

THE BOTTOM LINE

The Bangladesh Solar Home Systems (SHS) Program contributed significantly to achieving near-universal access to electricity by installing over 4 million SHSs from 2003 to 2018, serving 16 percent of rural households by 2016. The government mobilized USD 683 million in loans and grants from international development partners for roll-out financing, which leveraged an additional USD 412 million from domestic sources. The Program provided significant benefits to all participants, especially rural households. These experiences are relevant to sub-Saharan Africa, where nearly 600 million people lack electricity access and 40 percent of electricity connections will need to be off-grid to achieve universal access by 2030. This Live Wire is based on Cabraal et al. 2021.

Learning from Large-Scale Solar Home System Electrification in Bangladesh

What made the Bangladesh Solar Home System Program unique?

The Bangladesh SHS Program was the world's largest and longest continuously running off-grid electrification program

Bangladesh has given high priority to electricity access to help transform rural areas. Rural access to electricity reached 95.2 percent by 2020, up from 66 percent in 2016 (World Bank 2022). Between 2003 and 2018 the program installed 4.1 million solar home systems (SHSs). At the SHS Program's peak in 2016, SHSs provided electricity to 16 percent of the country's rural households.

Over 15 years, 20 million rural people in Bangladesh obtained access to basic electricity services using SHSs, far sooner than if they had waited for the electricity grid. These families enjoyed modern lighting, a cleaner and safer home environment, and power for recharging phones, TVs, radios, and small appliances. They also avoided the risk of home fires as well as respiratory illnesses from breathing kerosene smoke. Eventually, their 10 million children will gain upward mobility through improved education and health due in part to electricity.

On the business side, some 200,000 rural enterprises and social facilities were able to extend their operating hours and offer better services at lower costs by using SHSs for lighting, communications, and powering small appliances. At the peak of the program, 29,000 people were employed by a partnership of Bangladeshi microfinance institutions, nongovernmental organizations, and private companies that assembled SHSs, marketed and delivered the systems, serviced

them, and provided credit to make them affordable. During the SHS Program's life, the costs of solar home systems dropped, and the quality of products improved; these benefits were passed on to rural customers.

Financially, SHS users gained the most, followed by the government and the implementing organizations. Only kerosene dealers did not gain. The net financial benefit of the SHS Program is about USD 1.9 billion from 2003 to 2042 (discounted at 10 percent to 2018 in constant 2018 USD).

From the environmental perspective, Bangladesh avoided burning 4 billion liters of kerosene for lighting and emitting over 9 million tCO₂.

Though local manufacturing was not a goal of the program, the demand for SHSs led to investments in domestic solar modules and system components, expanded battery manufacturing, and the founding of several battery recycling plants.

How did this come about?

From 2003 to 2018, the government of Bangladesh carried out a market-based program to supply SHSs to rural customers across the country

Universal rural access to electricity is enshrined in the Bangladesh 1972 constitution (Government of Bangladesh 1972). The Bangladesh Rural Electrification Board (BREB) was founded in 1977 to achieve this goal. In 2002, the government committed to achieving universal access to electricity by 2021; making the power sector financially viable, improving sector efficiency, and increasing the reliability and



Anil Cabraal was formerly a lead energy specialist at the World Bank.



V. Susan Bogach was formerly a senior economist at the World Bank.

affordability of electricity (Government of Bangladesh 2002). But in 2003, the rural electricity access rate was only 27 percent; over 15 million rural households did not have access. Urban-rural disparities and the health and safety impact on the rural population from lack of electricity access were great, especially for women and children. At the current pace of grid electrification, the government realized that it would take over 30 years to achieve universal access using grid electricity alone (World Bank 2002).

SHSs offered an alternative technology and delivery model to help meet the universal access goal. The technology had shown promise in the mid-1990s in pilot applications in Bangladesh. It had the potential to lower the cost of supplying basic electricity services in areas that would not be connected to the grid soon. Deployment could be quick, and there was interest among private firms and nongovernmental organizations.

