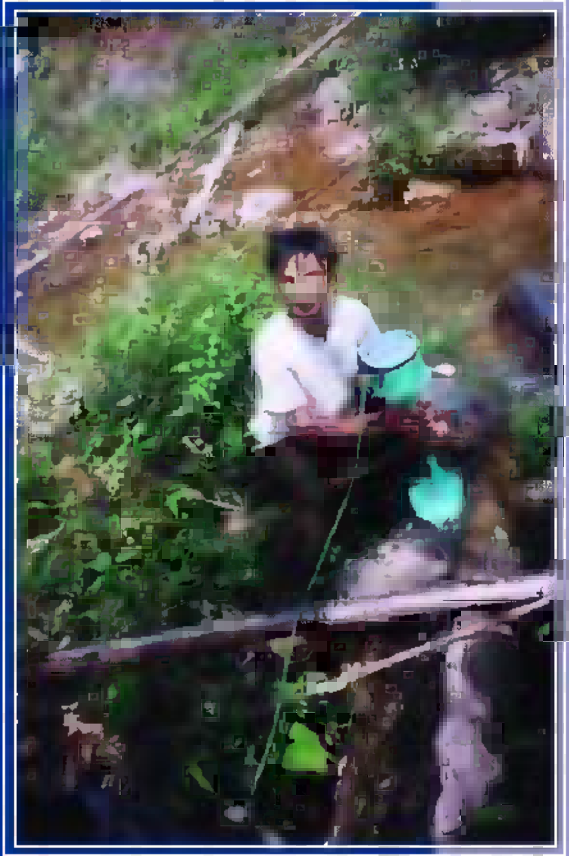
A Guide to CDM and Family Hydro Power



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CDM Project to Stimulate the Market for Family Hydro for Low Income Families

Final Technical Report

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EXECUTIVE SUMMARY

Family-hydro can provide electricity to low-income rural households in developing countries around the world. Tens of thousands of low-income households living in rural, rice-farming regions of Vietnam presently rely upon family-hydro as the only affordable means of obtaining electricity. These systems, the most common size being between 100 Watts to 200 Watts, are used for domestic lighting, radio and in some cases TVs.

IT Power Ltd, in conjunction with Renewable Energy Association of the Philippines (REAP) and the Vietnam Support Programme for Sustainable Energy Development (VSED), was supported by the UK Department for International Development (DFID) under the Knowledge and Research (KaR) Programme for Energy, to determine the feasibility of the clean development mechanism (CDM) in stimulating the market for family-hydro systems for low income families, and to provide an overview of the potential market in Asia, Latin America and Africa.

In Vietnam, where there are thought to be have been around 120,000 units installed, systems are sold at local markets and installed by the customers themselves. Although the study has found that the way in which the market has developed in Vietnam, and the fact that the carbon-based energy displaced (hence emission reductions) by the family-hydro systems are very low, means that the prospect for aggregating family-hydro systems together in a portfolio for CDM is relatively limited.

In the Philippines, where rural household consumption of kerosene and diesel is higher than in Vietnam, the CDM may become a viable proposition. A more centralised approach to the distribution and sales of systems in the Philippines will also make the development of a CDM project in the Philippines more attractive. The study found that carbon finance delivered from a small-scale hydro project in the Philippines could potentially lower system costs to end users by around 10-15% depending on the price of carbon, and this cost reduction could allow the market to develop using better quality pico-hydro systems (in terms of operation and reliability) which may otherwise be too expensive for many low-income households. However, the development of a CDM project is not without its difficulties. A number of barriers, including low carbon prices, high CDM transaction costs, low emission reductions per system, and the risks involved in the market penetration of pico-hydro, all need to be overcome if CDM is to help stimulate the market. The report shows that with the right organisational approach, a large number of systems, risk mitigation in the design of the project, and the marketing of the project's sustainable development benefits in order to gain a higher carbon price, the CDM is a viable prospect for family-hydro.

There is clearly a large global market for family-hydro projects in many countries in Latin America, Africa and Asia. Carbon finance could play a role in helping to stimulate this market if the price of CERs was to rise to more than US\$7/tCO_2, which could perhaps be obtained with the support of WWF's Gold Standard or through an expected rise in demand with the introduction of a CDM link to the European Emissions Trading Scheme (ETS). Family-hydro can then take on a key role in the provision of energy services for low-income communities, whilst reducing emissions and dependence on often imported fossil fuels.

CONTENTS

1. INTRODUCTION

1.1 BACKGROUND

This report assesses the potential for good quality family-hydro to provide electricity to low-income rural households in the Philippines, it determines the cost reduction that could be provided by the Clean Development Mechanism (CDM), and it provides an overview of the potential market in Asia, Latin America and Africa. The project was undertaken by IT Power, in association with Renewable Energy Association of the Philippines (REAP) and Vietnam Support Programme for Sustainable Energy Development (VSED), between October 2002 and December 2003, supported by the UK Department for International Development (DFID) under the Knowledge and Research (KaR) Programme for Energy under Theme 6, Energy and the Environment[1].

Tens of thousands of low-income households living in rural, rice-farming regions of Vietnam rely upon family-hydro as the only affordable means of obtaining electricity. These systems, the most common size being between 100 Watts to 200 Watts, are used for domestic lighting, radio and in some cases TVs. The units are small and cheap, and are usually owned, installed and utilised by a single family. In many situations family-hydro offers by far the cheapest and often the most sustainable electricity supply option to millions of low-income families living in rural low-lying areas far from the existing grid system. However, Vietnam and China are the only countries to-date where 'family-hydro' technology has become widely available. One of the key barriers to its use is that the cheapest units (US$20-25 for 100Watt unit) are of very low quality, typically lasting less than two years. Improved quality units are available, but at a significantly higher price (US$85 for a 200W unit that typically lasts up to five years).

Funding from the CDM could be utilised in order to reduce the cost of good quality equipment to provide low-income households living in isolated off-grid locations with an affordable and sustainable electricity supply which can meet their needs for lighting for educational, productive and recreational uses. There is believed to be massive unexploited potential for family-hydro throughout South-East Asia, China, the Indian sub-continent, Africa and South America. Several countries, including the Philippines, are beginning to import the technology from Vietnam.

IT Power has recently been involved in a number of projects which focus upon determining ways in which small-scale projects can be bundled together and fast tracked under the CDM. In 2000 and 2001, in conjunction with ECN and Sunrise Technologies Consulting, IT Power made recommendations to the UNFCCC to influence the CDM Executive Board to adopt procedures which would enable Solar Home Systems (SHS) to utilise a standardised global baseline. Two project reports were produced on 'Streamlining CDM procedures for Solar Home Systems' and published at the end of 2000 and 2001 respectively (Ybema et al., 2000; Martens et al., 2001).

Family-hydro has the same modularity and similar size as Solar Home Systems and is also used by individual households. A major advantage of considering family-hydro is the significantly lower cost of the equipment and the higher capacity factor that can typically be obtained from a hydropower unit. This family-hydro project has built on the findings from the earlier work on SHS and has applied them to the Philippines, where there has been a newly emerging market for pico-hydro development in the countryside, and developed a Project Idea Note (PIN) for the Philippines in order to pave the way for family-hydro under the CDM. IT Power is also managing an ESMAP project entitled 'Stimulating the market for pico-hydro for low-income households in Ecuador', which will continue until July 2004. This project has been designed to complement this DFID KaR Family-hydro project, in terms of learning from the huge experience of dissemination of the technology in Vietnam.

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[1] See http://www.dfid-kar-energy.org.uk/html/r8150.htm for more details

1.2 OBJECTIVES OF THE PROJECT

The main project goal is to alleviate poverty in lowland farming areas in developing countries through the development and promotion of renewable energy sources, specifically very small (pico) hydropower, thereby assisting countries to achieve the Millennium Development Goals and reduce the environmental impacts of energy use. The purpose of the work done in the project is to the build capacity of institutions in Vietnam and the Philippines to develop CDM projects for family-hydropower.

The project had the following main outputs:

- ❒ Internal project report clarifying the current costs, existing uses and emissions reduction potential of family-hydro units in Vietnam.
- ❒ Project Idea Note (PIN)/Project Design Document (PDD) for a Family-hydro CDM project in the Philippines.
- ❒ Report assessing the cost reduction provided by the CDM.

A PIN has been submitted to the Community Development Carbon Fund (CDCF) of the World Bank, but at present it has not been recommended that the project progress to the full project proposal (Project Design Document (PDD) stage. Nevertheless, due to the work carried out by the project, the institutions involved in the Philippines and Vietnam have strengthened their involvement in family-hydro and are continuing to pursue their proposal to the CDCF. The project developers are also exploring opportunities with other potential buyers, particularly those who may be looking for CDM projects with high sustainable development benefits.

1.3 FAMILY-HYDRO TECHNOLOGY

1.3.1 Background

The term 'family'-hydro covers the pico-hydro power range of systems normally less than 2kW, with the most common size range being 200-1,000 Watts, typically being used for lighting, TV/radio and battery-charging. The units are small (see Photo 1) and cheap enough to be owned, installed and utilised by a single family, hence their name.

In general throughout the world, low-head sites (below 5 metres) are by far the most widespread, available on irrigation canals as well as streams, and both in hilly and plain areas. These sites often avoid the political difficulties of crossing land outside the ownership of the family seeking to develop a

Photo 1: A Typical 200W Family Hydro unit being installed in Vietnam (Feb 2003)

Pico-hydro types throughout the world:

Pico-hydro technologies cover a range of turbine types, applicable to different heads. For example:

- ❒ Tiny pelton wheels ('Peltric' sets) are being promoted in Nepal for sites with 20-50m head - only a hose-pipe is required for a penstock.
- ❒ In the Philippines, tiny crossflow turbines ('Fireflies') are being tested on 5-20m head.
- ❒ In the USA, Canada and Australia, a few companies offer a variation on the turgo-turbine for medium and high head sites, principally to serve remote off-grid dwellings.
- ❒ China and Vietnam have had the greatest dissemination of low-head propeller turbines, suitable for only 1-2m head, and tiny turgo turbines for 5-20m head.

scheme. High head sites have been developed in areas where the topography lends itself to this type of development, such as in countries of the Himalayas.

1.3.2 Countries with pico-hydro developments

Vietnam and China are the only countries to date where family hydro technology has become widely available at affordable cost, with many thousands of units installed. This market development has been with a mixture of locally made low- and medium-head units and has occurred despite the existing technology being fairly inefficient and short-lived. Other countries with some pico-hydro developments are listed in Table 1 below.

Countries that are known to have workshops involved in pico-hydro manufacture with mainly propellor, crossflow and pelton turbine types	**Additional countries that have had low-head pico-hydro installations**
☐ China	☐ Chile
☐ Vietnam	☐ Ecuador
☐ Bolivia	☐ Nicaragua
☐ Colombia	☐ Guyana
☐ Peru	☐ Panama
☐ India	☐ Paraguay
☐ Nepal	☐ Indonesia
☐ Sri Lanka	☐ Malaysia
☐ Lao PDR	☐ Myanmar
☐ Philippines	☐ Thailand

Table 1: Global pico-hydro developments

Low-head family-hydro units have also been sold in North America, countries in Europe and several countries in Australia and the Pacific Islands. There has been only minor uptake of pico-hydro in Africa to date (Whalan, 2003), however there are believed to be massive unexploited potential throughout South-East Asia, South America and the Indian sub-continent for pico-hydro units serving single families, or small household groups, either for battery-charging or continuous operation. In some cases, the systems could also drive machinery for agro-processing, workshop tools, etc. in order to generate income.

1.3.3 Market characteristics in Vietnam

In Vietnam, millions of rural households lack access to electricity and have little hope of a grid connection in the foreseeable future. This is very similar to the situation in many developing countries. But in Vietnam, a large number of households have chosen off-grid solutions to obtain electricity, and due to the favourable hydro resources and the presence of cheap hydro turbines, the country has the highest use of family-hydro in the world, thought to be in the region of 120,000 units having already been installed.

Pico-hydro systems are sold for cash in the markets in Hanoi and other towns and cities, mainly in the northern provinces. They are sold by shops that deal with electrical equipment, pumps, generators, or agro-machinery. Although some very small subsidies have reportedly been available in certain provinces, the market is basically 'cash and carry' (Rijsenbeek, 2000). In general the government of Vietnam is not providing funding for promoting renewable energy in general and pico-hydro in particular and all the promotion has been done by word of mouth (Nguyen Duc Loc, 2004). Rural people install these systems on their own land (irrigation fields or channels) or even on public land (a river or creek). Usually concentrations are found where several families have built a small dam in the river to create a head difference and installed a number of systems. Wires to the houses (often without insulation) are supported by bamboo and cover distances up to 200 - 300m. The load is normally fixed, running a few lights continuously (to keep the generating voltage steady) and radio-cassette, black-white TV or electric desk-fan as required. There are no sluice gates to stop water flowing to the machines and often no electronic controllers to govern their electrical output. When not in use, the units are simply removed from the small dams and left by the river-side or taken home (to prevent theft).

1.3.4 Available equipment

Chinese imports

Family-hydro systems in Vietnam are mostly imported illegally from China where they are manufactured near Nanning City using conventional permanent magnets in the generator. The most common units come with nameplate outputs of 300W, 500W and 1,000W but actual outputs are typically 100W, 200W and 450W respectively. No guarantees are given on any part of the system, the only instructions if any, are in Chinese, sales service is scarce, being the sole responsibility of local pico-hydro dealers. However since there are already so many installed, buyers can refer to those that are already in operation. The installation is done by customers themselves with the help of friends or local technicians.

Prices of Chinese pico-hydro units in the local market-place vary, but are in the range US$14-16 for the 300W unit, US$20 for the 500W unit and US$40 for the 1,000W unit (Nguyen Duc Loc, 2004). This price does not include the draft tube for the turbine or the transmission cable, and excludes any civil works costs. These balance-of-system elements can cost in the range US$40-60 and hence are the more significant cost element for the 100W unit.

The Chinese 100W units (see Photos 2 - 4) dominate the market with over 90% coverage, achieved through its very low unit price (illegally avoiding tax and import duty) and a well-established distribution network of importers and retailers in the provinces and district towns. However the technical quality of the system is low. Total repair and maintenance cost for the 100W unit over one year is estimated to be about the same as the purchase price of the product (~$25). The lower bearing is the most frequent cause of failure, and generator windings and seals also fail on a regular basis. However, owners seem to be able to fix their units with the help of a local repair shop. In general most systems become unusable after 2-3 years and have to be completely replaced, although many units can last only 6 months.

Vietnamese products

There is a more efficient and reliable Vietnamese design, utilising rare-earth magnets in the generator, available from the Renewable Energy Research Centre (RERC) at the University of Hanoi that attempts to overcome most of the shortcomings of the Chinese units (Nguyen Duc Loc, 2004). This design has a higher output and a longer lifespan (typically 5 years). However the system currently costs US$45 to the end-user for a 200W output and


Photo 2: 100W Chinese Propellor Turbine


Photo 3: 100W Chinese TurgoTurbine


Photo 4 - Chinese made family-hydro systems for sale on the street in Hanoi (100W and 500W)

therefore has not yet gained a significant market share among rural households short of cash. For export RERC also supply a real capacity of pico-hydro unit of 200, 500 and 1,000W for US$80, US$140 and US$260 respectively (see Photo 5).

Photo 5 - Vietnamese family-hydro systems made by RERC and Material Institute (200W, 500W and 1,000W)

By mid 2003, RERC in a cooperation with Hydro Power Center (HPC) of Institute of Hydro Resources, Ministry of Agriculture and Rural Development have been manufacturing all kinds of pico-hydro units in series as well as small hydro power systems up to 1,000 kW in capacity (see Photo 6).

Photo 6 - New Vietnamese family-hydro systems made by RERC and Hydro Power Centre in series (200W, 500W and 1,000W)

In the last five years a Canadian company, Asian Phoenix Resources Ltd, identified the market potential for improved quality pico-hydro units in Vietnam and nearby countries, and developed the 'Powerpal' 200W, 500W and 1,000W propeller turbine unit manufactured in Hanoi[2]. The unit sells for US$90 in Vietnam and between US$100-200 for export to other countries. Sales volumes achieved in Vietnam are unknown, although over 300 units have been sold throughout the world since 1999 (Whalan, 2003). The original design of Powerpal comes from RERC (for the hydro part) and the Material Institute of the National Centre for Science and Technology (for the generator part). The advantage is that the units come with a voltage regulator which can be set at the appropriate voltage once the typical load has been connected. This offers protection against the voltage and frequency fluctuations that the Chinese imports suffer from.

1.4 FAMILY-HYDRO ACTIVITY IN THE PHILIPPINES

The Philippines has recently seen significant activity in the development of pico-hydro and micro-hydro schemes for communities[3]. The Department of Energy (DoE) has been promoting a rural electrification programme in recent years, lead by the O'Ilaw program (bringing light into the countryside), where penetration of the grid has risen from 79% of the total of 41,945 barangays (villages) in 2000 to 89% in 2003[4]. However, despite these impressive gains as many of 30.5%[5] of households remain without a connection in these villages because the DoE can claim 'barangay electrification' if a minimum of only 10 houses are given a connection. With a favourable rain pattern and topography across the islands of the archipelago, this has given room for the development of micro- and pico-hydro in clusters of households that remain off the grid.

