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Solar Irrigation for Agricultural Resilience

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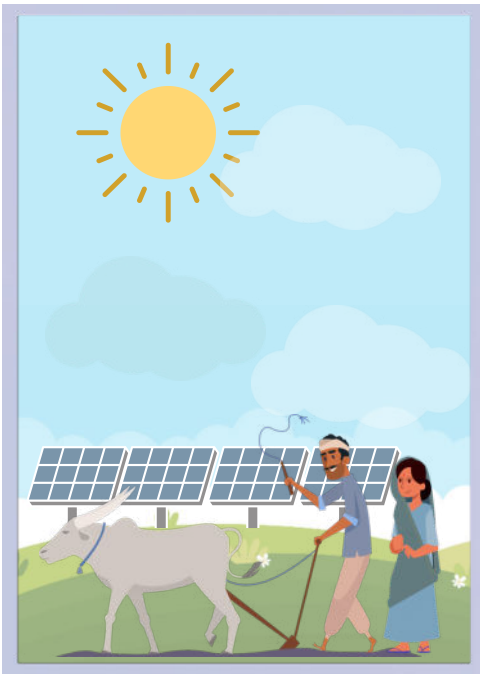

Making renewable energy investments sustainable through grid-connected solar pumps in Bangladesh

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The Bangladesh government plans to generate 10% of its electricity from renewable sources by 2030. The Infrastructure Development Company Limited (IDCOL), a nodal agency for renewable energy in Bangladesh, has so far installed 1,523 off-grid solar irrigation pumps (SIPs) with 42.1 megawatts (MW) capacity through an innovative fee-for-service model. These pumps have a high panel-to-pump capacity ratio to meet irrigation demands during the peak irrigation season of summer boro paddy. However, beyond the boro season, irrigation demand is limited. Over-reliance on one crop for revenue generation and low usage during the off-season affect the financial viability of SIP investments. Grid integration can offer a one-stop solution for increasing the capacity utilization of solar panels and helping the government meet its renewable energy targets by utilizing the existing solar infrastructure.

Fossil fuel dependency and resulting energy crisis in Bangladesh

Bangladesh's energy demand for electricity generation, irrigation, and transport sector depend on fossil fuels, most of which are imported from outside. For example, approximately 30% of the current (installed) electricity generation capacity is dependent on imported petrol and diesel (Figure 1). The rise in petroleum prices due to the Russia-Ukraine war has led to an energy crisis and an exponential increase in fuel import bills. There have been countrywide power cuts and protest rallies against fuel price hikes.

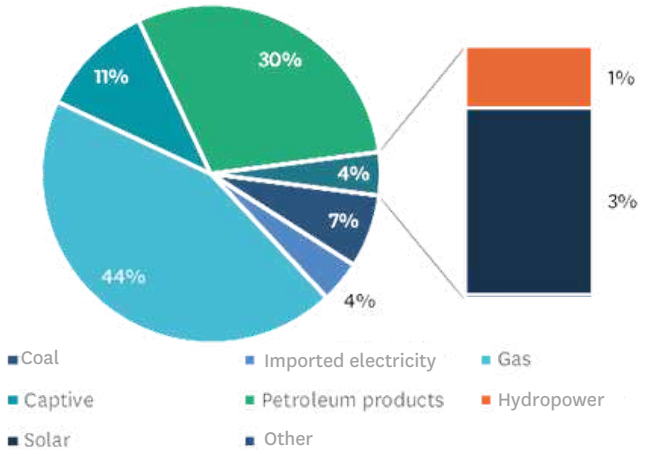

Figure 1. Energy mix of installed capacity of electricity by fuel type in 2022.
Source: SREDA 2020a

The consequences of an energy crisis are also dire for Bangladesh's agricultural sector, particularly its food security. Boro rice, instrumental for the country's food security, predominantly depends on diesel-run groundwater irrigation. Escalating diesel price is thus bad news for the sector and makes a case for renewable energy transition more vital than ever before.

