment package is assembled, including pre-investment costs, working capital and fixed investment. The latter should ideally also include meters and household wiring and efficient lights. Repayment periods should be long enough to allow a low repayment installments: no higher than 6 or 7% of the municipality’s current income. In those communities that cannot cover periodic maintenance with their tariff, this cost should be included in the financing package for a long-enough time to allow the development of additional sources of income.

6) **Subsidies.** Contracts between the local ESPEL and existing formal electricity concessionaires must be developed to guarantee access to FOSE.

7) **Promoting productive usage.** Promote local production activities, specially those aimed at the regional and national markets; also, activities that use water resources jointly with power generation. The promotion of productive activities needs to be carried out as an integral part of the MH promotion process, starting from its initial stages, because of its importance in guaranteeing sustainability.

8) **MPF rules and regulations.** These need to be revised in several ways:
- Longer repayment periods, such that the burden of repayment instalments are a manageable percentage of municipal incomes,
- Interest rates should, however, follow market trends and conditions. However, to the extent that preinvestment and post-investment costs can be added to the package being financed, and the cost of loan recovery can be reduced
through specially tailored policies, the actual rates could be lower than prevailing bank rates.

- Loan packages should also include household metering and wiring and the purchase of efficient lights, as this would improve the economics of the MH project.
- Finally, this strategy should also consider including a clause to refinance the loans in case of considerable damage to the facilities caused by natural disasters.
ANNEX 1

BIBLIOGRAPHY


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By: DONALD TARNAWIECKI


ANNEX 2

SUMMARY MH PROJECT FILES

Summary files have been opened for a sample of 20 of the projects developed by ITDG\textsuperscript{83}.

The following abbreviations and conventions have been used:

1: The projects have been listed in order of their approval date.

2: The slanting text signals a problem.

3: Abbreviations:
OC= Public Works
EEM= Electro-mechanic equipment
PEF= Up and running
CASEP= Production and electrical service management committee
ESPEL= Local Public Service Electricity Enterprise
OyM= Running and Maintenance
CM= Municipal Council
ED= Definitive Study
M/o= labour
MB= Michel-Banki
PROMANACHS= River and soil preservation National administration programme

\textsuperscript{83} Based on Davila (2000), chapters VIII p. 33 and anex pp.37-48
1. Name of MH plant: CHALÁN

**Background.**
1) Development commits makes an artisan MCH, but *only light the main square or Plaza de Armas.*
2) Collects from non resident andean and buy a diesel machine, *but only gives light to 16 homes.*
3) Diaconía NGO contacts ITDG with the Mayor.
4) Mayor applies for credit.

**Approval.**
1) ITDG makes one profile and aproves the project on May 94.

**Investment and Financing (US$).**
1) \( I = 71.618; \ TIR = 12.6 \% \)
2) \( FPM = 19.218; \ Diaconía y otros^{84} = 52.400 \)

**Implementation.**
1) ITDG starts building in May 94: lays the foundations and builds EEM and networks and supervises changes to the existing OC and PEF.
2) The work was completed (30 kW)i in 10 months (March 95).

**Operation.**
1) ITDG organizes a CASEP and trains it in management, OyM and tariffs.
2) 3 tariffs are established: industrial, commercial and doméstic.
3) In the first year, ITDG subsidised the managers salary (S/. 250), and CM paid the two operators.
4) New municipal authority takes over management: changes personnel and subsidises 40% of running costs. *Lack of experience leads to the burning of the generator and CM has to pay for repairs.*

**Production Activities.**
1) A parabolic antena was installed to get retransmission of TV signals.
2) A radio-telephine was installed.
3) A dental centre was opened, a tool repair workshop and a welding workshop too. Before these were established the population of Chalán had to travel to Celendín to get these services.

**Current state.**
1) MCH is shut down since the first quarter of March 2005 due to problems with the vibration of the generator.
2) The debt was paid. There was a months delay due to the change of Mayor.

**Sustainability.**
Up to April 2002, the MCH was not sustainable because of CM’s bad management and a high subvention of costs. Now the MCH has shut down and the population awaits to be connected to the Red de Hidrandina.

---

84 Supesedly, although it is not stated explicitly, the population participated with non qualified labour.
2. Name of the MH plant: EL TINTE

**Background.**
1) ITDG built the pilot Atahualpa MCH (45 kWi).
2) General manager of a cooperative asks ITDG to built an MCH of 15 kWi.