There are home-grown pico-hydro technologies used in the Philippines, such as small crossflow runners for battery charging from medium head ('Fireflies'), but the application of low-head, propeller turbines for 220 V supply (i.e. family-hydro) has only been possible through import of equipment from Vietnam. The distance of the Philippines from mainland China has meant that the poorer quality equipment that has flooded the Vietnamese market has not been able to penetrate the Philippines, which has meant comparatively more controlled and sustainable development of family-hydro there.

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[2] See www.powerpal.com

[3] As of 2001, there are thought to be a minimum of 180kW of micro-hydro installed in the country (17 schemes), but there have been a significant number installed since then

[4] Rural Electrification Program of the DoE www.doe.gov.ph/servlet/page?_pageid=679,681,683&_dad=portal30&_schema=PORTAL30

[5] See www.nea.gov.ph/accomplishments_of_re.html

Photo 7 - Vietnamese Pico-hydro equipment imported into the Philippines (Iloilo

The Renewable Energy Association of the Philippines (REAP) is just one of the suppliers of family-hydro in the Philippines. They supply the Hydrotec product from Vietnam and have helped communities install approximately 65 units to-date (200W to 1,000W units, with a total of 31kW installed). Powerpal of Vietnam have a local dealer and the total number of units installed (mostly 200 500W) is thought to be about 30[6]. There have also been other installations carried out, and therefore it is estimated that, as of early 2003, approximately 100 150 family-hydro systems have been installed countrywide.

Given the comparatively low number of developments of low-head pico-hydro in the Philippines compared to Vietnam, the typical style of projects has so far been quite different. A project in the village of Igputoy in Antique, Panay Island serves as an example of the method of setting up an electrification system based on pico-hydro (Navarro, 2002).

A cluster of 35 households in Igputoy was chosen for an electrification project based on the use of low-head pico-hydro equipment due to the village's location next to a low-lying large river where it was only possible to obtain a few metres head of water. Before the pico-hydro intervention, the households were dependent on kerosene and automotive battery for lighting and the village had a difficult economic situation, requiring men in the community to go outside for at least five months in a year to work in the sugar cane farms in order to earn extra income for their family. The objective of the project was to address the needs of the community for electricity and lighting and to encourage income generation at home (for example, from processing of root crops) rather than require labour to be sought far from the village.

The original design of the system was to install one 1,000 Watt pico hydro turbine to provide electricity to 25 households with two 14 Watt lights each, but this was later expanded to accommodate another 500 Watt turbine to provide electricity to all households. The project was organised so that the community worked together, giving free labour ('Dagyaw') to the project (worth P80,000 = US$3,000), in order to develop a communal hydro-electricity system. The work was supported financially by the Local (Municipal) Government (P20,000 = US$750), REAP (P100,000 = US$3,500) and the NGO leading the work (ANIAD - Antique Development Foundation), giving their engineering and community organising work for free. Engineering support was also given by Solar Electric Co. Ltd., a company based on the same island and with experience in installing pico-hydro systems.

The project was successfully completed in 6 months and is characteristic of the way that pico-hydro has been exploited for 'community' use much more than in Vietnam. This is due to the presence of many NGOs (such as ANIAD) that have experience of community level organisation and the mobilisation required in rural development, the co-operative nature of people in Philippine villages and the possibility of obtaining local (and national) government funding to support rural electrification and economic development in poor areas.

Photo 8 - Igputoy pico-hydro system for community electricity supply, Antique province (Solar Electric Co. Ltd.)

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[6] See examples of these installations www.solarelectric.com.ph/water.htm#Negros and ww.powerpal.com/1inuse.html

2. DEVELOPMENT OF THE CDM PILOT PROJECT

2.1 INTRODUCTION

There is significant potential for pico-hydro in the Philippines (as noted in the previous section and later in 2.7.2) to provide cost-effective energy services to households that are unlikely to be connected to the grid system in the next few years. These households currently rely on often expensive and polluting fuels, such as kerosene and diesel, for the provision of their energy services. Pico-hydro could provide a low cost and clean replacement.

Initial assessment has found that "good quality" pico-hydro systems (in terms of operation and reliability) are likely to be too expensive for many low-income households in the Philippines due to their high upfront cost, in comparison to the regular small payments required for purchasing kerosene. However, these households may be able to afford cheaper versions, such as those regularly sold in local markets in Vietnam imported mostly from China. These systems have a short lifetime, often do not supply their design capacity and efficiency, and have a number of factors affecting their reliability (documented for Vietnam in 1.3 above). Early demonstration of pico-hydro by REAP in the Philippines has avoided using these cheaper less reliable systems, as their unreliability could jeopardise the overall pico-hydro market potential through negative experiences by consumers.

The prime objective of this project has been to investigate through a pilot study the stimulation of the pico-hydro market by using carbon finance to "buy down" the cost of good quality pico-hydro units to a cost similar to those of the cheaper less reliable units. The first installations in the Philippines are using imported equipment (from Vietnam), but the long-term aim is to stimulate the market demand to an extent where local manufacture can be initiated to further reduce system costs.

This section describes the development of a CDM pilot project that was explored for the Philippines (analysis was also done for Vietnam but it proved to be less viable), with the prime objective being to stimulate the pico-hydro market by "buying down" the price of the systems via carbon financing.

2.2 BACKGROUND TO THE CDM

The CDM is an instrument established under the Kyoto Protocol to achieve both sustainable development and contribute to the cost-effective mitigation of climate change. The CDM allows countries with emission reduction commitments (Annex I countries[7]) to meet part of their reductions abroad, where greenhouse gas (GHG) abatement costs can be lower. The CDM also enables developing countries to attract investments in clean energy and environmental technology and assist them on a sustainable development path.

In practice the CDM operates as follows and is illustrated in Figure 1. A project in a non-Annex 1 country[8] that reduces greenhouse gas emissions (or sequester greenhouse gas emissions) and contributes to sustainable development is identified. The project then goes through a number of steps to ensure that the emission reduction is additional, real, long term and measurable. For each metric tonne of CO_2 equivalent[9] that the project saves, a Certified Emissions Reduction (CER) certificate is generated. Annex 1 countries can then buy these CERs to contribute to their own Kyoto target.

Despite the fact that the Kyoto Protocol has still yet to come into force, there have been a significant number of renewable energy, energy efficiency and fuel-switch CDM projects in various stages of development, with CERs being bought by various organisations including the World Bank, and several Annex 1 country governments, such as the Netherlands and Finland. To date, it is large-scale projects that have attracted the majority of CDM investments. Smaller scale energy projects that are often more appropriate for the needs of many rural communities, particularly in South East Asia, have been limited due to the current low CER prices

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[7] Industrialised countries
[8] Developing countries
[9] Global warming potentials of the six greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) are normalised to CO_2 equivalent

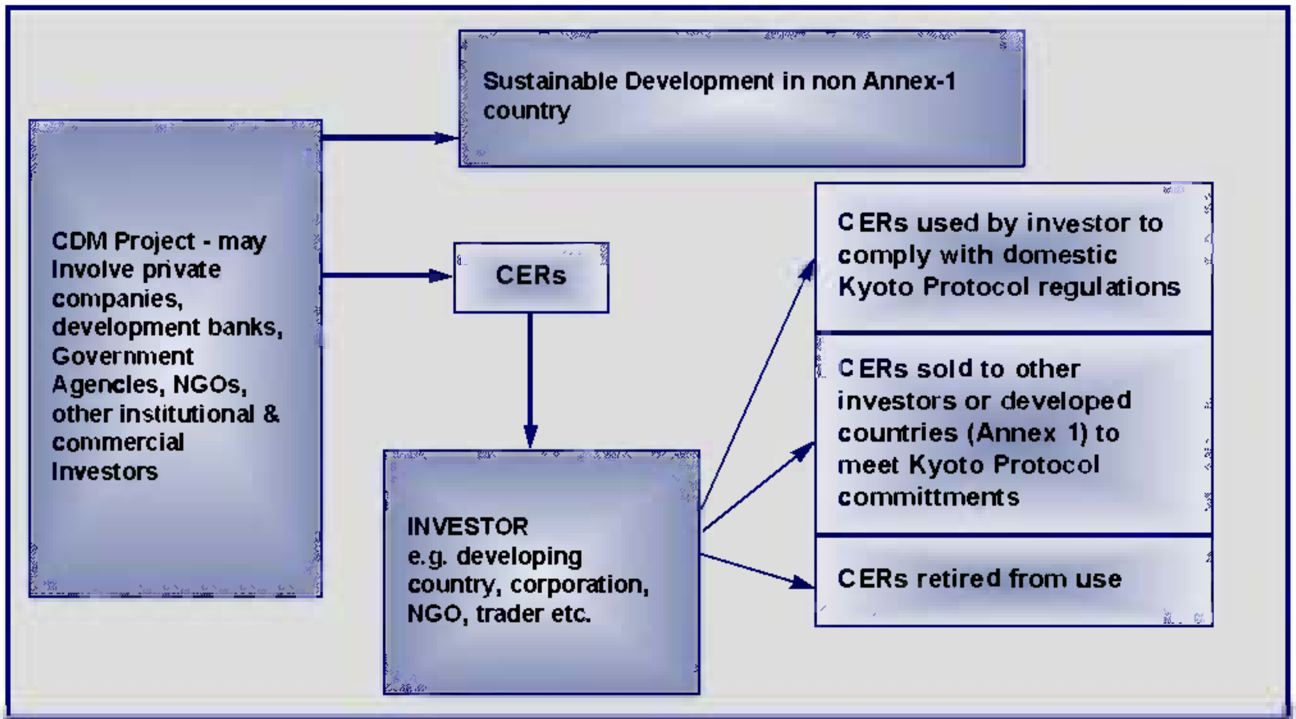

Figure 1: CDM outputs

(~US\$3-5/tCO_2) and high CDM-related transaction costs. Consequently, there has been considerable concern that this situation will continue with very few investments made in poorer developing countries, where small-scale projects will often be the most suitable development option.

Small-scale CDM projects are now eligible for streamlined procedures and modalities[10], developed by the CDM Executive Board (EB) to reduce transaction costs and 'fast-track' small-scale projects. In the new streamlined procedures and modalities, baseline methodologies assigned to the different project types are now indicated and outlined rather than left entirely to the developer. Essentially, this means that time spent on baseline formulation is drastically reduced, however, where there is no suitable baseline then a proposed approach can be submitted to the CDM Executive Board for approval. This process has simplified the process for small-scale CDM projects, and compared to regular CDM projects the main simplification for these small-scale initiatives are:

- baseline methodology: simplified baseline methodologies are provided for 13 types of small-scale CDM project activities and no new methodology needs to be approved by the Executive Board;
- monitoring methodology and plan: simplified modalities are specified per project category, including a less frequent and reduced monitoring plan, and no new methodology needs to be developed for approval by the Executive Board;
- project design document (PDD): has been simplified for use by small-scale CDM activities;
- additionality requirements: project participants shall show that the project would not have occurred anyway due to an investment barrier, a technological barrier, a barrier due to prevailing practice, or other barriers such as institutional barriers or information requirements;
- environmental impacts: documentation of environmental impacts need only be provided if required by the host country;
- leakage: no calculation is required if the renewable energy technology is installed for the first time[11];
- Designated Operational Entity (DOE): the same designated operational entity may undertake validation, verification and certification;
- registration period: reduced from 8 to 4 weeks with a lower administration fee;

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[10] Paragraph 6C, of the Decision 17/CP7 (Article 12) The Marrakesh Accords

[11] Leakage may occur if the implementation of the CDM project lead to an increase in emissions outside the project boundaries

- ❒ debundling: as it is possible that larger projects (e.g. >15MW) may try to utilise the simplified procedures and modalities and gain transaction costs, a debundling test is required to ensure that any small-scale project utilising the simplified procedures and modalities are not components of a larger project (e.g. 3x15MW projects may in fact be one 45MW large project).

These options could deliver transaction cost reductions for many small-scale CDM projects. Road-testing of the procedures and modalities have been estimated to reduce the relative weight of transaction costs to CER value by as much as half (De Gouvello and Coto, 2002). So far there is still little real project experience with these procedures, however a number of projects are now being developed using them, including the Aquarius hydroelectric project in Argentina[12], showing considerable transaction cost savings.

2.3 CDM BUNDLING

Bundling has also been suggested as a way of reducing transaction costs for small-scale CDM projects and is included as an option in the simplified procedures and modalities. Essentially, bundling refers to aggregating a number of small projects to a larger project which can then be put through the CDM process. Similar aggregation has already been carried out in the electricity markets of North America and Europe (Gregerson and Mariyappan, 2001) to allow small distributed generation schemes to successfully compete with large generation plant in liberalised energy markets. In this way the overall transaction costs and in some cases the fixed costs of a project can be reduced. These reduced costs will be related to CDM, but other non-CDM costs could also be reduced enhancing the viability of individual projects. This approach has been advocated by a number of commentators and desk studies carried out by IT Power have shown that it can make marginally viable CDM projects more financially attractive increasing internal rates of return (IT Power and KITE, 2002).

Despite the potential for enabling small-scale projects, in practice there have been few examples where this approach has been applied successfully in developing countries and there are a number of challenges ahead before it can become fully operational. Part of this reason is that many interested organisations lack the capacity to undertake the development of CDM project bundles or portfolios. Such an organisation, or partnership of organisations, could establish relationships with other entities, such as the individual project developers, CER buyers, and the financing source, to receive the CERs, as shown in Figure 2. The entity that carries out the bundling, which could be anything from a project developer to a greenhouse gas related fund or NGO, would sell on the total CERs of all the projects in the bundle to buyers.

The types of projects within each bundle do not necessarily have to be the same, nor do projects need to be in the same country or region. However, some similarities between projects will be essential in gaining the advantages that bundling offers, such as baselines being common between them. Initial experience from completed and ongoing projects assessing the viability of different bundled projects suggest that any project portfolio should be "single location-multi-technology" or "single technology-multi-location", but preferably with a single baseline, as then either approach can help reduce the costs of preparing a PDD and monitoring. The "single technology-multi-location" approach will be used in this project. IT Power and the Energy research Centre Netherlands (ECN) is developing a screen for suitable bundling projects based on location, type of technology used, prior experience of developers in handling CDM projects, and social relevance. A number of pilot CDM bundling projects, including renewable energy and energy efficiency, are now being facilitated by IT Power in India as part of an ongoing European Commission funded project and experience from these projects will give a further indication of the most suitable projects for bundling[13]. Bundling could enable small-scale energy projects benefiting from the CDM, particularly if their often high "sustainable development" benefits are reflected in

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[12] see http://www2.dnv.com/certification/ClimateChange/Upload/PDD_Aquarius_2003-04-17.pdf

[13] Project funded by EU Synergy Programme commenced in May 2003, for up-to-date progress and information see www.cdmpool.com

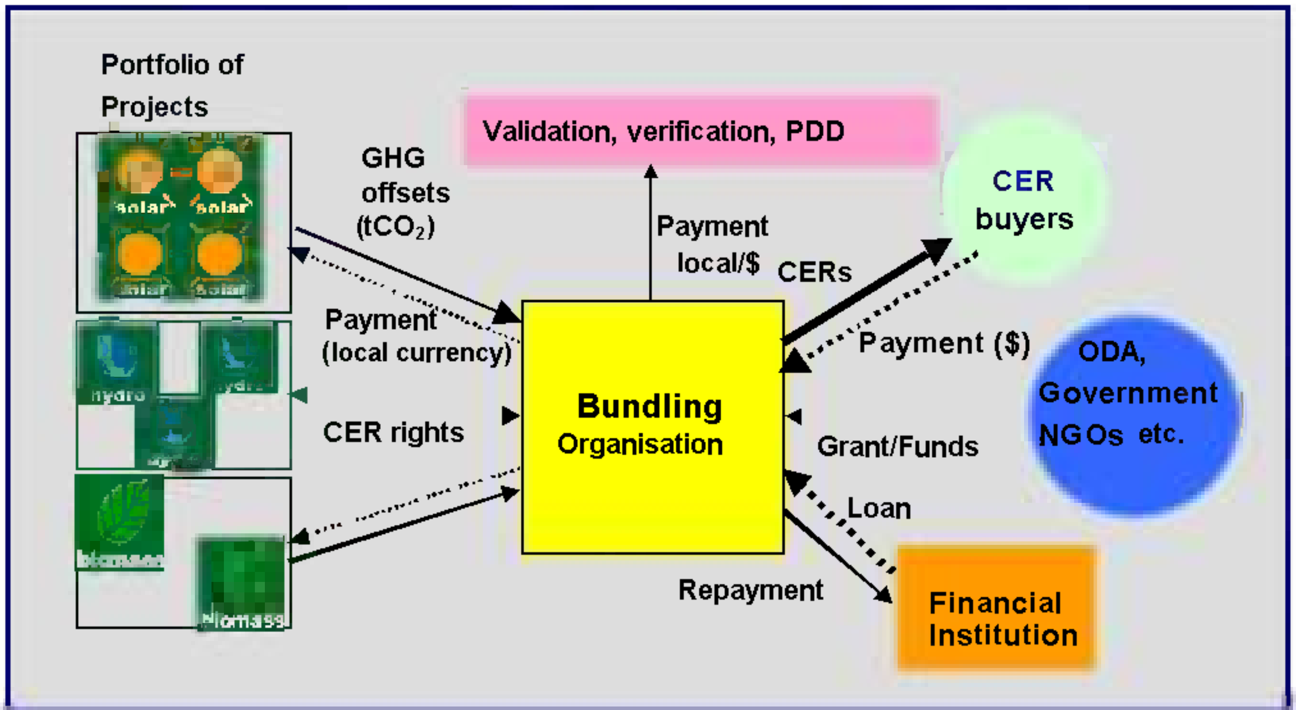

Figure 2: Bundling Organisation Transactions and Linkages

CER prices. However, the viability of small-scale project portfolios may be limited to particular types of projects with certain characteristics, particularly given current market prices for CERs.