Solarizing irrigation: A step towards 10% renewable energy mix by 2030

Even though, as of August 2022, Bangladesh's total installed renewable energy capacity is only 3.6% against an initial target of 10% by 2020 (SREDA 2020b), Bangladesh has immense potential for expanding the share of renewable energy in its total energy mix through rapid solarization.
Transitioning to solar energy is also crucial for achieving Bangladesh's updated Nationally Determined Contribution (NDC) targets of greenhouse gas (GHG) emissions reductions. As part of its possible mitigation actions, the Government of Bangladesh (GoB) has set a target of installing 176 megawatts (MW) of solar irrigation unconditionally and an additional 164 MW with financial and technical support (MEFCC 2021). Currently, off-grid solar irrigation pumps (SIPs) account for about 8% (50.4 MW) of the total solar capacity installed in the country (SREDA 2020b).

As of 2019, there were 1.24 million diesel pumps and 0.34 million electric pumps for irrigation in Bangladesh (BADC 2020). Additionally, 2,716 solar pumps with 50.4-megawatt peak (MWp) capacity have been installed until mid-2022. Around 56% (1,523) of the total number of SIPs with 84% (42.1 MW) of the total installed capacity are financed through the Infrastructure Development Company Limited

Drone shot of solar panels at a village in Bangladesh (*photo*: Waresul Haque).

(IDCOL), a nodal agency for renewable energy financing in Bangladesh. IDCOL plans to scale-up solar irrigation in Bangladesh using its unique fee-for-service financial model. However, IDCOL is currently focusing on the boro-dominated areas for implementing its SIPs. High seasonal demand for irrigation presents unique challenges threatening the long-term financial viability of IDCOL's SIPs.

Challenge 1: High panel-to-pump ratio requires higher investments

IDCOL needed to increase the panel size-to-pump ratio of the SIPs to meet the constant flow requirement of irrigation water during the peak irrigation season of boro. The average pump size of an IDCOL SIP is 15.3 kilowatts (kW), with the average solar panel capacity at 29.7-kilowatt peak (kWp). Over the years, pump sizes have been getting larger, with even larger panel capacity, resulting in an increasing panel-to-pump ratio (Figure 2). Increasing the panel size enables the SIP sponsors to cover larger command area for boro paddy than would have been otherwise possible. Ensuring maximum coverage of boro is vital from a financial viability perspective as this crop accounts for 65%-70% of total revenues from SIPs (Mitra et .al. 2021). But oversizing the panels has clear cost implications, borne mainly by private sector companies or non-governmental organizations (NGOs), who pay 15% as