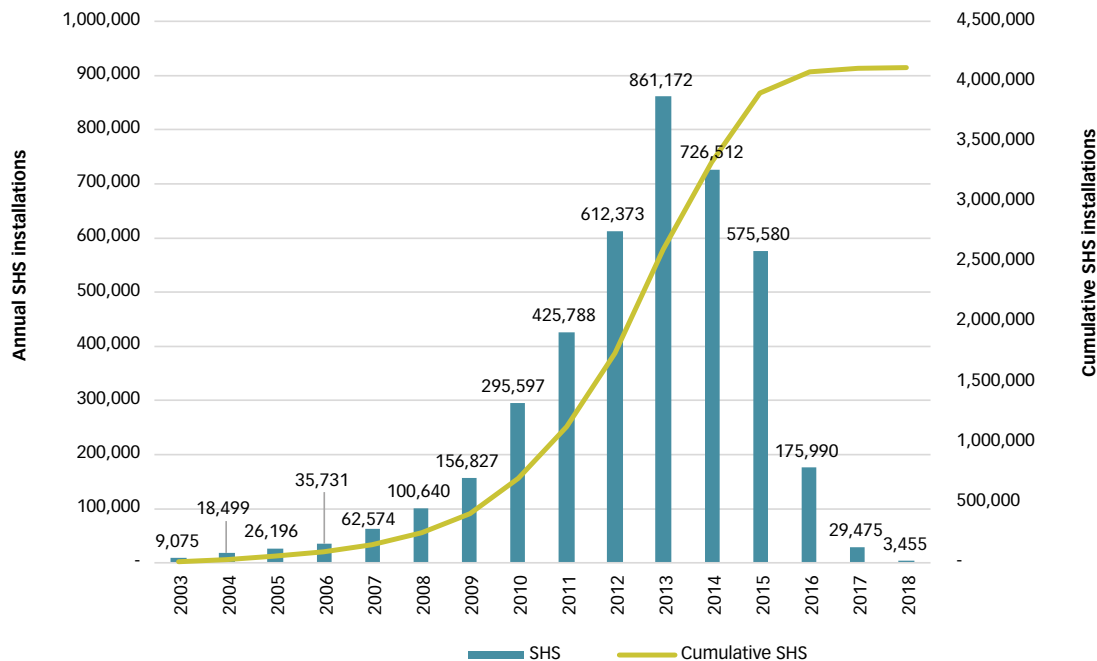
The government appointed the Infrastructure Development Company, Ltd. (IDCOL) to manage the SHS Program, as BREB was fully engaged in grid electrification. IDCOL is a government-owned non-bank financial institution that had the financial and management strengths to implement such a program. Through the SHS Program, the government leveraged the capacity of the private sector, microfinance institutions, and nongovernmental organizations as partner organizations to deliver SHSs to rural customers. The partner organizations competitively marketed, financed, and delivered SHSs to rural customers. Without this partnership and the facilitating role of IDCOL the program would not have taken off in Bangladesh.

With government support, the SHS Program systematically mobilized enormous financial resources from international development partners. With the World Bank in the lead, those partners provided financing of USD 683 million in loans and grants over the course of 15 years, leveraging an additional USD 412 million from customers, retailers, microfinance organizations, and the supply industry. Details on the financing of the SHS Program appear further on.

Sales under successive phases of the program grew rapidly from 2003 and peaked in 2013 with over 861,000 SHSs installed that year (figure 1). Cumulatively 4.1 million SHSs were sold between 2003 and 2018. The motivations for purchasing SHSs included a low expectation of getting an electricity connection and the promise of improved electricity services, including better light and more hours for activity and improving children’s education (especially in women-headed households). After 2013, SHS sales began to decline as the pace of grid electrification accelerated rapidly.

As the SHS Program was a market-based, competitive one, SHS sales were widely spread out across the country. The sales concentration varied, with 39 percent of households using SHSs in one administrative division versus only 6 percent in another. At a district level, SHS adoption ranged from a high of two-thirds households in one district to a low of 0.2 percent in a highly urbanized district.

Figure 1. Solar home systems installation progress, 2003–18



Source: Cabraal et al. 2021.

Faces of the SHS Program: Power for Learning

Brighter lighting allowed children to study longer. Children with solar lights studied 50–60 hours more per year than those using kerosene lamps.



How did the SHS Program benefit rural Bangladeshis? SHSs brought the benefits of basic electricity services to rural consumers before the grid was available to them

By purchasing a solar home system, families and businesses gained access to electricity services immediately, with no need to wait for a grid electricity connection. Electricity brought many benefits—modern lighting as well as the ability to operate appliances and communication devices.

Rural families benefitted in myriad ways. Brighter lighting allowed children to study longer. Children with solar lights studied 50–60 hours more per year than those using kerosene lamps. SHS households enjoyed greater safety, comfort, and convenience compared to non-SHS households. More indoor and outdoor lighting gave a greater sense of security. SHS households could power their TVs, radios, fans, and mobile phones at a cost lower than alternatives such as generators or batteries recharged at charging stations. SHSs had a positive influence on women's mobility, economic decision-making, and sense of security. They spent more time tutoring children, reading, socializing, and visiting friends and neighbors after adopting a solar home system. TV, radio, and mobile phones enabled rural people to connect to the rest of the world and brought about a greater understanding of their rights (Bangladesh Institute of Development Studies 2012).

SHSs benefited 200,000 enterprises and social services with better quality light, extended hours of operation, and power for small appliances. These organizations included (i) offices, educational institutions, restaurants, and retail shops (11 percent); and (ii) mosques (89 percent).

The competitive business model permitted SHS consumers to benefit from technology improvements, especially more efficient LED lighting and direct-current appliances. Consumers benefited from cost reductions due to increased appliance efficiency, price drops for solar modules, and economies of scale.

“The solar home system has enabled us to break out of darkness and live in light.”—Muktilia Bhromo, SHS user in Thakugaon District, in a conversation with Noara Razzak and others from BRAC University in 2012.

Faces of the SHS Program: Power for Women



The program helped develop the local solar PV industry, including SHS retailers, service providers, finance companies, and manufacturers. Given Bangladesh’s industrial capabilities, the program induced backward integration of manufacturing from deep-cycle batteries and other components to solar PV modules in later years.