2.4 CDM EXPERIENCE IN THE PHILIPPINES AND VIETNAM

Whereas countries in South America have vigorously sought CDM investment, developments in Asia, particularly South-East Asia has been somewhat slower. This has been attributed, in part, to some early scepticism from Governments as to the value of the mechanism for developing host countries. Both Vietnam and the Philippines have no fully developed CDM projects to-date, and in fact South East Asia only has 8 (out of 49) projects, shown in Table 2, for which a Project Design Document is available. However, Vietnam and the Philippines have become progressively supportive of the CDM, and they have both participated in a number of capacity building and project identification initiatives.

Both countries have now ratified the Kyoto Protocol (Vietnam on 25 September 2002 and the Philippines on 23 October 2003) and are involved in numerous activities to develop the institutional capacity, for example for the relevant CDM National Authorities, and identifying and formulating CDM projects.

CDM capacity building activities in the counties include:

- PREGA ("Promotion of Renewable Energy, Energy Efficiency and Greenhouse Gas Abatement"), being undertaken by the Asian Development Bank with finance from the Dutch Government. PREGA helps carry out pre-feasibility studies of investment projects for financing through commercial, multilateral, and bilateral sources, including specialised treaty-linked mechanisms such as the CDM. PREGA has been implemented in both the Philippines and Vietnam;
- CD4CDM ("Capacity Development for the Clean Development Mechanism") is another Dutch funded project launched by the United Nations Environment Programme (UNEP) that aims to increase the broad understanding of the opportunities offered by the CDM, and to develop the necessary institutional and human capabilities to formulate and implement CDM projects. Both the Philippines and Vietnam are participating;

Project Name	Location	Description	Credits claimed (i.e. reductions in tCO_2e)	Status
AT Biopower Project	Thailand	22MW rice husk biomass plant	585,076	Baseline and monitoring methodology approved by the EB
Yala biomass project	Thailand	23MW rubber wood residue biomass plant	~60,000/year	Intending to seek validation soon
Mitr Phol Biomass cogeneration project	Thailand	36MW biomass cogeneration plant	Up to 1,269,000 up to 2012, the end of the Kyoto Protocol's first commitment period	Under consideration by the PCF
Unocal's Wayan Windhu Geothermal project	Indonesia	110MW geothermal plant	5,432,469 in a 10 year period	Accepted by the Dutch Govt as a source of carbon credits
Unocal's Sarulla Geothermal project	Indonesia	200MW geothermal plant	14,532,000 in 21 years	Rejected by Dutch government as a source of carbon credits but may be seeking new buyer
Indocement efficiency project	Indonesia	Upgrading of Indocement's operations	1,000,000/year	Under consideration by the PCF and CDM Executive Board
Bumibiopower project	Malaysia	6.3MW biomass plant using wastes from adjacent palm oil plant	171,710 over 7 years	Unclear - possibility of Japan Govt. as a buyer stated in the PDD. Methodology under consideration by EB
FELDA Lepar FELDA Lepar Hilir Palm Oil Mill Biogas Project	Malaysia	650 kW biogas plant using wastes from palm oil processing	27,1000 over 10 years	Buyer unclear. Methodology not approved (category C) by the CDM Executive Board

Table 2: CDM Projects in South East Asia

- Japan's New Energy Development Organisation (NEDO) is conducting a range of CDM feasibility studies including some in Vietnam;
- The Philippines and Vietnam are part of the "Developing National Capacity to Implement Industrial Clean Development Mechanism Projects in ASEAN" program of UNIDO. Country reports have been produced[14].
- The Asian Development Bank's "Asia Least-Cost Greenhouse Gas Abatement (ALGAS)" project prepared country studies that identified GHG mitigation potential including some projects which are potential CDM projects. Reports were completed for the Philippines and Vietnam[15].

2.5 INSTITUTIONAL PROGRESS FOR CDM IN THE PHILIPPINES

At present the Philippines, like most countries, does not have all the necessary institutional capacity in place to approve CDM projects, as required under the Kyoto Protocol. However, a number of activities have been started in preparation for CDM implementation in the Philippines, particularly through the Inter-Agency Committee on Climate Change (IACCC).

The IACCC, which has been in existence for over 10 years, is composed of 12 governmental organisations with non-governmental organisations being represented by the Philippine Network on Climate Change. The IACCC is presently implementing the necessary steps to provide institutional support needed to carry out the CDM project cycle. At present, plans are being developed

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[14] Country reports have been produced Country reports can be found at http://www.unido.org/userfiles/PembletP/RASI_17-53_report.pdf for the Philippines, and http://www.unido.org/userfiles/PembletP/RASI_17-55_report.pdf for Vietnam

[15] ALGAS country reports can be found at http://www.adb.org/Documents/Reports/ALGAS/phi/default.asp for the Philippines, and http://www.adb.org/Documents/Reports/ALGAS/vie/default.asp for Vietnam

to establish the IACCC as the "CDM National Authority". This host country entity will provide written approval confirming that the proposed CDM project is voluntary, complies with national and international criteria and assists in sustainable development of the host country. There are also proposals to establish an office in the Philippines that will promote the development of CDM projects in the country. This office is envisioned as a link between the public, private and financial sector in the development and financing of CDM projects; and between project developers and CDM investors. The CD4CDM project is supporting these efforts[16].

Opportunities for CDM projects have been identified in previous projects discussed in section 2.4. A selection of these were presented at the South East Asia Forum on Greenhouse in Manila in September 2003[17], including 30MWe and 50MWe biomass cogeneration projects on Negros Island. The institutional framework and capacity will need to be in place before this first pipeline of projects can be realised, particularly for host country approval.

2.6 INSTITUTIONAL PROGRESS FOR CDM IN VIETNAM

Similar to the Philippines situation and many other developing countries, Vietnam does not presently have all the necessary capacity in place to approve CDM projects and awareness and knowledge of the mechanism itself is still relatively limited. However, since ratification of the Kyoto Protocol, a number of activities have started that will eventually enable Vietnam to adequately identify and designate CDM projects. The Ministry of Natural Resources and Environment was initially assigned by the Government as the National Authority for implementing the UNFCCC and Kyoto Protocol and an important 'National Strategy Study on CDM' is being completed. The 3-year CD4CDM project which started in April 2003 will help in this task by:

- developing the necessary institutional and human capacities that allow Vietnam to formulate and implement projects under CDM; and
- generating a broad understanding of the opportunities offered by CDM.

Considerable progress has been made on the latter with key areas of significant opportunity being identified for improving the efficiency of electricity use in industry and buildings, and for renewable energy. A number of possible projects, such as a wind-diesel electricity supply system for Phu Quy Island[18], are already being developed into CDM projects. The links to CDM and the country's sustainable development aims, such as development and use of new energy sources and the application of clean production technologies to minimise the use of natural resources and waste, have also been identified.

The next steps for Vietnam will be to establish a National CDM Authority (or Designated National Authority - DNA), and draft a legal framework for the CDM, as well as further awareness and capacity building under the CD4CDM.

2.7 FEASIBILITY OF DEVELOPING A FAMILY-HYDRO PILOT PROJECT

2.7.1 Introduction

Research undertaken through the 1990s (Green, 1993, Dang Dinh Thong, 1999, Rijsenbeek, 2000) has highlighted the extent to which Chinese-made low-head pico-hydro systems have entered the market in Vietnam. It is now estimated that 120,000 family-hydro units have been installed in the country over the last 10-15 years, supplying 130,000 households mostly in the north-west corner, near the border with China. The systems are rated at 200-300 W (but only produce 100W), they are sold in open markets in district towns and larger cities, installed and owned by single families and used for domestic lighting, radio and TVs. Since the units have such a short lifetime, it is doubtful whether more than half of these machines (60,000) are actually in operation.

However, despite this rather poor technical record and uncontrolled development of the family-hydro market in Vietnam, this type of family-hydro development can offer cheap and sustainable

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[16] See http://www.klima.ph/cd4cdm for further details

[17] All presentations and further information can be viewed at http://www.ieta.org/About_IETA/Events/Manila03.htm

[18] Project was presented at the IETA Southeast Asia forum on GHG mitigation, market mechanism and sustainable development in Manila 10-12 September, 2003

electrification to millions of low-income families in developing counties, even those living in low-lying areas where traditional hydro schemes (requiring either high head or high flow) cannot be utilised. The issues to be addressed to guarantee sustainability are being taken seriously by institutions in Vietnam, and neighbouring countries such as the Philippines want to see better pico-hydro developments, having learnt from the Vietnam experience.

A pilot-study was undertaken to explore the feasibility of bundling a large number of pico-hydro systems under the CDM in both Vietnam and the Philippines, to help meet the overall project aim of utilising carbon finance for the stimulation of the pico-hydro market. This section describes the formulation of this bundling project and the issues and hurdles that arose during the course of the pilot-study.

2.7.2 Market demand

The ideal location for a low-head pico-hydro system, is a site with a drop of 1.5 m and a perennial stream flow of more than 30 l/s available to a single unit[19]. Analysis of the potential for family-hydro in the two countries involved in the project was undertaken in order to have good base information for the development of CDM proposals for both countries.

Vietnam

In Vietnam, the number of households without grid power is estimated at 4.8 million living in approximately 1,500 communes. Approximately 50 % live in a rural setting where houses are close to a stream or irrigation canal, and of these 2.4 million households 65% are dependent on agriculture and can be assumed to have direct access to a water course, reducing the number of potential pico-hydro users to about 1.5 million households. It has been estimated that only a maximum of 10% (or 150,000 households) are likely to have access to a water course in a suitable location for the installation of a pico-hydro unit. Similar figures have been put forward by the Hydropower Department of the Institute of Energy, Vietnam, which estimates:

- ❒ 40,000 to 50,000 existing units in the range of 200 to 500 Watt need to be rehabilitated,
- ❒ 60,000 to 80,000 new units of the same power range could be installed in the next 5 to 8 years.

Thus, their estimate of the total market size for family-hydro units is between 100,000 and 130,000 units, making the potential pico-hydro market in Vietnam in the order of 20,000 units annually.

An important market push factor is the fact that grid electricity prices were subsidised until 1995, and were only US$0.04/kWh, but have since increased to double that. Coupled with the unreliability of the grid in rural areas, this has caused many more rural people to consider alternative options for electricity supply even in grid areas and has thus boosted the sales of pico- and micro-hydro equipment.

Philippines

With 30.5% of the rural population without electricity in the Philippines, a large market of 2.72 million households exists as potential beneficiaries of renewable energy systems such as family-hydro. As part of the DFID-funded project a market assessment was undertaken in the Philippines; 37 provinces were chosen for the family-hydro projects based on the following key indicators:

- ❒ electrification level,
- ❒ topography and water resources,
- ❒ affordability.

Using a spreadsheet analysis (the result of which is shown in Appendix A), initial conservative calculations of the immediate potential family-hydro market in selected provinces of the Philippines was estimated as more than 24,000 units (¾ would be 200W). This corresponds to over 100,000 households (as many of the pico-hydro units would be shared by houses in clusters), which is 7.5% of the total potential off-grid households in the 37 priority provinces. This analysis was done in detail in only half of the provinces of the country, and further analysis concluded that the total market could be as large as 120,000 units over ten years.

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[19] There is a pico-hydro unit designed for slightly larger drop of 6m and lower flow of 6 l/s, but they are less abundant

2.7.3 Comparison of family-hydro under the CDM in Vietnam and the Philippines

An initial feasibility of a CDM project was explored in both Vietnam and the Philippines using the same number of systems and installation rates based on likely market demand (as explained in earlier in section 2.7.2). The emission reduction potentials were calculated and shown in Table 3, whilst the methodology for such calculations are explained in section 2.7.7. Having analysed the family-hydro situation in Vietnam in detail, which included a Rapid Rural Appraisal (RRA) process carried out in 40 households in the field (30 with family-hydro and 10 without) to analyse existing uses and energy reduction potential, and supported by information on the current costs and market analysis of pico-hydro, the viability of developing a CDM project for good quality equipment in Vietnam was considered to be quite low.

Firstly the market delivery mechanism prevalent in Vietnam would make any control over the systems installed, for monitoring and verification purposes, difficult. The emission reduction potential was calculated for Vietnam as only 13,270 tonnes of CO_2 over 10 years, mainly due to the low use of alternative fuels that would be displaced, which is a sign of the high incidence of poverty found in the areas where family-hydro would be applicable. This low CER potential would make a CDM project impossible when considering the transaction costs, with only 3-4% of the cost of investment able to be carried by the revenue of the CERs. An extra concern was that any project may not have additionality, i.e. because of the widespread availability of very cheap pico-hydro units from China, even without any CDM component funding it is likely that more pico-hydro projects would occur anyway.

The type of family-hydro developments that have occurred in the Philippines, as seen in field visits undertaken during the project and discussed with the engineers that helped install the early units, is very different to Vietnam. Firstly, the unelectrified rural population in the Philippines are using more fuel for their power needs (ESMAP, 2002). In general, good quality (Vietnamese) systems are chosen, there are technical NGOs / private sector renewable energy companies supporting the installations, and there is funding available from the O'Ilaw Programme and local government agencies. The systems have been employed for small communities (clustered households), as well as just for individual residences.

		Vietnam		Philippines	
Year	Total New Installed (MW)	Projected Emission Reductions (CO_{2e}/yr)	Projected CERs	Projected Emission Reductions (CO_{2e}/yr)	Projected CERs
2005	0.09	0	0	0	0
2006	0.15	75	0	122	0
2007	0.26	211	0	340	0
2008	0.42	444	730	717	1,179
2009	0.58	736	736	1,189	1,189
2010	0.73	1,111	1,111	1,794	1,794
2011	0.93	1,521	1,152	2,456	2,456
2012	0.93	1,972	1,972	3,186	3,186
2013	0.93	2,282	2,282	3,687	3,687
2014	0.93	2,459	2,459	3,973	3,973
2015	0.93	2,459	2,459	3,973	3,973
Total 7 Years	3.14	6,070	6,070	9,805	9,805
Total 10 years	5.92	13,270	13,270	21,438	21,438

Table 3: Emission reduction calculation of possible family-hydro projects in Vietnam and the Philippines

The emissions reduction potential of a bundle of CDM pico-hydro projects in the Philippines calculated in the same way[20] as in Vietnam was found to be nearly 21,450 tonnes CO_2 over 10 years. This was significantly higher than in Vietnam due to higher energy consumption rates in the rural areas of the Philippines reflecting higher income, as the type of fuel displaced was similar (mainly kerosene and some diesel). The potential value of CERs accruing to such a project could possibly make a viable CDM project, and as such the project idea for the Philippines was developed further.

2.7.4 Technical description

Family-hydro systems using low-head turbines of 200 - 1,000 Watt capacity will be installed in many remote and unelectrified communities in the Philippine countryside where appropriate water resources such as irrigation canals and small streams are available. The low-head turbines are ideal for use in irrigation canals and small streams where conventional micro-hydro systems are not suitable. They are low-cost and easy to install using local skills and materials.

Following further investigations with developers in the Philippines it was decided that a Project Idea Note would be submitted for a bundle of pico-hydro projects with a total capacity of approximately 3.14 MW installed over 7 years (the installation rates expected are shown in Table 4). The scale of the project was decided by considering the market data very conservatively as the Philippines is a relatively new market and there is a considerable risk with diffusion of any new technology. The number of installations is expected to be low in the first few years while the market develops, and later new installations will replace older systems that reach the end of their operational lifetime. The total capacity will be made up of a mix of 200W, 500W and 1,000W systems, in a ratio of approximately 1:1:2. The actual numbers were not specified to allow some flexibility, as it may be that larger systems, shared between a number of households rather than individual systems (as is the case in Vietnam) may be the way the market develops.

Year of Installation	New Installations (MW)
2005	0.085
2006	0.153
2007	0.263
2008	0.415
2009	0.575
2010	0.725
2011	0.925
Total	**3.140**

Table 4: Installation rates for Pico-hydro projects in the Philippines

It is planned that either a series of two or more turbines capable of delivering the power required by a community, or individual turbines for single or small clusters of households will be installed in streams or irrigation canals. The households and communities will use the pico-hydro systems for lighting, TV, radio and small livelihood activities.

In the case of community systems being established, the beneficiary community will be provided with training from the project developer to achieve the required operating and maintenance skills. For individual users, operation and maintenance can be disseminated through the dealers (sharing of practical experience and knowledge, and the provision of manuals). Initially, Vietnamese turbines will be deployed, however it is expected that after 2 years, local turbine production will naturally emerge in the Philippines.

