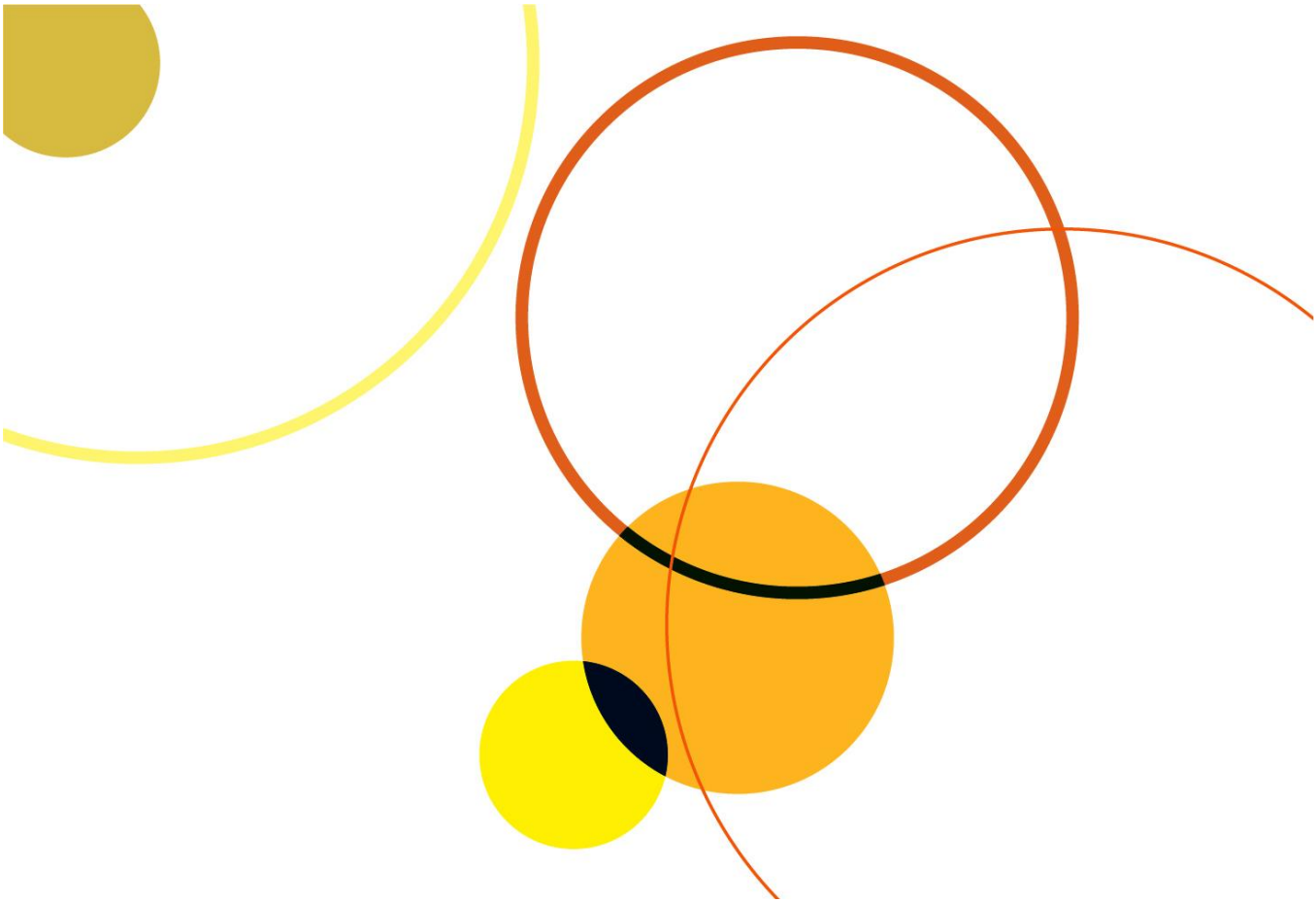
Solar irrigation pumps

Business model brief - Bangladesh

February 2019

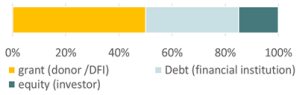
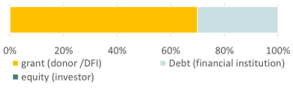
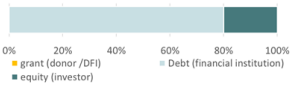


1 Introduction

This brief summarises the current business model for solar-powered irrigation (SIP) systems in Bangladesh, and suggests short term improvements to these business models to support market development. It synthesises the current state of market development and the business model that has delivered SIP projects to date. It then summarises lessons learned from experience and recommends improvements to the business models within the existing policy and regulatory framework. A separate investment case describes how these business models present opportunities to financial institutions, project investors, and public sector financiers (government, donors and DFIs).

