Final Report

Policy and Governance Framework for Off-grid Rural Electrification with Renewable Energy Sources (TF090884)

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By

Winrock International

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<td>AEDB</td>
<td>Alternative Energy Development Board</td>
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<td>ESCO</td>
<td>Energy Service Company</td>
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<td>GoP</td>
<td>Government of Pakistan</td>
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<td>IRR</td>
<td>Internal Rate of Return</td>
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<tr>
<td>kW</td>
<td>Kilowatt</td>
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<td>kWh</td>
<td>Kilowatt hour</td>
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<td>MTDF</td>
<td>Medium Term Development Framework</td>
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<tr>
<td>MW</td>
<td>Megawatt</td>
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<tr>
<td>MWh</td>
<td>Megawatt hour</td>
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<tr>
<td>NGO</td>
<td>Non-governmental Organization</td>
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<td>O&amp;M</td>
<td>Operation and Maintenance</td>
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<td>PO</td>
<td>Partner Organization</td>
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<td>Pakistan Poverty Alleviation Fund</td>
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<td>PV</td>
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<td>RE</td>
<td>Renewable Energy</td>
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<td>SHS</td>
<td>Solar Home System</td>
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<td>PRs</td>
<td>Pakistani Rupees</td>
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<td>USC</td>
<td>US Cents</td>
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<td>WAPDA</td>
<td>Water and Power Development Authority</td>
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Executive Summary

This study has attempted to develop a policy and governance framework for implementing sustainable large-scale off-grid rural electrification in Pakistan. This was done by assessing the effectiveness of existing policy, governance, and institutional frameworks in actual implementation of off-grid supply (OS) projects in the country; examining regional and global models for off-grid supply which have worked; and exploring which combination of these experiences might work to scale-up access in Pakistan to reach the roughly 7,000 villages which are not likely to be supplied by grid electricity in the near future.

Pakistan has in place, with the “Policy for Development of Renewable Energy for Power Generation” (2006), a policy framework for renewable energy development, with a particular emphasis on attracting the private sector investments. One of the goals of the Policy is to “help ensure universal access to electricity in all regions of the country.” The RE Policy spells out the financial and fiscal facilities to be provided to private sector investors who wish to set up off-grid and dispersed RE power generation. However, experience in Pakistan as well as globally shows that OS for rural electrification, to any large scale, will be unlikely to attract investment from the private sector without support from the government.

The governance and institutional framework for implementing off-grid rural electrification, through public sector investment or Public Private Partnerships, has not been spelled out in the RE Policy or in other Government of Pakistan policy documents. As the most advanced among the OS scale-up activities in the country, the “Off-Grid Rural Electrification Program” and community-based micro-hydel activities provide the basis for proposing a policy, governance and institutional framework. This study proposes a framework based on partnership between the government, private sector and communities. The main models for scaling up OS for rural electrification which are discussed in this report are the Fee-for-Service Energy Service Company (ESCO) Concession, Vendor Sales, and Community-based.1

Recent experiences with OS technologies in Pakistan consist largely of pilot activities supplying communities with solar home systems and micro-wind turbines. The micro-hydropower sector has been relatively well established since the mid-1980s with community-managed micro-hydel projects currently supplying power to some 40,000 rural families through isolated mini-grids to in the Northern Areas and Chitral. A review of experiences of the pilot solar and wind energy projects as well as the micro- and mini-hydel projects, based on field visits in the course of this study, are provided in Section 6.0.

The Alternative Energy Development Board (AEDB) is in the process of executing the first concentrated large-scale electrification of some 64 villages in Sindh under the “Off-Grid

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1 The Fee-for-Service ESCO Concession model relies on competitively selected private companies supplying households within a certain geographic concession area with reliable electricity using OS technologies. In addition the ESCO would also operate and maintain the systems, using tariff collected from users, over an extended time frame, typically 5-10 years. Users would pay a monthly tariff for electricity services without having to own the hardware or being responsible for maintaining it. The Vendor Sales model is based on private companies selling systems to user households under an enabling market environment created by the government. Users choose the vendor and pay the majority of system costs with cash or micro-finance. Users are responsible for maintenance of their systems beyond the warranty period and for replacement of used components. The designated government agency typically ensures quality control of equipment and provides support for training of technicians, awareness among users, and often a subsidy to bring down the price of systems. Community-based energy systems are often provided grants by government for all or part of the externally purchased equipment. Users pay local construction costs, typically 20% of total costs, in cash or in kind. The systems are owned and managed by communities themselves with users paying a monthly tariff to cover the salaries of operators and to replenish a maintenance fund.
Rural Electrification Program” using solar home systems, with funding from the Government of Pakistan. Over 2,500 homes have been electrified in Tharparkar district of Sindh in the past six month under this program with another 500 homes under installation. A similar activity is expected to start in Balochistan later this year.

After completion, the two private companies which are carrying out the installations in Sindh under the “Off-Grid Rural Electrification Program” are contracted to maintain the systems for a year as well as collect tariff from the users on behalf of AEDB. The systems are to be handed over to the provincial authorities after this first year of operation. The authorities in Sindh are unlikely to be adequately prepared to take over the system, however, after the completion of the first year. The best course of action would be to encourage the two private companies, which have supplied the equipment and are currently maintaining the systems, to extend their operation tenure, to cover a 5-10 year period, so that the technical responsibilities of the provincial authorities are greatly reduced. This would in essence transform the current contract to the equivalent of a Fee-for-Service ESCO Concession contract.

The Fee-for-Service ESCO Concession model shows promise as a way to scale-up rural electrification using OS technologies, particularly in Balochistan and Sindh, in a sustainable manner. The main advantages of this model are firstly that it provides universal access and secondly that users don’t have to take responsibility for maintaining the technology. This model, which has been used in South Africa for a number of years, has been shown to be successful when government makes a long term commitment to it. It is likely that most if not all the capital costs of future solicitations, for ESCOs to supply all houses within a concession area, will be required to be subsidized. The minimum amount of subsidy required to be supplied by the government can be one of the main parameters in a competitive bidding process. Further study is required to understand if additional subsidy is likely to be required to cover the O&M costs.

The Vendor Sales model provides an alternative framework particularly for the sale of household OS technologies. In this framework, private companies sell systems directly to users using a small government subsidy, some equity, and the remainder through micro-financing. This model is ‘demand driven’ and immediately tests if the user values the service and is prepared to invest in the technology. It is the model under which some 200,000 solar home systems have been sold in Bangladesh in the past 5 years with financing from the World Bank and KfW. The major advantage of this framework is that it requires relatively little public sector investment. Users themselves invest the majority of the required costs through equity and repayment of the micro-finance loan. The disadvantage is that as a market-based model, it is likely that no more than 50% of the households will be able to afford technologies such as solar home systems even with the availability of micro-finance. As the Government of Pakistan is committed to universal supply of electricity in the areas marked for OS, the Vendor Sales model is not favored as the main instrument for achieving off-grid electrification at present.

Community ownership and management of energy systems are particularly relevant for micro-hydel mini-grids. Micro-hydel tends to be attractive for rural electrification as it is often the least cost source of power in mountain areas and the technology has been well established over the past 20 years in the country. Community-managed micro-hydel systems are currently funded by the Pakistan Poverty Alleviation Fund under its Technology Innovations Program. PPAF has provided funding to 63 micro-hydel projects under a standard formula of 80% grant with the community having to come up with the remaining 20% contribution in cash or kind. An NGO, which is a Partner Organization (PO) of PPAF,
serves the community by providing social mobilization and technical support. Operators are trained from within the community to operate and maintain the systems. Tariffs are low and there is good experience with community-managed systems operating well for at least 10 years after installation. Availability of financial support through PPAF to expand funding for micro-hydel projects would extend the availability of this technology to the remaining unserved mountain areas in the country.

The same methodologies for social mobilization and technical support by POs can in principle be extended to other OS technologies, such as wind energy, solar PV, or hybrid systems for providing lights as well as water pumping. PPAF has already provided funding to communities for over 40 projects for wind energy, solar PV lighting and pumping. These OS technologies tend to be more expensive to install and also to operate than micro-hydel, however. They can also be technologically more challenging. Together with expanding funding for these OS systems through PPAF there is a need for inputs from AEDB and PCRET to establish quality standards for these mini-grid technologies.

Mini-grids powered by micro-hydel, wind, solar PV or hybrid technologies might also fall inside an ESCO concession area. The positive experience of social mobilization and community management around implementation of isolated mini-grids can be replicated in this situation. Furthermore social mobilization is equally valuable in the formation of user groups for managing maintenance and tariff collection among groups of individual household users of solar home systems within the ESCO concession area.ESCOs could take advantage of the economy of community-management by providing contracts to NGOs active in the region for social mobilization on similar terms to what PPAF is currently employing them.

Although it is not very common there are private companies which have invested in mini-hydel systems and are supplying small towns in the mountainous areas of Northern Pakistan. Expanding this model can also provide a sustainable way to increase electricity access to rural communities. Private suppliers may have a comparative advantage in the mini-hydel range (> 150 kW) which can power small industries in rural areas. Private companies can hire professional technical staff which can ensure 24-hour reliable supply of well regulated electricity. Under the present framework such companies are not eligible to receive any subsidy and are forced to sell electricity at higher than WAPDA rates to secure returns on their investment. This has resulted in limiting the growth of this potential sector.

The main institutional actors who will be responsible for scaling up off-grid rural electrification are expected to be AEDB at the federal level, provincial and district authorities where the projects will be carried out, PPAF on the community-based projects, and PCRET to provide R&D and technical standardization support. The mandates of these organizations might be as follows:

**AEDB:**
- Providing overall leadership to expand energy access to rural communities through OS technologies;
- Clustering of communities for supply by Fee-for-Service ESCO concessions, designing tender documents for procurement and evaluating bids - in consultation with Provincial Authorities and WAPDA;
- Monitoring of supplied technology, installations and maintenance of systems by ESCOs before handover to Provincial authorities;
- Providing programmatic support for community-based mini-grid electrification (micro-hydel, wind energy, biomass-based energy, solar mini-grids, solar and wind water pumping and hybrid technologies);
- Designing and overseeing a subsidy program to support privately-owned mini-grid systems.

**Provincial Authorities:**
- Identifying off-grid electrification needs in districts;
- Providing input to the design of ESCO concessions and evaluation of tender documents;
- Monitoring of operation and maintenance of OS systems by ESCO over the contract period;
- Carrying out environmental and regulatory approval process for OS systems;
- Monitoring of supply reliability and evaluation of reasonableness of tariff in community-managed or privately-owned mini-grid systems.

**PPAF:**
- Managing a program to provide subsidy support for community-based mini-grid electrification (micro-hydel, wind energy, biomass-based energy, solar mini-grids, solar and wind water pumping and hybrid technologies);
- Including energy activities in future portfolios of community infrastructure projects;

**PCRET:**
- R&D support for local manufacture of different OS systems as appropriate;
- Setting up technical standards and establishing test centers and testing methodologies as per standards;
- Training for capacity building of equipment manufacturers and operators.

The total market for solar home systems in Pakistan to electrify the 7,000 villages is thought to be around 500,000 systems. Investment needed to procure and install these systems will be in the order of US$250 million. Public investment required as subsidy to produce 50 MW of power from micro- and mini-hydel projects might come to around $50 million including the cost of social mobilization. It is difficult to predict how large the market will be for centralized wind and solar systems and drinking water systems. We can thus assume that the investment required for a massive scale up of OS supply in Pakistan will need at least $300 million in investment over the next 10 years or so.

In addition to this investment, there are needs for substantial investment into capacity building. Capabilities will need to be enhanced of all major stakeholders including AEDB, Provincial and District governments, ESCOs, PPAF, NGOs, PCRET and equipment supply companies. The report provides a list of the main areas where capacity building might be focused in order to achieve the ambitious goals of scaling up of off-grid rural electrification in Pakistan.

**Pilot Activities**

Two pilot activities were carried out within the current study to demonstrate a sustainable governance and institutional framework for ESCO and community-based energy activities. The first ‘ESCO pilot’ entailed examining clusters of SHS recently installed by supply companies under AEDB’s “Off-Grid Rural Electrification Program” to determine what monthly user tariff would need to be charged and other conditions put in place to transform this procurement into a Fee-for-Service ESCO Concession. The second ‘Community-based pilot’ examined a recently installed solar powered drinking water project by one of the PPAF partners to put in place effective governance and technology back up systems to operate it in a sustainable manner.
The ESCO pilot showed that current tariff covers a quarter or less of the full costs of operating a solar home system including costs of replacing batteries. It is unlikely that users will be prepared to pay significantly higher tariff than they are paying at present. Provinces can either pay the balance or offer to procure the batteries when they need replacement. The pilot shows that the cost of O&M subsidy roughly doubles the capital subsidy needed for the solar home system over a 10 year operation period.

The Solar Water Pumping pilot shows this to be an application in high demand with communities prepared to invest 20% of the capital cost as well as pay the maintenance cost of systems. Solar water pumps can be provided within the ESCO package or through the Pakistan Poverty Alleviation Fund (PPAF). Social mobilization is a key component which needs to be budgeted in either modality.

**Lessons Learned and Recommendations:**

The major lessons learned from the study and its principle recommendations are listed below:

1) The governance and institutional framework most suitable for scaling up OS in Pakistan, to supply communities which will not be connected to the national grid, is likely to be one which builds on successful experiences in the country and will be based on partnerships between government, private sector, and communities.

2) Based on successes in Pakistan and globally, it is recommended that scale-up of OS be carried out in Pakistan through three main models: a) Fee-for-Service ESCO Concession for solar home systems and micro-wind turbines; b) Community-based mini-grids for micro-hydel, solar/wind powered drinking water projects, and to include wind energy and solar wind hybrids as appropriate; and c) Private sector ESCO investment and management of mini-hydel.

3) It is recommended that this current study be followed up with a design exercise to develop a large-scale national level OS project to include these modalities. A program to supply 500,000 households with solar energy and to generate 50 MW of power to supply mini-grids is expected to need an investment in the order of US$300 million. This would roughly double once the O&M subsidy is also included in the program. Additional investments will be required to carry out capacity building of the relevant actors.

4) Fee-for-Service ESCO modality is best suited to reach some 500,000 remote un-electrified rural households in Balochistan and Sindh with solar home systems and micro-wind turbines to a lesser extent.

5) Community-based micro-hydel should be promoted in the Northern Areas and Chitral as well as in other mountain communities by expanding PPAF’s current program.

6) Community-based solar water pumping is in high demand and can be provided either as part of an ESCO Concession or through expansion of the PPAF program which currently supplies it.

7) A private sector ESCO modality is relevant to expand mini-hydel projects in mountainous districts of the country. ESCOs would provide towns and larger load centers with larger power plants. It is recommended that a subsidy be provided to private companies supplying off-grid consumers at a level which allows them to generate commercial returns on their investment without having to charge a tariff higher than WAPDA. It is expected that around 50 MW of off-grid micro- and mini-hydel might be generated through the community-based and ESCO modalities.
1. Background

The Government of Pakistan (GoP) plans to electrify some 7,000 remote villages (to serve around 10 million citizens) in Pakistan through the Alternative Energy Development Board (AEDB) using off-grid renewable energy technologies. It is unlikely to be economic to serve these remote communities through expanding the national electricity network in the coming decades. Renewable energy experience in the country to date includes electricity from solar home systems provided to 4,700 houses, wind electricity from small turbines provided to 500 households, and some 40,000 households supplied from around 400 micro hydel plants.

GoP/AEDB asked for support from the World Bank to meet its off-grid electrification commitments. The World Bank put out a solicitation for experienced consultants that could analyze Pakistani as well as regional experience in off-grid supply (OS); carry out a review of OS field experience in Pakistan through the lens of economic and financial analysis, social analysis, governance and institutional arrangements; propose institutional and financing arrangements and governance structures; and pilot new governance structures and institutional arrangements in two villages. Winrock International was hired through a competitive process to carry out the study, “Policy and Governance Framework for Off-grid Rural Electrification with Renewable Energy Sources (TF090884)”.

The main outputs of the study will be: a) a proposal for a policy and governance framework, based on demonstrated best practices in Pakistan and globally, for implementing a scaled-up program for off-grid electrification in Pakistan using renewable energy technologies; and b) results of the proposed pilot activities when those are completed.

2. Objective

The objective of the study was to develop an adequate policy and governance framework for off-grid rural electrification by:

i) assessing the effectiveness and key socio-economic factors and governance structures in present off-grid electricity supply schemes; and

ii) exploring and testing sustainable decentralized service-delivery models for future large-scale off-grid rural electrification in Pakistan.

3. Approach and Methodology

The study objectives were met by carrying out the following tasks and activities.

Task 1: Desktop review of past experiences

Winrock collected, analyzed and summarized the results of international studies and experiences on off-grid supply (OS) schemes. The review addressed issues related to OS technologies, socio-economic factors including affordability, financing and subsidy issues, and governance. Experiences from Bangladesh, India, Sri Lanka or other South-Asian countries were highlighted as were relevant international experiences including from South Africa. Successful scale-up models for OS programs which are supported by the World Bank for solar home systems in countries like Sri Lanka, Bangladesh and micro-hydropower in Nepal were particularly examined for relevance to the Pakistani context.
The Winrock team collected, analyzed and summarized studies prepared by various donors, government bodies, consultants and NGOs on off-grid rural electrification in Pakistan. A list of all the papers and project documents (both national and international) studied in the course of this project are provided and the listed papers and project reports will be available on demand, if required by the AEDB or the World Bank. Winrock is also preparing a list of villages, structured by districts and provinces that have been benefiting in, or will be potential beneficiaries in the near future, of various forms of RE supply in Pakistan.

The Winrock team looked beyond the technology assessments which have been done in most of the earlier studies on existing pilot OS projects and focused the search for analyses on institutional sustainability, socio-economic aspects including gender issues, what may be the key factors of success and failures, and what could be the elements of replicable and sustainable models for large scale rural electrification. Documentation which has recorded experience in the use of social mobilization for promotion of OS technologies was examined in the context of replicability within the Pakistan Poverty Alleviation Fund (PPAF) or through the Rural Support Programme Network (RSPN). Similarly, Winrock also sought out studies and experiences to examine the involvement of the private sector as providers of energy services and OS equipment in Pakistan.

Task 2: Field surveys
Winrock carried out extensive field surveys on ongoing OS schemes covering all four provinces of Pakistan. Field surveys were carried out to collect data to understand how well earlier attempts at implementing off-grid rural electrification have worked in Pakistan through distributed OS technologies. The three major OS technologies covered are solar PV, small wind, and micro-hydel. The Winrock team carried out field surveys in four villages each using solar PV and small wind and three micro-hydel projects. One criterion in the selection of villages was that the project implementation must have been carried out at least a year ago in order to be able to assess both the impact of technology and to evaluate how well the mechanisms designed to ensure sustainability were working. Five households per village were surveyed along with a general meeting with the villagers to construct a village profile. In the case of micro-hydel only one community was surveyed at every project even though the plants are supplying electricity to multiple communities.

Questionnaires were designed to explore sustainability aspects including appropriateness of the technology used, financial and economic returns to users from use of the technology, social impacts of the technology; and the effectiveness of the governance and institutional arrangements used in the implementation of the projects. The surveys were carried out by a Renewable Energy engineer and a social worker along with a helper.

List of Villages Visited
The list of villages surveyed is provided below. The list covers sites in all four provinces and covers all the major off-grid technologies. Sites were also chosen to represent diversity in terms of community organization approaches and included off-grid energy projects implemented by AEDB, WWF, NUST/Islamic Relief, Empower, AKRSP, and Indus Earth/PPAF to provide a wide scope for assessments of different experiences in the field.
Wind:
1. AEDB supported project in village Juma Goth, District Thatha, Sindh,
2. WWF supported project in village Tippun, District Thatha, Sindh,
3. Indus Earth/PPAF supported project in village Haji Noor Muhammad, District Karachi West, Sindh,
4. Empower/ADB supported project at village Durgai, District Harnai near Sibbi, Balochistan,

Solar:
1. NUST/Islamic Relief supported project Patkin, District Kharan, Balochistan,
2. AEDB supported project in village Allah Baksh, District Turbat, Balochistan,
3. AEDB supported project in village Qadirabad, District Turbat, Balochistan,
4. AEDB supported project in village Bharomal, District Tharparkar in Sindh,

Micro-, mini-hydel
1. Izh community-managed micro-hydel plant in Chitral supported by AKRSP,
2. Ayun mini-hydel plant in Chitral invested and operated by a private company,
3. Reshun mini-hydel plant in Chitral invested by the government department SHYDO.

Winrock has prepared a short field report on each of the 11 villages. The village survey findings are summarized in this report.

The field surveys covered the following specific aspects, subtasks:

Task 2.1 Off-grid supply technologies
The Winrock field survey team has prepared a short systematic technology report on each village visited. The reports include:

- Short summary of the applied technology with a small ‘map’ of the area, equipment, network etc.
- Stock of equipment with key technical details, date of installation, replacement if any, maintenance-needs, comments on operation condition (good, fair, run-down, out-of order, missing), and expected life-span ahead.
- Summary of in-house equipment (initial bulbs used, replacement of bulbs, controllers, and batteries,..) in solar and wind OS. In hydel systems equipment included s used, and customer’s experiences on this service (hours per day, reliability, blackouts, coping etc.)
- Form and procedure applied for technical maintenance, replacement, quality control.
- Statement of technical reliability, supply hours per day, per month (covering seasonal effects), and statement on overall technical quality of the system/equipment.

Task 2.2 Economic and financial analysis:
The Winrock team carried out economic and financial analysis of the OS scheme in each village, which was visited, based on data available from AEDB, NGOs and investors, and data obtained in the field from project managers’ files and from household interviews. The specific aspects analyzed include the following:

- **Funding arrangement**: Summary of initial capital expenditures, additional capital expenditures (subsequent replacement, major refurbishment if any); indication of funding sources (AEDB, PPAF, Donors, NGOs) with special focus on community and users’ contribution and credit.
Cost structure and O&M arrangement: Summary of O&M expenditures and how these are financed. In-house O&M were estimated based on interviews. The cost structure for O&M was documented where possible and assessment was made on the sustainability of the installations.

Economic linkages: Any economic activities and income generation in the villages were documented wherever they had been enhanced through availability of electricity.

Assessment of commercial viability: the commercial viability of these OS schemes were assessed and conclusions drawn on whether any private involvement would be feasible with expected positive effects on the service quality of any of the OS schemes.

Economics of Distributed and individual OS systems: The economics, investment and O&M cost structure of distributed (e.g. hydel) and individual (house-by-house) OS schemes were analyzed.

Long term Sustainability of the investment: The magnitude of replacement expenses at the end of the expected useful life period of the major equipment were assessed, as well as any institutional arrangements that may have been made to cover these expenses by the stakeholders.

Task 2.3 Social analysis:
The Winrock team carried out social analyses through interviews including the following aspects/subtasks:

- Social profile of the village including issues of age, gender, education structure, number of households, education and culture facilities, economic activities, businesses, employment/unemployment, poverty etc.
- Social benefits of electricity: exploration of improvement of the social conditions attributable to the electricity supply.
- Willingness to pay: simple willingness/ability to pay survey and assess that against the key findings of the above mentioned financial analysis.
- Review of Existing or Possible Subsidy Schemes: exploration of both implicit, ad-hoc, discretionary and explicit subsidies if attached to any of these OS schemes. In connection to the financial analysis (particular O&M) and willingness and ability to pay an assessment was made of the feasibility of an explicit targeted subsidy scheme specifically for the poorest of the poor with the objective of improving overall electricity supply in these communities.

Task 2.4 Governance and institutional arrangements:
Winrock analyzed the governance and institutional arrangements in all phases of the OS schemes including the following activities/subtasks:

- Governance and institutional arrangement of the off-grid rural electrification program: Exploration and summary of the past and present governance and institutional arrangement of the off-grid rural electrification program through review and analysis of all supporting documents, rules, regulations, where they were available and by identifying key stakeholders via interview etc.
- Governance and institutional arrangement in investment decision and funding: Records of the governance structure in investment decision including a list and explanation of key stakeholders involved in identifying the villages, approving project technical characteristics and funding arrangement. The role, involvement, and reaction of the village communities as well as the NGO or supporting donor regarding the investment decision were all explored.
• **Governance and institutional arrangement in running the OS scheme:** Exploration and synthesis into basic models the governance and institutional arrangement established for operating the OS scheme. Performance of any institutionalized arrangements for O&M were reviewed and any informal arrangements were recorded which may have emerged for O&M or if the OS is abandoned from a governance perspective.

Since the villages being served by OS projects are generally small, and there was limited time to carry out the field surveys, the datasets generated from the survey are not extensive. There were around five houses surveyed in each village visited with a prepared questionnaire. The survey team consisted of a renewable energy engineer, one social and community mobilization specialist and one assistant. The teams also carried out focus discussions with knowledgeable members of the community.

Field data and information have been collected in standardized forms that are consistent, complete, and easy to summarize. Draft templates of summary tables, questionnaires planned to be used for standardized data collection on the field were submitted for Bank and AEDB comments and approval.

**Task 2.5 Synthesis of the experiences and proposal for institutional and financing arrangement and governance structure:**

Based on the results of the above tasks the Winrock team has prepared a proposal for institutional and financing arrangements and governance structure for OS schemes aiming at long-term sustainability. Special attention has been paid to involvement of communities and the private sector. Models developed by the PPAF and its partner organizations for social mobilization of communities were analyzed for ensuring sustainability. Social mobilization is likely to be a key factor for success in community activities like micro-hydropower and small wind turbines. Here the Rural Support Programs and NGOs have existing programs and expertise. Proposals have been developed for adding energy projects to their portfolio of community infrastructure projects. Winrock has sought opportunities to enhance sustainability with the involvement of the private sector where this is appropriate.