2.7.5 Project sites

Demonstration of the family-hydro systems serving both individual and clusters of households have been made in a number of provinces, principally on Luzon and on some Visayas islands. The first systems that were set up were mostly undertaken through collaboration with NGOs and community organisations. Lately, some Local Government Units have recognised the usefulness of the systems for remote areas and additional project sites have been identified. The provinces of Negros, Antique (in Visayas) and Kalinga and Ifugao (in Northern Luzon) have the most number of operational pico-hydro systems to-date.

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[20] also assuming the same installed capacity of 5.92MW

For the proposed CDM project, REAP is identifying an initial 150 sites (for the first installations) situated in Cordilleras, Sorgoson, Panay and Negros Island, and possibly Palawan and Mindanao (see map in Appendix B). These areas have been selected using the market demand study (discussed earlier) considering hydro resource, current energy use, level of grid connection, local incomes and expected willingness to pay.

2.7.6 Development of a baseline and monitoring methodology

2.7.6.1 Introduction

The baseline is essentially an estimate of what future emissions would be without the CDM project intervention. Of course any estimate of the future has a certain degree of uncertainty and although a baseline cannot be verified after the CDM project has been completed, its underlying assumptions can be monitored and rigorously assessed. To-date around 40-50 PDDs have been submitted to the CDM methodologies panel and 8 have so far been approved, however no baselines for off-grid projects similar to the family-hydro situation has yet been submitted.

In setting a baseline, from the project developers' perspective the main objective is to determine the most suitable baseline, whilst maximising the emission reductions for the project. For this, project developers need to understand the issues and practicalities of baselines, additionality, equivalence of different GHGs, leakage, project boundaries and permanence of emission reductions. A useful guidance document for identifying possible baselines options has been developed by UNIDO (UNIDO, 2003), which outlines steps for selecting project specific baselines amongst a number of options.

The baseline scenario for this project is a continuation of the use of kerosene, diesel, and some grid-based electricity consumption for off-grid energy provision. The pico-hydro systems in the Philippines will displace energy services provided by kerosene lamps, diesel gensets and car batteries, with car batteries being charged via off-grid diesel gensets or grid-based electricity. As mentioned earlier the procedures for small-scale CDM projects, for which this project is eligible[21], specify indicative simplified baseline and monitoring procedures. For many types of small-scale CDM technologies a standard baseline technology may be used and a standard emission factor or equation for this baseline technology used to estimate annual emissions from the CDM project.

This project falls into the 'Type 1A Renewable energy projects - Electricity Generation by User' classification given in the simplified modalities and procedures for small-scale CDM project activities[22], and the baseline options for this type of project activity are shown in
Table 5. For minimising transaction costs in the development of a small-scale project and ease of baseline calculation given the available data, it is better to opt for b), however the simplified modalities and procedures for small-scale projects also allow for project developer to submit revisions or different formulae to the CDM Executive Board (EB). Baseline Methodology Option 1 was initially proposed using the simplified baseline methodology options for Type 1A small-scale projects, whilst an alternative Baseline Methodology Option 2 was developed using an alternative formula that could be submitted as a new methodology to the CDM Methodology Panel. The latter was based on a previous study involving IT Power based on solar home systems (Ybema et al., 2000; Martens et al., 2001), and for both options a more detailed spreadsheet is given in Appendix C.

2.7.6.2 Calculation of emission reductions using Baseline Methodology Option 1

Firstly, for Baseline Methodology Option 1 the energy baseline for a Project Type 1A is the fuel consumption of the technology presently being used or that would have been used in the absence of the project activity. In this project, the pico-hydro units are displacing fossil fuels, mainly kerosene and diesel, used in the off-grid generation of electricity and some battery charging from the grid. Taking option b from Table 5 for which the project is most applicable, an annual energy baseline

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[21] the project is eligible for the simplified procedures, being a renewable energy project activity with a maximum output capacity of up to 15MW in total for the bundle

[22] see http //cdm unfccc int/pac/howto/SmallScalePA/sscclistmeth pdf

Project Type	Example of Technology	Baseline Emissions[23]	Monitoring
1A Electricity Generation by User	Solar, hydro and wind home systems, solar battery chargers	Emissions coefficient of fuel displaced (kg CO2/kWh) multiplied by: a) Number of customers * average individual consumption (kWh/yr) for the same end-use in a nearby grid-served area; or b) The estimated annual output of the renewable energy technology installed (in kWh) The impact of distribution losses may be taken into account by dividing baseline emissions	An annual check that a sample of systems are still operating as planned or metered power generated. Published values for T&D losses may be used

Table 5: Baseline Calculation Options of the Simplified Baseline and Monitoring Methodologies for Selected Small-Scale CDM Project Activity

can be estimated using the following equation:

$$E_B = \sum_i O_i/(1 - l)$$

Where:

EB = annual energy baseline

$\sum$ = the sum over the group of "i" renewable energy technologies (e.g. solar home systems, solar pumps) implemented as part of the project

O_i = the estimated annual output of the renewable energy technologies of type I installed (in kWh)

l = average technical distribution losses that would have been observed in diesel powered mini-grids installed by public programmes or distribution companies in isolated areas, expressed as a fraction.

Following this formula the annual energy baseline was calculated by finding the estimated annual output of each pico-hydro unit as shown in Table 6, multiplied by the total number of units operating in each particular year (i.e: EB = (299 x a) + (748 x b) + (1496 x c))[24]. However, a distribution loss factor was not included as the majority of displaced electricity was from kerosene and off-grid diesel gensets, and losses for grid-based electricity are accounted for later in the Philippines grid emission coefficient.

The emissions baseline is then the annual energy baseline times the CO_2 emission coefficient for the fuel displaced. For emission coefficients, IPCC default values can be used including 0.90kgCO_2/kWh derived from diesel generation units. As displaced fuel in this project was a combination of kerosene for lighting, batteries charged from the grid and diesel for gensets (also used for charging car batteries), a weighted average emission coefficient was calculated. A household energy use survey was carried out under a World Bank project in which IT Power participated (World Bank, 2001) for unelectrified villages in five provinces, and the average energy use from 800 households surveyed are shown in Table 7.

A weighted average for energy use from kerosene, batteries and gensets based on the percentage use by households was calculated assuming 100% displacement of existing electricity use (gensets and batteries) and 75% displacement for kerosene use by

Capacity (W)	Av. Run hrs/day	Power Wh/day	Power kWh/yr	No of Units operating
200	5	850	299	a
500	5	2125	748	b
1000	5	4250	1496	c

Table 6: Annual Energy Baseline Calculation for Pico-hydro Systems

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[23] IPCC default values shall be used for emission coefficients, unless otherwise stated

[24] a = no of 200W systems, b = no of 500W systems, and c = no of 1000W systems

Province	Average use per household (litres/month)	Equivalent energy used from kerosene (kWh/month)	Average energy use for appliances (kWh/month)	Average equivalent battery energy used per household (kWh/month)	Average equivalent genset energy used per household (kWh/month)
Iliolo	5.29	21.45	3.40	13.62	31.12
Palawan	11.32	27.96	6.69	-	33.86
Davao Sur	14.90	25.18	4.71	7.78	33.50
Negros	4.04	16.63	3.52	20.75	38.91
Masbate	20.49	29.16	6.25	17.51	31.53
Total	9.01	24.08	5.15	11.79	31.86

Table 7: Average Kerosene, Appliances, Battery and Diesel Genset Consumption for Unelectrified Villages in Five Provinces in Philippines

the pico-hydro units. These displacement figures were derived from data gathered during the project for pico-hydro users before and after installation. From the weighted average energy use (kWh/month), the average CO_2 emissions coefficient was derived using IPPC default values for kerosene and diesel, and assuming a grid/diesel genset mix for battery use. Grid emission factors, including transmission and distribution (T&D) losses, for present and future (up to 2012) energy mix in the Philippines were adopted from Martens et al., 2001. The overall emissions factor for fuel displaced was calculated at 0.93kg/CO_2, which is similar to the default value for diesel gensets given in the small-scale procedures, which could also be used. Using the Baseline Methodology Option 1, the project would generate less than 10,000 tCO_{2e} over a full 7-year period, but over 20,000 tCO_{2e} for a 10-year period, as the installations per year for pico-hydro increase considerably. Although the 10-year period was much more desirable in terms of carbon revenue, the option of 7 years has less risk, particularly given the low penetration of pico-hydro to date in the Philippines (see section later on risks)and the expected three year lifetime of the turbines. Furthermore due to the initial numbers of installations, emissions reductions per year for the first few years (2006, 2007) are relatively low, but rise as more systems are installed. Consequently, to limit transaction costs of verification, the first CERs will be verified in year 2008.

Year	Total New Installed (MW)	Projected Emission Reductions (CO_{2e}/year) claimed	Projected CERs to be obtained each year
2005	0.085	0	0
2006	0.153	122	0
2007	0.263	340	0
2008	0.415	717	1,179
2009	0.575	1,189	1,189
2010	0.725	1,794	1,794
2011	0.925	2,456	2,456
2012	0.925	3,186	3,186
2013	0.925	3,687	3,687
2014	0.925	3,973	3,973
2015	09.25	3,973	3,973
Total 7 years	3.140	9,805	9,805
Total 10 years	5.915	21,438	21,438

Table 8: Baseline Methodology Option 1 Emission Reduction Projections

**Installed capacity in year n = existing capacity in n-1 + new capacity in n - retirements in n (pico-hydro systems assumed to have a 3 year lifetime)*

However, the resulting baseline for the 7-year period generates only very few CERs, and in this case would provide total CER revenue of US$68,637 (at US$7/tCO_2) which would only just cover the estimated CDM transaction costs (~US$62,000). Assuming a higher CER price of US$12/$tCO_2$, the contribution of carbon finance to this project would still be minimal at only 4% of overall project costs. Only at prices in the region of US$18/$tCO_2$ would the CDM project start to look a little more attractive, contributing over 9% of the overall project investment.

2.7.6.3 Calculation of emission reductions using Baseline Methodology Option 2

The low number of CERs produced in Baseline Methodology Option 1 were problematic for the viability of the CDM enabling the pico-hydro project, hence an alternative - Baseline Methodology Option 2 was considered by the project team. This methodology is based on a formula adopted from a study by Martens et al. (2001a) prepared for the Netherlands Government, and based on previous work by ECN, Sunrise Technologies and IT Power[25] (Martens et al. 2001b) who proposed a "standardised baseline" based on a number of studies that quantified the substitution of conventional fuels with solar home systems. A relatively conservative figure for substituted conventional fuels - kerosene and car batteries (diesel genset or grid charged) - was used in developing the baseline[26]. The formula for calculating emission reductions (ER) from a pico-hydro unit is shown below, and was derived from an assessment of off-grid renewable energy systems in different countries, and assumes a default value of 5 hours typical household electricity use per day, which is consistent with pilot installations in the Philippines:

ER (tCO_2e) = no. of systems x (75 kg/yr + 2 kg/yr CO_2 per W installed capacity of each system)/1000

Based on this formula the annual emission savings for each pico-hydro system to be installed during the project were calculated as shown in Table 9.

Using the annual emissions savings figures, the projected emission credits using Baseline Methodology B for a 7 and 10-year period are shown in Table 10. Using the Baseline Methodology Option 2, the project would generate nearly 15,000 tCO_2e over a full 7-year period and over 30,000 tCO_2e for a 10-year period. This is around a third more CERs than for Baseline Methodology Option 1, and therefore, in terms of CERs production and carbon finance, this is the preferred baseline option. However, it must be noted that Baseline Methodology Option 2 would need to be submitted as a new methodology to the CDM Methodology Panel. As such it is not yet clear that a global baseline of this nature would be accepted given the current focus on procedures linked to project activity as shown in the small-scale procedures and used in Baseline Methodology Option 1. The standardised baseline proposed by Martens et al. (2001) was developed in lieu of detailed information on project specific baselines, and its simplicity would no doubt benefit small-scale projects of this kind. However, it is certainly not clear that the CDM Executive Board would accept such a baseline, whereas a standardised baseline similar to Baseline Methodology Option 1 has already been accepted.

Recently, an amendment by the CDM Executive Board poses another potential baseline option. The amendment allows the small-scale project proponent to use, with adequate justification, a higher emission factor from Table 11. For this pico-hydro project and for projects in other

Capacity (W)	Av. Run hrs/day	Power Wh/day	Annual Emissions savings ($KgCO_{2e}$/yr)
200	5	850	475
500	5	2125	1075
1000	5	4250	2075

Table 9: Baseline Methodology B Annual Emissions Saving Calculation

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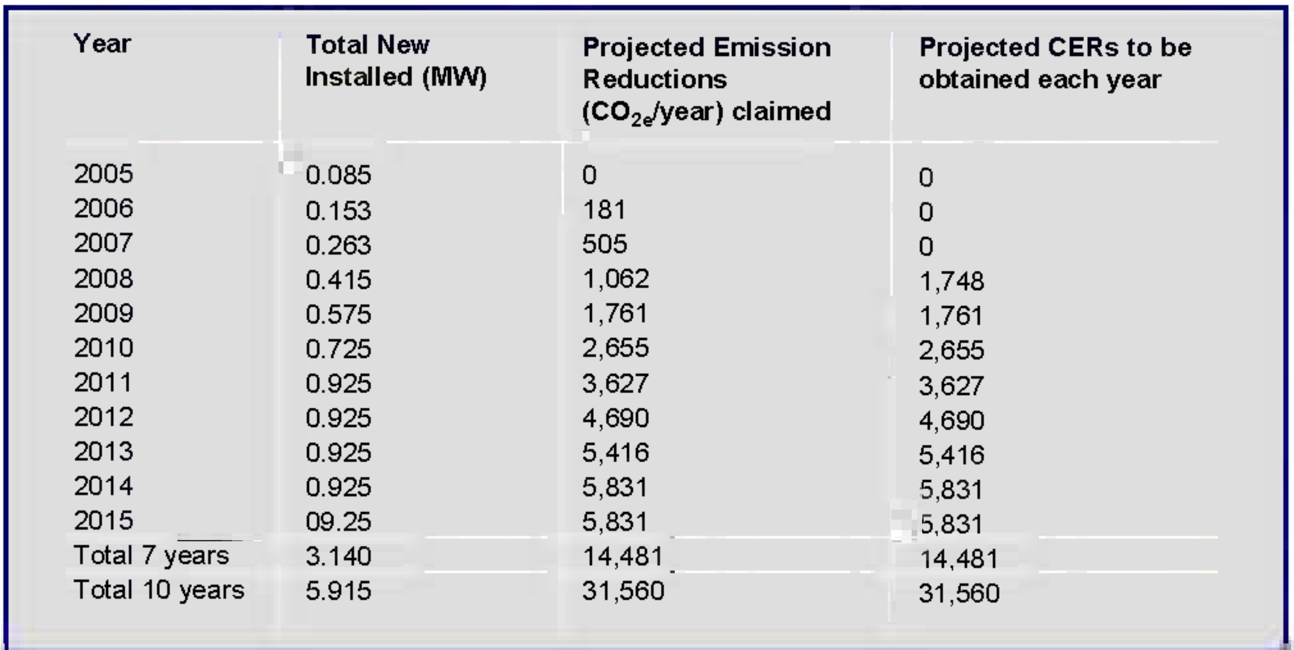
[25] Report can be downloaded at http://www.ecn.nl/unit_bs/kyoto/mechanism/cdmshs.html

[26] Average emission reduction in 8 countries studied was 275 kg CO_2 per SHS system, however for calculating the final formula a conservative estimate of 200 kg/CO_2 per year was used



Year	Total New Installed (MW)	Projected Emission Reductions (CO_{2e}/year) claimed	Projected CERs to be obtained each year
2005	0.085	0	0
2006	0.153	181	0
2007	0.263	505	0
2008	0.415	1,062	1,748
2009	0.575	1,761	1,761
2010	0.725	2,655	2,655
2011	0.925	3,627	3,627
2012	0.925	4,690	4,690
2013	0.925	5,416	5,416
2014	0.925	5,831	5,831
2015	09.25	5,831	5,831
Total 7 years	3.140	14,481	14,481
Total 10 years	5.915	31,560	31,560

Table 10: Baseline B Emission Reduction Projections

*Installed capacity in year n = existing capacity in n-1 + new capacity in n - retirements in n (pico-hydro systems assumed to have a 3 year lifetime)

countries/regions it may well be possible to justify using a higher emission factor, such as 1.4 kg CO_2equ/kWh, which could generate significantly higher emission reductions than Baseline Methodology Option 1.

It is also important to point out that both baselines assume that although there are installations in the first year (2005), the associated emission reductions for these installations are not registered for that year. Emission reductions for each year are for the installations operating at the end of the previous year. This approach was taken because installations will be staggered at different times throughout the year and this may change year to year. Another option could be to register an average of the first years' installations in year 1, and in year 2 this would rise to the total for year 1 plus half of the installations in year 2, and so on. This would increase the emission reductions using both baseline approaches, and therefore the approach that has been used can be seen as conservative in this respect.

Overall, this section has provided a brief description of two alternative baseline methodologies that could be developed fully in a PDD. At this time the project team have opted for developing Baseline Methodology Option 2, however before developing a PDD this would have to assessed again, particularly in view of any other baseline methodology submissions/approvals for off-grid projects over the coming months. At the time of writing it is likely that the final choice will be between Baseline Methodology Option 1 and the third higher emission factor option.

