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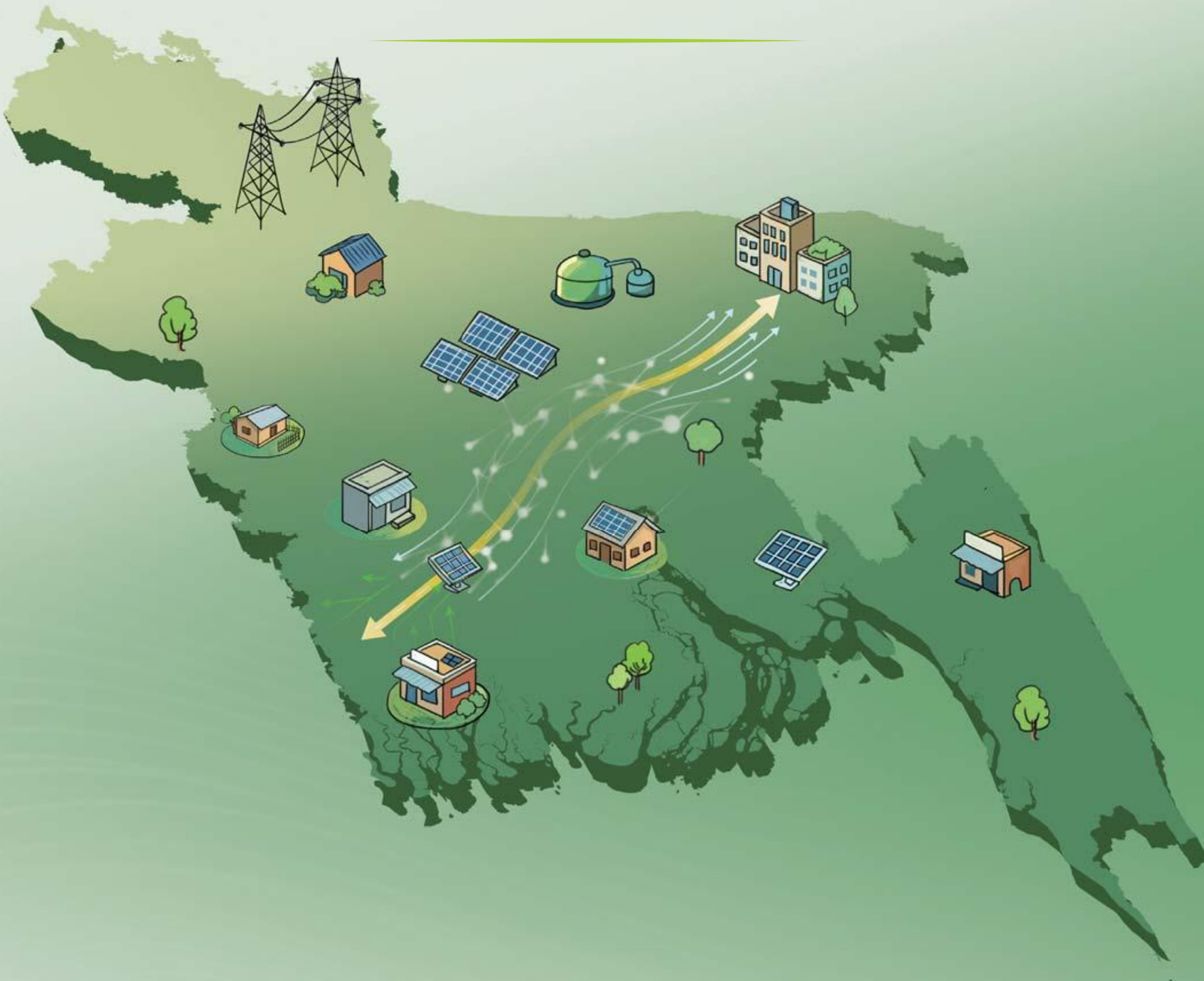

CENTRE FOR POLICY DIALOGUE

DREP Distributed Renewable Energy Platform

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Executive Summary

Despite significant policy emphasis on renewable energy transition in Bangladesh, the share of renewable energy remains modest, with distributed renewable energy (DRE) systems playing a critical role in overall capacity. While technologies such as solar home systems (SHSs), rooftop solar, and solar irrigation pumps (SIPs) have achieved notable initial success, their adoption has slowed and post-installation retention remains a major challenge. This paper examines the role of micro and meso-level linkages in shaping the adoption, retention, and scalability of DRE technologies in Bangladesh.

Adopting a mixed-method approach, the study combines quantitative analysis of the SREDA National Database of Renewable Energy and the CPD SHS Survey 2025 with qualitative insights from key informant interviews and field observations. It develops an analytical framework focused on interactions between micro-level users (households, farmers, and firms) and meso-level institutions (such as IDCOL, BREB, distribution utilities, NGOs, microfinance institutions, and sectoral agencies).

The study finds that DRE technologies follow markedly different growth trajectories. SHS installations expanded rapidly in the early 2000s but collapsed after 2018 as grid electricity reached rural areas, rendering the micro-credit-based off-grid model less attractive; a similar stagnation affects solar mini-grids. In contrast, net metering rooftop solar has grown strongly since 2023, driven by industrial and commercial demand, while SIP installations have declined sharply since 2018 despite their cost advantages over diesel irrigation.

Adoption is also highly concentrated geographically and institutionally. Rooftop solar is concentrated in Dhaka and other urban centres, while SIPs cluster in the north-western agricultural belt (Rangpur and Rajshahi) due to cropping patterns. A small number of institutions, chiefly IDCOL, BREB, and DESCO, dominate implementation across nearly every DRE segment, and financing structures diverge sharply: rooftop solar is largely self-financed, while SIPs and mini-grids depend heavily on government and IDCOL concessional financing.

At the meso level, institutions are driven primarily by disbursement targets, portfolio growth, and sectoral mandates, with weak incentives to ensure continued usage, maintenance, or retention once installation and repayment milestones are met. This has produced an installation-centric DRE system. At the micro level, heterogeneous user characteristics, financing constraints, weak maintenance ecosystems, and shifting energy preferences, especially following grid expansion, shape both adoption and retention decisions. Behavioural factors, such as farmers' preference for night-time irrigation, further limit solar irrigation uptake. Compounding these dynamics, the study identifies asymmetric information flows: policy and programme design flow downward from institutions to users, but user-level feedback on performance, evolving needs, or dissatisfaction rarely feeds back into programme redesign. Fiscal factors such as approximately 28-29 per cent tax incidence on solar panels and inverters, alongside continued diesel subsidies for irrigation further weaken DRE's competitiveness relative to conventional alternatives.

The paper argues that accelerating DRE adoption and improving retention requires action across four areas. First, institutional reforms, including a National DRE Coordination Committee under SREDA to harmonise fragmented mandates, and structured micro–meso feedback mechanisms (user surveys, grievance systems, Solar Information Officers) to institutionalise learning. Second, programme redesign, including shared-ownership and grid-integrated models for SIPs, transition pathways for obsolete SHSs into on-grid or hybrid systems, and formalisation of solar charging station infrastructure for the growing electric transport sector. Third, financing and credit reforms, including a dedicated Renewable Energy Financing Window at Bangladesh Bank, expanded commercial bank participation in DRE lending, and bundling DRE financing with conventional consumer and agricultural loans to ease adoption barriers. Fourth, capacity building and awareness, including behavioural campaigns to align irrigation practices with solar generation and stronger local maintenance ecosystems built around trained technicians and performance-based service contracts.

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Acronyms

ADB – Asian Development Bank
APSCL – Ashuganj Power Station Company Limited
BADC – Bangladesh Agricultural Development Corporation
BARI – Bangladesh Agricultural Research Institute
BMDA – Barind Multipurpose Development Authority
BPDB – Bangladesh Power Development Board
BREB – Bangladesh Rural Electrification Board
BRRI – Bangladesh Rice Research Institute
CAPEX – Capital Expenditure Model
DAE – Department of Agricultural Extension
DBBL – Dutch-Bangla Bank Limited
DESCO – Dhaka Electric Supply Company Limited
DPDC – Dhaka Power Distribution Company Limited
DRE – Distributed Renewable Energy
EGCB – Electricity Generation Company of Bangladesh
EPC – Engineering, Procurement, and Construction
ERD – Economic Relations Division
EU – European Union
FD – Finance Division
GIZ – Deutsche Gesellschaft für Internationale Zusammenarbeit
GoB – Government of Bangladesh
GPRBA – Global Partnership on Results-Based Approaches
IDCOL – Infrastructure Development Company Limited
IPP – Independent Power Producer
JICA – Japan International Cooperation Agency
KIIs – Key Informant Interview(s)
kWp – Kilowatt Peak
LDC – Least Developed Country
MFI – Microfinance Institution
MoDMR – Ministry of Disaster Management and Relief
MoF – Ministry of Finance
MoWR – Ministry of Water Resources
NESCO – Northern Electricity Supply Company Limited
NGO – Non-Governmental Organisation
NRTSP – National Rooftop Solar Programme
OPEX – Operational Expenditure Model

PBS	– Palli Bidyut Samity
PO	– Partner Organisation
PV	– Photovoltaic
RDA	– Rural Development Academy
RE	– Renewable Energy
RMG	– Readymade Garments
RPCL	– Rural Power Company Limited
RTS	– Rooftop Solar
SHS	– Solar Home System(s)
SIP	– Solar Irrigation Pump(s)
SREDA	– Sustainable and Renewable Energy Development Authority
UNDP	– United Nations Development Programme
UNIDO	– United Nations Industrial Development Organization
WB	– World Bank
WZPDCL	– West Zone Power Distribution Company Limited

1 Introduction

In Bangladesh, despite several national-level policies emphasising and promoting renewable energy transition, the share of renewable energy remains around 1,694.6 MW which is just 5.4 per cent of total installed capacity[1]. Of this, the distributed renewable energy consists of more than one-third share, accounting for 654 MW. This suggests decentralised systems' momentous contribution to the overall progress in the renewable sector.

Distributed renewable energy (DRE), especially solar panel-based technologies, appeared as important source of clean and affordable energy sources in both rural and urban areas in Bangladesh. There are over 6 million home solar systems (SHSs) that have been installed across the country[2]. Besides, adoption of other technologies such as solar irrigation pumps and net metering rooftop solar is gaining pace gradually.

Despite noticeable initial adoption success and huge future potential, these DRE technologies are not retained after adoption and new adoption is sluggish. The off-grid DRE system such as solar home systems (SHSs), and solar mini grid became obsolete with the expansion of grid electricity. Besides, while the national policies such as Renewable Energy Policy 2025 aims at an ambitious target of 6,145 MW of renewable energy (Moazzem et al., 2025), they do not set out targets and action plans for adopting different DRE technologies, and the measures that foster the post installation retention. Moreover, national-level policies generally operate at a macro scale and tend to assume relatively homogeneous implementation conditions across the country. In practice, however, the conditions under which renewable technologies are adopted vary significantly across regions, communities, and economic factors.

Therefore, for enhancing the adoption and fostering the retention of DRE technologies, the roles of actors or institutions such as IDCOL, BREB, micro finance institutions and NGOs become important which often act as facilitators, financiers, and distributors of renewable energy technologies at the local level. These actors operate between national policy frameworks and end users, translating policies into implementable programmes and enabling access to finance, technical support, and information. Because they function between the macro policy environment and micro-level users, they can be understood as meso-level actors within the renewable energy ecosystem.

Understanding the interactions between micro-level users and meso-level institutions is therefore essential for explaining the patterns of adoption, retention, and scaling of distributed renewable energy technologies in Bangladesh. This study examines how these micro–meso linkages influence the diffusion and sustainability of DRE systems across different contexts. By analysing existing initiatives, institutional arrangements, and implementation practices, the study aims to identify key challenges and opportunities for strengthening these

1 According to National Database of Renewable Energy in January 2026. https://ndre.sreda.gov.bd/index.php?id=7

2 https://ndre.sreda.gov.bd/index.php?id=2&i=1

linkages in order to accelerate the adoption and long-term sustainability of distributed renewable energy in Bangladesh. The specific objectives of the study include:

01 **To map the existing meso-level institutional landscape for distributed renewable energy;**

02 **To investigate the challenges that hamper the adoption and retention of DRE among existing micro and meso-level actors; and**

03 **To explore alternative meso-level approaches that could adopt and retain renewable energy uptake.**

2 Conceptualisation of Micro-Meso Linkages

The meso-level constitutes of the intermediaries which create niches and dismantles previous incumbent regimes in an institutional arrangement (Ehnert, 2023). In the distributed renewable energy transition context, the intermediaries can be defined as 'actors and platforms that positively influence sustainability transition processes by linking actors and activities, and their related skills and resources, or by connecting transition visions and demands of networks of actors with existing regimes in order to create momentum for socio-technical system change, to create new collabo-rations within and across niche technologies, ideas and markets, and to disrupt dominant unsustainable socio-technical configurations' (Kivimaa, 2022). Their role in the transition thus amounts to connecting different actors within the transition framework. There is an intricated network of enterprises, non-government organisations, and semi-autonomous governmental organisations which makes up the meso-level of distributed renewable energy structure of Bangladesh. The meso-level in Bangladesh includes a network of organisations such as IDCOL, BREB, NGOs, microfinance institutions, and suppliers that mediate between national policy structures and end users.

The consumer actors and processes at the niche level consist of individuals, enterprises, households and other economic units. These units vary widely in economic status, location, and motivation for adopting renewable technologies. In the context of distributed renewable energy (DRE), these micro-level actors represent the demand side of the transition. Their decisions to adopt renewable technologies depend on a combination of perceived usefulness, perceived cost, ease of use, social influence, knowledge and attitude (Masukujjaman et al., 2021) . Thus, they form the foundation upon which any successful transition must be built.