Examples from regional countries show that the involvement of the private sector in supplying systems and services will strengthen market growth of the sector since the private companies have a direct interest in expanding their market. Once the right models are in place, financing for OS schemes can come from a number of sectors including grants from bilateral donors, loans from multilateral banks, and funds from carbon finance for the use of renewable energy technologies which reduce carbon emissions. The proposal has explored ways in which micro-finance can be mobilized for financing energy systems.

This sub-task included the following actions:

*Interim report:* Winrock submitted to AEDB and World Bank an interim report with preliminary findings and proposals.  
*Policy dialogue:* After feedback on the interim report, Winrock made presentations at a half-day workshop organized by the World Bank and AEDB on the findings and proposals with a broader group of stakeholders (AEDB, relevant government officials, donors, local government and village representatives, and NGOs).

**Task 2.6 Piloting:**

After completion of Task 2.1 through 2.5 Winrock is now ready to pilot new governance structures and institutional arrangements in two villages selected from the villages planned or
being supplied with off-grid electrification by AEDB and by PPAF. The specific funding set aside for financing this task will be used for the following actions:

- **Proposal for implementation**: a detailed implementation plan is being prepared for OS in pilot villages including institutional and governance structure, funding arrangement, and technology proposal.
- **Socio-economic framework**: Winrock will set up, discuss with key stakeholders, and implement the adequate socio-economic framework including required stakeholder consultations, environmental and social impact assessment, financing arrangement and target subsidy scheme.
- **Civil works**: Winrock will deploy an adequate composition of the team for implementing the pilot projects, but the AEDB or PPAF and not the consultant is expected to procure any OS equipment that may be needed.
- **Summary of experiences**: Upon completion of piloting, Winrock will prepare a short summary of experiences with proposals for modalities for scaling up and capacity building.

The time period of the study has been extended to the end of October 2008 so that the implementation of the pilot activities will be completed and the full results and experiences can be collected.

**Task 3: Policy and regulatory framework for off-grid electrification**

Based on the results of Tasks 1 and 2 and dialogue with key stakeholders, Winrock has proposed a policy and regulatory framework for rolling out large-scale off-grid electrification with renewable energy sources. These would build on the Pakistan Renewable Energy Policy (2006). This exercise has been informed by policies and regulations governing the renewable energy sector in regional countries. The results of this study will be expected to inform the formulation of the Medium Term policy framework (currently set at July 1, 2008 to June 30, 2012) which is being developed by the Government of Pakistan under the Renewable Energy Policy (2006).

This task included the following actions/subtasks:

**Task 3.1 Policy framework**:

Based on both international and regional experiences and the results of Task 2 Winrock has proposed a policy framework for sustainable off-grid rural electrification. This sub-task has included the following actions:

- Take into account all relevant existing policies (renewable energy policy) and guidelines.
- Propose changes in legal and regulatory framework as deemed to be necessary.
- Propose national guidelines for institutional arrangements and governance structures for OS schemes in (a) national level including program management, (b) subnational district and TMA level, and (c) project/village level.
- Prepare detailed proposal for financing and subsidizing both investment and O&M of OS schemes: (a) national program (e.g. RE investment and subsidy fund, selection and allocation procedures); (b) subnational district and TMA contribution, and (c) village, community, CCB contribution.
- Prepare proposal for strong participation of the private sector and micro-enterprises to participate in the market expansion for OS technologies.
- Prepare proposal for capacity building in all federal, subnational and local level.
**Task 3.2 Regulatory framework:**
Winrock has proposed a regulatory framework with proposals on how the following may be included:

i. Determination of benchmark tariff or acceptable unit cost

ii. Rules and procedures for subsidization of either investments, O&M or both; and monitoring target subsidies

iii. Regulating technical standards.

These will be elaborated further once the pilot activities are completed.
4.0 Regional and International Experiences with Institutional and Governance Models

There is substantial experience both regionally and globally in implementation of off-grid rural electrification. Although grid-based electrification continues to dominate investment, off-grid rural electrification of rural areas now attracts significant investment from governments, as well as bilateral and multilateral donors. Off-grid electrification is expected to increase in importance as most of the accessible rural areas, where it is economical to do so, have been or are being covered through grid-based electrification.

“A growing diversity of electrification arrangements around the world, including off-grid electrification is reflected in the World Bank’s patterns of lending for electrification. A recent review of the World Bank energy projects approved during fiscal year (FY) 2003 through 2005 identified almost US$500 million in direct physical investments in electricity access” (The World Bank, 2006). The portfolio review identified four categories of electricity access investment – Grid-based Peri-urban Electrification; Grid-based Rural Electrification; Off-grid Rural Electrification; and Electrification Funds.

The review confirmed that grid-connected electrification remained the dominant electrification arrangement, but identified considerable regional variations, with off-grid investment important in Africa and predominant in Latin America and Caribbean (LAC). Off-grid electrification comprised almost 10 percent of the total assistance to electrification provided by the World Bank over the past three fiscal years. This proportion is expected to grow along with progress toward universal access, as remaining populations will be more difficult to economically electrify using conventional grid extension arrangements. (ESMAP 2007 a) pg xxvi).

4.1 Technologies for OS

A range of technologies are available for off-grid supply (OS) electrification. A recent study from ESMAP/WB provides a summary of costs of generation from different OS technologies. Figures 3 and 4 show the relative levelized costs of different off-grid electricity supply options including both renewable and non-renewable sources. Figure 3 lists energy prices from technologies (including solar (PV) home systems, pico-hydro, micro-wind, and small diesel/gasoline generators in the under 1 kW capacity range appropriate to individual households. Figure 4 lists the costs of energy produced for mini-grids (including generation up to 200 kW from micro and mini hydro, wind energy, hybrid technologies, diesel generators, biomass gasifiers, biogas, micro-turbines, and fuel cells).

“The only electrification technology choice for small, isolated loads is expensive diesel generation and several renewable power options, including pico-hydro, geothermal, small wind and solar PV. These renewable technologies are the least-cost option on a levelized generating cost basis for off-grid electrification, assuming resource availability. However, these off-grid configurations are very expensive (US$30-50/kWh), with pico-hydro the notable exception at only US$12/kWh. However, they are economical when compared with the US$45-60/kWh for a small, stand-alone gasoline or diesel engine generator.” (ESMAP 2007 a) page 57)

Fig 1: Stand-along solar PV system
“Renewable energy is more economical than conventional generation for off-grid (less than 5 kW) applications. Several RE technologies – wind, mini-hydro and biomass-electric – can deliver the lowest levelized generation costs for off-grid electrification (Figure 3), assuming availability of the renewable resource. Pico-hydro, in particular, can deliver electricity for US¢10-20/kilo watt hour (kWh), less than one-quarter of the US¢40-60/kWh for comparably-sized gasoline and diesel engine generators. Even relatively expensive RET (solar PV) is comparable in levelized electricity costs to the small fuel-using engine generators under 1 kilo watt (s) (kW) in size. (ESMAP 2007 a) pg xxix).”
Fig 3: Off-grid Forecast Generating Costs

Source ESMAP 2007 a)
Fig 4: Mini-grid Forecast Generating Costs

Source: ESMAP 2007 a)
4.2 Institutional and Business Models for Off-grid Supply

International experience in OS systems follows three main models:

1) Vendor sales
2) Fee-for-Service Concessions
3) Community-based approaches

4.2.1 Vendor sales
The Vendor sales model is perhaps the simplest of the three models. Under this model, renewable energy vendors sell systems to individual households based on their level of affordability. In its basic form, this model works under market principles. In Kenya sales of solar home systems through market actors have exceeded 200,000 (Jacobson and Kammen 2005) with little government support and the market is growing at around 15% a year. Systems are typically purchased by the more wealthy rural farmers engaged in commercial crops like tea, coffee, cut flowers and enterprises in safari tourism. Without a framework for regulation and quality control, there is a danger that competition is based mainly on price, and quality of systems suffers. This can result in a bad reputation for the energy technology and limit prospects for expansion of the market. Although some suppliers may provide a warranty on the main components for a limited time period, there is little compulsion to provide repair and maintenance support in rural areas. The responsibility of operating and maintaining systems lies largely with the user.

In more developed markets, vendors have been able to establish a reputation for supplying high quality systems without government-enabled market conditions. They have been creative in establishing relationships with banks and micro-finance institutions as well as with local NGOs. SELCO-India (http://www.selco-india.com/) is a private company that has designed and sold over 75,000 solar home systems in South India. The company employs over 170 people, 25 at their headquarters in Bangalore and the rest at 25 service centers in South India. SELCO-India has demonstrated out that poor people are able to afford modern energy services - and that PV is actually cheap for the poor (in comparison with kerosene lamps and dry cell batteries).

Lack of initial capital is a major obstacle, and SELCO does not provide credit or loans, but it has developed good working relationships with local banks and microcredit organizations. This has given finance organizations the confidence to provide credit for PV systems, and an understanding of the payment terms which different owners may need. Some users work directly with the finance organizations, others work through self-help-groups which provides additional security that a loan will be repaid.

In the Belthangadi region in Karnataka, SELCO’s principal partner is the NGO Shri Ksetra Dharmastala Rural Development Project (SKDRDP), which runs a network of 5,000 self-help groups. These groups meet to support members in domestic and farming matters, and make regular savings. If a member wants a loan, the group decides whether it is an appropriate purchase, and the group as a whole takes out the loan. Although there is great enthusiasm to purchase SHS in this way, the groups make sure that members have covered more basic needs (like wells or farming equipment) before they invest in an SHS. Most of the most of the 3,000 solar home systems that the local SELCO service center has installed have been for members of the self-help groups.

Public sector enabled market conditions for vendor sales
In some countries, as part of a larger national program, government-supported programs have begun to enforce quality control through pre-qualified vendors for systems sold and also provide
a basic subsidy on systems. This public-private partnership where the public provides an enabling mechanism including quality control and a limited subsidy on systems and the private sector sells systems to users on a competitive basis has resulted in a number of countries in South Asia reaching sales of solar home systems in the 100,000 range in the past 10 years. Program support within such a public-private partnership often includes training and capacity building of vendors, system installation technicians and system operators. There is often also a strong linkage with micro-finance institutions which provide loans to systems supplied by pre-qualified and quality controlled companies.

One characteristic of the demand-driven vendor sales model is that it can not provide universal access. Figure 5 below shows the 4 market segments for sales of solar home systems. Although the percentages vary by county, one can see that generally only 5-10% of the population can purchase systems without credit and without subsidies; another 10-30% may be able to purchase systems with credit. The third market segment will only be able to purchase systems if there is a subsidy. In most markets there will be a population of the poor at the bottom of the pyramid which will not have the capacity to purchase and own solar home systems.

**Fig 5: Market segments for sales of solar systems**

![Market segments for sales of solar systems](image)

Market segment 1: buying against cash (ca. 5 - 10 % of HH))  
Market segment 2: purchase on credit (ca. 10 - 30 % of HH)  
Market segment 3: buying only if subsidized  
Segment 4 No capacity for purchase and owning

Source: GTZ

The World Bank has invested in two major initiatives for solar home systems for OS supply in South Asia which rely on vendor sales. In Sri Lanka the Renewable Energy for Rural Economic Development (RERED) program, has expanded on the success of the earlier Energy for Sustainable Development (ESD) program, also supported by the World Bank. The program is housed in the public sector bank DFCC. Nine companies participate in the market selling around 20,000 systems each year. A total of 95,000 systems had been sold by the end of March 2008.

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2 [http://www.energyservices.lk/offgrid/introduction.htm](http://www.energyservices.lk/offgrid/introduction.htm)  
3 Distribution of systems is around 52,000 systems in the 20-40 W size, 40,000 in the 40-60W size, and 3,000 in the >60W size range.
Consumer finance is provided to buyers by well established rural development and micro-finance institutions like SEEDS of Sarvodaya.

Similarly the Rural Electrification and Renewable Energy Development Project (REREDP) in Bangladesh has incorporated end user financing to expand its reach to poorer households.

**Figure 6: Growth of SHS under IDCOL, Bangladesh**

The program is managed by the semi-government infrastructure finance organization Infrastructure Development Company Limited (IDCOL). REREDP has 15 active approved companies which sell systems to users, of which the largest is Grameen Shakti. The program was started in 2003 with financial support from World Bank IDA and GEF. In August 2005, IDCOL achieved its target of 50,000 systems, three years ahead of schedule. A total of 200,000 systems have been sold by April 2008. IDCOL has revised its target and plans to sell 1 million systems by 2012.

Under the program IDCOL provides Participating Organizations (PO) like Grameen Shakti with both subsidy and concessional loans. The cash pool from credit repayments will enable Grameen Shakti to continue the scheme when the subsidy, which is being phased out, ceases in 2008. Grameen Shakti has initiated a network of technology centers throughout Bangladesh to manage the installation and maintenance of solar home systems. Focusing on technicians who know local customs it has trained 2,000 technicians, most of them women.

Table 1 below shows how a 50 Watt solar home system is typically financed in Bangladesh under the IDCOL project.

**Table 1: Financing of a SHS under IDCOL**

<table>
<thead>
<tr>
<th>(a) Solar Home System Cost</th>
<th>US$ 440</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b) Buy-down Grant from IDCOL</td>
<td>$ 40</td>
</tr>
<tr>
<td>(c) Remaining Cost (b-a)</td>
<td>$ 400</td>
</tr>
<tr>
<td>(d) Household Down payment [15% of (c)]</td>
<td>$ 60</td>
</tr>
<tr>
<td>(e) Remaining Cost (c-d)</td>
<td>$ 340</td>
</tr>
<tr>
<td>(f) Loan from IDCOL to PO [80% of (e)]</td>
<td>$ 272</td>
</tr>
<tr>
<td>(g) Contribution of PO as loan to customer (e-f)</td>
<td>$ 68</td>
</tr>
</tbody>
</table>
Under the model of this government-enabled market-based model, public funds are utilized to provide partial subsidy and credit and to leverage high quality in the systems sold. This basic model is being used for solar home systems (Sri Lanka, Bangladesh and Nepal) and for biogas (Nepal and Bangladesh). In all these projects the objective has been to provide the subsidy to “prime the pump”. There is an implicit assumption that the subsidies will be reduced and the market will take over the process. The initial subsidy investments were made as much to support the market linkages (company establishment, retail network) as to buy down the system cost. Once the market network is in place and volume of business has increased, the cost of supplying new systems is reduced. The project plays a facilitating role, while letting the free market operate. The project also provides support in the form of generic promotional campaigns and training to technicians. While the project sets technical specifications and warranty and service requirements, the companies are free to set price and adopt their own marketing strategies in a competitive market. This should establish a sustainable model for future supply.

4.2.2 Fee-for-Service Concessions
The fee-for-service model is an alternative to vendor sales. Under this model users will not be asked to purchase systems but to pay a fee each month for the use of the energy services. Concessions often give to private companies, through a bidding process, the responsibility for rural electrification of populations in a particular geographic region using off-grid supply (OS) systems. The energy supply concessionaires, also referred to as Energy Service Companies (ESCOs), have a similar monopoly status as a grid-based power utility serving the demarcated locations. Concessionaire ESCOs take responsibility for providing universal access through provision of OS systems as well as operation and maintenance and cover these costs by collecting a user fee from users. As government subsidies are provided to cover a significant portion of the capital cost, these projects fall into the category of public-private partnership. The percentage of the capital costs to be borne by the ESCO and the government might be determined through a bidding process. Part of the collected fee will also be used to generate returns on the partial investment made by the company into the capital cost of the project.

The major advantage of the fee-for-service concession framework for promotion of OS systems is that it overcomes the problem of high upfront cost of systems to users. Under this framework, ESCOs systems would provide services to off-grid consumers on similar terms as WAPDA does to on-grid consumers i.e. the consumer pays a connection fee but not the initial cost of electricity generation hardware. This framework is thus more conducive to universal electricity access than if the user would have to purchase the full OS system. Consumers pay a monthly fee for a choice of service levels. A second advantage of this framework is that users do not have to take responsibility for operation and maintenance of systems and these technical tasks can be left to professionals. This avoids households having to develop technical expertise in the O&M of the OS technology.

The principle of the fee-for-service concessions using solar home systems is as follows (Lemaire 2006):

“Fee-for-service concessions enable to overcome at once the two main barriers to the implementation of photovoltaic systems:
- (1) the initial high investment cost,
- (2) the question of the maintenance of the systems.

(1) The initial investment costs for solar home systems are higher than other standalone systems like diesel generators. This is due to the fact that it is actually an investment on systems that are supposed to provide electricity for at least 20 years, with operational costs limited to the one of
the replacement of the batteries. With a fee-for-service concession, the initial investment is not borne by the final users but by the concessionaire (who himself gets a subsidy from the government).

(2) The creation of concession areas for rural electrification with solar home systems relies on the acknowledgement that programmes of solar home systems have been unsuccessful in the past due to the lack of maintenance of the systems. Solar home systems can be very reliable and robust in extreme conditions, but they do need a minimum of maintenance!

With a fee-for-service concession, the maintenance is not borne by the final users but by the concessionaire (whose staff have been trained). The concessionaire gets a monthly fee from the clients, which covers the maintenance costs and the cost of replacing the batteries. The concessionaire acts like a small local utility that provides a service – electricity – in exchange for remuneration.”

The rural concessions for solar home systems (SHS) in South Africa represent one of the most ambitious projects of rural electrification using solar energy. This project follows a massive programme of grid-connected rural electrification launched by the post-apartheid regime. The SHS program aims to provide basic services like lighting and communication to people scattered in the most remote places.

There are some similarities between South Africa and Pakistan in terms of off-grid electrification challenges. Both countries have similar electrification rates: 65% in South Africa, and 60% in Pakistan. While both countries have ambitious targets for grid-based rural electrification; there are substantial numbers of households in both Pakistan and South Africa which are remote and are unlikely to be electrified by grid extension in the next few decades: estimated to be 1.5 million in South Africa, around 4.4 million in Pakistan. This makes the rural concession experience in South Africa of potential interest for Pakistan as well.

Lemaire comments, “This scheme seems simple, but it took a long time and a series of failures in the implementation of projects for the solar energy sector to (re)invent it and dispel the idea that solar energy was free and that people in rural areas could manage relatively complex solar systems by themselves.”

One of the concessions considered successful in South Africa is operated by the company NuRa. As the NuRa concession has been operating for over five years, the experience from this ambitious program of rural electrification with solar energy in South Africa can have important lessons for Pakistan. Excerpts from Lemaire’s review (2006) of NuRa are given below:

**Capital Investment**

“NuRa does get a capital grant from the government. The average capital cost for a solar home system in this concession is around 4,000 Rand (550 US dollars). The subsidy represents the major part of the total cost of the solar home system. The rate of

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4 Personal communication Dr. Ekkehart Naumann.

5 The NuRa concession is considered to be the most successful of all the concessions established by the South African government. This case study remains therefore limited in its scope, as the other concessions have not been surveyed. This case nevertheless demonstrates that the dissemination on a large scale of solar home systems can be done even in a sustainable way in the poorest areas.
implementation of the systems by NuRa is therefore completely dependent on the funding made available by the government, which is reluctant to commit to a long-term project.

This level of subsidy could be a burden for the government, if this program is to be extended to the 1.5 million people not connected to the grid in South Africa. But, the total cost of the solar systems (4,000 Rand) is far less than the one that the utility would bear to connect households to the grid (between 10,000 and 15,000 Rand). And the governmental subsidy for solar energy (3,500 Rand) is not very far from the one given to the utility ESKOM to connect households to the grid (4,000 Rand).

In rural areas, where people do not use a lot of electricity, solar electricity appears to be competitive with grid supply, as it provides for basic needs at a limited cost.

<table>
<thead>
<tr>
<th></th>
<th>Solar</th>
<th>Grid</th>
</tr>
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<tbody>
<tr>
<td>Capital Cost per Household</td>
<td>R 4,000</td>
<td>R 10,000 – 15,000</td>
</tr>
<tr>
<td>Subsidy per Household</td>
<td>R 3,500</td>
<td>R 4,000</td>
</tr>
<tr>
<td>Utility Cost per Household</td>
<td>R 500</td>
<td>R 6,000 – 11,000</td>
</tr>
</tbody>
</table>

Source: NuRa, 2006.

**Connection & User Fees**
To get connected, customers need to pay just a small fee - initially 100 Rand in 1999 (16 US dollars in 1999), today 500 Rand (68 US dollars) - which represents only a marginal part of the cost of the system. The demand for solar home systems seems to be quite high with more than 1,000 customers waiting to get an installation.

The customers have to pre-pay a monthly fee of 60 Rand, which may (or may not) partially be paid by local municipalities. Some municipalities agree to give the Free Basic Electricity tariff and pay half of the monthly fee, leaving only 20-30 Rand (4 US dollars) for the clients to pay; other municipalities do not, leaving the customers with the 60 Rand (8 US dollars) to pay. This creates considerable distortion between clients.

**System Operation and Maintenance**
Owing to the large numbers of customers, contacts with the customers takes place mainly at the energy stores where people make their payment. With small-size ESCOs, the limited number of customer enables them to conduct a monthly visit to each customer at which point they collect the fee and check the functioning of the solar system. In contrast with this, NuRa visits the installations only when there is a problem or during the planned routine visits, which take place every six months.

The contract states that:
"The SOLAR SYSTEM will be able to supply an average of 170 watt-hours of electricity per day, and will be available for at least 90% of the year". The contract gives NuRa ten days to repair breakdown and thirty days to attend to any other complaints.

The energy stores are central to the process. People come to the energy stores mainly to charge a token which gives them a credit of electricity. The token also contains data on the functioning of the system, which can be transferred to a computer. All the data can be manipulated at the energy store, but are also immediately centralized at the headquarters.
Even with this efficient system of reporting, the process of resolving a failure can still take several weeks because: first, the customer needs to signal his problem to the nearest energy stores, and second, the energy store needs to log the failure which is sent electronically to the headquarters. Technicians will have then to be sent from NuRa’s headquarters.

The distance from the headquarters of NuRa to some clients can be quite long (sometimes as far as 150 Km). NuRa uses a quite sophisticated software system, whereby all installations are located by means of GPS. The software groups the installations in reasonable proximity to each other, thereby allowing them to be visited in one day so to avoid unnecessary journeys. The technicians use then their GPS to locate the first installation to be visited, followed by the second... and so on till the end of the day. Even with the help of GPS, to find the right path to get access to a house can be tricky and time-consuming: in one day, technicians may be able to visit only 4-5 houses.

Moreover, it frequently turns out that the cause of failure indicated on the "job card" produced by the reporting system differs from the actual cause discovered by the technicians after visiting a house. As a consequence, technicians may not have the appropriate parts to do the repair. In this case, customers who may have waited several weeks for the visit of a technician may be disappointed to see the technician leave without repairing the system!

Lemaire provides analysis based on the experiences of NuRa regarding: a) user satisfaction with the level of service provided and how that may be improved and b) how institutional efficiencies might be achieved.

**User satisfaction with level of service provided**

“One has to bear in mind that the monthly fee represents a high cost for rural household. The first point is that other priorities like access to clean water or improvement of the roads may be perceived as more immediate. The fact is that solar home systems do not bring any economic development, but this is consistent with the aim of the National Electrification Programme. The question is: does the service provided by solar home systems justify its cost?

The first point of dissatisfaction for some clients is the limit of the system provided: the basic photovoltaic systems currently include a 50 Wp panel with 4 lights and a socket for a radio or a black/white TV only. Each client can choose to upgrade his system to have more lighting or even an inverter and pay a higher fee. This financial cost could be reduced if upgraded systems were more systematically proposed or even considered as the basic system.

Although a shortage of silicone has stopped this trend, the cost of solar systems in itself should continue to decrease. The main cost component of solar home systems will therefore increasingly be the one of maintenance. To maintain a 120 Wp system with an inverter is not a lot more costly than to maintain a 50 Wp system. A general increase of the power of the systems may be therefore an option for the majority in the near future.

The second point of dissatisfaction is the contract, because people are required to pay while the system is not functioning. A rebate for the number of days of failure should be given automatically when the failure is due to a fault or a delay that is the responsibility of the provider. It nevertheless appear that a number of faults are the result of a misappropriate use by the clients - such as the overuse of the batteries. This can sometimes be the result of a lack of information or deliberate tampering. Regular visits by local technicians from the nearest energy stores during the first months of the installations may facilitate the process of understanding of the system by the clients.

Numerous systems are also stolen. The question of theft is a plague for the solar sector in a lot of African countries – owing to the high value of solar panels. This is often the result of a lack of mutual social control. Technical devices provide only a partial solution and increase the cost and the complexity of the systems.
There is no easy solution to this question, apart from the identification of panels and batteries which enables a control of their origin. The transfer of ownership could reduce thefts/tampering by the users of the systems.

The third point of dissatisfaction is electricity in itself is only a part of the energy requirement of a household. Solar electricity should be provided among other energy services, notably cooking. This is why allowing sale of LPG by energy stores not only is important for their financial equilibrium, but also provides a very useful service to many customers. This diversification is one of the reasons for the success of NuRa.”

**The size of the concession and the level of decentralisation**

“Large rural concessions seem to be a useful means of implementation of solar home systems. The project nevertheless also faces considerable logistic difficulties when it comes to the daily maintenance of the systems. Large centralised concessions are indeed difficult to manage as the follow-up of photovoltaic systems implies regular visits to the clients not only to replace parts of the systems, but also to train the customers in use of the systems.

