

MINI GRIDS IN BANGLADESH

A CASE STUDY OF AN INCIPIENT MARKET



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PREAMBLE

The Energy Sector Management Assistance Program's (ESMAP) Global Facility on Mini Grids hired Castalia to study mini grids regulation in six jurisdictions in Sub-Saharan Africa and Asia (Kenya, Tanzania, and Nigeria; and Bangladesh, Cambodia, and Uttar Pradesh in India). The study's objective is to understand what regulatory settings governments may adopt to scale up electrification through private development of mini grids, drawing on the experience of these six jurisdictions; provide technical assistance to four countries that want to further develop their mini grids framework; and disseminate findings and recommendations globally to inform successful mini grids regulation.

The study focuses on mini grids defined as small, privately-owned and operated systems with generation of up to 10 megawatts (MW) capacity and a network that distributes power to several customers. The study includes small mini grids of less than 1 kilowatt (kW) capacity, also known as 'micro' or 'pico' grids.

The six case studies are intended to be synthesized in one report. The report is to provide a cross-country comparison of these topics: it examines side by side how each of the countries studied have responded to a specific regulatory question, and presents a decision-tree approach to developing regulatory frameworks for mini grids.

This case study is based on in-depth interviews with a number of key stakeholders in Bangladesh, conducted during and after a research trip in August 2017. We supplemented the insights gained from these interviews with extensive background research. Several experts in the Bangladesh context and mini grids more broadly reviewed this case study for accuracy and clarity, and we have incorporated their comments while retaining a neutral fact-based position.

This case study focuses on Bangladesh. Like the other five, this document is structured as follows:

- A brief introduction (Section 1 |),
- A brief description of the context of the country (Section 2 |),
- An overview of the power sector (Section 3 |),
- Main aspects of the policy setting for mini grids (Section 4 |),
- Technologies and business models used in the mini grids sector (Section 5 |),
- The process to authorize mini grid operators (Section 6 |),
- Technical and service standards for mini grids (Section 7 |),
- Tariff setting, financing, and subsidies (Section 8 |),
- Handling the relationship with the main grid (Section 9 |), and
- A summary of lessons learnt from the experience of the country (Section 10 |).

1 | INTRODUCTION

There are seven mini grids in Bangladesh, connecting 2,243 rural customers, as of early 2017.¹ Mini grids serve 0.01% of customers connected. Bangladesh's first commercial solar mini grid started operating on the island of Sandwip in 2010.

Rural areas of Bangladesh remain poorly connected to the grid, despite a rapid increase in electrification. The overall rate of electrification increased from 7% in 1990, to 32% in 2000 and 76% in 2016.² However, interconnection to electricity greatly varies between rural and urban areas. In 2014, 65% of the population resided in rural areas where 51% of households were electrified, while 35% of the population resided in urban area where 90% were electrified.³

The Government aims to provide electricity to all by 2021 through grid extension, mini grids and stand-alone systems. The Power Sector Master Plan (PSMP) 2010 sets out to accommodate the Government's vision by 2021. According to the PSMP, 57 million USD is needed to develop the generation, transmission, and related facilities required to achieve country-wide electrification.⁴ The Government recognizes that public sector investment alone will not be sufficient to achieve its target and wants to mobilize resources from the private sector.

The Government seeks to catalyze and promote private sector participation in renewable energy projects through Infrastructure Development Company Limited (IDCOL), a fully government-owned financial institution. IDCOL works alongside the Ministry of Power, Energy, and Mineral Resources (MPEMR) to identify areas where grid expansion is unlikely in the foreseeable future, and to entice private mini grid developers.

Mini-grid operators are occupying a small but growing space in Bangladesh, with seven mini-grids connecting around 2,243 households in rural areas.⁵ IDCOL has approved 18 mini grid systems and plans to install 50 by 2018.⁶ Independent mini-grid developers are operating within a regulation by contract environment. Licenses are not required but tariffs and strict standards are set by IDCOL to the incentivize quality of service that is superior to the main grid. Mini grid operators charge BDT30 per kWh (around US\$0.38), a tariff that is highly subsidized.

Table 1.1 presents the key metrics of mini grids in Bangladesh, including level of interconnection, tariffs, and quality of service for the year 2015. Three more mini grids have been commissioned in 2017, connecting roughly 3,000 people.