The SHS Program improved standards for battery manufacture and battery recycling capabilities. Battery manufacturers were required to adopt international standards for battery

Faces of the SHS Program: Power for Business



manufacture. IDCOL regularly inspected those facilities. The program set up four battery recycling centers. All participating battery suppliers had to send their spent batteries for recycling.

The SHS Program avoided the burning of about 4 billion liters of kerosene from 2003 to 2021. The CO₂ emissions avoided by the program are estimated at 9.6 million tCO₂, equivalent to the CO₂ emissions from a 300 MW coal plant over a 6-year period. The value of the kerosene saved between 2003 and 2018 is estimated at more than USD 900 million (in constant 2018 USD).

IDCOL combined its expertise in infrastructure financing with Bangladesh’s pioneering work in microfinance and early attempts at solar electrification to build an off-grid electrification business model.

How was the SHS program organized?

IDCOL managed a national network of nongovernmental organizations, microfinance institutions, and private companies with rural outreach that competitively marketed, financed, installed, and serviced quality-certified SHSs

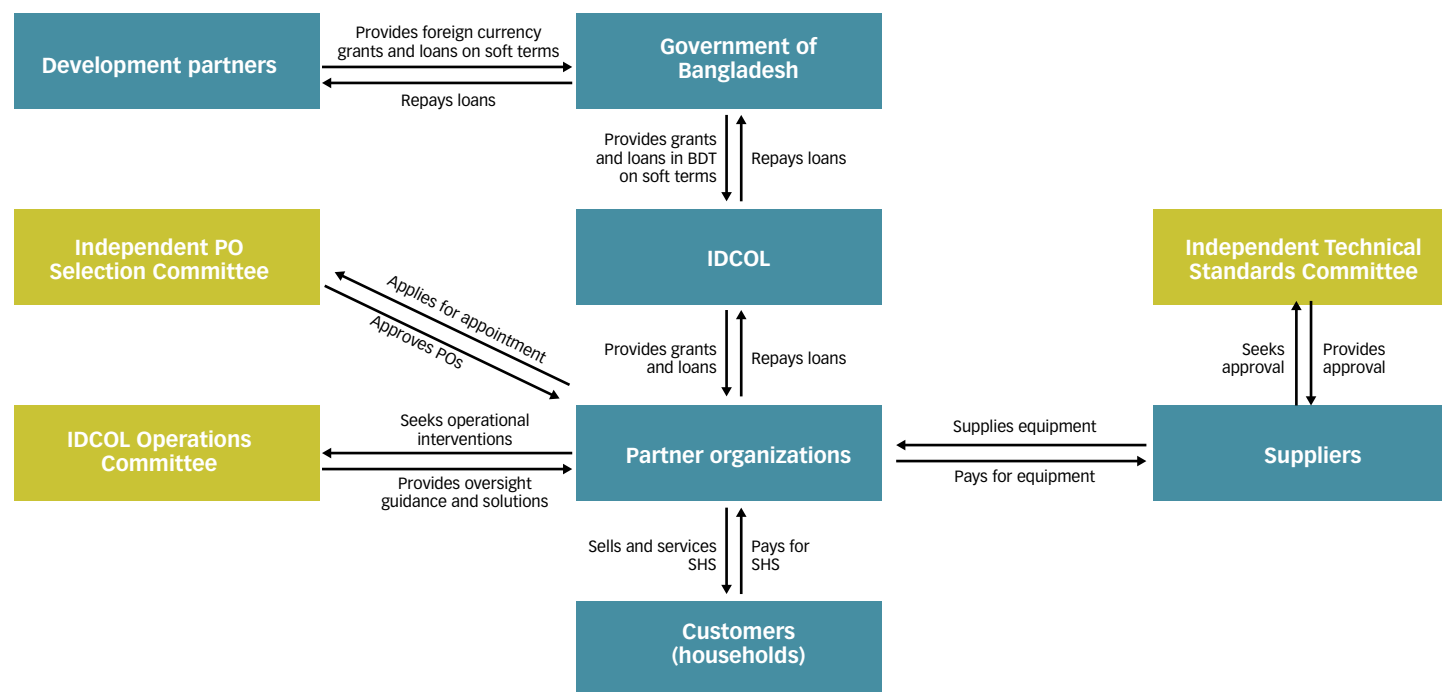
IDCOL combined its expertise in infrastructure financing with Bangladesh’s pioneering work in microfinance and early attempts at solar electrification to build an off-grid electrification business model. Most of IDCOL’s network of 57 partner organizations were nongovernmental organizations and microfinance institutions that competitively marketed, financed, installed, and serviced quality-certified

SHSs to rural customers. New SHS technologies were adopted as they emerged, under the watchful eye of a Technical Standards Committee.

The organizational arrangements, flow of funds, and relationships between various entities are shown in figure 2 and described further below.

The partner organizations provided warranted SHS products, spares, and repair services. They sold SHSs on credit, with affordable financing terms. SHS customers repaid loans to partner organizations, IDCOL refinanced the partner organizations while repaying the government, and the government financed IDCOL with funds from international agencies. IDCOL’s approach was adaptive—responsive to changes in market and other conditions. The Program scaled up gradually, with participants learning along the way.

Figure 2. Organization of the SHS Program



Source: Cabraal et al. 2021.
BDT = Bangladesh taka.

