RESEARCH & DISCUSSION SERIES

# Renewable Energy: *Solar*

P P A F
پی پی اے ایف

Pakistan Poverty Alleviation Fund

The effect of carbon emmissions, global warming, and fragility of ecosystems, is captured in the frayed edges of the planet earth. The potential of renewable energy in arresting depletion of natural resources and fossil fuels is expressed in a kaleidoscope of colors: yellow/orange *(solar)*, light/dark blue *(hydel)*, light/dark green *(biomass)*, light/dark brown *(geothermal)*, blue/aquamarine *(tidal)* and whirling white *(wind)*.

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## Foreword

The second publication in *Research & Discussion Series* dedicated to renewable energy, this study assesses prospects of providing Solar Home Systems to poor communities at the grassroots. As an outcomes assessment exercise it analyzes 'before' and 'after' situation in project as well as non project areas. Twelve social, economic and demographic indicators were developed and used for gauging outcomes and impact. Due diligence was exercised in interpretation of results given the complexity associated with such research, especially as it relates to issues of causality and attribution. The study also attempts to control for other interventions being undertaken by PPAF in these areas.

Baseline and assessment surveys were carried out in four villages (two treatment and two control) and a representative sample (300 households) was enumerated. A specifically developed household based questionnaire was the principal survey instrument.

Conceived and carried out by Muhammad Muslim Nabeel (Evaluation Research & Development unit), the study benefited from facilitation and support extended by Indus Earth Trust, partner organization of PPAF.

**Kamal Hyat**
Chief Executive/Managing Director

# 1 Study Results

A review of existing literature reveals that adoption of new and emerging means of energy generation is taking root at both large/commercial scale and micro/household level. The role of renewable technologies in mitigating power and energy shortage is well recognized. International experience points to the high potential of renewable energy in meeting large demand-supply deficit of conventional fuels. There exists evidence to suggest that renewable sources have positive outcomes, especially as they relate to the relatively poor

and disadvantaged. Experience from developing countries shows that such projects can be effective instruments of rural development and poverty reduction.

Among various means of energy generation from renewable sources, solar power is arguably the most popular and widely used. In spite of high upfront establishment cost, solar technology is preferable to other renewables owing to longevity, low maintenance and service costs and abundantly available input (sunlight).

## Key Findings

- There is a significant income effect, especially per capita income, associated with households (with SHSs) in the project area compared to households (without SHSs) in non-project areas. The increase in capita income in treatment group was recorded 10 percent compared to 3 percent in control group.
- Savings in expenditure on fossil fuel (kerosene oil) in treatment households is directly attributable to the SHSs. A reduction of 7 vs. 2.3 percentage points in kerosene oil expenses was observed in treatment and control areas respectively.
- Increase in incomes and savings collectively enabled beneficiary households to shift their consumption patterns to higher spending in other important heads like food, clothing and fresh/potable water. An increase of 10 percentage points has been recorded in food consumption in treatment areas while no such change has been observed in control group.
- There is an appreciable difference in the quality of housing stock post introduction of solar technology, as evident in a discernable shift towards better quality of construction. More households in the treatment area have durable housing than those in control area – 13 percentage points versus 6 percentage points.
- Provision of SHS technology has increased female labor force participation as more

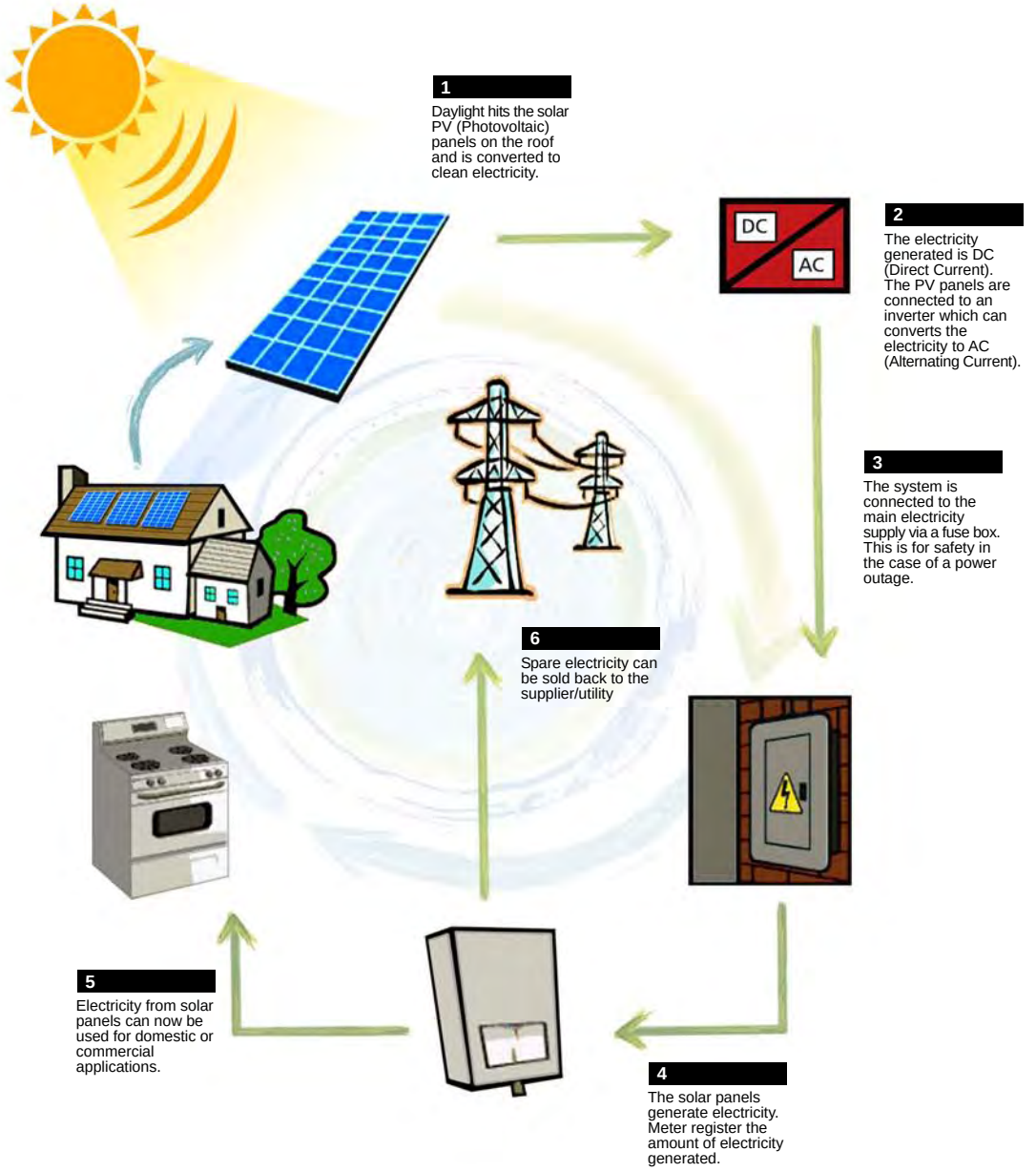
women in project areas are now involved in income generating activities than previously due to having extra availability of time especially in the evenings. There is an increase of 7 percentage points in the number of women involved in economic activities, whereas the comparable increase in non-beneficiary households is 2.7 percentage points.

- Fewer cases of snake, scorpion or insect bites have been reported in beneficiary households before and after introduction SHS technology due to improved visibility and availability of light.
- No significant difference between beneficiary (treatment) and non-beneficiary (control) households was observed in the indicators related to education and literacy, household assets and household debt or borrowing status.
- Although no direct economic/ poverty impacts of SHSs were indicated explicitly, subsidiary effects were visible through increased availability of time (esp. women) which was being put to income generating use and reflected in higher incomes.
- As SHS is a private good serving household need, other second order welfare effects can possibly be obtained if it is provided in combination with a public good to which there is currently little or no access, such as health and/or education.

Figure 1.1

## Solar Power

### Range of potential applications



# 2 The Sector Potential

Energy, and its availability, is central to sustainable long term economic development and energy consumption and standards of living have been shown to be positively correlated. Deficiencies in energy supply are especially evident in developing countries, as more than half of the world's population living in rural areas has no access to nonconventional forms of energy (AUSAID, 2001). Notwithstanding several impediments, adoption of the new and emerging means of energy generation is taking root in remote and least developed areas. A

mode of generation which is rapidly gaining acceptance is renewable energy. It has not only proven feasible on large/commercial scale but also at individual household level. Renewable energy projects have also demonstrated their viability in poverty reducing activities such as growth in businesses and creating employment. Its utility in the fields of health care and education is also well recognized. Furthermore, emerging energy technologies are gaining increased public support due to their intrinsic advantage of renewability and environmental sustainability.

Although benefits of renewable energy have been demonstrated worldwide, there is still need for its promotion at national levels. At least 60 countries (including 37 developed and 23 developing) have some policy regime to promote renewable power generation. China, for instance, has set a target of obtaining 15 percent of primary energy from renewable sources by 2020. Besides China, several other developing countries have also adopted and upgraded national objectives during past few years (REN, 2007).