Between 2013 and 2018, over 1,000 SIPs have been deployed, almost all by the Infrastructure Development Company Limited (IDCOL), a government owned financial institution. IDCOL has financed 1,031 of the 1,131 solar irrigation pumps (SIPs) in Bangladesh, with the Bangladesh Agricultural Development Corporation (BADC), and the Rural Electrification Board (REB) financing another 100 in total. Across all the SIPs installed, this represents a total solar PV installed capacity of approximately 21 MW.[1] Commercial banks have played a very limited role to date. Figure 1 summarises the main elements of these different financing options.

Figure 1. **Summary of financing structures for SIP in Bangladesh**

Financier	IDCOL	REB or BADC	Commercial banks / DFIs
finance structure			
grant finance and sources	**Grant of 50%** Financed by DFIs / donors: to date (DFID, KFW and GPOBA)	**Grant of 70%** Govt provides 70% - remainder recovered from farmers	**No grant component**
cost of debt	**6%** Concessional loan for 30% of project, subsidised by DFIS (JICA and IDA) and paid back over 8 years	**0%** Nominal fees charged to farmers to recover 30% of investment cost over 20 years	**9%** Commercial rate of 12% reduced by Bank of Bangladesh refinancing scheme
pricing	**Price ceiling of c. 30 BDT per kWh** Variable per customer up to ceiling	**10,000 BDT fixed fee per year** Annual fees are collected from farmers to cover a portion of the initial investment cost	**Variable pricing**
technical standards	**Specified component standards** Technical standards set by cross-institutional standards committee	**System provided by GoB meeting own design specifications**	**No restrictions** on technical specification and import restrictions
# projects to date	**1,000 +**	**100**	**Limited**

Source: *Vivid Economics*

[1] IDCOL (2017) *"Annual Report 2017"*

Section 2 provides a brief overview of the history of SIP market development in Bangladesh, and provides an overview of the outlook for scaling up SIP market size in the coming years.

Section 3 summarises the current business models to deliver SIP projects, outlining the technical, commercial, financing and pricing parameters of current business models.

Section 4 describes adjustments to the business model to improve the bankability of projects based on experience in Bangladesh and lessons learned from international case studies.In particular:

— ensuring the timing of construction is timed to allow for customer rollout in the highest period of need, i.e. during the *BORO Rice* planting season;
— conducting technical and financial modelling with clear sensitivity analysis around key parameters to ensure robust decision making by investors and financiers.