The partner organizations provided warranted SHS products, spares, and repair services. They sold SHSs on credit, with affordable financing terms. SHS customers repaid loans to partner organizations, IDCOL refinanced the partner organizations while repaying the government, and the government financed IDCOL with funds from international agencies.

The partner organizations offered customers choices among SHSs with assorted sizes, prices, and functions. Customer choice was an important feature. Customers could choose from SHSs that ranged from 10 peak watts (Wp) for basic lighting and mobile phone charging to 300 Wp for powering TVs and fans. Early on, the size averaged about 50 Wp. As more efficient LED lamps began replacing fluorescent tube and compact fluorescent lights, the average size decreased to about 30 Wp by 2013, increasing affordability. As SHS prices continued to fall with decreases in PV module costs and reductions in the minimum battery size requirement, the average SHS size increased to 40 Wp to obtain a greater level of electricity service. In 2003, the installed unit cost averaged USD 12 per Wp; this dropped to USD 10 per Wp in 2010 and to less than USD 5 per Wp by about 2017 (constant 2018 USD). This cost included free maintenance services for three years, a five-year warranty for batteries, and tax of about 12 percent.

Several specialized committees played key roles in program management. Quality was enforced by an independent Technical Standards Committee. Selection of the partner organizations was governed by the Independent Partner Organization Selection Committee. The Operations Committee was singularly important and enabled constant monitoring and adaptation. The CEO of IDCOL chaired the committee comprised of IDCOL staff and representatives of partner organizations. Its monthly meetings enabled IDCOL to obtain timely information from the field, respond to partner organizations' suggestions, convey consistent messages to the partner organizations and efficiently manage the program. The meetings offered a venue for learning from each other. Today, with the advent of online conferencing technology, such meetings could be conducted more efficiently, conveniently, and at lower cost.

How was the SHS Program financed?

Roll-out financing of USD 1.1 billion came from development partners, partner organizations, customers' down payments, and manufacturers' equity; ultimately SHS purchasers paid for much of the program

Credit support of USD 602 million came from the World Bank, Asian Development Bank, Japan International Cooperation Agency, and Islamic Development Bank. Grant funds of USD 81 million came from the Global Environment Facility, Global Partnership on Output-Based Aid, United States Agency for International Development, Kreditanstalt für Wiederaufbau, German Agency for International Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit), and UK Department for International Development. Equity from partner organizations, customers' down payments, and manufacturers' equity investments in their factories contributed USD 412 million. The sources of total up-front financing are given in figure 3.

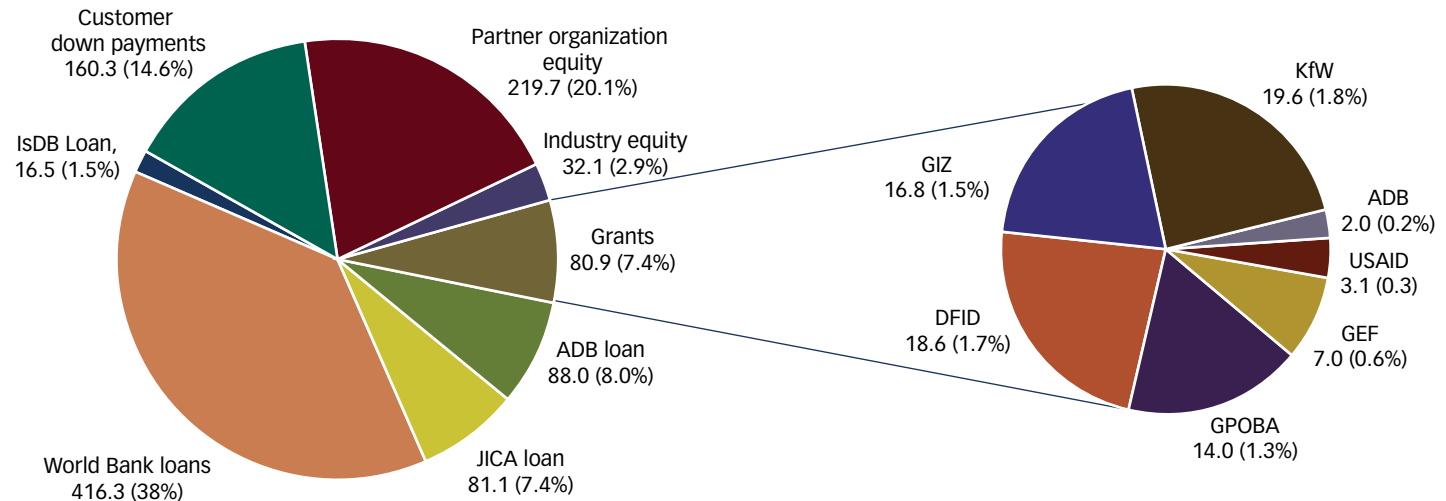
Consumer financing was the essential instrument to improve affordability by helping to match payment terms to customer's ability to pay. The Bangladesh government, through IDCOL and then the partner organizations, delivered the international financing to rural families in micro-loans. The government lent to IDCOL in Bangladesh taka, with the government carrying the foreign exchange risk. IDCOL refinanced a portion of the partner organizations' loans to customers. The partner organizations financed sales and secured the loan with the SHS. The financial flows and on-lending terms are illustrated in figure 4.

