Energising Development - Final Technical Report

Bangladesh

Project title	Promotion of Renewable Energies in selected rural areas of Bangladesh
Project country	Bangladesh
Project contract number	2002.2129.1
Project period	09/05 – 02/07
DGIS Funding	2,200,000 EURO (Annual Planning 2005) 1,750,000 EURO (Annual Planning 2007; 450,000 EURO will be shifted to the second Phase)
Total disbursement until 31.05.2008	1,740,000 EURO (remaining funding of 460,000 EURO wil be shifted to the 2. Phase) 1,716,660 Euro (amount disbursed to IDCOL; does not include other costs incurred by GTZ)

May 2008

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1 Summary of project proposal

1.1 Summary

Energy services provided (fields of activity)	Rural Electrification (Distribution of Solar Home Systems (SHS))
Planned outcomes (number of people with access to energy)	<u>Annual Planning 2005 (AP05)</u> 1. Energy for Lighting/ Household Applications: **225,500** 2. Energy for Cooking: **0** 3. Energy for Social Infrastructure **45,000** 4. Energy for Productive Use: **5,640** **Total: 276,140** <u>Annual Planning 2007 (Re-Planning) (AP07)</u> Decrease of outcome due to shortage of original project period (End Date Annual Planning 2005 = 12/07; Re-Planning 2007 = 02/07); Shortage of project period because of the start of the 2. Phase) 1. Energy for Lighting/ Household Applications: **151,475** 2. Energy for Cooking: **0** 3. Energy for Social Infrastructure **2,660** 4. Energy for Productive Use: **3,787** **Total 157,922**
Planned key interventions and expected outputs	1. Installation and Financing of SHS by POs (**41,000** AP05; **27,540** (AP07))

	2. Installation and Financing of SHS in social institutions (500 solar water heater AP05; Solar Home Systems AP07)
Cost efficiency - costs per person: - cost per system:	• Average: 9.4 Euro per person • 51,7 Euro per system (1,740,000 / 33,660) • 51 Euro per system disbursed to IDCOL

2 Key interventions and outputs

2.1 Key Intervention 1: Installation and Financing of SHS by POs

With the aim to contribute to the commercialisation of SHS dissemination the following interventions were done by the Partnership Project.

- Provision of funds for buy-down grants and institutional development grants for participating organisations for the sale of SHSs (50 Wp, four lamps)
- Provision of funds for management and monitoring of the use of the refinancing loans and grant components by IDCOL
- Funding of capacity building and business development support for participating organisations like NGO and micro-financing institutions to widen their outreach capacities in rural areas
- Facilitation of provision of electricity for schools and clinics

Output

	Expected Output (AP05)	Expected Output (AP07)	Realised Output	Difference (AP07-Realised Output)
Installed SHS	41,000	27,540	33,660	6,120
Inspection of Installed Systems	25,000	25,000	25,000	0
Training of POs and customers	10/10	10/10	10/0	0/10

Interventions have been very successful. KfW and World Bank are supporting IDCOL further. The intervention methodology is remaining the same. The household level dissemination is progressing very well. With DGIS fund, a sum of 51 € per SHS sold has been provided to IDCOL. From this 51 € per SHS, IDCOL transfers 30 € per SHS to the POs as a buy down grant for the systems and another 8 € per SHS as development grant for the PO. The remaining 13 € per SHS keeps IDCOL for its own administrative and monitoring activities.
A typical SHS with 50 Wp costs in Bangladesh about 320 €. Consequently the subsidised system costs about 290 €. Customers have to make a down payment of 15% (or more if capable) which would be about 44 € in this case. The remaining 246 € is financed by the PO and paid by the customer over 24 -36 months in monthly installments, whereby a service charge of 6% is being collected. The PO usually receives a long-term refinancing credit from IDCOL for about 80% of the required finance (in this case 80% of 246 € = 197 €). The payback of this long-term credit starts after 10 years.