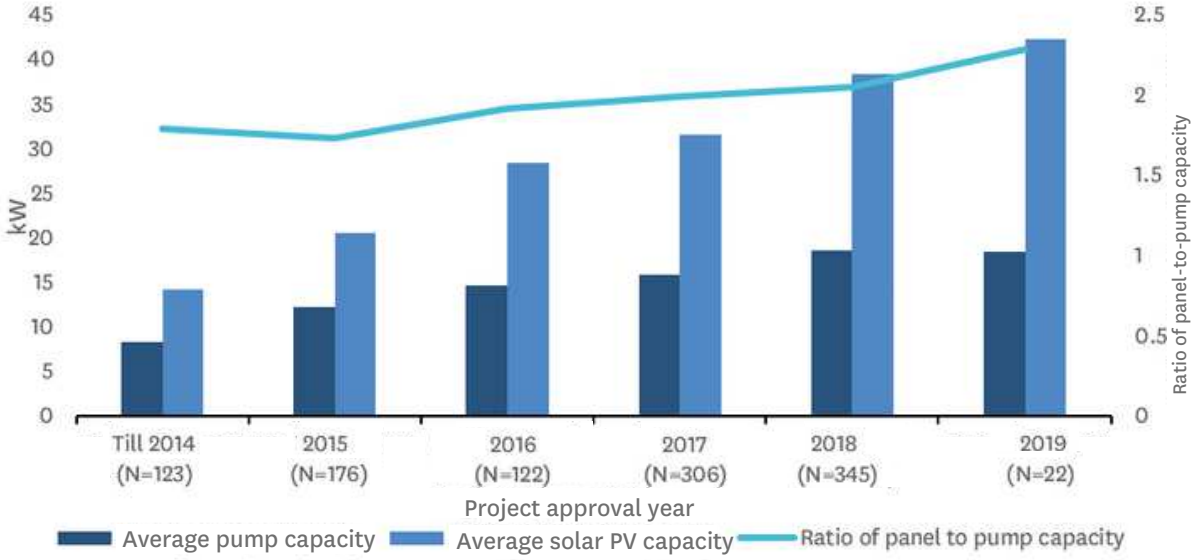

Figure 2. Year-wise panel-to-pump capacity ratio of IDCOL SIPs.
Source: IDCOL monitoring data of 1194 IDCOL SIPs

Solar panels with facility of fishing in Bangladesh (*photo:* NGO Forum).

Farmer busy sowing paddy seeds (*photo:*NGO Forum).

equity and 35% as loans and recover the same from the farmers as irrigation fees.

Challenge 2: Seasonal irrigation demand leads to underutilized panel capacity

However, irrigation demand in Bangladesh is limited to only a few months of the year. It is the highest from March to June (84 days out of 122 days), while quite limited for the rest of the year (Figure 3).Compared to the northwest region, capacity utilization is slightly better in the southwest region, where cultivation of three crops in a year is more common. This seasonal demand for irrigation leaves much of the expanded panel capacity underutilized and threatens the financial sustainability of SIPs.

A diesel pump at a village in Bangladesh (*photo:*NGO Forum).

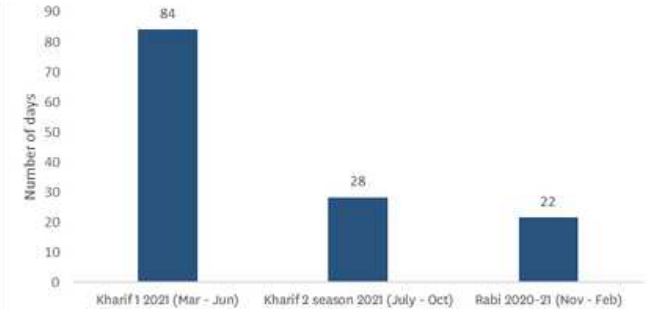

Figure 3. Season-wise average number of days of SIP use for irrigation.
Source: SoLAR SIP telephonic survey of a representative sample of IDCOL pumps