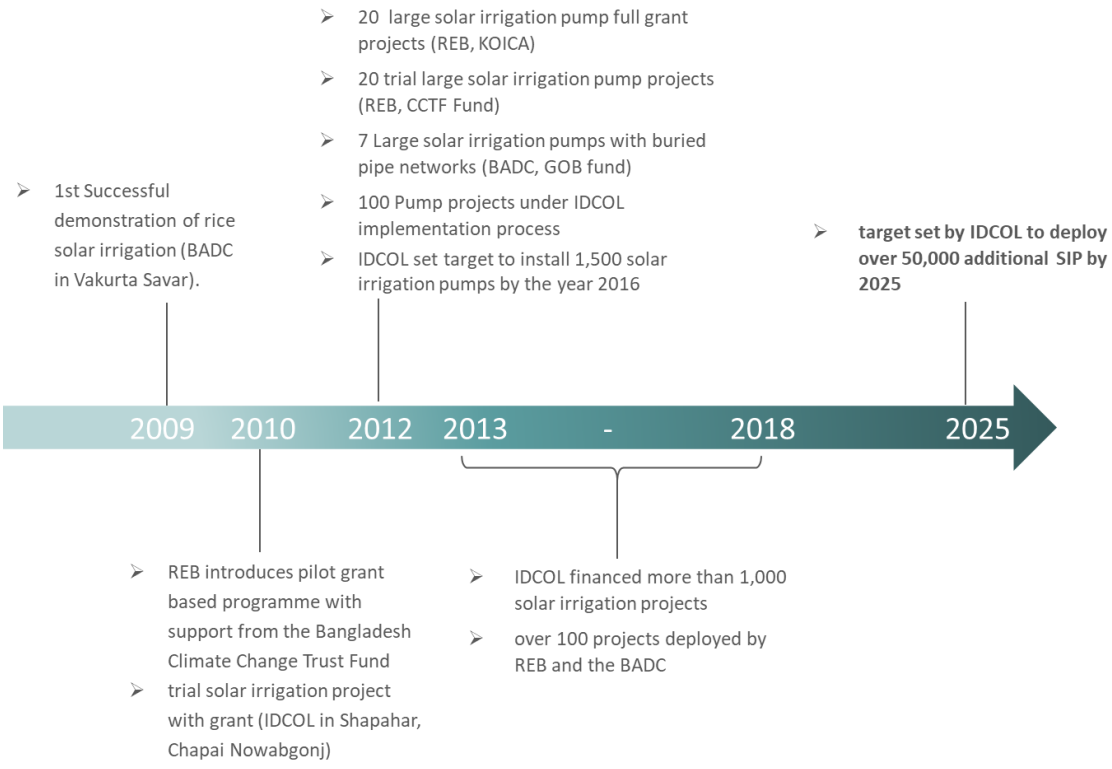
2 Overview of the market for SIPs

Irrigation plays a vital role in Bangladesh at least for half of the year when water scarcity would otherwise present a major challenge for farmers. Different crops are grown in different seasons through year, so irrigation has potential to be used year-round. However, so far it has been most valuable the *'BORO'* rice season only, and irrigation pumps are often not well utilized outside of this *BORO* season.

The monsoon drives heavy rainfall in May, June and July, during which period there is limited demand for irrigation. There is also typically lower demand in the November, December and January, when maize, tomato and vegetables are grown – cash crops which are less intensive in irrigation needs than *BORO*, which is typically grown February through May.

While the technology has been under trial version since the early 2000s, the market has only really taken off since 2010. As shown in Figure 2, the first set of IDCOL projects were introduced around 2012, since then IDCOL has gone on to finance over 1,000 pumps, with BADC and REB financing a further 100.

Figure 2. **The first solar irrigation project was introduced in 2009 by the BADC**



Source: *Vivid Economics*

IDCOL plans to roll-out 50,000 solar irrigation pumps in the next seven years, which will require an acceleration in the pace of market development. Most SIP are currently financed and implemented under the 'fee-for-service' model where project sponsors own and operate the equipment and recover the costs by

charging farmers an irrigation fee. IDCOL is additionally exploring an ownership model where the funding is given to an investor that purchases equipment and then sells it at credit to farmers who own the equipment after completing payment. There is therefore a large and important opportunity to achieve a far larger scale for this technology than the current 1,131 pumps in operation.

While IDCOL will continue to be the main financier for the technology, as the market matures there will be an increasing need to attract commercial finance. To date, IDCOL has financed SIPs in regions which are not served by alternative financing schemes, such as that offered by BADC. Areas that are eligible for IDCOL funding include areas with at least three crop types per year and areas currently using diesel pumps.[2]

The alternative emerging financing options are summarised in the bullets below:

— **BADC offer grant-based finance for solar irrigation.** However, these are only implemented in regions where IDCOL is not working and are a highly concessional mode of finance. For example, BADC provides all of the initial capital to install the system and seeks to recover around 30% of this initial cost through nominal fees from farmers over a period of 20 years. It also installs the system and trains farmers on how to make optimal use of the irrigation enabled by the pumps. BADC intends to install another 400 pumps by 2021.

  This financing structure may be helpful in supporting roll-out of solar irrigation in very low income rural areas but does not present an opportunity to crowd in private sector finance, as there is no equity investment and BADC can only implement government financed projects.