2.7.6.4 Additionality

In addition to the actual calculation of emissions, the baseline also needs to show that the project is 'additional' i.e. that without the CDM component the project would not necessarily occur. This project would be very unlikely to occur without the addition of the carbon revenue, as there are a number of cheaper and well established fossil fuel options e.g. diesel gensets, batteries and kerosene lamps that are presently being used by the majority of off-grid households. In the absence of this project market uptake of family-hydro would be limited.

The simplified procedures for small-scale activities also indicate that a barrier test may be used to 'prove' additionality. It is clear that market uptake of family-hydro systems faces a number of barriers in the Philippines, many of which are faced by

Cases	**Mini-grid with 24 hour service**	**i) Mini-grid with temporary service (4-6 hr/day)** **ii) Productive applications** **iii) Water pumps**	**Mini-grid with storage**
Load factors (%)	**25%**	**50%**	**100%**
<15 kW	2.4	1.4	1.2
>=15<35 kW	1.9	1.3	1.1
>=35<135 kW	1.3	1.0	1.0
>=135<200 kW	0.9	0.8	0.8
> 200 kW***	0.8	0.8	0.8

Table 11: Emission factors for diesel generator systems (in kg CO_2equ/kWh) for three different levels of load factor***

** A conversion factor of 3 2 kg CO2 per kg of diesel has been used (following IPCC guidelines)*
*** Figures are derived from fuel curves in the online manual of RETScreen International's PV 2000 model, downloadable from http //retscreen net/*
**** default values*

other new and renewable energy technologies. The CDM component reduces a number of barriers currently faced by pico-hydro in the Philippines, including:

- ❐ Reducing the cost barrier - due to bulk importation of pico-hydro equipment within this project, end users will see a reduction in cost over systems currently in the market, making hydro energy more competitive with kerosene and diesel-based alternatives. This cost advantage is expected to increase once systems are manufactured in-country;
- ❐ Increasing awareness - without the project, end-users would only have information from the limited number of pico-hydro dealers currently in the country;
- ❐ Availability of technology - pico-hydro has not been widely disseminated in the Philippines and the project will aim to deliver this technology into the rural areas and make it more available and help provide cost effective energy service provision.

For developing a full PDD, the project team will focus on the main barrier which would be "cost". The price of 'good quality' pico hydro systems is currently too high for many end users compared to fossil fuels and cheap 'low quality' pico hydro systems (discussed earlier) which are currently being used. Carbon finance could overcome this barrier by reducing the cost of the good quality to an affordable cost in the range of these other alternatives.

2.7.6.5 Monitoring methodology

For a group of similar individual technologies, such as the three different sized pico-hydro units, the annual emission reduction equals the total number of units installed times the standard emissions factor or formulae described for the baseline methodologies. In order to verify the certified emission reductions calculated above, some proof of the 'actual' emission reductions is required. For most energy projects it is usual to monitor energy output/consumption on a regular basis, for example through a meter, however, for small-scale bundling projects, such as this, it is relatively more time consuming and often impractical for a large number of installations to be monitored.

The simplified procedures for small-scale project activities - Type 1A - allows for just a sample of systems to be monitored rather than all systems, which would substantially increase transaction costs. There are presently, no approved monitoring methodologies for a project activity of this type, therefore the project team proposed the following. As all systems installed as part of this project will have a customer operation and maintenance (O&M) contract that will be fulfilled by local technicians, the technicians, organised by REAP, will make an annual check on 20% of all existing project systems in that year (they are likely to have annual information on substantially more than this if required). The verification of this sample of systems in full-working order will be used to estimate the total energy output and therefore total emission reductions. This basic methodology will be developed formally in the PDD.

2.7.7 CDM project risks

Apart from the usual risks associated with any new energy project, such as financial or performance (technology) risks, many of which the project developer is experienced in dealing with, there are also additional risks to be considered when developing a CDM project. It will be particularly important for project developers to be aware of how potential buyers may view these risks, as it will ultimately effect their ability to enter into a contract to sell CERs before they have been issued. Projects with relatively high risks may be offered very low CER prices or none at all.

2.7.7.1 Non-realisation of emissions reductions

The main additional CDM risk is the risk that the emission reductions estimated for the project will not occur, consequently the estimated CERs may not be delivered (delivery risk) or delivered at the time stated in the contract (timing risk). This is a major risk, particularly with the nature of the project depending on the market penetration of a relatively new technology within the country. The emission reductions calculated rely on the implementation of family-hydro systems over the time-frame planned, and any deviation from the initial estimation could result in penalties being imposed on the project owners. Thus, all possible occurrences that could reduce the expected emission reductions should be considered. For this project these will specifically relate to factors that may affect the demand for the technology such as:

- poor acceptance of the technology by customers which hinders the implementation and demand for further systems;
- changes in the national electrification plans i.e. off-grid areas included in the project may suddenly be included in grid electrification plans due to a political change;
- householders being unable to afford the systems, due to an economic downturn or natural disasters in which rural households may be particularly vulnerable.

Bearing these in mind, the project team have tried to minimise the risks where possible. In view of the market demand analysis discussed in section 2.7.2, a very conservative view of pico-hydro market development was used to decide on the number of systems to be installed within the project. By being conservative it may actually turn out that more systems are installed within the expected timeframe. Furthermore by reducing the crediting period of the project to 7 years rather than the more financially attractive 10 years (with considerably greater CER production) will further minimise the risk of uncertainty in the market penetration projection.

Actions are also needed in order to minimise the likelihood of poor acceptance of the technology by users. Firstly, 'good quality' systems are being used with established longer lifetimes, power outputs at the rated value, and fewer technical problems. Secondly, training in the required operation and maintenance skills will be carried out by the project developer, for community systems, whilst single householders will benefit from the sharing of practical experience and knowledge dissemination from the installers and a network of dealers. Furthermore, a service contract is included in the pico-hydro system cost to end users, to ensure the sustained operation of the systems. Good feedback from demonstration projects already carried out by the project developer have shown that initial acceptance by rural households has been positive.

Changes in the national electrification plans and the effect of natural disasters and economic downturn on rural households are outside the sphere of influence of the project developer. However, by choosing a very conservative market penetration projection and several different Provinces where installations will be sited will mean that whereas there may be low take up in some affected areas these are likely to be balanced by higher than anticipated penetration in others, thus minimising the risk. One option could be for the project developers to invest in venture insurance to minimise the risk of systems being destroyed, but this is, of course, costly and may not be required if acceptable to the CER buyer.

2.7.7.2 Other risks

Apart from the risk of non-realisation of emission reductions, there are a number of other CDM related risks should be considered, including:

- ❒ risk of the project not gaining acceptance by the Philippines DNA;
- ❒ risk that the Kyoto Protocol will not enter force (Kyoto risk);
- ❒ risk related to the baseline methodology (e.g. not being accepted);
- ❒ risk related to the market or price of CERs (market risk);
- ❒ risk from the country the project is located in, such as breach of contract (country risk)

Many of these risks can be minimised by the project developer itself, for example through fully articulating the sustainable development benefits to the host country, selecting an adequate baseline methodology, and marketing the project to ensure a good price for the CERs. In this project, REAP with a good history of renewable energy project development in the Philippines, has been acquiring the necessary knowledge and expertise through working with IT Power and other capacity building projects. The question of the Kyoto Protocol not entering into force is a risk currently shared by all parties involved in CDM projects at this time, and of course is taken into account by buyers. Investment agreements for the project must clearly state how risks will be mitigated and shared. If a CER purchase agreement is used and all of the risk is borne by the project developer or consortium, and this should be reflected in a higher CER price.

Finally, the perceived risk of the project developers (sellers), in this case REAP, by potential buyers will be particularly important. This is called counter-party risk and will be significantly determined by the country the sellers are located in, as well as credit rating and reputation. The same risks do apply to the buyer from the perspective of the seller, how-ever this risk is limited where the buyer is an Annex I government or organisations like the World Bank.

2.7.8 Sustainable development benefits

The sustainable development benefits of a project, particularly to the host country, have been highlighted as an important factor in the determination of whether a project will be accepted under the CDM. The Bonn Agreement of July, 2001 (COP6 bis) gave specific text relating to this:

"The COP agrees that it is the host Party's prerogative to confirm whether JI/CDM project activities assist in achieving sustainable development" (ENB, 2001).

Studies, such as IT Power and KITE (2002), have demonstrated that small-scale renewable energy projects can have significant sustainable development benefits in least developed countries (LDCs). A number of indicators have been identified by various organisations, such as the OECD, 2001, such as informing foreign direct investment in developing countries. These indicators have generally been split into economic, environmental and social criteria for which each project may be assessed. For CDM projects, each host country will need to develop its own sustainable development criteria to assess the benefits on a project-by-project basis, as in each country situation these benefits and sustainable development aims may be quite different. The Philippines has not yet developed such sustainable development criteria, however the following social, economic, environmental and technological benefits are expected.

The Philippines family-hydro project will provide a number of benefits both globally and locally. Installation of the systems will provide increasing amounts of electricity from 0.13 to 4.30 GWh per year to rural households in the Philippines, and benefits will include:

- ❒ the supply of good quality, clean, energy services without the negative environmental impact caused by fossil fuels, such as kerosene and diesel; and
- ❒ a reduction in the dependence on imported fossil fuels (and a corresponding reduction in the need for foreign currency required to purchase it).

More specifically at the local level, the households and clusters of households living near irrigation canals and small streams will be provided with power for lighting, education, entertainment and livelihood activities. Lighting could extend the productive time of farmers and other rural inhabitants by enabling them to work extra hours in the evening to attend to small livelihood activities that could augment family income and contribute to poverty alleviation. The development of a pico-hydro market in this project could result in direct employment gains for technicians and installers, and also indirectly from the additional jobs created by the productive use of the pico-hydro systems.

With the additional benefit derived from the small streams, it is possible that the community will be more receptive to preserve the watershed and this will result in additional positive environmental effect. Energy derived from the family-hydro system is cleaner, cheaper and more useful energy than existing energy sources used (kerosene lamps) which are a major cause of indoor air pollution which can have resulting health impacts. The unit cost of energy provided by family-hydro is lower than kerosene, which is the main fuel to be displaced. In the medium term, sustainable development is enhanced as additional livelihood activities are expected to follow after a stable energy supply is established in the community.

Furthermore the project will also help in the transfer of clean renewable energy technology to the Philippines. By building up a manufacturing base during the course of the project, it may well be possible to export technology and expertise to neighbouring countries.

2.7.9 Selection of a CER buyer

Finding a buyer of the CERs expected to be produced is one of the most important steps in developing a CDM project. Buyers will generally be looking to be assured on a number of factors when considering purchasing CERs from a project, and it is important that project developers recognises the buyer's perspective when attempting to market their CERs. Issues to be considered from the buyer's perspective and determinants of the prices they are willing to pay include:

- creditworthiness and experience of the project sponsor;
- the effectiveness, support and willingness of the host country;
- additional social and environmental benefits;
- structure of the contract e.g. liabilities the project sponsors are willing to take on if the project fails to deliver the contracted certified emission reductions;
- confidence in the quality of the ongoing CDM project management and delivery of CERs over the project lifetime;
- cost of validation and potential certification.

At the present time, the main buyers include the World Bank, various governments (particularly The Netherlands and Finland), and numerous CDM funds that a being established. In general, these organisations have been willing to purchase CERs at only relatively low market prices of around US$3-5.5/$tCO_2$. Prices within this range would have very little affect on the viability of this family-hydro project, although prices are expected to rise as more buyers enter the market, particularly when the Kyoto Protocol actually comes into force. At US$3-5.5/$tCO_2$ the revenue from CERs would at most only cover transaction costs for the family-hydro project.

As this project has significant sustainable development benefits, efforts have been made to attract a higher price from prospective buyers. The extra 'value' attributed to high sustainability CDM projects has so far not been substantially more than regular CER prices. However, the WWF has developed a "Gold Standard"[27], which can be awarded to projects that meet a certain set of criteria based on a number of sustainable development indicators shown in Table 12. By recognising these benefits, through a rigorously approved standards process, "Gold Standard" projects could gain far higher prices, perhaps in the range of US$12-23$tCO_2$. Therefore the best strategy will be to submit the project for the Gold Standard using the special PDD form that has been developed by the WWF, and market the project CERs to potential buyers looking for "high quality" CERs, such as German Watch.

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[27] See http://www.panda.org/about_wwf/what_we_do/climate_change/what_we_do/business_industry/gold_standard.cfm and http://www.panda.org/downloads/climate_change/goldstandard.pdf

Local/regional/global environment
- Water quality and quantity
- Air quality
- Other pollutants
- Soil condition
- Biodiversity (species and habitat conservation)

Social sustainability and development
- Employment (quality)
- Livelihoods of the poor
- Access to energy services
- Human and institutional capacity

Economic and technological development
- Employment (job creation)
- Impact on the balance of payments
- Technological self reliance

Table 12: Matrix of sustainable development indicators by which a project activity must be assessed for the WWF Gold Standard

Initially, the project was presented to the World Bank in Manila in September, 2003, after a Project Idea Note (PIN) was developed for the World Bank's Community Development Carbon Fund (CDCF), as attached in Appendix D.

2.7.10 Next steps for the family-hydro pilot project

After the PIN had been presented to the CDCF some comments were fed back to the project developer in the Philippines. CDCF requested further details about some proposed sites for the family-hydro units before they were willing to recommend that the project is carried forward to the next stage (including developing a PDD). As of the end of January 2004, not all of the required information had been gathered.

Parallel to promoting pico-hydro under the CDM programme, a similar effort was undertaken to highlight the technology as a sustainable option in the community electrification program of the Philippine government. This activity gained the positive attention from other development sectors including environmentalists and the World Bank who suggested tapping other means of support (outside CDM) for the pico-hydro project under other appropriate programs of the Bank as well as other institutions, such as the Global Environment Facility and the Government of the Philippines.

Both avenues of project finance will be pursued by the partners, with the sustainable development benefits of the project marketed to possible CER buyers and funding organisations. If there is suitable interest from a buyer a project design document (PDD) will be completed by the partners in the Philippines using the WWF Gold Standard template and efforts will be made to draw-up relevant contracts for the project developers and sponsors. Much of the information for the PDD has been collected during the project, however a full PDD would require a full baseline methodology and justification, an environmental impact assessment (EIA)[28], and a summary of stakeholder comments, all of which are specific to the final project which is proposed[29].

If the CDM project does not get off the ground due to low carbon prices, the low level of emission reductions, and other risk factors, alternative local and international funding sources will be sought in order to lower the cost of the pico-hydro technology to stimulate the large market potential.

2.8 GLOBAL MARKET POTENTIAL FOR PICO-HYDRO

Work has been completed by the project team to assess the potential for family-hydro in other developing countries, using a similar approach to that used in the Philippines (as presented in 2.7.2). Analysis of the potential was done by looking at the countries most applicable for pico-hydro development within Latin America, Africa and Asia, i.e. territory where rainfall is above 1,000mm per year, which has large rural populations living in river basins or near streams in the uplands. Some countries were also chosen because a certain amount of information was already available on the potential for pico-hydro.

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[28] An EIA is not required for small-scale CDM projects, unless specifically requested by the host government

[29] each proposed CDM project must invite local stakeholders to comment on the project and a summary of these comments added to the PDD

2.8.1 Basic assumptions

To assess market demand for pico-hydro in these three regions, it was necessary to establish the basic conditions for demand. These were identified as:

- the rural population are not already electrified or likely to attain grid connection in the near future (in general it is unlikely that households will supplement grid connection with other renewable energy systems);
- there are sufficient hydro resources in the location (this is difficult to assess and some estimates have had to be made based on rainfall and topography, resulting in a percentage figure of rural areas of the country applicable for tapping low-head hydro resources);
- there is an ability to pay for the systems. Systems cost approximately US$150 to buy. Through international experience, it has been shown that households typically spend 20% of their income on energy. Therefore, the assumption has been made that households require an annual income of US$750 in order to be able to purchase systems, although households below this income level may be able to pay through using lump sum purchasing from savings or credit. Estimations were made about the percentage of population that could afford pico-hydro based on the $750 income level.

It is assumed that a household will only have demand for a pico hydro system when these three conditions co-exist, i.e. a household will need to live in a rural location not already electrified, with sufficient hydro resources, and also have enough income to purchase the system.

2.8.2 Assessment process for Latin American, sub-Saharan and Asian countries

An assessment of the market demand for pico-hydro systems was carried out for each of the main countries thought to be appropriate for pico-hydro development. Data was used from various sources, including key indicator sets used by international organisations, in order to estimate the levels of electrification, hydro resources, and ability to pay. Table 13 shows the process that was used in the analysis.

A review was undertaken of indicator data sets available from international organisations such as the World Bank and United Nations agencies. The most useful national level indicators published on a regular basis are the World Development Indicators. These were drawn on for some of the data sets required and most countries could be analysed using only this source. However, for sub-Saharan Africa (SSA), it was necessary to carry out more detailed research for data by going directly to the records of national level household surveys that had been completed. The main resource for this material is the Africa Household Survey Databank listed by the World Bank[30]. Surveys have been carried out in all Sub Saharan African countries, including:

- National census;
- Income and expenditure surveys;
- Demographic and Health Surveys (DHS);
- Living Standards Measurement Surveys (LSMS).