When a good system of reporting is in place, it is possible to avoid relying on a complete centralization of repairs, which always introduces considerable delays for small failures. As the fault is currently reported by the clients themselves at the energy store, this can lead to a wrong diagnosis (even if part of the information on the system is on the token the clients bring with them, there is still a need for data provided by the client himself). As a result the wrong cause of failure is often logged at the headquarters. It would seem that failures might be more accurately diagnosed if someone from the nearest energy store could inspect the system before the technicians from the headquarters visit the house and discuss with the owner of the system. It may be desirable that energy stores in the future play a more proactive role and serve as a base for technicians who could then come directly from local energy stores when there is a problem (and also do monthly visit).

The idea of using the local shopkeepers as retailers, currently being experimented by NuRa, also seems a way to keep a regular contact with the clients. Local shopkeepers can supply basic elements of a solar system like light bulbs or recharge batteries. They can also earn their living by supplying electricity from their own system for local people who do not have a solar system (like charging mobiles).

But local shopkeepers cannot handle repairs themselves. An advantage of creating many energy stores is that it facilitates the communication process between the headquarters and the clients. The drawback of giving more autonomy to many different energy stores is that it requires more trained staff and more stocks of parts. This can only be justified with a high density of customers near-by. This is why it is so important for the concession to reach a critical mass of customers.

Economies of scale must be supported by economies of density which means that in an area open to rural electrification there should be a sufficient density of clients to enable a network of small shopkeepers to earn their living and to have a sufficient number of energy stores so to canvass the territory and provide a reactive follow-up of the installations.”

ESCOs tend to participate in fee-for-service concessionaire programs where the government is able to provide all or most of the capital expenditure as subsidy. ESCOs are generally not prepared to make high levels of their own capital investment into OS installations for two basic reasons. Firstly, the monthly tariff which would have to be charged would be excessive, i.e. much larger than what grid connected life-line consumers are currently paying, to cover these capital costs. This would make many rural users unable to afford to participate in the program. Secondly, in many countries inflation and devaluation of the local currency make it uncertain for the investor to get his returns without being able to raise the tariff regularly.
“Although technical problems are being solved, ESCOs in Zambia are still facing financial uncertainty due to macro-economic conditions which are out of their control. This situation of excessive inflation is not specific to Zambia and proves to be quite damaging for small companies.” Lemaire 2006.

**Figure 7: News clip for Fee-for-service Concessionaires**

The » Not Enough « Syndrome

Renewed interim contracts may leave South African SHS concessionaires surviving hand to mouth

The three remaining fee-for-service concessionaires have signed contracts with the South African government for subsidies through March 2006, each for 8,000 solar home systems (SHS). But the truncated agreements, yet another interim solution to the once comprehensive goal envisioning 300,000 SHS, have left these off-grid utilities scrambling to make their businesses profitable.

Photo International December 2004
4.2.3 Community-based approaches

Community-based approaches can be valuable to sustainably manage off-grid rural energy systems particularly for mini-grid systems. They can provide a distinct alternative to private sector energy provision where the community owns and manages a community-based energy generating and mini-grid distribution system. In some cases community approaches can also complement private concessionaire and vendor sales approaches, which are used in the case of individual household owned systems such as solar home systems or micro-wind turbines.

Community-based mini-grids

Community-based mini-grid projects allow community management of larger energy systems which supply the full community. These systems often have the following characteristics:

a) The energy project is designed to build social capital among members as much as to produce and distribute energy. As such the project is selected such as to require the participation of most/ all community members. Micro-hydropower or larger wind or solar energy systems serving the full community lend themselves to this approach.

b) In addition to any grants received for the project, there is always a component of cash or in-kind contribution and voluntary labor from the community. Rules of participation are often designed such as to ensure access to poorer households as well and also to allow these poorer households to participate in the construction of these systems.

c) Community based systems are generally set up to be operated as rural-based enterprises that meet operation and maintenance costs through tariff collected every month. Although the tariff is seldom sufficient to pay back the capital cost of the system, it is generally sufficient to cover operation and routine maintenance costs. Well managed systems also generate funds to cover larger repair and equipment replacement.

d) The project is designed not only to meet the domestic energy needs but can also provide power for productive uses: irrigation pumps (to increase agricultural yield), mills (for processing grains produced), and electric motors (for other off-farm enterprises needing mechanical power for processing) – energizing rural livelihood activities and thus helping reduce poverty.

In Pakistan a number of NGOs are investing in community-based mini hydropower in different parts of the country. The most established is the Aga Khan Rural Support Programme (AKRSP), with installations of over 240 projects in Northern Pakistan generating close to 10,000 kW and serving over 100,000 inhabitants living in a harsh mountain environment. AKRSP is currently in

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6 A positive feature of community-scale projects is that the collective endeavor of planning, building and operating the project can build trust and social capital that is ultimately the foundation for rural development dynamic that goes far beyond electricity provision. This, in turn, can provide impetus for economic development that stretches beyond the reach of the wires of the mini-grid itself. The flip side of the coin is that successful development of the project and accompanying social capital requires additional investment – especially of time, by a skilled facilitator agency, usually an NGO, that assists the target community members in organizing themselves and acquiring technical capacity to own and manage the village-level energy facility. The NGO typically provides assistance in project feasibility studies, assembling financing for the project and accessing available grant funds, start-up operation of the facility, marketing of the produce of the community and coordinating with government authorities and other entities whose support and cooperation are crucial in the success of the project.

7 When compared with household-scale systems, an attractive feature of community-based energy projects like micro-hydropower is that tariffs for community projects can be structured to include a cross-subsidy in the form of low “lifeline” rates that provide basic service at low cost to poorer households that use little electricity.
the process of installing around 100 community-based mini-hydropower systems totaling 15 MW of power using funds from the PPAF, as well as from carbon financing.

Afghanistan, Nepal and Sri Lanka provide other examples in the region of country-wide programs to support community micro-hydropower projects. Afghanistan launched the National Solidarity Program (NSP) in 2002 under which support has been provided to over 500 communities to install micro-hydro systems below 25 kW. NSP provides a block grant to Community Development Committees (CDCs) amounting to US$200 per household. Communities prioritize the infrastructure project they would like to invest in with their block grant from among irrigation projects, motor able roads, drinking water, or energy (typically micro-hydropower or solar PV). CDCs are helped in their selection of projects and their quality implementation by external NGOs called Facilitating Partners. The micro-hydropower systems installed under this program are providing power for lighting and milling in mountainous districts of Afghanistan. In Sri Lanka, village hydropower installations are also supported under the off-grid component of the Worldbank/GEF financed RERED project. A total of 150 off-grid micro-hydropower projects have been constructed of installed capacity 1,141 kW and serving 4,350 households.

Nepal has the widely acclaimed Rural Energy Development Programme (REDP) initiated by UNDP. Since 1998, the project has installed a total of 234 micro-hydropower projects with installed capacity 3,611 kW and around 38,300 households served. [http://www.redp.org.np/phase3/](http://www.redp.org.np/phase3/). A review of this project by Winrock International found that the REDP project has contributed significantly to MDG targets, particularly for MDGs 2-7, in the communities where the energy projects are active. While there is anecdotal evidence that the project has had some impact on the MDG 1 target of reducing poverty, it was difficult to quantify how much of this reduction resulted specifically from the REDP project.

One challenge that the community-based projects can present is the “common property” problems. The system performance can be strongly affected by the collective action of users. In stand-alone generating systems such as a micro-hydel plant, the electricity available is limited in quantity by the capacity of the power plant. Once users are connected to the electricity lines, however, it is difficult to restrict access to consumption of the resource. Over-consumption by some individuals pursuing their own short-term interest can degrade the resource for all. These challenges can be addressed with sufficient social mobilization of the communities and by putting in place well thought through and transparent management systems. These include well designed tariffs, metering arrangement, setting up of maintenance funds, and proper training of local operators in repair and maintenance. These issues, unfortunately, receive inadequate attention in many projects. The projects listed above are good examples for setting up sustainable systems for construction and operation and management of community-based mini-grid systems.

**Community management through user groups**

A number of the positive elements of community-based energy systems can also be transferred to involve users in the management of household level OS systems. The basic premise that users should be at the centre of the decision making process and will be able to manage their energy systems in a cost effective way can be equally valid for household OS systems as for community-based systems.

Through processes of social mobilization, groups of users of solar home systems, biogas or micro-wind turbines can be mobilized to engage in collective investment, collect monthly tariff,

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8 Report on Assessment of Rural Energy Development Programme – Impacts and its Contribution in Achieving MDGs.
and employ an operator for simple repair and maintenance. There is already a component of this in the AEDB promoted solar home systems in Sindh and Balochistan where user groups have been formed for monthly collection of tariff. Similar user groups have been set up and are effectively managing systems using wind energy systems promoted by Indus Earth and WWF.
5.0 Institutional and Policy Framework Options for Scaling up Off grid Electricity Supply for Pakistan

5.1 Status of Scale-up of Off-grid Electricity Supply in Pakistan
The experience in Pakistan in OS has largely been limited to pilot and demonstration activities so far. The one exception is with off-grid micro-hydropower systems which provide power to significant numbers of households in the Northern Areas and the Chitral District of NWFP. It is estimated that some 40,000 families have access to electricity from these community-managed mini-grid systems. Scale up is currently being attempted by AEDB particularly with solar (PV) home systems under the Roshan Pakistan initiative to fulfill the Government’s commitment to universal electricity access in the country. A number of NGOs have also included solar and wind energy projects into their project activities with funding from PPAF.

5.2 Policies and programs for Scale-up
Under its Policy for Development of Renewable Energy for Power Generation (2006) the Government of Pakistan has set a goal for renewable energy development in the country - generation of a minimum of 9,700 MW of renewable power by 2030 and universal access to electricity in all regions of the country through both grid extension and renewable energy in off-grid areas.

Under its Policy for Power Sector, the Medium Term Development Framework 2005-10 (MTDF) for Pakistan envisages: ‘encouraging the utilization of renewable energy (such as solar, wind, and biomass) especially for remote areas.’ Annex II of the MTDF has called for an allocation of Rs 19,633 million ($310 million) between 2005-10 for investment into OS through the AEDB under the Power Sector Investment Plan.

The Planning Commission’s Vision 2030 document states regarding off-grid energy access that, “AEDB would also develop and implement off-grid electrification program for rural areas. In addition, under the remote village electrification program, the first 400 villages (54,000 homes) will be electrified through wind and solar sources by 2010.”

The main government program which has begun to scale up off-grid rural electrification is the Off-Grid Rural Electrification Program (Roshan Pakistan Program) of the Government of Pakistan being implemented by AEDB. Roshan Pakistan attempts to provide electricity to several thousand remote off-grid villages through solar and wind energy, mainly in the provinces of Balochistan and Sindh. Under this program contracts have been awarded for electrification of over 3,000 homes in Sindh as of April 2008; of which around 2,000 systems have been installed in the previous six months. Bids are currently being evaluated for electrifying a similar number of households in Balochistan.

5.3 Main actors
The main actors in Pakistan with an active interest in the scaling up of OS-based rural electrification are as follows:

AEDB
The Alternative Energy Development Board (AEDB) was established by the Government of Pakistan in 2003 as an autonomous body with the aim of promoting and facilitating investments into renewable energy technologies. Under the remote village electrification program, AEDB has
been directed by the Government of Pakistan to electrify 7,874 remote villages in Sindh and Balochistan provinces through renewable energy technologies (http://www.aedb.org/intro.php).

PCRET
The Pakistan Council of Renewable Energy Technologies (PCRET) was established under the Ministry of Science and Technology by merging the National Institute of Silicon Technology (NIST) and the Pakistan Council of Appropriate Technology (PCAT). PCRET has been assigned the responsibility for research and development, dissemination, training, and promotion of renewable energy technologies. http://www.pcret.gov.pk/. PCRET areas of focus include: Photovoltaic (Solar Electricity), Solar Thermal Appliances (Solar Cookers, Solar Dyers, Solar Water heater, Solar desalination Plants), Micro-hydel, Wind, Bio-energy (Biogas, Bio-oil and other Bio fuels), Geothermal, and energy from Ocean Waves. The Council has offices in Islamabad as well as the four provincial capitals of the country.

PPAF: Pakistan Poverty Alleviation Fund (PPAF) is an autonomous fund set up by the Government of Pakistan to invest in community-based infrastructure projects and micro-credit for enterprises that reduce poverty. It represents an innovative model of public-private partnership and works with a total of 72 intermediary Partner Organizations (POS) for effective outreach to tens of thousands of Community Organizations (COs). The target beneficiaries of PPAF are poor rural and urban communities, with specific emphasis being placed on gender and empowerment of women. The Community Physical Infrastructure (CPI) Unit of the PPAF provides support in the form of loans or grants to partner organizations for approved physical infrastructure interventions. Identification of the projects is demand driven, and is determined by the communities through an internal participatory process. For purposes of ownership it is mandatory for the communities to share in the cost of the project, and also to manage and maintain the infrastructure provided, and ensure equitable benefits to all community members. A total of 10,889 community physical infrastructure projects have been constructed to date, including a number of micro-hydopower projects as well as a small number of wind energy projects through PPAF support.

Khusaal Pakistan Fund (KPF): KPF is a Government of Pakistan initiative working in the areas of income generation, health, education, roads, water and sanitation. KPF plans to extend its network each and every district of country. KPF aims to lift people from poverty by motivating them to utilize their resources, strength, and capabilities through self help schemes. Social mobilization is the driving force for implementation of KPF projects to get maximum benefits of infrastructure schemes. KPFs implementing partners are local governments as well as private and non government organizations that establish partnerships with local governments. KPF gives priority to lagging districts of the country, as identified by the provincial governments according to their own assessments. http://www.kpf.gov.pk/.

Although rural electrification is not an implicit focus for infrastructure funds under KPF, The Fund has invested in a number of community based micro-hydopower projects as well as expanding grid access.

NGOs and Rural Support Programs
Non Governmental Organizations (NGO), Community Based Organizations (CBO), and Rural Support Programs (RSP) use social mobilization to organize rural communities to support communities to implement Community-based Infrastructure projects. They build social capital in the process allowing these same community organizations (COs) to effectively carry out other development activities in future. One NGO active in the OS area has been the Aga Khan Rural Support Program (AKRSP).
AKRSP works with Village Organizations (VOs) under an agreed Terms of Partnership which has been developed over 20 years of experience supporting community micro-hydropower projects. Over 240 micro-hydropower projects, generating some 10 MW of power have been constructed by communities in the Northern Areas and Chitral in the past 20 years, providing power to over 30,000 households. The Sarhad Rural Support Program (SRSP) has likewise supported the construction of a large number of micro-hydropower projects in Chitral. The National Rural Support Programme (NRSP) installed a number or pilot units of solar PV lanterns and Light Emitting Diode (LED) lamps, solar water pumps, wind energy systems, biogas, and improved cook stoves (NRSP 2002).

**Provincial Government:** The provincial governments of Balochistan and Sindh as well as the authorities in Northern Areas and AJK have supported rural electrification through OS systems for remote communities that will not have access to grid power in the coming decades. In the case of larger micro and mini hydropower systems and larger stand-alone diesel generators, specialized organizations like SHYDO in NWFP and the Public Works Department of the Northern Areas continue to construct and operate Off-grid supply systems. So far provincial governments have not been involved in executing or managing smaller community level micro-hydropower systems or projects involving micro-wind or solar home systems. AEDB plans to strongly involve the Environment & Alternative Energy Department of the Government of Sindh and the Irrigation Department of the Government of Balochistan in the execution of OS projects in the respective provinces. The exact role and responsibilities of these provincial bodies is being worked out.

**Local Government:**
According to the SBNP Local Government Ordinance 2001, the concerned local government has responsibility for provision of electrification as well as for street lighting:

“86. Street lighting and electrification. — (1) The concerned local government shall take such measures as may be necessary for the proper lighting of the public streets and other public places vested in the local government by oil, gas, electricity or such other illuminant as the local government may determine.

(2) The local government shall also provide or cause to be provided electricity in coordination with the concerned department to its local area for public and private purposes.

(3) A concerned local government may frame and enforce a street lighting and electrification schemes.” (Page 171, LGO 2001)

In addition to the formal local government agencies, GoP’s Local Governance Ordinance (LGO 2001, and amended in 2005) has attempted to make local governance accessible to communities at the grassroots through the formation of Citizen Community Boards (CCBs). According to the Ordinance, “In every local area, a group of non-elected citizens may, for energizing the community for development and improvement in service delivery, set up a Citizen Community Board.” CCBs are voluntary associations of local people mandated and funded under the LGO to carry out development projects. Over 30,000 CCBs have been registered throughout Pakistan.

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‘Local government’ includes- (a) a District Government or a City District Government and Zila Council; (b) a Tehsil (Taluqa) Municipal Administration and Tehsil Council; (c) a Town Municipal Administration and Town Council; and (d) a Union Administration and Union Council.
Initiatives such as the Devolution Trust for Community Empowerment (DTCE) have supported and empowered CCBs, including female CCBs. Rural electrification is not among the activities CCBs have taken up to date. However, operation and maintenance of installed OS systems may be a potential activity for the better organized CCBs.

5.4 Reviews of OS Projects in Pakistan, Strategies, and Project Design Documents

5.4.1 Off-grid Rural Electrification Program of the Government of Pakistan is an ongoing activity currently being implemented under the national Roshan Pakistan initiative. It represents the most developed of the activities by the AEDB to fulfill its obligations to electrify some 7,000 villages which are more than 20 km from the closest power grid and are expected to be most cost-effectively electrified using off-grid supply. Under this program contracts have been issued for installation of 3,000 solar home systems in remote villages in Sindh, of which more than 2,000 have been installed, and tenders have been put out soliciting bids for installation of similar numbers of systems in the North, Central and Southern parts of Balochistan.

The program has followed standard procurement and installation procedures with a one year warranty on the supplied equipment. In addition, under these contracts, the commercial companies supplying the equipment are also required to manage and operate the systems including collection of monthly tariff from the users for the first year and maintaining the systems. In addition to being sizable in terms of size and coverage, these procurements thus display the beginnings of a Energy Service Company (ESCO) implemented ‘fee-for-service concession model’ and could provide a basis for movement towards a full-fledged concession model in future procurements.

The procedure followed by AEDB to implement the “Off-grid Rural Electrification Program of the Government of Pakistan” has involved the Provincial authorities in its design and implementation. An outline of this process is presented below:

- AEDB asked the Provincial authorities of Sindh and Balochistan to select 100 villages in one district each to be electrified using solar home systems as per the PC-1 submitted to the Government of Pakistan.
- The final selection of villages has been arrived at through discussions between AEDB and officials of the Provinces. The main considerations in the selection were needs identification by provincial and district authorities, generally based on needs as well as political priorities, and technical feasibility and financial resources availability on the part of AEDB. Two clusters of villages in Sindh were electrified in the first round and none from Balochistan due to financial resources not being available from the Federal Government to the level expected.
- AEDB set the technical standards for the procurement, put out the tenders, evaluated the bids, and awarded the contracts as per Government of Pakistan rules. Provincial authorities were invited in the bid evaluations.
- AEDB has been supervising the installations as they are being carried out and will monitor the systems to make sure they are operated and maintained by the supplying company over the one year agreement period.
- At the end of this one year period, AEDB intends to hand over the installations to the respective Provincial authorities for operation and maintenance of the systems.
- Individual households which have received electrification through the OS systems have signed for the receipt of equipment, which belongs to the Government of Pakistan, and have agreed to use and operate them without abuse.
The equipment supply companies have formed user groups, of around 100 households each, with the help of AEDB for system maintenance and tariff collection. They have trained a number of local operators to carry out routine maintenance. Operators were selected for training by the village committees and district nazim.

The mechanisms for monitoring the quality of technology and the actual installations were found to be well designed and thought through. AEDB field officers have done a good job in monitoring progress and technology standards. Technical support from GTZ has played an important role in keeping quality standards high. Within the one year company maintenance period most of the teething problems are likely to be worked out. However, it is unlikely that the Provincial authorities in Sindh will be ready to take over the two completed clusters at the end of this period as there has been little preparation to date for this. The best solution will likely be to persuade the two companies, Trilium and Petrocon, to continue to maintain the systems and collect the user fees for at least another year while other arrangements are made.

Monthly tariff for off-grid solar home systems are currently Rs 150, Rs 200, and Rs 300 for 40W, 80W, and 120W systems. This is used to cover the cost of routine maintenance as well as the salary of the village operator. It does not recover the capital costs in any way. Users have been paying these tariffs as long as the service is satisfactory. In a number of earlier pilots where the technology had broken down and not been replaced, users stopped paying tariff. It is likely however that this tariff structure is unsustainable and monthly fees may need to be increased for a private company to be able to cover O&M costs for these systems as a long term ESCO operating a fee-for-service concession. This will particularly be the case if the ESCO will be expected to replace the battery in 3-4 years. Additional analysis is needed based on the past year’s experience to gain a better understanding of how much a tariff will need to be to sustain an ESCO.

The modality of establishing user groups of around 100 beneficiary households and training operators from them to carry out routine maintenance and tariff collection is an innovative approach which makes it cost effective to carry out O&M, provides for quick response, and also provides employment in the communities. Private companies appreciate this modality and this is likely to remain an important component of future ESCO models.

5.4.2 Pakistan Council of Renewable Energy Technologies (PCRET)
Under its mandate to carry out research and development, dissemination, training, and promotion of renewable energy technologies, PCRET has installed a large number of off-grid energy systems in rural areas. Funded through a series of PC-1 submissions, PCRET has constructed over 300 micro-hydel systems, 134 micro-wind systems, and 650 kW of solar PV systems. Programs are currently ongoing to construct 550 kW of micro-hydro projects using Low Head High Discharge turbines and 60 kW of solar PV systems. PCRET works with community organizations and the private sector to install OS technologies. In addition to carrying out installations PCRET can be a specialist organization in setting technology standards and carrying out training of equipment suppliers and operators. PCRET has recently joined forces with AKRSP to provide technology and training support to the 103 micro- and mini-hydel projects under the “Community-based Renewable Energy Development in Northern Areas and Chitral”.

It is currently not in the mandate of PCRET to carry out large scale-up of solar home systems or micro-hydel. As the sector expands and organizations like AEDB and PPAF are able to implement large scale OS projects in the country, PCRET will be best suited to specialize in technology R&D, setting technical standards, capacity building of equipment manufacturers, and carrying out training of operators.
5.4.3 Pakistan Poverty Alleviation Fund – Technology Innovations Program
PPAF has financed communities to carry out a number of OS based rural electrification projects with technical oversight and social mobilization from its Partner Organizers. The list currently includes 63 micro-hydel systems, 32 wind turbines systems, 16 villages with solar PV clusters, and 12 solar water pumps. PPAF finances these projects out of its Water Management Center using the same modality that it uses for its other community physical infrastructure projects. The projects must benefit the members of the Community Organization or Village Organization and not single individual households. Social mobilization is a key component of all projects. PPAF provides 80% of the capital expenditure as a grant and the community must contribute the remaining 20%.

Although energy projects currently make up a negligible part of PPAF’s community infrastructure, and many of the projects other than micro-hydel are being carried out as pilot activities, it will be easy to scale up the implementation by building on existing modalities. PPAF is keen to expand its portfolio of energy projects and should play an important role in scaling up community-based mini-grid systems in the country – including micro-hydel, wind, solar, and water pumping.

5.4.4 Socio Economic Survey for Defining Village Energy Need in Balochistan and Sindh (April 2007)
This baseline survey report prepared by consultants for AEDB provides information about the socio-economic conditions, lifestyle patterns, energy demand and supply, current household energy costs and the willingness and ability of households to pay for Solar Home Systems (SHS) in nine districts of Balochistan and one district in lower Sindh. A total of 1,128 interviews were carried out in 60 villages among household which are currently not supplied with SHS. The main findings of the report are as follows:

*Socio-economic parameters among sampled households:*
1. About half the population is below the age of fifteen, indicating high fertility rates in the region and high economic dependency ratio with around 4 persons dependent on one bread winner.
2. Household size in Balochistan is 6.5 and 7.0 in Sindh with 89% of households in Balochistan and 71% of households in Sindh being nuclear families.
3. Average house in Balochistan has 3.24 rooms and in Sindh it is 2.97 with 90% of households in both areas being made of mud (katcha). Roughly half the households have separate kitchens.
4. Half the houses in Sindh have toilet facilities at home; in Balochistan only a few households do.
5. There is an increasing trend toward education among children with boys twice as likely to go to school as girls.
6. Every third household in Balochistan and every second household in Sindh have radios; ownership of television is negligible in both provinces is negligible.
7. Every seventh household in Balochistan and every fourth household in Sindh has at least one member living away from home to earn money.
8. Monthly average income for all households is PRs 4,700 with Upper Balochistan being the wealthiest.

Free time of adult males during the day is spent meeting friends and relatives. Females spend time doing embroidery and visiting close relatives. On average male and female adults in Balochistan have 3 hours between dusk and bedtime; this is slightly longer in Sindh. This is spent with family and listening to the radio and music.
9. The most common source of water is a well (70%), followed by hand pump and pond. On average a household in Balochistan spends 85 minutes a day collecting water; in Sindh it is 145 minutes a day. About 63 liters of water are consumed per household in Balochistan; in Sindh it is 75 liters.

