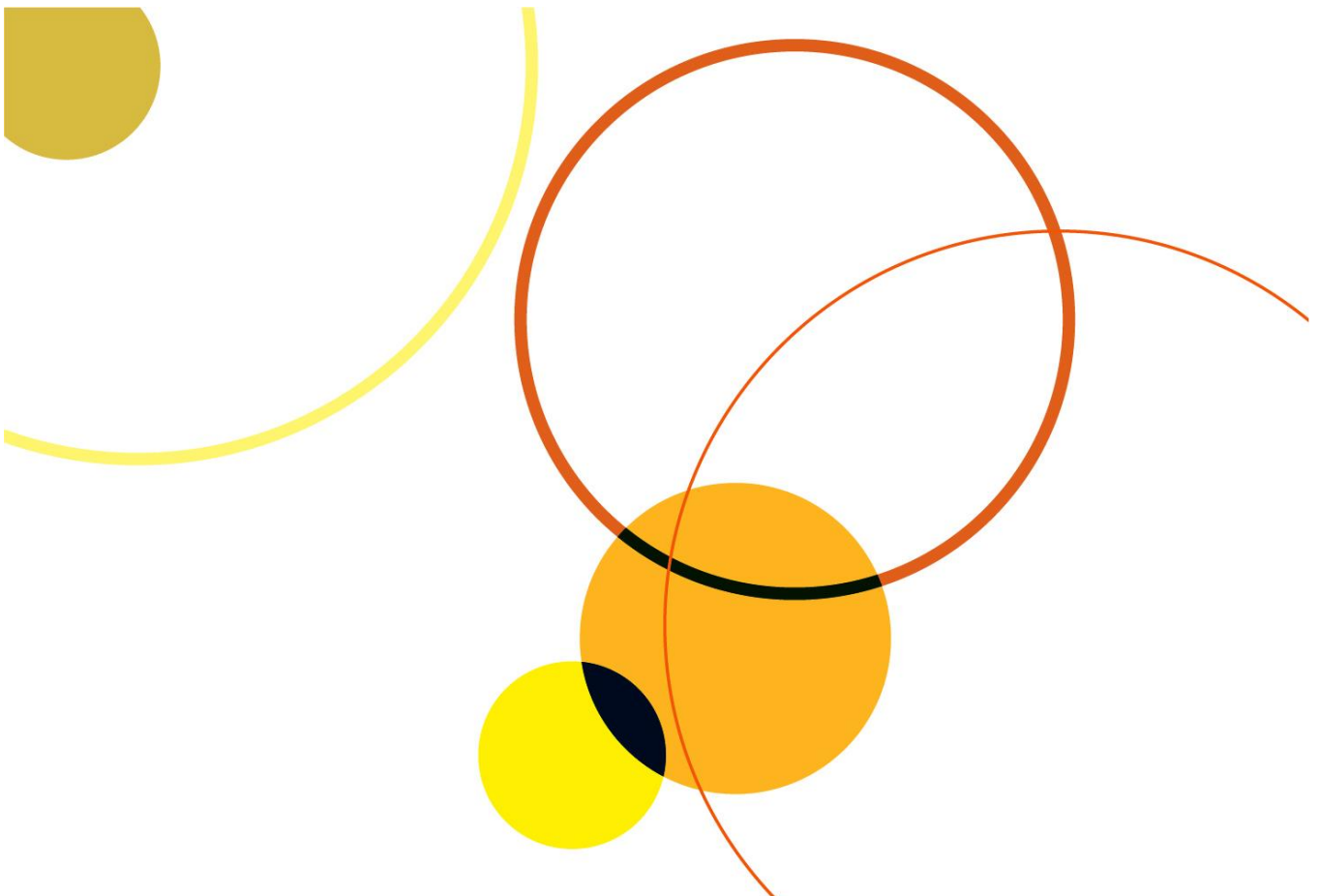


Solar mini-grids

Investment case - Bangladesh

February 2019

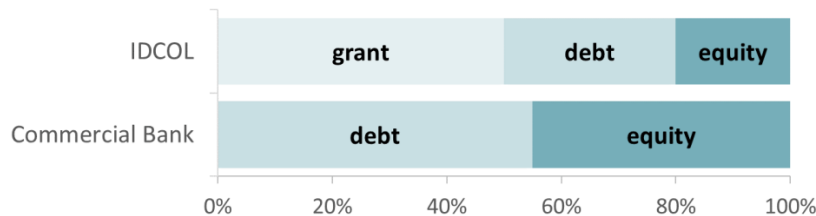


Executive Summary

The government of Bangladesh (GoB) has identified solar mini-grids (SMGs) as an important way to electrify remote areas of the country and deliver the associated social benefits, while simultaneously reducing carbon emissions. A typical solar mini-grid, meeting an annual demand of 400 MWh, emits approximately 90% less CO₂ emissions relative to grid connected power and diesel mini-grid alternatives.

There are currently 22 SMGs operational in Bangladesh; however, the technical potential for growth is much greater. Infrastructure Development Company Limited (IDCOL) has financed the majority (20) of 50% grant, 30% concessional loan and 20% equity investment, and intends to finance a further 200 SMGs over the coming seven years. Commercial finance is becoming a viable alternative to the IDCOL financing programme, and Uttara Bank has financed one small micro-grid. Figure 1 shows the current financing structures through these two alternative structures– which have different degrees of concessionality.

Figure 1. There are two financing structures for SMGs currently deployed in Bangladesh



Despite the availability of concessional financing, project profitability has failed to meet equity investors' expectations. A typical SMG of 250 kWp will require an initial investment of around BDT 100 million (approximately USD 1.2 million), and generate an equity internal rate of return (IRR) of 18% with a payback period on equity of 9 years.