The policies at the national level create a macro environment which treats the micro units as homogenous. However, there exists heterogeneity in the micro level (Schenk et al., 2007). The micro level remains beyond the reach of the policies and regulations which prescribe 'one-size-fits-all' solutions in a top-down approach. In this context, the meso-level which is between macro and micro level can play a crucial role in addressing the gap between macro and micro taking the heterogenous characteristics of the micro units. Thus, assuming the macro level as given, this study will shed lights on strengthening the micro and meso-level to accelerate the distributive renewable energy adoption in Bangladesh.

The role of the meso-level is to act as a linking and translating mechanism between national-level policies and local adoption realities. They help in facilitating and distributing renewable energy. The facilitators design instruments and programmes and provide financing services and the distributors supply renewable components, coordinate community-based installation and maintenance services to the micro actors. In this sense, the meso-level ensures that the intentions of macro policies materialise through contextually relevant local actions.

Conceptually, there exists a feedback loop between the micro and meso-level (Schenk et al., 2007). For they closely interact with the heterogenous micro actors with different characteristics and needs. The bottom-up feedback mechanism helps meso-level intermediaries to adjust programme design, financing terms, and create innovative models based on local experiences and adoption patterns. As a result, well-functioning feedback mechanism is vital for enhancing the adoption and retention of distributive renewable energy.

For an effectual micro and meso-level linkage and sustainable renewable energy adoption, there has to be strong alignment among the incentives of micro actors with that of the meso-level intermediaries (Schenk et al., 2007). The end users need to benefit from the use of renewable energy and the meso-level organisations sufficient incentives in the form of financial returns, operational sustainability, and institutional growth to continue facilitating and expanding renewable energy services.

This study, therefore, aims to investigate the alignment of the incentives or motives and the feedback mechanisms between the micro and meso-level and suggest alternative approaches and institutional arrangements to accelerate the adoption and retention of distributed renewable energy in Bangladesh.

3 Analytical Framework and Methodology

3.1 Analytical Framework

This study considers that macro policy environment regarding renewable energy is fixed. As such, it sheds light on how strengthening linkages between micro and meso-level actors though a strong feedback mechanism and alignment of incentives can propel adoption and retention of distributed renewable energy (DRE) in Bangladesh. Figure 1 depicts the analytical framework.

The behavioural aspects of micro units induce their decision to adopt renewable energy. Besides, they face structural issues that deter adoption. Once adopted, they face barriers to retaining the use of renewable energy. Therefore, at the micro level, the behavioural determinants of micro actors, structural challenges and retention barriers need to be analysed to determine their incentives to use renewable energy.

Mapping the meso-level intermediaries and interaction mechanisms is essential to identify how they connect with micro units. As incentives induce meso-level actors to render financing and facilitation services, those incentives need to be critically reviewed. Identification of incentives will help us guide how micro and meso-level incentives can be better aligned.

As feedback between micro and meso-level plays an important role for incentive or motive alignment and redesigning of the instruments and programme, it will also be analysed the lacking in the feedback mechanisms in case of distributive renewable energy in Bangladesh.

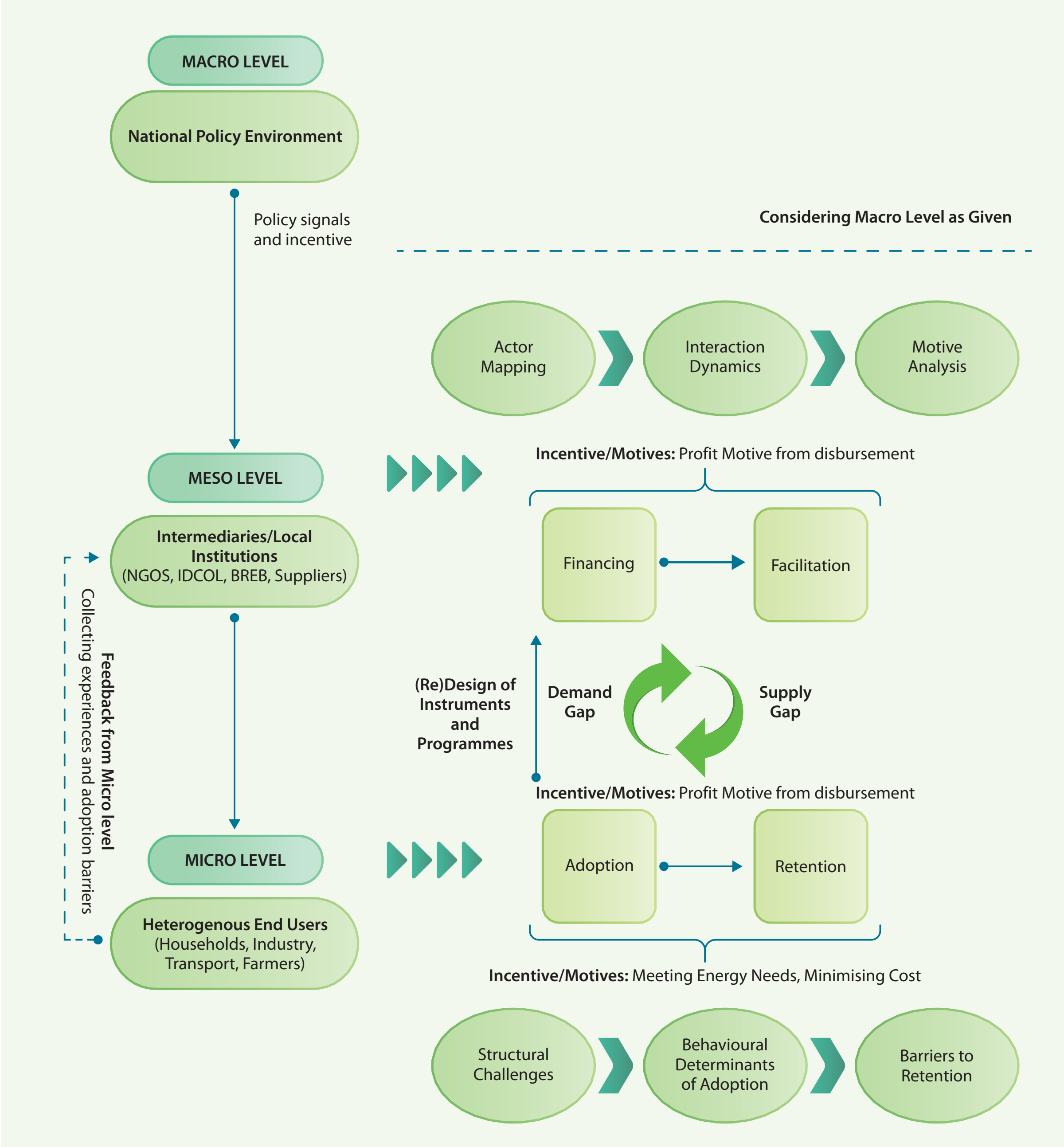
3.2 Methodology

The study employed a mixed-method approach combining qualitative and quantitative techniques. The Distributed Renewable Energy (DRE) systems which have been considered under the study include rooftop solar with and without net metering, solar irrigation, solar home systems (SHS), solar mini-grid, and solar charging station.

The quantitative analysis mainly relied on the National Database of Renewable Energy maintained by the Sustainable and Renewable Energy Development Authority (SREDA) which provides comprehensive administrative data on the deployment, geographic distribution, financing structure, and implementation status of DRE systems across Bangladesh. Besides, it utilises CPD SHS Survey 2025 for analysing the retention challenges of the home solar systems and the structural challenges.

Several structured key informant interviews (KIIs) have been conducted. The KIIs participants comprises of officials of key meso-level organisations involved in the planning, financing, regulation, and implementation of DRE programmes. These interviews were designed to capture insights into institutional incentives,

Figure 1 **Analytical Framework**



Source: Authors' Creation (Adapted form Schenk et al. (2007)).

coordination mechanisms, implementation challenges, and feedback pathways between micro- and meso-level actors within the respective DRE ecosystem.

Multiple field visits were conducted to interact with the micro-level actors such as farmers, households, and firms to observe the on-ground implementation of different DRE systems and to understand user experiences, operational challenges, and maintenance practices. Insights from the field visits along with the KIIs were used to contextualise the quantitative findings and to assess gaps in micro and meso-level linkages, particularly with respect to adoption, usage, and long-term retention of DRE systems.

4 Review of the Distributed Renewable Energy in Bangladesh

4.1 Current Overall Status of Distributed Renewable Energy in Bangladesh

Table 1 presents the distribution of Distributed Renewable Energy (DRE) systems in Bangladesh by system type, number of installations, installed capacity, and share of a particular system in overall DRE capacity. Of total installed renewable energy capacity (1,694.6 MW), the DRE consists of a significant one-third share (654.9 MW).

Table 1 Distribution of Distributed Renewable Energy Systems by Type and Capacity

Type	Number of Installations	Installed Capacity (MW)	Share in Total DRE Capacity	Share in Total RE Capacity	Average Capacity (KW)
Net Metering Rooftop Solar	4,551	213.31	32.57%	12.58%	25.57
Rooftop Solar (except Net Metering)	270	94.08	14.37%	5.55%	190.4
Solar Home Systems (SHSs)	60,37,583	263.46	40.23%	15.54%	-
Solar Irrigation Pump (SIP)	3,523	60.7	9.27%	3.58%	17.22
Solar Charging Stations	15	0.291	0.04%	0.02%	19.4
Solar Drinking Systems	116	0.126	0.02%	0.01%	-
Solar Street Lights	2,97,691	17.10	2.61%	1.01%	-
Solar Mini Grid	28	5.81	0.89%	0.34%	207.3
		654.88	**100%**	**38.64%**	

Source: Authors' Calculation from National Database of Renewable Energy.

With over 6 million installations, solar home system (SHS) contributes 40 per cent of the total DRE capacity[3]. On the other hand, with only 4,554 installations, net metering rooftop contributes the largest share of capacity

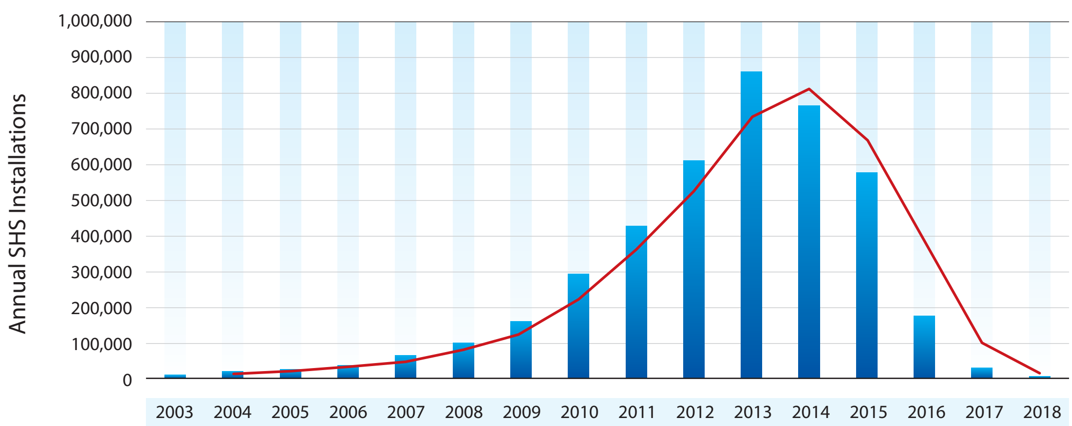
3 However, about 46.9 per cent of the SHS are currently non-functional according to CPD SHS survey 2025.

(32.6 per cent). However, Rooftop Solar without net metering shows a very high average system size (190.4 kWp) but remains extremely limited in number, only 270 installations. The solar irrigation, solar mini-grid, and solar charging stations consists of 9.3 per cent, 0.9 per cent, and .04 per cent of the total DRE capacity, respectively.

4.2 Solar Home Systems (SHSs)

Launched in the early 2000s, the SHSs played a crucial role in providing electricity to over 20 million people in the rural and remote areas where grid extension was not economically viable at that time (Cabraal et al., 2021). The Infrastructure Development Company Limited (IDCOL), with support from the government and development partners, played a central role in implementing and scaling up the programme. However, with the expansion of grid, the demand of the SHS programme declined sharply. Figure 2 shows the SHS installation trend over time. In 2018, the installation dropped sharply to just 3,455.

Figure 2 **Trend of SHS Installation by IDCOL**



Source: Authors Illustration using data from Cabraal et al. 2021.
Note: The trend line in red represents two-year moving average. The yearly installation data is not available after 2018.

Table 2 shows the distribution of SHS installations across implementing organisations. It reveals a high degree of institutional concentration, IDCOL accounts for over 74 per cent of all installations, which is followed by the Ministry of Disaster Management and Relief (MoDMR) with nearly 25 per cent.