Energy use among sampled households
1. Kerosene is the primary fuel used for lighting while wood is used for cooking and heating.
2. A household in Balochistan consumes 23 munds (920 kg) of wood in winter and 14 munds (560 kg) of wood in summer. In Sindh the numbers are 640 kg and 400 kg respectively. About half the population in Balochistan collect their firewood for free. In Sindh, nearly all households pay for wood.
3. Monthly expenditure on kerosene oil in Balochistan is PRs 453 and PRs 581 in Sindh. Kerosene supply in Balochistan is cheaper because of supplies from Iran.
4. The most common problem reported in the use of kerosene was dim light and smoke. Problems reported in the use of wood are smoke and bad smell. Quick burning of fuel was reported as a problem where wild bushes are used for cooking and heating.
5. All households in both regions are willing to pay for Solar Home Systems (SHS). Mean monthly amounts which households are willing to pay is PRs. 147 in Balochistan and Rs 120 in Sindh. Most households, 86% in Balochistan and 96% in Sindh, would be prepared to pay on a monthly basis.
6. The most commonly reported anticipated benefit of the SHS was improvement in the quality of life while very few expected the SHS to contribute towards increase in income.

5.4.5 Off Grid Electrification Strategy in Balochistan Province (2005)
This document prepared for the Alternative Energy Development Board (AEDB) provides elaboration of aspects of a possible framework for development of OS for remote areas of Pakistan. The OS technologies under consideration are solar home systems and micro-wind turbines. The strategy is based on interviews and data collection in some 20 villages in Balochistan and was developed through extensive discussions with AEDB officials, provincial authorities, NGOs, and industry representatives. The strategy was prepared under Technical Assistance from Asian Development Bank, “ADB TA No 4500-PAK: Capacity Building for the Alternative Energy Development Board.”

The main facets of the Balochistan O/S strategy can be summarized as follows:

A. Basic Principles for Off Grid Energy Service Supply
Energy policy of the Federal and Provincial governments must observe the following principles:
- Equal rights of all population groups for equal satisfaction of (basic) needs, a least cost energy service for rural and remote population forms a basic right.
- No additional damage to the environment by including so far not electrified user groups to energy service supply
- Equal public funding for off grid electrification, as is spent for grid connection in feasible cases
- Commercialization of Electricity Generation, Transmission and Distribution on the long run

B. Public Private Partnership after an Interim Period
Commercialization of off grid energy service supply should be realized in a Public Private Partnership (PPP) approach, aiming at:

- Creating a PV related industry, importing and/or manufacturing PV system components
- Creating Commercial Energy Service Providers (ESPROs: private enterprises licensed for energy service provision in well defined concession areas)
- Incentives and interventions, provided by the public sector of Pakistan, to make energy service provision a profitable business
- Limitation of energy tariffs such that the respective rural user groups can afford the energy service needed
- An interim period of some years will be needed, to form such a private sector industry. During that period, Community based Energy Service Providers (CESPROs) will start implementing off grid electrification.

\C. Implementation of Focal Villages

To start a Learning by Doing Process, special selected villages will be electrified, including public service and private income generating activities (SMEs), in parallel with:

- Manpower development
- Capacity building
- Quality standard implementation and control mechanisms will be started for all stakeholders concerned
- An institutional and administration structure will be created.

D. Financial Modeling

A Financial Model (courtesy Bremer Energy Institu and KfW) was applied for finding the crucial parameters for profitable ESPRO business, including:

- System design and respective investment and operation costs
- Fee for service tariff structure
- Governmental incentives and subsidies
- Private investments
- A first assessment resulted in positive cost/revenue balance (profit), for parameters set to:
  - Flat rate of Rs 300 per month
  - 100% capital investment subsidy
  - 25,000 users connected during the first 5 years of operation

E. Project Preparation

A detailed project preparation mission has to be carried out, including comprehensive analysis of:

- Demographic structure of the beneficiaries
- Technical analyses and system designs
- Financial analysis
- Economic viability.

The proposed strategy for off-grid rural electrification in Balochistan was discussed on September 19th, 2005 in Islamabad at a well attended meeting of all major stakeholders, “One Day Stakeholders Workshop on Off-Grid Electrification of Rural Villages in Balochistan”. It was organized by the Alternative Energy Development Board, Government of Balochistan Irrigation and Power Department, and the Asian Development Bank.

The framework favored by the proposed strategy for OS rural electrification is a Public Private Partnership which relies on commercial Energy Service Providers (ESPROS: private enterprises, licensed for energy service provision in well defined concession areas). The strategy proposes
that the Government of Pakistan should cover the capital cost of systems while the ESPROs would provide energy services to off-grid rural households through high quality solar PV and micro-wind energy systems at affordable prices. The strategy proposes that as some years will be needed to develop a private sector industry of ESPROs, Community-based Energy Service Providers (CESPROs) can start implementing off-grid electrification as pilots in the interim.

The general concession model for OS rural electrification builds on what South Africa has used for the past five years for its ambitious OS rural electrification program. The international experience from South Africa and other countries which have tried the fee-for-service concessionaire model is described in detail in a later section.

Following the stakeholders’ workshop and based on the Mid Term Development Framework, a revised PC-1 was proposed for the Government of Pakistan for electrification of 7,500 villages in all four provinces. Out of this total number the vast majority of 6,968 villages are in Balochistan. After receiving guidance from the Planning Commission that OS rural electrification should be carried out in the country in a phased manner a PC-1 was submitted and approved for First Phase electrification of 400 villages, 300 in Balochistan and 100 in Sindh.

The following OS rural electrification projects were sanctioned by the government on March 21st, 2006 to be undertaken by AEDB with effect from July 1st 2006 and completed in 30 months.

<table>
<thead>
<tr>
<th>Rural Electrification</th>
<th>Cost (Rs million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Balochistan</td>
<td>308.96</td>
</tr>
<tr>
<td>Central Balochistan</td>
<td>316.43</td>
</tr>
<tr>
<td>Sindh</td>
<td>262.30</td>
</tr>
<tr>
<td>Southern Balochistan</td>
<td>280.04</td>
</tr>
</tbody>
</table>

These projects are being funded by Development Funds of the Government of Pakistan. However, the government has directed that efforts be made to develop an Energy Service provider concept through the private sector and community partnership, supported by Government subsidies, international funding and managed through a micro-financing leasing scheme.

The current status of these projects is that just over 2,000 solar home systems have been installed in Sindh by two Pakistani companies: Petrocon and Trilium. These companies were selected through a competitive bidding process to procure and install solar home systems in around 60 villages in Sindh. Tenders were announced and bids have been received and are being evaluated for the electrification of 300 villages in Northern, Central and Southern Balochistan.

The projects for which funding has been approved by the Government of Pakistan are not for the full ‘ESPRO’ (Energy Service Provider) fee-for-service model outlined in the strategy paper described above. The model followed for the projects is for companies to supply and install systems in the homes for rural consumers and to manage and operate these systems for a period of one year. The companies are working through locally established user group where an operator trained by them will carry out repairs and maintenance and will be paid from monthly tariff collections from user households. The systems will remain under ownership of the Government of Pakistan and are being made available for use to individual households. After the one year period of company operations is over the OS electrified clusters are to be handed over to the respective provincial authorities.
5.4.6 The Productive Use of Energy in Chitral District (2005)

This Project Design report carried out by GTZ has focused on the use of micro- and mini-hydropower projects to not only provide electrification in mountain areas but also to power productive activities. AEDB is currently developing a PC-1 for government support for this project with additional funding support coming from UNDP-GEF.

Hydropower has been selected as the main technology both because it is a resource which is abundantly available in Chitral at off-grid locations and also because it is an O/S technology which is able to provide sufficient power for industries and other productive uses, “... only hydropower can provide sufficient capacity to initiate rural economic development”. The project design document states that, “Rather than focusing on providing access to energy as project objective, the project aims to provide electricity as a basic tool to initiate value added productive chains in rural areas.”

The project plans to construct 5 demonstration mini hydel projects each of size 200-300 kW to meet the productive uses of the beneficiary communities ((Izh-Ovirk, Bilphok-Shagore, Shagram, Raman-Harchin, and Bumburate) along with their domestic needs. The details of these projects, including capacity, investment cost, expected operation cost, proposed tariff, as well as the results of the economic analysis for the proposed projects (pay back period, and NPV at different discount rates) is presented in the table below.

The analysis confirms that where the resources are available, mini and micro-hydel generally provide the least cost energy. It can be seen from the Table 2 below that given sufficient revenue generation through high utilization of the produced electricity for productive uses, even with the modest tariff of 2.0 US cents per kWh the projects can generate a positive Net Present Value over its life at a discount rate of 5-10%.

Table 2: Economic Analysis of Mini-hydel Projects

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Izh-Ovirk</th>
<th>Bilphok-Shagore</th>
<th>Shagram</th>
<th>Raman-Harchin</th>
<th>Bumburate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total investment (US $)</td>
<td>248,710</td>
<td>665,420</td>
<td>568,740</td>
<td>686,520</td>
<td>660,240</td>
</tr>
<tr>
<td>Installed Capacity (kW)</td>
<td>300</td>
<td>300</td>
<td>200</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Cost per kW installed capacity (US $)</td>
<td>2,416</td>
<td>2,311</td>
<td>2,764</td>
<td>2,295</td>
<td>2,201</td>
</tr>
<tr>
<td>Operational Cost/ year</td>
<td>49,083</td>
<td>47,205</td>
<td>39,124</td>
<td>46,611</td>
<td>45,214</td>
</tr>
<tr>
<td>Cash Flow positive after (years)</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Full cost recovery after (years)</td>
<td>4</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Pay back period (years)</td>
<td>11</td>
<td>10</td>
<td>12</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Surplus revenues (US $) after 25 years</td>
<td>956,799</td>
<td>286,444</td>
<td>594,044</td>
<td>715,253</td>
<td>523,604</td>
</tr>
<tr>
<td>Internal rate of return (%)</td>
<td>12</td>
<td>7</td>
<td>11</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>NPV (5%) in US $</td>
<td>440,244</td>
<td>110,629</td>
<td>288,013</td>
<td>324,996</td>
<td>231,841</td>
</tr>
<tr>
<td>NPV (10%) in US $</td>
<td>57,307</td>
<td>68,605</td>
<td>26,120</td>
<td>31,507</td>
<td>15,125</td>
</tr>
</tbody>
</table>

The project proposes that sustainable management of the micro-hydel units will result through the following management and organizational model:

- An elected “construction committee” should participate in the planning and designing process (ownership) and have a full insight in the purchase of equipment.
All HHs should either contribute in cash or in labour force according to their financial possibilities and time availability. The community should decide under which conditions a HH could be exempted from his contribution.

The concerned villages including all electricity consumers should select an overall management committee overseeing all necessary activities concerning the MHP.

The MHP is owned by the communities included in the supply system.

The management committee selects
- 1 president of the management committee
- 1 secretary responsible for billing and book keeping
- 1 secretary per village responsible for supervising the correct meter reading and collecting payments of bills
- 1 external auditor for the book-keeping of every village and the auditing of the joint maintenance and repair fund at the MHP bank account.

The existing monthly flat rate needs to be changed into a consumption-based kWh payment in all villages. Meters to monitor will be provided from the project.

The president, secretary and the electricity fee collectors should propose an operational cost covering tariff (e.g. 1 Rs. per unit kWh) to the HHs

Preferential treatment for poor HHs should also be discussed and decided by the villagers/management committee.

In an annual information meeting the president of the management committee has to brief the villagers about the ongoing MHP technical performance, financial situation and book keeping. The auditor has to report about all financial transaction and provide a clearance certificate for the management committee.

Bills are issued by the MHP management according to monthly meter readings.

A certain portion of the revenues are paid as leasing fee to the management unit which transfers the money to a bank account, solely to be used for major repairs and replacements. The remaining revenues (capital cost are deducted) belongs to the leaseholder who has to transmit 10% of hereof also to a bank account for purchasing spear and wear parts.”

The GTZ project document proposes a joint community and private sector management “private based management concept” for the sustainable operation of the plants under which:

- Responsibility and decision making is located as near as possible to the station and the beneficiaries themselves. Thus, line of command is short and local interests can be much better taken into consideration.
- Operation and management of the power plant should be private based. Thus, income is directly output oriented and can be controlled and influenced by the management itself. Bad performance will directly lead to lower profits whereas additional measures supporting power consumption will lead to higher profit rates.
- Rights and duties are to be distributed in an appropriate way among the stakeholders. The leaseholder is responsible for power generation and transmission, whereas the community as owner of the station is responsible for distribution and billing. This includes respective sharing of losses. The community is responsible for the losses in the distribution system and thus for non-technical losses (it has also the means to enforce respective regulations and fines). Appropriate leasing management contracts are to be conducted among the parties involved.
- Participation of HHs during the construction time increases the sense of ownership and should be asked from the villages. The villages are used to communal work as they regularly have to repair their irrigation channels and their roads sometimes.
Representatives referred to their present system of contribution where each member has to participate in labor work at least on weekends.

Figure 8: Proposed Organization of Mini-hydro Power Supply

Preference for community and private sector management over ‘government ownership and management’ of systems is expressed in the design document as follows:

“A government owned and operated power station will always have to struggle with conflicts in interests, low motivation of public paid workers, high bureaucratic rules and regulations (e.g. revenues have to be transferred to the central budget, from which (if so) expenses are transferred back), intransparency of cash flow and decision making. Central administration also reduces the local impact of electricity supply because locally collected money is not circulated locally but transferred to central level, services for the power station are provided through centralised channels which often do not consider locally available capacities and know how thus reducing again the economic benefits.”

5.4.7 Community-based Renewable Energy Development in Northern Areas and Chitral (2008)

This project is being developed by the Aga Khan Rural Support Programme (AKRSP) as a carbon finance project. Each of the plants constructed under the project will be managed and operated as a community-based management system—backed by AKRSP. The full project activity consists of 103 community-based micro- and mini-hydel projects planned to be constructed in the districts of Gilgit and Baltistan regions in the Northern Areas and Chitral District in NWFP in the time frame 2008-2011.10

In addition to receiving revenue from sale of carbon credits, the project expects to receive funding from the Pakistan Poverty Alleviation Fund. AKRSP also expects to receive technical support from PCRET, AEDB, Northern Areas Public Works Department (NAPWD), and Chitral Works Department (CWD), and GTZ in carrying out the project.

The Project Design Document (PDD) which has been prepared for the project describes the environmental and economic benefits of the project as follows:

“The Community-based Renewable Energy Development in the NAC project will invest in micro and mini hydropower projects (MHP) at various sites in the federally administered Northern

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10 Construction has begun on individual projects. The project is expected to be registered with the CDM Executive Board by September 2008.
Areas and Chitral District of NWFP, Pakistan. The project aims to generate around 15 MW of power from 103 projects ranging in size from 35 kW to 350 kW. This will provide much needed power for meeting community energy needs at the same time substituting for the use of diesel fuel, thereby contributing to reduction of greenhouse gas emissions. The vast majority of those that will be served by the MHP, do not currently have access to electricity from any source. However, there is a growing trend in the consumption of diesel fuel, which is state subsidized, for power generation at the household level in rural areas as well as by public utilities for town centres in the NAC. Without a clean energy alternative, there would be a penetration by diesel generators into the proposed project area. NAC is facing an acute shortage of energy.

The region has rare alpine forest resources which are being consumed at unsustainable rates for domestic use, mainly cooking and heating. To a limited extent, the electricity generated by the project will provide cooking and heating energy at the household level. Although firewood use is not in the baseline for this project, its partial replacement will be an additional benefit of the project. Without the proposed project, use of fossil fuels and unsustainably harvested fuel wood would continue to increase despite potential for generating adequate renewable and clean energy from local streams.

NAC offers tremendous potential to generate renewable energy primarily from hydropower. NAC serves as vital upper catchments for the River Indus, on which much of Pakistan’s irrigation and hydroelectricity depends. The perennial flow of water from snow melt in fast flowing streams, gives the area substantial potential to produce hydroelectricity through small, off-grid projects to serve the local area.”

“In addition to the environmental benefits the project will create opportunities for economic development and alleviation of poverty in the underdeveloped and remote mountain communities of northern Pakistan through value added to agriculture and forestry products and value added to the local gems industry and tourism services. Provisions of basic amenities such as good quality power supply, television, and possibility of mobile phone networks as a result of electrification will contribute to improved quality of life. Improved health and education services are likely to be available to local people as these remote areas become more attractive for teachers and health workers to live in.”

The projects are constructed by the construction committees set up by the Village Organizations (VOs). AKRSP provides technical support to make sure that construction is of high quality as is the equipment supplied. Operation and management of the projects will be the responsibility of the VOs. They may decide to entrust the tariff collection to a private contractor.
6.0 Survey Results

6.1 Social Aspects

i. Demography
The solar and wind energy villages were in Sindh and Balochistan with population ranging from 200 to 500 except two villages that were at 1000 and 1200. The micro- and mini-hydel projects in Chitral typically served multiple villages and had large variation in populations served; with the largest serving close to 90,000 people (12,210 families), the second serving a population of around 17,000 (2,458 families) and the smallest one serving around 2,000 people (298 families). The Sindh and Balochistan villages tended to have multiple households within a compound – all belonging to one extended family. In Chitral the situation was different – one family per house.

ii. Education
The state of education was found to be rather poor in all the villages visited in Sindh and Balochistan. Very few children go to school. Typically they help their elders in earning a living. The percentage of school going children varied from 0 to 15% of the total population; Durgai was an exception with 25% of population going to school.

The level of education is much higher in the Chitral micro-hydel villages, where 17 to 25% of population goes to school. It appears to be due to many years of social mobilization work by AKRSP.

iii. Economic Profile
As is apparent from the Economic Profile in Table 3 below, the Sindh and Balochistan villages were mostly dependent on agriculture and livestock except Tippun that was an exclusive fishing village. Two villages had a significant percentage of population working in the Gulf. The Chitral population also had the largest percentage earn their living from agriculture and livestock; however, due to their better education there were a good percentage of men and women working for the government, NGOs and other private employers.

Table 3: Economic Profile of Surveyed Villages

<table>
<thead>
<tr>
<th>Technology</th>
<th>Village Name</th>
<th>Agro &amp; Livestock</th>
<th>Labor</th>
<th>Overseas Employment</th>
<th>Govt &amp; Pvt Employment</th>
<th>Self Employed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pop%</td>
<td>Pop%</td>
<td>Pop%</td>
<td>Pop%</td>
<td>Pop%</td>
</tr>
<tr>
<td>SHS</td>
<td>Allah Bakhsh Bazar</td>
<td>40</td>
<td>15</td>
<td>25</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Bharomal</td>
<td>60</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Haji Dost Mohd Patkin</td>
<td>50</td>
<td>35</td>
<td>0</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Qadir Abad</td>
<td>50</td>
<td>20</td>
<td>25</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>WTS</td>
<td>Durgai Zardullah</td>
<td>75</td>
<td>10</td>
<td>0</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Goth Haji Juma</td>
<td>50</td>
<td>50</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Haji Noor Mohd Goth</td>
<td>45</td>
<td>20</td>
<td>0</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Tippun</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>MHP</td>
<td>Reshun</td>
<td>50</td>
<td>5</td>
<td>5</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Ayun</td>
<td>50</td>
<td>10</td>
<td>5</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Izh Garam Chashma</td>
<td>50</td>
<td>20</td>
<td>0</td>
<td>20</td>
<td>10</td>
</tr>
</tbody>
</table>
Almost everywhere it was observed that economic activity increased when light came to households. Women benefited the most. They started sewing/stitching, embroidery, carpet and basket weaving at night. At Tippun, a purely fishing village, men catch fish all day and come home when it is dark. It is women’s job to sort different kinds of fish. Before light came to their homes, women used to throw away small shrimp not knowing what it was. Now with the light they can see and are able to save typically 1 kg of small shrimp per household per day earning Rs 80-100 extra.

The larger mini-hydropower projects contributed strongly to the economy and employment generation by powering industries and commercial establishments. The 2,800 kW Reshun plant powered xx industries and commercial establishments while the 640 kW Ayun plant (Sahan village) powered yy industries and commercial. The 50 kW Izh micro-hydropower plant was more limited in its ability to power industries but was providing electricity to zz shops and offices.

**iv. Income/Expense**

Tables 4a, 4b, and 4c below show income profiles of the villages. In general, the income and savings of villages in Sindh and Balochistan were low. The only exception was Allah Bakhsh Dandar that had 25% of its male population working in the Gulf and as a consequence their income was high. Villages in Chitral had significantly higher income and savings. Almost all villages were spending Rs 200 to 500 on lighting charges as a combination of tariff charges for OS electricity and for kerosene oil.

**Table 4a: Income profile Solar Villages**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Allah Bakhsh (Balochistan)</th>
<th>Bharomal (Sindh)</th>
<th>Haji Dost Mohammad (Balochistan)</th>
<th>Qadir Abad (Balochistan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Monthly Cash Income</td>
<td>22,800</td>
<td>7,800</td>
<td>19,940</td>
<td>5,200</td>
</tr>
<tr>
<td>Food</td>
<td>6,800</td>
<td>3,200</td>
<td>8,200</td>
<td>2,600</td>
</tr>
<tr>
<td>Education</td>
<td>2,160</td>
<td>30</td>
<td>1,580</td>
<td>20</td>
</tr>
<tr>
<td>Health</td>
<td>1,340</td>
<td>1,040</td>
<td>3,200</td>
<td>1,200</td>
</tr>
<tr>
<td>Clothing</td>
<td>3,060</td>
<td>2,000</td>
<td>3,800</td>
<td>750</td>
</tr>
<tr>
<td>Transport</td>
<td>840</td>
<td>460</td>
<td>1,500</td>
<td>200</td>
</tr>
<tr>
<td>Social Needs</td>
<td>1,800</td>
<td>500</td>
<td>1,000</td>
<td>300</td>
</tr>
<tr>
<td>HH items</td>
<td>1,600</td>
<td>200</td>
<td>600</td>
<td>250</td>
</tr>
<tr>
<td>Fuel Charges</td>
<td>500</td>
<td>170</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>Lighting Charges</td>
<td>520</td>
<td>300</td>
<td>300</td>
<td>250</td>
</tr>
<tr>
<td>Savings</td>
<td>4,120</td>
<td>0</td>
<td>0</td>
<td>(570)</td>
</tr>
</tbody>
</table>

Note: One data anomaly was observed with Qadirabad village. Their economic profile is the same as Allah Bakhsh Bazar but their income is less than a quarter of the latter village.
Table 4b: Income profile Wind Villages

<table>
<thead>
<tr>
<th>Feature</th>
<th>Durgai Zardullah (Balochistan)</th>
<th>Goth Haji Juma (Sindh)</th>
<th>Haji Noor Mohammad (Sindh)</th>
<th>Tippun (Sindh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Monthly Cash Income</td>
<td>6,800</td>
<td>7,000</td>
<td>11,800</td>
<td>13,400</td>
</tr>
<tr>
<td>Food</td>
<td>3,000</td>
<td>5,000</td>
<td>5,200</td>
<td>6,000</td>
</tr>
<tr>
<td>Education</td>
<td>240</td>
<td>150</td>
<td>760</td>
<td>500</td>
</tr>
<tr>
<td>Health</td>
<td>200</td>
<td>200</td>
<td>780</td>
<td>1,200</td>
</tr>
<tr>
<td>Clothing</td>
<td>960</td>
<td>150</td>
<td>1,200</td>
<td>1,350</td>
</tr>
<tr>
<td>Transport</td>
<td>300</td>
<td>200</td>
<td>780</td>
<td>420</td>
</tr>
<tr>
<td>Social Needs</td>
<td>900</td>
<td>300</td>
<td>1,000</td>
<td>760</td>
</tr>
<tr>
<td>HH items</td>
<td>400</td>
<td>300</td>
<td>1,200</td>
<td>1,200</td>
</tr>
<tr>
<td>Fuel Charges</td>
<td>320</td>
<td>400</td>
<td>350</td>
<td>250</td>
</tr>
<tr>
<td>Lighting Charges</td>
<td>350</td>
<td>300</td>
<td>200</td>
<td>480</td>
</tr>
<tr>
<td>Savings</td>
<td>0</td>
<td>0</td>
<td>350</td>
<td>1,600</td>
</tr>
</tbody>
</table>

Table 4c: Income profile Micro- Mini-hydel Villages

<table>
<thead>
<tr>
<th>Feature</th>
<th>Izh (Chitral)</th>
<th>Reshun (Chitral)</th>
<th>Ayun (Chitral)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Monthly Cash Income</td>
<td>19,200</td>
<td>17,000</td>
<td>11,600</td>
</tr>
<tr>
<td>Food</td>
<td>5,900</td>
<td>6,000</td>
<td>5,400</td>
</tr>
<tr>
<td>Education</td>
<td>2,320</td>
<td>3,500</td>
<td>325</td>
</tr>
<tr>
<td>Health</td>
<td>560</td>
<td>620</td>
<td>1,200</td>
</tr>
<tr>
<td>Clothing</td>
<td>500</td>
<td>1,000</td>
<td>1,600</td>
</tr>
<tr>
<td>Transport</td>
<td>1,600</td>
<td>2,000</td>
<td>850</td>
</tr>
<tr>
<td>Social Needs</td>
<td>400</td>
<td>500</td>
<td>1,400</td>
</tr>
<tr>
<td>HH items</td>
<td>550</td>
<td>550</td>
<td>450</td>
</tr>
<tr>
<td>Fuel Charges</td>
<td>1,850</td>
<td>1,400</td>
<td>1,420</td>
</tr>
<tr>
<td>Lighting Charges</td>
<td>72</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>Savings</td>
<td>5,270</td>
<td>1,080</td>
<td></td>
</tr>
</tbody>
</table>

v. Available Services
Tables 5a and 5b, below show access to some of the services. The villages in Sindh and Balochistan were typically in far flung areas; as an example, the distance from the tehsil headquarter ranged from 7 to 170 km. As a result, the availability of services such as healthcare, bank, post office, PCO, market, paved road, etc was rather poor. Only 2 out of 8 had any water supply schemes. The villages in Chitral were closer to cities and tended to have better facilities. Telephone penetration was quite impressive everywhere, especially with PTCL’s V-phone facility. Water supply and sanitation was better in Chitral villages due to the work done by AKRSP.
## Table 5a: Access to Services in Surveyed Villages

