

Subsidy In Solar Homes Systems In Bangladesh

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Background

- The IDCOL has been implementing a program on solar home system (SHS) since 2003 in the off-grid regions of rural areas of Bangladesh.
- Around 50-60 thousand SHSs are being installed every month under the Program. So far, a total of 3.41 million SHS have been installed.
- The program aims to enhance the socio-economic life of rural people of Bangladesh by increasing long study hour for students, allowing women empowerment, developing village entrepreneurs, reducing health and environmental hazards and so on (Khandker et al. 2014)
- The IDCOL has been providing concessionary credit support and subsidy/grant to the POs for implementing the program and motivating the potential adopters with occasional revisions.
- When the IDCOL program first started in 2003, the capital buy-down grant was \$90 per system. Over time, the subsidy has been gradually reduced to the current level of \$20/SHS applicable to only smaller systems ($\leq 30\text{Wp}$).

Background (contd.)

- In the backdrop of subsidies available only for smaller systems, sales of those systems have been increasing very fast with average year on year growth rate 81%. Monthly installation rate of small SHS installation is more than 65% of total installation

Table : Phasing out of subsidy on SHS:

	2003-4	2004-5	2006-7	2008-9	2010-11	2012-13	2013-14
Capital Buy down grant (\$)	70	55	40	40	25	25	20
Institutional capacity development Grant (\$)	20	15	10	5	3	0	0

Objectives of the Study

- *Analysis of current subsidy mechanism of IDCOL:*

The study provides an insight on how the benefits of subsidy component is passed through to the households by the POs and suggest if the current mechanism and rate of subsidy are satisfactory or not

- *Determine impact of further reduction of subsidy given the objective of commercialization*

The study is expected to suggest how to reduce the subsidy further considering the objective of commercialization, current market demand, household's affordability and other impacts and what would be the optimal time for this reduction.

Methodology: Analytical Aspects

- From HH Perspectives

- Estimation of price elasticity of demand,
- Willingness to pay and consumer surplus and
- Changing pattern of demand
- Estimating Internal Rate of Return with/without subsidy

- From POs Perspective

- Rate of return of POs,
- Operational aspects and management of SHS
- Estimates/simulations have been done considering different scenarios of incentive structure for POs

Methodology: Sampling strategy

- **Survey of HHs:** A total of 517 HHs were surveyed from 10 districts of 7 Divisions.

Division	District	Upazila	Sample Villages		POs	Total Sample
			Treated Control combined	& Sample Households		
7	7	14	21	21*22 = 462	47	517

- **Survey of PO:**

About 45 POs are now operating under the IDCOL's SHS program. All the 45 POs were communicated with a structured questionnaire through e-mail and personal visit. Of them, only 30 POs have finally responded. However, we have collected audited financial statements of all 45 POs from IDCOL to assess their financial viability.

Poverty Status of HHs

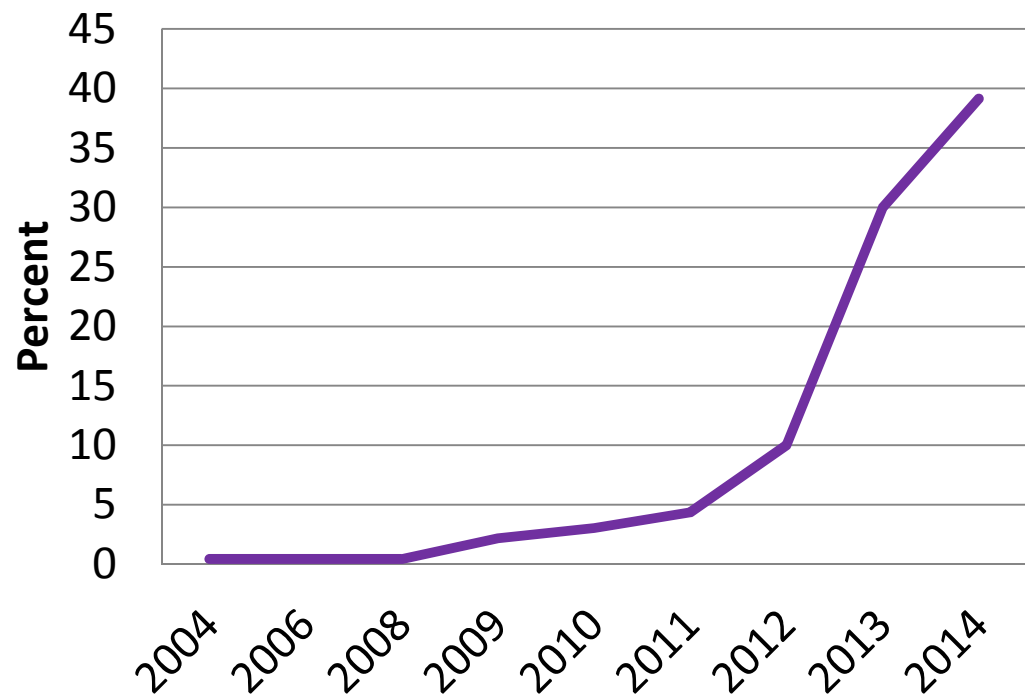
Table : Percentage of HHs below the (upper) poverty line