**Approval.**
ITDG does the ED required by BID approves the project in June 94, construction began in January 95.

**Investment and Financing (US$).**
1) \( I = 42.531; \ TIR = 10.9 \% \)
2) \( FPM = 30.000 \ y \ others^{85} = 12.531 \)

**Implementation.**
1) The turbine is built on March 1st 95 and finished in June 96; for the second the date were July 2000 and June 2001.
2) *After 6 months of running MB turbine could not work over a potency of 8 of the 15 kW installed due to vibrations in the turbine. Deficient turbine design; and non qualified maker.*
3) *The Cooperative did not want to pay until the problem was solved.*
4) ITDG replaced the MB turbine for a Pelton one.

**Operation.**
1) Only 5 Kw is needed to run the milk cooler.
2) This cooperative is inspired in a religious belief that grants it great social cohesion.
3) *However, a specific organisation has not been set for the management of the MCH and the real costs are unknown.*

**Current Estate.**
1) Turbine 1: deficient.
2) Turbine 2: normal.
3) Debt has been paid off although with 6 month delay.

**Sustainability.**
If an independent business were to take over the OyM of the MCH, it would not be sustainable even though the debt was paid.

---

85 The population contributed with a non qualified work force.

*By: DONALD TARNAWIECKI*
3. Name of the MH plant: YUMAHUAL

<table>
<thead>
<tr>
<th><strong>Background.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) A businessman solicits credit from an ITDG.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Approval.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) ITDG assesses the project and grants credit in January 95.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Investment and Financing (US$).</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) I = 36.513; TIR = 26.8%</td>
</tr>
<tr>
<td>2) FPM = 30.000 and businessman = 6.513</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Implementation.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Work begun ITDG’s supervision on May 1995 and the 1st turbine is completed by May 96; the second turbine is begun in September 97 and completed by November 97.</td>
</tr>
<tr>
<td>2) Because of the uneveness of the ground obras de arte con canal en voladizo are needed.</td>
</tr>
<tr>
<td>3) The MB turbine only reached 5 of the expected 11 kWs. The contractor tried with another MB, but did not go over 7 kW. It was the same provider used by El Tinte.</td>
</tr>
<tr>
<td>4) The businessman decides not to pay the installments.</td>
</tr>
<tr>
<td>5) ITDG decided to replace the MB turbine with a Pelton one of 14 kW.</td>
</tr>
<tr>
<td>6) The charge regulator had to be repaired because rats destroyed the isolating material on February 98 and a rock damaged the pressure tube.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Operation.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) The demand is satisfied in the chicken raising incubator and sales to third parties.</td>
</tr>
<tr>
<td>2) The same businessman is in charge of management with training from ITDG.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Current State.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Defficient functioning of 1st. turbine.</td>
</tr>
<tr>
<td>2) Normal functioning of 2nd turbine.</td>
</tr>
<tr>
<td>3) Debt was paid with some delay.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Sustainability.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The business behind the MCH seems adequate to guarantee the project’s sustainability.</td>
</tr>
</tbody>
</table>
4. Name of MH plant: INKAHUASI

**Background.**
1) The Mayor asked for a credit from PRONAMACHCS to build an irrigation channel.
2) RENOM suggests the irrigation channel and an MCH.
3) RENOM hires an ITDG.
4) A contract is signed between RENOM – ITDG – Municipalities, and ED is in charge of ITDG paid by CM.

**Approval.**
ITDG approves the project on July 96.

**Investment and Financing (US$).**
1) \( I = 236.433; \) TIR = 28 %
2) \( FPM = 35.000 \) y RENOM and others \(^{86}\) = 205.360

**Implementation.**
1) Start date: July 96. End: August 99.
2) *Delay in OC due to delays in RENOM payments. The building lasted 3 years, años, instead of the expected year.*

**Operation.**
1) *In 2000 work was stopped for 2 months due to a landslide over the channel. CM subsidises 40 % of running costs.*
2) ITDG promoted crating an ESPEL, but CM advised by the contractor feared problems with SUNAT and chose to work with a CASEP.