Availability of financing and its accessibility by partner organizations with minimal collateral requirements were key to the rapid uptake of the SHSs. It also meant that IDCOL and the government were carrying greater risk than a typical commercial bank. The partner organizations also carried a risk, as repossessing a solar home system installed on a defaulting customer's roof was difficult, and, with SHS prices dropping steadily, the residual value of the system declined relatively quickly.

Figure 3. Source of the SHS Program’s roll-out loans, equity, and grants (millions of USD, percent)

Loans = USD 601.9 million; grants = USD 80.9 million; equity and down payments = USD 412.2

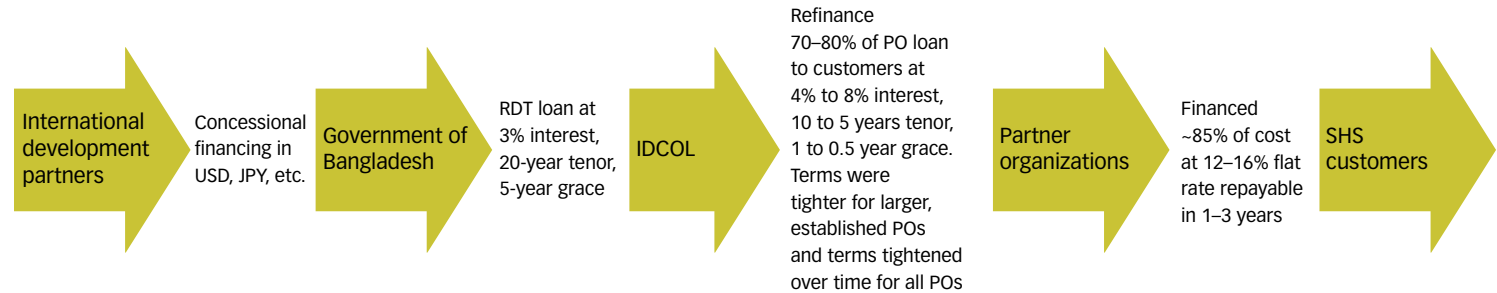
Consumer financing was the essential instrument to improve affordability by helping to match payment terms to customer’s ability to pay.



Source: Derived from data in Cabraal et al. 2021.

Note: ADB = Asian Development Bank; JICA = Japan International Cooperation Agency; ISDB = Islamic Development Bank; GEF = Global Environment Facility; GPOBA = Global Partnership on Output-Based Aid; USAID = United States Agency for International Development; KfW = Kreditanstalt für Wiederaufbau; GIZ = German Agency for International Cooperation; DFID = UK Department for International Development.

Figure 4. Financing flows and terms



Source: Derived from data in Cabraal et al. 2021.

BDT = Bangladesh taka; PO = partner organization; SHS = solar home system.

Necessary in the early stages of the program, the role of grants diminished in later years. Grants were used to provide a results-based, end-user subsidy to increase affordability and to enable partner organizations to strengthen their sales and service infrastructure.

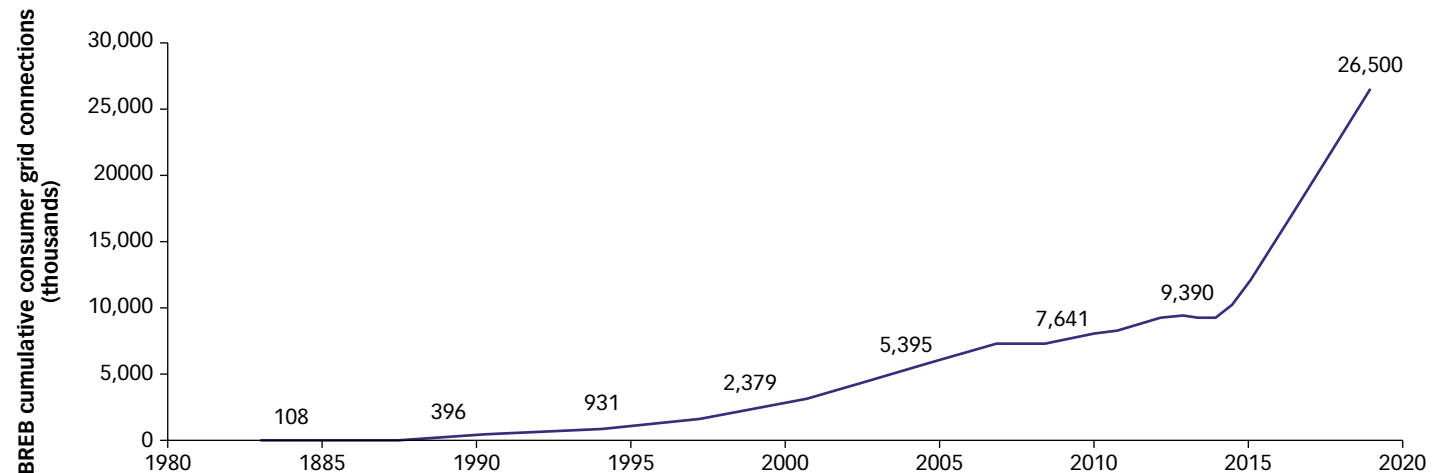
Necessary in the early stages of the program, the role of grants diminished in later years. Grants were used to provide a results-based, end-user subsidy to increase affordability and to enable partner organizations to strengthen their sales and service infrastructure. In 2003 the grant was USD 90 per SHS (19 percent of cost on average) irrespective of size, with USD 70 for an end-user subsidy and USD 20 for institutional strengthening. By 2011, when 1 million SHSs had been sold, the subsidy had gradually been reduced to USD 28 per SHS, or 7 percent of its cost (of which USD 25 was an end-user subsidy). After 2012, only an end-user subsidy of USD 25 was given for SHSs below 30 Wp. The higher subsidy in the early years was justified as helping to overcome the wariness of early adopters.