Explanation on difference between planned and realised

Annual Planing 2005 compared with realised Output:
The real project period (July 2006 – February 2007) was considerably shorter than planned (November 2005 – December 2007). IDCOL received funding from other sources till June 2006. As such the project could start only in July 2006. Secondly, PURE project of GTZ ended in February 2007. Because of formal reasons, the EnDev project had to be ended at

the same time,i.e. on 28 February 2007. The resulting project period was July 2006 – February 2007.
Installation of SHSs in social institutions could not be realized as originally planned. The main obstacles of SHS dissemination in social institutions are: (a) higher consumer level costs of systems in comparison to grid electricity, even in comparison to diesel based power, which are subsidized, (b) most of the schools and health clinics are operating during the day time. As such, they do not generally need electricity for illumination. Rural off-grid health clincis are mostly served with vaccines from nearby towns, where grid-electricity is available. Only in few cases PV is used. Since these clinics are government owned and any decision of procurement is made by the government centrally, decision of adopting PV refrigeration is beyond the capacity of local clinic staffs. NGO operated rural health clinics can hardly afford PV refrigeration and other services. Because of these, during the redesign of the project in 2006, the target for social institutions was set to Zero.
Annual Planning 2007 and Realised Output:
At the project initiation, it was assumed that the installation rate would not slow down in the short term. It has proved that the assumption was correct. In fact, the installation rate has further increased. This is at least to a small extent attributable to the unreliable power supply situation of the country.
Even though planned, IDCOL did not conduct any customer trainings during the time of GTZ's intervention, as IDCOL officials did not feel the need for these trainings. They refered to the fact that customers were introduced to the functioning of the SHS by the PO staff setting up the system. However, for the next project phase of GTZ's energy programme, GTZ plans to increase its support for organised customer trainings by IDCOL.

2.2 Installation and Financing of SHS in social institutions

New concepts for making PV power available to social service providers were searched for. The piloting of the concept "computer education in rural schools through PV power" has been initiated in two high schools. These projects are not co-financed from the DGIS fund. In one school, 220 students, school management (administrational works, teaching and examination material preparation are being done) and 700 local people benefitted. In the other case, 300 students and school management (administrational works, teaching and examination material preparation are being done.) were provided with electricity. The pilot measures in the schools have shown that computer education and operation in non-power grid area is possible.
The main obstacles of SHS dissemination in social institutions are: (a) high cost of systems, (b) most of the schools and health clinics are operating during the day time. As such, they do not generally need electricity for illumination. But, for using computer and other modern technologies, electricity is necessary. Most of the remote area health clinics are served with vaccines from nearby towns, where electricity from the grid is available. Since these schools and clinics are mostly government owned, any decision on procurement is made centrally by the government. Local school or clinic authorities may hardly be able to influence the decision.
GTZ-PURE has piloted solar systems successfully in two schools. However, the willingness of the school authorities for payment could not be proved. In both cases the complete systems, including computers and PV systems were provided to the schools for free. The viability of the concept under commercial conditions could not be verified.

3 Outcome

Number of people with access to energy per energy service type

House Hold Applications	Energy for Cooking	Energy for Social Infrastructure	Energy for Productive Use
185,130			4,618

How was the information gathered?

Data on the number of installed systems was available through regular monitoring reports submitted by IDCOL. IDCOL is collecting information on the progress of SHS installation directly from the POs. Furthermore, IDCOL inspectors checked 25,000 of the 33,660 installed systems on site.
The figures for productive use are based on impact studies of IDCOL and GTZ as well as estimations from POs in the field.

Basic information about calculation (compare Annex: Updated Baseline)

The Number of persons reached by SHS is calculated by the Number of systems sold (as a system is normally used by one family) and the household size:
33,660 (SHS =HH) * 5,5 (HHS) = 185.130 persons.

In Bangladesh, solar systems for productive use are not directly disseminated. However, impact studies from IDCOL and GTZ revealed that SHS are used for productive purposes as well. An average of 10% of the HH use their systems as well in productive manner generating about 25% of the HH income. Therefore a share of 2.5% of the disseminated SHS are counted as well in the category of productive use.
185,130 person * 2.5% = 4,628 persons.

Estimation about sustainability of the outcome (How many people are going to still have access to modern energy services in 2015?)