**Current State.**
1) MCH is working
2) Change of Mayor and management brought dalya in payment. Debt has been paid off.

**Sustainability.**
The CASEP is not a sustainable solution.

---

\(^{86}\) Supposedly the population provided a non qualified work force.
5. Name of MH plant: TRINIDAD

**Background.**
1) Businessman had built the charge chamber but lacked money so it hired an ITDG.

**Approval.**
1) ITDG approves the project in August 96.
2) Composed by a turbine of 3 KW for the rainy season and a peak of 0,5 KW for estiaje. It is unclear why it was impossible to regulate the water level; and if it was not possible then how could the project have been possible.

**Investment and Financing (US$).**
1) I = 14.876 con TIR = 46,6 %
2) FPM = 12.000; businessman = 2.876

**Implementation.**
1) Start date: October 96; End: August 97. The job was done well.

**Operation.**
1) The suggested business was a battery charging shop, a mill, a video club and sale of excess energy to neighbours. With the profit gained on the last business they could invest in the mill and video club.
2) The businessman invested the downpayment his clients gave him for the sale of the excess energy to neighbours in other things so the planned investment never happened.
3) This lack of responsibility deterred them from generating enough cash flow to meet the payment of debt.

**Current State.**
1) MCH is working.
2) The businessman in is complete debt because he did not pay any of the installments and is on trial.

**Sustainability.**
1) The business prospects were not adequately assessed. The businessman’s capability to pay the debt was not well assessed. The downpayments he received should have been kept by ITDG, and not by himself.
2) Maybe it would have been better to include the mill and the video club as part of the original loan.
3) The huge gap between the available potency of the centres for drought and rainy season must have taken its toll on the incoming cash flow en el flujo, because the average charge in a biggest turbine was forseably low.
4) Even if after the trial 100 % of the loan is retrieved, very difficult considering trials in Peru, the project will generate loss for the FPM.
6. Name of MH plant: TORAYA

<table>
<thead>
<tr>
<th><strong>Background.</strong></th>
<th>The businessman hires ITDG.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Approval.</strong></td>
<td>ITDG approves the project on Aug.96.</td>
</tr>
</tbody>
</table>
| **Investment and Financing (US$).** | 1) I = 24.450; TIR = 14,9 %  
2) 100 % by FPM. |
| **Implementation.** | 1) Start: Oct. 96; End: Aug.97. |
| **Operation.**   | 1) *Businessman was late in paying because his mill and battery charging shop came to a standstill. Presumably these were not profitable.* |
| **Current State.** | 1) MCH is working.  
2) Currently lights 6 fish farms which seem like a good business and has allowed to solve financial problems. *5 month delay in installment payment. Businessman refinances debt and is again 3 months late. Finally, he pays off all debt.* |
| **Sustainability.** | 1) *A close evaluation of the business plan is necessary for the project’s sustainability.*  
2) In this case the businessman aparntly achieved to change to a sustainable business. |
7. Name of MH plant: CHUGUR

Background.
1) Part of the OC and the EEM were acquired with funding from PRONAMACHCS, but more money was needed to complete the job.
2) RENOM was asked for financment, for pressure pipes and completion of OC.
3) Mayor asks for credit from TDG to build a transmission web, supervision of the remaining work and of the PEF

Approval
ITDG approves the project en Nov. 96.

Investment and Financing (US$).
1) I = 240.360, TIR = 107 %
2) FPM = 35.000; RENOM and others = 205.360

Implementation.

Operation.
1) Work stopped due to faults in an open part of the channel. It is not clear why the finishing layer was not included in the pending OC.
2) The electrical charges are not always well balanced, due to operator’s lack of training.
3) High debt index so, CM covers 30 % of total running costs and pays for the salary of two operators.

Current State.
1) MCH is working.
2) Even with an inefficient management, there was no late payment of installments and the loan has been paid off.

Sustainability.
Even thought there was no delay repaying FPM, the sustainability is not guaranteed because the CM covered MCH running costs and this could not be permanent.