The purpose of this 'investment case' is to summarise the potential for investment in SMGs, and present recommendations to improve profitability based on a stylised cashflow model of a typical SMG. It finds that two key factors affecting returns are the profile of customer acquisition, and capital and operational costs.

The main recommendations put forth in this document are described below:

- **Adopting an 'Anchor – Business – Community' approach to boost returns, and ensure stable cash flow in the early years of the project.** This approach prioritises the acquisition of industrial and business customers with a steady and significant demand load as an anchor before the project starts, in contrast to the standard procedure of acquiring all customers once SMG operations have commenced.
- **Controlling initial investment costs by procuring equipment from less expensive suppliers.** IDCOL imposes strict technical standards for the SMGs it funds. Commercially funded projects are not tied to these requirements, and may reduce investment costs by procuring from less expensive suppliers. However, it is essential for new equipment to be vetted by a technical expert for safety and efficiency given the site characteristics.



- **Undertaking a comprehensive study of current projects' out-run costs compared to pre-implementation projected costs.** Operations and maintenance (O&M) and equipment replacement cost overruns can have a large impact on financial returns, and further study is necessary to understand where cost overruns are most likely to occur, and conversely, where potential cost savings lie.



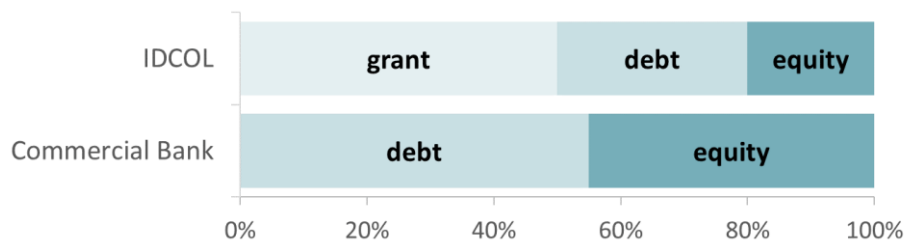
1 Introduction

This document summarises the potential for investment in solar mini-grids (SMGs) for project developers, financiers and government (including support from donors and DFIs). It summarises the financial returns to investors, and analyses key technical and financial parameters which may be uncertain and have important impacts on this financial return. It discusses the potential role for concessional and commercial financing structures, and describes the broader environmental and social benefits that are typically not assessed and/or reflected in projected financial returns.

IDCOL has financed 20 SMGs and plans to finance 200 planned by 2025.¹ Project developers select the sites in collaboration with the Rural Electrification Board to ensure that identified areas will not be connected to the national grid in coming years. A separate *'Solar mini grids: business model brief'* summarises the current state of the SMG market and its prospects in the coming years, and the business models and financing structures available to project developers to implement SMG projects in Bangladesh.

IDCOL provides finance under a fixed 50% grant: 30% concessional loan: 20% equity structure. This has proven to be an attractive mode of mobilising public and private finance in the early stage of market development. However, commercial finance is also a viable option, and both IDCOL and commercial bank capital will be needed to achieve the target of 200 SMGs by 2025. Figure 2 summarises representative examples of these two financing structures.

Figure 2. The opportunities for private and public sector financiers depend on the financing structure used



Note: This figure is repeated at the beginning of each section with the relevant investor (grant, debt or equity) highlighted in yellow.

Under the current business models and financing structures, a typical investment would expect to make a return on equity of around 18%.² However, as this document discusses, a number of factors could push this return higher or lower. For example, project developers face substantial risk around the rate of customer acquisition, and are exposed to any revenue shortfall from failing to connect customers as quickly as expected, or falling short of full utilisation of the mini-grid over its lifetime.

The remaining sections discuss the motivations and risks faced by different stakeholders who have interest in the expansion of the SMG market in Bangladesh. They are structured as follows:

¹ IDCOL (2017). Annual report, page 18.

² This is an indicative rate of return based on cashflow projections for the 250 kWp SMG project at Saint Martin Island developed by Blue Marine Energy Limited and financed under the IDCOL model.



Section 2 describes the role of debt financiers in mobilising resources. While the majority of solar mini-grids in operation have been financed by concessional debt and grants from IDCOL, to support achievement of maximum market potential will require both continued IDCOL debt capital, and capital from commercial banks.

Section 3 describes the financial returns to equity investors and presents a stylised cashflow model, to show the effect on returns of key technical and financial modelling assumptions.

Section 4 describes the continued rationale for grant financing. It details the environmental benefits delivered as a contribution to the Nationally Determined Contribution (NDC) and wider social outcomes delivered.

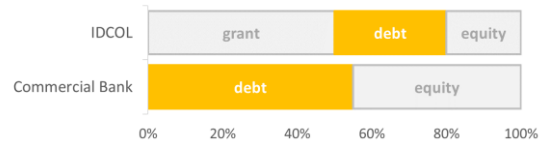
Section 5 presents two case studies on successful SMG projects. One financed by IDCOL, and the other financed through a loan from a commercial bank.



2 Returns to debt financiers

IDCOL has financed the majority of projects to date under a fixed structure of 50% grant, 30% concessional loan and 20% equity from the project sponsor.