<table>
<thead>
<tr>
<th>Technology</th>
<th>Village</th>
<th>Health Care</th>
<th>Water Supply Schemes</th>
<th>Nearest Town</th>
<th>Tehsil Headquarter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At village</td>
<td>At village</td>
<td>At village</td>
<td>At village</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Distance (Km)</td>
<td>Distance (Km)</td>
<td>Distance (Km)</td>
<td>Distance (Km)</td>
</tr>
<tr>
<td>SHS</td>
<td>Allah Bakhsh Bazar (Balochistan)</td>
<td>Yes</td>
<td>-</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Bharomal (Sindh)</td>
<td>No</td>
<td>2</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Haji Dost Patkin (Balochistan)</td>
<td>Yes</td>
<td>0</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Qadir Abad (Balochistan)</td>
<td>No</td>
<td>4</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td>WTS</td>
<td>DurgaiZardullah (Balochistan)</td>
<td>No</td>
<td>2</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Goth Haji Juma (Sindh)</td>
<td>No</td>
<td>1</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Haji Noor Goth (Sindh)</td>
<td>No</td>
<td>28</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Tippun (Sindh)</td>
<td>No</td>
<td>10</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td>MHP</td>
<td>Reshun (Chitral)</td>
<td>No</td>
<td>1</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Ayun (Chitral)</td>
<td>Yes</td>
<td>-</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Izh Garam Chashma (Chitral)</td>
<td>No</td>
<td>1</td>
<td>Yes</td>
<td>-</td>
</tr>
</tbody>
</table>

## Table 5b: Access to Services in Surveyed Villages

<table>
<thead>
<tr>
<th>Technology</th>
<th>Village</th>
<th>PCO</th>
<th>Telephone</th>
<th>Post Office</th>
<th>Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At village</td>
<td>At village</td>
<td>At village</td>
<td>At village</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Distance (Km)</td>
<td>Distance (Km)</td>
<td>Distance (Km)</td>
<td>Distance (Km)</td>
</tr>
<tr>
<td>SHS</td>
<td>Allah Bakhsh Bazar (Balochistan)</td>
<td>Yes</td>
<td>-</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Bharomal (Sindh)</td>
<td>No</td>
<td>2</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Haji Dost Patkin (Balochistan)</td>
<td>No</td>
<td>0</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Qadir Abad (Balochistan)</td>
<td>No</td>
<td>4</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td>WTS</td>
<td>Durgai Zardullah (Balochistan)</td>
<td>No</td>
<td>10</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Goth Haji Juma (Sindh)</td>
<td>No</td>
<td>3</td>
<td>No</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Haji Noor Goth (Sindh)</td>
<td>No</td>
<td>28</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Tippun (Sindh)</td>
<td>No</td>
<td>10</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td>MHP</td>
<td>Reshun (Chitral)</td>
<td>No</td>
<td>1</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Ayun (Chitral)</td>
<td>Yes</td>
<td>-</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Izh Garam Chashma (Chitral)</td>
<td>No</td>
<td>1</td>
<td>Yes</td>
<td>-</td>
</tr>
</tbody>
</table>
vi. Willingness and Ability to Pay

In all villages the inhabitants had experienced the convenience of light through OS technologies. Now they could not live without it. Even those villages where the OS installations were less successful, the villagers expressed a desire to get newer and better systems. And they were willing to pay for it. Here are some excerpts from four different villages – two with successful installations and two with not so successful installations.

Allah Bakhsh Dandar (solar - successful): The villagers said that they pay electricity charges of Rs 200 per month per HH to be used for operation and maintenance of SHS. They said that if the SHS production capacity were to improve they were ready to pay more money.

Bharomal (solar – not successful): The villagers said that they had agreed to pay maintenance charges up to Rs 200 per month per HH. However, after the failure of 70 SHS they decided not to pay. They further added that if the systems were improved and provided to all houses in the village they would start paying. The community was demanding bigger systems to run TV and radio along with the lights and fan. They were ready to pay 20% of the initial cost for such a system and Rs. 300 to 400 per month for operation and maintenance.

Patkin Village (solar – not successful): On project completion the villagers had agreed to pay Rs 150 per month for o/m charges. However, it did not happen due to lack of follow-up by the NGO. Secondly, they started bypassing the solar controllers to get more hours. It degraded the batteries and now they can get only 2-3 hours of light. The community was demanding bigger systems to run TV and radio along with the lights and fan. They were ready to pay 20% of the initial cost in monthly installments for such a system and Rs. 200 to 300 per month for the operation and maintenance.

Haji Noor Muhammad (wind – successful): The villagers said that they were ready to pay electricity charges up to Rs 300 per month per HH if it was provided in their homes.

Almost all of them desired to have grid power for the “real electricity” and low ‘lifeline’ costs. As an example, WAPDA’s lifeline rates are Rs 150 for the first 50 units per month, whereas, in AEDB projects villagers pay Rs 200 for only about 9 units.

Prior to getting OS electricity they were paying Rs 200 to 500 for kerosene oil for lighting purposes. They were more than happy to pay similar charges for the higher quality lighting from OS electricity. Not everyone in the village may have the ability to pay the full charges; it requires some concessions for the very poor, usually mediated by the community organizations.

6.2 Analysis of Off-grid Supply in Pakistan

6.2.1 Technology

a. Micro/Mini Hydel

Three different plants were visited in Chitral. The plant capacities were 50 kW, 640 kW and 4,200 kW. The plants were generally running smoothly providing electricity to large population. Winters are a challenge for hydropower projects in the Northern mountain areas as the production goes down due to reduced water flow in the streams while demand goes up. This can cause power shortages resulting in for example 8 hours load shedding each day for 6 months of winter in the
case of Reshun (4,200 kW) power plant. The Ayun (640 kW) and Izh (50 kW) power plants produce sufficient power even in winter and have negligible or no load shedding. Power is supplied to domestic as well as commercial and industrial consumers. The two larger plants operate 24 hours a day and have a significant share of industrial consumers. Izh supplies mainly to domestic and some commercial customers. It operates 19 hours a day from 1:00 pm to 8:00 am.

The power house equipment used in Reshun was imported from Germany and the installation was done to high technical standards. Similarly the civil works were well engineered and constructed to high standards. Operators, who are employees of SHYDO, are competent and follow standard operation and maintenance procedures. Two turbine generator units of 2,800 kW have performed well in the power house with no major technical problems from installation in 1999 to the present. The third unit of 1,400 kW was installed in 2007. The justification for this later addition is not clear, except perhaps as a spare unit or as a political compulsion, since there is only sufficient flow in the Reshun Gol (river) to produce 1,000 kW in the winter, at a time when the demand for power is the highest. The addition of this third unit is not going to reduce the load shedding during winter months.

The power house equipment at the Ayun plant was imported from China and the installation of powerhouse equipment was done to adequate standards. However, lack of trained operators or adoption of standard operation and maintenance procedures has resulted in this relatively new power plant (2001) looking well used. One of the runners has had to be repaired, in a workshop in Chitral, and circuit breakers were replaced. The civil works is of uneven quality and results in relatively high operation and maintenance costs.

The Izh power plant uses a turbine manufactured in Taxila and a low-cost alternator from China. It does not have a governor or load controller and power output has to be controlled manually. The overall efficiency of the system is low with the output of the nominally 50 kW system being limited to around 32 kW. Nevertheless the system has been working well and serving the needs of the community for close to 10 years. The basic technology and the fact that much of the equipment was fabricated in Pakistan allows for easy and low cost repair and maintenance.

The lack of system governor to keep the voltage and frequency constant and low power output has meant that the output power of the system is not used for saw mills and other industrial loads in the day time. These continue to run on diesel power. Control of power usage at the consumer level is done socially rather than with any technology. Households subscribe to anywhere from 3-7 lights and pay a flat fee irrespective of how many hours they use the lights. Certain appliances like television sets, computers, and irons are allowed to be used at different times of the day with no additional charge. Other appliances like rice cookers and space and water heaters are not allowed to be used for fear of overloading the system. A more efficient way to maximize the electricity produced and the energy used would be to install load controller equipment in the power house and to install circuit breakers or energy meters at the user end.

Paradoxically Reshun with the best equipment and most competent operators is also the one with the largest load shedding problem; Ayun is technically mediocre compared with Reshun but is commercially the best managed, while Izh with the simplest equipment provides power mainly lighting throughout the year and also has surplus to the nearby bazaar. This shows the tradeoff between technology and management between centralized projects compared to more local and community-managed projects.
b. Solar and Wind Turbine
All AEDB installations used 80W solar panels along with deep discharge 100Ah sealed lead acid batteries and four 14W CFL lights. Charge controllers have been installed at all sites to prevent over discharge of batteries. The panels and batteries are imported while charge controllers are locally manufactured. The equipment was adequate for the lighting requirements of the villagers. Typically one compound would get the system with lights distributed among the households within the compound. A household is generally one room. Patkin village project was done by NUST and Islamic Relief. It had smaller systems with 14W panels, 24 Ah batteries and two 6W CFL lights. Every house had its own solar system.

For wind typically 500 W locally made micro turbines were used except one village, Durgai, had a 10KW installation. Durgai wind turbine and batteries were imported while the controllers were locally manufactured. The height of the tower varied between 7 and 9m except Durgai had 24m high tower. The turbines were connected in one village to 3 houses, in another to 17 houses and the larger Durgai system had 29 houses connected.

6.2.2 Problems with Solar and Wind Turbine Installations

i. Lack of Trained Resources
There are very few technical people trained in these technologies in Pakistan. It creates problems in replacement of parts and the maintenance of systems is sub-standard.

ii. Poor Availability of Spare Parts
Replaceable parts such as CFL bulbs, batteries and controllers are available only in bigger towns. Villagers have to wait sometimes for weeks to get the replacement. It creates a sense of frustration and a desire not to pay the monthly charges.

iii. Organizations Lack Experience
Organizations that have had some significant experience in the implementation and support of these technologies are practically non-existent. It results in poor implementations and poor follow up by the implementing organizations leading to all sorts of problems. As an example, in village Patkin the users started bypassing the controllers to get more light hours. It resulted in premature degradation of batteries and now they are getting even fewer hours than before. It happened because the implementing organization did not educate the community on a regular basis about such issues and also did not closely monitor the use of the systems as they did not have trained technicians.

In another implementation the vendor complained that the cluster of villages given to them for installation was too spread out for them to work effectively. The problem will only exacerbate when need arises for maintenance support. Less experienced companies may get into trouble not being able to fully assess the higher costs of electrifying spread out communities.

iv. Poor Quality of Components & Installation
There are problems of poor quality of components and installation. In one village 6 out of 12 wind turbines fell down during a storm. In another village the CFL bulbs were burning out in large numbers. In another village solar controllers started dying within months of installation. No standards have been developed for these components and there is limited or no enforcement of warranties.
6.3 Financing Modalities

OS technologies tend to be capital intensive. Different financing modalities were followed by different funding and implementing organizations. Some are discussed below.

6.3.1 Funding Modalities for Solar/Wind Turbine Installations

i. PPAF/IET

In the projects PPAF funds, it requires 20% contribution from the community in cash or cash and labor/material combined. They also require monthly o/m charges that need to add up to 3% of project cost on annual basis. As an example, in the Haji Noor Muhammad village, which was supported by PPAF through its Participating Organization Indus Earth Trust (IET) 33 households contributed Rs 600 each to contribute 10% of the project cost. The remaining 39 families contributed 3 days of labor to take care of the other 10%. Almost all households are contributing Rs 10 each monthly to fulfill the 3% o/m fund requirement. In a future solar project Indus Earth Trust, the PPAF partner organization, plans to have the community members purchase the battery and pay for internal wiring and civil work to take care of the 20% contribution requirement. PPAF methodology follows the “Community-based Model” as defined later in the report.

ii. WWF

World Wide Fund for Nature follows the PPAF methodology as far as the 20% community contribution goes. However, their o/m charges are determined by the Community Organizations (COs); they do not enforce a certain percentage as PPAF does. The Tippun village we visited is part of the “Indus for All”, a livelihood project. 16 households contributed Rs 2,000 each to make the 20% cash contribution. WWF methodology also follows the “Community-based Model” as defined later in the report.

iii. AEDB

AEDB does not require any up front contribution by the community. Instead they require one time connection fee of Rs 1,000 and o/m monthly charges of Rs 200. They have had mixed results with the collection of monthly charges. Some villages have fared better than others. AEDB follows the “User Group Operated Fee for Service Model” as defined later in the report.

iv. Empower Consultants

Empower Consultants and their local NGO partner who together implemented the Durgai wind energy project did not require any capital expenditure from community members on this ADB funded project. Empower did require users to pay for energy charges by the units consumed to take care of the running expenses at the rate of Rs 11/kWh. Initially this worked fine and showed a remarkable willingness to pay high tariffs by rural users. Over time it turned out that the collection was insufficient to take care of the running expenses as due to lack of control the villagers had installed large appliances and were heavily using the diesel generator to charge the batteries. Empower followed the “Community-based Model” as defined later in the report. However, insufficient social and technical controls were placed on over-use of energy resulting in system failure.

v. NUST University /Islamic Relief

The Patkin solar home system and water pumping project was implemented jointly by NUST and Islamic Relief with funding from USAID SARI/E small grants. No direct contributions were required from the beneficiary community. The community had agreed with the implementing partners to pay Rs 150 per month for o/m but due to lack of follow up by Islamic Relief, it did not happen. So it was a poor execution of the “Community-based Model”.

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6.3.2 Micro/Mini Hydel Methodology

The micro/mini hydel projects are different from the solar and small wind projects as typically there is relatively large scale electricity production at the plant and it is distributed to the community via supply lines. So the methodology is more like that of a utility company that charges by the units consumed. All of them recover their recurring expenses and part of the initial investment through the monthly collection from the consumers. Financing and the operational methodologies for the three plants visited were as follows:

i. Izh plant: AKRSP funding 60%, community 40% – run under “Community based Model”
ii. Ayun: Private investor 40% equity, 60% bank loan – run under “Fee for Service Model”
iii. Reshun: Government of Pakistan with a small grant from German Government – run under “Government Department (SHYDO) Operated System”

6.4 Governance and Institutional Modalities

Right governance structure is crucial for long term sustainability of any OS scheme. The Winrock team developed indicators to judge the success of an implementation as follows:

a. How regular are the villagers in making their monthly o/m payments?
b. How willing are users to make additional contribution for either enhancing their current system or getting a new project?
c. What is the operating condition of the equipment?

The first two indicators show the satisfaction of the community with the project and the third shows their sense of ownership for the equipment as well as the involvement of the implementing agency. In our limited study of the villages, we found continued involvement of the implementing organization crucial to the long term sustainability of the project.

In our study we came across several governance and institutional modalities as presented below.

6.4.1 Institutional and Governance Modalities for Solar/Wind Turbine

i. PPAF/IET
Pakistan Poverty Alleviation Fund works through partner organizations (POs), typically NGOs. PPAF provides project funding and requires community contribution – 20% of project cost up front and monthly o/m fees amounting to 3% of project cost per year. The POs do the social mobilization, project implementation and post implementation support. PPAF does the monitoring and requires regular reports.

Haji Noor Muhammad was the village visited by the Winrock team, that is being served by Indus Earth Trust (IET), one of PPAF’s POs. IET had installed a 500 W wind turbine to supply electricity to a mosque, a community center and a school. The wind turbine project we visited appeared to be a success. Villagers were quite satisfied with what they had and they were regularly making the PPAF required monthly payments.
IET works closely with the community. They help them form community organizations of both men and women. COs elect their own office bearers such as President, General Secretary and Treasurer. COs collect the monthly funds and manage the community projects. IET’s social worker visits the village once a week and thus maintains close contact. According to the CEO of IET, it requires 3-6 months of educating the villagers before launching a project. In our interviews at Haji Noor Muhammad Village we found the villagers to be very knowledgeable about the technology and enthusiastic about the upcoming projects including the willingness to contribute financially and in kind.

IET has had a previous association with the community. They started with a drip irrigation project in 2005, followed by a sanitation project and then installed the wind turbines. They have also installed solar street lights in the village. In the next phase IET is working on providing solar home systems to the households.

As indicated earlier PPAF/IET followed the “Community-based Model”. It appears that IET was successful with the project because of the following reasons:

- NGO had done due diligence in educating the community. Since they were already working with this community, it was an easy task,
- The financing model required 20% contribution by the community thus invoking a sense of ownership in the community,
- IET continued its involvement not only through weekly visits to monitor the wind turbine project but also through new projects.

ii. WWF
The charter of WWF is to conserve and protect the environment. Providing electricity to villagers by using clean energy was in line with their charter. They did the social mobilization and hired Alternate Energy, an alternate energy technology company, to do the installation. WWF works similarly as IET. They require 20% contribution by the community before launching a project and monthly o/m contribution as decided by the community to take care of the operation and maintenance needs.

Tippun was the village our team visited. WWF had already been working with the village for the previous 4 years. They had done mangrove plantation as a natural resource conservation project. Then they launched “Indus for All” project; wind turbine project was part of this larger project as a livelihood project. The village had one 500W turbine supplying electricity to 16 homes. They had already started installing another turbine for the next 16 homes and to date they have installed 5 turbines for almost 100 people. WWF has helped the community form a joint CO for both men and women with elected office bearers. The CO manages the community projects and collect the monthly o/m charges. The villagers’ satisfaction with the current project and enthusiasm for more installations leads us to believe that the project was a success. Same three factors as observed with the PPAF/IET model appear to be present as follows:

- WWF already had their presence at the village and had educated the community about the project,
- The financing model required 20% contribution by the community thus invoking a sense of ownership in the community,
- WWF continued its involvement. As a matter of fact they have a fully staffed office very close to the village.
As indicated earlier WWF followed the “Community-based Model”.

iii. AEDB

AEDB has been installing solar and wind turbine systems since 2005. They provide the funding and do social mobilization. Then they hire private companies to provide the equipment and install it. AEDB provides the after-installation support. In this regard they set up community organizations that manage the project including monthly collection of o/m charges. They follow the “User Group Operated Fee for Service Model”.

They have had mixed results. Winrock team visited one of their WTS villages and three SHS villages. Two of the solar villages Allah Bakhsh Dandar and Qadirabad were reasonably good; however, the other solar village, Bharomal, and the wind village, Haji Juma Goth had some problems. In the latter villages systems were down and the villagers were not paying the monthly dues.

If we compare with the PPAF or WWF methodology, the difference becomes quite obvious. In the PPAF and WWF methodologies the NGO works with the community day in and day out as typically they are doing multiple projects. In almost all cases before the launch of the OS project, the NGO has already been involved with the village for years. It gives them a chance to assess the needs of the village and educate them thoroughly on the OS project. It almost becomes a “pull”. In the case of AEDB the situation is different. When they go to a village for the OS project, they are new to the community. In the case of PPAF and WWF even after the installation, the NGO continues to be present at the village as it has some other projects to work on; whereas, AEDB has no reason to visit other than to look after the OS project.

So if we look at the three factors that made PPAF/IET and WWF projects successful as mentioned above, we do not see them in AEDB’s case.

iv. Empower Consultants

Empower Consultants implemented the Durgai wind/solar/diesel hybrid with funding from ADB and in cooperation with a local NGO. COs for both men and women with President and Treasurer as office bearers were formed with assistance from Empower Consultants. COs were collecting the monthly energy use fees. However, COs have little powers in this village as decision making is being done by a few individuals.

They were following the “Community-based Model” where the project ownership was handed over to the community. The project was initially working well with users prepared to pay up to Rs 11/kWh for the electricity. Afterwards, there seems to be a serious lack of control as the villagers started using heavy appliances. Since the wind turbine and solar panels could not cope with the load, they started using the diesel generator heavily for charging the batteries and the expenses went out of control. Eventually the inverter malfunctioned thus rendering the system useless. In the meantime WAPDA extended their grid.

v. NUST University/Islamic Relief

NUST University and Islamic Relief executed the electrification of Patkin solar energy project with a small grant from the South Asia Regional Initiative for Energy of USAID. The local project proponents provided 25% of the financing. IR did the social mobilization and NUST did the design, procurement and installation. There were community organizations for both men and women that manage the community affairs. Islamic Relief helped the community in formation of these COs having memberships of 19 and 25 for men and women respectively. The COs have
office bearers such as President, Vice President and Joint Secretary. They have an operation and maintenance committee for the SHS.

When the Winrock team visited the village, they found the batteries in poor condition as the villagers had bypassed the solar controllers to gain more hours out of the batteries not realizing that it would degrade their batteries and eventually they would get fewer hours than before. Since NUST had funding only for installation, they could not go back to the village. It was left to Islamic Relief to monitor the systems and also set up a mechanism for collection of o/m funds on monthly basis. It did not happen. Their technical people who were trained on the SHS left the organization and the project basically got stranded. The “Community-based Model” was followed but the execution was less than satisfactory.

### 6.4.2 Institutional and Governance Modalities for Micro/Mini Hydel

The governance methodologies in micro/minihydel projects are well developed since the projects have been around since the 1980’s. Winrock team in their visit came across three different models as follows.

#### i. AKRSP Methodology (Izh Project)

AKRSP provided most of the funding for this project and also provided technical support for the design and construction of the project. AKRSP has a standard methodology of going through 3 dialogue processes with the community and signing a Terms of Partnership as a pre-condition of support. This TOP defines the terms under which the construction will take place and the plant will be operated. AKRSP provides support to other projects in these communities including income generation, agriculture, health, and education. After construction, AKRSP monitors progress of MHP projects as well as other development projects in the community.

The micro hydropower project serves a Cluster of 5 Village Organizations (VOs) and 6 Women’s Organizations (WOs). Whereas, many other development projects are carried out with AKRSP support for a single VO or CO, larger projects like micro-hydel can cover a cluster of V/W Organizations.

The General Body of the Cluster covers the full population, male and female, in the community. It meets once a year and selects a Chief Representative, a President, a Manager, as well as an Executive Body. All elected representatives work voluntarily and have a one year term. The Chief Representative is overall responsible for all development projects carried out in the cluster including those in sectors of health, education, and power. The President has the responsibility of calling meetings and the Manager keeps records for all projects.

The elected body specifically responsible for the electricity project is the Executive Committee. This EC has 13-16 members including one Convener, and three representatives of each of the 4 transformer committees. The EC members are responsible for billing, tariff collection and carrying out line repairs. This responsibility is divided among the transformer committees. The EC meets twice a month.

This project is being run under the “Community-based Model”.

#### ii. Government Methodology (Reshun Gol Project)

This project was financed by Pakistani Government along with a small grant from German Government and is being run under the “Government-operated Model” by Sarhad Hydel
Organization (SHYDO). In this project decision making is centralized as all SHYDO decisions are made in Peshawar. This has a number of impacts. Firstly, decisions are made on a political basis. The lines have been extended to more customers than there is power, resulting in load shedding. The decision to install a third unit of 1400 kW was made even though there is not sufficient water in the winter for the two existing units. Secondly, centralization results in delays in repairs. Feeder lines were found to be down for weeks while customers suffered. There is little incentive for the operators to maximize energy sales. Similarly there are billing delays.

iii. Private Ownership Methodology (Ayun Project)
“Fee for Service Model” was followed in this project. The private company has a clear incentive to increase energy sales and it is important that the supply is of good quality; it is available 24 hours and can power larger industries. Since the owner did not receive any government grant, his equipment is of lower cost and civil works is limited. This means somewhat higher operating and maintenance costs. From the consumers’ perspective the rates are higher than WAPDA rates and the connection fees are higher.

6.4.3 Summary of Institutional and Governance Models

In the study of the existing OS projects in Pakistan the Winrock team found implementation of four Institutional and Governance models with different levels of success. The models are summarized below:

a) Community-based Model
In this model systems are owned by the community or individuals in the community. Community Organization with NGO’s support manages the systems including collection of o/m charges and maintenance of the systems. The PPAF/IET wind turbine project in Haji Noor Muhammad was a successful execution of this model; whereas, NUST/IR project in Patkin was not such a success. We found that the following three elements helped in making a Community-based Model project successful:

• The NGO had already been working with the village prior to the OS project introduction and they had done due diligence in educating the community,
• The financing model required 20% contribution by the community thus invoking a sense of ownership in the community,
• The NGO continued its involvement not only through regular visits to monitor the OS project but also through new projects.

b. Fee for Service Model
In this model systems are owned by some entity other than the community. The entity provides electricity and maintains the equipment; in return it charges the community monthly fees. This model is difficult to practice in the absence of government subsidy as the capital and running costs are high and not enough income from the energy sale. The privately owned Ayun micro hydel plant in Chitral is an example of this model.

c. Group-operated Fee for Service Model
In this model systems are owned by some entity other than the community. However, the community manages the project including collection of o/m charges and maintenance of the systems. In this model success depends on how closely the organization works with the village before, during and after project implementation. AEDB OS projects follow this model.
d. **Government-operated Model**

In this model the plant/system is owned by the government. All decision making is centralized and politicized rendering the plant rather inefficient. There is no incentive for operators to maximize energy production. The Reshun mini hydel plant in Chitral is an example of this model.
7.0 Policy Framework, Governance Structure, and Financing Options for Scaling up Off-grid Electricity Supply for Pakistan

7.1 Policy Framework in Pakistan

Government of Pakistan has put in place its policy - Development of Renewable Energy for Power Generation (2006) - to promote off-grid renewable energy supply (OS) systems to achieve its goal of universal electrification in the country. Budgets have been indicated within the Medium Term Development Framework (2005-10) to finance significant rural electrification. The 2006 Policy states the government’s commitment to “greatly deregulate and simplify” procedures for investment into off-grid electrification. The Policy is to be followed with new procedural arrangements by AEDB as well as by Provincial and AJK Agencies. The Policy provides for financial and fiscal incentives, including waiver of customs duties and sales tax on equipment, and exemption from income tax.