87 Evidently it was calculated only regarding the PFM loan, and not considering the whole project.
88 Possibly includes a non qualified work force contributed by the population.
8. Name of the MH plant: COLASAY

| Background. | Mayor hires ITDG thorough a pipe building business in order to give light to Sta. Rosa de Congona, a town 8 Km from Colasay. |
| Approval.  | ITDG approves the on Feb.97. |
| Investment and Financing (US$). | 1) I = 11736; TIR = 93 %  
2) FPM = 11.000 |
| Implementation. | Start: August.97 and ends Jan.98. Executed with delay due to the CM’s bad management. |
| Operation.  | CASEP (apparently, yet it is unclear ). Delays due to change of accountant. |
| Current State. | 1) MCH is working.  
2) 36 month delay. Debt has been paid. |
| Sustainability. | CM’s bad management generates doubts about project’s sustainability |
9. Name of MH plant: EL TINGO I Y II

<table>
<thead>
<tr>
<th><strong>Background.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiber sector businessman hired ITDG.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Approval.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>ITDG approves the Tingo I project on Feb. 97.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Investment and Financing (US$).</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) <strong>Tingo I</strong>: I = 21.080; TIR = 52 %. <em>Tingo II</em>: I = 18.362; TIR = 21 %</td>
</tr>
<tr>
<td>2) <strong>Tingo I</strong>: FPM = 19.500; businessman = 1.580. <em>Tingo II</em>: FPM = 34.000; businessman = - 15.638. <em>These numbers are not consistent between them and need reviewing.</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Implementation.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) <strong>Tingo I</strong>: started <em>Feb. 97</em> and completed on Feb. 2000. In January 2001 the Utcubamba river levels were high, after clearing the landslide that reached and covered 300 m over the machine room and completely vanishing it, the EEM and the aserrío equipment.</td>
</tr>
<tr>
<td>2) <strong>Tingo II</strong>: Started at the beginning of <em>Feb. 2001</em> and completed by May 2001 in the same place but taking all the necessary precautions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Operation.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The businessmen decides to change business and invest in ice production but after a year of running this business (aprox. April 2002), a local competitor appears and sells ice at half the price even though he uses a Diesel generator.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Current State.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) MCH Tingo doesn’t exis; ITDG condoned 50 % of the remaining debt.</td>
</tr>
<tr>
<td>2) Tingo II is working. Even after refinacement with partial pardon of the original debt there are financial problems that delays payment in 8 months. Almost all the original loan remains to be paid plus the corresponding interest rates.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Sustainability.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>To guarantee sustainability there must be a clear policy and proper organisation to solve problems and the physical risks of an MCH caused by natural disasters. Even though it was noble of the ITDG to have helped the affected businessman cuidado this was not studied deeply enough. The result is that the project’s sustainability was not secured. en ayuda del empresario damnificado, ésta parece no haber sido estudiada suficientemente.</td>
</tr>
</tbody>
</table>
10. Name of MH plant: KAÑARIS

**Background.**
El Alcalde solicita apoyo del ITDG en el marco del Convenio Tripartito con la RENOM

**Approval.**
Se aprueba el proyecto en **marzo 97**

**Investment and Financing (US$).**
1) \( I = 190.200; \) TIR = 144 \( ^{89} \%
2) \( FPM = 50.000; \) RENOM and others \( ^{90} = 140.200 \)

**Implementation.**
**Start: May 97** and ended **Oct.2000.**  
*Delay in payment of OC due to delay in money from RENOM.*
1) **Problems with a turbine.** Seems there was sabotage by opposition to local Mayor. The support system was knocked down and they threatened the operator if he did not abandon his post.
2) **Users blame ITDG for the problems.**

**Operation.**
1) An ESPEL was established with CM backing but it was only one person run it.
2) However, **due to lack of demand and the low tariffs paid** (S/. 5 /family.mes) *(the families considered them to be too high), running costs are not met.*

**Current state.**
1) MCH is working.
2) A change in Mayor and new management delayed payment in 8 onths but the debt has now been fully paid.

**Sustainability.**
Payment of the debt is no proof of sustainability. And this cannot be guaranteed if disagreements within the community are not studied to find a consensus. It should be clear to everyone what ITDG, ESPEL and CM’s responsibility.

---

89 Posibly calculated only referring to the loan and not the total investment.
90 Posibly includes the community’s work force.
### 11. Name of MH plant: LA PECA

**Background.**
1) Bad management on behalf of the municipality resulted in a burnt MCH generator.
2) The Mayor hires ITDG to finance repairs.

**Approval.**
Credit is granted on March 97

**Investment and Financing (US$).**
1) $I = 12,000; \ TIR = 5612\%$ (repairs to a generator)
2) $FPM = 10,000$

**Implementation.**
From May 97 to August 97

**Operation.**
CM continues to be in charge.

**Current State.**
1) MCH is working.
2) After 20 months of debt and late installments, during which a new Mayor is elected and there is a change in management of the MCH and finally debt is paid. These changes and communication problems forced ITDG to follow up debtors from their Jaen office.