Table 2 **Distribution of SHS Across Implementing Organisations/Agencies**

Agency	Number	Percentage
BREB	15250	0.25
NESCO	13952	0.23
IDCOL	4494162	74.44
GIZ	400	0.01
MoDMR	1513619	25.07
RDCD	200	0.003
Total	**6037583**	**100**

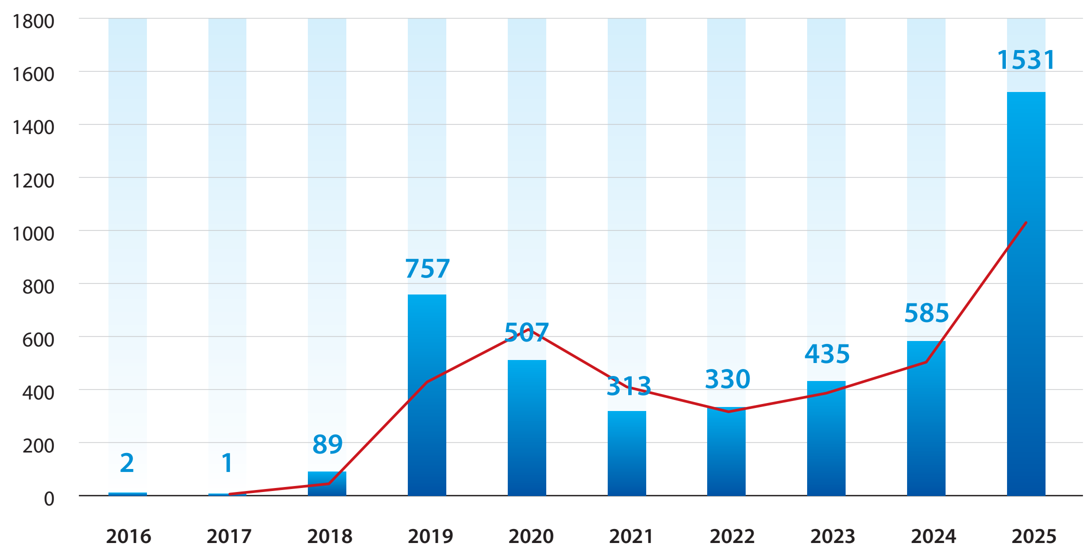
Source: Authors' Calculation from National Database of Renewable Energy.

4.3 Net Metering Rooftop Solar

Trend of Installation

According to the National Database of Renewable Energy, a total of 4,551 Rooftop Solar with net metering is available. Figure 3 depicts an increasing trend in installations of net metering rooftop. From 2016 to 2020, growth in net metering rooftop solar was gradual, with occasional spikes. Starting 2023, installations accelerate sharply. The year 2025 alone marks a total of 1,531 installations. This suggests a growing demand and progress in the net metering rooftop.

Figure 3 Trend of Net Metering Rooftop Installation



Source: Authors' Illustration from National Database of Renewable Energy.
Note: The trend line in red represents two-year moving average.

Present Status Net Metering Rooftop

Table 3 depicts the status of the 4,551 Net Metering Rooftop solar. Around 98 per cent of the systems are completed and running, while only 82 systems (1.8 per cent) are now obsolete and out of operation.

Table 3 Present Status of Net Metering Rooftop

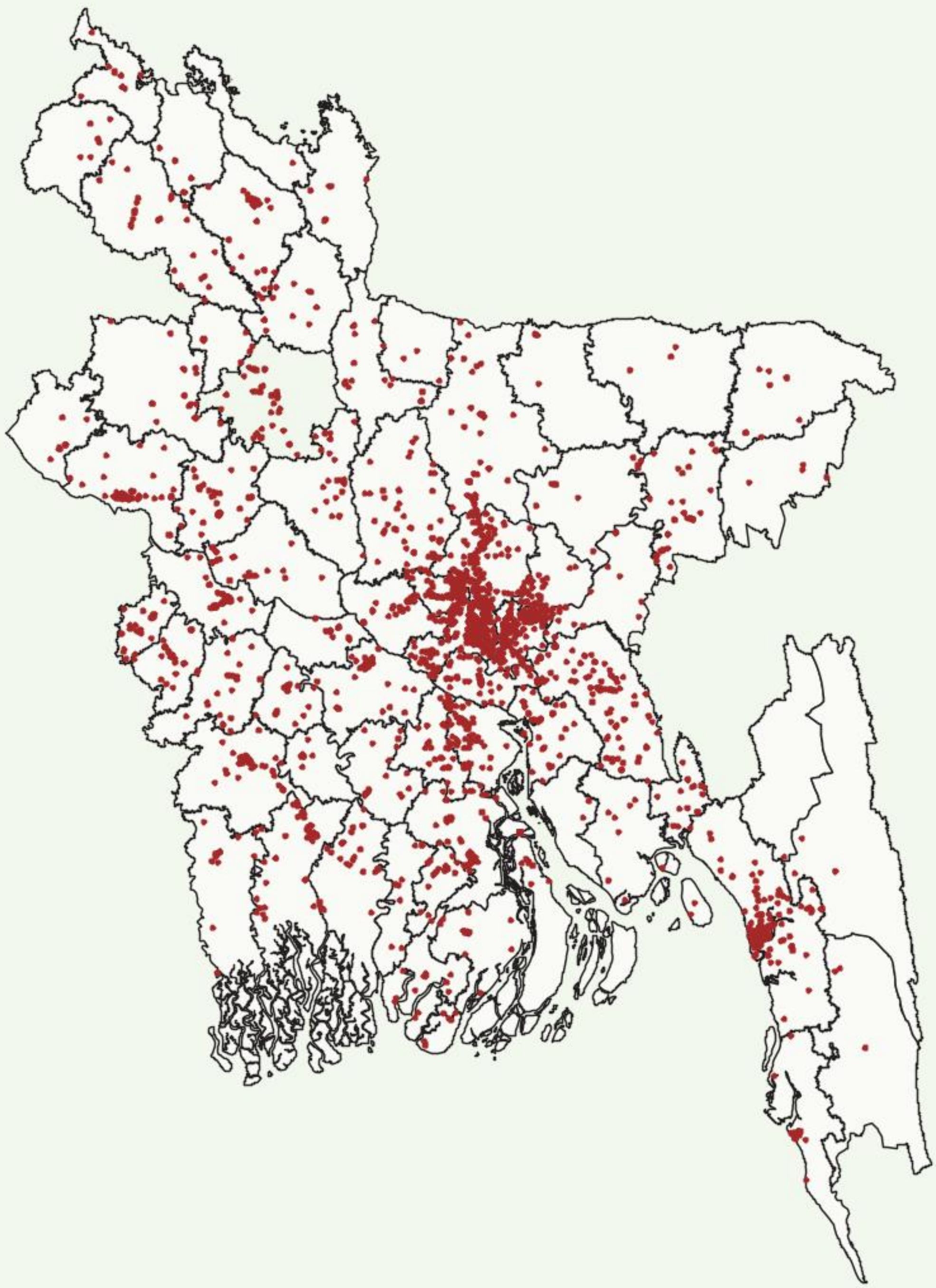
Present Status	Frequency	Per cent
Completed & Running	4,466	98.13
Implementation Ongoing	2	0.04
Obsolete System/Plant	82	1.80
Rejected from Planning/Implementation	1	0.02
Total	**4,551**	**100**

Source: Authors' Calculation from National Database of Renewable Energy.

Geographical Distribution and Implementing Organisation

Figure 4 shows the distribution of the net metering rooftop solar across the whole country and Table 4 represents the distribution across the divisions. Majority (around 60.4 per cent) of the concentration is in Dhaka. Chattogram ranks second with 733 (16.1 per cent) net metering rooftop solar. It is noticeable that the other divisions significantly lag regarding the progress in the rooftop solar with net metering.

Figure 4 Distribution of Rooftop Across Whole Country



Source: Authors' Illustrations and Calculation from National Database of Renewable Energy.

Table 4 Distribution of Rooftop Across Divisions

Division	Frequency	Per cent
Barisal	196	4.31
Chattogram	733	16.11
Dhaka	2,747	60.36
Khulna	401	8.81
Mymensingh	73	1.60
Rajshahi	233	5.12
Rangpur	104	2.29
Sylhet	62	1.36
Not Specified	2	0.04
Total	**4551**	**100**

Source: Authors' Calculation from National Database of Renewable Energy.

Financing, Implementation Agency and Model

The majority of net metering rooftop solar installations, 63.6 per cent, are financed through self-investment (table 5). The financing of the remaining 36.5 per cent of installations came from ADB, IDCOL, ERD, DBBL and GIZ. This indicates that adoption has largely been driven by entities with sufficient upfront capital, while third-party or institutional financing plays a comparatively smaller role.

Table 5 Distribution of Net Metering Rooftop Solar Installations by Financing Source

Financing	Frequency	Per cent
Own Investment	2,892	63.55
Others	1,659	36.45
Total	**4,551**	**100**

Source: Authors' Calculation from National Database of Renewable Energy.

The distribution of net metering rooftop solar installations by implementation model shows that CAPEX-based projects account for 45.4 per cent of total systems, while OPEX-based projects remain extremely limited at less than 1 per cent (table 6). Notably, more than half of the installations (53.9 per cent) are recorded as "Not Specified," indicating significant gaps in data reporting and classification within the national database.

Table 6 Distribution of Net Metering Rooftop Solar by Implementation Model

Implementation Model	Frequency	Per cent
CAPEX	2,067	45.42
OPEX	33	0.73
Not Specified	2,451	53.86
Total	**4,551**	**100**

Source: Authors' Calculation from National Database of Renewable Energy.

Table 7 shows the distribution of net metering rooftop installations across implementing organisations. It reveals a high degree of institutional concentration, BREB accounts for over 40 per cent of all installations, which is followed by DESCO with nearly 24 per cent. However, SREDA implemented just a single (0.02 per cent) net metering rooftop. The growth in the net metering rooftop is driven by the distribution utilities.

Table 7 **Distribution of Organisations Implementing the Net Metering Rooftop**

Organisation	Frequency	Percentage
BPDB	546	12
BREB	1,829	40.19
DESCO	1,088	23.91
DPDC	433	9.51
NESCO	138	3.03
SREDA	1	0.02
WZPDCL	516	11.34
Total	**4,551**	**100**

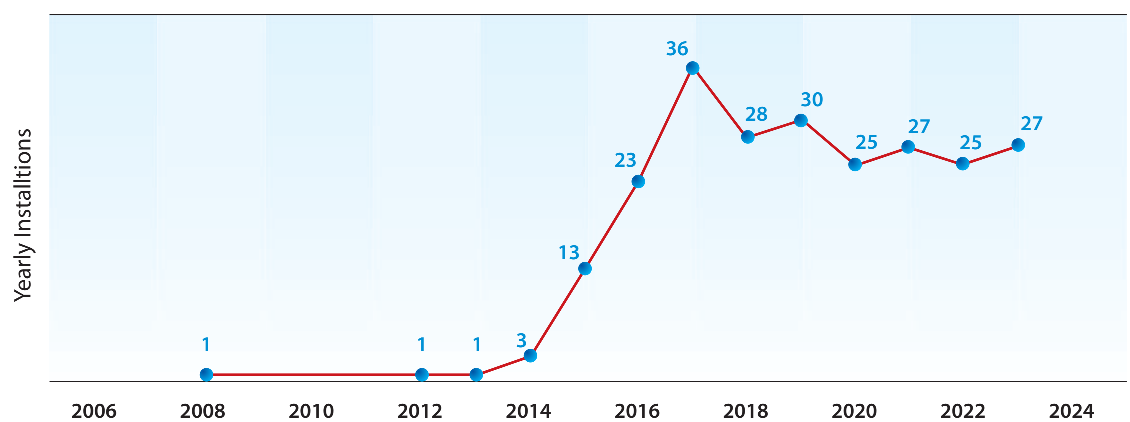
Source: Authors' Calculation from National Database of Renewable Energy.

4.4 Rooftop Solar Without Net Metering

Trend of Installation

There are around 240 solar rooftops available without net metering in the country. The adaptation of rooftop solar without net metering showed an increasing trend between 2014 to 2017. As figure 5 shows, the adaptation fell after 2017 and a stagnation is observed.

Figure 5 **Trend of Rooftop Solar Without Net Metering**



Source: Authors' Illustration from National Database of Renewable Energy.

Present Status

Of the 240 rooftop-solar facilities without net metering, around 96 per cent are completed and they are actively in operation (table 8). Only a small fraction of facilities is obsolete and under maintenance. The Non–net metering rooftop solar in Bangladesh is largely operational but shows little evidence of renewal or scaling as only three are ongoing.

Table 8 Status of Rooftop Without Net Metering

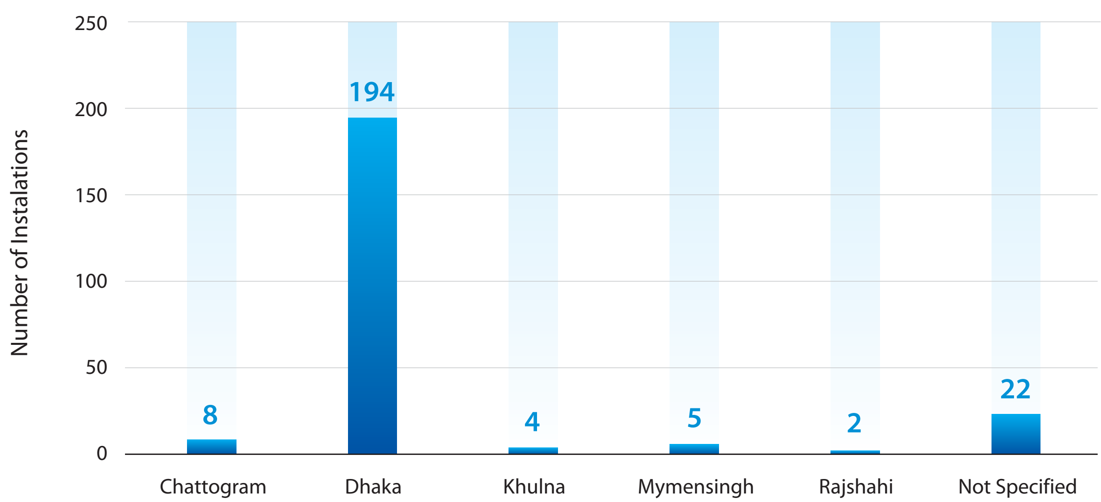
Present Status	Frequency	Per cent
Completed & Running	230	95.83
Implementation Ongoing	3	1.25
Obsolete System/Plant	1	0.42
Rejected from Planning/Implementation	2	0.83
Under Maintenance	3	1.25
Under Planning	1	0.42
Total	**240**	**100**

Source: Authors' Calculation from National Database of Renewable Energy.