District	Capacity of the SHS system		
	10Wp	20Wp	30Wp
Overall	84.21	74.32	81.03
Barisal	100.00	45.45	44.44
Satkhira	0.00	48.28	50.00
Natrokona	60.00	100.00	83.33
Sunamgonj	100.00	100.00	92.31
Pabna	0.00	83.33	100.00
Kurigram	0.00	72.73	90.00
Noakhali	80.00	100.00	90.00

Demand for SHS

- The demand for SHS has been increasing significantly over time.
- While less than 1 percent of the respondents (households) adopted SHS in 2004, it has increased to near 40 percent in 2014

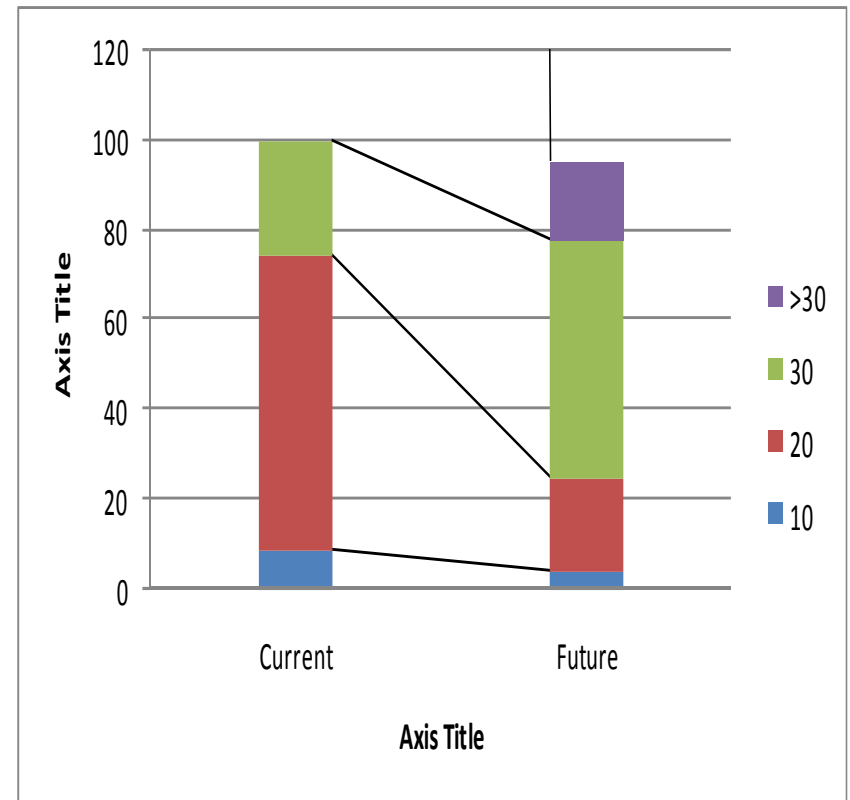
Figure: SHS adoption by year from sample data



Demand for SHS: Change in demand pattern

- The findings suggest that most of the existing adopters are willing to adopt higher watt-peak SHS if they need to replace the current one irrespective of higher prices.
- The most preferred capacity is 30Wp because it allows one to operate television in addition to basic necessity of lights .
- This indicates that there is a higher demand for higher-capacity Wp SHS considering its welfare impact in the rural off-grid areas among the existing users.