**Sustainability.**
CM's management or a CASEP has proven to be incapable of guaranteeing the MCH project's sustainability.
12. Name of MH plant: COMBAYO

**Background.**
The Mayor of La Encañada requests financement form ITDG, considering the three party agreement (Convenio Tripartito) where the CTAR Cajamarca replaces the former RENOM to back electrification projects for 95 families in Combayo.

**Approval.**
The project was approved on **Sept.97**.

**Investment and Financing (US$).**
1) \( I = 160.231; \) TIR = 99 % \(^{91}\).
2) FPM = 50.000, for the electromechanic equipment and the instalation; the balance will be covered by CTAR (to finish the channel), Minera Yanacocha (primary network), and FONCODES was asked for help for the second network, help that was never granted.

**Implementation.**
1) Started on **Sept.97** and completed on Dec.99.
2) The channel financed by CTAR was not concluded due to lack of funding.
3) FONCODES funds for the secondary network were not consolidated so this was not built.

**Operation.**
The whole thing is on standby until the system is built.

**Current state.**
1) In theory it is working but has, in practice, been paralyzed because the secondary network is not finished and neither is the OC.
2) Besides this after an initial delay of 4 months is payment, the total debt was paid off.

**Sustainability.**
This is another example of a project that has paid off its debt but is far from a sustainable situation. Not a single Kwh was generated because of lack of financement for the remaining electrical networks and other costs. Since there are no sales there is no way to maintain the MCH which is in danger of deteriorating if the problem is not solved soon.

---

\(^{91}\) Probably calculated as an investment of FPM’s credit.
13. Name of the MH plant: TABACONAS

**Background.**
1) The NGO SIAT based in Jaén started an MCH.
2) The Mayor of Tabaconas was contacted by SIAT to assist an ITDG to finish the work.

**Approval.**
Project approved on Sept.97, without ED, only profile.

**Investment and Financing (US$).**
1) \( I = 119,900; \) TIR 141 %
2) \( FPM = 44,000 \) (to finish OC and get EEM); the rest in charge of FONCODES (secondary network), CM (primary network and reinforced plumbing).

**Implementation.**
1) Start on Nov.97 and completed on Nov. 98.
2) The reinforced plumbing bought by CM had been stored for too long and was deformed by bending that caused great delays in the installation and leaks because the joints did not seal properly. The contract did not contemplate this responsibility.
3) PEF gave good results; the necessary potency was generated.
4) The business contractor that installed the primary network did tests in order to make the secondary network work but due to lack of experience they burnt light bulbs and appliances. Since the secondary network was not connected yet because the house did not have the equipment they connected the primary network for a few users who got electricity from an old generator and they did not realise that the distribution switchboard’s electrical wires were of 380/220. An arc was generated between the medium voltage lines and this affected the AVR generator.

**Operation.**
An ESPEL was set and run by two people and meters were installed. Business runs well and the income is enough to pay management, O and M and a repair fund.

**Current State.**
1) MCH is working.
2) Even though they had a 40 month debt, the repayment of the loan has not taken place because of change in Mayor. It seems new management does not want to take on the debt due to internal problems in CM. Legal action has been taken to get payments.

**Sustainability.**
The project’s sustainability will now be hard to accomplish even though the law suit is won and they accept the debt and the interest. Also a high TIR has nothing to do with the financial sustainability of a project.

---

92 Probably found calculating as investment only the FPM credit.

*By: DONALD TARNAWIECKI*
14. Name of MH plant: CORTEGANA

**Background.**
The Mayor of Corte
gana requests a loan from ITDG as part of an agreement (Convenio Multilateral) between CTAR Cajamarca – ITDG – Municipios.

**Approval.**
ITDG approves the ED begun by a third party on Sept. 97.

**Investment Financing (US$).**
1) I = 122.973 ; TIR = 11.7 %
2) FPM = 50.000; salary : CM

**Implementation.**
1) Start Jan. 98 and completed on Sept. 2000
2) OC in charge of the CM, with ITDG supervision. After a change in Mayor, the location of the machine box is changed for reasons unknown, as a result there was a lower salto útil and a lower installed potency so the turbine transmission system had to be redesigned and the diameter of the injectors was also reduced.
3) ITDG advised buying an EEM, but CM hired a separate business to install the equipment.