¹ IDCOL states seven mini grids (http://idcol.org/home/solar_min) whereas the World Bank, Bangladesh Country Office stated 10 in November 2017

² <https://data.worldbank.org/indicator/EG.ELC.ACCE.ZS?locations=BD> Accessed on 11/15/2017

³ Ibid

⁴ Gram er Alo Limited, Environmental Impact Assessment (2016) "Solar Mini-Grid Power Plant by GEA"

⁵ http://idcol.org/home/solar_min Accessed on 11/15/2017

⁶ Ibid

Table 1.1: Key Metrics for Mini Grids in Bangladesh, 2015

Mini grids Penetration		
Number of mini grids	Number	7
Average growth in number of mini grids from 2005 to 2015	%	N/A
Customers served by mini grids	Customers, thousands	2,3
	People, thousands	9,106.6
	% of total population	Negligible
	Of the population with access to electricity, % connected to a mini grid	0.01%
Growth in connections from 2005 to 2015	Thousand/year	N/A
	%/year, compound rate	N/A
Tariffs and Rates		
Cost of connection ⁽¹⁾	US\$	370
	% of GDP/Capita	12%
Average subsidy per connection	US\$	246
	% of GDP/Capita	7.9%
Monthly bill for Tier 2 ⁽²⁾ consumption	US\$	2.22
	% of GDP/Capita	0.9%
Average tariff ⁽³⁾	US\$/kWh	0.38
Quality of Service		
Availability of electricity	Hours of service/day	24

Source: https://www.esmap.org/sites/esmap.org/files/ESMAP_SAR_EAP_Renewable_Energy_Resource_Mapping_Islam.pdf

2 | COUNTRY CONTEXT

Table 2.1 presents the summary statistics on Bangladesh's demographics, economy, governance, and electricity sector.

Table 2.1: Bangladesh Summary Statistics, 1995, 2005, 2014

		1995	2005	2014
Demographics				
Population	Million	118.4	142.9	159.1
Population growth	Annual average	2.2%	1.5%	1.2%
Rural population	Million	93	105	106
Rural population growth	Annual average	1.7%	0.5%	0%
Population density, National	People/sq. km	911.9	1,101.9	1,224.6
Economy				
GDP	PPP, 2011 US\$ million	37,939.7	69,442.9	172,885.5
GDP per capita	PPP, 2011 US\$	1,437.6	1,929.9	2,973.0
Real GDP per capita growth	5-year compound rate	2%	3%	5%
Debt to GDP ratio	%	51%	47%	39%
Governance				
Ease of Doing Business rank	See (1)	N/A	N/A	173
Corruption Perceptions Index	See (2)	N/A	1.7	2.5
World Bank Governance Indicator	See (3)	-0.70	-1.00	-0.81
Electricity Sector				
Electricity connection rate, National		19.7	44.2	62.4
<i>Urban</i>	% of population	51.3	82.6	90.7
<i>Rural</i>		10.9	31.2	51.4
Electrification growth rate	% change in population with a connection, 5- year compound rate	23.7%	8.5%	4.8%
Population with an electricity connection	Thousands	23,274.0	63,217.9	99,264.4
<i>Urban</i>		13,159.3	30,475.1	44,791.2
<i>Rural</i>		10,114.8	32,742.8	54,473.2

		1995	2005	2014
Electrical power consumption	kWh/person /year	75.9	170.7	310.4
	kWh/person with an electricity connection/year	386.2	385.9	497.4
Customers served by the grid	Thousands	3,097.0	7,729.9	17,763.9

Source: *World Bank Development Indicators (2016), Asian Development Bank (2017), BPDB (2016), Bangladesh Ministry of Finance (2016), DESCO (2016), DPDC (2015), Power Cell (2006), WZPDC (2015)*

Notes: (1) *The Ease of Doing Business Index ranks countries from one to 190. The closer a country is to 1, the more conducive its regulatory environment is to the starting and operation of a local firm.*

(2) *The Corruption Perceptions Index ranks countries on a scale of zero to 10, with zero indicating very high levels of corruption and 10 indicating very low levels of corruption.*

(3) The Worldwide Governance Index assign scores to countries from -2.5 to 2.5, with higher values indicating higher quality of governance.