There are at least seven identified sources of renewable energy:

- **Hydro:** Generation of electricity through water is suitable for small (micro-hydro) as well as large applications. It is considered the cheapest of all the means of power generation. However, requiring special sites that may not be abundantly available and on large scale it may prove highly capital intensive.
- **Wind:** The utility and cost effectiveness of wind-powered energy is well established; (Potentially in the Netherlands and some parts of US) it tends to be more viable at larger scales. Moreover, it requires special sites with constant minimum wind velocities throughout the year. Having mechanical parts, it needs extra care and constant maintenance.
- **Biomass:** Requires steady supply of residues (forestry, crops or livestock manure) and labor intensive maintenance on regular basis. Properly managed, it can effectively supplant conventional lighting

and cooking fuels. It is arguably more viable and successful at micro/household level.

- **Solar:** Solar Photo-voltaic (SPV) technology is most widely and innovatively used both at industrial and household level. The system barely comprises of any mechanical parts therefore requires no specialized technical expertise for maintenance. Moreover, the service life of most of the components involved is very long. However, as with most of modern technologies, its establishment cost is relatively high.
- **Solar Thermal:** This technology not only extracts but also amplifies heat energy directly from the sunlight. It is comparatively simple and offers very cost effective means of acquiring energy mainly for heating purpose. It is being extensively used in most parts of the world especially China and India.
- **Marine:** Energy from wave/tide has not yet been widely adopted and more development work is needed. Moreover, it also requires suitable sites (seas/oceans) for installation which may limit its adoption and utility.
- **Geothermal:** Energy obtained from hot/dry rocks is being investigated for future application. It has been successfully piloted in Asia Pacific Region (New Zealand). At the emerging stage viability and adoptability prospects are still to be established and validated.

Each means of renewable energy has its own specific costs, prospects and prerequisites for adoptability and dissemination. (See Annex I for a comprehensive cost/benefit analysis of various renewable technologies). There is a range of constraints that may limit access and provision especially at grassroots/community level:

I. The emphasis in literature is generally upon technological aspects rather than outcomes. This implies that technical and financial issues have been addressed during the past few decades but socioeconomic issues have not been sufficiently highlighted.

II. Inappropriate use of technology is another adverse factor in increased use of renewable energy. The focus has traditionally been on more popular sources rather than compatibility, cost effectiveness and economies of scale.

III. Over or under estimation of viability and potential demand has been another reason of failure of a number of such projects. For example in an electrification project in Indonesia, individuals wanted access to small amount of energy (20 watt to power two ten watt bulbs) but the product offered by the utility was 100 watt, too expensive for most households who were therefore unable to acquire the technology.

IV. As most of these technologies require advanced specialized skills for service and maintenance, lack of such knowhow in communities has led to lack of success at a large number of projects.

## Rationale for Solar Energy

Although solar power is in use for a few decades, significant progress has been made more recently for enhancing capacity and affordability in recent years. This development has made technology relatively more viable for small scale projects as well as domestic use. Most common use of solar energy is electricity generation through SPV (solar photovoltaic) means. This is an option most attractive for off-grid remote rural areas that have little prospects of connection to national grid in the near future. According to an estimate, 1.6 billion people in the developing world do not have access to suitable and viable sources of energy. Some characteristics making this a preferred choice for such consumers:

- SPV technology is relatively simple and does not involve complex mechanical parts therefore components have durability and longer life.
- Quality of an 8W solar bulb (400 lumens) is much higher than a kerosene lamp (60 lumens), which can translate into enhanced capability and quality of work owing to better visibility.

- The maintenance involves simple tasks such as dusting solar panel and changing dry batteries after a certain period. Therefore, no special expertise and trainings are required to maintain and service the system.
- Upgradation is simple and the cost is low as the main system remains essentially intact and only additional components (solar panels/batteries) are required.
- Sunlight is the only input (raw material) therefore it is successful in all such areas where sunlight is readily available most of the year.
- The system is portable as it can be relocated easily at minimal cost if required.
- Parts of the system that are exposed (solar panels and foundations) are robust enough and resilient for extreme climate.
- Long term sustainability of the system is well established and proven from international evidence at both commercial and domestic level.

As with all choices involving technology and resource allocation, there are also a number of constraints:

- Upfront establishment cost is relatively higher therefore it may not be affordable by poor communities/households.
- It is not suitable at tropical regions or where the sun is not out for most time during the day.
- Operational costs (principally change of batteries) require availability of regular and predictable cash flows at the consumer/household level.
- Technology is at a nascent stage as the available small scale systems offer just a few kilowatts merely sufficient for lighting purpose. Other larger installations that produce higher power may or may not be feasible for poorer households.

## Utility and Versatility

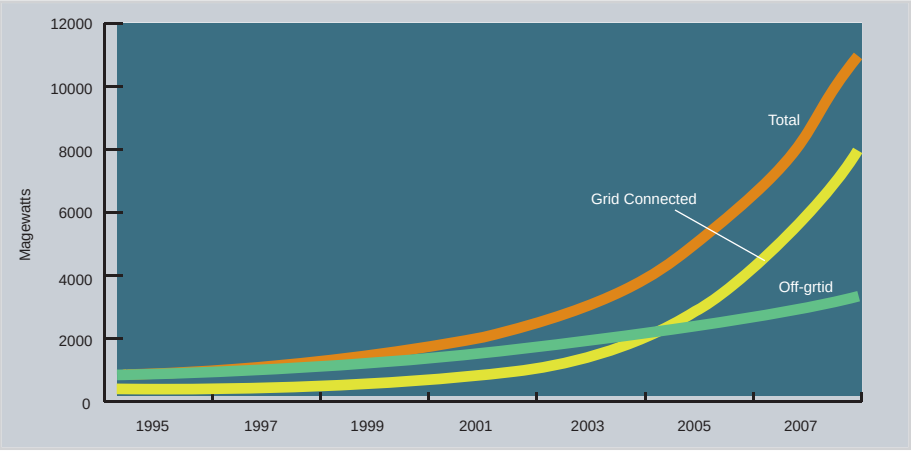
Evidence suggests that the technology is successfully being used with all its versatility at both industrial and domestic level.

Developed part of the world is exploiting this technology to supplement existing conventional systems whereas developing countries are using it as an alternative to traditional energy sources becoming scarce or unaffordable. However, the utility and efficacy of the technology is well acknowledged and recognized all over the world and therefore rapidly being adopted.

### *Evidence from Developed Countries*

Developed countries like Germany, Japan, USA, Spain and Netherlands are at the forefront in utilizing SPV for grid connected power generation. Grid connected SPV continues to be the fastest growing power generation technology in the world with 50 percent annual increase in cumulative installed capacity in 2006 and 2007 to an estimated 7.8 GW by the end of 2007 (see Figure 1). This capacity translates into an estimated 1.5 million homes with rooftop solar PV feeding into the grid worldwide. Germany accounted for about half the global market in 2006 with a production of 850 – 1,000 GW (REN, 2007).

**Figure 1: Solar PV, Existing World Capacity**



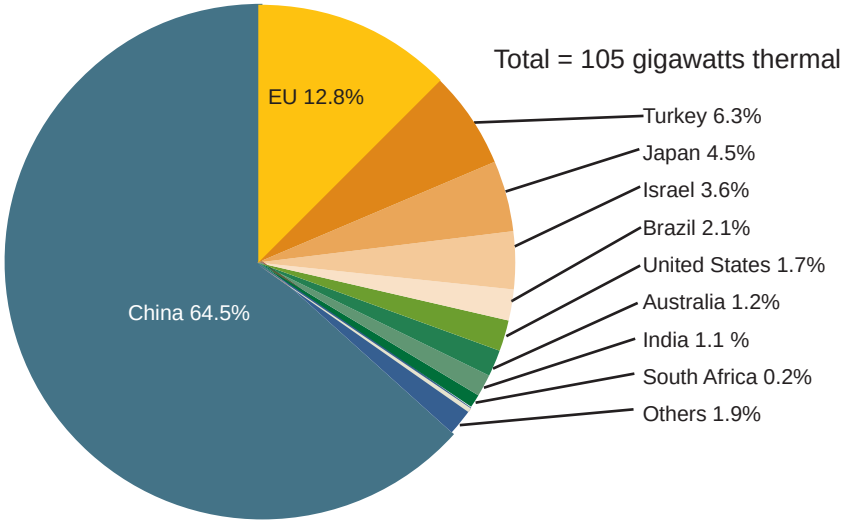

**Source: Renewables 2007, Global Status Report**

There are numerous small off-grid installations of usually less than a kilowatt for a variety of applications (solar homes, remote telecommunications, road signs, street lights and consumer products). Including these off-grid installations of solar PV, which continues to grow at a rate of double digits annually, cumulative existing solar PV worldwide is reported to have reached 7.7 GW in 2006 (see Figure 1).

On the other hand, two highly visible SPV installations in USA have attracted a lot of attention. Altogether there were over 800 plants worldwide with capacity greater than 200 kW and 9 plants larger than 10 MW till 2007. (REN, 2007).

Figure 2 shows that solar hot water technologies are also becoming widespread and contributing significantly to hot water in Asia (Japan & China) and Europe (Turkey & EU countries).