Geographical Distribution

Like the net metering rooftop, as shown in figure 6, the concentration of non-net metering rooftop solar is in Dhaka, accounting for 82.6 per cent (194 installations). Chattogram ranks second with just 8 installations. The installation scenario in the rest of the divisions shows very pessimistic figures.

Figure 6 Division-wise Distribution of Non-net Metering Rooftop



Source: Authors' Illustration from National Database of Renewable Energy.

Implementing and Financing Organisation

The distribution of implementing utilities and agencies for non–net metering rooftop solar systems reveals a highly concentrated implementation structure, with DESCO alone accounting for nearly three-quarters (72.8 per cent) of all installations. This dominance indicates that non–net metering rooftop deployment has been largely urban-centric and utility-driven, particularly within DESCO's service area. Table 9 shows the distribution of non-net metering rooftop solar by implementing utilities.

Table 9 **Distribution of Non-Net Metering Rooftop Solar by Implementing Utilities**

Implementing Utility/ Agency	Frequency	Per cent
APSCL	3	1.28
B-R PowerGen	1	0.43
BADC	1	0.43
BARI	1	0.43
BCSIR	3	1.28
BPDB	15	6.38
BREB	2	0.85
Bangladesh Army	1	0.43
CPGCBL	2	0.85
DESCO	171	72.77
DPDC	10	4.26
EGCB	1	0.43
LGED	2	0.85
MoF	1	0.43
MoWR	2	0.85
RPCL	8	3.4
SID	1	0.43
SREDA	5	2.13
WZPDCL	5	2.13
Total	**235**	**100**

Source: Authors' Calculation from National Database of Renewable Energy.

The distribution of financing of non-net metering rooftop solar is shown in table 10. The financing structure of non–net metering rooftop solar systems is overwhelmingly dominated by own investment, which accounts for 85.8 per cent of installations. This indicates that the segment is largely driven by self-financed adopters, primarily public institutions and commercial entities, rather than by structured financial support mechanisms. The limited contribution of development partners and public financing such as ADB, UNDP, UNIDO, and government sources, suggests weak institutional financing engagement in this segment.

Table 10 **Distribution of Non-Net Metering Rooftop Solar by Financing Organisation**

Financing Organisation	Frequency	Per cent
ADB	5	2.08
BCCT	1	0.42
GoB	8	3.33
IPP	5	2.08
N/A	12	5
Own Investment	206	85.83
UNDP	1	0.42
UNIDO	2	0.83
Total	**240**	**100**

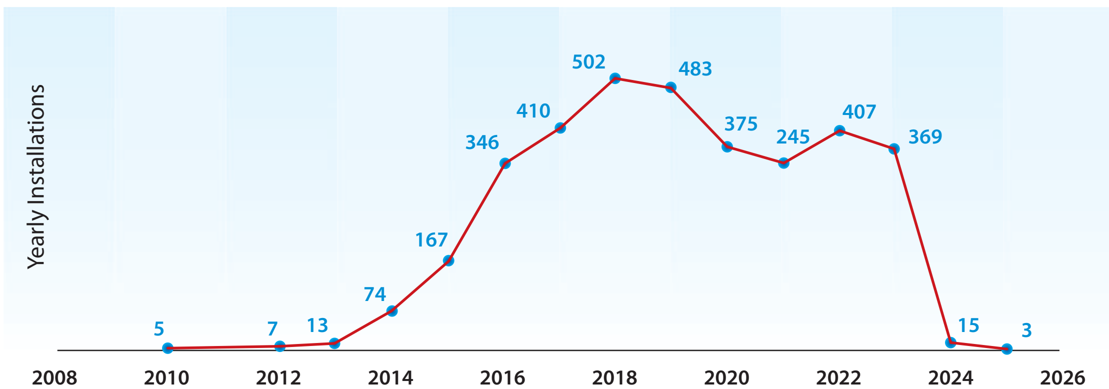
Source: Authors' Calculation from National Database of Renewable Energy.

4.5 Solar Irrigation Pumps (SIPs)

Trend of Installation

According to National Database of Renewable Energy, there are around 3,523 solar irrigation programmes. Figure 7 shows the trend of SIP installation. The installation got pace between the period 2013 to 2018. After 2018, the number of installations started to decline steadily and in 2023 onwards the adoption fell sharply down to single digit.

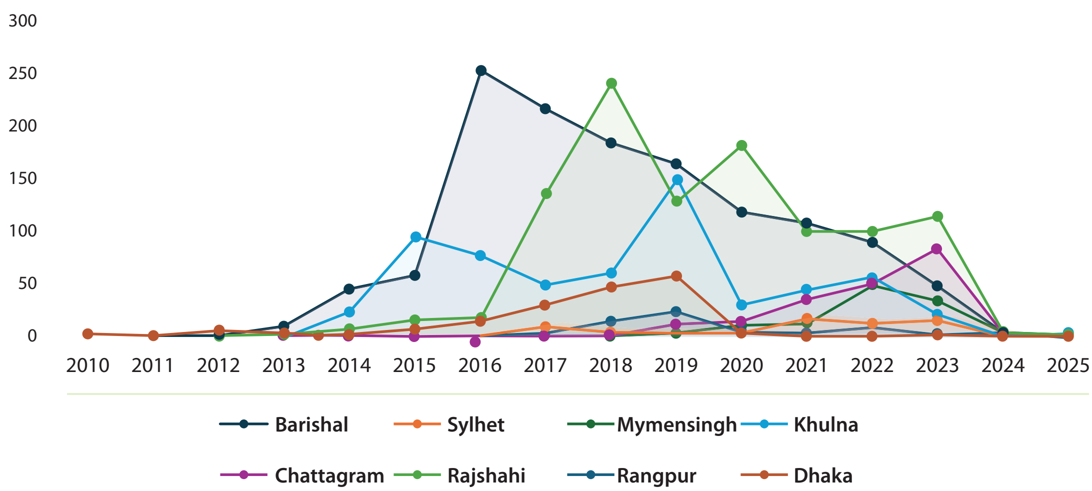
Figure 7 **Overall Trend of Solar Irrigation Pump Installations**



Source: Authors' Illustration from National Database of Renewable Energy.

If we look at the division-wise trend of SIP installation in figure 8, this also reflects the overall pattern that the installation is on decline in all the divisions.

Figure 8 **Division-wise SIP Installation Trend**



Source: Authors' Illustration from National Database of Renewable Energy.

Present Condition and Grid Status

Of the 3,523 solar irrigation pumps, majority of the pumps (97.2 per cent) are complete and operational (table 11). Besides, around 98 are at the implementation stage. The number of obsolete facilities is just one.

Table 11 Present Status of Solar Irrigation Programmes

Present Status	Frequency	Per cent
Completed & Running	3,424	97.19
Implementation Ongoing	98	2.78
Obsolete System/Plant	1	0.03
Total	**3,523**	**100**

Source: Authors' Calculation from National Database of Renewable Energy.

Initially, the solar irrigation programme started with off-grid systems. Later, initiative was taken to connect them with the grid. However, currently majority of the SIP (nearly 91 per cent) are off grid. Only 309 SIPs (around 9 per cent) are on grid and 22 of the SIPs do not produce any electricity at all (table 12).

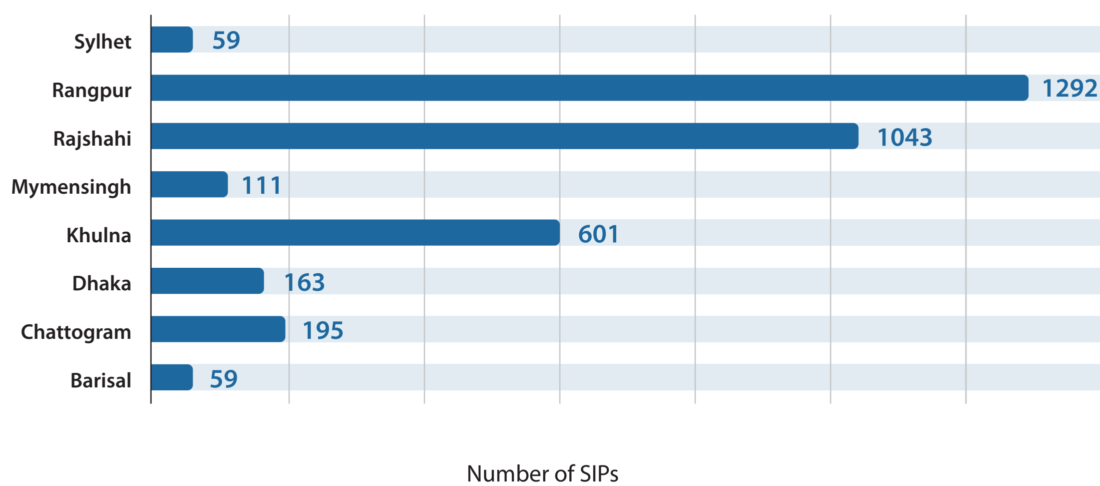
Table 12 Grid Status of Solar Irrigation Pump

Grid Status	Freq.	Per cent
Electricity not Produced	22	0.62
Off Grid	3,192	90.60
On Grid	309	8.77
Total	**3,523**	**100**

Source: Authors' Calculation from National Database of Renewable Energy.

Geographical Distribution

Figure 9 Distribution of Solar Irrigation Across Divisions



Source: Authors' Illustration from National Database of Renewable Energy.
Note:

Figure 9 depicts the distribution of Solar Irrigation across different divisions. The SIPs are largely concentrated in the north-western part of the country. Rangpur ranks top with 1,291 SIP programmes, followed by Rajshahi with 1,043 SIPs. However, adoption of SIP in other parts of the country is very low.

Implementing and Financing Organisation

Table 13 represents the distribution of solar irrigation programme by the implementing organisation. There are three organisations that are dominating SIP installation: Infrastructure Development Company Limited (IDCOL), Barind Multipurpose Development Authority (BMDA), and Bangladesh Agricultural Development Corporation (BADC). IDCOL alone is responsible for 46 per cent of SIPs, followed by BMDA with around 23 per cent. BADC implemented around 20 per cent (692 SIPs). BREB installed around 9 per cent of the overall solar irrigation pump.

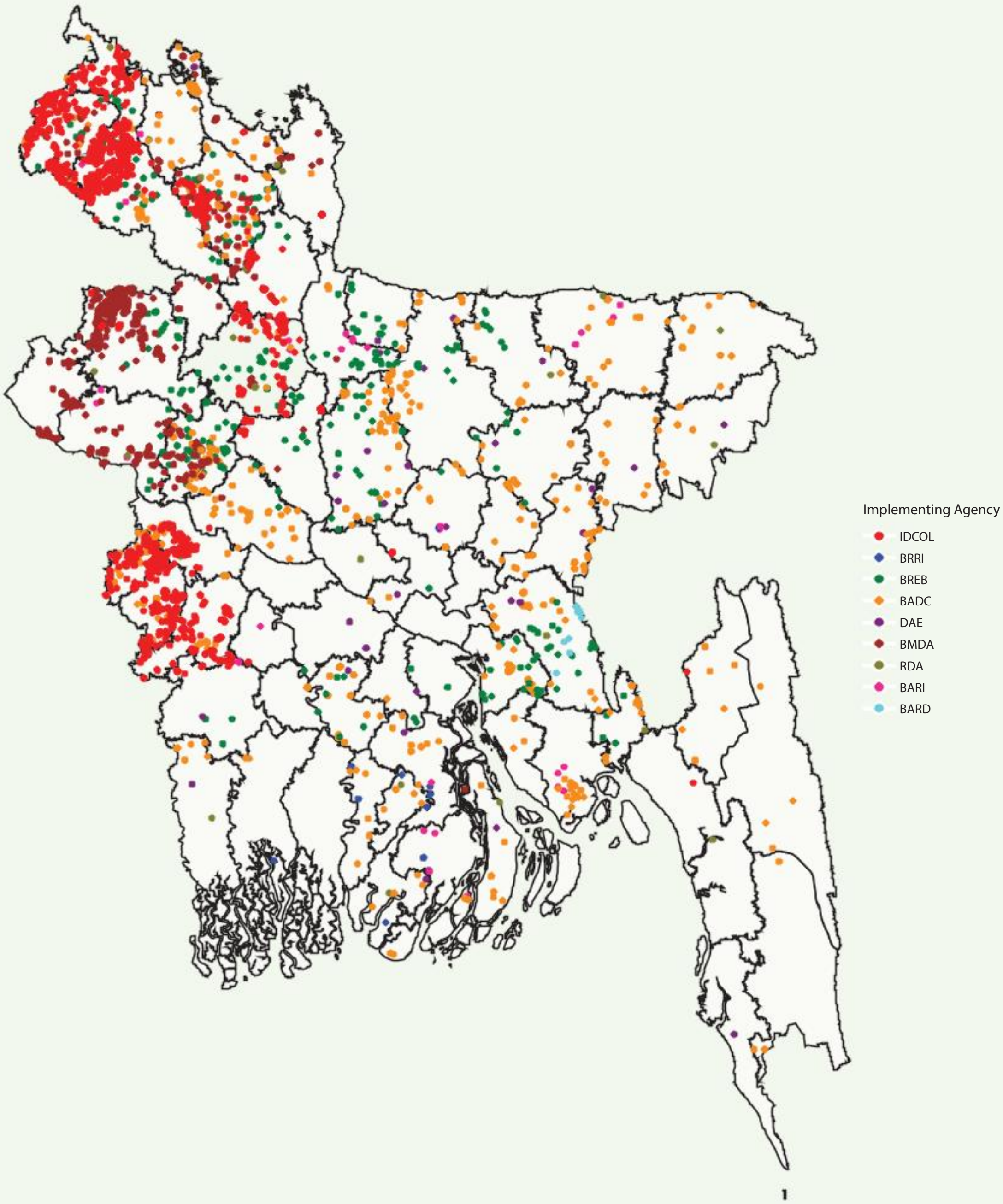
Table 13 **Distribution of SIP by Implementing Organisation**

Implementing Organisation	Frequency	Per cent
BADC	692	19.64
BARD	9	0.26
BARI	37	1.05
BMDA	792	22.48
BREB	302	8.57
BRRI	11	0.31
DAE	33	0.94
IDCOL	1,621	46.01
RDA	25	0.71
SREDA	1	0.03
Total	**3,523**	**100**

Source: Authors' Calculation from National Database of Renewable Energy.