Additionally the Policy places an emphasis during its first Short Term Phase (2006-08) on “design, demonstration, and testing of dispersed off-grid, community embedded, and standalone RE systems, including their financing and marketing modalities and integration with other social and physical infrastructure development.” The Policy intends that the lessons learned during implementation of short term activities will be scaled up in the next medium term phase, “Extensive, widespread funding and deployment will be targeted, based on such initial studies and field evaluation, for the medium term (2008-12), with specific RET- and market-wise targets and financing arrangements to be in place starting at the onset of that period.” This ongoing study on the Policy and Governance Framework for OS systems fits in well with the scale-up time table planned by the Government of Pakistan.

7.1.1 Experiences within existing governance frameworks

Consistent with the RE Policy (2006), the AEDB has carried out a number of pilot/demonstration OS project activities before and within its first short term phase of the Policy. Many of AEDB’s earlier activities, some of which have been evaluated in the preparation of this report, piloted solar PV and micro-wind technologies and management of systems at the user group level in clusters of roughly 50-200 households. These pilot activities achieved their basic objectives of technology demonstration and raising awareness among users and policy makers. However, as a result of their small size, it is universal experience that such pilots can not put in place the full institutional mechanisms of technology back up and a comprehensive system of sustainable operation and maintenance. This limits their value in showing the way to effective institutional mechanisms for scaling up the pilots to achieve large scale rural electrification using OS systems.

More recently AEDB activities following the announcement of the RE Policy have focused on developing models that can be scaled up to meet the full objectives of the “Off-grid Rural Electrification Program of the Government of Pakistan” under the national Roshan Pakistan initiative. AEDB has received technical support from GTZ for these activities. Under this program contracts have been issued for installation of 3,000 solar home systems in remote villages in Sindh, of which more than 2,000 have been installed, and tenders have been put out

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11 Under its Policy for Power Sector, the Medium Term Development Framework 2005-10 (MTDF) for Pakistan envisions: “encouraging the utilization of renewable energy (such as solar, wind, and biomass) especially for remote areas.” Annex II of the MTDF has called for an allocation of Rs 19,633 million ($310 million) between 2005-10 for investment into OS through the AEDB under the Power Sector Investment Plan.
soliciting bids for installation of similar numbers of systems in the North, Central and Southern parts of Balochistan.

The recent activities covering procurement and installation of solar home systems under “Off-grid Rural Electrification Program of the Government of Pakistan” have followed standard equipment procurement and installation procedures with a one year warranty on the supplied equipment. In addition, under these contracts, the commercial companies supplying the equipment are also required to manage and operate the systems including collection of monthly tariff from the users for the first year and maintaining the systems. In addition to being sizable in terms of size and coverage, these procurements thus display the beginnings of a ‘fee-for-service concession model’ and provide a basis for movement towards a full-fledged concession model in future procurements.

The procedure followed to implement the “Off-grid Rural Electrification Program of the Government of Pakistan” provides insight into the governance framework inherent in the most recent off-grid renewable energy activities in the country:

- AEDB asked the Provincial authorities of Sindh and Balochistan to select 100 villages in one district each to be electrified using solar home systems as per the PC-1 submitted to the Government of Pakistan.
- The final selection of villages has been arrived at through discussions between AEDB and officials of the Provinces. The main considerations in the selection were needs identification by provincial and district authorities, generally based on needs as well as political priorities, and technical feasibility and financial resources availability on the part of AEDB. Two clusters of villages in Sindh were electrified in the first round and none from Balochistan due to financial resources not being available from the Federal Government to the level expected.
- AEDB set the technical standards for the procurement, put out the tenders, evaluated the bids, and awarded the contracts as per Government of Pakistan rules. Provincial authorities were invited in the bid evaluations. While the provincial representative from Balochistan participated in the evaluations, the representative of Sindh opted out of the process due to professed lack of technical knowledge.
- AEDB has been supervising the installations as they are being carried out and will monitor the systems to make sure they are operated and maintained by the supplying company over the one year agreement period.
- At the end of this one year period, AEDB intends to hand over the installations to the respective Provincial authorities for operation and maintenance of the systems.
- Individual households which have received electrification through the OS systems have signed for the receipt of equipment, which belongs to the Government of Pakistan, and have agreed to use and operate them without abuse.
- The equipment supply companies have formed user groups, of around 100 households each, with the help of AEDB for system maintenance and tariff collection. They have trained a number of local operators to carry out routine maintenance. Operators were selected for training by the village committees and district nazim.

The overall governance structure under which the household electrification is taking place using solar home systems under the Off-grid Rural Electrification Program is sound. Procurement is done professionally by AEDB with assistance from GTZ on technical specifications. Competent private companies have been selected through a competitive process and have installed quality systems for the most part. AEDB provincial staff are monitoring the installations and maintenance of systems.
However, it is doubtful that the Provincial authorities will be able to take over operation and maintenance of these systems, after the one year of company maintenance is completed, from the supplying companies since there has been no investment in capacity building at the provincial government level in anticipation of the handover, in the case of Sindh. Having AEDB take over operation and maintenance at the end of this time period is also not an attractive option as this would require AEDB to maintain a large field staff to support these projects. The best solution would be to develop an agreement through which the companies continue operating and maintaining the systems under an extended contract.

For community-based energy projects supported by the Pakistan Poverty Alleviation Fund (PPAF), including for micro-hydropower and micro-wind, a different policy and governance framework currently exists. Here NGOs support the communities to procure and install the systems, financed by PPAF grants and 20% contribution from the community. The systems are owned by the communities and they take responsibility for maintaining them. The communities typically select a committee to manage the system, collect monthly tariff, pay the operators’ salary and also make decisions regarding repair and maintenance expenditures. The NGOs are often available to provide technical support for serious repairs and rehabilitation beyond the capability of the community.

This system has worked well in the case of micro-hydrel projects in the Northern Areas and Chitral (NAC) where the supporting NGO has been AKRSP. This success appears to stem from two important reasons – firstly micro-hydrel often provides the lowest cost energy, where resources area available, and maintenance costs are manageable even within the low tariff paid by households. Micro-hydrel is also a relatively simple technology and most breakdowns can be fixed at reasonable cost at workshops right in the region. Secondly it is because AKRSP has a high degree of coverage among communities in the NAC on both energy and non-energy projects and is able to provide back up technical support to the micro-hydrel systems at little additional cost. As an experienced NGO working in the region for over 25 years, AKRSP is likely to be available for community support in the region over the long run. These two conditions might not, however, apply for the more expensive technologies like wind and solar, which are likely to be applicable in Balochistan and Sindh, and where long term presence by NGOs can not be assumed as a given.

For privately owned energy systems such as the Ayun mini-hydrel power project, it is the private company which invests in the project, secures a loan from the bank if needed and takes full responsibility for procurement of equipment, installation, and operation and maintenance. The private company also collects the tariff each month, pays back the loans, pays the operators, pays for maintenance, and provides dividends to the investor. From a governance perspective private sector supply is a robust model particularly for low cost energy from hydrelpower which can in principle be sold to consumers at close to WAPDA rates.

However, the case study of this project shows that the investor in Ayun is not making a commercial return on investment. This is mainly because as an off-grid system, the kWh sales of electricity are too low for this project to generate attractive returns without increasing the tariff significantly higher than WAPDA’s. Off-grid mini hydrel systems in a rural area generally have a plant load factor of less than 50% compared to a mini-hydrel supplying the grid at a typical PLF of around 70%. For private sector off-grid mini-hydrel projects like Ayun to expand, in areas like Chitral where there is plenty of potential, they would need a partial capital subsidy to buy down the cost of installation. This would allow them to generate financial returns at the level which are generally expected by the local private sector in an alternative investment in the region.
7.1.2 Role of Local Government

One important institutional and governance question is what role provincial, district and other local government bodies such as the TMA may have in the supply, management, maintenance of OS systems in rural areas. According to the SBNP Local Government Ordinance 2001, the concerned local government (defined as: a. District Government or a City District Government and Zila Council; b. Tehsil (Taluqa) Municipal Administration and Tehsil Council; c. Town Municipal Administration and Town Council; and d. Union Administration and Union Council) does have some responsibility for provision of electrification as well as for street lighting:

“86. Street lighting and electrification.— (1) The concerned local government shall take such measures as may be necessary for the proper lighting of the public streets and other public places vested in the local government by oil, gas, electricity or such other illuminant as the local government may determine.

(2) The local government shall also provide or cause to be provided electricity in coordination with the concerned department to its local area for public and private purposes.

(3) A concerned local government may frame and enforce a street lighting and electrification schemes.” (Page 171, LGO 2001)

In addition to the formal local government agencies, GoP’s Local Governance Ordinance (LGO 2001, and amended in 2005) has attempted to make local governance accessible to communities at the grassroots through the formation of Citizen Community Boards (CCBs). CCBs are voluntary associations of local people mandated and funded under the LGO to carry out development projects; and over 30,000 CCBs have reportedly been registered throughout Pakistan. It is possible for CCBs to receive funds from the TMA to carry out community rural electrification.

Despite its inclusion in their mandate, rural electrification is not among the activities that local government organizations or CCBs have taken up to date in any substantive manner. Under the Khushhal Pakistan Fund funding a number of local government bodies in Balochistan did receive grants for rural electrification. However this was limited to grid extensions and the money was generally handed over to WAPDA to extend transmission and distribution lines and for the procurement of transformers. Electricity supply is considered a technically complex subject which is generally left to more specialized organizations. It is perhaps for this reason that there is little experience in Pakistan as well as regionally for a supply role in off-grid electrification for local government.

There will, however, be a substantial role for local government agencies in different aspects of OS supply. Provincial and district government bodies have a role on the regulatory and planning components in the implementation of all three governance modalities discussed above. All projects need environmental clearance from the provincial authorities. Both district and provincial authorities will need to take the lead in pinpointing those communities which will be served by off-grid solutions. These authorities must also coordinate with WAPDA so that there is no risk of the grid being extended in the immediate term where investments have recently been made in OS systems.

AEDB’s planning in the Off-grid Rural Electrification Program envisions that provincial authorities should take over the OS systems after the first year of operation and maintenance by the private supply companies. It is now thought that the authorities in Sindh may not quite be ready to take over the two ongoing projects in the next six months when the contracts of the two companies would be over. If future contracts with supply companies would be under the fee-for-service concession model, where the companies would maintain the systems for multiple years
and collect the tariff, the technical expertise needed from the local government authorities would be much more modest. One governance model which could work well in this case would be that AEDB would be strongly involved to the point of awarding the contracts (designing the concession, specifying the technical aspects of the procurement tender, evaluating the bids) and that after a year of successful operations, the concessions would revert to local government authorities to oversee.

In fee-for-service concessions in South Africa, such as NuRa, it is seen that some local governments have also offered to pay part of the monthly fee owed by the users located within their jurisdiction. Depending on what the most competitive supply companies demand in terms of monthly fees for supplying villages in Balochistan and Sindh, it may be that communities which are the most remote and thus expensive to supply and have the lowest income, these two factors are often coincident, may well need regular subsidy on the O&M costs. This ongoing O&M subsidy may or may not be of interest for local governments to supply in Pakistan. This depends on whether the budgeting process of local government agencies allows this.

The role of provincial and district authorities in OS supply projects which are community-owned and managed or which are owned by the private sector are relatively well established, since such projects are already ongoing having fulfilled the requirements of these authorities. The role of these authorities in energy planning and supporting these OS initiatives could be significantly increased. In particular, in order for provinces and districts to provide universal energy access to their residents, they need the capacity to plan, with technical assistance from specialized organizations like AEDB, which of the governance models are most suitable for specific regions under their jurisdictions. In addition to energy planning, provincial and local government authorities can also monitor tariff and quality of service provision in privately owned or community-managed distribution systems as has been proposed in the concession model. For low income communities they may also agree to provide additional subsidies on the capital expenditure or subsidize monthly fees for the poorer households.

7.2 Global governance models and their applications in Pakistan
Global and regional models for efficient supply and management of OS systems can generally be listed as: a) Vendor model; b) Fee-for-service concessionaire model; c) Community-based models; and d) Privately owned mini-grid model. Details of these models and experiences with them in regional countries and internationally are described in an earlier section. There are well documented functioning examples for all three models on the ground supplying energy systems and services to rural populations. The table below compares the models and lists the strengths and weaknesses of each.
<table>
<thead>
<tr>
<th>OS Supply Technologies</th>
<th>Vendor sales</th>
<th>Fee-for-service concessionaire for solar home systems</th>
<th>Community-based mini-grids</th>
<th>Privately-owned mini-grids</th>
</tr>
</thead>
<tbody>
<tr>
<td>OS technologies</td>
<td>Most suitable for household level OS technologies like solar home systems, micro-wind turbines, and domestic biogas</td>
<td>Suitable for household level technologies such as solar home systems. Can also be suitable for mini-grid technologies such as micro-hydel, and larger central wind and solar PV.</td>
<td>Most suitable for mini-grid technologies such as micro-hydrel, possibly for community wind and solar PV.</td>
<td>Most suitable for mini-grid technologies such as micro-hydrel, and community wind and solar PV.</td>
</tr>
<tr>
<td>Affordability to User</td>
<td>Affordable only to richer rural households as: - requirement for large upfront capital investment from user is a major barrier. Can be partially mitigated through micro-finance.</td>
<td>Affordable to all users as: - upfront investment is made by concessionaire (through government subsidy). - monthly fee covers only operation and maintenance costs.</td>
<td>Highly affordable to users as: - 80% of upfront cost by government; 20% cash or in-kind contribution from beneficiaries. - monthly fees to cover O&amp;M costs (for micro-hydro) tends to be lower than present monthly kerosene fuel costs.</td>
<td>More expensive than WAPDA tariff unless subsidy is provided by the government to buy down capital cost. Tariff is high because not all the energy produced can be sold.</td>
</tr>
<tr>
<td>Willingness to pay</td>
<td>Higher income rural households show willingness to pay capital amounts for purchased systems. Middle income households can pay with micro-credit. Poorer households can not pay even with micro-finance unless significant subsidy is available.</td>
<td>Households reluctant to pay the full required fee-for-service to cover capital costs. Willingness to pay tariff which will only cover O&amp;M costs.</td>
<td>Poor households willing to contribute in-kind for their share of local investment. High level of willingness to pay low tariff of micro-hydropower.</td>
<td>Commercial consumers and industries are willing to pay since power is reliable and sufficient for larger load. Poorer households willing to pay life-line tariff for low levels of energy consumption.</td>
</tr>
</tbody>
</table>
### Operation & Maintenance

| | Primarily users’ responsibility: - user needs to understand technology and to take responsibility for O&M. This can result in poor operations. Can be partially mitigated by extending the period of warranty from supplying company and supporting local technical repair entrepreneurs. | Responsibility of competent technical staff of supply company. Travel difficulties to remote households may cause delays. | Responsibility of local operator: - with sufficient training, local operators can fix most routine problems. Difficult technical problems and repair needs will be taken to urban-based workshops. | Responsibility of private manager and operators/ technical staff: - operators can fix most routine problems. Difficult technical problems and repair needs will be taken to urban-based workshops. |

### Public sector investment and opportunity for micro-financing

As the earlier section describing the different models shows the fastest scale up under all three make use of some form of Public Private Partnership. We discuss here the institutional modalities through which these various models might be implemented in Pakistan.

**Vendor Sales Model**

There is currently a low level of vendor sales in Pakistan of OS systems, particularly solar home systems and micro-wind turbines. The lack of systematic support from the government, manifested in the absence of subsidies, quality control or training, for OS systems sold directly from vendors to consumers has resulted in limited numbers of systems sold in the country. Those that are sold are of uneven quality.

The example of Bangladesh shows that it is possible, through the Vendor model, to expand the market for solar home systems at the scale that is required to meet the target of 500,000 homes within a time period of 10 years. The main drawback of the Vendor Sales model is, however, that typically sales do not penetrate to the poorer households in the community.

Should the Government of Pakistan choose to promote a vendor sales model, for the sale of solar home systems or micro-wind turbines, the institutional framework for a public-private partnership might be as follows:

a) A Project Management Unit (PMU), set up in AEDB, would be responsible for:
   - securing funds from the government and donors to reach the installation targets;
   - providing funds for a subsidy on systems and micro-finance for credit to make systems more affordable to poorer consumers;
   - short-listing qualified suppliers or NGOs which will be responsible for selling systems to users;
   - establishing quality standards and testing facilities for renewable energy equipment supplied to the market;
   - ensuring quality control of systems sold through surveys of installations and a transparent process of rewards and punishment;
   - training of technical staff of supply companies;
   - ensuring that maintenance centers are set up for repair of equipment; and
   - providing awareness about the program to potential customers.

b) The role of Provincial and district authorities could be to bring about awareness and increase demand for OS systems; a more ambitious role would be to house the PMU within provincial government offices in technical collaboration with AEDB.

c) Private companies or NGOs would sell and install high quality RET systems to households and also provide a warranty on the equipment and installation of at least a year. The companies would also set up a mechanism for repairing systems after the warranty period.

d) Micro-finance Institutions (MFIs) and banks would provide credit to households either on collateral or through Community Organizations for a period of 1-3 years to spread payment and make systems more affordable.

e) The specific tasks of establishing quality standards and testing facilities and training of technical staff are best carried out by specialized institutions like PCRET.
Fee-for-Service Concessionaire Model

Under the Roshan Pakistan Program, the AEDB has initiated electrification of rural off-grid communities in Sindh and Balochistan using solar home systems. The goal is to eventually develop these projects in the fee-for-service concessionaire model through private sector Energy Service Company (ESCOs) taking responsibility for the operation and maintenance of these systems over a substantial period. The private companies’ responsibility for operation and maintenance is currently limited to one year. At the end of this period, it is planned that the responsibility would revert to the Provincial authorities.

Should the Government of Pakistan choose to promote a fee-for-service concessionaire model, for scaling up of electrification in the country through solar PV home systems or micro-wind turbines or through mini-hydropower projects, the institutional framework for a public-private partnership might be as follows:

a) A Project Management Unit (PMU), set up in AEDB, would be responsible for:
- securing sufficient funds from the government and donors to reach the electrification targets through a concessionaire approach;
- marking out the areas to be electrified in close cooperation with Provincial authorities and designing the concession boundaries;
- designing and implementing the bidding process (evaluated on technical quality, subsidy required by the concessionaire per installation, and the user fee to be collected) to be competitive and transparent;
- establishing quality standards and testing facilities for renewable energy equipment and installations;
- ensuring quality control of system installations through surveys of installations;
- establishing a mechanism to ensure the concessionaire is providing operation and maintenance services as per the terms of the contract.

b) The role of Provincial authorities could range anywhere from participating in the early design of the concession and bidding process in technical collaboration with AEDB to being responsible to take over the system after a year of operation of the concession.

c) Private companies would install high quality RET systems at households and operate and maintain the systems for the contract period (typically 5-10 years). The companies would be responsible for collecting tariff from users and for all repairs and maintenance of systems.

e) The specific tasks of establishing quality standards and testing facilities and training of technical personnel might best be carried out by specialized institutions like PCRET.

Community-based Model

The community-based model is well established in the country for promotion of micro- and mini-hydel systems, with some globally acknowledged pioneering projects located in Pakistan (e.g. AKRSP). Scaling up of this activity is being carried out through the proposed Community-based Renewable Energy Development in Northern Areas and Chitral with funding from the Pakistan Poverty Alleviation Fund and with revenue from carbon financing.

Should the Government of Pakistan choose to expand the community-based Model to electrify the remaining communities in the country which can be served by micro- and mini-hydropower or promote the community-based model for larger wind and solar energy projects including for water pumping, the institutional framework for such an initiative might be as follows:
a) A Project Management Unit (PMU), set up jointly by PPAF and AEDB, would be responsible for:

- securing sufficient funds from the government and donors to meet the increased demand for electrification and water supply projects;
- increasing investment into community-based energy projects through Partner Organizations (PO) using the standard ratio of 80:20 under the terms of the Community Physical Infrastructure or Water Management Centre;
- increasing the capability of POs to design and install high quality energy projects through social mobilization of the Community Organizations (CO);
- establishing technical quality standards for energy projects;
- ensuring quality control of system installations through surveys of installations.

b) The Provincial and local government authorities would be involved in the planning process of projects as well as in issuing environmental clearances for them.

c) Private companies would supply the equipment for the hydropower and water pumping installations.

e) The specific tasks of establishing quality standards and testing facilities and training of technical personnel are best be carried out by specialized institutions like PCRET.

Hybrid Models

Elements of more than one of the three models that are described above can co-exist with each other and form ‘hybrid models’ for efficient operations. One example of a hybrid between the Fee-for-service and Community-based system might be as follows:

Within the fee-for-service concession it may be efficient for the concessionaire to work with user groups or community organizations to organize collection of tariff and operation and management of systems. In this way the concessionaire would have overall responsibility for the systems and would be responsible for the equipment but would reduce costs by transferring the operational responsibilities to COs. There may also be an overlap where there would be a renewable energy powered water pumping system which is implemented in a community-based modality within an area where there is a concessionaire for household electrification.

Privately-owned Mini-grids

Privately owned hydel mini-grids are not wide spread in the country so far. The 640 kW Ayun project in Chitral, which fits this description, was visited in the course of this study is one of few. The low level of private sector investment results from it not being financially attractive for companies to invest in such mini-grids under commercial terms of financing, unless tariff can be charged to users at much higher rates than WAPDA. Privately operated hydel projects, to supply isolated mini-grids in Northern Areas as well as parts of NWFP and AJK, would have many aspects similar to a fee-for-service concession model. If public funds could be provided to cover part of the capital cost of an off-grid mini-hydel system, many more examples of Ayun would be feasible in mountainous districts of the country.

Should the Government of Pakistan choose to expand the privately-owned mini-grid model to electrify towns and other mountain communities with significant power demand, the institutional framework for such an initiative might be as follows:

a) A Project Management Unit (PMU), set up jointly by AEDB would be responsible for:
Policy and Governance Framework for Off-grid Rural Electrification with Renewable Energy Sources (TF090884)

- securing sufficient funds from the government and donors to meet the increased demand for electrification;
- increasing investment into privately-owned energy projects by providing a subsidy to bring down the capital cost to private investors;
- increasing the capability of private companies to design and install high quality mini- and small-hydel projects;
- establishing technical quality standards for energy projects;
- ensuring quality control of system installations through surveys of installations.

b) The Provincial and local government authorities would be involved in the planning process of projects as well as in issuing environmental clearances for them.

c) Private companies would supply the equipment for the hydropower and water pumping installations.

e) The specific tasks of establishing quality standards and testing facilities and training of technical personnel are best be carried out by specialized institutions like PCRET.

7.3 Changes in legal and regulatory framework

The legal and regulatory framework in the country appear to be adequate for moving ahead with scaling-up off-grid electrification activities for all four governance modalities described above (vendor sales, fee-for-service, community-based, and private investment and supply).

Additional regulations will be needed for the following:

iv. Determination of benchmark tariff or acceptable unit cost,
v. Rules and procedures for subsidization of either investments, O&M or both and monitoring target subsidies,
vi. Regulating technical standards.

The Renewable Energy Policy (2006) states that off-grid power generation for supply to local communities through isolated mini-grids “shall be greatly deregulated and simplified” and “new procedural arrangements shall be developed by the relevant AEDB/Provincial/AJK Agency”. There is no mention in the RE Policy of any regulations which might apply to solar home systems.

As there will be substantial public investments into any scaling up of OS systems, determination of benchmark tariff will be closely tied with subsidies which are provided on the investments or on O&M. It is proposed that a more detailed analysis of both subsidies required and tariffs for the fee-for-service concession ESCO model will be carried out as part of a proposed pilot activity (see section at end of report). Rules are well established for capital subsidies of community-managed micro-hydel systems. As these systems are owned by the communities themselves, tariff determination is an internal matter. An analysis of micro-hydel systems being constructed by AKRSP showed that IRR on investment comes to around 7%, based on prevailing tariff, without taking into account revenue from carbon financing. The tariff charged by privately-owned hydropower projects is currently not regulated. Tariff charged by the Ayun project in Chitral was found to be around 60% higher than WAPDA tariff. Should AEDB/GoP decide to provide subsidy to private mini-grid power in order to lower tariff the basis of the calculation may be that the tariff should come down to WAPDA levels, as a benchmark.
Technical standards are currently set on a project by project basis. Scaling up of OS systems to reach tens of thousands provides an opportunity to establish national technical standards for different technologies.

**7.4 National guidelines for institutional arrangements**

It will be best for future institutional arrangements to follow and build on what is already existing and working in the country. The three models described in the section above cover:

1. Government funded fee-for-service systems
2. Community-owned mini-grid systems
3. Privately owned mini-grid systems

It is proposed that the existing government funded fee-for-service model be further developed into a concession model where private companies will, in response to future solicitations, be asked to bid to install solar home systems in a cluster of communities and in addition operate and maintain them for a 5-10 year period. This is likely to be the most widely applicable model for electrifying 7,000 unelectrified villages in Balochistan and Sindh, which fall under the mandate of AEDB, with OS systems.