Figure 2: Solar Hot Water/Heating Capacity, Selected Countries 2006




Source: Renewables 2007, Global Status Report

Solar space heating and cooling is also gaining grounds in developed countries. In Asia Pacific (Australia) and Europe (Germany and Sweden) more than 50 percent of annually installed collector area is for combined hot water and space heating system. Over the last few years, solar assisted cooling attracted increased interest of a variety of commercial and industrial buildings; some dozen of large scale systems (i. e., 100 to 500 sq meters) entered service in Europe, mostly in Germany (REN, 2007).

### *Solar Technology in Developing Countries*

Over the last few years SPV technology has seen steady increase in popularity in developing countries. Such countries that lack resources for mega installations have effectively exploited solar technology for providing off-grid power domestically and in the field of agriculture, health, education, microenterprise and public services. Some glimpses from developing countries are given in the following text.

- In India, Grameen microfinance group offers improved credit terms for SHS, with concessional loans. The program includes intensive outreach and training program through 52 branch offices. A variety of artisan, rural industry and agriculture uses are reported.
- Similar to Grameen model in India, a well established microcredit organization in Sri Lanka promoted SHS through assistance from corporate sector. In this model, the loans to end users are initiated by the solar companies. In an impact study, 60 percent households reported increased income mostly indirect, e. g., saving on fuel and batteries (Fishbein 2003)
- Himalayan Light Foundation (HLF) offers Home Employment and Lighting Package in Nepal. In this package participating villagers are offered skill trainings, tools to set up an income generating activity and solar electricity system. Marketable products are mainly handicrafts with marketing support by HLF.
- Morocco Maison Energie a part

of a larger natural resource management program consists of commercialization of various forms of solar energy including PV equipment, solar water heaters and ovens.

- A demonstration project has been initiated in Mexico, including pumping water for livestock, micro-irrigation, ice-production for fishermen and milkmen. A total of 300 such units were targeted. The project has been replicated successfully and the beneficiaries are reaping the benefits of the project.
- In Senegal, food processing, village workshop and home business applications have been developed using solar PV powered DC motors. After 10 years experience with local stakeholders to develop a design to ensure technology is firmly grounded locally. The technology is used for food processing, village workshop, fans, sewing, drilling etc.
- In Argentina, several thousand solar powered drinking water pumps have been installed successfully during 1990 – 1998.
- In Inner Mongolia, China solar PV/wind hybrid systems are installed to provide TV/Radio access to the herdsmen. Access to regular information has helped to reduce risk by enabling them to plan sheep shearing, protection of newborn, moving hay indoor and avoiding unnecessary watering of fields (Campen 2000).
- In Kenya about 70,000 SHSs installed in 1997 were mostly sold by commercial companies more than 90 percent on cash sales. As a proxy indicator of its success, according to a study 70 percent owners of SHSs were willing to pay another US$ 390 on average for upgradation of the system (Plas).

## Solar Home Systems (SHSs)

SHS is dominant use of solar PV as confirmed by a large body of literature (Campen, 2000). It has brought a new revolution in use of solar PV especially for rural development and poverty alleviation. It is ultimate option for bringing households to life that neither have access to the grid nor

is such extension in near future a realistic option.

SHSs have made their impact mainly at the domestic level. For analytical reasons, the outcomes of this technology can be categorized into following broad areas:

### *Economic Impacts*

- While it is concluded in some studies that there is little or no evidence of direct economic impact by SHS (Cabraal 1994, Wamukonya, Davis 1999), other investigations show that that SHSs support household economic and income generating activities for some end-users. A recent study conducted in Nepal on a sample of 250 households shows that 13 percent men and 11 percent women perceived an increased income due to introduction of SHS (AEPC/DANIDA, 1999).
- Increasing trend in upgrading average SHS has been observed worldwide (Campen, 2000). Larger systems offer excessive power but at the same time increased installation and maintenance costs. This "willingness to pay" may be regarded as a proxy indicator of financial benefits potentially accrued by beneficiary households. Furthermore, if this trend is confirmed and supported by decreasing PV system prices, there could be higher prospects of impact on household economies. There are, for instance, some examples from China where the installation of larger PV systems (100 – 300 Wp per family) led to an increase in productive uses (Campen, 2000).
- Another rudimental indicator that may be used for quantifying SHS impact is savings on energy expenditure such as kerosene or candles which the new system supplants. Considerable saving (US$ 10 per month) had been reported in Kenya where households mostly install small 10-12 Wp systems just for lighting purpose (Plas, Hankins, 1997).

### *Welfare Impacts*

The impact of SHS on social welfare is also confirmed by the reviewed literature. Studies on

SHS mention that there is definitely a positive social impact in the form of 'improved quality of life' at household level (Hankins, 1993). Some often reported effects of SHS on life styles are given below:

- Extended household work schedule
- Time and labor savings
- Increased reliability and convenience in energy use
- Decrease in outdoor pollution
- Decrease in accidents
- Improved health and hygiene
- Increased education
- Increase in leisure time.
- Increased social gathering resulting in better social cohesion

A field study also reported that disadvantaged rurally located users feel that because of SHSs they now have conditions which are comparable with the more comfortable urban lifestyles (Richter 1997).

### *Gender Dimension*

The impact of SHS on men and women differ significantly. Feedback from various studies suggests that there is higher impact of SHSs on women and children than on men (Cabraal, 1996). The former spend more time at home, performing indoor duties hence reap more benefits. Endeavors such as handicraft, sewing and embroidery are carried out by women translating technology into gainful economic activities.

Despite the tendency for higher impact on women, marketing and financing of SHSs is generally men's responsibility in poor rural households as male members are often main decision makers in finance and investment matters. Training in operations and maintenance is also directed at men. However, with advent of technology women are becoming more independent through higher incomes, Grameen Shakti (Bangladesh) and Genesis (Guatemala) show that women can be reliable investors in and managing SHSs and these systems can help them to increase their productivity considerably. The experience from Himalaya Light Foundation in Nepal is a good example of where SHS

commercialization, micro-enterprise development, productive uses and gender aspects meet via an unusual source of private financing.

## PPAF Initiatives

Along with provision of conventional small-scale infrastructure projects, PPAF emphasizes dissemination of emerging innovative technologies. Such projects, termed as Technology Innovation Projects (TIPs), include desalination plants, wind mills, incinerators, and small scale power generation projects. PPAF has completed 236 TIPs nationwide with a cost of US$ 2.2 million benefiting 93,748 households.

Keeping in view shortage of electric supply at national level and mounting energy needs of communities, PPAF initiated Solar Home Systems (SHSs) Project on pilot basis in February 2008 in Keimari, coastal outskirts of Karachi city (Sindh Province). The project was identified and implemented by a PPAF partner organization Indus Earth Trust (IET) working for development in the project area for more than eight years. Each beneficiary household was furnished with solar powered lighting sources and mobile chargers.

The project was initiated in two villages namely Arab Soomar and Hussaini Faqeer that are home to fishermen communities. For gauging the impact of the intervention, baseline of the treatment hamlets (Hussaini Faqeer and Arab Soomar) was carried out in May 2008 by a team from Evaluation, Research and Development (ERD) unit of PPAF. As counterfactual, control hamlets of Alwani and Juma Hamid Goth from same area and with similar socioeconomic backgrounds were selected.

The pilot project was undertaken in the village clusters of Chattara and Allah Banu. Both of these areas are geographically adjacent and home to more than 30 rural hamlets scattered over an area of around 25 square kilometers. Various other projects like drinking water supply, irrigation, community latrines, desalination plants along with a health facility has already been provided by IET in the area with support and financial assistance

from PPAF. Table 1 shows different types of projects and their cost already completed in control and treatment villages.

An amount of over Rs. 5 million (including SHS project) has been allocated for seven different infrastructure projects in both treatment and control villages. Owing to these projects an overall prosperity and betterment in living standards has been observed in the area. The issues of causality and attribution notwithstanding, key indicators have been identified that are directly correlated with the inputs of the project. The associated externalities of SHS with initiation of micro/household based economic generating activities are also examined in this report.

During baseline, the activity of basket making by women in some villages was also observed by the survey team being carried out in the area. It was found appropriate to investigate this activity further and factor it in the assessment at hand. For this purpose, a study was undertaken and different prospects for enhancing productivity of enterprises were explored (PPAF, 2008). Both treatment and control groups benefited from the activity equally. This was intended to control for possibility of contamination of survey results because of this activity.