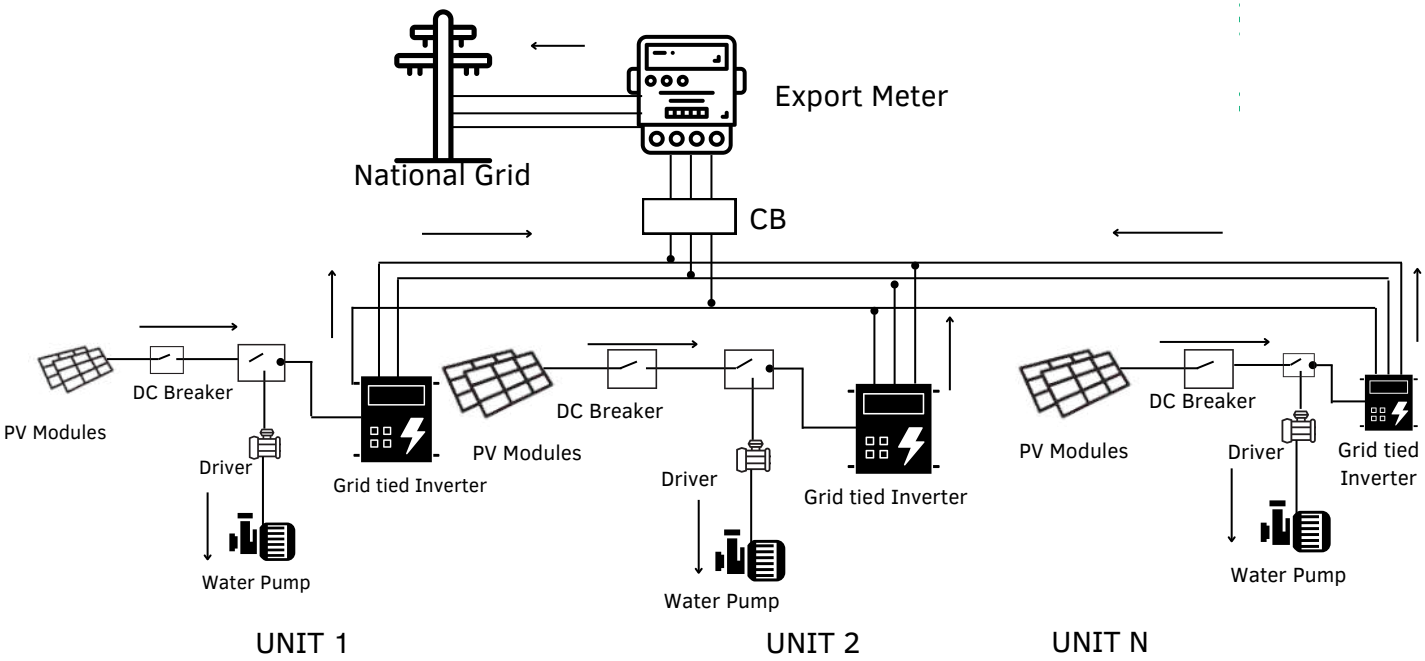

Figure 4. Grid connection for multiple SIP systems using multiple inverters.
Source: IWMI-SoLAR project adapted from SREDA 2020a

Grid-connected SIPs: One solution to two challenges

Solar-grid integration is a network allowing evacuation of (unutilized) photovoltaic (PV) power into the national utility grid. It prevents the wastage of surplus energy, and the pump owners can subsequently monetize this surplus power by selling it back to the national grid. Grid integration (Figure 4), therefore, can be an effective strategy for augmenting the revenues of the IDCOL sponsors, who risk investing their own money and taking loans to set up an irrigation service business in off-grid areas. Most of the SIPs in Bangladesh are in areas where PV electricity potential is around 1,400 kilowatt hours per kilowatt peak (kWh/kWp) (Figure. 5). Annual SIP utilization estimates show that irrigation usage accounts for only 27% of annual sunshine hours (Buisson et al. 2022), and there is an opportunity to sell approximately 800 to 1,200 kWh/kWp through a grid connection.