— **commercial banks can lend for solar water pumps, and some sponsors use commercial loans for small pump systems.** We have only heard of a limited number of examples of this approach, which has typically been used for smaller pumps, where project sponsors have already identified their target customer.

  Increasing the role of commercial banks will be important in scaling up the market, and could support achievement of the 50,000 target.

— **accessing finance provided by DFIs potentially through commercial banks.** The Asian Development Bank is developing a sizeable program of finance for solar irrigation, comprising USD 20 million in loans and a further USD 25 million as grants.[3] The business model and implementation plan for this finance has not been finalized, but it is likely to be operationalized through the ADBs sovereign lending portfolio through the REB, with 50% grant and 50% loan. The ADB plans to initially install 2,000 solar irrigation pumps.

  SREDA will need to make sure the integrity of existing models is preserved, and complemented by any such new approaches.

[2] IDCOL (2015), *'IDCOL Solar Irrigation Projects'*

[3] https://www.adb.org/news/454-million-spur-grid-solar-driven-pumping-irrigation-bangladesh

3 The business model for delivering SIP projects

The typical model for delivery of SIP projects using IDCOL IDCOL finance is a 'fee for service' model. As shown in Figure 3, project sponsors apply for grant and concessional loan finance from IDCOL. To be eligible for finance , the project sponsor must meet the minimum standards set by Technical Standards Committee (TSC), including by using an approved suppliers list . The project sponsor then installs the pumps, and sells irrigation to farmers on a fee-per-hectare-irrigated basis.

The remainder of this section describes the attributes of the business model in terms of:

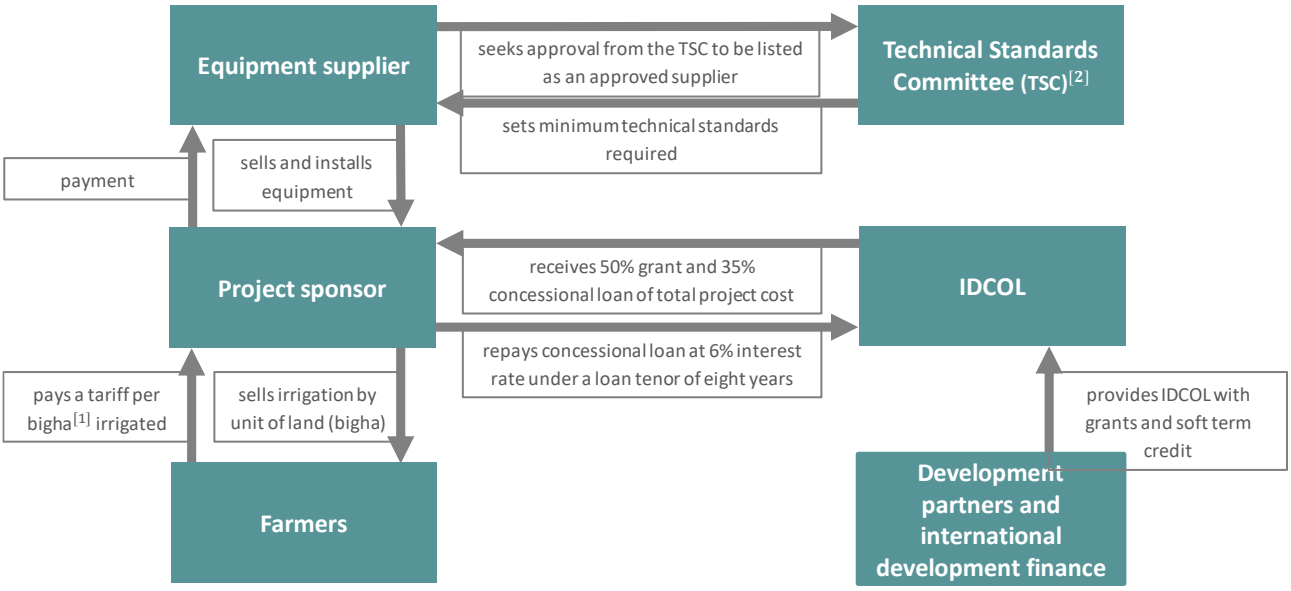
— *technical and commercial aspects*, such as the role of the TSC and equipment suppliers, are described in **Section 3.1**;

— *project finance*, centred on the role and terms of IDCOL finance, is discussed in **Section 3.2**;

— *consumer pricing*, on a fee for service basis for farmers purchasing irrigation from the project sponsor, is set out in **Section 3.3**;

— *broader environmental and social benefits*, which motivate the role of concessional finance supported by development partners, is introduced in **Section 3.4**.