**Table 1: PPAF: Water & Infrastructure Interventions in Study Areas**

| Village / Cluster | Project Type | Beneficiary HH | Total Cost (Rs.) |
|---|---|---|---|
| Arab Soomar | Solar Home Systems | 100 | 1,561,180 |
| Arab Soomar | Safe Drinking Water | 100 | 1,473,572 |
| Arab Soomar | Community Latrines | 100 | 599,350 |
| Juma Hameed | Wind Turbine for school & mosque | 65 | 220,432 |
| Hussaini Faqeer | Solar Home Systems | 50 | 1,000,000 |
| Hussaini Faqeer | Community Latrines | 50 | 244,666 |
| Mohammad Allwani | Wind Turbine (School, Mosque) | 82 | 220,432 |
| | **Total** | **297** | **5,319,632** |

Source: Indus Earth Trust

# 3 Design & Methodology

The research is an outcomes and impact evaluation study of SHS pilot project. Before/after snapshot of the project areas were taken by conducting baseline and impact evaluation surveys. For the sake of gauging overall intervention impact, counterfactuals were also selected having similar socioeconomic conditions. For this purpose two treatment (Hussaini Faqeer and Arab Soomar) and two control (Alwani and Juma Hamid Goth) where selected. The detail of households surveyed during baseline and impact survey are shown in the table below:

| Table 2: Sample Households (Number) | | | |
|---|---|---|---|
| **Area** | **Before** | **After** | **Total** |
| Treatment | 72 | 61 | 133 |
| Control | 84 | 83 | 167 |
| **Total HHs:** | | | **300** |
| Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009 | | | |

Though not a panel survey, the study obtained a minimum of 80 percent of households from each village were enumerated at the time of baseline and impact. There is a high level of confidence that at least 60 percent of households were revisited during the exercise.

## Survey Tools

Structured survey tools were developed for specifically gathering information on household demographics, economy, assets, infrastructure and other social and economic aspects. Moreover, interviews were conducted with community members for discussion on long term sustainability prospects of the project.

## Conduct of Survey

A team of 5 enumerators was deployed in both before/after surveys following a comprehensive orientation session. During the baseline survey, one full day was devoted for orientation and pretest and the questionnaire was modified according to area specific characteristics. Some questions enveloping the intervention specific aspects were also included in the questionnaire.

ERD team supervised the fieldwork. Questionnaires filled in field were cleaned and discrepancies removed each afternoon immediately after the survey.

## Data Entry & Analysis

Specialized software was designed using MS Access for entering the data collected in the field. All appropriate checks and restrictions were provided in the software to ensure correct and consistent data conversion from hard to electronic form. The questionnaires entered were randomly checked and hard copies reconciled with database records. Data were subsequently exported to SPSS 15 and analyzed. Some of the tasks like data formatting and graphs were undertaken using MS Excel 2007.

## Review of Literature

Different relevant reports and case studies were reviewed to confirm the efficacy and effectiveness of the technology. Moreover, experiences from all over the globe have been shared to back and validate current study results.

## Report Writing

Writing of the report was also carried out in-house. Before/ after situation (of both treatment and control groups) has been presented vis-à-vis with analytical explanations. Main emphasis in the report has been on determining project efficacy by gauging a range of outcomes. The results also have been compared with experiences obtained regionally and internationally as relevant and appropriate.

# 4 Household Characteristics

This chapter presents the demographic and socioeconomic indicators in the sampled households, which are crucial to determine household size, sex ratio, dependency ratio, literacy rate and level of education. There is also an analysis of both before and after conditions and the change in characteristics is also determined.

In treatment area, males slightly dominate the population as in both before and after survey male population is over 51 percent. Whereas, in control group the

| Table 3: Household Members: Gender Breakup | | | | |
|---|---|---|---|---|
| **Members** | **Before** | | **After** | |
| | **Treatment** | **Control** | **Treatment** | **Control** |
| Male | 51.1 | 49.4 | 51.8 | 50 |
| Female | 48.9 | 50.6 | 48.2 | 50 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** |
| Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009 | | | | |

proportion is fairly equal as both pre and post survey results exhibit equal male/female ratio (Table 3).

## Household Members

Table 4 shows pre/post surveyed households and household size in both treatment and control areas.

When compared to control group, treatment areas are characterized by larger household size. A larger household is perceived potentially 'better-off' due to sharing of resources, costing and earning sources. However, there may be certain other factors that need to be considered for explaining differences.

### *Age Groups*

The distribution of population by age groups is given in Table 5.

According to data the proportion of children of age less than 5 years increased from 16 to 19 percent in treatment and 18 to 20 percent in control during pre and post survey period. When clubbed with the next age bracket (6 – 15 years), the proportion of children under 16 years is significantly high (48 and

| Table 4: Average Household Size | | | | |
|---|---|---|---|---|
| | **Before** | | **After** | |
| | **Treatment** | **Control** | **Treatment** | **Control** |
| HHs | 72 | 84 | 61 | 83 |
| Members | 446 | 403 | 376 | 414 |
| Average HH Size | 6.2 | 4.8 | 6.2 | 5 |
| Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009 | | | | |

| Table 5: Age Groups (%) | | | | |
|---|---|---|---|---|
| **Age Groups** | **Before** | | **After** | |
| | **Treatment** | **Control** | **Treatment** | **Control** |
| <5 | 15.9 | 18.4 | 18.6 | 19.6 |
| 6 - 15 | 31.8 | 25.1 | 31.4 | 26.1 |
| 16 - 30 | 30.9 | 30.8 | 27.4 | 26.3 |
| 31 - 45 | 10.8 | 15.4 | 15.7 | 15.2 |
| 46 - 60 | 7.2 | 9.2 | 4.8 | 10.9 |
| > 60 | 3.4 | 1.2 | 2.1 | 1.2 |
| **Total (%)** | **100.0** | **100.0** | **100.0** | **100.0** |
| Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009 | | | | |

50 percent in treatment and 43 and 46 percent in control in pre and post analysis respectively). This may be attributed to high fertility and/or high survival rate in the area in the past. It is also an indicator of large number of dependents in household economy. However the proportion of population over the age of 60 years is low ranging from 1 to 3 percent in each group in pre and post analysis.

### *Dependency Ratio*

The dependency ratio (the ratio of population below 15 years and above 65 years to the number of working age group falling between 15-64 years) is presented in Table 6. Communities that have a high dependency ratio have different economic considerations than communities with a smaller proportion of non-working individuals. Dependents

| Table 6: Dependency Ratio | | | | |
|---|---|---|---|---|
| | **Before** | | **After** | |
| | **Treatment** | **Control** | **Treatment** | **Control** |
| < 15 | 43.5 | 41.9 | 47.6 | 43.2 |
| 15 - 65 | 53.8 | 57.1 | 50.8 | 53.9 |
| > 65 | 2.7 | 1.0 | 1.6 | 2.9 |
| Dependency ratio | 85.8 | 75.2 | 96.9 | 85.7 |
| Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009 | | | | |

place heavy demands for daily consumption, health and education that must be maintained and funded by the working members of the household.

High dependency ratio with increasing trend has been reported in both treatment and control groups. An increase of around 10 has been witnessed in both the groups with treatment group demonstrating higher proportion of dependents in the population. This shows that the treatment group is slightly more overburdened as far as dependents are concerned. However, in poor rural areas where children are not sent to school, the working age is fairly low as small children are also often observed involved in different economic activities. Therefore, the effects of high dependency ratio are more pronounced in areas like household's education and health rather than overall economy.

### *Work Status*

Percentage distribution of work status by age-group and gender-wise is depicted in Table 7.

The data show that most of the people in both treatment and control groups are associated

**Table 7: Occupations (%)**

| Work Status | Before | | | | After | | | |
|---|---|---|---|---|---|---|---|---|
| | Treatment | | Control | | Treatment | | Control | |
| | Male | Female | Male | Female | Male | Female | Male | Female |
| Not working | 66.5 | 16.2 | 59.0 | 15.5 | 60.5 | 17.0 | 53.8 | 12.8 |
| Household work | - | 80.3 | - | 79.2 | - | 70.7 | - | 78.3 |
| Own farming | 0.5 | - | - | - | 1.8 | - | 0.5 | - |
| Farm labor | 0.5 | - | 0.5 | - | 1.3 | 0.9 | 2.0 | - |
| Off farm labor | 1.5 | - | 2.4 | 0.5 | 11.8 | 1.4 | 6.0 | 0.5 |
| Service/job | 1.0 | - | - | - | 1.3 | - | 0.5 | - |
| Business | 1.9 | - | - | - | 0.9 | - | 1.0 | - |
| Own fishing | 1.5 | - | 3.4 | - | 2.2 | - | 1.0 | - |
| Fishing labor | 10.2 | 0.6 | 20.3 | 0.5 | 11.0 | - | 21.1 | 1.5 |
| Other | 16.5 | 2.9 | 14.4 | 4.3 | 9.2 | 10.0 | 14.1 | 7.0 |
| **Total (%)** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

with fishing labor. Male members' occupation is deep sea fishing during the season with large boats or trawlers. They either get a share from the catch or receive wages by the end of the trip as per agreement with the boat owner. There are very few who are involved in 'own fishing' as the catch of the fishermen has dwindled over the past few years. Mainly the reasons cited by local communities are introduction of latest fish catching technology and deep sea trawlers, which the traditional fishermen cannot compete with.

High percentage of population in 'not working' category in both treatment and control groups is a function of high dependency ratio. However, when before and after situations are analyzed a positive trend is evident both in male and female as the percentage of population not involved in any economic activity significantly drops off. The decrease in male is approximately the same in both groups (around 6 percentage points), whereas, there is a significant proportion of females starting economic activities in treatment area over the observation period. In before situation about 3 percent women of treatment group were involved in some kind of economic activity. However, the data in post analysis show that around 9 percent of women have been involved in some sort of income generating activities who were previously not earning whereas such proportion in control area is only 4 percent. Further analysis of women work status in treatment group shows that 'others' category increases by 7 percentage points (from 3 to 10 percent). Among these, most of the women are involved in basket making and few in embroidery. This rising trend evident in treatment group can undoubtedly ascribed to the intervention as supported by a previously conducted study (PPAF 2008). Although this activity of basket making has been started in both project and non-project areas yet treatment group is observed to be capitalizing more on it owing to provision of extra time at night.