Demographics

In 2016, Bangladesh had a population of 163 million people. Population has grown steadily over the last decade, with annual rates between 1.1 and 1.2%. Two thirds of the population of Bangladesh live in rural areas. Population is rapidly urbanizing, at a rate of 3.6% per year.⁷

Economy

Bangladesh has been the third most thriving economy in the South Asian region in the past 5 years.⁸ During this period, the country's annual GDP growth rate varied between 6 and 7.1%. In 2016, GDP per capita was of US\$1,359, almost four times higher than two decades earlier.⁹

Governance

Bangladesh became an independent nation in 1971 after over two decades of political unrest and is now a parliamentary democracy. In 1947, after India became independent from the British colonial rule, a state composed of two distinct territories, East and West Pakistan, was established on either side of India. Two years later, the Awami League was created to campaign for East Pakistan's independence, which was to become modern Bangladesh. The Awami League has been the ruling party since 2008.

3 | OVERVIEW OF THE POWER SECTOR

The Bangladesh Energy Regulatory Commission (BERC) Act of 2003 established BERC as an independent regulator for the energy sector. BERC has been in place since April 2004 and seeks to "provide energy at reasonable cost, and protect consumers' interest and satisfaction through fair practice."¹⁰

⁷ <https://www.cia.gov/library/publications/the-world-factbook/fields/2212.html> Accessed on 11/15/2017

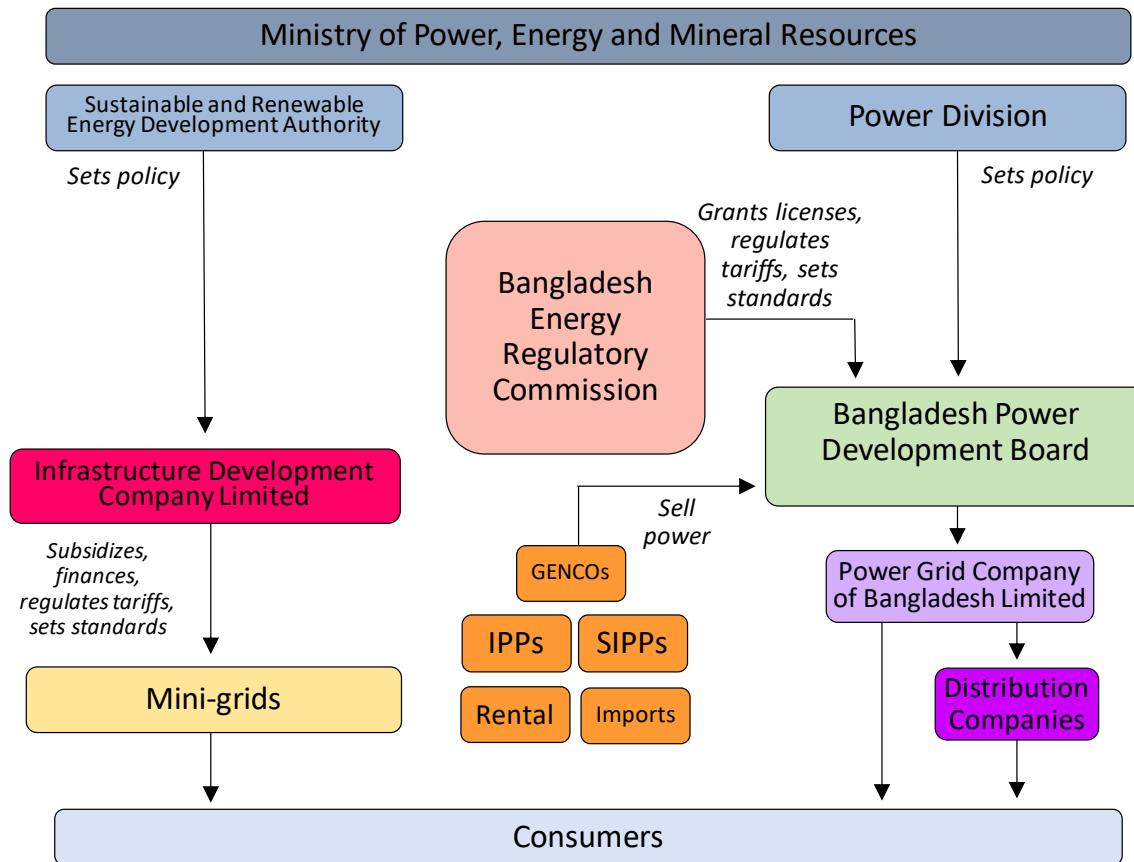
⁸ The Asian Development Bank includes in the South Asian region the following countries: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