Figure 3. **The current operating model for the SIPs is on a 'fee for service' basis between project sponsors and farmers**



Note: *[1] bigha is a unit of land equivalent to 0.25 hectares.*

[2] the TSC, composed of experts and government officials, was formed by IDCOL

Source: *Vivid representation from IDCOL (2017) "Annual Report 2017"*

3.1 Technical and commercial aspects

Solar irrigation pumps provide small scale solutions for rural farmers, with pump capacity ranging from 5 to 20 kWp per pump. The market is for rural farmers or potentially cooperatives of farmers. Depending on the site they may use surface water, or groundwater, each of which presents different challenges. With both surface water and ground water there are concerns about arsenic poisoning, and with ground water there are also sustainability concerns. These considerations will need to be carefully managed by project sponsors and monitored by SREDA and/or the Department of Environment.

There are a large number of project sponsors who have been active at different stages of market development. For example, Rahimafrooz were very involved in the early stages since 2009, and has worked with IDCOL and with BADC/REB on a large number of projects. It has acted both as a TSC approved supplier selling imported pumps to project sponsors, and as project sponsors making the investment. Rahimafrooz is looking to expand their investment in the sector, aiming to install a few hundred pumps in the coming years. Solar Gao are now a very active provider having installed over 500 pumps since 2013.

IDCOL regularly updates the list of TSC approved suppliers, currently composed of 20 suppliers offering pumps with a solar panel capacity ranging from 8 kWp to 30 kWp.[4] The majority of these suppliers are locally based and distribute largely imported technology.[5] Some suppliers like Rahimafrooz and Solar Gao are both TSC approved suppliers and project sponsors. That is, they sell equipment to independent project sponsors as well as secure funding from IDCOL directly to sponsor their own projects.

Table 1. Technical and commercial parameters of IDCOL's solar irrigation programme in Bangladesh

Parameter	Description
Typical capacity of the solar pump	pumps ranging between 5 to 20 kW, powered by solar panels ranging between 8 and 30kWs[6]
Customer segment targeted	Rural farmers
Site selection	Site must be approved by the Technical Standards Committee. Factors which influence approval of the include:[7] — current use of diesel pumps in the area — depth of the water table — potential for 3-4 crops per year — potential for alternative uses of electricity generated — land not inundated during rainy season
Sponsors and equipment suppliers	Equipment suppliers install the pumps following IDCOL's technical standard protocol. Some examples are listed below: Rahimafrooz Renewable Energy Ltd.(RREL) ; Navana Renewable Energy Co.Ltd (NREL) ; Energypac Electronics Ltd.(EEL) ; Sherpa Power Engineering Ltd (Sherpa) ; B-Trac Engineering Ltd (BTEL) ; Solargao Ltd. ; Solar E Technology ; Electro Solar Power Ltd (ESPL) ; UDDIPAN Energy Ltd (UEL) ; SamajUnnayonPalliSangstha (SDRS) ; JSF Technology Pvt Ltd(JSF) ; Power utility Bangladesh Ltd. ; Superstar Renewable Energy Ltd.(SREL) ; Bright Green Energy Foundation ; ATES Bangladesh Limited ; SCUBE Technologies Ltd

[4] IDCOL (2019) http://idcol.org/download/Updated_SIPS_Suppliers_list_03.01_.19_.pdf d

[5] IDCOL (2019) http://idcol.org/download/Updated_SIPS_Suppliers_list_03.01_.19_.pdf

[6] https://k-learn.adb.org/system/files/materials/2015/05/201505-presentation-business-models-solar-irrigation-bangladesh-and-india.pdf

[7] https://www.icimod.org/resource/17186

Parameter	Description

3.2 Producer financing

The majority of the solar pumps have been installed under a sponsorship model with a fixed financing structure from IDCOL. As detailed in Table 2 IDCOL provides 50% grant, 35% concessional loan (typically at 6%) and an investment from the project sponsor of 15%. The concessional loan is repaid by the project sponsor over a 10-years period, with a one-year grace period for construction and customer acquisition.