## Literacy & Education

International research and other developments support the assertion that education plays an important,

perhaps critical, role in growth, economic development and poverty reduction with positively correlated welfare outcomes at the household level. The magnitude of which is a function of whether it is publicly or privately delivered and how well it is designed or structured (PPAF, 2009).

### *Literacy*

In both treatment and control areas, female literacy is very low as 1.5 percent and 0.5 percent female are literate in treatment and control groups respectively. The situation did not change in post evalution as well. Therefore, while discussing literacy, enrolment status and educational attainment in the following text the gender is implicitly male. Table 8 shows the literacy rates.

Although very low by national standards, literacy rate in treatment areas (17 percent) was recorded much better than control group (6 percent) during baseline survey. Slight improvement has been recorded during impact evaluation in both groups, however, control group shows more progress (3 percentage points) compared to treatment group (1 percentage point). Both in project and non-project areas there is a scarcity of access. For a population scattered over 25 square kilometers, there are just four Government primary schools operational and those too for boys only. For high-school the children have to go to Maripur, 30 kilometers away from the area. Transportation is another problem cited as only one bus from the area makes a daily round trip to the city charging Rs. 50. Therefore, education is an expensive option in terms of both actual and opportunity cost.

**Table 8: Literacy (%)**

| Male Literacy | Before | | After | |
|---|---|---|---|---|
| | Treatment | Control | Treatment | Control |
| Literate | 16.5 | 5.5 | 17.1 | 8.7 |
| Illiterate | 83.5 | 94.5 | 82.9 | 91.3 |
| **Total (%)** | **100.0** | **100.0** | **100.0** | **100.0** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

The option for female education practically does not exist.

### *Educational Attainment*

Educational attainment of the population is very low as only 0.2 and 0.5 percent members have education beyond grade 10. Among the rest most literate population has attained primary level (grade 5) or below. However, increase in up to primary level attainment in both control and treatment group shows new enrollment which is a positive trend.

### *Educational Status*

Enrolment status indicates the tendency of the population towards acquiring formal education. As indicated by the literacy rate, the enrolment status is also very low.

As shown by baseline data (Table 10) only 7.3 percent of the population was enrolled which slightly crept up to 7.5 percent in post situation. The change is so small that we cannot regard it as 'significant'. This may also be a result of difference of sample size

**Table 9: Educational Attainment (%)**

| Education Level Attained | Before | | After | |
|---|---|---|---|---|
| | Treatment | Control | Treatment | Control |
| Never Enrolled | 83.5 | 94.5 | 82.9 | 91.3 |
| Grade 5 or below | 11.5 | 4.2 | 12.2 | 6.1 |
| Grade 6 to 8 | 3.6 | 0.6 | 3.9 | 1.8 |
| Grade 9 to 10 | 1.2 | 0.6 | 1.4 | 0.8 |
| Grade 11 to 12 | 0.2 | 0.0 | 0.5 | 0.0 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

**Table 10: Educational Status (%)**

| Schooling | Before | | After | |
|---|---|---|---|---|
| | Treatment | Control | Treatment | Control |
| Never enrolled | 83.5 | 94.5 | 82.9 | 91.3 |
| Currently not enrolled | 9.2 | 3.3 | 9.6 | 3.1 |
| Currently enrolled | 7.3 | 2.2 | 7.5 | 5.6 |
| **Total (%)** | **100.0** | **100.0** | **100.0** | **100.0** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

in baseline and impact survey. In control group the proportion of school going population is also low but the change is significant (increased from 2.2 percent to 5.6 percent in before and after situations respectively).

## Household Infrastructure & Facilities

The region containing both treatment and control areas is mostly barren and deprived of basic facilities. The livelihoods are scarce and economic activities are limited. Mostly people are associated with fisheries. The income of local fishermen has significantly declined since bigger players have introduced latest technologies of catching fish.

The people are accustomed to live in huts made of wood and straws. Poverty and destitution may be one reason of using such accommodations. However, such huts are well aligned with the local climate as houses made from blocks and bricks do not last long due to wet winds blowing almost throughout the year. Moreover, as these areas are also not connected to the grid, therefore, people do not have the option for cooling their homes through electricity. These huts have an excellent ventilation system that keeps their accommodations cool during summer. However, some people in the area who have the means have turned their huts into cemented structures.

### *Household Infrastructure*

Table 11 presents the information about household structure. The analysis of baseline and impact

**Table 11: Housing (%)**

| Type | Before | | After | |
|---|---|---|---|---|
| | Treatment | Control | Treatment | Control |
| Pakka | 31.9 | 54.8 | 42.5 | 62.7 |
| Katcha (Huts) | 44.4 | 22.6 | 44.3 | 22.5 |
| Pakka & Katcha | 23.6 | 21.4 | 13.3 | 14.8 |
| **Total (%)** | **100.0** | **98.8** | **100.0** | **100.0** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

data reveals an interesting phenomenon. The proportion of Katcha houses (huts) remains the same in both treatment and control groups, however, there is a significant transition from Pakka and Katcha (semi-cemented/mixed) to Pakka (concrete/cemented) households in both treatment and control areas.

One possible reason may be that rising incomes have led the shift to more durable housing options.

### *Water Sources*

Table 12 shows water sources used by the population in the area. Mostly the ground water is saline and therefore not potable; therefore, people have very few options to cater to their needs for drinking and washing purposes. However, at some places fresh water can be found underground but such areas are scarce and very difficult to identify. IET has provided community water tanks filled by fresh ground water through wind mills. It has helped women to divest from laborious work of fetching water from remote locations. Availability of adequate fresh water has reportedly promoted health and hygiene practices in the area.

Mostly people in both treatment and control areas rely on water tanker as it is an option for around 80 percent population in treatment and about 90 percent control areas. One tanker costs Rs. 400 to Rs. 600 and lasts for one week for a household. This is one of the major expenditures a household incurs in these areas.

In treatment areas, however, about 9 percent population has the option for using community water sources provided by IET. The reason fewer

**Table 12: Access to Water (%)**

| Sources | Before | | After | |
|---|---|---|---|---|
| | Treatment | Control | Treatment | Control |
| Community Water | 9.2 | 0.0 | 8.2 | 0.0 |
| Water Tanker | 76.9 | 89.3 | 77.0 | 92.8 |
| Other Sources | 13.9 | 10.7 | 14.8 | 7.2 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

people using this source is that it is not homed exactly in the treatment areas. Women still have to trek to these sources available in other communities.

### *Electricity*

Although at a distance of 20 kilometer form the local power station, the area is deprived of the facility of electricity. Apart from the solar lights provided by PPAF, some wind turbines and solar panels are sporadically found in the area installed on public places (mosques, health centers or battery charging points) by IET or other donors working in the area. However, provision of solar lighting sources in households is a maiden endeavor financed and supported by PPAF

### *Cooking & Lighting Fuel*

Provision of SHSs is perceived to impact in area of lighting fuel the most. Traditionally, the households use wood for cooking and kerosene oil as lighting fuel purpose. Therefore, reduction in users and use of kerosene oil is one of the major aims of the project.

As shown in Table 13, the users of kerosene oil have significantly reduced with the introduction of SHSs. In control group this reduction is almost negligible. In treatment areas still around 46 percent households are using kerosene. However, as it will be discussed in detail in section pertaining to household consumption, the quantity of use of kerosene has been considerably reduced. Now the households use kerosene for occasional cooking or in lanterns for outside use.

### *Toilet Facility*

IET has also provided community latrines in the area which is an option used by most of the

**Table 13: Energy Sources (% HHs)**

| Source | Before | | After | |
|---|---|---|---|---|
| | Treatment | Control | Treatment | Control |
| Wood | 100.0 | 100.0 | 100.0 | 100.0 |
| Kerosene | 85.6 | 88.1 | 45.7 | 85.9 |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

households. This facility has been provided in both the treatment villages and one of the control village (Juma Hamid Goth).

Table 14 reveals the fact that mostly people in both control and treatment areas use community toilets built outside. However, a positive trend of making latrines inside the houses is demonstrated in control areas where inside toilet facility increases from 22 to 30 percent. No such trend is observed in the treatment group rather people going in open fields (bushes) have increased from 10 to 15 percent. This may be a result of some community latrines becoming non-functional in treatment areas.

**Table 14: Toilet Facility (% HHs)**

| Toilet Facility | Before | | After | |
|---|---|---|---|---|
| | Treatment | Control | Treatment | Control |
| Inside | 18.1 | 22.1 | 18.2 | 29.8 |
| Outside | 71.9 | 60.0 | 67.2 | 50.6 |
| Open fields | 10.0 | 17.9 | 14.6 | 19.6 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

# 5 Household Economy & Assets

Loss of GDP growth in the economy, rising trends in unemployment and weakening wage growth are main factors effecting poverty. This chapter analyzes household economy and related dimensions, and different economic features of the population and the area. Labor force participation, employment status, sectoral distribution of labor force, occupational status and unemployment will be discussed in detail. Furthermore, we will try to single out the impact of our intervention from the available data and information.