If we look at the geographical distribution of the SIP by implementing organisations in figure 10, we can see the highest concentration of IDCOL and BMDA's SIP are in the North-western region of the country. However, BADC and BREB's SIP programmes are scattered across the country. It is noticeable that the solar irrigation programmes are very negligible in the Southern part of the country.

Figure 10 **Geographical Distribution of SIPs by Implementing Agency**



Source: Authors' Illustration from National Database of Renewable Energy.

Table 14 shows the distribution of SIP by financing organisation. The financing structure of Solar Irrigation Pumps (SIPs) is highly concentrated and predominantly public-sector driven, with IDCOL (46.0 per cent) and the Government of Bangladesh (44.6 per cent) jointly accounting for over 90 per cent of total financing. The government financing SIPs are implemented by various sector specific government agencies such as BADC, BARD, BARI, BMDA, BRRI, DAE AND RDA. This concentration underscores the centralised and programmatic nature of SIP deployment in Bangladesh, where large-scale adoption has been facilitated primarily through government-led and quasi-government financial mechanisms. The Asian Development Bank (ADB) is the third largest financing source (8 per cent) of SIP which are implemented by BREB. In contrast, private and self-financing in SIP adoptions are almost negligible.

Table 14 Distribution of SIP by Financing Organisation

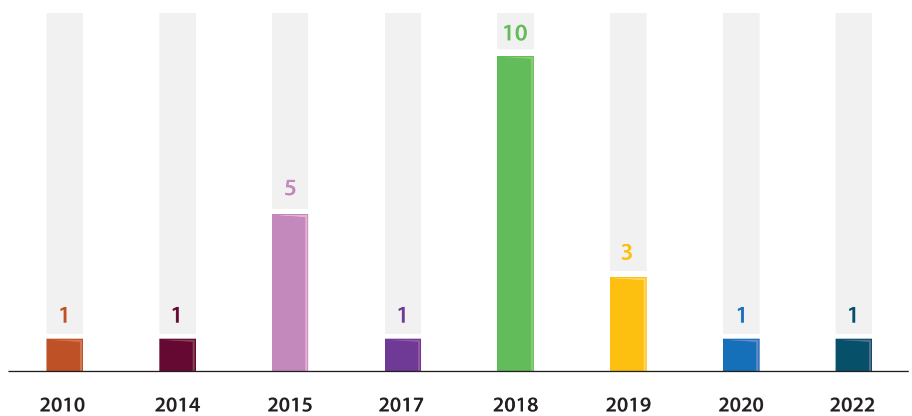
Financing Organisation	Frequency	Per cent
ADB	302	8.57
Citibank	1	0.03
FD	4	0.11
GIZ	6	0.17
GPRBA	3	0.09
GoB	1,571	**44.59**
IDCOL	1,621	**46.01**
N/A	2	0.06
Own Investment	2	0.06
WB	11	0.31
Total	**3,523**	**100**

Source: Authors' Calculation from National Database of Renewable Energy.

4.6 Solar Mini-grid

According to SREDA's National Database of Renewable Energy, a total of 28 solar mini-grids have been established in Bangladesh, with a combined installed capacity of approximately 5.805 MWp. The installation trend has slowed significantly in recent years, and no new mini-grids have been commissioned since 2022, largely due to the expansion of the national grid (figure 11). Among the existing installations, 27 out of the 28 solar mini-grids have been financed and implemented by Infrastructure Development Company Limited (IDCOL).

Figure 11 Solar Mini-grid Adoption Trend



Source: Authors' Illustration from National Database of Renewable Energy.

4.7 Solar Charging Stations

Currently there are 15 solar charging stations with combined capacity of approximately 0.291 MWp. Of 15, 7 of them were implemented by BREB and about 80 per cent (12 stations) were self-financed. The highest number of installations occurred in 2017, with eight stations commissioned, following five installations in 2016 (table 15). However, deployment slowed significantly afterward, with only one installation recorded in 2019 and another in 2023.

Table 15 Installation Trend of Solar Charging Stations

Year	Number of Installations
2016	5
2017	8
2019	1
2023	1

Source: Authors' Calculation from National Database of Renewable Energy.

4.8 Overall Insights

The preceding analysis of DRE systems in Bangladesh reveals several important patterns regarding the structure, and evolution of decentralised renewable energy deployment in the country.

The growth trajectories of different DRE technologies vary considerably over time. The SHS programme experienced rapid expansion during the early 2000s but declined sharply after 2018 as grid expansion reached many rural areas. A similar stagnation is observed in solar mini-grids and rooftop solar systems without net metering, both of which show limited recent growth. In contrast, net metering rooftop solar has shown strong growth in recent years, particularly since 2023, suggesting increasing adoption among urban and commercial electricity consumers.

The adoption of DRE technologies shows strong geographical concentration. Rooftop solar systems, both with and without net metering, are heavily concentrated in Dhaka and other major urban areas, reflecting higher electricity demand and greater investment capacity. In contrast, solar irrigation pumps are primarily concentrated in the north-western agricultural regions, particularly Rangpur and Rajshahi, where irrigation demand is high and groundwater-based agriculture is prevalent.

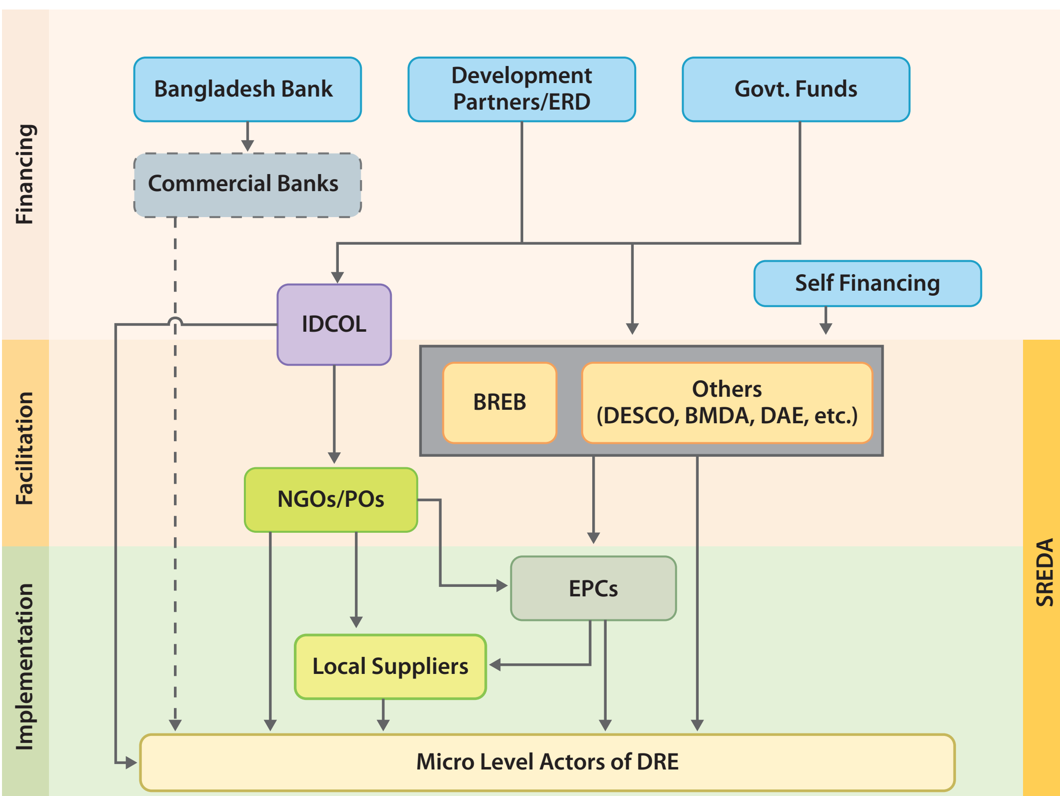
Besides, the analysis reveals a clear difference in financing structures across DRE technologies. Rooftop solar systems are largely financed through private or self-investment, indicating that adoption is driven primarily by entities with sufficient upfront capital. Conversely, solar irrigation pumps and solar mini-grids are predominantly financed through public or quasi-public mechanisms, particularly through the Government of Bangladesh and IDCOL. This indicates that large-scale deployment in certain sectors has been dependent on programmatic government support.

Finally, institutional concentration is a common feature across several DRE segments. IDCOL plays a dominant role in SHS installations, solar irrigation pumps, and solar mini-grids, while distribution utilities such as BREB and DESCO are the primary implementing agencies for rooftop solar systems. This concentration highlights the central role of a few key institutions in driving the development of distributed renewable energy in Bangladesh.

5 Meso-Level: Institutions, Incentives, and Interaction Channels

The meso-level institutions or actors remain at the core of Bangladesh's distributed renewable energy (DRE) ecosystem. The actors help translate the national policy objectives into actionable financing arrangements, facilitation mechanisms, and implementation pathways. The patterns of adoption of DRE systems observed in section 3 such as the concentration of rooftop solar in particular utility's service areas, the concentration of financing sources and geographical location of solar irrigation, and the decline of solar home systems (SHSs) following grid expansion can not be ascribed to the technology or user behaviours alone. Rather, these reflect the interaction modalities, structure and incentives of meso-level actors that share how the DRE systems are financed, deployed and sustained.

Figure 12 Meso-level Actors for DRE and Their Interaction Dynamics



Source: Author's Illustration from the finding of Desk Review, KIIs, and Field visit.

Figure 12 maps the meso-level actors and institutional ecosystems of DRE in Bangladesh. It illustrates the functional separation and linkages across financing, facilitation, and implementation roles and the channels through which these across interact with the micro level DRE adopters and the private implementers of the DRE systems at the user level.

5.1 Institutional Ecosystem at the Meso-level

The meso-level institutional ecosystem consists of a diverse set of actors that perform distinct but interlinked functions or activities. These actors include financial intermediaries, electricity distribution utilities, sector-specific public agencies, non-governmental organisations (NGOs), micro finance institutions and private suppliers.

Infrastructure Development Company Limited (IDCOL)

The Infrastructure Development Company Limited (IDCOL) has historically been a notable meso-level institution in the Bangladesh's DRE landscape, particularly in expansion of solar home systems (SHSs) and solar irrigation pumps (SIPs). As state-owned non-bank financing organisation, IDCOL mobilises public and development partners funds (received from EU, World Banks, JAICA, ADB, etc. as concessional loans) for DRE adoption through partners organisations (POs). IDCOL affiliated partner organisations (POs) are non-governmental organisations (NGOs) and micro-finance organisations in nature. Currently, there are around 30 affiliated POs with IDCOL. Upon receiving funding from IDCOL, the POs interact with local level suppliers or EPCs and the individual or household-level DRE adopters. They assume an important intermediary role for the expansion of SHS deployment by facilitating access to finance, disseminating information, and providing after-sales services to rural households. However, for the industrial rooftop solar, IDCOL directly interacts with the firms in RMG, Textile, Glass, Pharmaceuticals, Paper & Particle Board, Sanitary & Ceramics, Cold Storage, Poultry, Automobile, Leather, Agro Processing, Plastics, Chemicals Sector and provide concessional loans, system design and implementation support.

Electricity Distribution Utilities

Electricity distribution utilities including Bangladesh Rural Electrification Board (BREB), Bangladesh Power Development Board (BPDB), Dhaka Electric Supply PLC (DESCO), Dhaka Power Distribution Company (DPDC), Northern Electric Supply PLC (NESCO), and West Zone Power Distribution Company Ltd. (WZPDC), have emerged as dominant meso-level actors in the diffusion of rooftop solar systems with and without net metering. Compared to other utilities, BREB and DESCO particularly stand out in terms of their large share in the implementation of rooftop solar systems. While sometimes utilise development funds, they often utilise their own revenue fund and install the solar on the rooftop on their own facilities and buildings. The BREB also provides technical assistance to the industries that are willing to install rooftop solar. In addition to rooftop solar, BREB is also notable for implementing solar irrigation pumps (SIPs) programmes. Unlike IDCOL, BREB engages directly with the farmers through providing loans, grants and awareness building and the ownership of the SIPs are transferred to the farmers.