The community-owned model funded by PPAF and carried out with technical support from an NGO works reasonably well, particularly for micro-hydropower. It is proposed that this experience be expanded to increase the coverage of micro-hydropower mini-grids in mountain communities and also expand to include other technologies which can power mini-grids such as larger wind energy systems, wind solar hybrids, and biomass based generation. PPAF is keen to add energy projects to the list of options which rural communities have for community infrastructure projects. As energy projects are more technology and maintenance intensive than other infrastructure projects funded by PPAF, it will be best to limit this option to only those communities with a Partner Organization which has strong roots and is likely to remain in the particular area for a long time.

It is also possible to consider a hybrid institutional arrangement which combines features of the first two institutional modalities described above. Within a cluster of villages which falls under a fee-for-service private concession, NGOs can play an important role in organizing communities to manage public services such as a drinking water system based on solar pumping of groundwater. Private companies have already discovered that forming user groups, of around 100 houses each, is a cost-effective way to collect tariff each month and provide basic maintenance through an operator trained from the local community. In both these cases, the companies would be responsible for major hardware failures. Beneficiary communities can not absorb such a risk particularly for relatively expensive technologies like solar or wind energy. Community groups on the other hand are much more efficient than the company in carrying out routine maintenance and collecting revenue. The NGO role would be to carry out social mobilization of the communities. The funding for NGOs to carry out social mobilization for energy projects, which will be installed by private companies, does not fit the modality currently employed by PPAF. However, if this is indeed a cost-effective modality, private companies should find it expedient to include social mobilization costs when they submit a bid for the fee-for-service concessions.

With a view to supporting investment into mini-hydro projects by the private sector to supply towns and larger load centers in mountain communities, it is proposed that private companies be provided a subsidy to be able to cover their costs on OS systems so they can be profitable without charging higher tariff than WAPDA’s. Private companies, which can hire and retain engineers
and technicians, may have an advantage over community-management of energy systems when supplying sophisticated load centers which have both industrial and domestic loads particularly in towns which do not have a homogenous community. The subsidy which needs to be provided to private companies can typically be lower than the 80% subsidy currently provided for community-based systems. This is both because the geographical areas which the private sector will be interested to supply power to will be more accessible and also because the private sector can be expected to be more efficient in operating larger and technically more complex power plants which can power industrial loads. The private sector has a direct interest in increasing sales of electricity and can be expected to install technology for governing and control to supply 24-hour reliable power.

As described in the section on Governance the role of the provincial and local government authorities is proposed to be the following in the three institutional modalities:

1. **Fee-for-service concession**
   - Provincial and district authorities will provide environmental and regulatory clearance for implementation of energy projects,
   - Provincial and district authorities will plan, in consultation with AEDB, which villages and clusters are to be electrified through OS systems and will coordinate with WAPDA to avoid overlap with grid-extension plans,
   - Provincial and district authorities will participate in AEDB exercises to design tenders for concessions and in evaluation of bids,
   - Provincial and district authorities will ‘take over’ the monitoring and supervision role of the concessionaire within their jurisdiction, after one year of successful operation under AEDB oversight, where the concessionaire is contractually bound to maintain and operate the system for 5-10 years.
   - Districts may decide to partially pay monthly O&M costs of the very poor families or of remote and marginalized communities,
   - In collaboration with the concessionaire, District and TMA officials and CCB representatives may play a role in organizing user groups to manage ‘public goods’ infrastructure like solar or wind pumped drinking water systems and to manage operation and tariff collection among served households.

2. **Community-owned mini-grid systems**
   - Provincial and district authorities will provide environmental and regulatory clearance for construction of energy projects,
   - District authorities will plan which villages and clusters are to be electrified through OS systems and will coordinate with WAPDA to avoid overlap with grid-extension plans,
   - Provincial and local government authorities may monitor tariff and quality of service provision in community-managed energy systems,
   - For low income communities, provincial and district authorities may agree to provide additional subsidies on the capital expenditure beyond the 80% provided by PPAF or subsidize monthly fees for the poorer households.

3. **Privately-owned mini-grid systems**
   - Provincial and district authorities will provide environmental and regulatory clearance for construction of energy projects,
   - District authorities will plan which villages and clusters are to be electrified through OS systems and will coordinate with WAPDA to avoid overlap with grid-extension plans,
   - Provincial and local government authorities may monitor tariff and quality of service provision in privately owned energy systems,
• For low income communities, provincial and district authorities may agree to provide subsidies on the capital expenditure so that the private company can provide energy at a tariff no higher than WAPDAs, or alternatively they may choose to subsidize monthly fees for the poorer households.

7.4.1 Capacity Building
Substantial investment has to be made in building up capacity at different levels of governance and to all the key institutions to achieve scale-up of rural electrification using OS systems in Pakistan. The sector is new and there is not sufficient human resources or institutional capacity in the country at present to implement the government’s ambitious targets. The main areas of capacity building may be listed as follows:

8) AEDB. Both the central and provincial offices of AEDB need substantial investment in capacity building in the following areas:
   a. Efficient clustering of solar home systems for supply by ESCOs using field visits and GIS technology and coordination with WAPDA on grid expansion plans,
   b. Determination of benchmark tariff,
   c. Developing rules and procedures for subsidizing investment and/or O&M costs,
   d. Regulating technical standards,
   e. Designing of tender documents for procurement and evaluation procedures for bids including assessment of proposed tariff to users,
   f. Monitoring of supplied technology and installation and maintenance of systems by ESCOs,
   g. Designing a program to provide technical and financial support to community-based mini-grid electrification through micro-hydel as well as wind energy, biomass-based energy, solar mini-grids, solar and wind water pumping as well as hybrid technologies,
   h. Review of feasibility studies for innovative off-grid electrification programs and provision of financial support if justifiable,
   i. Designing a subsidy program to support privately-owned mini-grid systems.

9) Provincial and district authorities.
   a. Identifying off-grid electrification needs in districts and coordination with WAPDA on grid expansion plans,
   b. Efficient clustering of solar home systems for supply by ESCOs using field visits and GIS technology,
   c. Providing input to the design of tender documents and in the evaluation of bids including assessment of proposed tariff to users,
   d. Monitoring of operation and maintenance of OS systems by ESCOs,
   e. Environmental assessment and regulatory approval process for OS systems,
   f. Monitoring of supply reliability and evaluation of reasonableness of tariff in community-managed or privately-owned mini-grid systems.

10) PPAF
   a. Designing a program to provide technical and financial support to community-based mini-grid electrification through micro-hydel as well as wind energy, biomass-based energy, solar mini-grids, solar and wind water pumping as well as hybrid technologies,
   b. Inclusion of energy activities in future portfolios of community infrastructure projects,
c. Preparation of manuals and procedures for social mobilization for the above technologies,
d. Monitoring of operation and maintenance of community-managed OS systems.

11) ESCOs
a. Design and implementation of OS systems under ESCO modality,
b. Technical standards for OS as established by AEDB,
c. Development of business plan, system costing and determination of tariff,
d. Working effectively with AEDB and provincial and district authorities,
e. Management, operation, and maintenance under ESCO modality.

12) NGOs
a. Design and implementation of community-based OS systems,
b. Working effectively with AEDB, provincial and district authorities, PPAF and ESCOs,
c. Social mobilization for mini-grids and other community-managed OS systems.

13) PCRET
a. R&D support for local manufacture of different OS systems as appropriate,
b. Setting up technical standards,
c. Establishment of test centers and testing methodologies as per standards,
d. Training of trainers for capacity building of equipment manufacturers and operators.

14) Equipment suppliers and manufacturers
a. Designs and manufacturing of different OS technologies,

7.5 Proposal for financing and subsidizing investment and O&M
We can use as a working number for 7,000 unelectrified villages at an average of 100 households per village, some 700,000 households which will be most cost-effectively electrified using OS systems. Although it is not accurately known, we might make a further assumption here that around 500,000 homes can best be electrified using solar PV systems, micro-wind energy systems both through supply of individual households and mini-grid systems. The remaining 200,000 homes are likely to be at locations which can not be clustered easily or may be suitable to be electrified using off-grid micro and mini-hydropower. The majority of the 500,000 households can be electrified by solar PV, mostly using solar home systems, taking into account the ubiquitous resources and well proven technology, but there will also be opportunities supplying power to communities through mini-grids for wind energy systems, hybrid technologies combining wind and solar, and biomass-based power generation.

There are financial implications of adopting the different governance and institutional models described above.

A. The costs to the government and the financing required from donor organizations of installing 500,000 solar home systems in Pakistan are compared between Vendor sales and Fee-for-service concession models.

a) Vendor Sales. For this model we can use the example of financing a 50 W system under the REREDP program in Bangladesh. The cost of each system is assumed to be $ 440. Of this
amount, the subsidy is $40, user equity investment is $60, and the remaining $340 is provided as credit.

Total investment required for 500,000 systems at $440 per system = $220 million

However, the public funds required are significantly less than this amount.

Subsidy required for 500,000 systems at $40 per system = US$ 20 million,
Total credit required for 500,000 systems at $340 per system = $170 million,
Revolving fund required to provide credit (estimated at around 25% of total disbursed credit\textsuperscript{12}) = $42.5 million,
Total public funds required = $62.5 million.

b) Fee for Service concessions. For simplicity we can assume here that the full capital cost of the systems will have to be provided as a subsidy by the government and that the fee collected each month will cover the operating costs.

Total investment required for 500,000 systems at $440 per system = $220 million.
Total public funds required = $220 million.

If we assume an average cost of US$ 500 per system in Pakistan, the total investment required to install 500,000 systems would be US$ 250 million.

The monthly tariff required for an ESCO to cover the O&M costs will be determined through a proposed pilot activity later in the study period. By comparing this required tariff with the users’ willingness and ability to pay, we will have a better understanding of any requirements for O&M subsidies.

B. The costs to the government and the financing required from donor organizations of installing 50MW of micro and mini-hydropower to serve 150,000 households in Pakistan:

a) Community-based model

Total investment required for 50 MW at an average of $1,200 per kW = $60 million
If 80% of the funds are provided as a grant under the prevailing rules = $48 million. Additional support of around 12% or $6 million will be needed for NGO support for social mobilization and technical design and construction supervision. So total support needed will be around $54 million.

b) Privately-owned mini-hydel grid

Based on the analysis of the Ayun Power plant in Chitral we estimate that the concessionaire needs a $800 subsidy per kW to make a reasonable return on investment\textsuperscript{13}. Larger mini-hydel projects are expected to cost more than micro-hydel projects since they require well engineered and permanent civil structures such as intakes and canals. So although the percentage subsidy for privately constructed projects may be lower than that required for communities, the total amounts may not be much different.

If $800 is provided as a grant per kW installed, total grant investment for 50 MW = $ 40 million.

\textsuperscript{12} This will depend on total number of installments and interest rate charged
\textsuperscript{13} A more detailed analysis is required here to determine the subsidy required so that the investor can receive reasonable returns and such that users can receive the same tariff as WAPDA.
For both the community-managed and privately-owned hydropower mini grid systems, it has been found that capital subsidies can bring tariffs to affordable levels and O&M subsidies are not needed.

It is anticipated that financing of subsidies and implementation costs will be provided through Government of Pakistan funding as well as donor funds. Off-grid electrification is attracting growing amounts of international financing. This sector comprised almost 10 percent of the total assistance to rural electrification provided by the World Bank from 2003-05 – the bulk of funding still going to grid-based electrification. The proportion of investment going to off-grid electrification is expected to grow along with progress toward universal access, as remaining populations will be more difficult to economically electrify using conventional grid extension arrangements.

### 8.0 Lessons Learned and Recommendations

The major lessons learned from the study and its principle recommendations are listed below:

1) Pakistan’s ‘Policy for Development of Renewable Energy for Power Generation’ (2006) spells out the financial and fiscal facilities to encourage private sector investment in off-grid electrification projects. However it does not elaborate the governance and institutional framework for investment into off-grid electrification from the public sector or for projects carried out under public private partnership - the most likely ways rural electrification is going to be financed to scale.

2) Field surveys at 11 communities served by solar PV, micro-wind energy and micro and mini hydropower lead to the following conclusions:
   - c. OS technologies can meet basic electricity needs of rural off-grid communities if they provide reliable supply and can be made available at an affordable tariff;
   - d. User households see significant benefits even from the limited energy services available from OS systems and pay monthly tariff when the systems work well;
   - e. Organization of consumers into User Groups provides a cost effective way to collect tariff and carry out routine maintenance through a local operator;
   - f. Strong technical back up by the vendor, in case of equipment breakdown, is required for OS programs to operate sustainably;
   - g. NGOs can provide social mobilization to organize communities to implement energy projects and initially provide technical back up but may not always be counted upon to provide long term support.

3) The governance and institutional framework most suitable for scaling up OS in Pakistan, to supply communities which will not be connected to the national grid, is likely to be one which builds on successful experiences in the country and will be based on partnerships between government, private sector, and communities.

4) Based on successes in Pakistan and globally, it is recommended that scale-up of OS be carried out in Pakistan through three main models: a) Fee-for-Service ESCO Concession for solar home systems and micro-wind turbines; b) Community-based mini-grids for micro-hydel, solar/wind powered drinking water projects, and to include wind energy and solar wind hybrids as appropriate; and c) Private sector ESCO investment and management of mini-hydel.

5) It is recommended that this current study be followed up with a design exercise to develop a large-scale national level OS project to include these modalities. A program to
supply 500,000 households with solar energy and to generate 50 MW of power to supply mini-grids is expected to need an investment in the order of US$300 million. Additional investments will be required to carry out capacity building of the relevant actors.

6) Fee-for-Service ESCO modality is best suited to reach some 500,000 remote un-electrified rural households in Balochistan and Sindh with solar home systems and micro-wind turbines to a lesser extent.

7) Community-based micro-hydel should be promoted in the Northern Areas and Chitral as well as in other mountain communities by expanding PPAF’s current program.

8) A private sector ESCO modality is relevant to expand mini-hydel projects in mountainous districts of the country. ESCOs would provide towns and larger load centers with larger power plants. It is recommended that a subsidy be provided to private companies supplying off-grid consumers at a level which allows them to generate commercial returns on their investment without having to charge a tariff higher than WAPDA. It is expected that around 50 MW of off-grid micro- and mini-hydel might be generated through the community-based and ESCO modalities.

9) The responsibilities and mandates of the main institutional actors under the ESCO and community-based modalities are proposed to be as follows:

   o AEDB
      a) Providing overall leadership to expand energy access to rural communities through OS technologies;
      b) Clustering of communities for supply by Fee-for-Service ESCO concessions in consultation with Provincial Authorities and WAPDA;
      c) Designing tender documents for procurement and evaluating bids;
      d) Monitoring of supplied technology, installations and maintenance of systems by ESCOs before handover to Provincial authorities;
      e) Providing programmatic support for community-based mini-grid electrification (micro-hydel, wind energy, biomass-based energy, solar mini-grids, solar and wind water pumping and hybrid technologies);
      f) Designing a subsidy program to support privately-owned mini-grid systems.

   o Provincial Authorities
      a) Identifying off-grid electrification needs in districts;
      b) Providing input to the design of ESCO concessions and evaluation of tender documents;
      c) Monitoring of operation and maintenance of OS systems by ESCO over the contract period;
      d) Carrying out environmental and regulatory approval process for OS systems;
      e) Monitoring of supply reliability and evaluation of reasonableness of tariff in community-managed or privately-owned mini-grid systems.

   o PPAF
      a) Managing a program to provide subsidy support for community-based mini-grid electrification (micro-hydel, wind energy, biomass-based energy, solar mini-grids, solar and wind water pumping and hybrid technologies);
      b) Including energy activities in future portfolios of community infrastructure projects;
9.0 Pilot activities for institutional and governance models

9.1 Concessionaire ESCO model for solar home systems

Under AEDB’s “Off-Grid Rural Electrification Program” ongoing in Sindh, two private companies (Trilium and Petrocon) have installed almost 3,000 solar home systems in around 64 villages. Under the terms of their contracts, in addition to installing the systems, the companies are responsible for operation and maintenance of the systems for a year after installation. At the end of the contract period the systems would be handed over to the Provincial authorities, of Sindh in this instance.

The pilot activity consisted of developing a financial model to understand how much the monthly user fee would need to be for the companies to extend their operation and maintenance contract for a 10 year period. This is based on O&M data which has been generated over the past six months of operations and projections regarding replacement of certain capital equipment components.

The pilot has used this financial model to study the feasibility of a concessionaire ESCO model for supplying solar home systems in rural Pakistan by assessing if there is a meeting point between what the users are prepared to pay and a rate that a private company must charge in order to be able to provide the operation and maintenance services over a substantial period of time.

The results of this pilot activity were expected to provide an understanding of:

- a) Interest on the part of companies to operate as ESCOs and their requirements,
- b) Actual and future expected O&M costs of a fee-for-service set up,
- c) Investment subsidies and O&M subsidies required to support an ESCO model.

The activity consisted of interviewing the chief executives of both companies, Trilium and Petrocon, and a visit to the field to interview the local operators and both men and women in the beneficiary households. Two villages – Chichari in District Mithi and Taguser in Taluqa Nangarparker, both in Sindh province – were visited by the Winrock team from October 14-15 for the field interviews. Findings of the pilot activity are as follows:
Private Company Interest in a Ten Year Operation Contract

Executives of both companies, Trilium and Petrocon, expressed an interest in a ten year maintenance contract provided it made business sense for them. They would be prepared to collect monthly tariff from users and utilize the revenue to maintain the systems as well as to take responsibility for replacement of broken components.

Their main requirements are:

- The monthly tariff needs to have an escalation factor built into it to be feasible for a ten year period,
- They would require the support of government authorities to apply magisterial powers to enforce monthly tariff collection and to take away systems from households which did not pay,
- The procedural and regulatory setup for Off-grid concessions as proposed needs to be clarified by the government.\(^{14}\)
- To keep their operation costs manageable they would need each cluster to be of at least 5,000 systems and in a compact geographical area.

In the current contracts there is a large spread in the location of villages with only a few villages being contiguous. As an example, 1000 systems being serviced by one of the companies are spread over a distance of 280 km. This makes it difficult and costly for the contractors to maintain the systems.

Operation & Maintenance Costs and Tariff

The monthly charges levied by AEDB on the villagers for 40, 80 and 120 W systems are Rs 150, 200 and 300 respectively. The installations currently consist of: 70% of 40W, 25% of 80W and 5% of 120W systems. The tariff is collected by the local operators, who are employed by the contractor companies for the first year, and is handed over to AEDB. Under the existing arrangements, the tariff would be collected by Provincial authorities after the first year and the operators would be paid by them.

There has not been any problem with the major components: solar panels, batteries and PV controllers in any of the houses since the systems went into commissioning about a year ago. However, Compact Fluorescent Lamps (CFL) have been burning out on a regular basis. One company has had particular problems with this and is reportedly switching over to a better brand. Lamps using Light Emitting Diodes (LED) have proven to be more robust than the CFLs, but tend to use less power and produce less light.

During interviews it was sensed that the villagers generally do have the capacity and willingness to pay the prevailing tariff. In the absence of the solar PV systems, they would be paying fuel costs of Rs 10-12 per kerosene lamp per day. The benefits of solar PV lighting are widely acknowledged by the users to be high; they include protection at night from animals such as snakes, safety from fire from kerosene lamps, and improved illumination resulting in children studying longer at night and in certain instances expansion of commercial activities such as sewing, carpet weaving etc.

However, the continued success of collection will likely be subject to the following factors:

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\(^{14}\) Renewable Energy Policy (2006 pg 16) states that ‘Off-grid power generation for supply to a local community through small, isolated distributed lines not connected to the utility grid – shall be greatly deregulated and simplified’ and that ‘new procedural arrangements shall be developed by the relevant AEDB/Provincial authorities’.
Longevity of components and easy availability of spare parts. Frequent fusing of CFL bulbs, which exists at present, will create high operating costs for the users once the one year operation period of the companies will be over. Component breakdown and shortage of spares create frustration among villagers and are likely to lead to payment defaults.

Most villagers are willing to make regular payments except when they see that some fellow community members, especially those with political connections, refuse to pay. Enforcement mechanisms need to be in place to ensure regular payment from all beneficiaries to ensure successful tariff collection. Both AEDB and contractors felt a need for appropriate legislation and magisterial powers to enforce tariff collection.

**Local Operators**

On an average one operator, who is a local resident, looks after 80 to 140 systems at present covering multiple small, adjacent villages. The frequency of visits to beneficiary households varies from daily to once a week. For carrying out simple maintenance on systems and collecting tariff each month, he gets paid Rs 3,000 per month. The operators have received hands-on training during installation of systems. The lead installers from the supply companies were technical diploma holders. The operator’s education level is modest and he has been provided the O/M manuals in the local language (Sindhi).

If the concession clusters can be increased, and density of served households is sufficiently high, it is expected that a single operator can cover around 200 households. Operators are supervised and supported by a qualified technician in the field for serious technical repair and maintenance. One technical supervisor currently provides backup for 10-15 operators. This may be increased to around 25 operators once the operators have more experience and require less supervision.

**ESCO Financial Model**

A financial model was developed containing key parameters and using financial data obtained from villages in Sindh where SHS are presently installed and operational under the Off-grid Rural Electrification Program of AEDB. The objective of developing this model was to create a tool in order to generate realistic projections of the household tariff which private company might demand in order for them to take up a contract to operate and maintain clusters of the SHS. In order to ensure accuracy and applicability of the model, the expense data collected from the existing installations was used in the forecasting exercise.

Initially, a base model was developed to analyze the tariff required to cover O&M expenses over a 10 year period for the existing situation in Sindh in the field under the Off-grid Rural Electrification Program, once the one year operation responsibility of the supply company is completed. Long term O&M costs consist primarily of two main components: upfront costs of the technical operators and personnel involved in the O&M activities and the costs incurred in equipment replacement.

Certain assumptions were incorporated into the model such as taking a typical village size to be 100 households each supplied with a solar home system. An O&M contract of 10 year duration was assumed. Lastly all expenses were expressed in US$ to shield against devaluation of the rupee and an annual inflation rate of 3 percent was assumed on the USD.

The technical personnel expenses per household were calculated using financial data obtained from the pilot activities with each operator servicing an average of 100 households and each technical supervisor overseeing the maintenance of a cluster of 1500 households. Furthermore,
expenses such as the operators’ monthly travel expenses along with the expense of maintaining the systems each month were also incorporated into the model.

The second component of the model was the expense associated with replacement of the key components, namely the battery and controller of the SHS over the 10 year contract duration. The replacement costs of each of these components used in the model were acquired through market research. Solar panels are expected to last 25 years and were not budgeted for replacement within the contract period; and replacement of fused lamps would be the responsibility of the individual household.

The detailed inputs and outputs from the financial model are provided in the Table below. It shows that the monthly tariff which would have to be charged for a 40W SHS ranges from USD 7.47 (Rs 598) for an assumed battery life of 5 years to USD 11.30 (Rs 904) for an assumed battery life of 3 years. The model shows that the present tariff of Rs 150 ($1.88) would pay between 17% to 25% of the monthly fee required to cover full costs of operating and maintaining a 40 W system.

Battery life and battery price are the major variables which determine the required monthly tariff. The batteries required under the REP contracts are tubular deep discharge batteries. They are of high quality, and hence expensive, and should last more than five years if managed properly.

Table 7: Financial Model for Monthly Tariff for 40 W SHS (Existing base case)

<table>
<thead>
<tr>
<th>Expenses types</th>
<th>Expenses (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upfront Expenses</strong></td>
<td></td>
</tr>
<tr>
<td>No. of systems installed</td>
<td>1500</td>
</tr>
<tr>
<td>Systems serviced per operator</td>
<td>100</td>
</tr>
<tr>
<td>Operator monthly expense per household</td>
<td>0.55</td>
</tr>
<tr>
<td>Technical person expense per household</td>
<td>0.42</td>
</tr>
<tr>
<td>Expenses per system per month</td>
<td>0.25</td>
</tr>
<tr>
<td>Total Monthly Operating expense per household (USD)</td>
<td>1.22</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Equipment Replacement Expenses</strong></td>
<td></td>
</tr>
<tr>
<td>Cost per Battery Replacement (USD)</td>
<td></td>
</tr>
<tr>
<td>40W</td>
<td>300</td>
</tr>
<tr>
<td>Cost per Controller Replacement (USD)</td>
<td></td>
</tr>
<tr>
<td>40W</td>
<td>20</td>
</tr>
<tr>
<td>Expected life of battery (yrs)</td>
<td>3 5</td>
</tr>
<tr>
<td>Expected life of controller (yrs)</td>
<td>6</td>
</tr>
<tr>
<td>Equipment Replacement expense per household per month (USD)</td>
<td>8.61 5.28</td>
</tr>
</tbody>
</table>
The financial model shows the tariffs needed to sustainably run the systems to be much higher than the Rs 150 ($1.88) per month which is currently paid by households using 40 W systems. While the current tariff can cover operation and simple maintenance costs ($1.22), it can not cover the full cost of replacing the batteries every 3 or even every 5 years. It is unlikely that households will show willingness to pay the full tariff required since it is significantly more than what they pay now and also substantially higher than WAPDA’s life-line tariff paid by low electricity consuming households supplied by the national grid.