The estimated technical lifetime of a SHS is about 20 years. Maintenance and after-sale service are provided free of charge within the first three years after purchase. During this time the systems are regularly checked by PO staff while collecting the monthly installments. After the three years payback period, maintenance is provided by the POs for a minimal monthly fee. As SHS users are owners of their systems, motivation to keep the system running will be high. As there are no further monthly installments after the payback period, the payment of a small monthly service fee as well as the replacement of the battery every 5 years will not be a major financial obstacle. It is expected that most SHS will still be in use in 2015. Medium term developments will be monitored by the following project phase.

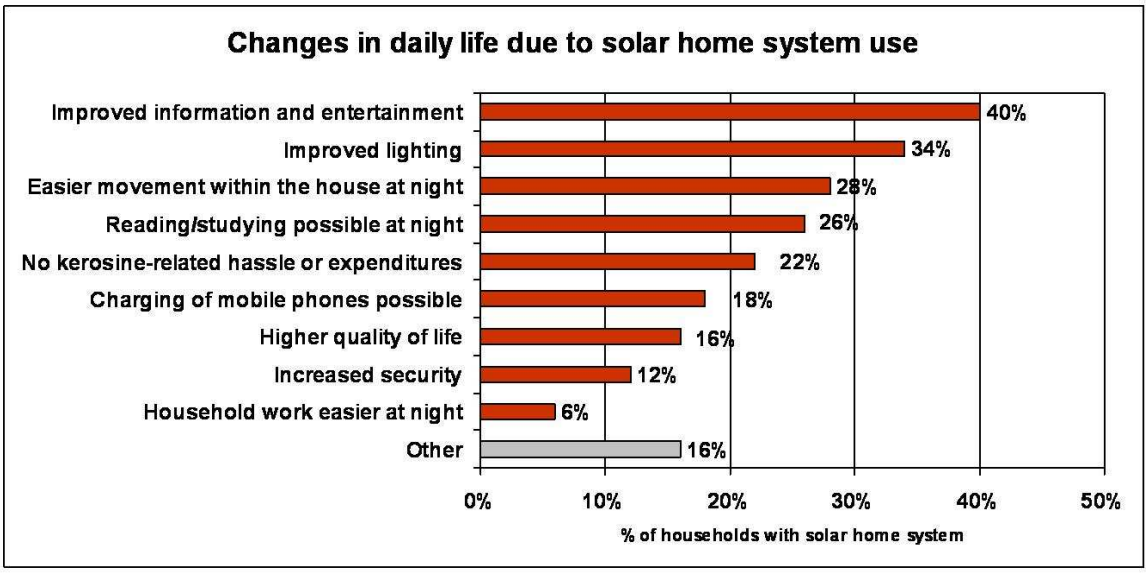
Explanation on the difference between planned and realised
Annual Planning 2005 and Realised Output:
The real project period (July 2006 – February 2007) was considerably shorter than planned (November 2005 – December 2007).
Annual Planning 2007 and Realised Output:
The rate of installation of solar home systems has increased over the project period which indicates that more and more people are getting access to modern energy and are prepared to pay for the systems. However, installation of solar systems in social institutions could not be realized as originally planned. The main obstacles of SHS dissemination in social institutions are: (a) higher consumer level costs of systems in comparison to grid electricity, even diesel based power, which is subsidized, (b) most of the schools and health clinics are operating during the day time. As such, they do not generally need electricity for illumination. Rural off-grid health clincis are mostly served with vaccines from nearby towns, where grid-electricity is available. Only in few cases PV is used. Since these clinics are government owned and any decision of procurement is made by the government centrally, decision of adopting PV refrigeration is beyond the capacity of local clinic staffs. NGO operated rural health clinics can not afford PV refrigeration.