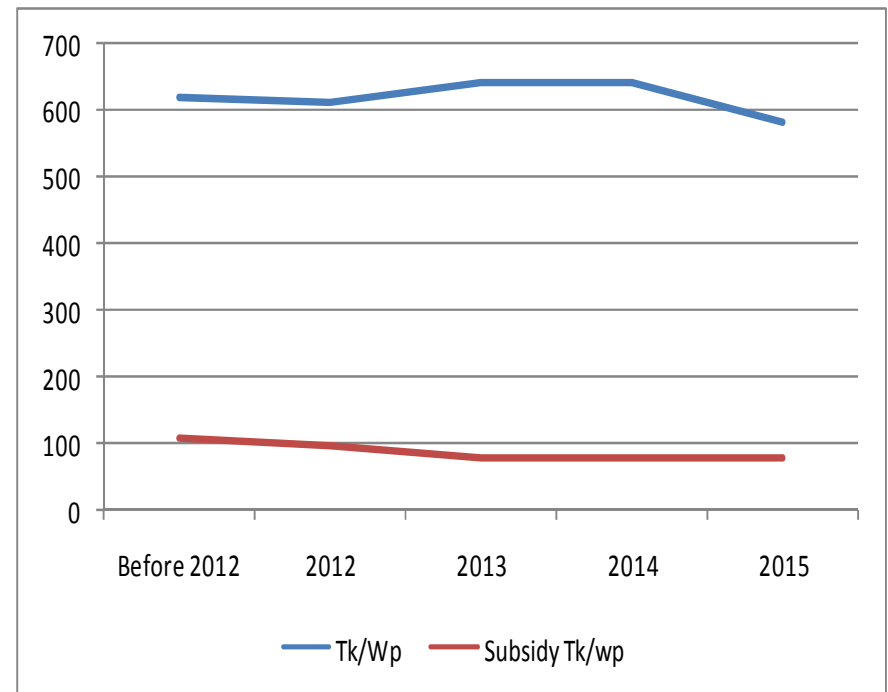
Figure: Change in demand pattern



Subsidy reduction and Pricing Pattern of SHS

- The impact of subsidy reduction has been reflected in price escalation of SHS. That is, the increase of price was just the amount of subsidy reduced.
- People are now being able to buy SHS outside market of IDCOL's POs, which are cheaper than that of POs though the quality has to be compromised.
- If the quality concerns regarding the systems available outside IDCOL program are correct, further subsidy reduction might lead to price escalation of SHS which will ultimately deprive the poor from buying quality panels

Figure: Impact of subsidy reduction on price of SHS



Elasticity of Demand for SHS

- The elasticity of demand for SHS could be an indicator by which one can understand the need for subsidies for a segment of population
- Elasticity of demand for SHS panels for the poor and non-poor segments of the respondents was estimated using probit regression model.
- The estimated elasticities are the highest for the poor (-0.96) and lowest for the non-poor (-0.36), justifying the existing subsidies for smaller systems.

Table: Demand elasticity for SHS

	Elasticity of demand		
	non-poor	poor	all
Price of offered SHS unit per Wp (Tk)	-0.3597	0.9624	0.853
Age of Household head	-0.0297	0.0351	0.040
HH land asset (decimal)	0.0237	0.0231	0.021
Cost incurred (Tk./month) for energy without solar and natural	-0.0498	0.0035	0.001

Willingness to Pay (WTP) and Consumer surplus

- The WTP is estimated as the difference between the consumers' maximum WTP for a SHS unit and the actual cost of the services
- On average, it can be seen that a household extracts about Tk. 4464.69 as consumer's surplus.
- Estimates also show that net benefit to the households is the highest when they purchase a SHS with Wp 30

Table. Estimated willingness to pay and consumer surplus

SHS Size owned (Wp)	WTP	Actual price paid by HHS for purchasing SHS	Consumer's surplus	Probability of purchase
Not SHS owner				0.895
10	13867.89	9,403.20	4464.69	0.992
20	16602.58	14,039.50	2563.08	0.643
30	25764.75	16,325.00	9439.75	0.676

Cost-Benefit Analysis: FIRR and EIRR

- The cost-benefit analysis was done as the avoided costs of the services (lighting provided largely by kerosene lamps and some by candles and torch cells, television and radio-provided largely by dry cells and rechargeable batteries) in un-electrified households that would be replaced by the PV (SHS) system with certain amount of subsidies.
- The analysis shows that FIRR is about 10% higher than EIRR for the 10Wp system while it is about 5% higher for the other two systems. . This result indicates that subsidy generates relatively higher benefits to the smallest system adopters, who are mostly the poor
- The overall analysis suggest that the current subsidy generates certain level of benefits to the system adopters and gradual reduction will decrease the benefit too though it is not too high.