What led the SHS Program to stop marketing SHSs in 2018 and to shut down in 2021?

The SHS market declined sharply after 2014, mainly because of an unprecedented acceleration in grid electrification

After 11 years of strong sales growth, the SHS market declined precipitously after 2014 as an unprecedented acceleration in grid electrification (figure 5) came together with more reliable service on the rural grid. This was coupled with competition from the government's poverty-targeted SHS give-away program—the TR/KABITA Program—and the expansion of commercial SHS sales, which benefited from the good reputation of the systems sold under the SHS Program. By 2018 there were fewer unelectrified rural households than the number of SHSs installed under the program, and BREB was continuing rapid grid extension.

Figure 5. Increasing pace of grid-based rural electrification after 2014



Source: Derived from data from Bangladesh Rural Electrification Board 2020.

The prospect of securing a grid connection dampened demand for SHSs, as consumers preferred unlimited access to electricity at subsidized low prices.

Popular preference for grid electricity and the public resources devoted to grid expansion were not secrets. However, closer cooperation with BREB could have helped IDCOL plan better to wind down the SHS Program as grid expansion ramped up. That said, IDCOL did take steps to adapt—first to counteract the market decline (unsuccessful) and then to bring the SHS Program to an orderly end (successful).

In 2011, IDCOL had estimated that the market for SHSs was about 6 million households, or about 50 percent of the unelectrified rural households in Bangladesh. At that time, the pace of grid electrification was slow, so the government sought additional financing for SHSs, and development partners responded with USD 377 million in credits and grants between 2012 and 2014, enough to finance an additional 2.7 to 3 million SHSs. IDCOL had recruited 17 new partner organizations in 2013 and 11 more in 2015 in the expectation that the SHS market would continue to grow. However, in 2015, BREB began rapidly accelerating its grid electrification with support from the government and development partners, significantly depressing the market for SHSs.

The prospect of securing a grid connection dampened demand for SHSs, as consumers preferred unlimited access to electricity at subsidized low prices. It also created cut-throat competition among partner organizations and led some SHS customers to default on their loan payments. As the partner organizations' profitability declined, their inability to service their debt to IDCOL affected IDCOL's financial position.

IDCOL began winding down SHS operations. It worked with the partner organizations to restructure their debt and help them recover arrears from customers. With help from an interest-rate reduction on its own debt to the Bangladesh government, IDCOL extended partners' debt repayment from 2023 to 2026 and waived interest on SHS loans. IDCOL's efforts have succeeded in improving the quality of the partner organizations' loan portfolio, with below-standard debt reduced from BDT 11.9 billion in 2018 (USD 143 million) to BDT 2.4 billion by 2019 (USD 28.6 million in 2018 USD). This is very small compared with the net present value of the benefits the SHS Program brought to the main stakeholders (as discussed in the next section).

At the government's request, IDCOL also took over management of the TR/KABITA Program, using its network of partner organizations to supply and service the systems supplied under that program. This improved services to the TR/KABITA beneficiaries and helped the partner organizations repay their outstanding debts to IDCOL.

Better coordination between grid and off-grid electrification planning and earlier actions by IDCOL could have lessened the problems IDCOL and its partner organizations faced when their market shrank. Similar coordination among government agencies and with development partners that were simultaneously increasing financing to grid and off-grid electrification would also have been beneficial.

Who were the program's winners and losers?

Rural households gained the most, but all major stakeholders, except kerosene dealers, gained from the SHS Program

The costs and benefits of the SHS Program were analyzed to determine its net contribution to the country's economy, the global impact of CO₂ emission reductions, and the net financial benefits from the perspective of project participants (SHS customers, partner organizations, IDCOL, kerosene dealers, and the Bangladesh government) (table 1).

The economic and financial analysis of aggregate households extends from 2003 to 2029, when the last SHSs installed in 2018 are assumed to stop operating. The financial analysis of stakeholders' net benefits extends to 2042, when IDCOL will have repaid the loans it received from the government. The analysis of the impact on the government of the development funds it received extends to 2054, when the government repays the final concessional loan for the program.