The ADB is working on an alternative financing structure with the REB. This would likely comprise a 50% grant and 50% loan recovered from charges to users. However, how this finance will be delivered and the business model used has not yet been determined.

Commercial banks could also provide finance to solar irrigation, potentially accessing Bank of Bangladesh refinancing to lower the cost of debt. Under this financing structure there would be no grant, and the cost of the loan using Bank of Bangladesh would be around 9% (compared to 12%-14% commercial lending rates). The advantage of this model is that it would not require sponsors to follow approved IDCOL / technical standards committee technical standards and suppliers, which can bring down the initial investment cost.[8]

Table 2. Financial parameters for solar irrigation project in Bangladesh funded by IDCOL

Parameter	Description
Estimated total project cost	Approx. 2.6 million BDT (31,343 USD)
Structure of financing (equity | debt | grant)	50% grant, 35% soft loan, 15% equity investment
Financiers	50% grant through IDCOL, provided by development partners like USAID, Global Partnership on Output-Based Aid (GPOBA) and Asian Development Bank (ADB). 35% soft loan through IDCOL, funded by International Development Association (IDA) and Japan International Cooperation Agency (JICA). Loan is for 10 years with an interest rate of 6% per annum and a one year grace period. 15% equity investment by sponsors.
Terms of loan	10 year loan, with 1 year grace period. Concessional interest rate of 6% per annum (compared to 12-14% market rate).
Financing requirements	100% loan collateral in the form of a bank guarantee of land mortgage required from sponsors.

[8] Standards and supplier lists available at http://idcol.org/home/downloads/irrigation

Parameter	Description
	Sponsors must also have prior experience in implementing small to medium scale projects in any sector, have a clean banking credit history, and demonstrate capability to operate and maintain SIP projects in rural settings. They must provide monthly reports outlining number of customers, area of coverage, revenue collection and any event of default. If the sponsoring entity is a joint venture involving a foreign company, the local party must own at least 51% of the shares of the joint venture.
Over budget expenses	Any costs over the anticipated budget in the implementation contract with IDCOL must be borne by the sponsor.
Sponsors (i.e. equity investors)	Sponsors are private entrepreneurs who provide capital investment and operate the project. Examples include: Rahimafrooz Renewable Energy Ltd.(RREL) ; Grameen Shakti ; NUSRA ; 4SL ; GHEL ; GRAM ; RDF ; SDRS ; MCL ; Solargao Ltd. ; AID ; Bright Green Energy Foundation (BGEF) ; GAZI ; INGEN Technologies ; RHECO ; BARI
Ownership of asset	Sponsor owns asset
Asset life	20 years
After sales services and maintenance	EPC warranty for 5 years

3.3 Product and pricing

Sponsors are responsible for customer acquisition and collecting payments from customers, that is from the farmers who pay for the irrigation service. As presented in Table 3, the sponsors typically charges BDT 2,500 – 3,000 for irrigating a bigha of land which is competitive against diesel based irrigation charges in the ranges of BDT 4,300 to 4,800. The charge per bigha of land depends on the crop type irrigated, as the irrigation (and therefore pumping requirement) vary from crop to crop.

Table 3. Pricing structures and revenue generation for solar irrigation in Bangladesh

Parameter	Description
Product for end users	Sponsor provides irrigation services to farmers.
Structure of end user tariffs	Irrigating one bigha (approximately 0.33 acres) costs 2,500 to 3,000 BDT. Diesel based irrigation costs about 4,300 to 4,800 BDT per bhiga per year.
Revenue collection model	Sponsor takes collection risk from customers.

3.4 Socioeconomic and environmental benefits

Access to a solar irrigation pump can save rural farmers expenditure on diesel, promote revenue generation, and reduce CO2 emissions.