The loan is provided at a concessional rate of 6% per annum, compared to a commercial loan typically in the range 10-14% per annum. The tenor of the loan is 10 years, with a two year grace period to allow for construction and customer acquisition, and an eight year repayment period. To access IDCOL finance, the project developer must provide a bank guarantee for 100% of the loan, or alternatively provide collateral (such as land). The annual cost of this guarantee is approximately 0.3% of the value of the outstanding loan.³



The IDCOL model has been successful in developing 20 solar mini-grid sites to date, and IDCOL plans to finance a further 200 SMGs by 2025. Box 2 provides an example of the mini-grid on Paratoli Island which has been developed using IDCOL finance and is on course to repay its debt within the loan tenor.

Commercial banks are also starting to play a role in SMG finance. The only example of this to date is for a micro-grid (50 kWp) developed by project developer (and sponsor) Angira, with debt capital provided by Uttara commercial bank. This project provides an early success for this financing structure, with 45% equity provided by the sponsor and 55% provided as a loan by the bank. In this case the debt was repaid in 3.5 years (well before the loan tenor of 5.5 years). The sponsor intends to develop further – and larger – solar mini-grids following this financing structure, providing an opportunity for debt financiers to invest in the expansion of a tested project. Box 3 provides a description of this project, and the key factors that have shaped its success.

Commercial banks can access green credit refinancing lines from the Bank of Bangladesh (BoB), which lower the cost of debt for SMG projects. The BoB offers a re-financing scheme for solar mini-grids at the Bank rate of 5% plus a mark-up for on-lending of up to 4%.⁴ At this early stage of market development, banks can also require the loan to be fully collateralised. Project developers will typically provide the technical and financial models, so due diligence costs should be relatively minimal, particularly for longstanding customers or known counterparties.

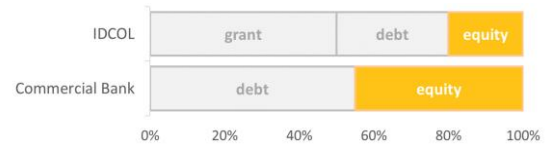
A number of factors could support further debt being provided to the market. For example, more good quality projects coming to market with good management teams; a growing dataset on loan repayment profiles to help better price the repayment risk; market deepening with more lenders and intermediaries (e.g. guarantee providers) coming into the market to help de-risk projects; bundling of projects so that they are a bigger scale and thus transaction costs on diligence are lower etc.

³ Representative percentage based on the SMG project at Saint Martin Island developed by Blue Marine Energy Limited.

⁴ More information available in the business model brief.



3 Financial returns to project sponsors (equity)



3.1 Internal Rate of Return (IRR)

Investors can expect to make a return of around 18% in a standard SMG project. This section explores a range of profitability indicators of relevance to equity investors, covering both return on equity and the overall rate of return on both equity and debt. It also summarises some of the key risk factors that an investor will need to control to maximise returns.

Box 1 describes the metrics used to assess financial returns. The analysis presents only financial returns to the investor; broader social benefits are discussed separately in Section 4.

Box 1. Metrics used to measure financial return

— Net present value (NPV)

The net present value of a project is the current value of all cashflows less the initial investment. The current value is calculated by discounting future inflows and outflows, capturing the delayed consumption. This analysis uses the Bangladesh Bank inflation rate (5%) as the discounting rate, as an estimate of a risk free national cost of capital.

— Internal Rate of Return (IRR)

The internal rate of return is the discount rate that results in the NPV being zero. For an investor, this would need to be higher than their 'hurdle' rate, which is the rate of return they would expect from a project with a similar risk profile.

— Equity IRR

The return on equity is similar to the IRR, but calculated only on the equity portion of the investment. It indicates the return on the initial equity investment into the asset.

— Payback period on equity

The payback period is the length of time required to recover the initial equity outlay.

A typical 250 kWp Solar Mini Grid generating 400 MWh of electricity will require an initial investment of around BDT 100 million (approximately USD 1.2 million), and generate an equity IRR of 18% with a payback period on equity of 9 years. Table 1 presents a stylised example of a typical solar mini-grid project, using IDCOL's financing structure. This entails a fixed structure comprising 50% grant, 30% concessional loan (at 6% annual interest rate) and 20% equity from project sponsors. Under this structure the initial capital outlay is recovered over time, with the debt repaid over the initial 10 years of the project. Project sponsors then effectively make their return on equity over the remaining years of the project.



Table 1. Financial indicators for a typical solar mini-grid offers investors a 18% return on equity (2018 BDT millions, unless otherwise stated)

| Year | 0 | 1 - 2 | 3 - 10 | 11 - 20 |
|---|----------------------------------|--------------------------|------------------------------|---|
| | <i>Initial investment period</i> | <i>Loan grace period</i> | <i>Loan repayment period</i> | <i>Stable revenue generation period</i> |
| <i>Loan income</i> ^[1] | 29 | 0 | 0 | 0 |
| <i>Grant income</i> | 49 | 0 | 0 | 0 |
| <i>Equity expenditure</i> | (20) | (0) | (0) | (0) |
| Total capital investment | 98 | 0 | 0 | 0 |
| Operating expenditure (including replacement costs) ^[3] | (0) | (4) | (49) | (68) |
| Financing cost | (0) | (4) | (38) | (0) |
| Revenue | 0 | 20 | 99 | 124 |
| Net total cash flow | (20) | 12 | 12 | 56 |
| NPV of net cash flow (using 5% discount rate) ^[2] | 27 | | | |
| Internal rate of return (IRR) | 12% | | | |
| Equity IRR | 18% | | | |
| Payback period on equity | 5 years | | | |

Source: Vivid Economics

Notes: [1] all financial units are given in 2018 BDT millions, pre-tax. [2] The NPV of the investment is calculated using a discount rate of 5%, as a representation of the opportunity cost of a 'risk free' investment. The hurdle rate for investors in this type of project and risk level is not known at this early stage of the market, which would provide a more appropriate measure of the NPV from an investor's perspective. [3] Replacement costs for components that need replacing within the 20 year asset life are included in operating expenditure. These costs amount to approximately BDT 70 million. It is then assumed that the asset has zero terminal value at the end of the 20 year period.