## Income Sources

Economic welfare of households largely depends upon the incomes. Income can be regarded as a sole determinant of poverty or wealth of a household. For better earnings, appropriate sources of income are crucial. Moreover, knowledge about the income major income earning opportunities is also critical in devising effective development strategies for an area.

Table 15 gives percentage distribution of wealth associated with major income sources in the area.

Data show that fishing/fishing labor mainly contributes towards the incomes in both treatment and control areas. The second largest, source of income is off-farm labor. In control, some income comes from crops also as people grow coconut, chiccu and some vegetables where fresh water is available. Mostly women fall in 'Other' category, which are involved in basket making and embroidery. This category has grown significantly in treatment area. A total of 35 percent households in treatment area are associated with some women involved in cottage industry. In control, the proportion of female involved in household based cottage industry is approximately the same, however,

**Table 15: Income Sources (% HHs)**

| Sectors | Before | | After | |
|---|---|---|---|---|
| | Treatment | Control | Treatment | Control |
| Crops | 1.4 | 10.1 | 1.0 | 12.1 |
| Fishery | 49.3 | 33.9 | 40.9 | 31.3 |
| Livestock | 0.5 | 1.2 | 0.3 | 3.8 |
| Business | 2.8 | 6.8 | 8.4 | 8.3 |
| Service | 7.0 | 2.7 | 5.3 | 0.0 |
| Labor | 31.6 | 33.1 | 25.6 | 30.4 |
| Pension | 0.0 | 0.0 | 0.0 | 0.0 |
| Rents | 0.0 | 0.0 | 1.5 | 0.0 |
| Remittances | 0.0 | 1.0 | 0.0 | 1.3 |
| Gift/Cash | 0.3 | 0.1 | 0.6 | 1.2 |
| Other | 6.0 | 11.1 | 16.4 | 11.6 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

they do not get enough time to work therefore contributing less towards overall incomes.

## Household Incomes

Related to key income sources/ occupations, this section presents quantum and distribution of incomes.

Table 16 & 17 shows analysis of mean household and per capita income and the change over evaluation period. According to the data treatment group had better mean household income than the control group at the time of baseline (Rs. 7,115 vs Rs. 5,827). The change in incomes over the period was 9.6 and 7.5 percent for treatment and control groups respectively. Although difference between average household incomes in both groups is trivial, however, if we analyze change in mean per capita incomes we find a significant improvement in project area when compared to control

**Table 16: Average Incomes (Rs.)**

| | Before | | After | |
|---|---|---|---|---|
| | **Treatment** | **Control** | **Treatment** | **Control** |
| Mean HH Income | 7,115 | 5,827 | 7,796 | 6,265 |
| Mean Per Capita Income | 1,148 | 1,214 | 1,257 | 1,253 |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

**Table 17: Change in Income (%)**

| **Rs. per month** | **Before** | | **After** | |
|---|---|---|---|---|
| | **Percent** | **Cumulative Percent** | **Percent** | **Cumulative Percent** |
| <=3,000 | 4.2 | 4.2 | 4.9 | 4.9 |
| 3,001 - 6,000 | 36.1 | 40.3 | 24.6 | 29.5 |
| 6,001 - 9,000 | 40.3 | 80.6 | 47.5 | 77.0 |
| 9,001 - 12,000 | 9.7 | 90.3 | 6.6 | 83.6 |
| 12,001 - 15,000 | 4.2 | 94.4 | 11.5 | 95.1 |
| 15,001 - 20,000 | 1.4 | 95.8 | 4.9 | 100.0 |
| 20,001 - 25,000 | 1.4 | 97.2 | - | - |
| <25,000 | 2.8 | 100.0 | - | - |
| **Total (%)** | **100.0** | **-** | **100.0** | **-** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

group (9.6 percent vs 3.2 percent). If not wholly, a significant part of this change can be attributed to SHSs where women have initiated economic activities and are earning better incomes than their counterparts in control group.

### *Income Groups*

Table 18 & 19 show percentage distribution of households by income groups in treatment and control areas respectively.

Analysis of both the tables shows

**Table 18: Treatment: Income Groups (% HHs)**

| Rs. per month | Before | | After | |
|---|---|---|---|---|
| | Percent | Cumulative Percent | Percent | Cumulative Percent |
| <=3,000 | 4.2 | 4.2 | 4.9 | 4.9 |
| 3,001 - 6,000 | 36.1 | 40.3 | 24.6 | 29.5 |
| 6,001 - 9,000 | 40.3 | 80.6 | 47.5 | 77.0 |
| 9,001 - 12,000 | 9.7 | 90.3 | 6.6 | 83.6 |
| 12,001 - 15,000 | 4.2 | 94.4 | 11.5 | 95.1 |
| 15,001 - 20,000 | 1.4 | 95.8 | 4.9 | 100.0 |
| 20,001 - 25,000 | 1.4 | 97.2 | - | - |
| <25,000 | 2.8 | 100.0 | - | - |
| **Total (%)** | **100.0** | **-** | **100.0** | **-** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

**Table 19: Control: Income Groups (% HHs)**

| Rs. per month | Before | | After | |
|---|---|---|---|---|
| | Percent | Cumulative Percent | Percent | Cumulative Percent |
| <=3,000 | 7.1 | 7.1 | 14.5 | 14.5 |
| 3,001 - 6,000 | 48.8 | 56.0 | 32.5 | 47.0 |
| 6,001 - 9,000 | 33.3 | 89.3 | 26.5 | 73.5 |
| 9,001 - 12,000 | 4.8 | 94.0 | 13.3 | 86.7 |
| 12,001 - 15,000 | 2.4 | 96.4 | 8.4 | 95.2 |
| 15,001 - 20,000 | - | - | 1.2 | 96.4 |
| 20,001 - 25,000 | 1.2 | 97.6 | 2.4 | 98.8 |
| <25,000 | 2.4 | 100.0 | 1.2 | 100.0 |
| **Total (%)** | **100.0** | | **100.0** | |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

general trend of households graduating from bottom to top income brackets when compared in before and after situations. As there is not much difference recorded in mean household income, it is very difficult to figure out which group has performed better in this respect. Nevertheless, one thing can be asserted that there is an overall positive change in household incomes in the area. However, in control group some households have fallen into the bottom income group (<=3,000) as the percentage of such households increased from 7 to 15 percent. On the other hand, households earning above Rs. 12,000 increased from 6 percent to 15 percent. Whereas, in treatment group the transition is more uniform as there is not much change in bottom most group (4.2 vs 4.9 percent). Moreover, significant number of households has graduated to higher brackets from the second group (Rs. 3,001 – 6,000) as during baseline there were 36 percent households in this group which dropped to 30 percent. However, 4 percent households with income higher than Rs. 20,000 slipped in lower brackets.

**Table 20: Food Expenditure (Rs.)**

| Item | Price Rs. | Before | | After | |
|---|---|---|---|---|---|
| | | Treatment | Control | Treatment | Control |
| Wheat | 25 | 286 | 272 | 311 | 277 |
| Rice | 50 | 153 | 280 | 168 | 294 |
| Pulses | 50 | 66 | 68 | 52 | 92 |
| Vegetable | 25 | 74 | 55 | 111 | 141 |
| Fruit | 50 | 36 | 17 | 39 | 15 |
| Beef | 150 | 23 | 9 | 37 | 21 |
| Mutton | 250 | 9 | 27 | 0 | 0 |
| Poultry | 200 | 53 | 114 | 69 | 33 |
| Fish | 100 | 156 | 215 | 256 | 240 |
| Eggs | 6 | 12 | 13 | 16 | 14 |
| Milk | 40 | 116 | 156 | 62 | 147 |
| Sugar | 35 | 108 | 116 | 127 | 113 |
| Oils | 120 | 181 | 190 | 177 | 149 |
| Spices | 50 | 28 | 28 | 22 | 16 |
| Tea | 250 | 129 | 156 | 149 | 155 |
| **Total Expenses (weekly)** | | **1,429** | **1,715** | **1,597** | **1,705** |
| **Total Expenses (monthly)** | | **5,718** | **6,858** | **6,388** | **6,821** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

## Consumption & Expenditure

As a converse of revenues and incomes, the consumption and expenditure patterns of households have been reviewed in the study. Therefore, a comprehensive analysis of household consumption has been presented in the following sections.

### *Food Consumption*

Table 20 depicts the monetary value of household food consumption against each consumed item. In the survey, quantities were asked pertaining to weekly consumption of each food item that were subsequently multiplied by the food prices obtained from the area.

As shown above, in treatment group average household food consumption increased from Rs. 5,718 to Rs. 6,388 at a rate of around 10 percent, whereas, in control group there is little change in the pattern. This change may be attributed to extra increase in mean per capita income in treatment group.