Cost-Benefit Analysis: FIRR and EIRR (contd.)

Table: Economic and Financial Analysis of SHS (FIRR and EIRR)

	No change in current subsidy structure (\$20/per system)			Gradual reduction for 20 Wp and 30 Wp	
				Subsidy \$15	Subsidy \$10
	10Wp	20Wp	30Wp	20Wp	30Wp
Financial Analysis					
FIRR: Cash	37.77	20.22	26.83	20.22	22.42
FIRR: 15% Down Payment	35.51	13.33	22.66	13.33	18.00
BCR: Cash	1.31	1.11	1.23	1.11	1.14
BCR: 15% Down Payment	1.22	0.97	1.13	0.97	1.05
NPV: Cash	4340.11	1816.49	2687.40	1816.49	2886.36
NPV: 15% Down Payment	3305.35	-639.95	1652.64	-639.95	1138.61
Economic Analysis					
EIRR: Cash	26.37	16.11	19.51	17.01	20.22
EIRR: 15% Down Payment	22.76	10.59	16.01	11.20	16.10
BCR: Cash	1.19	1.02	1.10	1.04	1.10
BCR: 15% Down Payment	1.12	0.90	1.02	0.92	1.02
NPV: Cash	2983.59	459.97	1330.88	799.10	2208.10
NPV: 15% Down Payment	1948.83	-1996.47	296.12	-1657.34	460.35

Some Features of the SHS Business

- POs activity is very important to have a proper SHS picture in the country. Their activities are also very much effective to expand SHS popularity in all over the country.
- Overall, the sales of SHS have increased by around 4% per year.
- The growth of SHSs (≤ 30 Wp) subsidized by the IDCOL experienced faster growth compared to the ones not subsidized even though these too are refinanced

Some Features of the SHS Business (contd.)

- Despite the increase in sales of the SHS the prices of the systems at large did not change.
- Most of the dominant sizes experienced decline in price irrespective whether subsidized or not which may be a reflection of the innovation in the quality as well as reduction of prices of deep cycle battery due inter alia to withdrawal of value added taxes on it.
- Another explanation could be new entrants to the market due to IDCOL's continuing efforts to enlist new POs every year and provide higher refinancing scheme at lower interest rates. Both of these factors might have worked favorably in stabilizing prices of the systems

Some Features of the SHS Business (contd.)

Table: Sales Prices of SHSs during the Last Five Years

Wp/Year	In Taka					Annual Growth (%)
	2010	2011	2012	2013	2014	2010-2014
10	9318	9688	10059	8965	8622	-0.39
20	12958	12353	12364	12301	12103	-0.34
30	17500	17500	17500	16746	15616	-0.56
40	21758	22127	22118	21524	20608	-0.27
45	22800	22800	22800	22800	22800	0.00
50	27946	28485	26291	27461	27030	-0.17
65	33538	34269	34122	34090	33872	0.05
75	36650	38160	37653	36743	35185	-0.20
85	36907	42231	38769	41880	40265	0.44
90	69250	58520	56666	42555	46147	-1.95
Others	31423	31423	31423	43306	28271	-0.52

Some Features of the SHS Business (contd.)

- The price of the PV modules has fallen in the international market is evident from the fall of material costs in recent years.
- One may justify the increase in costs of labor in view of inflation and pay increase; it is hard to justify sharp increase in overhead and other costs.
- The POs appear to take advantage of the subsidy on systems less 30 Wp. As a result, the ratio of investment in ≤ 30 Wp systems to > 30 Wp systems increased from 15% to 21.50% during this period.

Some Features of the SHS Business (contd.)