3.2 Customer acquisition and revenue stabilisation

A key parameter in maximising the financial returns and minimising risk, is the profile of customer acquisition. This has been a key factor in determining the more successful SMG projects as described in Box 2 and Box 3 below. As recommended in the business model briefs, this can be facilitated by adopting an 'Anchor-Business-Customer' (ABC) approach. This would entail a two staged customer acquisition, first securing commitment from key industrial and/or medium size business customers before the project is started, and then acquiring household and smaller individual commercial customers once the SMG is operational. The anchor customer's role is to ensure a steady base load demand, providing greater revenue certainty and stability compared to the alternative of beginning customer acquisition only once the SMG is operational. Suitable anchor customers should therefore have a significant and steady load, preferably in the day time when the SMG can supply power without relying on batteries. The anchor customers should also ideally be located close to the SMG to facilitate connection. Saw mills, cold storage warehouses, village markets, and base transceiver stations (BTS) for telecommunications are some examples of good anchor customers. The analysis in this section assumes the anchor is a group of medium sized enterprises (1 ice factory, 1 workshop, 1 cold storage, 6 irrigation pumps and 15 auto rickshaws), which commit to



connecting as soon as the SMG begins producing power and stay on as customers till the end of the project life.⁵

Adopting an ABC approach offers a potentially higher rate of return, and lowers project risks. Figure 3 illustrates three possible scenarios based on the rate of customer acquisition for non-anchor customers, presented both with and without adoption of the ABC model. These scenarios are based on examples of the challenges identified by project sponsors in stakeholder interviews:




- the ‘fast’ scenario would see all target customers connected to reach the generating capacity of the SMG within two years. Under this scenario the equity IRR is as high as 22% with the ABC model compared to 18% without;
- the ‘slow’ scenario where customer acquisition takes six years instead of two. If the ABC model is adopted (i.e. industrial and business customers are connected immediately), the equity IRR is 16%, but falls to 10% otherwise.
- the ‘partial customer acquisition’ scenario where the SMG is only able to acquire 70% of projected customer demand – the remaining 30% of customers are never connected. With this reduced customer base, IRR on equity would fall to -4% without an anchor, and -3% even with an anchor.

These scenarios underline the importance of ensuring a plan to connect enough customers to maximise usage of the SMG, and the importance of connections in the early years. Gaining momentum in acquiring customers quickly helps build credibility and trust with other customers, to make sure the full size of the project is met by demand.

⁵ Representative customer mix and load based on the SMG project at Saint Martin Island developed by Blue Marine Energy Limited.



Figure 3. The maximum customer penetration is an important parameter determining project returns

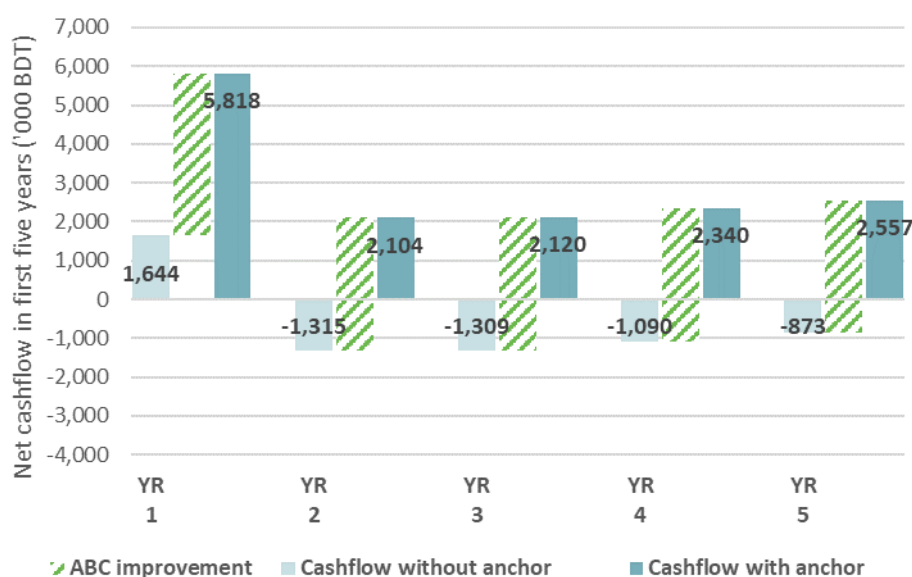
| | | Time taken to acquire 100% of customers | | | | | |
|---|----------------------|---|--------------------|---------------------------|--------------------|------------------------------------|--------------------|
| | | Fast customer acquisition | | Slow customer acquisition | | Partial (70%) customer acquisition | |
| | | (1) With anchor | (2) Without anchor | (3) With anchor | (4) Without anchor | (5) With anchor | (6) Without anchor |
|  | Households | 2 years | 2 years | 6 years | 6 years | > 6 years | > 6 years |
|  | Hospitality/services | 2 years | 2 years | 6 years | 6 years | > 6 years | > 6 years |
|  | Industrial | At start | 2 years | At start | 6 years | At start | > 6 years |
| | | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| IRR on equity | | 22% | 18% | 16% | 10% | -3% | -4% |
| IRR on equity and debt | | 13% | 12% | 12% | 9% | 0% | 0% |
| Payback period on equity | | 4 | 9 | 10 | 16 | N/A | N/A |

Source: Vivid Economics

Note: (i) In the partial customer acquisition scenario, only 70% customer penetration is achieved over the lifetime of the SMG project. (ii) The financial returns stated above are based on cashflow projections for a typical SMG (specifically, the 250 kWp SMG project at Saint Martin Island developed by Blue Marine Energy Limited and financed under the IDCOL model).