Table 21 presents percentage contribution of each item

**Table 21: Average Food Expenditures (%)**

| Item | Before | | After | |
|---|---|---|---|---|
| | Treatment | Control | Treatment | Control |
| Wheat | 20.0 | 15.9 | 19.5 | 16.2 |
| Rice | 10.7 | 16.3 | 10.5 | 17.2 |
| Pulses | 4.6 | 4.0 | 3.3 | 5.4 |
| Vegetable | 5.1 | 7.2 | 5.0 | 8.3 |
| Fruit | 2.5 | 1.0 | 2.4 | 0.9 |
| Beef | 1.6 | 0.5 | 2.3 | 1.2 |
| Mutton | 0.6 | 1.6 | 0.0 | 0.0 |
| Poultry | 3.7 | 2.7 | 4.3 | 1.9 |
| Fish | 10.9 | 12.5 | 16.0 | 14.1 |
| Eggs | 0.8 | 0.7 | 1.0 | 0.8 |
| Milk | 8.1 | 9.1 | 5.9 | 8.6 |
| Sugar | 7.5 | 6.8 | 8.0 | 6.6 |
| Oils | 12.7 | 11.1 | 11.1 | 8.7 |
| Spices | 2.0 | 1.6 | 1.4 | 1.0 |
| Tea | 9.0 | 9.1 | 9.3 | 9.1 |
| **Total (%)** | **100.0** | **100.0** | **100.0** | **100.0** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

towards overall household food consumption as a percent of total food expenditure for a better analytical insight.

With reference to Table 21, around 30 percent of total household consumption on food is allocated to wheat and rice. Other items consuming most of the household food expenditure are fish, Oils or 'Ghee', milk, and tea. No noticeable change in consumption pattern is observed in both treatment and control over the period of evaluation.

### *Household Expenditure*

Along with food consumption, data on total household expenditures was also collected. Table 22 gives the consumption pattern, of both treatment and control groups.

In overall household expenditure in treatment area an increase of more than 2 percent is recorded. In control group the average household expenditure has dropped by 1 percent.

Table 23 presents the percentage distribution of expenditure by items.

**Table 22: Average Annual Household Expenditure (Rs.)**

| Item | Before | | After | |
|---|---|---|---|---|
| | Treatment | Control | Treatment | Control |
| Food | 68,613 | 82,298 | 76,650 | 81,851 |
| Clothing | 5,426 | 4,848 | 7,372 | 3,430 |
| Housing | 4,094 | 4,013 | 1,180 | 8,169 |
| Health | 7,264 | 10,252 | 5,830 | 9,743 |
| Education | 740 | 229 | 836 | 272 |
| Social Functions | 2,683 | 1,958 | 1,936 | 2,391 |
| Transport | 2,689 | 3,210 | 5,139 | 3,586 |
| Soap/laundry | 2,363 | 2,029 | 3,058 | 2,888 |
| Kerosene | 9,046 | 8,706 | 1,433 | 6,139 |
| Water Tanker | 3,678 | 9,198 | 7,592 | 9,164 |
| Other | 1,891 | 2,279 | 754 | 661 |
| **Total (Rs. per annum)** | **108,488** | **129,018** | **111,781** | **128,294** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

In line with spending patterns of poor households generally, a large proportion of overall household expenditure goes to food. The contribution of household food expense in treatment group increased by 5 percent as a part of overall household expenditure. More than 100 percent rise in expenses related to housing shows that over the period of evaluation, control group has spent more on building and improving household infrastructure compared to treatment group.

The most important aspect that must be highlighted in connection to this study is analysis of use of kerosene oil, which is widely used as lighting fuel in both treatment and control areas. There is an overall decline in expense on kerosene oil in both the areas. There is a decrease of 29 percent in kerosene expense in control group while the decline in treatment area is much higher 84 percent. The decrease in kerosene expense in control area may be ascribed to recently fallen oil prices that were at the peak during baseline. However, it is

**Table 23: Average Annual HH Expenditure: % of Total Expense**

| | Before | | After | |
|---|---|---|---|---|
| | **Treatment** | **Control** | **Treatment** | **Control** |
| Food | 63.2 | 63.8 | 68.6 | 63.8 |
| Clothing | 5.0 | 3.8 | 6.6 | 2.7 |
| Housing | 3.8 | 3.1 | 1.1 | 6.4 |
| Health | 6.7 | 7.9 | 5.2 | 7.6 |
| Education | 0.7 | 0.2 | 0.7 | 0.2 |
| Social Functions | 2.5 | 1.5 | 1.7 | 1.9 |
| Transport | 2.5 | 2.5 | 4.6 | 3.6 |
| Soap/laundry | 2.2 | 1.6 | 2.7 | 2.3 |
| Kerosene | 8.3 | 6.7 | 1.3 | 4.4 |
| Water Tanker | 3.4 | 7.1 | 6.8 | 6.7 |
| Other | 1.7 | 1.8 | 0.7 | 0.5 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

quite obvious that SHS project has contributed significantly towards substantial drop in kerosene expense in treatment area as the use of kerosene oil has dropped considerably.

Another major expense recorded in both treatment and control areas is on health. A significant proportion of household expenditure is allocated to health related problems. The reason cited by the community members during focus group discussions was unavailability of health facilities in the area. There is only one health facility (operated by IET with support from PPAF) operational since last one year or so in this area. The facility is merely sufficient to address primary health issues and people are forced to travel to Karachi for more complicated ailments. As previously mentioned, transport is one of the major problems in the area. Some of the times the patient is taken to

**Table 24: Assets Ownership (Value in Rs.)**

| Type | Before | | After | | % contribution in change | |
|---|---|---|---|---|---|---|
| | Treatment | Control | Treatment | Control | Treat-ment | Control |
| Land | 23,542 | 24,524 | 38,590 | 36,627 | 41.5 | 57.2 |
| Livestock | 4,828 | 3,246 | 5,934 | 4,199 | 3.1 | 4.5 |
| Poultry | 230 | 160 | 139 | 223 | -0.3 | 0.3 |
| Carts | 0 | 0 | 2,787 | 181 | 7.7 | 0.9 |
| House | 44,750 | 46,262 | 58,066 | 52,878 | 36.8 | 31.3 |
| Other Structure | 0 | 238 | 0 | 0 | 0.0 | -1.1 |
| Motorcycle | 2,764 | 1,310 | 3,443 | 313 | 1.9 | -4.7 |
| Bicycle | 63 | 208 | 869 | 0 | 2.2 | -1.0 |
| Sewing Machine | 274 | 173 | 202 | 60 | -0.2 | -0.5 |
| Radio | 108 | 71 | 700 | 17 | 1.6 | -0.3 |
| Savings | 208 | 100 | 246 | 145 | 0.1 | 0.2 |
| Loans | 389 | 127 | 200 | 189 | -0.5 | 0.3 |
| Jewellary | 806 | 238 | 2,210 | 566 | 3.9 | 1.6 |
| Boats | 2,600 | 1,786 | 3,393 | 4,217 | 2.2 | 11.5 |
| **Total (Rs.)** | **80,561** | **78,443** | **116,779** | **99,614** | **100.0** | **100.0** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

the city on a bed tied on the roof of water tanker. People, who can afford, arrange a taxi that charges Rs. 2,000 to Rs. 2,500 one way.

Unavailability of fresh potable water in the area is another problem that leads to extra expenses. As already discussed, fresh water is scarce in the area therefore people have to purchase water tankers for drinking and household use. Around 4 to 7 percent of total household expense are allocated to acquisition of fresh water in both treatment and control groups.

## Household Assets

Possession of assets strengthens the potential of household to bear economic shocks. It is also a powerful indicator of poverty. This section gives an insight of asset possession of treatment and control groups. Moreover, an analysis of change in quantity/worth of assets will also be presented. Sale and purchase of assets has also been recorded and analyzed to have better understandings of economic dynamics.

### *Assets Ownership*

Table 24 shows distribution of worth by asset type and percentage change in the worth over the period of evaluation. Last two columns provide information about how much that particular asset has contributed towards overall change in value of household assets.

On the average there is an increase of 31 percent and 21 percent in asset/asset value over the period. Despite having less average household incomes the control group is slightly better off than treatment group in terms of land ownership. The change in land value is quite significant in both treatment and control group (42 and 57 percent respectively). However, additional 15 percentage point increase of land in control area may be ascribed to extra investment on housing. Moreover, owing to other development projects by PPAF and some donors in the area generally the land prices have gone up recently.

Other than increase land and house values, there is no significant change in other items.

### *Assets Purchased*

Total spending on purchase of assets is presented in Table 25. There has not been much activity recorded during baseline as in a full year assets of worth Rs. 110,550 and Rs. 103,000 were purchased in treatment and control areas respectively.

However, during impact evaluation survey two fold increase in expenditure for purchase of assets in control group has been recorded whereas spending in treatment area was approximately the same. The increase is due to a boat purchased by one individual (worth Rs. 150,000) and it cannot be interpreted as an overall change.

Table 26 gives the percentage distribution of assets purchased during last one year. According to the table most of the amount has been spent on purchase of livestock in treatment group. While in control group, expense on purchasing boat and livestock mainly dominates overall expenditures.

### *Sale of Assets*

Table 27 shows amount obtained through sale of assets and the reason of selling assets.