The economic internal rate of return of the SHS Program is estimated at 20 percent using the avoided cost of kerosene and grid electricity for lighting to estimate benefits.¹ When the additional

1. Defining benefits simply as the avoided kerosene costs for lighting in both the economic and financial analyses overlooks the important benefits of the program to households reviewed earlier. Although these other benefits were prime motivations for households to buy a solar home system, they were excluded from the cost-benefit study because they are difficult to estimate. In any case, the avoided costs for lighting alone justify the program in economic and financial terms.

Table 1. Distribution of financial benefits to stakeholders in the SHS Program, 2003–42

Stakeholders	Net financial benefits 2003–42 (constant 2018 USD million)		
	Undiscounted	Present value in 2018	
		10% discount rate	5% discount rate
Households' net savings on kerosene and electricity savings, with grants and loans factored in	1,348	745	1,088
Government taxes collected on SHS sales and savings on kerosene subsidies	200	474	313
IDCOL's earnings from on-lending to partner organizations	54	379	223
Partner organizations' profits on SHS sales	147	310	214
Kerosene distributors' forgone profits	(47)	(56)	(51)
TOTAL	1,702	1,852	1,787

Source: Cabraal et al. 2021.

Note: All discounted figures are in constant 2018 USD. The duration of benefits varies. Only IDCOL benefits extend to 2042, reflecting debt servicing payments to the government. The societal discount rate of 10 percent in constant terms is excessive for IDCOL and the partner organizations. Since IDCOL's opportunity cost of capital is estimated at 2.5 percent in constant terms, the NPV of its financial benefits would more appropriately be estimated at USD 139 million (constant 2018 USD) when discounted at 2.5 percent. Similarly, the NPV of the partner organizations' net gains would be estimated at USD 262 million in constant 2018 USD, discounted at 2.5 percent.

When the additional benefit to the global community from carbon emissions reduction is added, the economic rate of return increases to 25 percent.

benefit to the global community from carbon emissions reduction is added, the rate of return increases to 25 percent. Using an alternative approach that estimates the benefits using a willingness-to-pay estimate of USD 2.23 per kWh (2018 USD) yields an EIRR of 51 percent.

The financial internal rate of return (FIRR) of the aggregate participating households based only on the energy savings is estimated at 17 percent—including grants and assuming an average interest rate of 14 percent for SHS loans and the repayment defaults near the end of the program. If there had been no defaults, the FIRR would have been 13 percent since the households would have repaid more. If there had been no loans or grants, the households' FIRR would have been 14.7 percent—though it is likely that far fewer households could have afforded the systems.

The financial analysis showed that all major stakeholders, except kerosene dealers, have reaped significant gains from the program

(see table 1). At any discount rate, households benefitted the most, followed by the government. On a cumulative present value basis discounted at 10 percent to 2018, the total net benefits are estimated at USD 1,852 million, of which SHS households gained USD 745 million. The government benefitted from on-lending concessional funds to IDCOL on less favorable terms, in addition to the direct benefits from taxes and reduced kerosene subsidies.²

2. For the period from 2003 through 2054, the national treasury's forecasted net gain on IDCOL payments minus repayments of international concessional loans is USD 1 million in constant 2018 USD on an undiscounted basis and USD 180 million when discounted to 2018 at 10 percent. On a cumulative present value basis discounted at 10 percent to 2018, the treasury's total net gain from the SHS Program is estimated at USD 655 million, made up of USD 384 million from taxes on SHS, USD 90 million from avoided kerosene subsidy, and USD 180 million from the pass-through of official development assistance. The relative stability of the Bangladesh taka (it depreciated at 2.5 percent per annum against the U.S. dollar from 2003 to 2018), is an important reason why the government reaped a significant pass-through benefit.

Give customers a choice of SHSs to match their needs and abilities to pay. One size does not fit all.

What has the SHS Program taught us?

The Bangladesh SHS Program shows that SHSs can make a large-scale contribution to rural electricity access in advance of the arrival of the grid; the systems are well accepted by rural households and businesses

The experience of the Bangladesh SHS Program suggests the following main building blocks for success. Although the Bangladesh model may not be exactly replicable in other countries, its experience offers valuable lessons for large-scale off-grid programs elsewhere.

Planning the program

- Assign responsibility for program management to a strong institution, preferably one with good financial management experience, that provides close and timely supervision as well as financial discipline.
- Work with capable partner organizations (private firms, non-governmental organizations, and microfinance institutions) that have strong rural outreach and a stake in the program's success. Agencies responsible for grid electrification may be too busy to take-on the added responsibility for off-grid electrification.
- Coordinate grid and off-grid electrification closely. Since consumers prefer grid electricity, foresee from the start an adaptation and exit strategy that manages shared risks as grid electrification proceeds. Plan for an off-grid service and spare part supply infrastructure beyond the program.
- Provide access to consumer finance for SHSs on affordable payment terms, including credit, that approximate household expenditure patterns. Use subsidies judiciously. They are most useful in the early stages of a program to overcome unfamiliarity of the product.

Implementing the program

- Give customers a choice of SHSs to match their needs and abilities to pay. One size does not fit all. Protecting the customer by ensuring the quality of products, components, installations, and support services builds the sustainability and the reputation of the program.