SIPs have the potential to abate between 8 tonnes and 18 tonnes of CO_2 annually. A diesel irrigation pump will emit an average of 0.75 kg of CO_2 per kWh generated.[9] Since SIP replace diesel pumps, they represent an abatement potential of 0.75 kg of CO_2 per kWh generated. The range of total annual abatement will therefore depend on the generation potential of the SIP. The ADB is planning to deploy SIP with an average solar peak potential of 10 kWp and an annual potential abatement potential of 9 tonnes of CO_2. Larger systems ranging between 20 and 30 kWh, such as the ones deployed through the IDCOL model, have an abatement potential ranging between 12 and 18 tonnes of CO_2 per year since they can meet a higher demand of kWh per year.

Table 4. Summary of socioeconomic and environmental benefits of solar irrigation in Bangladesh

Parameter	Description
Community benefits	Solar irrigation has the potential to improve farming practices and reduce costs for rural farmers. Additionally, the use of solar pumps can be deployed in parallel to technical assistance for farmers on alternative revenue generation streams off-season.
Environmental benefits	Compared to irrigation with a diesel pump, the range of solar pumps deployed can lead to between 8 and 18 metric tonnes of CO2 abated per year.
Socio-economic benefits	Farmers could save approximately 13,667 BDT per year on diesel costs.[10] They will be able to re-invest this saved income on household development or crop expansion to boost their income. Additionally, the power from the pump may have additional uses powering the local community during idle times.

4 Suggested adjustments to improve the business model

The current business model has largely been successful in developing the market for the first 1,000 pumps. To accelerate growth of the market to the target of 50,000 pumps over the coming years may be possible with the current business model structure, with two light-touch recommendations below. These are suggested as solutions to address some key barriers that were identified through the study of the current business models. The intention of both of these recommendations is therefore to provide a higher and/or more stable rate of return to investors in line with some identified barriers to development.

The recommendations included below were generated from a combination of national and international research. This included a review of international experience in developing commercial business models for solar irrigation pumps in Nepal and India, and stakeholder interviews with project sponsors and policy makers in Bangladesh over three in-country visits across July, October and November 2018. Meetings were held with:

[9] Every kWh generated would require 0.28 litres of diesel (source: Blue Marine SMG pre-investment model), and for every litre of diesel consumers 2.68 kg of CO2 are emitted (source: UK MEF (2015) *"Summary of Emissions Factors for the Guidance for Voluntary Corporate Greenhouse Gas Reporting – 2015"*).

[10] https://k-learn.adb.org/system/files/materials/2015/05/201505-presentation-business-models-solar-irrigation-bangladesh-and-india.pdf

— investors such as e.g. Solar Gao, Rahimafrooz, Grameen Shakti;
— financial institutions such as IDCOL, One Bank Ltd, Uttara Bank, BIFFL and Bangladesh Bank;
— development partners and development finance institutions such as ADB, DFID, GIZ
— national policy makers including SREDA, MoEFCC, MoPEMR, Power Division, BERC.

A separate set of more involved measures to mobilise investment, requiring more substantial policy or regulatory change are developed in a separate implementation roadmap.

Business model adjustment #1: Timing the beginning of operations to match seasonal irrigation demand and innovative pricing to encourage customer uptake

Rationale: Making sure that the construction period is timed to ensure the pump is operational in time for the *BORO* growing season maximises revenues and reduces project risk. This is important, as if the value is not demonstrated quickly to farmers (i.e. during the most valuable *BORO* cultivation season), it is much harder to later convince farmers to maximise usage of the pumps. Timing construction for the *BORO* season could be combined with complementary measures to ensure customer buy-in to the new technology. For example, offering the first *BORO* season at a heavily reduced tariff to demonstrate the effectiveness of the technology to encourage usage in other growing seasons and in subsequent years.

Source: project sponsors, who noted that seasonality of use has been a major constraint, and in some cases pumps that become operational at other seasons than the *BORO* season were not as well utilised.

Barrier addressed: this addresses two key barriers: (i) customer uptake and establishment of a new technology, (ii) generating early revenue for project cash flows.

Making sure that the pumps become operational for farmers in time for the main irrigation season for *BORO* helps establish the utility of the pump and encourages uptake and continued use from farmers. It also means revenue is generated early in the project, which helps align incoming cash to repayment of the loan.

Implementation feasibility: this is a question of best practice, but is important to implement in time. If there are delays in completing construction, there is also a risk that local climate conditions can result in long construction delays.