The assets are mainly sold to meeting expense although borrowing is a common norm in the area. Mostly people sell livestock

**Table 25: Assets Acquired (Last One Year)**

| Asset Type | Before | | After | |
|---|---|---|---|---|
| | Treatment | Control | Treatment | Control |
| Land | 0 | 0 | 30,000 | 0 |
| Trees | 0 | 0 | 0 | 0 |
| Livestock | 42,500 | 31,000 | 19,509 | 57,000 |
| Poultry | 250 | 0 | 0 | 0 |
| House | 0 | 0 | 5,000 | 0 |
| Motorcycle | 42,000 | 10,000 | 45,000 | 26,000 |
| Bicycle | 1,500 | 0 | 0 | 0 |
| Sewing Machine | 10,000 | 0 | 0 | 0 |
| TV/Radio | 1,300 | 0 | 0 | 1 |
| Jewellary | 13,000 | 12,000 | 0 | 0 |
| Boat | 0 | 50,000 | 0 | 150,000 |
| **Total (Rs.)** | **110,550** | **103,000** | **99,509** | **233,000** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

for meeting 'life cycle' needs. However, other items are also sold for but selling assets is not a common practice in both treatment and control areas.

## Loan Transaction & Utilization

Borrowing is a tradition tightly embedded into the cultural norms of the area since ages. As most of the people are dependent on

**Table 26: Assets Acquired (% share)**

| Item | Before | | After | |
|---|---|---|---|---|
| | Treatment | Control | Treatment | Control |
| Land | 0 | 0 | 50.4 | 0 |
| Trees | 0 | 0 | 0 | 0 |
| Livestock | 38.4 | 30.1 | 32.8 | 24.4 |
| Poultry | 0.2 | 0 | 0 | 0 |
| House | 0 | 0 | 8.4 | 0 |
| Motorcycle | 38 | 9.7 | 8.4 | 11.2 |
| Bicycle | 1.4 | 0 | 0 | 0 |
| Sewing Machine | 9 | 0 | 0 | 0 |
| TV/Radio | 1.2 | 0 | 0 | 0 |
| Jewellary | 11.8 | 11.7 | 0 | 0 |
| Boat | 0 | 48.5 | 0 | 64.4 |
| **Total (%)** | **100** | **100** | **100** | **100** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

**Table 27: Assets Disposed (Last One Year)**

| Item | Before | | | | After | | | |
|---|---|---|---|---|---|---|---|---|
| | Control | | Treatment | | Control | | Treatment | |
| | Meeting Expense | Repaying Loan | Meet Expense | Repaying Loan | Meet Expense | Repaying Loan | Meet Expense | Repay-ing Loan |
| Livestock | 3,500 | 0 | 4,500 | 7,504 | 4,000 | 0 | 0 | 0 |
| House | 0 | 0 | 13,000 | 0 | 0 | 0 | 0 | 0 |
| Motorcycle | 0 | 0 | 0 | 0 | 0 | 0 | 12,500 | 0 |
| Bicycle | 0 | 0 | 500 | 0 | 0 | 0 | 0 | 0 |
| Jewellary | 0 | 0 | 0 | 0 | 0 | 0 | 2,400 | 0 |
| **Total (Rs.)** | **3,500** | **0** | **18,000** | **7,504** | **4,000** | **0** | **14,900** | **0** |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

fishing, they continually borrow (esp. for working capital needs) until they manage a trip in the sea and get their catch sold. This cycle often lasts for one month or so. However, when fishing season is off (in June, July and August), the loaning cycle stretches to two to three months. This is the period when boat owners/middlemen play a vital role in sustaining the local economy. They keep on lending for three months and the loan is returned either in cash or in kind (catch). Return in form of catch is preferred by local fishermen as the fish is sold in advance.

Table 28 shows average borrowing by the households in treatment and control areas. During baseline the amount of loans borrowed and payable are high as it was the beginning of off season for fishing. However, during impact it has nearly halved as in February when the impact evaluation was done, fishing season is at its peak. However, dealing with loaning system for ages, households very efficiently manage and return the loans and do not allow it to go beyond debt capacities.

Among major lenders are middlemen and boat owners that often employ the local fishermen on their boats for fishing labor. This is most important source of financial assistance especially during off season for local fishermen and they consider it vital for their survival.

**Table 28: Type of Borrowing**

| Sources | Before | | | | After | | | |
|---|---|---|---|---|---|---|---|---|
| | Treatment | | Control | | Treatment | | Control | |
| | Borrowed | Owed | Borrowed | Owed | Borrowed | Owed | Borrowed | Owed |
| Friends | 708 | 583 | 905 | 98 | 746 | 582 | 265 | 831 |
| Shopkeepers | 229 | 201 | 857 | 595 | 1,352 | 246 | 343 | 209 |
| Banks | 2,083 | 2,083 | 4,064 | 4,064 | 0 | 0 | 0 | 0 |
| Middlemen | 4,244 | 2,023 | 1,750 | 1,488 | 1,482 | 1,689 | 2,771 | 2,500 |
| Land owners | 278 | 278 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other | 0 | 0 | 583 | 314 | 311 | 574 | 398 | 123 |
| Total (Rs.) | 7,543 | 5,168 | 8,159 | 6,560 | 3,892 | 3,091 | 3,777 | 3,663 |

Source: PPAF SHS Project: Baseline and Impact Survey 2008 & 2009

Moreover, during off season some well-off boat owners take loans from banks for boat repairs and nets. Therefore, during baseline the second largest in treatment and first largest source of lending in control group are banks. Shopkeepers, friends and relatives are the other significant sources of funding.

When overall loaning patterns were analyzed it was revealed that on average control group has slightly more tendency towards borrowing.

As far as repayment is concerned, there are constantly ongoing cycles of loans as people keep on borrowing and repaying. Therefore, if examined at any point of time the amount borrowed and owed will approximately be the same. Notwithstanding, there is sufficient evidence to suggest that amount of loan borrowed and payable closely proximate the fishing season and middlemen/boat owners are the major lending sources in the area.

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# Annexure I

**Characteristics and Cost Analysis of Renewable Technologies**

| Technology | Typical Characteristics | Typical Energy Costs (U.S. cent/kilowatt-hour) |
|---|---|---|
| | | |
| **Power Generation** | | |
| Large hydro | *Plant size*: 10 megawatt (MW)-18,000 MW | 3-4 |
| Small hydro | *Plant size*: 1-10 MW | 4-7 |
| On-stove wind | *Turbine size*: 1-3 MW<br>*Blade diameter*: 60-100 meters | 5-8 |
| Off-stove wind | *Turbine size*: 1.5-5 MW<br>*Blade diameter*: 70-125 MW | 8-12 |
| Biomass power | *Plant size*: 1-20 MW | 5-12 |
| Geothermal power | *Plant size*: 1-100 MW Type: binary, single- and double-flash, natural steam | 4-7 |
| Solar PV (module) | *Cell type and efficiency*: single-crystal 17%; polycrystalline 15%; amorphous silicon 10% thin film 9-12% | - |
| Rooftop solar PV | *Peak capacity*: 2-5kilowatt-peak | 20-80* |
| Concentrating solar thermal power (CSP) | *Plant size*: 50-500 MW (trough), 10-20 MW (tower); Typ: troug, tower, dish | 12-18* |
| | | |
| **Hot Water/Heating** | | |
| Biomass heat | *Plant size*: 1-20 MW | 1-6 |
| Solar hot water/heating | *Size*: 2-5 $m^2$ (household); 20-200 $m^2$ (medium/multi-family); 0.5-2 MWth (large/district heating); *Type*: evacuated tube, flat-plate | 2-20 (household)<br>1-15 (medium)<br>1-8 (large) |
| Geothermal heating/ cooling | *Plant capacity*: 1-10 MW; *Type*: heat pimps, direct use, chillers | 0.5-2 |
| | | |
| **Biofuels** | | |
| Ethanol | *Feedstock*: suger cane, suger beets, corn, cassava, sorghum, wheat (and cellose in the future) | 25-30 cents/liter (suger)<br>40-50 cent/liter (corn)<br>(gasoline equivalent) |
| Biodiesel | *Feedshock*: soy, rapeseed, mustard seed, palm, jatropha, or waste vegetable oils | 40-80 cent/liter<br>(diesel equivalent) |
| | | |
| **Rural (off-grid) Energy** | | |
| Mini-hydro | *Plant capacity*: 100-1,000 kilowatt (kW) | 5-10 |
| Micro-hydro | *Plant capacity*: 1-100 (kW) | 7-20 |
| Pico-hydro | *Plant capacity*: 0.1-1 (kW) | 20-40 |
| Biogas digester | *Disgester size*: 6-8 cubic meters | n/a |
| Biomass gasifies | *Size*: 20-5,000 kW | 8-12 |
| Small wind turbine | *Turbine size*: 3-100 kW | 15-25 |
| Household wind turbine | *Turbine size*: 0.1-3 kW | 15-35 |
| Village-scale mini-grid | *System size*: 10-1,000 kW | 25-100 |
| Solar home system | *System size*: 20-100 watts | 40-60 |

*Source*: REN, 2007


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