⁹ <https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=BD> Accessed on 11/15/2017

¹⁰ <http://www.berc.org.bd/site/page/ef59f071-9770-4095-95b3-b4f1a1f9ba4f/Vision-&-Mission> Accessed on 11/15/2017

Figure 3.1 presents the structure of the power sector in Bangladesh.

Figure 3.1: Bangladesh Power Sector Structure



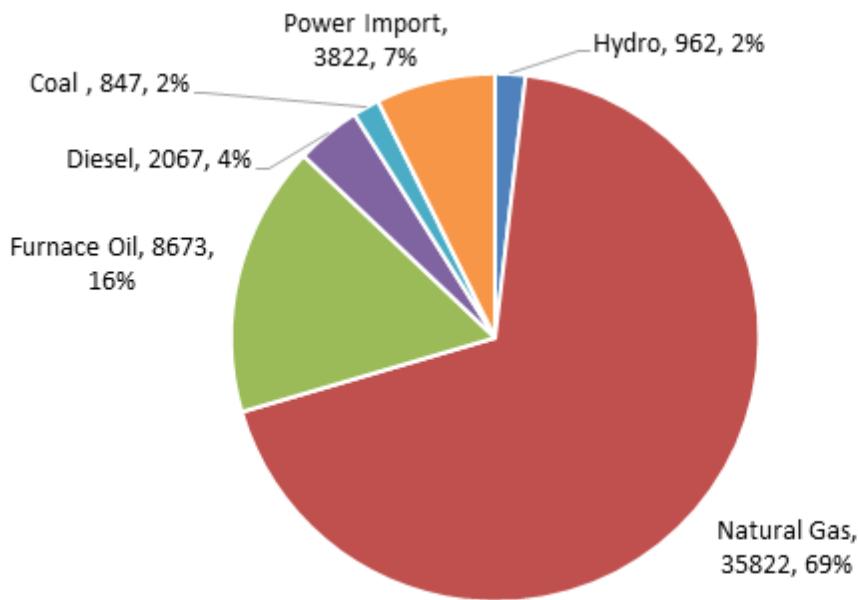
3.1 MAIN ACTORS

Bangladesh's most important power sector actors are the Bangladesh Power Development Board (BPDB), the BERC, the IDCOL, the Power Grid Company of Bangladesh (PGCB), the MPEMR, and the Rural Electrification Board.

Bangladesh Power Development Board (BPDB)

BPDB is a partially integrated public utility that generates, trades, and distributes power. BPDB was created in 1972 to enhance the country's power sector after Bangladesh became an independent state. BPDB is also responsible of planning and developing the sector's expansion plan, and constructing most public-sector power plants at least cost.

Figure 3.2: BPDB's Generation by Source (GWh), 2016



Source: BPDB (2016), "Annual Report 2015-2016"

BPDB has an installed generation capacity of 4,508MW and procures 9,219MW through third-party sources.¹¹ Natural gas accounts for 69% of Bangladesh's installed capacity, furnace oil for 16% and diesel for 4%, as Figure 3.2 shows. BPDB distributes electricity in most urban areas in Bangladesh, except in Dhaka, the West Zone, and some rural areas. BPDB acts as a single buyer by procuring electricity from three main sources:

- Public sector generation companies, which account for 21,103GWh of BPDB's net energy generation,
- Independent Power Producers (IPPs), Small IPPs, and rental power plants, which account for 19,255GWh, and
- Imports, which account for 3,380GWh.

Table 3.1 details the installed generation capacity procured by BPDB.