Unlocking finance: provides a clear early revenue base from farmers by ensuring uptake as soon as the pump is operational. This both increases returns by maximising revenue generation, and minimises revenue risk by getting customer buy-in to the technology as quickly as possible

Business model adjustment #2: Carry out clear sensitivity and scenario analysis for new sites, identifying key risk parameters

Rationale: Improving the standard pre-investment modelling tools used to assess the investment potential would provide greater reassurance to project sponsors and financiers. This should form a core part of due diligence carried out jointly by the financier and the investor to align on expectations and pre-agreed contractual arrangements before initiating a project.

Source: Investors identified a difference between returns in pre-investment models, and actual project returns, as a major barrier to successful project finance and investor confidence.

Barrier addressed: there have been large differences between the technical and financial modelling analysis undertaken pre-investment, and the outturn results. This is eroding confidence in the market, and trust in the cashflows expected from potential new projects.

Implementation feasibility: Clear sensitivity and modelling would receive good buy in from project sponsors and financiers. It could quickly become best practice with a clear template for implementation. It could be owned by SREDA or IDCOL and provided as part of a technical assistance facility to project sponsors.

Unlocking finance: A deeper understanding of project risks would help inform better investment decisions, and enhance management of identified and quantified risk factors.

Annex: List of Key Sources for Solar Energy Projects

	Institution	Role	Relevant personnel and Contact information
1.	Power Division	Policy maker for Power Sector, renewable energy generation and energy efficiency. Oversees all activities related to power generation, transmission and distribution, incentive mechanisms and R&D	Mohammad Alauddin, Joint secretary (Renewable Energy) Biddut Bhaban, Power Development Board, Abdul Gani Road, Dhaka Tel: 02-9574406 Email: mohammad_alauddin4124@hotmail.com
2.	Sustainable Renewable Energy Development Authority (SREDA)	Coordinates, conducts R&D on renewable energy and energy efficiency and mobilizes investment for renewable energy projects	Siddique Zobair, Additional Secretary, Energy Efficiency & Conservation IEB Building (9 & 10th floor) Ramna, Dhaka-1000 Tel: +8802-55110340/+88-02-55110335 Ext -130 Email: siddique.zobair@gmail.com
3.	Infrastructure Development Company Limited (IDCOL)	Promotes, develops and finances infrastructure including renewable energy, and energy efficient projects	Farzana Rahman (Senior Vice President and Unit Head (Investment) Renewable Energy) UTC Building, 16th Floor, 8 Panthapath, Kawran Bazar, Dhaka-1215, Bangladesh Tel. 88-02- 9102171-8/261 Email: frahman@idcol.org
4.	Bangladesh Bank	Central bank and apex regulatory body for the country's monetary and financial system, finances renewable energy projects	Qazi Mutmainna Tahmida (Joint Director, Sustainable Finance Department) Motijheel, Dhaka Bangladesh Tel: 88-02-55665001-20 Email: qm.tahmida@bb.org.bd
5.	Bangladesh Agricultural Development Corporation (BADC)	Promotes agriculture development, including financing of solar irrigation pump projects	Md. Shah Alam Siddiqui (Chief Engineer) Krishi Bhaban 49-51, Dilkusha Commercial Area Dhaka-1000 Tel: 9556080-7 E-mail: info@badc.gov.bd
6.	Bangladesh Rural Electrification Board (BREB)	Distributes electricity to rural communities, shareholder of solar energy and, contracts, finances and sets up solar energy projects	Sayed Mahbubur Rahman, Director (Technical) Head Office, Nikunja-2, Khilkhet, Dhaka-1229 Tel: 88-02-8916424-28 Email: rebdirpp@gmail.com
7.	Bangladesh Infrastructure Finance Fund Limited (BIFFL)	This Non-Banking Financial Institution issues bonds and debt instruments and equity offerings for infrastructure projects	S. M. Farmanul Islam, Executive and CEO, Borak Unique Heights, Level-3, 117 Kazi Nazrul Islam Avenue, Eskaton Garden, Dhaka Tel: +880-2-8333238-9Email: ceo@biffl.org

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Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

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Company Profile

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