Table: Annual Expenditures and Investment during the Last Five Years

Heads	In Tk. Million					Annual Growth (%)
	2010	2011	2012	2013	2014	2010-2014
Expenditures						
Labour	30.92	55.41	89.40	96.35	106.46	7.01
Material	189.82	268.81	282.64	300.43	244.65	1.30
Overhead	25.55	46.27	63.73	76.80	87.91	7.01
Utility	0.45	0.70	1.11	1.23	1.79	7.95
Taxes/VAT	0.78	1.19	1.62	1.82	2.31	6.06
Others	2.17	5.27	9.88	15.79	25.66	15.97
Total	249.69	377.64	448.37	492.42	468.77	3.36
Investment						
I. SHS≤30 Wp	44.99	51.90	85.04	125.91	132.37	6.02
II. SHS>30 Wp	305.09	418.42	543.17	530.71	616.29	3.77
Ratio of I to II (%)	14.75	12.40	15.66	23.72	21.48	1.95

Some Features of the SHS Business (contd.)

- The POs are in fierce competition in attracting clients. Though the forms of competition vary across POs and space, the major forms are limited to quality competition of Cournot type (93.75%) and price competition of Bertrand type (56.25%). Other forms of competition include volumes and seasonality of sales.
- That the POs are not expanding their operations is evident that the number of branches of an average PO increased from 118 in 2010 to 140 in 2014, with a meagre annual compound growth of 1%
- The total employment appears to be declining in recent years. As a result, employment per branch is also secularly declining.

Some Features of the SHS Business (contd.)

- The POs are involved in several other activities apart from SHS marketing (96.77%). These include provision of backstopping services (19.35 %), sale of biogas plants (25.81%). However, it appears that most of the POs are directly and indirectly involved credit (48.39%) and non-credit activities (35.49%) akin to NGOs

Some Features of the SHS Business (contd.)

Table: Major Activities of the POs

Major Activities	Cases	Percent
SHS Marketing	30	96.77
SHS Installation, Maintenance and Servicing	6	19.35
Biogas Plant	8	25.81
Improved Cooking Stove	3	9.68
Microcredit	15	48.39
Social and Human Development (Health/Education)	11	35.49
Other Activities	7	22.59

Prospects and Challenges of the POs

- The POs cited several problems that they encountered during the last five years
- About three-fourths of them cited subsidy reduction by the IDCOL as a major challenge; the other challenges include losing large number of customers due to fierce competition and marketing strategies by other SHS sellers.
- The POs attempted to overcome these obstacles through increasing efficiency (87.50%), dynamic and innovative product mix (81.25%). The notable other measures include accessing to finance (62.50%), introduction of modern technology (59.38%) and expenditure reduction (56.25%).

Prospects and Challenges of the POs (contd.)

- Despite the above problems the POs cited several strengths, weakness, future opportunities and threats of the SHS.
- Among the 20 odd types of strengths cited by the POs a few of them include appropriate quality control and marketing strategy as it is an environment-friendly system (29%), huge demand in the off-grid areas (26%), monitoring by the technical committee at IDCOL (23%) and its contribution to employment generation (19%).
- The industry also suffers from several fundamental weaknesses which include high cost of PV module (39%) as potential buyers are rural lower middle income households, competition with poor quality product in the local market (36%) sold by non-enlisted POs, low Wp due to clouds and rain (36%), periodic costs due to change and damage of deep cycle battery (26%), use of limited load (26%) which is an imperfect and poor substitute of grid electricity

Prospects and Challenges of the POs (contd.)

- The POs also foresee bright prospects of the SHS as the system can be used to form min-grid in the off-grid areas (47%), which would provide better lumen and brightness to the users, for irrigation (33%), which would save diesel dependence, and ultimately higher production and better technological coupling would enable the system with the national grid lines thus saving foreign exchange for import of fossil fuel used for electricity generation.
- The POs are apprehensive of timely collection of instalment (50%), unfair competition with non-enlisted POs and hence reduced sale (30%), expansion of new grid lines (17%), and technical fault that betrays warranty provided by the POs (13%)

Prospects and Challenges of the POs (contd.)