Table 3.1: Installed Generation Capacity by Owner

Generation Company	Capacity (MW)
BPDB	4,508
APSCL	1,508
EGCB	622
NWPGL	440
RPCL	77

¹¹ http://www.bpdb.gov.bd/bpdb/index.php?option=com_content&view=article&id=5 Accessed on 11/15/2017

Generation Company	Capacity (MW)
BPDB-RPCL Joint Venture	149
IPPs	3,133
SIPPs	350
Rental	1,890
Imports	600
Captive generation	2,200
TOTAL	5,048

Source: BPDB (2016), "Annual Report 2015-2016"

Bangladesh Energy Regulatory Commission (BERC)

BERC acts as an independent and impartial regulatory body for the power sector in Bangladesh. It determines the tariff of electricity generation and transmission, issues licenses, resolves disputes, sets quality of service standards, and monitors the sector under existing laws. BERC consists of a Chairman and four members appointed by the President on the proposal of the Ministry.

Infrastructure Development Company Limited (IDCOL)

IDCOL is a state-owned financial institution providing grants and loans to private renewable energy initiatives. IDCOL receives funding from international donor agencies such as the World Bank, the Asian Development Bank, the Islamic Development Bank, and KfW. IDCOL provides financing to medium to large infrastructure and renewable energy projects in Bangladesh and oversees tariff and standard setting.

Power Grid Company of Bangladesh Ltd (PGCB)

PGCB operates the country's transmission system. PGCB was established as national grid operator in 1996, during the restructuring of the power sector. PGCB is responsible for grid connections, upgrades, and the expansion and operation of the national grid.

Generation companies (GENCOs)

GENCOs are state owned and account for nearly a quarter of all electricity generated in Bangladesh. Since the 1990s, and the vertical unbundling of the power sector, five subsidiaries GENCO have been created:

- Ashuganj Power Station Company (APSCL),
- Electricity Generation Company of Bangladesh (EGCB),
- North West Power Generation Company (NWPGL),
- Coal Power Generation Company (CPGCL),
- Rural Power Company Ltd (RPCL).

Distribution companies (DISCOs)

Besides BPDB, three DISCOs are responsible for distributing power in Dhaka and the West Zone:

- Dhaka Power Distribution Company (DPDC),
- Dhaka Electric Supply Company Ltd (DESCO),
- West Zone Power Distribution Company (WZPDC)

Other power sector actors

The MPEMR sets policies and strategies through its Power Division and the Sustainable and Renewable Energy Development Authority (SREDA). The Power Division formulates, implements, and administrates policies, strategies, and planning in the energy sector. SREDA, established in 2014 within the Power Division, promotes renewable energy and energy efficiency. It coordinates renewable energy and energy efficiency policies and programs.

The Rural Electrification Board (REB) was established in 1977 to enhance rural electrification. REB implements rural electrification projects and acts as BPDB's distribution rural counterpart. Since its inception, REB has connected 15,586,106 customers. The REB has created 80 rural electricity cooperatives called Palli Bidyut Samity (PBS) as part of the implementation of the rural electrification program. PBS buy electricity from the BPDB and distribute it in the upazila served.¹² REB monitors and evaluates PBS' performance, and suggests corrective measures.

3.2 EVOLUTION OF THE SECTOR

Interconnection to electricity in Bangladesh has grown exponentially, with a threefold increase in the past two decades. Only 3% of the population was connected to electricity in 1971, after the independence of Bangladesh. In 2014, 62% of the population was connected to electricity. This compares to 51% in Myanmar and 97% in Pakistan.¹³

The electricity generated and consumed in Bangladesh has increased correspondingly in the past decade, but is still insufficient to meet demand. Electricity consumption in Bangladesh has grown by an average of 9.7% annually from 2004 through to 2015.¹⁴ This increase in consumption has contributed to the country's GDP growth of 6% annually in recent years. Population growth averaged 1.2% for the same period, resulting in a growth in per capita electricity consumption of 8.4% annually.¹⁵ However, at 311kWh in 2014, the per capita energy consumption in Bangladesh is one of the lowest in the world.¹⁶

¹² Upazilas are sub-unit of districts in the Bangladeshi administrative system.