In order to reduce the tariffs to levels similar to that prevailing at present the following options have been considered:

a) Increase of SHS cluster size to 5,000 systems from 1,500 systems used in the base case. A larger cluster size is expected to be more economic to manage.
b) The Provincial Government provides most or all battery replacement costs during contract duration so that the tariff does not have to cover this major expenditure,
c) Less expensive batteries are used than currently specified for solar home systems under REP.

Figures 9 and 10 below show sustainable tariff requirements under three cases:
Case 1: Base case – Cluster of 5,000 households showing tariff needed to fully cover battery replacement in 3 and 5 years.
Case 2: Shows tariff when Provincial Authorities will cover battery replacement costs and commercial company will need to cover all other costs from monthly tariff.
Case 3: Tariff is maintained as per present, with battery costs being covered by a combination of fixed user contribution per battery replacement, payment by company from collected fees, and remaining to be paid by Provincial government.

Figure 9: Tariff Projections under Three Cases Assuming Battery Life of 5 years

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15 Including company overhead.
The figures show that the tariff which would have to be charged under Case 1 is much higher than what users are currently paying if it would have to cover the full costs of battery replacement. It is clear that in addition to 100% capital subsidies, some kind of subsidy is also needed for Operation and Maintenance if the monthly tariffs are to stay at levels similar to that paid by users at present. One way to provide this is by provincial authorities covering three quarters or more of the monthly tariff and households paying the remainder. A second way to maintain the tariff at current low levels is for the Province to pay for the purchase of the batteries when they need to be
replaced, since the battery replacement cost is responsible for the largest percentage of the monthly tariff.

The Case 2 option shows the tariff once the Provincial government takes the responsibility for paying for battery replacement, as additional procurements, during the Concession period. The tariff would be reduced substantially in this scenario, even below the tariff which is currently paid by users.

Case 3 which requires the users, to pay a fixed fee (proposed to be Rs 1,000) per replacement of the battery, and the company to also pay a portion of the battery replacement costs would have the advantage of building in incentives for both the user households and the O&M company to ensure more responsible operation and supervision of the batteries to give it longer life. We have assumed here that the tariff would remain at the current level if the batteries would last five years. The tariff would need to be increased above this if the batteries lasted only 3 years.

Table 7 shows the tariff under the 3 cases as well as how the cost of the battery replacement may be shared between the Province, Company and households under Case 3. It is clear from the table that the O&M subsidy required by the provinces would be of similar magnitude and in some cases larger than the capital subsidy required during system procurement.
Table 7: Monthly tariff ($) for 40W, 80W, and 120W systems for the Three Cases

<table>
<thead>
<tr>
<th>Life of Batteries</th>
<th>40 W</th>
<th>80 W</th>
<th>120 W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1 Tariff</td>
<td>10.97</td>
<td>12.14</td>
<td>13.06</td>
</tr>
<tr>
<td>Case 2 Tariff</td>
<td>1.38</td>
<td>1.49</td>
<td>1.49</td>
</tr>
<tr>
<td>Case 3 Tariff</td>
<td>2.12</td>
<td>3.00</td>
<td>4.86</td>
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</table>

<table>
<thead>
<tr>
<th>Contributions (USD) to battery replacement (Case 3)</th>
<th>3 yr</th>
<th>5 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>By user</td>
<td>41.67</td>
<td>41.67</td>
</tr>
<tr>
<td>By Company</td>
<td>76.67</td>
<td>157.21</td>
</tr>
<tr>
<td>By Province</td>
<td>881.67</td>
<td>912.24</td>
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Figures 11 and 12 below show the same three cases but when battery costs are reduced through the use of standard solar batteries and not the tubular batteries currently used. Table 8 shows the tariff under the 3 cases as well as how the cost of the battery replacement may be shared between the Province, Company and households under Case 3.

**Figure 11: Tariff Projections under Three Cases Assuming Battery Life of 5 years with Less Expensive Batteries**
Figure 12: Tariff Projections under Three Cases Assuming Battery Life of 3 years with Less Expensive Batteries

Table 8: Monthly tariff ($) for 40W, 80W, and 120W systems – lower cost batteries

<table>
<thead>
<tr>
<th>Life of Batteries</th>
<th>40 W</th>
<th>80 W</th>
<th>120 W</th>
</tr>
</thead>
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<tr>
<td>Case 1 Tariff</td>
<td>6.71</td>
<td>8.94</td>
<td>10.80</td>
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<td>Case 2 Tariff</td>
<td>1.38</td>
<td>1.38</td>
<td>1.38</td>
</tr>
<tr>
<td>Case 3 Tariff</td>
<td>2.12</td>
<td>2.50</td>
<td>3.75</td>
</tr>
<tr>
<td>Contributions (USD) to battery replacement (Case 3)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>By user</td>
<td>41.67</td>
<td>41.67</td>
<td>41.67</td>
</tr>
<tr>
<td>By Company</td>
<td>77.10</td>
<td>156.80</td>
<td>351.70</td>
</tr>
<tr>
<td>By Province</td>
<td>436.80</td>
<td>579.30</td>
<td>606.30</td>
</tr>
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Summary of findings from the Pilot ESCO Model

Institutional Aspects
1. Discussions with AEDB and Provincial authorities in Balochistan indicate that ESCO Concessions may provide a feasible institutional model for providing high quality electricity services from off-grid renewable energy supply to households which are unlikely to be served by the grid.

2. While there is ambition on the part of some of the Provincial officials to take over the operation and maintenance of solar home system clusters subsequent to the completion of the one year operation phase after installation, there is currently little capacity to do so. Officials expressed the view that they would be able to collect tariff, bring the local operators under their payroll and hire additional staff to supervise them. They would like the supplying companies to replace any non-functioning components for a period of five years after installation. The companies are for their part, however, not able to take responsibility for the full life of the
batteries and other components unless they are in charge of operations. It will be best for the ESCO to take responsibility of the professional O&M of systems. The responsibility of the Provincial authorities can range from direct supervision of ESCOs to one which is limited to their facilitation and support.

3. The companies have expressed their interest in operating and maintaining sizable clusters of solar home systems for 10 years, in addition to executing the procurement and installation contract, if it makes business sense for them. Their requirements for taking over such systems is to have a mechanism for tariff escalations over time to reflect inflation; to have more dense clusters and more homes under each cluster; to have a clear procedural and regulatory framework under which ESCO concessions have unambiguous legal status; and also to have support from the Provincial authorities on enforcement of payments. They also expressed a preference to continue working with AEDB rather than directly with the Provinces – citing the risk of politicization of the projects.

4. It will be important for the GoP to define more clearly the role of AEDB during the O&M contract period of the ESCO. The AEDB role can be that of a hands-off regulatory body which is called upon to approve petitions on tariff and to reconcile differences between Provincial authorities and O&M contractors. It needs to be clarified by GoP how this regulatory role would be shared with NEPRA, the National Electric Power Regulatory Authority. AEDB could alternatively have a more hands-on role which includes technical backstopping and day to day interactions with the contractor on behalf of the Provincial authorities much as WAPDA does for grid-based rural distribution systems.

5. Under all circumstances Provincial authorities would have a clear role in the design of clusters to be electrified and in the review of bids and selection of the ESCOs. During the O&M phase, the Provincial authorities would, at a minimum, need to support the ESCO by enforcing the law and order situation when necessary. This would entail enforcement of rights of the ESCO to remove systems from the homes of users who are delinquent on monthly bill payments. Provincial authorities could alternatively have the full responsibility of direct supervision of the ESCOs in operation and maintenance.

Financial sustainability aspects

6. The analysis above shows that full O&M costs can not be covered by current monthly user tariff. In particular the tariff will not cover the cost of battery replacement which would be required every 3-5 years of operation.

7. One option would be for Provinces to pay three quarters or more of the full tariff each month to the O&M Company with the households paying the remainder. The Company would then be responsible for using the accumulated tariff to replace the batteries.

8. A second option is for AEDB or Provincial Government to take responsibility for procuring and supplying batteries to the Company during the O&M contract period. The analysis shows that the O&M subsidy from the government, using either of the two options, can be substantial and is comparable to the initial capital subsidy provided by the government for procurement of systems.

9.2 Community management of solar pumped drinking water

Together with demand for energy for household use, there is a compelling demand for energy to power community infrastructure in areas of Pakistan not served by the national grid. The most ubiquitous of these demands, particularly in arid areas of Balochistan and Sindh, where solar and wind energy OS systems are expected to be most applicable, is for pumping ground water for human and livestock consumption and where necessary treating it to make it potable. The
challenge to make water pumping systems sustainable over time is both of technology and governance.

A second pilot activity was carried out on a solar pumped water drinking water project in a village named Bittri in District Tharparkar, Sindh province. The site was chosen close to the area where Pilot 1 was carried out so as to explore any complementarities between the ESCO and community-managed models. The pilot studied how well-proven social mobilization methodologies used by NGOs to prepare communities to manage Community Physical Infrastructure projects are being adapted for use in technologically complex infrastructure projects such as solar-powered water pumping projects. The pilot tested the hypothesis that ‘in the implementation of technically complex energy projects which provide public services like drinking water, private companies (e.g. concessionaires) may be best suited to take on the technological risks whereas community management backed up by social mobilization from NGO are likely to provide sustainable management through provision of equitable distribution, tariff collection, and routine operation and maintenance’.

The project was supported by the Thardeep Rural Development Program (TRDP), an NGO, with funding from the Pakistan Poverty Alleviation Fund (PPAF). Thardeep has, to date, installed 27 community drinking water systems with solar water pumps in the Tharparkar area.

The results of this pilot activity were expected to provide an understanding of:

a) Effectiveness of extending standard social mobilization techniques to technically complicated energy projects,

b) Possible linkages between the ESCO model and the management of mini-grids or drinking water pumping within the concession area.

The study team first analyzed the workings of a recently initiated solar water pumping project including both the technical and community-management aspects. The analysis included performance of the system, sufficiency of pumped water to meet community needs, effectiveness of management structure, sufficiency of tariff collection to meet maintenance and operation needs, and sufficiency of tariff collection to meet equipment repair and replacement needs. The study team has proposed, based on this analysis, a governance and institutional modality which combines the strength of social mobilization methodologies and private sector equipment supply and technology backup. The findings were as follows.

**Project Background**

The system supplies potable water to 200 people to their livestock, consisting of 500 cows, 250 camels and 100 donkeys, in 25 beneficiary households. Water is used to meet domestic needs including for bathing and washing clothes; limited irrigation activity has also started with surplus water. Water is pumped from a well and stored in a storage tank. Users come to the water pumping station to collect the water as there is no piped distribution network.

The system which has been operating since June 20th 2008, consists of 8 panels each of 130 Watts, a Lorentz pump and controller (PS-1800) which can operate at a maximum power of 2 kWp. According to the TRDP engineers, the pump has a capacity of delivering 100,000 liters per day and a 12,000 liter capacity storage tank was observed to be in operation. The water is pumped from a 80 ft deep well which reportedly has sufficient recharge for reliable supply of water.

Calculations show that with the installed array of panels, and at the depth from which the water is being pumped, the actual delivery of water is likely to be around 30,000 liters each day.
During the field visits, villagers expressed their happiness with the water supply. Women were particularly happy as they have the responsibility for fetching water. They reported that they spend significantly less time and effort in collecting water after the installation of the pump. They claimed that they use this time to carry out economic activities, embroidering clothes and Sindhi caps, and in agriculture.

Thardeep had been working with this village for the past 10 years and were able to do a very effective job of social mobilization with excellent participation of villagers. The community had seen a similar solar water pump in another village also done by Thardeep and asked for one for their own village as well. It was found during the course of the field trip that solar water pumping is in high demand among communities in Tharparkar.

The total project cost was Rs 1,256,712 with PPAF providing 80% of the funds and 20% contribution coming from the community as per standard practice for Community Physical Infrastructure projects funded through PPAF. The cost breakdown was as follows:

**Cost breakdown of solar water pumping project in Village Bitri**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump &amp; charge controller:</td>
<td>250,000</td>
</tr>
<tr>
<td>Panels:</td>
<td>590,000</td>
</tr>
<tr>
<td>GI poles:</td>
<td>50,000</td>
</tr>
<tr>
<td>Piping**</td>
<td>20,000</td>
</tr>
<tr>
<td>Transportation:</td>
<td>30,000</td>
</tr>
<tr>
<td>Boarding and lodging of company staff during installation:</td>
<td>20,000</td>
</tr>
<tr>
<td>Taxes:</td>
<td>20,000</td>
</tr>
<tr>
<td>Total</td>
<td>1,010,000</td>
</tr>
<tr>
<td>Discount:</td>
<td>10,000</td>
</tr>
<tr>
<td>Net cost:</td>
<td>1,000,000</td>
</tr>
</tbody>
</table>

Rs 256,712 was invested in cash and kind for construction of the civil works on the project.

**Operation and Maintenance**

Following PPAF rules, in addition to the 20% contribution during construction, Thardeep has required the community to deposit 3% (Rs 37,071) of the capital expenditure for the project in a bank account as a maintenance fund prior to the start of the project. The community makes a commitment to regularly replenish this maintenance fund as money is spent for repairs and maintenance on the system. The burden of this replenishment will be borne equally by all beneficiary households. Thardeep engineers believe that if equipment is maintained properly such as no dirt or sand is allowed to get into it, the pump can last 15-20 years. The company which supplied the equipment and completed the installation provides 2 year and 20 year warranties for the pump/controller and panels respectively. International experience shows that high standard brushless pumps like the Lorentz PS-1800 can indeed operate easily for more than 10 years and often up to twice as long. However, high quality installation and regular maintenance are pre-requisites for this.

The operator is a local villager from a beneficiary household and does not get any salary. He manages the pump activity by turning it on and off at appropriate times depending on the weather conditions and quantity of stored water and its usage etc. He has received some training during installation and is supported by engineering staff at Thardeep’s office for any technical problems.
Thardeep and community members do not currently see a need for monthly tariff collection as operation costs are minimal and they believe that the Maintenance fund should take care of repairs needed to the system. PPAF does not generally provide funds for equipment repair or replacement after installation, requiring the communities to cover this cost from tariff collections. The advantage of instituting a monthly tariff among users is that the Maintenance fund could grow to pay for larger repair costs which may be needed after completion of the 2 year warranty period from the company on the pump and controller. Such a collection mechanism would also reduce the dependency of the community on Thardeep over the long run. A financial analysis model shows that monthly tariff of USD 1.71 (Rs 137) would be required per house in the pilot village above to pay for replacing the pump and controller in 10 years.

**Ten Year O/M Contract**

Detailed discussions were held with Thardeep management regarding the best way of maintaining the pumps and controllers, including the idea of paying for a service contract with a company such as Trillium or Petrocon. The village currently has a maintenance fund of Rs 37,071 in a bank account. Each village has a volunteer operator for Operation and minor maintenance; and engineers in the Thardeep office provide technical support for serious repair and maintenance.

Thardeep management had strong feelings that a service contract was not necessary for solar water pumping technology and that for the current 27 pumps the villagers would not be willing to give their O/M savings to the new company. They would rather keep this money and when the need arises replace the defective component by seeking technical help from Thardeep. For new projects such an arrangement has the potential to work if the technical company is involved right from the beginning.

**Summary of findings from the Community Managed Solar Pumping Pilot Project**

**Institutional Aspects**

1. Discussions with AEDB, Provincial authorities, and private companies confirm that community solar water pumping should be an important part of future ESCO Concessions. The assessment of the pilot activity shows that drinking water systems are in high demand and there is good experience with the technology and communities managing these systems. It may thus be possible for ESCOs to install these systems, provide a warranty on panels, pumps and controllers, hand the systems over to communities and leave the tariff collection and maintenance to the communities themselves. However, community mobilization was seen to be critically important to the sustainable operation of these systems. This mobilization includes organizing the community for the project and getting a commitment for the 20% contribution, establishing a maintenance fund, and agreeing on monthly tariff collection. There would be additional expenses for groups like Thardeep, to carry out these services, which would also have to be budgeted for. PPAF typically budgets a one time fee of 8-12% of the capital costs for social mobilization to be paid to partner NGOs on similar community physical infrastructure projects.

2. A second alternative would be for AEDB and PPAF to jointly support the installation of community managed solar pumping projects, and keep this component out of the ESCO Concession. The justification of this alternative is that unlike solar home systems solar water pumping does not require routine replacement of expensive components like batteries. If operated well, the pump and controller should last between 10 and 20 years. These systems are used to provide a public good and hence social mobilization to achieve effective community management becomes a critical factor in their success. The assessment of the pilot activity shows that the institutional model of Thardeep working directly with the community for installation of systems, using funds from PPAF, and letting the community operate and manage the systems works well. The role for AEDB could be to provide technical standards, aggregation of demand through
linkages with the Provincial governments, and mobilization of funding for thousands of similar systems.

3. There is likely to be scope for both the institutional models described above. Where there are well established NGOs like TRDP, the second model may have some advantages. However in Balochistan where the majority of demand exists for solar pumping systems, there is a shortage of NGOs with the coverage and reputation which TRDP has in Tharparkar. In such cases, it is likely that the ESCOs would install the systems and work with a number of smaller NGOs to provide social mobilization.

Financial sustainability aspects

4. The analysis above shows that the Maintenance Fund established by the community is not likely to be sufficient for major repairs on the controller or pump for the solar pumping system. It is advised that in addition to the Fund, a monthly tariff of around USD 1.71 be collected from each beneficiary household to be added to the maintenance fund. This would allow for major repairs and replacement of key components after 10 years. This would make the whole project financially sustainable requiring no additional subsidy after the one time installation grant.

5. A second option would be for the Province to procure or pay for replacing major components, controller and pump, in much the same way as it is proposed for batteries of SHS in the ESCO model described above.
References:


NRSP 2002. NRSP’s Environmental Initiative in Rural Areas (in collaboration with LED Tronics inc. USA).


Annex:

Policy and Governance Framework for Off-grid Rural Electrification with Renewable Energy Sources
(Summary of Workshop Proceedings)

Following the study on Policy and Governance Framework for Off-grid Rural Electrification with Renewable Energy Sources, The World Bank, Alternative Energy Development Board and Winrock International held a joint workshop on 26th of June, 2008 to discuss the findings and proposals of the draft report with a broader group of stakeholders (AEDB, Ministries, Donors, village representatives, NGOs). List of participants is attached as annex I.

Agenda of the workshop was to present the findings of the survey report; related international and local experience in the sector; and policy proposals and framework for future up scaling of the off grid rural electrification projects. Workshop benefited from the experience of the participants most of whom had worked in the field on various off grid electrification projects in Pakistan.

To start the proceedings the Winrock International team gave the following presentations:
- International Experience in Off-Grid Rural Electrification
- Summary of Pakistan Experiences and Studies
- Study of Past Experiences in Pakistan (Based on the survey done by the team)
- Policy Lessons and Options for Off-Grid Rural Electrification in Pakistan

Presentations were followed by a lively debate amongst the participants encompassing issues ranging from governance and institutional models, economic benefits, tariff structure, O&M arrangements, community participation, gender issues and PPP viability including risk management, local technical expertise and regulation mechanisms.

Governance and Institutional Models:
Three models were presented for service delivery of off-grid energy services: Vendor Sales, Fee-for-Service (FfS) Concessionaire, and Community-based models. All three models benefit from being carried out through a Public Private Partnership framework. The discussions largely focused on the FfS Concessionaire and Community-based models. While the Vendor Sales model is demand driven (based on willingness to pay for installations by users) and thus reduces the capital expenditure liability for the government, it was found to suffer from two weaknesses: firstly the poor can not afford the cost of systems even with micro-finance and secondly it requires users to take responsibility for technical management of their own systems. The discussions focused on the FfS Concessionaire model as being suitable for solar home systems (SHS) and the community-based models being suitable for micro-hydel systems. Solar or wind-powered community drinking water systems and centralized solar or wind-based mini-grid electrification could be managed either as community-based systems or as a component of FfS Concessions.

Tariff Structure:
Tariff was considered a critical issue in the sustainability of systems as sufficient revenue is needed to cover O&M systems. Monthly tariff for off-grid solar home systems are currently Rs
150, Rs 200, and Rs 300 for 40W, 80W, and 120W systems. Participants mentioned that current cost and tariff structure is unsustainable and prices need to be adjusted. One participant stated that based on experience so far the tariff would have to be increased to Rs 500 per month to fully cover O&M costs of SHS under a FfS concessionaire model. The discussions were inconclusive on whether subsidy would be needed on the monthly tariff as well. It was pointed out by another participant that adjustment must be made carefully as experience from micro hydro projects in northern areas show that increase in tariff results in decline of usage and revenues. Discussion concluded on the point that tariff should not be the starting point in designing the system, but appropriate tariff should be calculated based on careful analysis. Quality of service is an important determinant of the tariff structure. It was observed that well maintained micro hydro projects with higher tariffs had better compliance from the consumers as compared to the ill managed low tariff systems.

**O&M arrangements:**
Lapses in O&M have resulted in the customers by-passing control circuitry in the case of a number of solar and wind systems installed in the past. Overburdened systems either collapsed or their output deteriorated substantially. Schemes with regular O&M arrangements and fiscal provision in the design of the scheme have been outperforming poorly managed systems. Whether there is a working O&M mechanism in an energy supply project or not is a governance and management issue. Participants discussed the option of engaging service contracts for longer term O&M of the schemes in addition to the current one year O&M guarantee provided by the supplier of the systems. This would allow a transition from the current management modality to a Fee-for-Service Concessionaire model of management. For the case of hydros O&M for local systems was discussed to be lower, and manageable by the local community, than high quality imported systems; but local systems require more frequent maintenance. Although a detailed analysis of the appropriateness of using local or imported systems was beyond the scope of the study, participants concluded that procurement of technology should be one of the design considerations, not necessarily the major one. The most important consideration is efficient implementation of off grid electricity supply; whether this is best done with imported equipment or locally manufactured technology will be decided on the specifics of the project.

**Community Participation & Gender Issues:**
Involving community in the project through NGOs like AKRSP who have long history of working with the communities was found beneficial. Especially for the collection of tariffs and regulation, communities are playing an effective role but their involvement in technical O&M has mixed results. For larger micro-hydel projects it was proposed that the responsibility for the management of the technology and O&M might be carried out by a private company which would be contracted by the community.

On demand side, participants shared that many communities demand provision of water services through off grid electrification, under the AEDB implemented Roshan Pakistan initiative but substantial progress could not be made in this regard due to the lack of funds. It was reported that PPAF has invested in a large number of solar-powered water pumping systems through the community-based project management modality. Participants shared their experiences regarding gender impact of the off grid rural electrification projects and pointed out that gender considerations need to be incorporated right from the design phase of the program. It was felt that off grid rural electrification programs should be sold as social improvement and poverty alleviation programs rather than simple electrification projects as the marginal benefit of first few kilowatt hours is substantial for the target communities.
Private Sector Participation:
The private sector has an important role in off-grid supply of electricity. Private sector companies have shown interest in developing hydropower projects in northern Pakistan. This may be relevant particularly for larger systems which are technically more complex. It needs to be examined carefully what kind of subsidy support these private parties might require, if any, compared to support for community-based systems. Public Private Partnership (PPP) remained a very active point of discussion amongst the participants. Potential PPP role in O&M service contracts was debated extensively. Risk was discussed as an important issue for engaging PPPs. Undue risk put on any of the partners in a PPP arrangement is unsustainable. It was agreed that PPPs are an important channel for quality provision of the services but can be successful only with solid partners and stable policy framework. Further study needs to be done for developing sustainable PPP engagements in the local context. IPDF intends to further explore regulation arrangements for successful PPP engagements beneficial to both consumers and service providers.

Winrock Consultants made suggestions for pilot project activities based on the lessons learned in the study. These pilots are part of the approved study activities. These pilots should demonstrated good governance and institutional practices leading to large scale program design in the future. IPDF agreed to further work with Winrock on it and request WB assistance where ever required.
## List of Participants

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Name</th>
<th>Organization</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Mujahid Sadiq</td>
<td>AEDB</td>
</tr>
<tr>
<td>2</td>
<td>Imran Ahmed</td>
<td>AEDB</td>
</tr>
<tr>
<td>3</td>
<td>Dr. Riazuddin Abro</td>
<td>AEDB</td>
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<tr>
<td>4</td>
<td>Ahsan Javed</td>
<td>AEDB</td>
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<td>5</td>
<td>Imran Aziz</td>
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<tr>
<td>6</td>
<td>Dr. Ekkehart Naumann</td>
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<td>7</td>
<td>Sher Khan</td>
<td>AKRSP</td>
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<tr>
<td>8</td>
<td>Maghfirat Shah</td>
<td>District Nazim Chitral</td>
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<td>9</td>
<td>Ulrich Stoehr-Grobowski</td>
<td>GTZ</td>
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<td>11</td>
<td>Khuram Shahzad</td>
<td>NUST Consulting</td>
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<td>Zaffar Sabri</td>
<td>PPAF</td>
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<td>13</td>
<td>A.N Obaidullah</td>
<td>SAARC Energy Center</td>
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<td>14</td>
<td>Mihaly Kopanyi</td>
<td>The World Bank</td>
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<td>Tahir Akbar</td>
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<td>18</td>
<td>Nafees Ahmad Khan</td>
<td>UNDP Wind Energy Project</td>
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<td>Qudsia Siddqui</td>
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<td>20</td>
<td>Rizwana Waraich</td>
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<td>Mary Harris</td>
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<td>Bikash Pandey</td>
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<td>23</td>
<td>Saeed Kazmi</td>
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<tr>
<td>24</td>
<td>Fazl-e-Rabi</td>
<td>CEO Green Alternative Power</td>
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