Table : Strengths, Weakness, Opportunities and Threats of SHS

SWOT Indicators	Cases	Percent
Strengths of Marketing SHS		
Appropriate Quality Control/Marketing System of SHS	9	29.03
Environment Friendly/Natural System	9	29.03
Huge Demand (to Users in off-greed/Remote Area)	8	25.81
Subsidy/Monitoring by IDCOL	7	22.58
Free From Load Shedding	7	22.58
Employment Generation/Creation of Efficient Worker	6	19.35
Weaknesses of SHS product		
High cost of import (PV module)	12	38.71
Competition with poor quality product in the local market	11	35.48
Seasonal system/low power during cloudy day	11	35.48
Increased cost after 5 year due to battery damage/change of battery	8	25.81
Use of limited load	8	25.81
Lack of standard panel/authority of standardization	6	19.35
Future Opportunities		
Possible to create mini-grid in rural area	14	46.67
Sale/user will be increased after innovation of new SHS products	13	43.33
Could be used for irrigation	10	33.33
Price reduction would create new customer/market	7	23.33
Employment generation	5	16.67
SHS may be converted as AC system	4	13.33
Threats Ahead		
Problem of instalment collection	15	50.00
Reduced sale due to low quality product sold at low price	9	30.00
Panel/battery damage due to natural disaster	8	26.67
Staff drop out	5	16.67
Connection of new grid line	5	16.67
Technical fault/warranty problem	4	13.33
Decreased demand	4	13.33

Concluding Remarks

Subsidies should be assessed by three aspects, such as their relative *efficacy*, *sector efficiency*, and *cost-effectiveness* (Barnes and Halpern, World Bank, 2000).

- *Efficacy*

- This relates to the target group-whether the subsidy reaches those for whom it is intended, particularly the poor

- The findings of this study suggest that 80 percent of the adopters of smaller systems are the poor, which satisfies the necessary condition of providing subsidies, that is, the program is well targeted.

Concluding Remarks (contd.)

- *Sector efficiency*

- The issue of subsidy that could be related to the fact that it encourages provision of service at least cost

- So far, 3.4 million off-grid rural households have adopted SHS with a rate of 0.5 million systems installed per annum.

- Our results also suggest that predicted probability of purchasing a system among non-adopters is 0.90 and it ranges between 0.64 and 0.99 for existing adopters.

- It has been observed that the number of annual sales of SHS by POs has been increasing over the years though price is stable or declining.

Concluding Remarks (contd.)

- *Sector efficiency (contd.)*

-The IDCOL has been trying to increase competition through introducing new POs every year. In 2015, IDCOL has identified 15 new POs for SHS marketing, which will likely to create more competition in the SHS market.

-It has been learnt from our survey that there are some panels available in the market (outside PO) with lower than POs price though there is a perception among POs that such panels are of low quality.

-Our analysis suggests that POs are making only normal profit, and their profit would go down to below 5% if subsidies are withdrawn

Concluding Remarks (contd.)

- *Cost-effectiveness*

-The cost-effectiveness aspects of subsidies highlight the importance of economic benefit accrued to the poor with proper incentive to the Pos.

-The POs are receiving \$20 per smaller system ($\leq 30\text{Wp}$), in addition to credit facilities up to 70 percent of required finance at a subsidized rates for all the systems.

-With withdrawal of subsidies from larger Wp systems, the sales volume of smaller systems have increased significantly indicating it a crucial incentive mechanism for the POs.

Concluding Remarks (contd.)

- *Cost-effectiveness (contd.)*

-Consumer surplus indicates that SHSs are highly beneficial to households given the current prices. The estimated financial rate of return (FIRR) is only about 5% higher than the economic rate of return (EIRR) justifying the need for subsidies though the size of subsidy is trivial.

-Thus, it can be suggested that the current subsidy structure for the SHS program is justified from widely accepted norms and practices and therefore it should continue as long as it brings benefits to the poor

Recommendations

Some ambiguity arises with the PO activities, to justify subsidy the following qualifications should be made by IDCOL:

- An evaluation of technical specifications of the systems available outside the PO market needs to be made to compare the quality and prices of the systems;
- A strict mechanism of monitoring and evaluation has to be enhanced/developed to ensure whether the set technical standard is maintained by the POs; and
- The backstopping services to SHS adopters committed to provide by the POs are reportedly weaker and therefore needs to be strengthened to ensure better SHS services

**THANK YOU FOR
LISTENING**