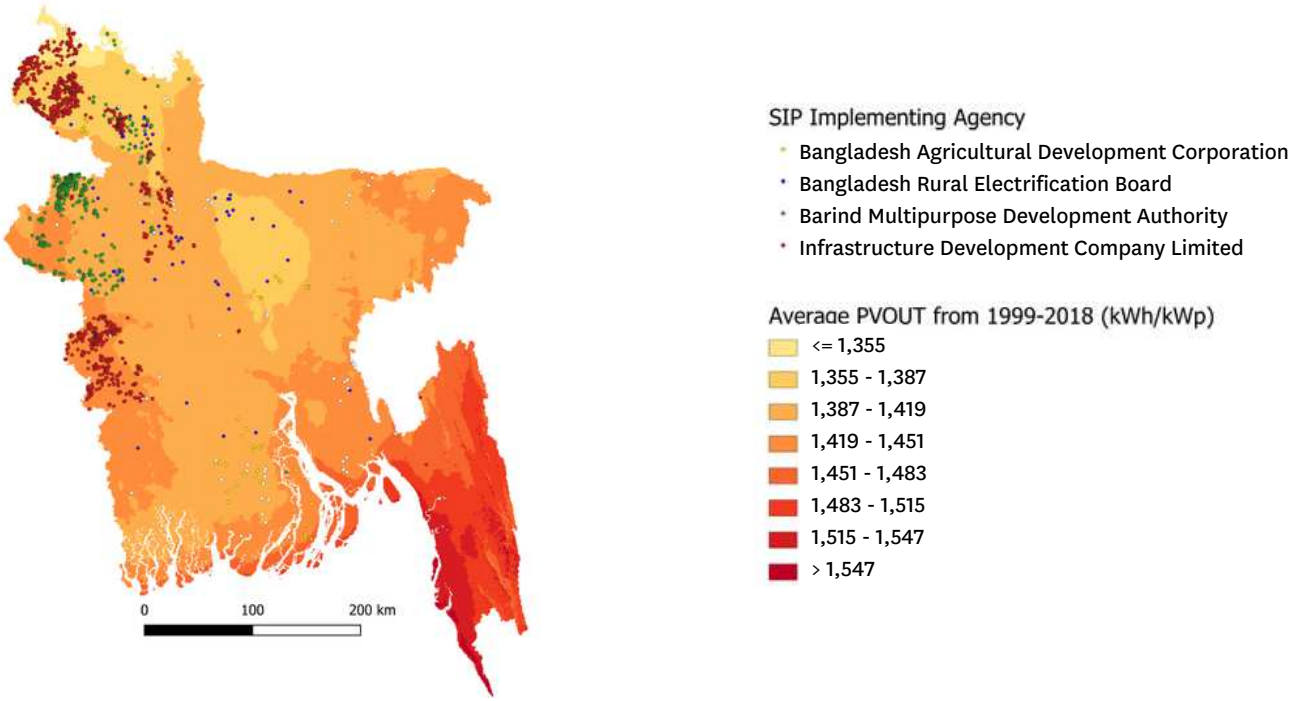

Figure 5. Long-term average of yearly potential electricity production from a 1 kWp grid-connected solar PV power plant.
Source: © 2020 The World Bank,Global Solar Atlas 2.0, Solar resource data: Solargis
Note: PVOUT is the estimated solar PV power generation potential. It represents a long-term average of yearly/daily potential electricity production from a 1 kW-peak grid-connected solar PV power plant.

This can lead to the possibility of earning an additional annual revenue of approximately BDT (Bangladesh Taka) 3,500 - 5,200* per kWp installed capacity, at BDT 4.36 per unit tariff rate. The tariff is decided per Bangladesh's grid connection policy (SREDA 2020a). For a SIP with a 30 kWp panel integration, this translates into BDT 0.11-0.16 million per year, which is more than or equal to the average revenue earned from irrigation services (approximately BDT 0.1 million/year) (Buisson et al. 2022).

Grid connection costs are also not very high compared to the investments in off-grid SIPs that have already happened. The average project cost of an off-grid SIP is around BDT 0.16 million/kWp of installed capacity, and much of its capacity is underutilized. With approximately 20% additional investment of about BDT 0.035 million/kWp, this readily available solar infrastructure can be easily connected to the grid. It can contribute to the target of a 10% renewable energy mix by 2030 but at a lower capital expenditure. Recent investments into large-scale solar park projects costed up to BDT 0.15 – 0.17 million /kWp (Byron and Hasan 2021; BSS 2021).

Getting the incentives right for speeding up grid integration

While the Sustainable and Renewable Energy Development Authority (SREDA) has already set out the rules for the grid integration process (SREDA 2020a), institutional interventions are also needed to improve the economics of the grid-integrated systems. At the current buyback rate of BDT 4.36/unit of the Bangladesh Rural Electrification Board (BREB), it can take as long as 10 to 12 years to recover the additional investment required for grid integration. According to estimates from pilot grid integration projects in Bangladesh, it can cost BDT 0.11-0.13 million per site for grid integration. If BREB can buy back solar power at a higher rate – comparable to the BDT 8.02/unit that the Bangladesh Power Development Board (BPDB) pays to purchase fossil fuel-based electricity from private companies – and get compensated for it by the government, grid integration will become a more attractive option for both the SIP owners and the utility.

Another option is to allow net metering to ramp up the demand for SIPs. SIP owners may use grid electricity to supplement high irrigation demand (e.g., through night-time irrigation during the initial peak irrigation days of boro cultivation) or low power generation (due to fog or cloud). As such, a larger command area can be brought under solar irrigation through net metering, thus reducing diesel dependency. However, some caveats need to be introduced for net metering to ensure that SIP owners do not abandon solar use to maximize grid evacuation. Interventions like capping the maximum amount of energy to be evacuated into the grid or allowing only a net exporter of electricity to remain grid-connected may be tested. Pilots to experiment with various net metering options can help guide future policies.