	Inputs				**Result**
Step 1	Population (2002)	% rural population	People/ household	% rural electrified	Rural households without electricity
Step 2	% rural areas with hydro resources				Total rural population with hydro resources
Step 3		Average GNP/capita	% with income of US$750 or more per year		Capacity to pay for pico-hydro **(= Total Potential Market)**

Table 13: Datasets used to estimate the potential size of the global market for family hydro

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[30] http://www4.worldbank.org/afr/poverty/databank/default.cfm

Sufficient data was retrieved from all of these sources to undertake a preliminary analysis of market demand. However certain countries remained for which there was insufficient data to make a reasonable analysis. For Angola, Burundi, DRC, Congo, Equatorial Guinea, Gambia, Guinea Bissau, Liberia and Togo, assessing market demand was not possible even though these countries have pico-hydro resources. This is due to survey information being too out of date, or information not being accessible (survey results not being written up and disseminated, or permissions to access restricted).

The resultant percentage of the populations in the countries that meet all three conditions for demand is an approximation, as it is not known exactly how the data sets for rural electrification, hydro resources, and income interrelate. For example, it not known whether all hydro resources identified fall within electrified areas, thereby negating any market demand (although this is not likely), or if persons able to pay are located in areas that do not have hydro resources. Percentages have been converted into the number of households that may have demand for a pico hydro system, in order to have an idea of the number of systems that could be sold in each market.

2.8.3 Results

The final list of countries that were analysed in the market study is given in Table 14 with the estimated total potential number of pico-hydro units. It shows that the total global potential for low-head pico-hydro is about 4 million units. The main markets have been considered but indicate that the analysis may be slightly conservative as only 83% of the total potential developing countries population have been picked up in the list of countries used. However, much of the remaining populations are in the Caribbean (Latin American region), Pacific islands (Asian region) or North Africa where pico-hydro may only have limited use.

The potential market share is, as expected, skewed to Asia (69%), with 72% of the developing countries' populations, but Latin America shows high global market share (19%) compared to its 12% population share. However, Africa has a lower global share (12%) than its 16% population share would indicate.

The results indicate that there are potentially highly significant markets where over 500,000 systems could be sold in Brazil, India and Indonesia.

There are also potentially very important markets where over 250,000 systems could be sold in Thailand and Nepal.

Other potentially strong markets where about 100,000 systems could be sold are in Ethiopia, China, Philippines, Sri Lanka and Vietnam.

Overall, the global potential market demand in developing countries could be in the region of 4 million systems and this is still thought to be conservative. These results show that there are very promising markets for pico-hydro in each of the three continents. However it is very important to take into account that these results are approximations which should not be relied upon if considering making investments, and it is strongly advised that more detailed market studies be carried out to further refine this analysis in each individual country.

Latin America		**Africa**		**South and SE Asia**	
Argentina	12,400	Benin	4,500	China	93,000
Bolivia	47,400	Cameroon	27,600	India	978,400
Brazil	524,300	CAR	7,200	Indonesia	558,300
Chile	5,200	Cote d'Ivoire	18,700	Lao PDR	10,000
Columbia	58,400	Ethiopia	97,800	Malaysia	30,600
Ecuador	35,700	Gabon	1,700	Myanmar	48,600
Guatemala	8,000	Guinea	9,200	Nepal	292,500
Nicaragua	29,600	Ghana	33,700	Philippines	118,700
Peru	20,300	Kenya	80,200	Sri Lanka	170,600
		Lesotho	2,000	Thailand	272,300
		Madagascar	46,100	Vietnam	153,900
		Malawi	1,800		
		Mozambique	9,200		
		Nigeria	32,600		
		Rwanda	4,900		
		Senegal	5,500		
		Sierra Leone	32,100		
		Tanzania	37,900		
		Uganda	17,500		
		Zambia	3,500		
		Zimbabwe	6,000		
LA Total (18.8%)	741,300	Africa Total (12.2%)	479,7	Asia Total (69%)	2,726,900
Analysed 64.1% of total pop.		Analysed 65.2% of total pop.		Analysed 90.1% of total pop.	

Table 14: Summary of Market Potential for pico-hydro units across LAtin America, sub-Saharan Africa, China, South Asia and South East Asia

3. CONCLUSIONS AND GUIDELINES FOR POTENTIAL DEVELOPERS

The use of CDM carbon finance is a feasible means of reducing technology costs and stimulating the market for family-hydro for low income families in the Philippines. Carbon finance, could also conceivably act as a 'trigger' for the development of the market for family hydro in other countries, and the approach depicted in this report can be used to develop similar projects. However, there are a number of important factors that should be recognised in developing such a project, including:

- ❐ The size of the market, the market delivery mechanism used in a country, rural energy consumption, end user acceptance, technology transfer capabilities, institutional capacity for CDM etc., can all be extremely important in determining whether it will be beneficial to develop a CDM project in a country. The CDM is only likely to become a viable proposition for supporting family-hydro in countries where the market is expected to each a critical minimum of approximately 1MW of system capacity being installed each year within the timeframe of the project;
- ❐ However, even with 1MW being installed each year the number of CERs produced is still small. Therefore, in order to overcome CDM transaction costs the more systems to be installed the better for delivering significant numbers of CERs;
- ❐ Streamlined procedures and modalities for small-scale CDM projects can reduce transaction costs for family-hydro projects. However, it important to realise that organisational costs involved in bundling, including contractual arrangements, can raise transaction costs and these should be factored into any financial evaluation;
- ❐ Despite the feasibility of developing a CDM project in this way, there are a number of additional risks and costs involved, and approaches should be taken in the design of the project to reduce these costs and risks in order to make the project more viable. These include:
    - using standard sizes of hardware for bundled projects;
    - obtaining detailed information on hydro resources, household incomes, current energy use, and alternative energy choices used in the country;
    - for verification of CERs, monitoring can be combined with O&M using service contracts built into the dealerships for the equipment;
    - limiting the crediting period to lower risk of no-realisation of emission reductions;
    - drawing on international CDM experience and progress to develop a credible baseline methodology and monitoring and verification plan that still maximises emission reductions.

Overall, project developers should be aware that the first stage of the project preparation and review will be the crucial part of the overall CDM project cycle. This evaluation and risk assessment should be used to 'fine tune' the design of the project or to explore other possible project finance avenues if the project is found to be not viable in terms of CDM.

The same approach could also be used to develop other small-scale bundling projects, using other technologies such as solar, biomass, and hybrid, however a 'multi-technology' project could negate the benefits of bundling as separate baselines and monitoring and verification plans may be required. Pico-hydro is very similar in approach to bundling Solar Home Systems for CDM that are advocated by many international organisations, but crucial differences such as their lower cost, quality of voltage (220V straight from system), higher capacity factor etc., make pico-hydro a more viable prospect. As with most CDM projects a rise in carbon prices will significantly increase the viability of using the

CDM to stimulate the market. Although, this factor is outside the influence of the project developer it will be important to publicise the sustainable developments of such projects and inform potential buyers of the quality of CERs on offer.

There is clearly a large global market for family-hydro projects and the CDM may have a role in helping to stimulate this market if the price of CERs rises to more than US$7/t$CO_2$, perhaps with the support of WWF's Gold Standard approach.

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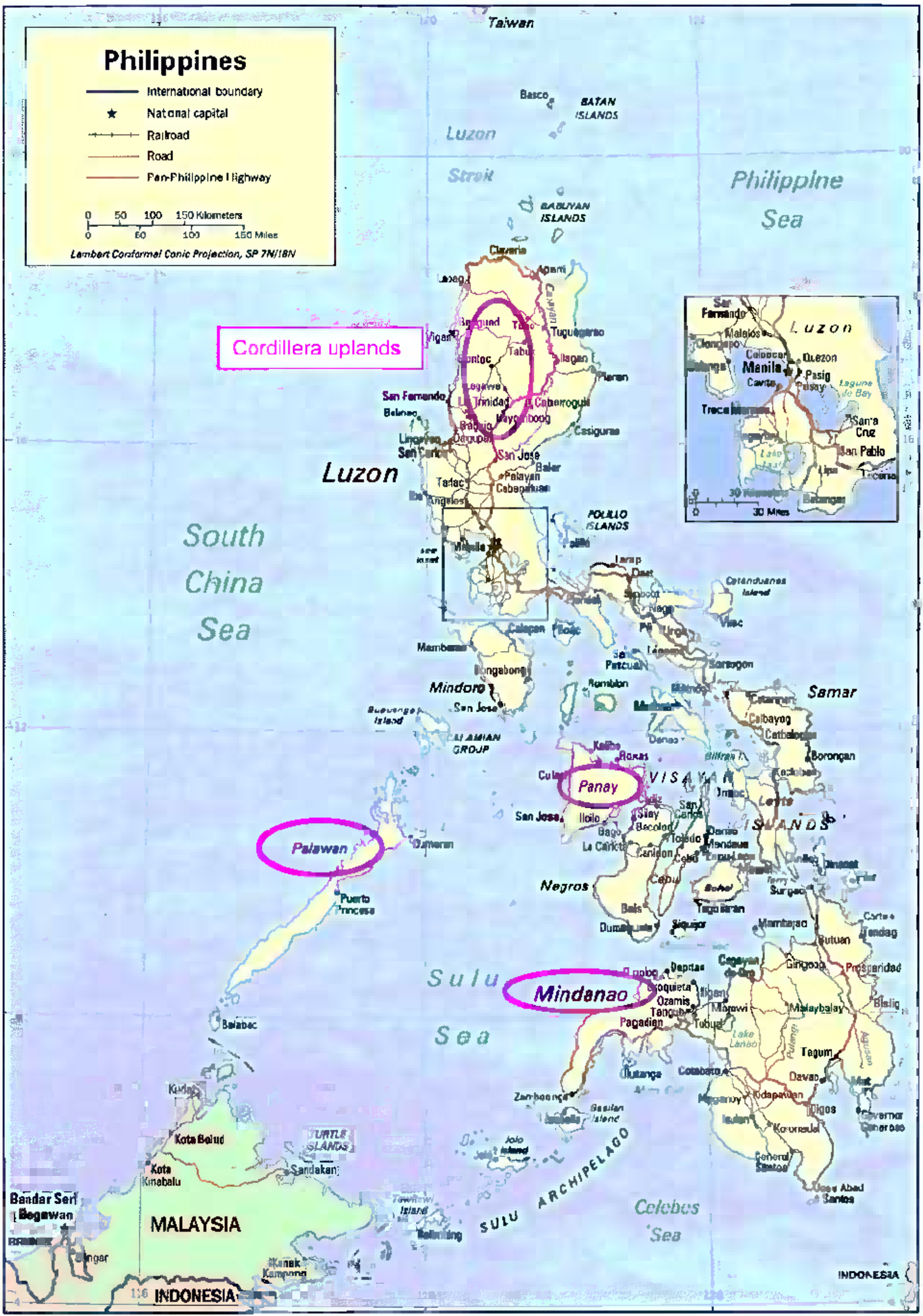
APPENDIX A - PICO-HYDRO (PH) MARKET DEMAND DATA FOR PHILIPPINES

Region	Province	Total Potential HH (Un-electrified)	Potential for PH micro-grid	Potential for PH stand-alone	Technical Market (with hydro resource)	% Afford micro-grid	% Afford stand - alone	Total HH Market	Total No. Units
CAR	Abra	6219	3151	3068	2394	50%	41%	1095	305
	Benguet (+Baguio)	7562	3745	3817	2968	50%	41%	1354	384
	Ifugao	9578	4414	5164	3975	50%	41%	1802	535
	Kalinga/Apayao	15435	6760	8675	6637	50%	41%	2996	918
	Mountain Province	5548	2409	3139	2400	50%	41%	1082	333
II	Quirino	5888	3073	2815	2208	50%	41%	1012	276
IV	Palawan	53544	33525	20019	13097	59%	49%	7237	1682
V	Albay	45717	30521	15196	10364	23%	19%	2201	478
	Camarines Norte	21052	14054	6998	4772	23%	19%	1014	220
	Camarines Sur	61373	40974	20399	13913	23%	19%	2955	641
	Catanduanes	5763	3847	1916	1306	23%	19%	277	61
	Masbate	59177	39507	19670	13415	23%	19%	2849	617
	Sorsogon	24338	16248	8090	5517	23%	19%	1172	254
VI	Aklan	12966	8537	4429	3638	13%	11%	452	99
	Antique	28540	13304	15236	11624	13%	11%	1395	412
	Capiz	24567	16822	7745	6498	13%	11%	812	172
	Iloilo (+Iloilo City)	116492	82194	34298	29441	13%	11%	3692	751
	Negros Occidental (+Bacolod)	137094	91289	45805	36344	13%	11%	4525	985
	Guimaras	7310	4965	2345	1308	13%	11%	163	34
VII	Negros Oriental	68200	45413	22787	18080	24%	20%	4172	908
X	Bukidnon	53462	34546	18916	15354	44%	37%	6410	1443
	Camiguin	2563	1764	799	527	44%	37%	222	46
	Misamis Occidental	16432	10618	5814	4719	44%	37%	1970	444
	Misamis Oriental	33760	21815	11945	9696	44%	37%	4048	911
XI	Davao del Norte	32800	18442	14358	11224	32%	27%	3372	867
	Davao del Sur (- Davao City)	47768	26493	21275	16585	32%	27%	4975	1294
	Davao Oriental	25435	14495	10940	8577	32%	27%	2580	656
	South Cotabato (+Gen Santos)	46791	27558	19233	15193	32%	27%	4587	1132
	Sarangani	41448	22987	18461	14391	32%	27%	4317	1123
	Compostela	60383	35562	24821	19606	32%	27%	5919	1461
XII	Lanao del Norte (+Ilagan City)	52016	31788	20228	16245	27%	23%	4119	982
	North Cotabato	67195	41065	26130	20985	27%	23%	5321	1268
	Sultan Kudarat	37397	22855	14542	11679	27%	23%	2962	706
Caraga	Agusan del Norte (+Butuan City)	15843	8376	7467	5792	22%	19%	1194	323
	Agusan del Sur	32837	17361	15476	12005	22%	19%	2475	669
	Surigao del Norte	28203	14911	13292	10311	22%	19%	2126	574
	Surigao del Sur	18823	9952	8871	6882	22%	19%	1419	383
TOTALS	**37 provinces**	**1,329,519**	**825,340**	**504,179**	**389,670**	**31%**	**26%**	**100,273**	**24,347**

APPENDIX B - PROPOSED LOCATIONS FOR PICO-HYDRO SYSTEMS IN THE PHILIPPINES



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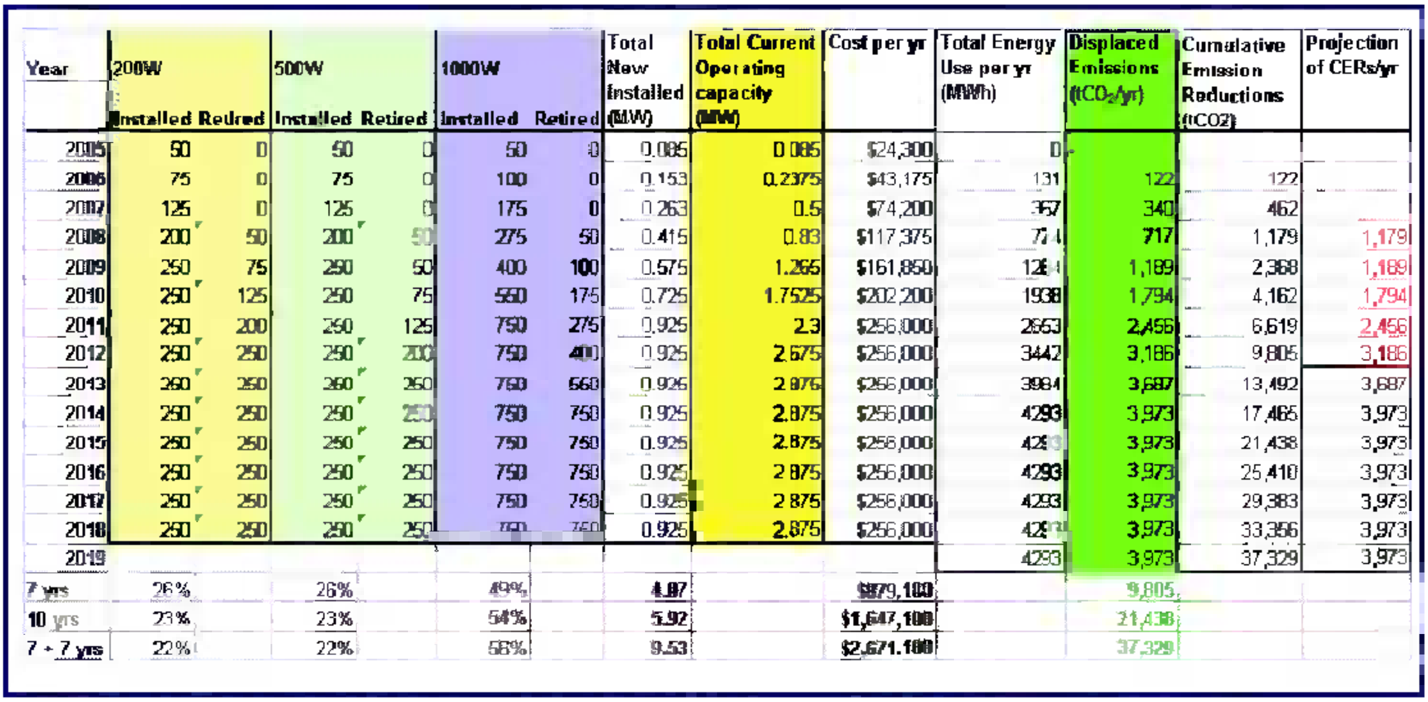
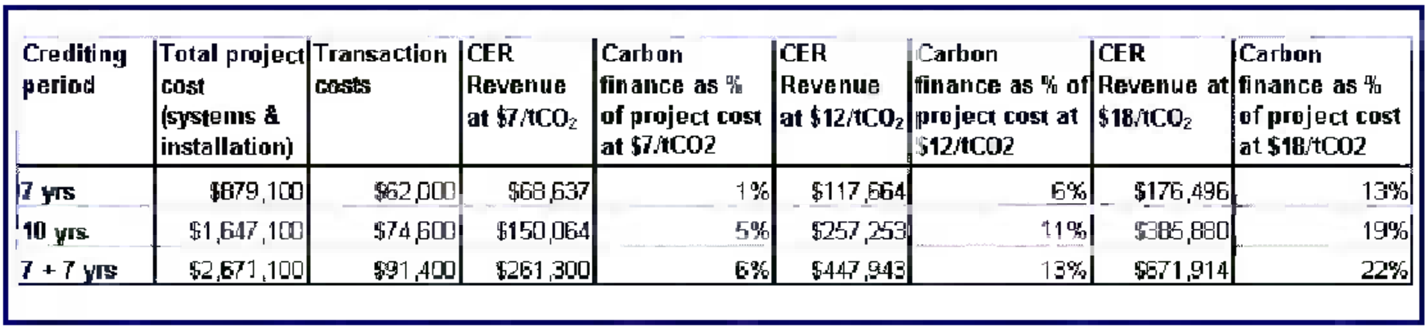
Appendix C - Spreadsheet Calculations for Baseline Options 1 and 2