**Operation.**
1) *The private company hired by the CM to install the machine, suggests to the Mayor that the management of the MCH should be in charge of CM itself, disregarding ITDG’s advice to create an ESPEL.*
2) There is great debt and bad management from CM.

**Current State.**
1) MCH is working.
2) A change of Mayor and then his passing away resulted in 10 months of debt until the vice mayor assumed the repayment of credit. 75% of the total debt is still to be paid.

**Sustainability.**
There are economic sustainability problems that will soon have consequences on the physical sustainability of the MCH if they are not solved.
## 15. Name of MH plant: HUARANGO

<table>
<thead>
<tr>
<th><strong>Background.</strong></th>
<th>An advance loan for OC was granted, and the Mayor requests further credit with ITDG in order to complete the MCH.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Approval.</strong></td>
<td>ITDG approves the project on Feb. 98.</td>
</tr>
</tbody>
</table>
| **Investment and Financing (US$).** | 1) $I = 105,251; \ TIR = 14,1 \%$  
2) $FPM = 50,000; \ Other = 55,251$ |
| **Implementation.** | 1) Work started on May 98 and it was completed on Oct. 2001.  
2) ITDG supervises installment, but work is delayed due to delays in the complementary financing promised by CM, this due to a change in Mayor. |
| **Operation.** | 1) ITDG promoted creating an ESPEL but did not give continuity to the work.  
2) It is in charge of CADEP. |
| **Current State.** | 1) The MCH is running with some problems in the secondary network.  
2) A change in Mayor produced late payments to FPM, 5 months late. Now the Mayor has paid the debt. |
| **Sustainability.** | Here we see the case of a CM that, against all odds, managed to pay the debt but is far from making the project sustainable. |
16. Name of MH plant: CONCHÁN

**Background.**
1) In 1994, an MCH was installed using PRONAMACHCS credit, but the hydraulic regulator never worked in automatic and was operated manually and deficiently.
2) Mayor requests credit from ITDG to install an electronic regulator.

**Approval.**
ITDG approves the proyect on April 99.

**Investment and Financing (US$).**
1) $I = 161,000; TIR = 36,8 \%.
2) $FPM = 18,000; balance= others.

**Implementation.**
1) Work started on August 99 and is completed by May 2000.
2) There was a delay in the delivery of the equipment due to delays in importing the main card.

**Operation.**
An ESPEL was created in 1998 and works well and covers running costs plus a fund for repairs.

**Current State.**
1) MCH is working.
2) *Political reasons delayed payment in 4 months. A notary issued a warning letter to CM. 50\% of the debt is yet to be paid.*

**Sustainability.**
The MCH sustainability depends on establishing a structure where responsibilities are clearly defined: the users, the owner of the MCH, the ESPEL and the person in charge of executing the project. The new model applied in Conchan should be closely monitored by ITDG to determine if it is sustainable.
### 17. Name of MH plant: SONDOR

**Background.**

1. ITDG on promotional visit.
2. The Mayor informed they have a 40 year old MCH that only feeds a third of the population, and that they are building a new irrigation and energy channel, so he requested a loan to buy an EEM, pressure plumbing and for the instalment.

**Approval.**

ITDG approves the project on May 2000.

**Investment and Financing (US$).**

1. \( I = 226,350 \); \( TIR = 23,7\% \)
2. \( FPM = 50,000 \); the CM and CTAR Piura = 176,350

**Implementation.**

1. Work was started on June 2000 and completed by September 2001 and there were problems importing the regulator.
2. MCH tests were satisfactory, after the maker of the 22.9 KV/380-220 V transformer changed it because it was faulty. So they were left waiting for its repair or replacement.
3. The transmission network financed by CTAR Piura was completed adequately.

**Operation.**

An ESPEL is being created. It will be run by 3 people (2 operators and 1 manager). ITDG has trained all personnel.

**Current State.**

1. MCH is working.
2. A 5 month delay in payment of the loan because municipal funds were assigned to different projects. 69% of the debt is yet to be paid.