4 Sustainability

	Sustainability criteria	Remarks and Action to be taken	status at reporting date
1	Prices/Tariffs cover investment and running costs and create profit	Annual account of POs show profit in the field of SHS.	fulfilled
2	Final price/tariff meets purchasing power of target consumers	Expectation is mostly fulfilled.	fulfilled
3	power supply is stable in areas with grid extension	Supply of grid power is not stable and reliable.	not relevant
4	Long term viability of products without subsidies	Expected to be viable with lower costs of SHS components, better quality of products and services.	fulfilled
5	High share of consumers pay for services	Recovery rate above 90% (Semiannual Information Sheet)	fulfilled
6	Providers/producers have business skills	At least all local office managers have got at an IDCOL training (Semiannual Information Sheet)	fulfilled
7	Production/operation of service is well managed	as above in 6.	fulfilled
8	Providers/producers have sufficient technical skills	Problems identified by IDCOL inspection staff are mostly solved at next visit of staff (Semiannual Information Sheet)	fulfilled
9	Quality control of services and products is ensured (Service and warranty will be part of every contract)	Documented in reports and minutes by IDCOL (Semiannual Information Sheet)	fulfilled
10	After-sales service exists, Warranty system is working	Defect parts replaced within a reasonable time (Semiannual Information Sheet)	fulfilled
11	Maintenance of product/services is ensured	At least 1 technician per local office (Semiannual Information Sheet)	fulfilled
12	Continuing demand for SHS (implying also an awareness of the benefits by the users)	Market is growing and won't decline in the near future according to experiences of POs - unless there are supply problems for PV panels in the international market	fulfilled
13	Additional income is created by productive units	Additional income is mainly limited to shops and businesses; income generation activities at homes are not very significant.	fulfilled
14	A part of the repayments is covered by savings due to the SHS	No further measures are necessary.	fulfilled

5 Impacts

A study conducted in 2006 revealed detailed information on benefits occurring through the use of solar electricity. Electric lighting was stated as the most important benefit of SHS by the interviewed households. Before the advent of electricity, lighting was mainly based on kerosene lamps that provided only dim lighting in the evening hours. In contrast, electric tube lights offer significant advantages. School children benefit from improved conditions for reading and studying: by average, children in households with solar lighting study 20 per cent longer than their counterparts in non-electrified households. Women perceive electric lighting at night positively, as it makes their household work easier and gives them the opportunity to move freely throughout the house. Furthermore filthy work - such as the filling of kerosene lamps - can now be avoided and indoor air pollution as well as the risk of hazards are reduced. The interviewed members of solar households feel safer in the evening due to improved lighting and thus, a decreased risk of robbery and theft. Social gatherings in the evening hours occur more often in households with solar home systems due to better lighting and TV facilities.



The advent of solar electricity significantly improved conditions for information and communication in rural areas. As illiteracy is prevalent, TV is often the first possibility for villagers to receive national and international news. Educational programs such as alphabetisation or health programs are regularly watched by most households with TV; agricultural programs are perceived as a useful source of knowledge. The wide use of mobile chargers enables an increased number of rural people to use mobile phones and benefit from improved communication facilities. Benefits through improved information and communication facilities are not only limited to the owners of solar home systems. The study revealed that neighbours from non-electrified households regularly visit electrified households to watch TV or charge their mobile phones. Hence, even poorer households which cannot afford a system for their own, indirectly benefit from solar home systems in other households of the same village. In bazaars, shopkeepers frequently use solar systems to power TVs and radios, as well as to better light their products. Due to these services, they reported an increased number of attracted customers. Furthermore customers tend to stay longer in the shops to watch TV and thereby spend more money for tea and snacks. The majority of shops utilising a solar home system reported to have an increased income due to the use of electricity.

5.1 Poverty (income and jobs created)

Income-generating activities due to electricity use were not yet very prevalent. It was observed that in many cases, as most SHS households already had relative high incomes, they preferred using their additional evening time for entertainment activities instead of income-generation. Low-income households that probably would have gained the biggest relative income benefits from longer working hours were at the same time the ones that could not afford the purchase of a SHS.