Baseline Option 1 - CER Calculations

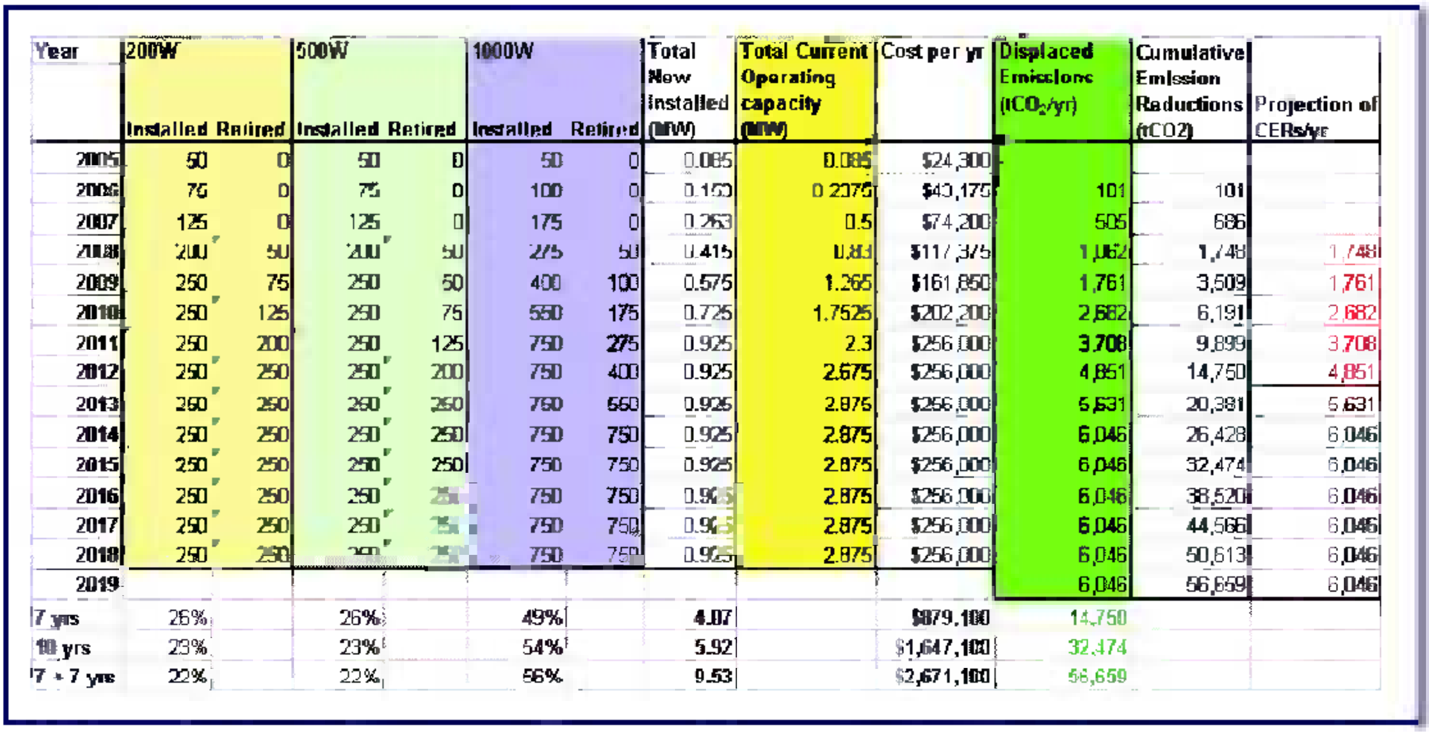


Year	200W		500W		1000W		Total New installed (MW)	Total Current Operating capacity (MW)	Cost per yr	Total Energy Use per yr (MWh)	Displaced Emissions (tCO$_2$/yr)	Cumulative Emission Reductions (tCO2)	Projection of CERs/yr
	Installed	Retired	Installed	Retired	Installed	Retired							
2005	50	0	50	0	50	0	0.085	0.085	$24,300	0			
2006	75	0	75	0	100	0	0.153	0.2375	$43,175	131	122	122	
2007	125	0	125	0	175	0	0.263	0.5	$74,200	357	340	462	
2008	200	50	200	50	275	50	0.415	0.83	$117,375	774	717	1,179	1,179
2009	250	75	250	50	400	100	0.575	1.265	$161,850	1284	1,189	2,368	1,189
2010	250	125	250	75	550	175	0.725	1.7525	$202,200	1938	1,794	4,162	1,794
2011	250	200	250	125	750	275	0.925	2.3	$256,000	2653	2,456	6,619	2,456
2012	250	250	250	200	750	400	0.925	2.675	$256,000	3442	3,186	9,805	3,186
2013	260	250	260	250	750	560	0.926	2.876	$256,000	3984	3,687	13,492	3,687
2014	250	250	250	250	750	750	0.925	2.875	$256,000	4293	3,973	17,465	3,973
2015	250	250	250	250	750	750	0.925	2.875	$256,000	4293	3,973	21,438	3,973
2016	250	250	250	250	750	750	0.925	2.875	$256,000	4293	3,973	25,410	3,973
2017	250	250	250	250	750	750	0.925	2.875	$256,000	4293	3,973	29,383	3,973
2018	250	250	250	250	750	750	0.925	2.875	$256,000	4293	3,973	33,356	3,973
2019										4293	3,973	37,329	3,973
7 yrs	26%		26%		49%		4.87		$879,100		9,805		
10 yrs	23%		23%		54%		5.92		$1,647,100		21,438		
7 + 7 yrs	22%		22%		58%		9.53		$2,671.100		37,329		

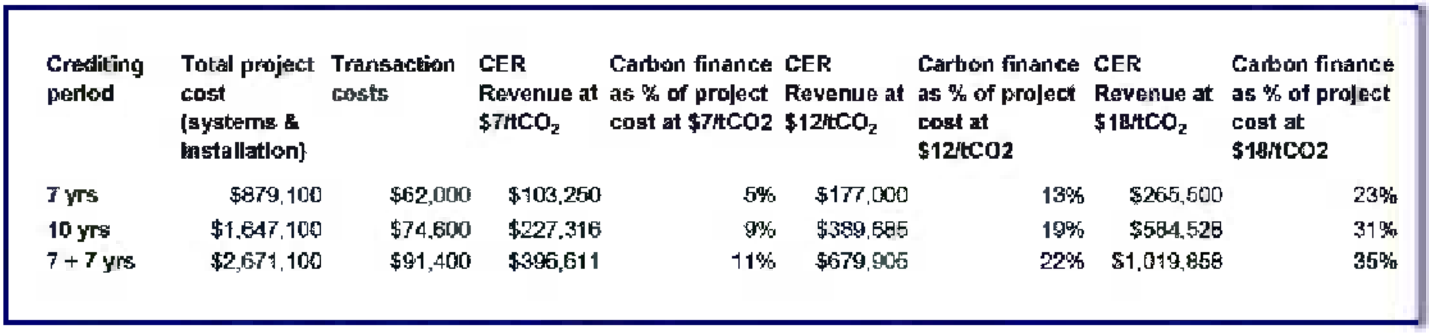


Crediting period	Total project cost (systems & installation)	Transaction costs	CER Revenue at \$7/tCO$_2$	Carbon finance as % of project cost at \$7/tCO2	CER Revenue at \$12/tCO$_2$	Carbon finance as % of project cost at \$12/tCO2	CER Revenue at \$18/tCO$_2$	Carbon finance as % of project cost at \$18/tCO2
7 yrs	$879,100	$62,000	$68,637	1%	$117,664	6%	$176,496	13%
10 yrs	$1,647,100	$74,600	$150,064	5%	$257,253	11%	$385,880	19%
7 + 7 yrs	$2,671,100	$91,400	$261,300	6%	$447,943	13%	$671,914	22%

Baseline Option 2 - CER Calculations



Year	200W		500W		1000W		Total New installed (MW)	Total Current Operating capacity (MW)	Cost per yr	Displaced Emissions (tCO_2/yr)	Cumulative Emission Reductions (tCO2)	Projection of CERs/yr
	Installed	Retired	Installed	Retired	Installed	Retired						
2005	50	0	50	0	50	0	0.085	0.085	$24,300			
2006	75	0	75	0	100	0	0.150	0.2375	$43,175	101	101	
2007	125	0	125	0	175	0	0.263	0.5	$74,200	505	686	
2008	200	50	200	50	275	50	0.415	0.83	$117,375	1,062	1,748	1,748
2009	250	75	250	50	400	100	0.575	1.265	$161,850	1,761	3,509	1,761
2010	250	125	250	75	550	175	0.725	1.7525	$202,200	2,682	6,191	2,682
2011	250	200	250	125	750	275	0.925	2.3	$256,000	3,708	9,899	3,708
2012	250	250	250	200	750	400	0.925	2.675	$256,000	4,851	14,750	4,851
2013	250	250	250	250	750	550	0.925	2.875	$256,000	5,631	20,381	5,631
2014	250	250	250	250	750	750	0.925	2.875	$256,000	6,046	26,428	6,046
2015	250	250	250	250	750	750	0.925	2.875	$256,000	6,046	32,474	6,046
2016	250	250	250	250	750	750	0.925	2.875	$256,000	6,046	38,520	6,046
2017	250	250	250	250	750	750	0.925	2.875	$256,000	6,046	44,566	6,046
2018	250	250	250	250	750	750	0.925	2.875	$256,000	6,046	50,613	6,046
2019										6,046	56,659	6,046
7 yrs	26%		26%		49%		4.07		$879,100	14,750		
10 yrs	23%		23%		54%		5.92		$1,647,100	32,474		
7 + 7 yrs	22%		22%		56%		9.53		$2,671,100	56,659		



Crediting period	Total project cost (systems & installation)	Transaction costs	CER Revenue at $7/tCO_2$	Carbon finance as % of project cost at $7/tCO2	CER Revenue at $12/tCO_2$	Carbon finance as % of project cost at $12/tCO2	CER Revenue at $18/tCO_2$	Carbon finance as % of project cost at $18/tCO2
7 yrs	$879,100	$62,000	$103,250	5%	$177,000	13%	$265,500	23%
10 yrs	$1,647,100	$74,600	$227,316	9%	$389,685	19%	$584,528	31%
7 + 7 yrs	$2,671,100	$91,400	$396,611	11%	$679,905	22%	$1,019,858	35%

APPENDIX D - PROJECT IDEA NOTE FOR A FAMILY HYDRO CDM PROJECT IN THE PHILIPPINES

A. Project description, type, location and schedule.

Name of Project: Pico-hydro in the Philippines

Technical summary of the project. Date submitted: September 2003

Objective of the project:	*Describe in less than 5 lines* The project aims to contribute to sustainable development in Philippine villages in rural areas by providing affordable, clean, appropriate renewable energy to households through the installation of "low-head" pico-hydro systems. The project activity will result in a reduction of CO_2 emissions through displacement of other fossil fuel options for off-grid energy service provision.
Project description and proposed activities (including a technical description of the project):	*About 1/2 page* Family hydro systems using low head turbines of 200 - 1000 Watt capacity will be installed in remote and unelectrified communities in the Philippine countryside where appropriate water resources such as irrigation canals and small streams are available. The low head turbines are ideal for use in irrigation canals and small streams where conventional micro-hydro systems are not suitable. They are low cost and easy to install using local skills and materials. It is expected that there will be a total installed capacity of approximately 3.14 MW over 7 years within the project. It is planned that either a series of two or more turbines will be used to deliver the power required by a community, or individual turbines for single or small clusters of households will be installed. The households and communities will use the pico-hydro systems for lighting, TV, radio and small livelihood projects. In the case of community systems being established, the beneficiary community will be provided the proper training from the project developer to achieve the required operating and maintenance skills. For individual users, operation and maintenance can be disseminated through the dealers (sharing of practical experience and knowledge, plus manuals). Vietnamese turbines will be deployed which have a longer life and lower maintenance costs than the cheap Chinese turbines widely used in Vietnam and China and it is expected that after 1-2 years, local turbine production will emerge in the Philippines.
Technology to be employed:	The pico-hydro systems consist of two types of turbine (propeller and turgo) operated by water pressure generated at low head (1-2 metres or 6-10 metres) and flows of 28-130 litres/second. Pico-hydro systems from Vietnam of 200 - 1,000 Watts capacity have been successfully installed in several provinces in the Philippines since 1999.

Small-scale:	Type I - Renewable energy projects A. Electricity generation by the user/household
Project Developer details	
Project developer Name:	REAP (Renewable Energy Association of the Philippines), in conjunction with pico-hydro dealers supplying to private individuals and community groups in the Philippines.
Organisational category:	NGO through private companies
Other function(s) of the project developer in the project:	Sponsor and intermediary
Summary of the relevant experience of the project developer:	REAP provides an avenue for key players in the private sector to exchange expertise on new and renewable energy technologies in the Philippines. REAP have led in establishing the first 65 systems in the Philippines through two commercial distributors (Solar Electric Co. and MATEC).
Address:	Renewable Energy Association of the Philippines 11 Liamzon St., Midtown, Marikina City, 1800, Philippines
Contact person:	Name of the Project Development Manager C/o Vicente O. Roaring, Executive Director, REAP Olegario S. Serafica, President, REAP
Contact details:	Tel: (+63) 2 646 7319 E-mail: renergy@compass.com.ph
Project Sponsors	
Name:	MATEC
Organisation category:	Private Company
Address:	Tech. Center, Buencamino St., Alabang, Muntinlupa City, Metro Manila, Philippines *www.matec.com.ph*

Main activities:	Power electronic equipment supply, solar PV equipment sales and installation, micro-hydro supplies and support engineering for renewable energy schemes.
Summary of the financials:	Total assets - PhP 45,142,185 (~US$ 791,000) Revenues - PhP 73,514,674 (~US$ 1,380,000) Gross profit - PhP 15,771,114 (~US$ 296,000)
Type of Project	
Greenhouse gases targeted	CO_2
Type of activities:	Abatement
Location of the Project	
Region:	East Asia and Pacific
Country:	Philippines
City:	Specific locations are nationwide in the Philippines, wherever appropriate water resource is available, and where there is demand for electricity by the surrounding communities.
Brief description of the location of the plant:	Initial locations are planned on the islands of Panay, Negros, Palawan, Mindanao as well as in the uplands of Northern Luzon (see PIN Annex 1 Map). The hydro resources and local affordability of pico-hydro systems in these areas have been assessed (data available) and the potential market is obtainable.
Expected Schedule	
Earliest Project Start date:	First units will be installed from mid 2004 onwards, for the following seven years, and the units will be operational from 2005 to 2011.
Estimate of time required before becoming operational after approval of the PIN:	6 months for the first units and 7 years for all units.
Expected first year of CER delivery:	Emission reductions will start in Year 2006, but CERs will not be delivered until 2008 because the modest emission reductions for the first two years (2006-2007) will be cumulated for verification in 2008.
Project lifetime:	7 years
Current status or phase of the project:	Identification and pre-selection phase.