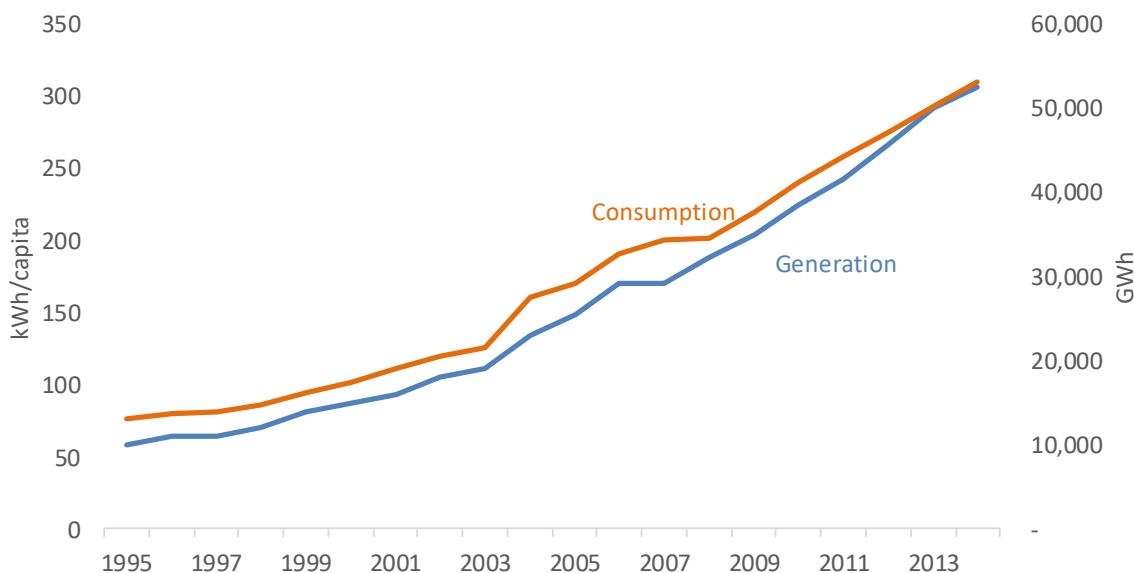
¹³ <https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS> Accessed on 11/15/2017

¹⁴ Institute for Energy Economics and Financial Analysis (2016) "Bangladesh Electricity Transition: A Diverse, Secure, and Deflationary Way Forward"

¹⁵ Ibid

¹⁶ Ziaur Rahman Khan (2016) "A review of energy sector of Bangladesh"

Figure 3.3: Evolution of Power Consumption (kWh/person) and Generation (GWh), 1995-2014