Across the board, all interviewed shops reported an increase in income during the last three years, irrespective of SHS ownership. However, all businesses using a SHS confirmed improved customer appeal and therewith-higher income due to the availability of electricity. They stated four main reasons for this development:

- Attraction of a new clientele
  Electric lighting provided improved illumination of the goods and services for sale, attracting more customers to the electrified shops in the evening. Furthermore, the availability of TVs was another factor, pulling new customers to electrified shops.
- Higher income from regular customers
  As many households do not own a television set, a lot of people gather in front of electrified shops at night to watch TV. Thus, customers tend to stay longer in shops with TV, spending more money on drinks and snacks.
- Diversification of offered services
  Solar electricity enabled one shopkeeper to offer new electricity-based communication

services, such as telephone facilities and mobile phone charging. It was stated, that these services provided a good additional income.

- Longer working hours
  One tailor shop with SHS emphasised the advantage of being able to work for longer hours in the evening. The electric lights provided the necessary high quality lighting for the tailoring work at night. As the local bazaars were most active during the evening, the tailoring shop was now able to open during that time and therewith enlarge his clientele.

Jobs of 1500 employees of POs directly depend on the project. Another 150 jobs were created for the people engaged in production of batteries, charge controllers, lamps, wires, etc. Indirect employment for about 200 persons (for transport of products, etc.) was also created.

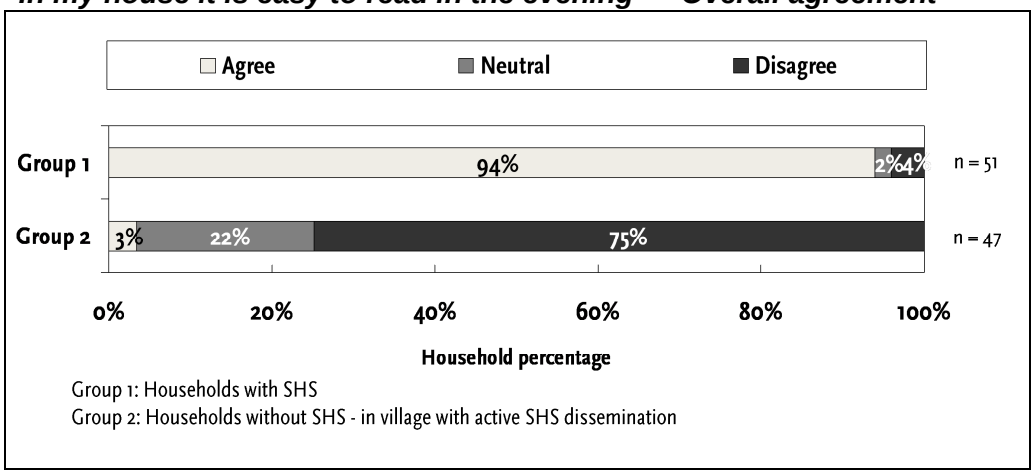
5.2 Health

Some interviewed respondents on household level pointed out that the indoor air of their homes felt fresher to them, as smoke and emissions from kerosene lamps were now avoided. Whether the absence of kerosene emissions will lead to a long-term improved health situation due to a decrease in incidence of respiratory or eye diseases could not be evaluated. For the moment, after the three years of SHS dissemination in the surveyed villages, no difference in the occurrence of respective diseases between SHS and non-SHS households could be observed. Many households stated to regularly follow programmes on radio and TV related to health issues therewith increasing their knowledge base on topics such as prevalent diseases or hygiene. In the long-term, increased awareness could result in an overall improved health situation. Even though generally not very prevalent, the risk of accidents from kerosene use (e.g. burns, fires) was considerably reduced due to the sparse usage of kerosene in SHS households. Solar-electrified health institutions were not yet very prevalent. The potential of solar technology for the improvement of respective facilities, however, seems to be high, especially with regard to vaccine refrigeration. Even though not resulting in an immediate improved health situation, improved indoor air, and increased awareness on health issues as well as reduced accidents due to kerosene use are factors probably contributing to overall improved health in SHS-households on a long-term basis.