- Adapt the program continuously based on built-in lines of communication. In Bangladesh, the monthly Operational Committee meetings where all participants were represented enabled real-time monitoring by IDCOL and rapid response and adaptation to challenges. Regular consumer surveys and means for consumers to contact the implementing agency are important for early feedback.
- Adopt new technologies that offer better quality and more reliable services (e.g., LEDs), as well as new business practices such as pay-as-you-go technology, mobile pay, and computerized management information systems.
- Provide users with solid, practical information and training in simple maintenance and safe operating procedures.

Additional hard-won tips on designing and implementing a successful program are offered in box 1.

Box 1. Additional tips for planning and managing a successful SHS program

- Build the program around a clearly defined goal such as reaching universal access by a certain year.
- Avoid running parallel initiatives with similar objectives but different operating and management modes.
- Use geo-spatial planning tools to coordinate grid and off-grid electrification.
- Build on the strengths of existing organizations and enterprises rather than creating new ones, wherever possible.
- View government and the private sector as complements, not alternatives or competitors.
- Seek development partners' support for technology and knowledge transfer and not just as sources of money. Use development partner financing to leverage domestic financing.
- Adhere to sound economic, technical, and business principles even when adapting to changed circumstances.
- Rationalize duty and tax structures to level the playing field for SHSs and alternatives.

Source: Adapted from Cabraal et al. 2021.

MAKE FURTHER CONNECTIONS

Live Wire 2014/20. "Scaling Up Access to Electricity: The Case of Lighting Africa," by Daniel Murphy and Arsh Sharma.

Live Wire 2014/21. "Scaling Up Access to Electricity: The Case of Bangladesh," by Zubair Sadeque, Dana Rysankova, Raihan Elahi, and Ruchi Soni.

Live Wire 2015/34. "Scaling Up Access to Electricity: Pay-as-You-Go Plans in Off-Grid Energy Services," by Alejandro Moreno and Asta Bareisaite.

Live Wire 2014/35. "Planning for Electricity Access," by Debabrata Chattopadhyay, Rahul Kitchlu, and Rhonda Jordan.

Live Wire 2015/51. "Scaling Up Access to Electricity: Emerging Best Practices for Mini-Grid Regulation," by Chris Greacen, Stephanie Nsom, and Dana Rysankova.

Live Wire 2017/86. "Data as an Enabler in the Off-Grid Sector: Focus on Tanzania," by Christopher James Arderne, Yann Tanvez, and Pepukaye Bardouille.

Live Wire 2019/106. "Planning Models for Electricity Access: Where Do We Go from Here?" by Rahul Srinivasan and Debabrata Chattopadhyay.

Live Wire 2021/113. "Tracking Advances in Access to Electricity Using Satellite-Based Data and Machine Learning to Complement Surveys," by Milien Dhone, Claire Nicolas, Christopher Arderne, and Juliette Besnard.

Live Wire 2022/121. "Access to Clean Cooking and Electricity: Righting the Policy Balance in Sub-Saharan Africa and Fragile Settings," by Sharmila Bellur, Paul Mathew, and Juliette Besnard.

Find these and the entire Live Wire archive at www.worldbank.org/energy/livewire.

Other countries may lack Bangladesh's capability with microfinance and its rural infrastructure, but they can apply these lessons to accelerate off-grid access programs while benefiting from today's more effective, efficient, and less costly technology and approaches, which include (i) using mobile pay and pay-as-you-go technologies to reduce collection costs and risks; (ii) relying on mobile phones, social media, and on-line conferencing to facilitate communications with partners and customers; (iii) engaging in geospatial planning to coordinate grid and off-grid electrification; and (iv) deploying program management platforms designed for off-grid electrification.

The SHS Program made a significant contribution to meeting the rural access requirement of Bangladesh's 1972 constitution by providing rural electricity service to 20 million people in advance of grid access. It provided very significant financial benefits to all parties, most importantly to the rural residents of Bangladesh.

The authors hope that sharing these experiences will help other countries achieve their electrification goals.

References

- Bangladesh Institute of Development Studies. 2012. *Household Survey Data on Impact Evaluation of Solar Home Systems in Bangladesh*. Report prepared for the World Bank.
- Bangladesh Rural Electrification Board. 2020. *Annual Report*. Dhaka, Bangladesh.
- Cabraal, A., W.A. Ward, V.S. Bogach, and A. Jain. 2021. *Living in the Light: The Bangladesh Solar Home Systems Story*. World Bank, Washington, DC. <https://openknowledge.worldbank.org/handle/10986/35311>
- Government of Bangladesh. 1972. *Constitution of the Peoples' Republic of Bangladesh: Part II—Fundamental Principles of State Policy*. Dhaka, Bangladesh. <http://www.commonlii.org/bd/legis/const/2004/part2.html>
- . 2002. "Vision Statement." Power Division, Ministry of Energy and Mineral Resources. Dhaka, Bangladesh. <https://policy.asiapacificenergy.org/sites/default/files/VSPSPSectorReform.pdf>
- World Bank. 2002. "Bangladesh Rural Electrification and Renewable Energy Development Project." Project Appraisal Document. Washington, DC: World Bank. <http://documents.worldbank.org/curated/en/226581468741678811/pdf/multi0page.pdf>
- . 2022. World Development Indicators. Database. <https://data-bank.worldbank.org/source/world-development-indicators>