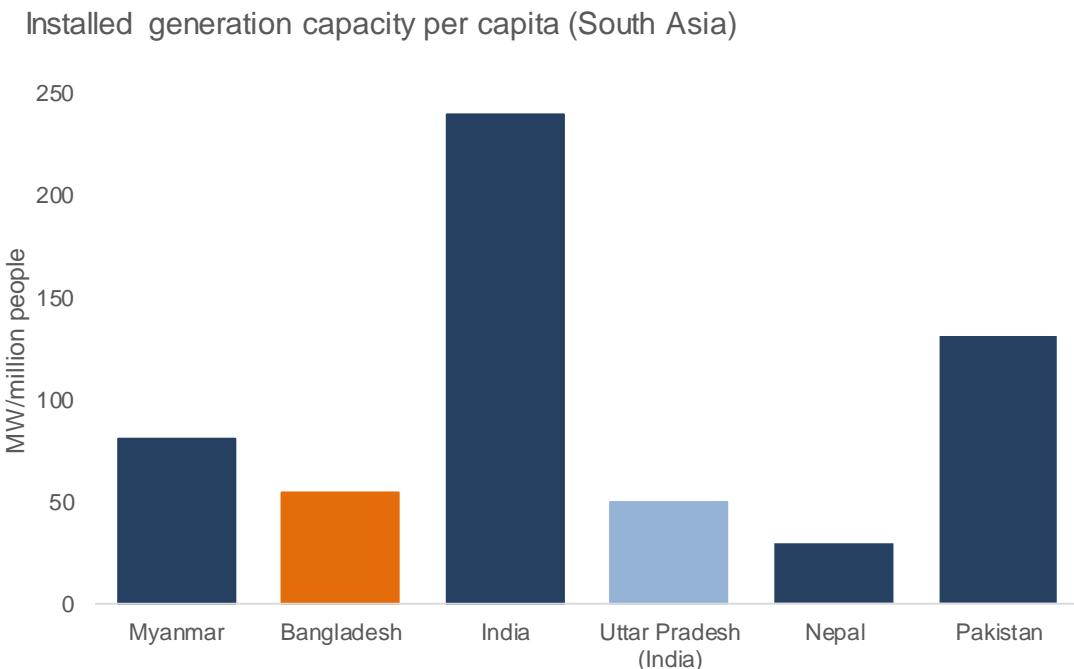


Bangladesh has increased its electricity generation by 145% from 2004 to 2015.¹⁷ Electricity consumption has increased at a slightly faster rate, following declining transmission and distribution losses over the same period. Distribution loss rates in Bangladesh have steadily declined in recent years, from 21.2% in 2004 to 11.2% in 2015.¹⁸ In 2016, however, 79% of connected consumers suffered from load-shedding, and 60% faced low voltage supply.

¹⁷ Institute for Energy Economics and Financial Analysis (2016) “Bangladesh Electricity Transition: A Diverse, Secure, and Deflationary Way Forward”

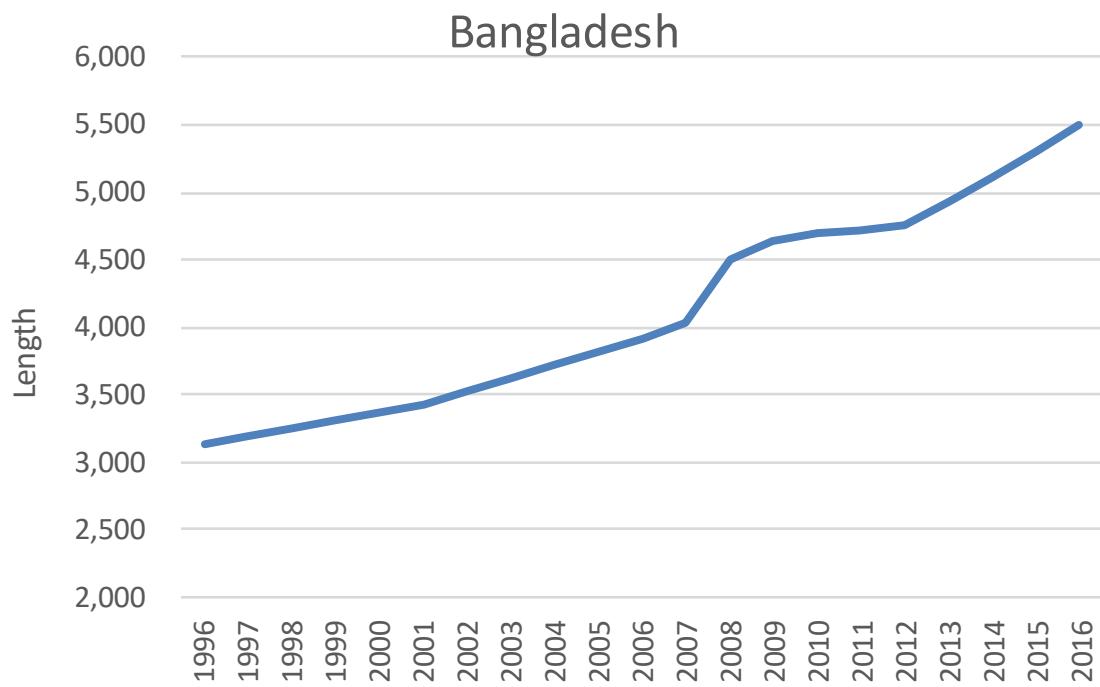
¹⁸ Institute for Energy Economics and Financial Analysis (2016) “Bangladesh Electricity Transition: A Diverse, Secure, and Deflationary Way Forward”