Securing a medium to long term commitment from an anchor customer to offtake a significant amount of demand can also ensure stable cashflows in the early years of the project. This is critical in ensuring the confidence of financiers that debt service obligations can be met. This is likely to be particularly important in a market at an early stage of development, helping to build trust so as to attract increased finance to the sector. It also eases the burden on investors to plug negative cashflows in the early years. Figure 4 illustrates the improvement in cashflow resulting from locking in industrial demand early on in the project life in a scenario where the project experiences negative cashflows in the first five years.

Figure 4. Cashflow in the first five years is more reliable with an anchor customer – and critical in ensuring revenues can match debt service obligations



Note: This graph reports cashflows under a scenario where the SMG is only able to acquire 50% of projected customer demand – the remaining 50% of customers are never connected. Under the variation with an anchor customer, industrial customers are connected immediately, and 100% industrial customer penetration is achieved.

Source: Vivid Economics

3.3 Investment and operating costs

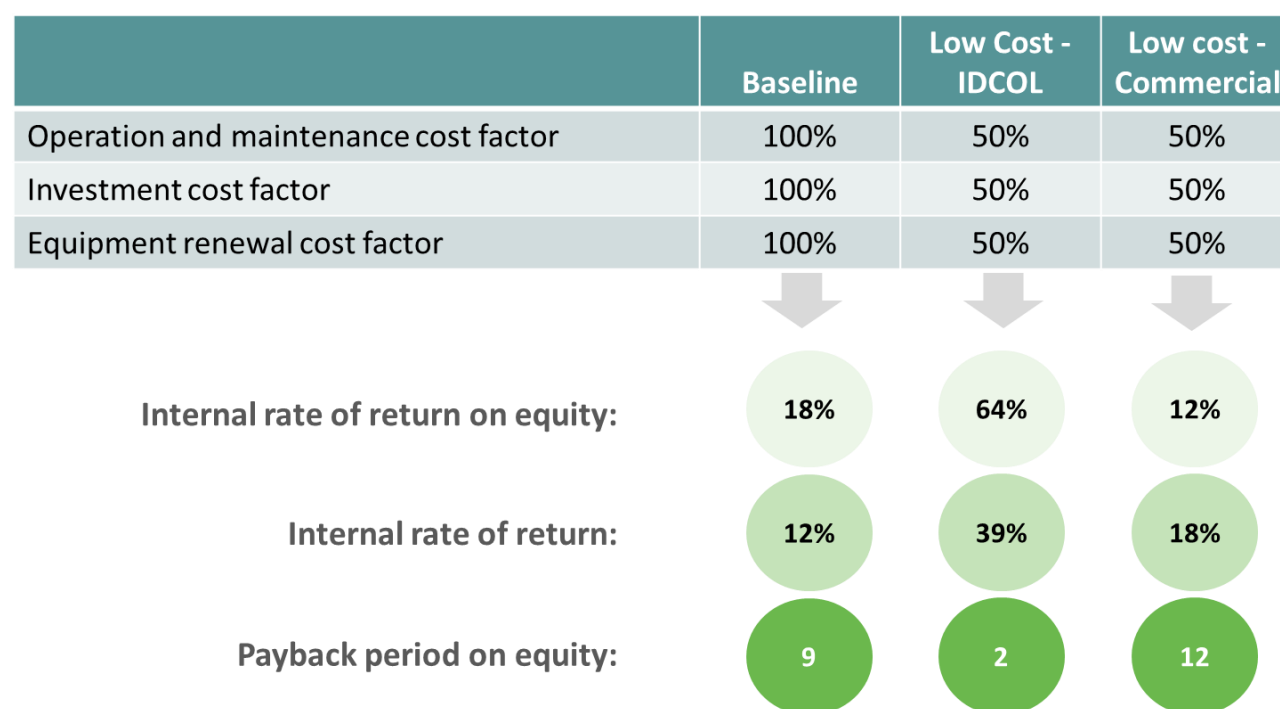
Investment costs for IDCOL projects are well established in the market, but SMGs might be able to lower the initial capital investment by directly negotiating prices with less expensive suppliers under different financing models. IDCOL's technical standards committee prescribes certain requirements which must be met by SMGs in order to be eligible for grant funding. In addition to safety and efficiency, these standards relate to ease of eventual integration into the national grid. However, the Angira mini-grid project (described in Box 3) was able to reduce costs by approximately 50% by opting to procure equipment from suppliers which did not adhere to all of IDCOL's requirements. This was a key part of the approach taken by the project which made it viable to be financed through a commercial loan. While the Angira project has not faced safety or efficiency concerns with the equipment in the 5 years since operation commenced, it is important to have new equipment vetted for suitability for the selected site by a technical expert.

Bringing down the up-front capital investment costs would help move the market away from reliance on grant funding, towards more commercial financing structures. Investment costs are project specific, but in general, could be reduced by procuring equipment from less expensive suppliers, and ensuring construction is completed by monsoon season in order to avoid delays and damage due to storms. For example, Figure 5 shows that reducing all costs by 50%⁶ would raise the equity IRR to 64% and project IRR to 39% under the IDCOL financing structure (which has a 50% grant component), opening up the scope for commercial bank finance, as was the case for the Angira project (see Box 3).