Sector-specific Public Organisations

Sector-specific public agencies, such as the Barind Multipurpose Development Authority (BMDA) and the Bangladesh Agricultural Development Corporation (BADC), the Bangladesh Agricultural Research Institute (BARI), Bangladesh Rice Research Institute (BRRI) and Department of Environment (DAE), play a key meso-level role in solar irrigation programmes. These agencies install the SIPs across the country using government funds and own the facilities themselves.

Suppliers and EPCs

Private sector suppliers and Engineering, Procurement and Construction (EPC) firms constitute another layer of meso-level actors. Their engagement is primarily transaction-driven and focused on providing system installation services and sale of components, with limited involvement in long-term operation and maintenance. They often interact with both the micro-level adopters and meso-level actors.

5.2. Supply-chain or Market Actors in the DRE Ecosystem

The table 16 summarises the main supply-chain and market actors operating within the distributed renewable energy (DRE) ecosystem in Bangladesh. It shows that the market is dominated by downstream actors involved in importing, supplying, and installing renewable energy components. A large number of firms operate as importers (127) and suppliers or resellers (134), indicating strong dependence on imported technologies and a well-developed distribution network.

In comparison, the number of local manufacturers (46) is relatively small, suggesting limited domestic value addition in the DRE supply chain. Export-oriented firms are even fewer (20), reflecting that the renewable energy market is primarily oriented towards domestic deployment rather than international trade. The presence of a substantial number of EPC companies (136) indicates growing technical and installation capacity, largely driven by project-based demand generated through financing programs and public or utility-led initiatives.

Table 16 Supply-chain and Market Actors of DRE

Market Agents	Number
Importer of RE components	127
Local Manufactures of RE components	46
Exporters of RE components	20
Suppliers / Reseller of RE components	134
EPC companies in RE sector	136

Source: Authors' calculation forms National Database of Renewable Energy.

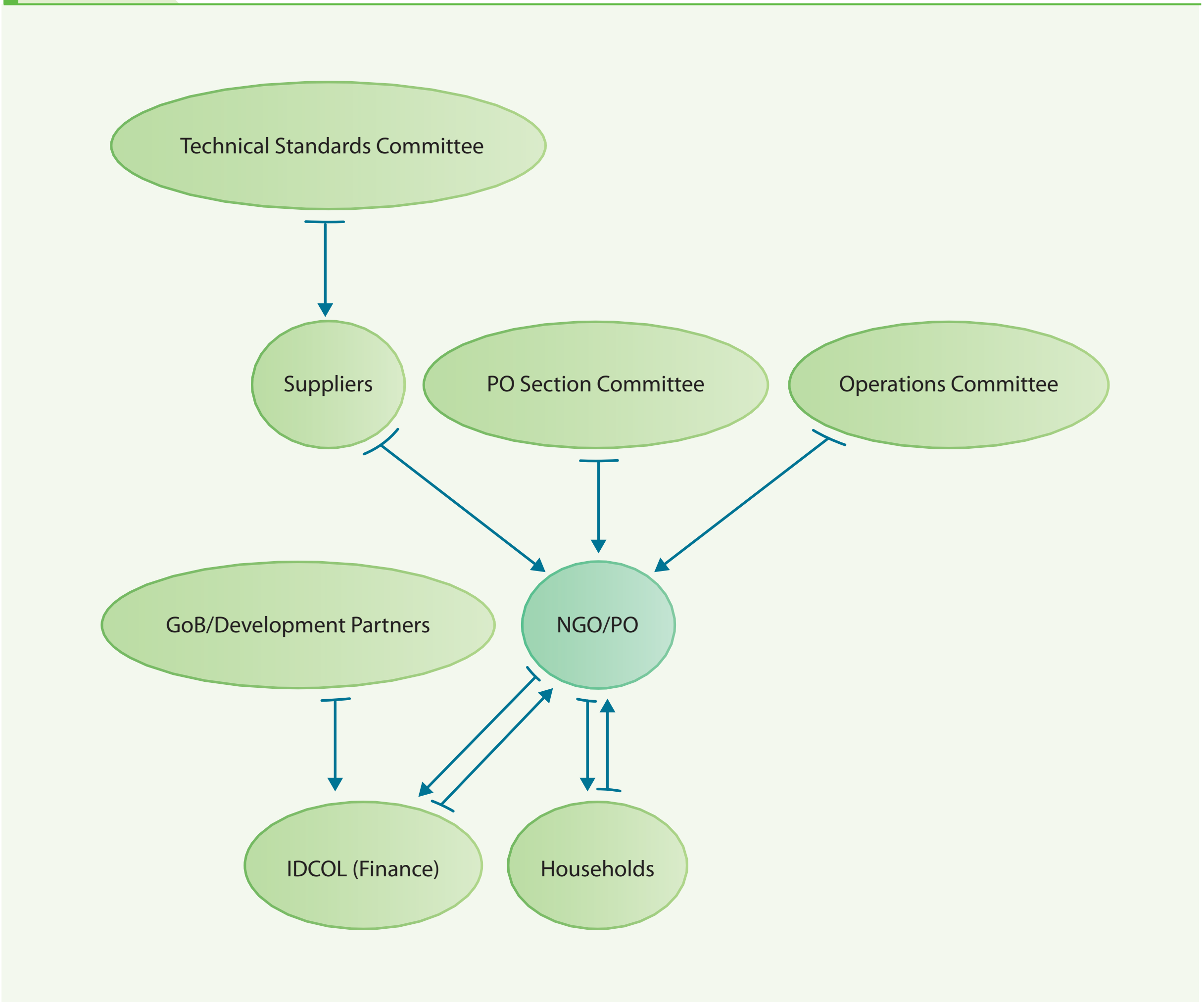
5.3 Interaction Channels of DRE Programmes at the Meso-level

Solar Home System (SHSs)

IDCOL is the biggest implementer of solar home systems (SHSs) in the country. While there are other implementers such as BREB, they all tried to replicate IDCOL's implementation model with some customisations. Therefore, IDCOL's model largely captures interaction channels of the meso-level actors regarding the SHSs programme. Figure 13 depicts the interaction channels of meso-level actors within the IDCOL's SIP model.

Table 17 depicts the description of the IDCOL's model. It is an ownership model where micro-actors such as the households receives the ownership of the facility after completion of the installment of loan. The programmes are designed combining loans and grants. Even though the grant consisted of around 50 per cent, it has fallen to 25 per cent recently. The grants help lower the initial upfront cost. The partner organisation procures the standard SHS programme components from the approved suppliers and takes responsibility of installation in the household.

Figure 13 **Meso-level Actors of SIP in IDCOL's Model**



Source: Authors' Illustration from IDCOL's website[4].

Table 17 **SHS Programme Description of IDCOL**

Domain	SHS Model Description
Financing Flow	Government → IDCOL → Partner Organisations (POs) → Households
Financing Modalities (Loan: Grant)	75:25
Implementing Entities	MFIs and Partner Organisations
Procurement	POs purchase SHS equipment from approved suppliers
Delivery mechanism	Installation by Pos
End-user payment	Installment-based payment system
Ownership	Household ownership after repayment

Source: Prepared by authors from the findings of KII and desk review.
Note: Currently the grant is around 25 per cent, which was around 50 per cent previously.

4 https://idcol.org/idcol_new/public/renewable/solar-home-system-program

Solar Irrigation Pumps (SIPs)

Table 18 presents the different institutional models through which solar irrigation programmes are implemented in Bangladesh. It highlights variations in ownership, financing structure, and grid connectivity of the SIPs across implementing institutions. IDCOL implements SIPs through a *fee-for-service* model in which a private sponsor owns the system and provides irrigation services to farmers, supported by a blended financing structure comprising loans, grants, and sponsor equity with a defined repayment period. The BREB follows an ownership-based model where farmers retain ownership of the system, supported by a higher share of grant financing and integration with the grid. In contrast, public sector agricultural agencies such as BMDA, BADC, and DAE adopt community ownership models that are *fully grant-financed* and operate largely in off-grid settings.

Table 18 Different Models of SIP Programmes by Different Meso-level Actors

Domain	Description		
Organisation	IDCOL	BREB	BMDA, BADC, DAE, and others
Model Nature	Fee for service model	Ownership Model	Community Ownership Model
Financing Modality (Loan: Grant: Down payment by sponsor / farmer)	50:35:15	30:60:10	0:100:0
Repayment Time	10	10	-
Grid Connection	Off-grid	On-grid	Off-grid
Ownership	Sponsor	Farmer	Farmers

Source: Prepared by authors' from the findings of KII and (Mitra et al., 2021).

Net Metering Rooftop Solar

Table 19 shows the different implementation models for net metering rooftop solar followed by IDCOL and electricity utilities. Under the IDCOL model, both capital investment and operation are part of the project design. IDCOL provides financing to rooftop owners, mainly in the industrial sector. Financing can cover up to 80 per cent of the project cost and includes concessional loan terms. When a rooftop owner wants to install solar in CAPEX model, IDCOL provides concessional loans and technical assistance. In OPEX model IDCOL finances the third party not the rooftop owner. These third-party providers interact with both IDCOL and the rooftop owner.

Utilities such as BREB follow a different approach. Rooftop solar systems are installed mainly on utility-owned buildings and public facilities. These include PBS offices, schools, colleges, and hospitals. Utilities finance these systems from their own budgets. They do not provide financing to third parties. Both installation and operation take place within utility-managed premises.

5.4 Incentive Structures Shaping Meso-Level Behaviour

The actions of the meso-level institutions are driven by the incentive structures rooted in their mandates, financing mechanisms, and operational models. These incentives vary significantly across actor types and DRE technologies, resulting in uneven adoption outcomes and retention performance.

Incentive Structure of IDCOL

Financing institutions such as IDCOL operate under incentives that emphasise fund disbursement efficiency, increasing portfolio and successful recovery of the loans from the POs. As a financial intermediary, repayment

Table 19 Implementation Models of Net Metering Rooftop Solar

Domain	IDCOL	Utilities (BREB and others)
Model	CAPEX & OPEX	CAPEX & OPEX
Interactions channels and actors	**CAPEX:** IDCOL and Rooftop Owner **OPEX:** • IDCOL and The Third Party • The Third Party and Rooftop Owner	**CAPEX:** On the Rooftop of PBS buildings **OPEX:** On the rooftop of government buildings, Schools, colleges and hospitals
Financing	Up to 80% of the project cost, around 6% interest rate and 1 year grace period	Self-financing for own facilities. Does not provide finance to third party.
Focus	Industry	Own Facilities (PBS buildings), School / College / Hospitals etc.

Source: Prepared by authors.

performance and portfolio stability constitute its primary accountability metrics. While expansion in the number of DRE installations contributes to portfolio growth, ensuring long-term system retention or post-installation service delivery does not form part of its core mandate and is weakly incentivised.

In the SHS and SIP programmes, concessional project-based financing mechanisms encourage rapid installations through standardised system designs and partner organisations. However, as grid expansion reduced the relative profitability of SHSs, institutional engagement in new SHS financing declined. At the same time, prevailing financing and implementation models provided limited incentives for maintenance, upgrading, or continued use of already-installed systems.

The concentration of IDCOL's SIP programmes in a few areas of country is also due to its incentive structure. Its SIP models are financially viable only in regions with high agricultural intensity and multi-crop potential such as Rajshahi and Rangpur. Therefore, it refrained from financing SIP programs in areas that produce less than three crops a year. It prioritises financially secure projects over broader geographic coverage.

Incentive Structure of MFIs and NGOs

As partner organisations of IDCOL, microfinance institutions and NGOs face several incentives which drive them to engage in expansion of the DRE systems. These include successful loan recovery, revenues generated from DRE facilities (particularly in the case of solar irrigation programmes), income derived from interest rate spreads, and the expansion of their institutional portfolios. Their performance is evaluated largely by repayment rates, portfolio size, and compliance with programme rules. However, for them long-term energy service provision remains weakly incentivised.

Incentive Structure of Distribution Utilities

For the distribution utilities, incentives to freely promote the DRE systems are mixed. By the institutional nature and mandate, promoting renewable energy is not their objective. Adoption of DRE systems such as rooftop solar can reduce electricity sales and increase administrative complexity. Therefore, utilities such as BREB and DESCO promote DRE as a part of the imposed responsibility or targets that come from the macro-level or national policy level. However, because of conflicting interest, they tend to deploy the DRE systems selectively. In particular, utilities prefer to fulfill the RE targets in such a way that does not affect their revenue from the electricity sale. As a result, the net metering rooftop by the utilises are observed to be installed on their own facilities and service areas following CAPEX model. BREB accounts for nearly 41 per cent of the net metering rooftop solar and 76 per cent of them are in CAPEX model.

Incentive Structure of Sectoral Agency

Sector-specific public organisations, particularly the ones involved in solar irrigation programs such as the Barind Multipurpose Development Authority (BMDA), the Department of Agricultural Extension (DAE), and the Bangladesh Agricultural Development Corporation (BADC), are driven primarily by mandates related to irrigation expansion, agricultural productivity, and infrastructure delivery. Their incentives are shaped by sectoral performance targets, budget utilisation requirements, and administrative accountability, rather than financial returns.