5.3 Education

Overall, the diffusion of SHSs in rural schools is quite low; a result of very limited needs for electricity. As most classes were predominantly running at daytime, lighting as such was not an urgent necessity. Furthermore, as there were no community-based approaches for school electrification existent in most SHS dissemination programmes, there was yet no viable option for the large-scale financing of SHSs for schools in sight. However, individual systems already installed in rural schools showed some potential benefits. SHSs were described as having the potential for lighting on cloudy days during the monsoon as well as providing the possibility of holding evening classes e.g. for adult education. Furthermore, children enjoyed the convenience of fans during the hot summer months. Improved conditions for children's studying were mentioned by many households to be an important benefit.

"In my house it is easy to read in the evening" – Overall agreement



The survey revealed a significant higher agreement with the statement "In my house it is easy to read in the evening" for SHS households compared to non-SHS households in the same respective villages, indicating superior quality of reading and studying activities.
The overall time spent on studying per evening was on average 21 minutes longer in SHS-households (133 minutes) in contrast to households without solar electricity (112 minutes) in the same village. Interviewees confirmed that improved lighting conditions seemed to motivate rural school children to spend more time studying, whereas children working under the light of kerosene lamps were not tempted to exceed education-related activities. This seems to be understandable as reading with the aid of kerosene lamps was described to be very straining on the eyes. Even though the impacts from electrified educational institutions remain very low due to their low prevalence, the educational situation of rural households seems to have improved with the advent of solar electricity. Especially the children in SHS households benefited from improved electric lighting for their studying, causing longer overall studying hours of more than 20% for children in solar-electrified houses compared to children from other households in the same village.

5.4 Environment

Whereas non-SHS households used on average 3.2 litres of kerosene per month, SHS households had reduced their monthly kerosene consumption on average by 80% to 0.6 litres per month. With a kerosene CO_2 emission factor of 2.4 kg/litre, this equals a monthly replacement of 6.24 kg CO_2 equivalent. One SHS in the study area therewith induces emission reductions of about 1.5 tonnes of CO_2 equivalent from kerosene use during its operating life of about 20 years. For comparison, this amount of CO_2 is emitted by one medium size car travelling a distance of about 7,600 km.
An aspect frequently addressed when relating to potential negative effects of SHS dissemination is the battery disposal practice. As the batteries in use have a limited lifetime, they need to be replaced about every five years. In fact, when referring to the current state of the IDCOL programme in Bangladesh, it is imaginable that an uncontrolled disposal of 100,000 batteries every five years would represent an enormous risk of soil contamination and underground water pollution. Most experts involved in the SHS programmes shared this impression. Throughout the interviews with local SHS experts, potential battery-related waste problems were stated as the only negative impact of the SHS dissemination programme. To limit negative effects on the natural environment, IDCOL has specified for all POs that batteries reaching the end of their lifetime have to be collected from rural customers and returned to the battery manufacturer for recycling purposes. The biggest manufacturer of SHS batteries in Bangladesh – Rahimafrooz – stated to have enough recycling capacity for the total amount of batteries to be returned within the coming years. However, the complete collection of all batteries from the villages is seen as a more challenging task. As most disseminated SHSs are not yet more than five years old, there have been no previous experiences with the willingness of SHS-owners to return their old batteries. To assure complete collection of old batteries, most POs offer small amounts of money for the return of used batteries to their respective offices.

5.5 Gender

When asked about the household members benefiting most from the SHS, many respondents referred to all household members benefiting equally. However, women were stated to be the main beneficiary or part of a group of beneficiaries in 88% of SHS households. This figure was 55% for men and 59% for children respectively. The decision to quote women was mostly reasoned by the fact that they worked most of their time at home, thereby benefiting most from improved lighting for household work as well as from avoidance of kerosene-related hassle. Children were stated to benefit from improved conditions for reading and studying.

Information for the previous paragraphs based on a survey in 178 households conducted in October 2006. For more detailed information:
BLUNCK M. (2007): Electricity and Sustainable Development: Impacts of Solar Home Systems in Rural Bangladesh. Mainz.

6 Lessons learnt

6.1 Key changes compared to the project plan; what is the nature and reasons for the changes

There has been no key change compared to the project plan.