⁶ Based on discussions with project developers on the potential scale of cost reductions using components sourced directly from suppliers not necessarily on the IDCOL approved list, and components which may not meet all of the approved technical standards.



Figure 5. A significant fall in capital and operational costs could move SMGs toward commercial viability



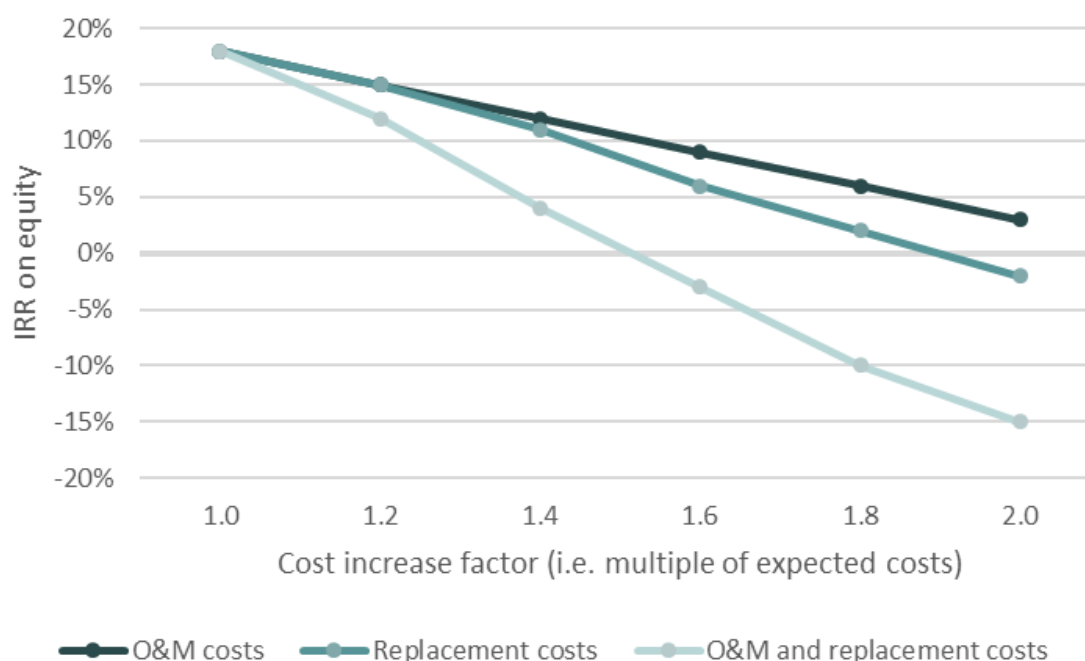
Note: (i) The IDCOL financing structure refers to 50% grant, 30% debt (at 6% per annum paid over 10 years with a 2 year grace period and 8 year repayment period), and 20% equity.

(ii) The commercial model refers to 55% debt (at 9% per annum, paid over 10 years with a 2 year grace period and 8 year repayment period), and 45% equity.

Source: Vivid Economics

However, it is also possible that costs, particularly those related to operations and maintenance (O&M) and equipment replacement, could increase. There is limited evidence on how out-turn costs compare to those in pre-investment models. However, anecdotal evidence suggests some project developers have faced challenges in maintaining costs at the levels anticipated in pre-investment financial models. O&M costs (including maintenance cost, cost of lubricating oil, salaries, administrative costs and insurance costs) and equipment renewal costs may increase for a number of reasons, such as storm damages, technical failures, price increases etc. As shown in Figure 6, a 40% increase in both O&M and replacement costs would result in an Equity IRR of 4%. If instead the costs increased by 60%, the project would make a negative IRR (-3%).

Figure 6. Operational cost overruns can have a large impact on financial returns



Source: Vivid Economics

Understanding the key factors determining capital and operational expenditure will be crucial to maintaining financial returns, necessitating a comprehensive study of current projects' out-run costs compared to pre-implementation projected costs. Figure 7 summarises the cost scenarios outlined above, showing that changes to capital and operational expenditure can result in wide range of returns to investors, from 64% IRR on equity under the low capital cost IDCOL model to -15% IRR on equity under a scenario with high O&M and replacement costs. An important next step for regulators like IDCOL and the Sustainable and Renewable Energy Development Authority (SREDA) would be to undertake an analysis of actual costs compared to projected costs to understand where cost overruns are most likely to occur, and conversely, where potential cost savings lie.



Figure 7. Changes in capital and operational expenditure can lead to a wide range of financial returns

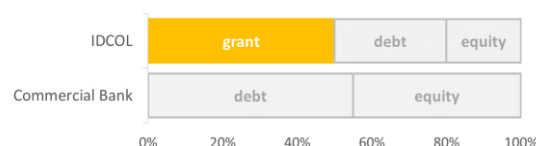
| | Low cost - IDCOL | Baseline | Low cost - commercial | High O&M | High O&M + renewal |
|---------------------------------------|---------------------|----------|--------------------------|----------|--------------------------|
| Operation and maintenance cost factor | 50% | 100% | 50% | 200% | 200% |
| Investment cost factor | 50% | 100% | 50% | 100% | 100% |
| Equipment renewal cost factor | 50% | 100% | 50% | 100% | 200% |
| | ↓ | ↓ | ↓ | ↓ | ↓ |
| Internal rate of return on equity: | 64% | 18% | 9% | 3% | -15% |
| Internal rate of return: | 39% | 12% | 18% | 5% | -13% |
| Payback period on equity: | 2 | 9 | 15 | 19 | N/A |

Note: (i) The IDCOL financing structure refers to 50% grant, 30% debt (at 6% per annum paid over 10 years with a 2 year grace period and 8 year repayment period), and 20% equity.