**Sustainability.**

If the ESPEL is solid and an efficient tariff charging system is set then the project could be sustainable, even if there were delays in paying the loan.
18. Name of the MH plant: SILLANGATE

**Background.**
1) They had a 20 kW generator that worked 3 to 4 hours a day.
2) The CM and the population decide to build an MCH. They request an ED.
3) The Mayor requests an ITDG loan to buy and install the electromechanic equipment.

**Approval.**
ITDG aprueba el proyecto en **jun. 2000**

**Investment and Financing (US$).**
1) I = 116.417; TIR = 21.3 %
2) FPM = 40.000; Other = 76.417

**Implementation.**
1) Work started on June 2000 and finished by March 2001 and is done by a company hired by CM.
2) The project and corresponding tests are concluded.

**Operation.**
This is not at all organised.

**Current State.**
1) The MCH is working.
2) Payment of installments was 12 months due to the Mayor’s lack of responsibility because he did not contemplate arranging the management of the MCH. The debt was refinanced but even so there was a late payment of one of the installments. With interest, the total debt is 104% of the original loan.

**Sustainability.**
If authorities follow an openly demagogic policy, it is difficult for the project to be sustainable.
19. Name of MH plant: SANTO TOMÁS

<table>
<thead>
<tr>
<th><strong>Background.</strong></th>
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</thead>
<tbody>
<tr>
<td>An advance credit for OC was given by PRONAMACHCS in 1994. The Mayor contacts ITDG and Eds are made.</td>
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<table>
<thead>
<tr>
<th><strong>Approval.</strong></th>
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<tbody>
<tr>
<td>ITDG approves the project on June 2000.</td>
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</table>

<table>
<thead>
<tr>
<th><strong>Investment and Financing (US$).</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) I = 196.580; TIR = 29.5 %</td>
</tr>
<tr>
<td>2) FPM = 50.000; others = 146.580</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Implementation.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Work is started on July 2000 and finished on April 2002.</td>
</tr>
<tr>
<td>2) Lack of co-financem ent after acquiring EEM with the credit PRONAMACHCS gave and an advance loan for the OC with CM funds works came to a stand still. FPM finances a transmission network and installs it, but the installation of the EEM is faulty and so is the secondary network so work is again stopped.</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th><strong>Operation.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Management under municipality.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Current state.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) MCH is running and service will be extended to other communities.</td>
</tr>
<tr>
<td>2) Good relations with ITDG. No late payment. They have requested ITDG’s help for new projects in other communities.</td>
</tr>
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<thead>
<tr>
<th><strong>Sustainability.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Good disposition to pay, this seems to be key in order to keep ITDG’s support. It is vital to work with an organisation that guarantees the project’s sustainability.</td>
</tr>
</tbody>
</table>
20. Name of MH plant: MANANTIAL ETERNO (also, E. WANGEMAN)

<table>
<thead>
<tr>
<th><strong>Background.</strong></th>
<th>A tourism businessman requests a loan to build an MCH to improve the quality of service he provides to his clients.</th>
</tr>
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</table>

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<thead>
<tr>
<th><strong>Approval.</strong></th>
<th>A project that only includes public works is approved on November 2000. However, there is no talk of when the rest of the work would be done.</th>
</tr>
</thead>
</table>

| **Investment and Financing (US$).** | 1) I = 50,000; TIR = 9.7 %  
2) FPM = 50,000 |
|-------------------------------|--------------------------------------------------|

| **Implementation.** | 1) Started on **nov.2000** and is completed on August **2001**.  
2) Parts: the bocatoma, de-sanding, channel, loading chamber and casa de fuerza. |
|---------------------|--------------------------------------------------------------------------------------------------------------------------|

<table>
<thead>
<tr>
<th><strong>Operation.</strong></th>
<th>None yet.</th>
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| **Current state.** | 1) Other components are missing.  
2) The businessman runs into financial problems and payment of installments is delayed in 3 months so 91% of the loan was still to be paid. Debt has been refinanced but the businessman wants to pay according to a campaign directed to attract clients, this means in six-monthly installments. |
|-------------------|--------------------------------------------------------------------------------------------------------------------------|

<table>
<thead>
<tr>
<th><strong>Sustainability.</strong></th>
<th>It does not seem wise to approve an incomplete project, without a solid guarantee that it will be completed within a reasonable time frame. On the other hand, it would be possible to adjust the repayment deadlines and installment according to the client’s real capability. This could help the project’s sustainability.</th>
</tr>
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</table>

By: DONALD TARNAWIECKI