<table>
<tr><td>Current status of the acceptance:</td><td>Letter of Endorsement available.</td></tr>
<tr><td>The position of the Host Country with regards to the Kyoto Protocol:</td><td>The Philippines has accepted and acceded to the Kyoto Protocol, and formal ratification was achieved in 2003. A CDM Authority is currently being set up, in-line with the ratification schedule, and this will be the designated UNFCCC focal point of Philippines.</td></tr>
<tr><td colspan="2"><u>B. Expected Environmental and Social benefits</u></td></tr>
<tr><td>Estimate of Greenhouse Gases abated/CO$_2$ Sequestered (in metric tonnes of CO$_2$-equivalent):</td><td>Annual:
Up to and including 2012: 14,481 tCO$_2$-equivalent
Up to a period of 10 years: 31,560 tCO$_2$-equivalent
Up to a period of 7 years: 14,481 tCO$_2$-equivalent
Up to a period of 14 years: 54,850 tCO$_2$-equivalent</td></tr>
<tr><td>Baseline scenario:</td><td>The project will reduce emissions of CO$_2$ associated with the displacement of fossil fuels, mainly kerosene and diesel, used in the off-grid generation of electricity and other energy services, such as lighting. Demand for pico-hydro has been assessed and systems targeted for off-grid areas with adequate hydro resources, but with no plans for grid connection in the next 7 years. The Project is a "small-scale CDM project activity" and eligible to utilise the baseline options set out in the simplified M&P for CDM small-scale project activities. In the absence of any standardised baseline for pico-hydro or other technologies the project will propose a new baseline methodology to the CDM Methodology panel. The methodology may be based on a formula derived in a study by Martens et al (2001) prepared for the Ministry of Housing, Spatial Planning and the Environment of the Government of the Netherlands. The formula, shown below, was derived from a global assessment of off-grid renewable energy systems, and assumes a default value of 5 hours typical household electricity use per day, which is consistent with pilot installations in the Philippines:

Emission reductions (tCO$_2$e) = number of systems x (75 kg/year + 2 kg/year CO$_2$ per W installed capacity of each system)/1000

Based on this formula the emission savings per year for each pico hydro system to be installed during the project were calculated as follows:

<table>
<tr><th>Capacity (W)</th><th>Av. Run hrs/day</th><th>Power Wh/day</th><th>Emissions savings/ yr (kgCO$_{2e}$/yr)</th></tr>
<tr><td>200</td><td>5</td><td>850</td><td>475</td></tr>
<tr><td>500</td><td>5</td><td>2125</td><td>1075</td></tr>
<tr><td>1000</td><td>5</td><td>4250</td><td>2075</td></tr>
</table>

Emission reductions per year for the first few years (2006, 2007) are relatively low, but rise each year as more systems are installed (see total new installed in table below). Consequently, the first CERs will be verified for year 2008 and include emission reductions from 2006 and 2007. The projected emission credits and installed capacity for the 7 years are as follows:</td></tr>
</table>

Baseline scenario:

Year	Total New Installed (MW)	Projected Emission Reductions (tCO_{2e}/yr)	Projected CERs
2005	0.085		
2006	0.153	181	
2007	0.263	505	
2008	0.415	1,062	1,748
2009	0.575	1,761	1,761
2010	0.725	2,655	2,655
2011	0.925	3,627	3,627
2012		4,690	4,690
TOTAL	**3.14**	**14,481**	**14,481**

N.B. Installed capacity in year n = existing capacity in n-1 + new capacity in n - retirements in n (pico hydro systems assumed to have a 3 year lifetime)

Without the addition of the carbon revenue, the project would be unlikely to occur as: there are a number of cheaper and well established fossil fuel options e.g. diesel gensets, batteries and kerosene lamps; and market uptake of pico-hydro systems faces a number of barriers in the Philippines many of which are faced by other new and renewable energy technologies. In the absence of this project market uptake of pico-hydro would be limited and likely to be characterised by lower quality, less reliable systems with less support. The CDM component reduces a number of barriers currently faced by pico-hydro in the Philippines, including:

- Reducing cost barrier - due to bulk importation of pico-hydro equipment within this project end-users will see a reduction in their cost over systems currently in the market, making hydro power more competitive with kerosene and diesel-based lighting. This cost advantage is expected to increase once systems are manufactured in-country later on in the project.
- Increasing awareness -with awareness generated by the project (and with the endorsement of the IACCC), end-users will be easier encouraged to install pico-hydro for their energy needs.
- Availability of technology - pico-hydro has not been as widely disseminated in the Philippines and the project will aim to bring this technology forward to the rural areas to help abate emissions from traditional forms of fuel.

Specific global & local environmental benefits:

The project will result in CO_2 abatement amounting to 14,481 tonnes for a 7-year period. It will displace kerosene and diesel used for genset electric supply and battery charging used by households in the project areas. The communities are expected to develop increased awareness in caring for and preserving the watershed of the local water systems and irrigation canals due to the additional direct economic benefits derived by the projects.

Which guidelines will be applied?

The policy and procedural requirement for an environmental assessment of WB Projects are required in Operational Manual (OP) and Bank Procedures (BP) 4.01. The Bank also provided the Environmental Assessment Sourcebook (1991) and the Environmental Assessment Sourcebook Updates issued periodically since 1993.

Also WWF's 'Gold Standard for CDM projects' (*www.panda.org/about_wwf/what_we_do/climate_change/what_we_do/business_industry/gold_standard.cfm*) will be applied.

Within the Philippines, Presidential Decree (PD) 1586, the Philippine EIS System Law and Water Code of the Philippines (PD 1067) will be followed.

Local benefits	The households and clusters of households living near irrigation canals and small streams will be provided with power for lighting, education, entertainment and livelihood activities. Lighting could extend the productive time available to farmers, enabling them to work extra hours in the evenings to attend to small livelihood activities that could augment family income. With the additional benefits being derived from the small streams, it is expected that the community will be more receptive to preserve the watershed and this will result in additional positive environmental effect. Energy derived from the pico-hydro system is cleaner, cheaper and more useful energy compared to the existing energy sources used (kerosene lamps) which are a major cause of indoor air pollution and resulting health impacts. The unit cost of energy provided by pico-hydro is lower and less polluting compared to kerosene, which is the main fuel to be displaced.
Global benefits:	Reduced carbon dioxide emissions.
Socio-economic aspects:	The energy derived from the pilot pico-hydro system installations provides social and economic benefits to individuals and communities, in terms of access to better quality energy supplies and a lower cost. This would not occur without the project. The impact of electricity enhances the social and economic status of the households and the community. Lighting extends the working hours in the community, can be used to provide access to information through the use of televisions and radios without the expense and difficulty of battery charging. In the medium term, sustainable development is enhanced as additional livelihood activities are expected to follow after a stable energy supply is established in the community.
Which guidelines will be applied?	The WB provides specific guidance on addressing the rights of indigenous peoples, including traditional land and water rights (OD 4.20, Indigenous Peoples (to be reissued as OP/BP 4.10) and on Cultural Property protection of archeological sites, historic monuments, and historic settlements (OP 4.11, Safeguarding Cultural Property in Bank-Financed Projects). Also, DFID Sustainable Livelihoods Framework (*www.livelihoods.org*) & WWF Gold Standard for CDM projects (*www.panda org/about_wwf/what_we_do/climate_change/what_w_e_do/business_industry/gold_standard.cfm*) would apply. Within the Philippines, The Indigenous Peoples Rights Act of 1997 (RA 8371) will be followed.
What are the best possible direct effects (e.g., employment creation, capital required, foreign exchange effects)?	Employment opportunities will result from the local assembly and installation of the pico-hydro systems, and in the medium-term from having in-country manufacturing capability. This will generate added value for the local economy. Savings in foreign exchange are also expected because less oil for kerosene production, which is the major fuel to be displaced, will need to be imported.

What are the possible other effects? For example: **- Training/education associated with the introduction of new processes, technologies and products and/or** **- the effects of a project on other industries:**	Every beneficiary community will benefit from training on the maintenance and use of the pico-hydro system as part of each community-based project implemented. Additional micro-industries are expected to prosper in the newly "energised" communities.
Environmental strategy/ priorities of the Host Country:	The Philippines Government is promoting renewable energy sources as the choice technology for energising approximately 50% of the remaining off-grid areas in the country that are uneconomical to connect to the existing grid system. Pico-hydro systems fit perfectly into this plan. Many of the remaining 5,400 (DOE figures as of 2003) unenergised villages, which are in turn are made up of 10-20 sitios (clusters of houses) have water resources that may be developed for pico-hydro systems.
<u>C. Finance</u>	
Total project cost estimate:	Development costs - US$ 0.05 million (covering the transaction costs and validation process) Installed cost -US$0.879 million (covering the pico-hydro unit costs) Other costs - US$0.087 million (administrative & training costs) Total project costs - US$1.017 million
Indicative CER price (subject to negotiation and financial due diligence):	US$18 tCO_2
Total Emission Reduction Purchase Agreement (EPRA) value:	A period until 2012 (end of the first budget period) - US$265,500 A period of 7 years - US$265,500 A period of 14 years (2 * 7 years) - US$1,019,858
If financial analysis is available for the proposed CDM activity, provide the forecast financial internal rate of return for the project with and without the CER revenues. Provide the financial rate of return at the expected CER price above and US$3/ tCO_2e. DO NOT assume any up-front payment from the CDCF in the financial analysis that includes CDCF revenue stream.	Please see Spreadsheet for calculating the above: 'Final PIN Calculations v3.3.xls'

APPENDIX E - GLOSSARY OF TERMS RELATED TO THE CLEAN DEVELOPMENT MECHANISM (CDM)

Additionality: According to the Kyoto Protocol, gas emission reductions generated by Clean Development Mechanism and Joint Implementation project activities must be additional to those that otherwise would occur. Additionality is established when there is a positive difference between the emissions that occur in the baseline scenario, and the emissions that occur in the proposed project.

Annex 1 countries: These are the 36 industrialised countries and economies in transition listed in Annex 1 of the UNFCCC. Their responsibilities under the Convention are various, and include a non-binding commitment to reducing their GHG emissions to 1990 levels by the year 2000.

Annex B countries: These are the 39 emissions-capped industrialised countries and economies in transition listed in Annex B of Kyoto Protocol. Legally-binding emission reduction obligations for Annex B countries range from an 8% decrease (e.g. EU) to a 10% increase (Iceland) on 1990 levels by the first commitment period of the Protocol, 2008-2012.

Baseline: The baseline for a CDM project activity is the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases (GHG) that would occur in the absence of the proposed project activity. A baseline should cover emissions from all gases, sectors and source categories listed in Annex A (of the Kyoto Protocol) within the project boundary.

Baseline methodology: A methodology is an application of a baseline to an individual project activity, reflecting aspects such as sector and region. No methodology is excluded a priori so that project participants have the opportunity to propose a methodology. The Executive Board agreed that in the two cases below, the following applies:
Case of a new methodology: In developing a baseline methodology, the first step is to identify the most appropriate approach for the project activity and then an applicable methodology;
Case of an approved methodology: In opting for an approved methodology, project participants have implicitly chosen an approach.

Baseline - new methodology: Project participants may propose a new baseline methodology established in a transparent and conservative manner. In developing a new baseline methodology, the first step is to identify the most appropriate approach for the project activity and then an applicable methodology. Project participants can submit a proposal for a new methodology to a designated operational entity by forwarding the proposed methodology in a draft project design document (PDD), including the description of the project activity and identification of the project partners.

Carbon offsets: used in a variety of contexts, most commonly either to mean the output of carbon sequestration projects in the forestry sector, or to refer to the output of any climate change mitigation project more generally.

Carbon credits: as for carbon offsets, though with added connotations of (1) being used as 'credits' in companies' or countries emission accounts to counter 'debits' i.e. emissions, and (2) being tradable, or at least fungible with the emission permit trading system.

Carbon Dioxide Equivalent (CO_{2e}): The universal unit of measurement used to indicate the global warming potential of each of the six greenhouse gases. Carbon dioxide - a naturally occurring gas that is a by-product of burning fossil fuels and biomass, land-use changes, and other industrial processes - is the reference gas against which other greenhouse gases are measured.

CERs (certified emission reductions): the technical term for the output of JI prospects, as defined by the Kyoto Protocol.

Certification: Certification is the written assurance by the designated operational entity that, during a specified time period, a project activity achieved the reductions in anthropogenic emissions by sources of greenhouse gases (GHG) as verified.

Clean Development Mechanism (CDM): The CDM was established by Article 12 of the Protocol and refers to climate change mitigation projects undertaken between Annex 1 countries and non-Annex 1 countries (see below). Project investments must contribute to the sustainable development of the non-Annex 1 host country, and must be independently certified. This latter requirement gives rise to the term "certified emission reductions" or CERs, which describe the output of CDM projects, and which under the terms of Article 12 can be banked from the year 2000, eight years before the first commitment period (2008-2012).

Conference of Parties (COP): The meeting of parties to the United Nations Framework Convention on Climate Change.

Crediting period: The crediting period for a CDM activity is the period for which reductions from the baseline are verified and certified by a designated operational entity for the purpose of issuance of certified emission reductions (CERs). Project participants are able to choose the starting date of a crediting period to be after the date the first emission reductions are generated by the CDM project activity. A crediting period should not extend beyond the operational lifetime of the project activity.
The project participants may choose between two options for the length of the crediting period: i) fixed crediting period (e.g. 10yrs for energy projects) or ii) renewable crediting period (e.g. 7 + 7 yrs for energy projects)

Designated operational entity (DOE): An entity designated by the COP (or MOP), based on recommendation by the Executive Board, as qualified to validate proposed CDM project activities as well as verify and certify reductions in anthropogenic emissions by sources of greenhouse gases (GHG). A designated operational entity shall perform validation or verification and certification on the same CDM project activity. Upon request, the Executive Board may however, allow a single DOE to perform all these functions within a single CDM project activity. COP at its eighth session decided that the Executive Board may designate on a provisional basis operational entities.

Emission Reductions Purchase Agreement (ERPA): Agreement which governs the purchase and sale of emission reductions.

Greenhouse gases (GHGs): These are gases released by human activity that are responsible for climate change and global warming. The six gases listed in Annex A of the Kyoto Protocol are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), as well as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).

Host Country: The country where an emission reduction project is physically located.

Internal Rate of Return (IRR): The annual return that would make the present value of future cash flows from an investment (including its residual market value) equal the current market price of the investment. In other words, the discount rate at which an investment has zero net present value.

Kyoto Protocol: Adopted at the Third Conference of the Parties to the United Nations Convention on Climate Change held in Kyoto, Japan in December 1997, the Kyoto Protocol commits industrialised country signatories to reduce their greenhouse gas (or "carbon") emissions by an average of 5.2% compared with 1990 emissions, in the period 2008-2012.

Leakage: Leakage is defined as the net change of anthropogenic emissions by sources of greenhouse gases (GHG) which occurs outside the project boundary, and which is measurable and attributable to the CDM project activity.

Monitoring methodology: A monitoring methodology refers to the method used by project participants for collection and archiving of all relevant data necessary for the implementation of the monitoring plan.

Monitoring plan: A set of requirements for monitoring and verification of emission reductions achieved by a project.

Operational Entity (OE): An independent entity, accredited by the CDM Executive Board, which validates CDM project activities, and verifies and certifies emission reductions generated by such projects.

Project Activity: A project activity is a measure, operation or an action that aims at reducing greenhouse gases (GHG) emissions. The Kyoto Protocol and the CDM modalities and procedures use the term "project activity" as opposed to "project". A project activity could, therefore, be identical with or a component or aspect of a project undertaken or planned.

Project Boundary: The project boundary encompasses all anthropogenic emissions by sources of greenhouse gases (GHG) under the control of the project participants that are significant and reasonably attributable to the CDM project activity.

Project Design Document (PDD): A project specific document required under the CDM rules which will enable the Operational Entity to determine whether the project (I) has been approved by the parties involved in a project, (ii) would result in reductions of greenhouse gas emissions that are additional, iii) has an appropriate baseline and monitoring plan.

Project Idea Note (PIN): A note prepared by a project proponent regarding a project proposed for a potential CER buyer, such as the World Bank or SENTER. The PIN is often set out in a given format as with the World Bank's PCF and CDCF.

Registration: Registration is the formal acceptance by the Executive Board of a validated project activity as a CDM project activity. Registration is the prerequisite for the verification, certification and issuance of CERs related to that project activity.

United Nations Framework Convention on Climate Change (UNFCCC): The international legal framework adopted in June 1992 at the Rio earth Summit to addresses climate change. It commits the Parties to the UNFCCC to stabilise human induced greenhouse gas emissions at levels that would prevent dangerous manmade interference with the climate system.

Validation: The assessment of a project's Project Design Document, which describes its design including its baseline and monitoring plan, by an independent third party, before the implementation of the project against the requirements of the CDM.

Verification: Verification is the periodic independent review and ex post determination by a designated operational entity against the requirements of the CDM as set out in decision 17/CP.7 on the basis of the project design document (PDD).

Verification report: A report prepared by an Operational Entity, or by another independent third party, pursuant to a Verification, which reports the findings of the Verification process, including the amount of reductions in emission of greenhouse gases that have been found to have been generated.

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