(ii) The commercial model refers to 67% debt (at 9% per annum, paid over 10 years with a 2 year grace period and 8 year repayment period), and 20% equity.

Source: Vivid Economics

4 Environmental and social justification for concessional financing

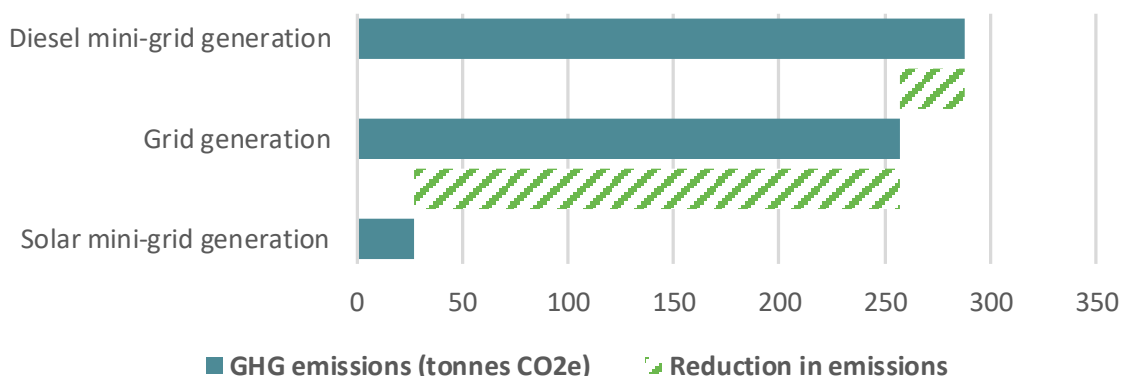


There is a continued role for public funds to support SMG market development in recognition of the broader social benefits they bring. In particular, SMG contribute to environmental goals through reduced GHG emissions, and to socio-economic development by typically focusing on relatively low income customer groups. Public funds could be used either through grants, or by reducing the cost of loans. Under the current IDCOL model, the grant is a key component in ensuring the projects have an IRR of 12%; without grant finance, the IRR would fall to just 2%. There will be a continued role for public finance as the market matures, although reducing the grant portion and improving the project IRR that can be achieved without grant finance will be important to ensure a sustainable market develops.

A typical solar mini-grid, meeting an annual demand of 400 MWh, emits approximately 90% less CO₂ emissions than grid connected power and diesel mini-grid alternatives. As shown by Figure 8, the difference between a SMG and a diesel mini-grid is 261 tonnes of CO₂e emitted per year, for a stylised mini-grid of 250 kWp. This assumes that a diesel back-up generator would be needed to meet 9% of total demand from the SMG site.⁷

Supporting the emerging solar market in Bangladesh to achieve the goal of installing 200 SMGs by 2025 would deliver emission reductions of 53,600 tonnes of CO₂e annually compared to grid generated electricity. This annual saving of 0.05 Mt would bring Bangladesh closer to realising its emissions reduction target of 12 Mt of CO₂e by 2030, as per its Nationally Determined Contribution (NDC) pledge to the Paris Agreement.⁸

Figure 8. Solar mini-grid generation is up to 90% less polluting than diesel and grid connected alternatives



⁷ Based on assumptions made in the pre-investment financial model for the 250 kWp SMG project at Saint Martin Island developed by Blue Marine Energy Limited.

⁸ Ministry of Environment and Forests, 2015. Intended Nationally Determined Contributions, page 3. Available at https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Bangladesh%20First/INDC_2015_of_Bangladesh.pdf.



Source: Vivid Economics

There is an increasing evidence base on the broader welfare impacts of energy access for the users of distributed energy solutions such as SMGs. These broader benefits include:

- cost savings from reduced consumption of diesel or kerosene based energy sources. In particular, poor rural households often spend a high proportion of the income on energy despite vastly inferior levels of energy services;⁹
- creating new employment opportunities and boosting productivity (and thereby income) through productive use of energy by consumers; including e.g. milling, sewing, ice making and food processing;¹⁰
- time savings from collecting alternative energy sources, which can be put to productive use or for leisure;
- improved education and skills acquisition from access to lighting and information and communication technology;
- health benefits from in-home air pollution where SMGs could replace e.g. kerosene use at home.¹¹

⁹ For example, GOGLA estimates that purchasing a solar product saves households \$192 on average over the product's lifetime: GOGLA (2017) "Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data",

¹⁰ See for example GOGLA (2018) "Powering Opportunity", Ministry of Foreign Affairs of the Netherlands. (2013) "IOB Study - Renewable Energy: Access and Impact", SE4ALL. (2017) "Why Wait? Seizing the Energy Access Dividend"

¹¹ Samad, H., Khandker, S., Asaduzzaman, M., & Yunus, M. (2013). "The benefits of solar home systems :an analysis from Bangladesh"



5 Case studies

While the SMG market is relatively new in Bangladesh, some projects have already made promising financial returns and delivered important environmental benefits. This section outlines two such projects, one which uses the IDCOL financing model, the other which was financed through a commercial bank.

Shouro Bangla Limited (SBL) set up a 141 kWp SMG at Paratoli Island in the central Bangladesh district of Narsingdi under the IDCOL model, and has been running it successfully since December 2014. It has delivered strong financial returns to investors, and spurred socio-economic development in the area. Box 2 provides an overview of the project.