A field being irrigated (*photo:* NGO Forum).

*USD 1 = BDT 94.68 as per Bangladesh Bank's exchange rate on July 26, 2022 https://www.bb.org.bd/en/index.php/econdata/exchangerate

Solar panels in Bangladesh (*photo:* NGO Forum).

References

BADC (Bangladesh Agricultural Development Corporation). 2020. Minor Irrigation Survey Report 2018-19". Dhaka, Bangladesh. http://badc.portal.gov.bd/sites/default/files/files/badc.portal.gov.bd/page/1797204a_d707_4d99_9b02_0b5a3b5b0ae6/2020-09-01-14-19-46f05fa15d06d65f320fefd87eb529a1.pdf

BSS (Business Support System). 2021 “EPC contract for 50MW solar plant in Feni to be inked next month”. The Business Standard (Accessed on May 17, 2021). https://www.tbsnews.net/bangladesh/energy/epc-contract-50mw-solar-plant-feni-be-inked-next-month-246898.

Buisson, M.; Mitra, A.; Osmani, Z.; Habib, A.; Mukherji, A. 2022. "Impact Assessment of Solar Irrigation Pumps (SIP) in Bangladesh: Baseline Technical Report". New Delhi, India: International Water Management Institute (IWMI). Report available on request.

Byron, R.K. ; Hasan, M. 2021. “ Govt to build Tk 1,511cr solar power plant”. The Daily Star, August 10, 2021. https://www.thedailystar.net/business/economy/news/govt-build-tk-1511cr-solar-power-plant-2148816.

MEFCC (Ministry of Environment, Forestry and Climate Change). 2021. “Nationally Determined Contributions (NDCs) 2021, Bangladesh (Updated).” https://unfccc.int/sites/default/files/NDC/2022-06/NDC_submission_20210826revised.pdf (Accessed on August 22, 2022).

Mitra, A.; Alam, M.F.; Yashodha, Y. 2021. “Solar Irrigation in Bangladesh: A Situation Analysis Report.” New Delhi, India: International Water Management Institute (IWMI). https://solar.iwmi.org/wp-content/uploads/sites/43/2021/09/BANGLADESH-SITUATION-ANALYSIS-REPORT_final-version-2.pdf

SREDA (Sustainable and Renewable Energy Development Authority). 2020a. "Guidelines for the Grid Integration of Solar Irrigation Pumps-2020". Dhaka, Bangladesh: Power Division, Ministry of Power, Energy and Mineral Resources, Government of Bangladesh(GoB). https://solar.sreda.gov.bd/doc/Guidelines%20for%20the%20Grid%20Integration%20of%20Solar%20Irrigation%20Pumps%20(SIP)%20sc.pdf

SREDA 2020b. "National Database of Renewable Energy". http://www.renewableenergy.gov.bd/ (Accessed on August 22, 2022).

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Project

The Solar Irrigation for Agricultural Resilience in South Asia (SoLAR-SA) project aims to sustainably manage the water-energy and climate interlinkages in South Asia through the promotion of SIPs. The main goal of the project is to contribute to climate-resilient, gender-equitable, and socially inclusive agrarian livelihoods in Bangladesh, India, Nepal and Pakistan by supporting government efforts to promote solar irrigation. This project responds to government commitments to transition to clean energy pathways in agriculture. All countries in this project have NDC commitments to reduce GHG emissions and SIPs can play a significant role in reducing emissions in agriculture. https://solar.iwmi.org/

About SDC

The SoLAR -SA project is supported by the Swiss Agency for Development and Cooperation (SDC). SDC is the agency for international cooperation of the Federal Department of Foreign Affairs (FDFA). Swiss Agency for Development and Cooperation, which is an integral part of the Federal Council’s foreign policy, aims to contribute to a world without poverty and in peace, for sustainable development. SDC, through its Global Programme Climate Change and Environment (GPCCE), helps find solutions to global challenges linked to climate change. It engages in global political dialogue and manages specific projects in the fields of energy, climate change adaptation, sustainable development of mountainous regions and prevention of natural hazards that are likely to influence regional and international policy.

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