Incentive Structure of Suppliers

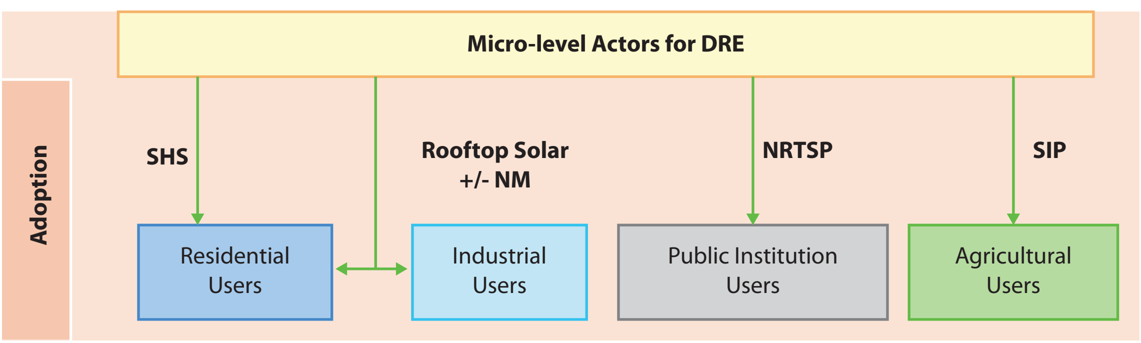
Private EPC firms and suppliers play an enabling but limited meso-level role. Their incentives are largely transaction and profit driven. Consequently, they focus largely on installation contracts rather than long-term operation and maintenance.

6 The Micro-Level: Adoption and Retention Challenges

6.1 Actor Mapping of the Micro Level

The distribution of DRE at the micro level consists of numerous types of users who act according to different motivations and energy needs. There is significant variation in the adoption pattern between off-grid and on-grid systems of DRE. In the on-grid category the users are simultaneously producers and consumers, referred to as prosumers, which is possible through net metering of their energy installations. The status of these user categories has different modes of income generation which affect both their energy use and affordability of DRE systems. The choice of adoption and retention for potential and current users depends not only on their own perceived needs, costs, views on efficiency and usefulness, but also on their risk-preference and exposure to information. Beyond simple adoption they face a choice of programmatic adoption facilitated by the meso actors which is usually debt-based and pursuing DRE at their own initiative through the market directly.

Figure 14 **Micro-level Actors for DRE and Programmes**



Source: Author's Illustration.

Figure 14 illustrates how the different categories of users at the micro level interact with the meso level in Bangladesh through different programmes. The programmes are designed to address a specific category of users and with sparse overlap. The residential users were the target of programmes like Solar Home System (SHS) and Rooftop Solar (RTS) with and without net metering. To a smaller extent, solar mini grids are in use for households in remote areas. The industrial users are incorporated in the Rooftop Solar programme. Public institutions like government offices, schools and hospitals are under the National Roof Top Solar Programme (NRTSP). The agricultural users who use renewable energy for irrigation by solar energy through the Solar Irrigation Pump (SIP) programme. These programmes are administered and facilitated by different meso-level organisations.

6.2 DRE Technology-wise Adoption and Retention Challenges

6.2.1 Solar Home Systems (SHS)

The earliest and most substantial off-grid residential solar electrification in Bangladesh occurred through the SHS programme. It offered electricity to households through solar installations with small storage capacity allowing lighting, cooling and appliance charging facilities who did not have grid electricity through a micro financing model. It allowed households to access electricity and energy services which saved time and funds employed by households in sourcing traditional lighting fuel like kerosene. This saving now could be used for productive activities and the additional hours of lighting allowed both productive activities and studying to continue longer.

The unplanned expansion of grid electricity in the past decade along with maintenance issues and loan defaults has caused a decline in use of off-grid solar photovoltaic installations under the SHS programme. With increasing access to grid electricity, the micro credit-based model of off-grid solar with limited capacity became less attractive to residential users. Along with this, the introduction of the TR KABIKHA programme which distributed solar panels free of cost under a social safety net programme further allowed potential users to substitute away from the micro-credit model of SHS.

The programme familiarised residential users with solar energy and provided affordable packages to access electricity. But as their energy demands grew, the installations were not sufficient to meet them, making the users turn to grid electricity. Moreover, maintenance issues and lack of knowledge regarding maintenance reduced the functionality of many installations. The Partner Organisation based model also prioritised financial viability for loan repayment which reduced their scope. Thus, the high number of adoptions did not continue to retention as users substituted away to grid electricity both due to unmet demand and supply issues. This indicates misalignment of the incentives between users and the programme design along with the lack of feedback flow and integration from the users to the meso-level.

6.2.2 Rooftop Solar (RTS)

For both residential and industrial users, Rooftop Solar (RTS) is now the prevalent method of renewable transition. It is available with both with and without net metering. The residential users have RTS installed due to a structural requirement by building and utility authorities requiring 10 per cent of sanctioned load to be sourced from solar energy. However, the installations at the residential level suffer in functionality status as most are not followed up with proper maintenance and only acquired for satisfying the conditions set by authorities.

The industrial sector has massive potential as they have large amounts of unused roof space at factories which can be used for solar installations. This potential is being actuated with the recent uptake in industrial adoption of RTS. However, the uptake is being led by larger industries which can absorb the cost or have access to credit or grants for covering the high initial cost of solar installations. The lack of utilisation of the financing channels for industrial rooftop solar installations is limiting the rate of adoption in this sector.

There is a significant incentive for export-oriented industries to scale up their renewable energy production to comply with requirements set by foreign buyers regulated by respective governments setting standards for doing business. Decarbonisation and renewable energy use are increasingly being required by buyers to meet their sustainability regulatory criteria from their own governments. This is likely to increase surrounding the LDC graduation Bangladesh faces in the near future. The industries also are motivated to install solar energy to make up for the energy shortage they face. Many industries have gas powered captive power plants which supplement the power input they need to maintain continuous production in case of power outages or loadshedding. But with an acute shortfall in gas supply to fuel these captive plants, many are turning to solar power to even marginally alleviate the power shortfall endangering production. But small and medium-sized industries are not yet capable of financing or managing the technical aspect of rooftop solar installations on their own.

6.2.3 Solar Irrigation Pump (SIP)

Farmers depend on diesel-based irrigation across large parts of the country for agricultural production. In this situation SIPs are considered as a viable alternative as they have no fuel cost post installation, and the lifetime cost is significantly lower. However, the access to SIPs is limited regionally and programme-wise. The farmers have solar pumps installed in fields from which they buy water, while the pump is owned by the Partner Organisation in the IDCOL model. But they have pathways towards ownership in the REB model. The specific water requirements of the type of crops rotation in the agricultural fields also determines the adoption of SIPs.

The fields producing three crops annually can utilize the pump around the year and thus are prioritised during installation. Except in the REB model, the pumps are not planned to undergo grid integration through net metering, resulting in pumps being regionally clustered in the north and western parts of the country due to cropping patterns. The farmers have the incentive of minimising costs and boosting productivity for cultivation. This leaves the scope on their parts to move towards cost and ownership sharing for SIPs along with integration of water-saving irrigation technologies. The profitability of the agricultural farm and the stability of crop prices are crucial in the sustainability of the solar irrigation programmes currently in practice. There are also several behavioural issues of farmers, when it comes to irrigation. Due to widespread awareness campaigns about irrigating agricultural land at night due to it being off-peak hour for electricity demand, this practice has become commonplace and poses a behavioural challenge for the uptake of solar irrigation.

6.2.4 Solar Charging Stations

The prevalence of electric vehicles saw an exponential rise in recent years in Bangladesh, in the form of battery-operated electric rickshaws. This expands the scope of distributed renewable energy to solar charging stations. There are numerous solar charging stations operational in the country, with many operating as battery swapping stations. But there is yet to be a government organisation facilitated initiative for its mass enrollment. The organisations in charge of such initiatives such as utilities like REB and non-bank financial institutions like IDCOL are still at the pilot phase for such a programme roll out. The existing ones, being on the private initiative, show potential but not without challenges. Rickshaw drivers often operate their vehicle on lease from garage owners rather than owning it themselves. As such the charging occurs mostly at the garage with grid electricity. But these garages have not been integrated into DRE adoption. The charging of the batteries is a time-consuming endeavor which would be required to take place during the day using solar power. This presents a challenge for charging stations as the operation of these electric vehicles occurs mostly during the day. The temporal misalignment necessitates a mechanism for battery swapping where charged batteries are swapped over for empty ones on a rental basis.

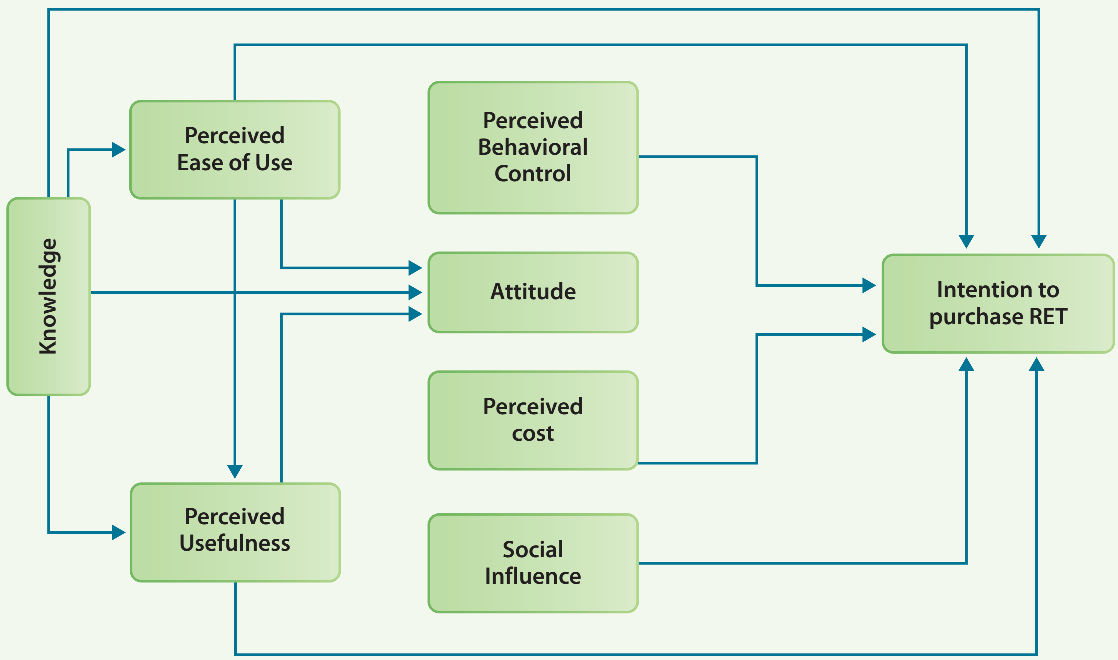
The transport sector requires contiguous charging infrastructure through areas where these vehicles operate. In the future for the scaling up of electric buses and cars, such a charging station network is crucial. The current filling station network for fossil fuel-based vehicles offers potential for retrofitting them as solar charging stations.

6.3 Overall Barriers Towards Adoption and Retention

The decision to adopt DRE is a complex decision based on the perception of the potential user, their knowledge and awareness and economic calculus based on the fossil fuel alternatives. The availability and affordability of the type of DRE demanded by the potential users are also important in deciding whether they end up adopting it or not. Thus, there are both behavioural and structural aspects at play while analysing the adoption decision of DRE.

Figure 15 shows the factors behind the purchase intent of Renewable Energy Technologies (RET). For scaling adoption, it is crucial to identify and resolve the barriers in this adoption process. Perceived ease of use and usefulness determines the attitude towards intent for adoption and is mediated by perceived costs. The actual cost facing the user and the knowledge level of the user limit the adoption process from scaling. The design of

Figure 15 **Framework for the Purchase Intention of Sustainable Energy**



Source: Adapted from (Masukujjaman et al, 2021).

DRE adoption programmes needs to both improve the utility and cost conditions faced by the consumers and improve communication and awareness to favourably shape their perceptions as well.

Not only the renewable technology ought to be more affordable than its fossil fuel alternatives, the timeline of the cost also matters. Smaller but regular fuel costs and readymade infrastructure of fossil fuel-based technologies are often more preferrable than renewable technologies with higher initial costs, low maintenance costs and zero fuel costs even if the latter has lower lifetime cost. The risk preference of the users also needs to be considered when analysing the adoption pattern. Risk averse potential users will defer towards familiar technology which does not require high initial investment. Thus, the risk or the initial cost needs to be absorbed by a financing model. The traditional credit-based model remains limited due to the lack of involvement of traditional financial institutions and the limited formalisation of the economy. This leaves a large part of the potential users without access to credit which they would depend on for self-motivated adoption. So, most adoption is still occurring through government organisations facilitated financing. The market demand is not organically growing due to both the affordability issue and the knowledge barrier among the users.

Beyond adoption, the retention of these technologies is a serious concern. There ought to be a mechanism for upgradation and integration of user feedback into system and product design as energy needs evolve for users and the technology becomes increasingly efficient through innovation. Any infrastructural lock-in within older technologies which do not align with consumer needs will lead to obsolescence and cease of use. This is particularly exemplified by the case of the Solar Home System (SHS). Thus, dynamic designs with scopes for upgrading are crucial for any long-term scaling of DRE.

7 Incentive Alignments and Feedback Mechanisms Between Micro and Meso-level

Drawing on key informant interviews and programme evidence, the analysis highlights persistent incentive misalignments and weak feedback mechanisms micro-level actors (firms, farmers, households) and meso-level institutions (financiers, utilities, partner organisations, and sector agencies) that constrain adoption and retention of DRE systems.

7.1 Demand-side Willingness and Financing Constraints

Findings from the KIIs indicate strong willingness among firms particularly industrial and commercial consumers to adopt rooftop solar systems. However, this willingness does not translate smoothly into adoption due to financing constraints at the meso level. Access to commercial bank financing remains limited, while green financing facilities routed through Bangladesh Bank involve extensive documentation, long approval timelines, and intermittent fund availability. As a result, potential adopters face high transaction costs even when technical and economic interest exists.