Angira set up the first and only commercially funded mini-grid in Bangladesh in 2014. The 50 kWp SMG in the Nur Mohammed Market in the Manikganj district was set up in 2014. It had an initial capacity of 30 kWp, but was upgraded to 50kWp due to customer demand. Box 3 provides a brief summary of the project.



Box 2. Case study of the Shouro Bangla solar mini-grid financed by IDCOL



The Shoura Bangla (SBL) SMG is a 141 kWp mini-grid at Paratoli Island in the Narsingdi district, which became operational in 2014. Much of the electricity consumption is during the evening/night, which increases the need for storage and use of the back-up diesel generator. The SMG produces energy using the solar PV panels during the day, and stores excess energy for overnight use in 288 lead acid batteries. It also has a 66 kVA diesel generator as backup, in case demand exceeds production from the solar panels. The lifetime of the project is 20 years.

All components meet the Technical Standards Committee's approved technical standards. The solar module was manufactured by Suntech (China), the battery by Rahimafrooz (Bangladesh), the inverter by SMA (Germany), and the generator by EM Power (Bangladesh). The total investment cost was 66 million BDT (approximately 0.8 million USD).

The project was financed under the IDCOL financing structure, and is on course to deliver an IRR of 12%. IDCOL provided a concessional loan with a 10 year tenor, grace period of two years, and interest rate of 6%. As per the IDCOL model of financing, 50% of the total cost was grant funded, 30% debt funded and 20% funded by equity from SBL. Customer acquisition and revenue thus far has been in line with the financial model submitted to IDCOL, which has projected a project IRR of 12%.

The project sponsor SBL believes strong customer demand from industrial anchors, commercial entrepreneurs and households with a high willingness to pay has been the key to the project's success. SBL relied on large industrial consumers like mobile base stations, saw mills and ice mills to anchor demand, while proximity to a large village market helped in the acquisition of commercial customers like local entrepreneurs. SBL also highlighted the strong willingness to pay of local households due to a recognition of (i) the benefits of electricity (for example to power cooling fans or pumps for water tanks), and (ii) the fact that the national grid is unlikely to reach them in the near future.

SBL's marketing efforts ensured that customer acquisition was quick, reaching 100% penetration in 2 years. 70% of customers were acquired in the first year, and the remaining 30% in the next year. SBL offered discounts or a few units of electricity for free ahead of special events like Ramadan, organised customer focus groups, and disseminated charts comparing kerosene lamps to SMG electricity.

The mini-grid serves a total of 724 households and 124 shops, charging a tariff of 30 BDT per kWh. The monthly bill for household customers is between 485-780 BDT per month, with some higher load users paying approximately 1,630 BDT. Commercial users paid on average 330-845 BDT per month.

Access to electricity has also afforded more economic opportunities to residents, who are now able to start new businesses or expand existing ones. Before the arrival of the SMG, walking was the only option for transport around the island. With access to energy, island resident Nazir Hossain was able to start a business driving people on bikes and rickshaws. He said of his business, "People can now quickly and



comfortably travel from one place to another which is particularly convenient for the aged and the sick. It costs me around Tk 250 to charge batteries of the three vehicles [two easy bikes and one engine rickshaw] and I make around Tk 500 daily.”¹²

¹² The Independent, 2015. Sunny days ahead for Paratoli Island. Available at <http://www.theindependentbd.com/post/21398>.



Box 3. Case study of the Angira solar mini-grid financed by Uttara Bank



Angira sponsored the development of a 50 kWp mini-grid in the Nur Mohammed Market in Singair of the Manikganj. The project began construction in 2012 and has been in operation since 2014. It serves 170 customers, of which around 150 are households and 20 are small businesses. The developer first identified and connected key business customers to ensure an initial base load of consumption and to generate trust in the project, and then expanded to household customers. This approach of targeting business customers also helped manage demand loads to reduce costs; because of this approach only 20% of energy demanded is overnight, when the energy generated from solar panels would need to be stored.

The project was developed using low-cost equipment, which reduced investment and maintenance costs substantially. The total investment cost was just 15 million BDT, with solar panels sourced from HHV (Germany), batteries from MPP Solar (China), inverter from Eifesun (China), and a charge controller from Morningstar (United States of America). These components do not need to meet the requirements defined by the Technical Standards Committee (which any project receiving IDCOL finance would need to meet). While meeting the aforementioned standards would make grid integration easier, Angira have not reported any safety or efficiency concerns from using this equipment, and the project lifetime is comparable to IDCOL compliant SMGs (i.e. 20 years).

The project was the first SMG to use commercial bank finance, raising 67% through commercial debt taken on from Uttara Bank, with the remaining 33% through equity investment. The 9% commercial loan was provided by Uttara Bank and took advantage of the Bangladesh Bank refinancing scheme, which offers loans for SMGs at the Bank base rate of 5%, plus a premium of up to 4%. The project paid back this commercial loan within the first four years of operation.

The lower initial investment, and therefore debt servicing cost, allowed Angira to attract customers by offering affordable tariffs. This included an initial tariff of 25 BDT per kWh for business customers, and 18 BDT per kWh for households.

The project has delivered strong financial returns, generating a revenue of BDT 4.8 million BDT in 2015-2016 and is expected to generate a project IRR of 16%.¹³ While the Angira mini-grid is of a smaller capacity than the IDCOL financed SMGs, its success could pave the way for larger commercially financed projects.

¹³ Note this is based on estimate provided by Angira, not modelled by the authors.



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 & 10 th 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: +880-2-8333238-9 Email: ceo@biffl.org |



Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

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Company Profile

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