6.2 Other relevant results/spin off (positive or negative)

Besides KfW, World Bank has come forward to provide more support to SHS program. It is expected that the present market development phase for SHS will come to an end by 2009 and the market will be able to sustain itself.

6.3 What constitutes success

The pillars of great success of SHS in Bangladesh are (1) the vicinity of service centres to the consumers, (2) micro-financing system of payment, and (3) intensive monitoring of the progress.

6.4 Problems encountered

The rise of the world market prices of SHS components has caused higher prices for systems. It is difficult for the POs to cope with the situation. The consumers of SHSs are irritated by price changes.

6.5 Strength and weakness of project

Strength: The main strength of the project is the targeted grant: buy down grant, grant for institutional development and grant for fund management and monitoring. Buy down grant enables the reduction of consumer level cost. Grant for institutional development helps the participating NGOs in developing their infrastructure. The fee for fund management and monitoring work enables IDCOL to monitor the progress closely and guarantee quality standards.
The long-term credit for refinancing the systems as provided by IDCOL enables the POs to maintain a healthy cash flow and expand their business.
The institutional capacity of IDCOL is a great strength for the project. The project implementation procedure is transparent and POs and IDCOL are accountable for their respective jobs.
Weakness: Under the project IDCOL supports till date only SHSs with PV generator capacity greater than 30Wp. Because of this the poorer sections of the population, which cannot afford the systems offered, have a problem to get access to SHSs. Pilot projects undertaken by GTZ-PURE have shown that there is substantial demand for smaller system. DGIS will now co-finance the GTZ initiative of installing SHSs smaller than 30Wp. Based on the

experience made by GTZ-PURE IDCOL appears to be willing to provide support for small solar home systems.

6.6 Main lessons learned

- Appropriate financial scheme put in place has made the project a successful one.
- Establishment of reasonable equipment standards and certification procedures for solar home system components is necessary to ensure quality service while maintaining affordability.
- Close monitoring of the progress is important.
- Having micro-financing and installation and maintenance in one hand is an important factor that contributes to the success of the SHS dissemination. The marketing is also easier.
- Local micro-finance organizations are capable to carry on with the SHS project as long as they retain skilled personal for installation, operation and maintenance of SHS.
- Capable and operational offices in the vicinity of the consumers are important for proper installation and maintenance services.

6.7 Recommendations to GTZ/BMZ/DGIS

- GTZ/BMZ/DGIS should undertake an independent study on the impact of the project.
- BMZ/DGIS can provide support for smaller SHSs. This is already in place and the project will start soon.

7 Annexes

Annex Updated baseline

Type of outcome	Number of people with access				Financial contribution			
	At project start	At project end	Not attributable to EnDev	Result of EnDev	Financial contribution DGIS	Other financial contributions	DGIS share of total costs %	DGIS share in number with access
Number of people with hh energy	0	185,130	0	185,130	1,716,660	0	100	185,130
Number of people with improved cooking stoves								
Number of people with energy in social infrastructure								
Number of people with energy for productive use	0	4,628	0	4,628	Part of the Cost mentioned above			

Calculation method for lighting/household application:
Number of households (HH) electrified * household size (HHS)

The Number of persons reached by SHS is caculated by the Number of systems sold (as a system is normally used by one family) and the householdsize:
33,660 (SHS =HH) * 5.5 (HHS) = 185.130 persons.

During the planning a certain dissemination even without the project intervention has been anticipated, thus a possible winfall gain factor has been discussed reducing the attributable number by 185.130 *(0.39) = 72,200 persons to 112,930.

Calculation method for cooking: not relevant

Calculation method for social infrastructure: not relevant

Calculation method for productive use:
In Bangladesh solar systems for productive use are not directly deseminated. Impact studies from IDCOL and GTZ show that SHS are used for productive purposes as well. An average of 10% of the HH use their systems as well in productive manner generating about 25% of the HH income. Therefore a share of 2.5% of the deseminated SHS are counted as well in the catagory of productive use.
185,130 person * 2.5% = 4,628 persons.
(1,815 persons could not be attributed to Endev in case of inclusion of a winfall gain factor of about 0.39 resulting in 2,813 persons)