At the same time, most meso-level financing actors rely heavily on development partner funding or government-backed concessional resources. This funding structure creates uncertainty regarding future availability, particularly as Bangladesh transitions out of least developed country (LDC) status. The anticipated tightening of concessional finance poses a structural risk to DRE expansion, especially for solar irrigation programmes.

7.2 An Installation-centric DRE System

The interaction between micro- and meso-level actors has produced a DRE system that prioritises delivery over sustainable and long-tern retention. Across technologies, institutional success is defined by installations completed, funds disbursed, and loans recovered, while long-term system use, upgrading, or integration receives limited attention. As a result, micro-level adoption is treated as a one-time event rather than an ongoing service relationship. Once contractual and financial milestones are met, institutional engagement weakens, leaving system performance largely dependent on user capacity.

7.3 Asymmetric Feedback and One-way Information Flow

A central characteristic of the micro–meso interaction is asymmetric feedback. Information flows downward from institutions to users through standardised programme designs and eligibility criteria but flows weakly in the opposite direction. Changes in user behaviour, declining utilisation, or shifting preferences rarely translate into institutional learning or programme adjustment.

This asymmetry persists not because feedback is absent, but because it is not institutionally valued. Performance signals that do not affect repayment or compliance metrics remain peripheral to decision-making. Consequently, the system lacks mechanisms to internalise micro-level signals as drivers of reform.

7.4 Cost Structures and Policy-induced Disincentives

Adoption costs remain elevated due to fiscal and policy factors. Total tax incidence -- approximately 28 to 29 per cent on solar panels and inverters, respectively -- significantly increases upfront system costs. These duties weaken the competitiveness of DRE relative to conventional energy options and reduce the effectiveness of concessional financing mechanisms. As a result, well-designed programs struggle to scale beyond niche segments, reinforcing dependence on subsidies and donor-supported initiatives rather than market-driven uptake.

In the case of solar irrigation, unequal regulatory treatment further distorts incentives. Licensing procedures for solar irrigation systems are more restrictive than those for diesel-based pumps, while diesel irrigation continues to benefit from fuel subsidies. This asymmetry undermines the economic case for solar irrigation and slows adoption despite its long-term cost and environmental advantages.

8 Conclusion and Recommendations

The preceding analysis demonstrates that the limited scaling and weak retention of Distributed Renewable Energy (DRE) in Bangladesh are primarily the result of institutional, financial, and policy misalignments rather than a lack of technological feasibility or user demand. Across households, farmers, and firms, willingness to adopt renewable energy technologies is evident, yet this willingness frequently fails to translate into sustained adoption due to high upfront costs, constrained access to formal finance, weak maintenance and service ecosystems, and limited institutional responsiveness to user needs.

At the meso level, DRE programmes have largely evolved as installation-centric interventions, where success is measured by deployment volumes and financial disbursement rather than long-term system performance or adaptability. This has produced asymmetric information flows, with limited feedback from micro-level users shaping programme redesign. Policy distortions, particularly high tax incidence on renewable energy equipment and continued subsidies for diesel-based irrigation, further weaken the economic incentives for renewable adoption. As Bangladesh approaches LDC graduation and concessional financing becomes increasingly uncertain, addressing these structural gaps is critical to ensuring a sustainable and resilient renewable energy transition.

A. Institutional Reforms

1. Establishing a National DRE Coordination and Oversight Committee

The governance of DRE in Bangladesh is fragmented across multiple meso-level institutions with overlapping mandates and limited formal coordination. This fragmentation has resulted in parallel programme implementation, inconsistent regulatory practices, and weak integration of learning across technologies such as SHS, RTS, SIP, and SCS. In the absence of an overarching coordinating mechanism, collaboration remains ad hoc and systemic inefficiencies persist.

To resolve this gap, a National DRE Coordination Committee should be established under the leadership of SREDA, with representation from IDCOL, REB, Bangladesh Bank, utilities, commercial banks, and partner organisations. The committee should be mandated to harmonise programme objectives, coordinate planning across DRE initiatives, and resolve regulatory inconsistencies. Importantly, it should review performance metrics related not only to installations but also to utilization, retention, and system functionality, thereby institutionalising a system-wide approach to DRE governance.

2. Institutionalising Micro–Meso Feedback and Learning Mechanisms

Existing DRE programmes largely operate with one-way information flows from institutions to users, while feedback from micro-level actors regarding system performance, maintenance challenges, and evolving energy needs rarely informs programme redesign. This lack of institutionalised feedback contributes to rigid programme structures and declining retention rates.

This gap can be addressed by embedding structured feedback mechanisms within all DRE programmes. Regular user surveys, online software-based grievance mechanism, system audits, and field monitoring should be incorporated into programme cycles. Solar Information Officers under SREDA should be tasked with collecting localised data and transmitting it into institutional decision-making processes. Incorporating feedback-based indicators such as uptime and effective utilisation into performance assessments would ensure that user experiences directly shape institutional learning and reform.

B. Programme Design and Technology Integration

3. Redesigning the Solar Irrigation Pump (SIP) Programme

Current SIP programme designs emphasise centralised ownership and limited grid integration, which has resulted in underutilisation, regional clustering, and weak long-term financial sustainability. Farmers often have limited incentives to optimise usage or invest in maintenance.

The SIP programme should be redesigned to promote shared ownership models among farmers, enabling cost-sharing and stronger incentives for efficient use. Integration of water-saving irrigation technologies such as drip and sprinkler systems should be prioritised. Expanding grid integration through net metering would allow surplus electricity sales, improve financial viability and reduce idle capacity.

4. Integrating Solar Home Systems (SHS) into the On-grid Transition

The expansion of grid electricity has rendered many SHS installations obsolete, leading to declining utilisation and erosion of user trust in renewable technologies. The absence of structured transition pathways has resulted in stranded assets.

SHS programmes should be reoriented to support integration into on-grid household solar systems through retrofitting, hybrid grid connection, or repurposing for backup and productive uses. Institutional support for upgrading and maintenance would extend system lifespans and preserve the value of past investments.

6. Scaling Solar Charging Stations (SCS) Through Infrastructure and Formalisation

Solar Charging Stations remain fragmented and largely informal, limiting their ability to support the growing electric transport sector. The lack of standardised infrastructure, security arrangements, and regulatory clarity constrains private investment and network expansion.

A nationally coordinated SCS programme should be launched with dedicated infrastructure investment and formal licensing frameworks. Retrofitting existing fossil fuel filling stations and vehicle garages as solar charging hubs would reduce costs and accelerate network development. Battery swapping models should be promoted to address temporal mismatches between solar generation and vehicle operation.

C. Financing and Credit System Reforms

7. Creating a Dedicated Renewable Energy Financing Window at Bangladesh Bank

The DRE financing in Bangladesh remains heavily dependent on development partner funds, while access to commercial bank financing is constrained by complex procedures, long approval timelines, and risk aversion. This financing structure increases transaction costs for adopters and exposes the sector to uncertainty as concessional finance declines post-LDC graduation.

To address this gap, Bangladesh Bank should establish a ring-fenced Renewable Energy Financing Window dedicated exclusively to DRE projects. This facility should feature simplified documentation requirements, standardised appraisal criteria, and predictable concessional fund availability, with resources routed through commercial banks. Incorporating risk-sharing mechanisms such as partial credit guarantees would encourage lender participation and reduce financing bottlenecks.

8. Expanding Commercial Bank Participation in DRE Lending

Despite strong willingness among industrial and commercial users to adopt rooftop solar, small and medium enterprises face financing constraints due to limited engagement by commercial banks. Many banks lack the technical capacity to assess DRE projects, leading to conservative lending practices and slow uptake.

Targeted technical capacity-building programmes for commercial banks should be implemented, complemented by refinancing incentives and performance-linked rewards for DRE lending. Developing standardised project templates and credit assessment tools would further reduce perceived risks. Expanding bank participation would unlock private capital and accelerate market-driven adoption of rooftop solar systems.

9. Development of Financial Instruments and Bundling of Technologies for DRE Adoption

Isolated adoption of technologies often fails because it requires independent assessment and decision making. Easing that adoption barrier by packaging useful technologies together allows faster diffusion of newer technologies. Since there is an acute lack of awareness about DRE among the different class of consumers, their inclination to adopt them at a mass scale depends on their integration into mainstream technology pathways.

Commercial banks ought to design combined packages which integrate DRE provisions to traditional loans to consumers. Net metered rooftop solar could be financed for residential consumers by bundling it with home or appliance loans. Similarly, SIP loans can be bundled with agricultural loans for agro-mechanic technologies like power tiller and harvesters.

D. Capacity Building and Awareness

10. Enhancing User Awareness and Behavioural Alignment

Behavioural practices and limited knowledge continue to reduce effective utilisation of DRE technologies, particularly in agriculture where irrigation patterns often conflict with solar generation profiles.

Targeted awareness campaigns should focus on optimising year-round utilisation of SIPs, aligning irrigation practices with solar availability, and highlighting productivity gains rather than solely cost savings. Integrating agricultural advisory services into SIP deployment would further improve outcomes.

11. Strengthening Maintenance and Retention Ecosystems

Weak maintenance infrastructure and lack of long-term service arrangements undermine system reliability and user confidence, contributing to low retention across DRE technologies. Maintenance is often treated as peripheral rather than central to programme success.

DRE programmes should explicitly incorporate sustainable maintenance and retention services through trained local technicians and performance-based service contracts coordinated by SREDA and partner organisations. Shifting towards service-oriented programme models is essential for ensuring long-term functionality and trust in renewable energy systems.

E. Other Recommendations

12. Reducing Fiscal Barriers to Renewable Energy Technologies

The affordability of renewable energy systems remains constrained by high import duties, VAT, and supplementary taxes on solar panels, inverters, and related components. These fiscal burdens significantly increase upfront costs, reduce the competitiveness of DRE relative to conventional energy options, and limit market-driven adoption beyond subsidised programmes.

To address this challenge, a targeted fiscal reform package should be introduced to reduce tax incidence on renewable energy equipment, particularly for rooftop solar and solar irrigation technologies. Lowering upfront costs would improve payback periods, enhance the effectiveness of financing mechanisms, and encourage broader participation from households, farmers, and small enterprises. Periodic reviews and sunset clauses can ensure fiscal sustainability while supporting market development.

13. Reforming Fossil Fuel Subsidies in Agricultural Irrigation

The continued subsidisation of diesel-based irrigation, combined with relatively restrictive regulatory treatment of solar irrigation systems, distorts relative prices and weakens the economic incentives for farmers to adopt Solar Irrigation Pumps (SIPs). This policy-induced imbalance slows the diffusion of solar irrigation despite its lower lifetime costs and environmental benefits.

A phased reform of diesel subsidies should be undertaken, alongside transitional support for farmers shifting to SIPs through capital subsidies or concessional finance. Regulatory procedures for SIP installation and operation should be simplified and aligned with those for diesel pumps. This gradual realignment would strengthen the economic case for solar irrigation while minimising adverse impacts on agricultural production.

References

Cabraal, A., Ward, W. A., Bogach, V. S., & Jain, A. (2021). *Living in the Light*. World Bank, Washington, DC. https://doi.org/10.1596/35311

Ehnert, F. (2023). Bridging the old and the new in sustainability transitions: The role of transition intermediaries in facilitating urban experimentation. *Journal of Cleaner Production, 417*, 138084. https://doi.org/10.1016/j.jclepro.2023.138084

Kivimaa, P. (2022). Policy and political (in)coherence, security and Nordic–Baltic energy transitions. *Oxford Open Energy, 1*, oiac009. https://doi.org/10.1093/ooenergy/oiac009

Masukujjaman, M., Alam, S. S., Siwar, C., & Halim, S. A. (2021). Purchase intention of renewable energy technology in rural areas in Bangladesh: Empirical evidence. *Renewable Energy, 170*, 639–651. https://doi.org/10.1016/j.renene.2021.01.125

Mitra, A., Alam, M. F., & Yashodha, Y. (2021). S*olar Irrigation in Bangladesh: A Situation Analysis Report.* https://www.researchgate.net/publication/363639611_Solar_Irrigation_in_Bangladesh_A_Situation_Analysis_Report

Moazzem, K. G., Shazeed, A., & Shamim, M. H. (2025). *Renewable Energy Policy (Draft) 2025—Major Observations and Recommendations.* https://cpd.org.bd/resources/2025/05/Renewable-Energy-Policy-Draft-2025.pdf

Schenk, N. J., Moll, H. C., & Schoot Uiterkamp, A. J. M. (2007). Meso-level analysis, the missing link in energy strategies. *Energy Policy, 35*(3), 1505–1516. https://doi.org/10.1016/j.enpol.2006.04.013

This paper examines the role of micro–meso linkages in shaping the adoption and retention of distributed renewable energy (DRE) systems in Bangladesh. Despite early success in technologies such as solar home systems, rooftop solar, and solar irrigation pumps, recent trends show stagnation in adoption and significant challenges in long-term usage. Using a mixed-method approach that combines national-level data, field observations, and key informant interviews, the study analyzes interactions between micro-level users (households, farmers, and firms) and meso-level institutions (such as IDCOL, utilities, and NGOs). The findings highlight that weak incentive alignment, limited feedback mechanisms, and an installation-centric approach have constrained the sustainability of DRE systems. While meso-level actors are primarily driven by financial and institutional targets, micro-level adoption is shaped by heterogeneous needs, financing constraints, and changing preferences, particularly with grid expansion. The study concludes that strengthening feedback loops, redesigning incentives, and improving coordination between micro and meso actors are essential to accelerate adoption and ensure long-term sustainability of DRE in Bangladesh.

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