Figure 3.4: Electricity Generation Capacity (MW per million people), 2014



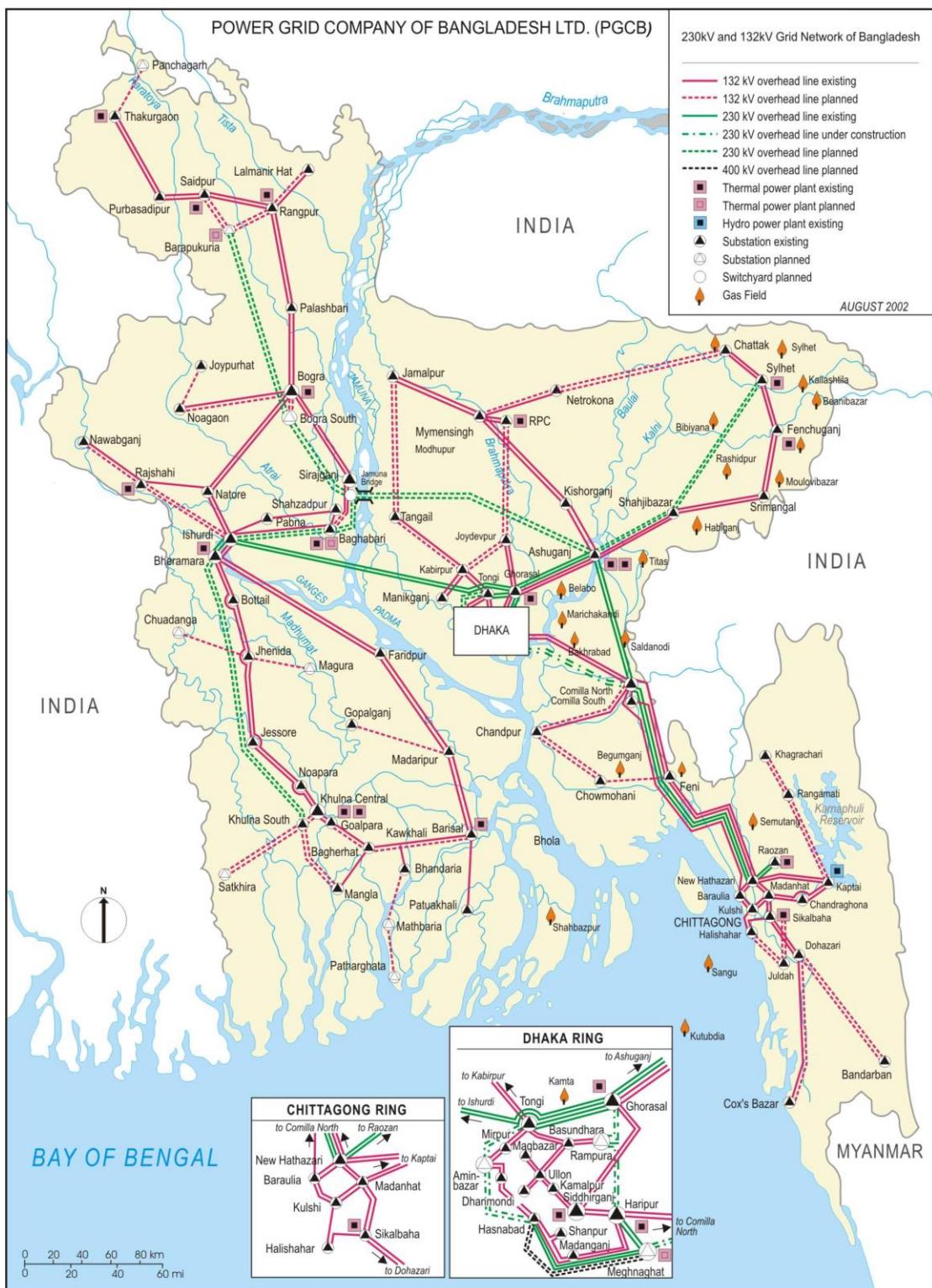
Bangladesh's generation capacity is still relatively low when compared to neighboring countries, and heavily reliant on natural gas. In 1974, the total installed generation capacity in Bangladesh was 667MW, whereas in 2017, installed generation capacity, including captive generation and power import from India, totals 15,755MW. Bangladesh's generation capacity is still only 60% of Pakistan's, which has a similar-sized population.

Figure 3.5: Evolution of the Transmission Network (km), 1995-2015



Bangladesh's transmission lines are comparable in length to neighboring countries such as Myanmar or Pakistan. Bangladesh's transmission lines span a total of 10,351km, up from 5,593km in 1995. Of those 10,351km, 560km are 400kV lines, 3,325km are 230kV lines and 6,466km are 132kV lines. Myanmar and Pakistan's transmission systems amount to 9,720km and 12,43km respectively.

Figure 3.6: Bangladesh's Existing Power Grid



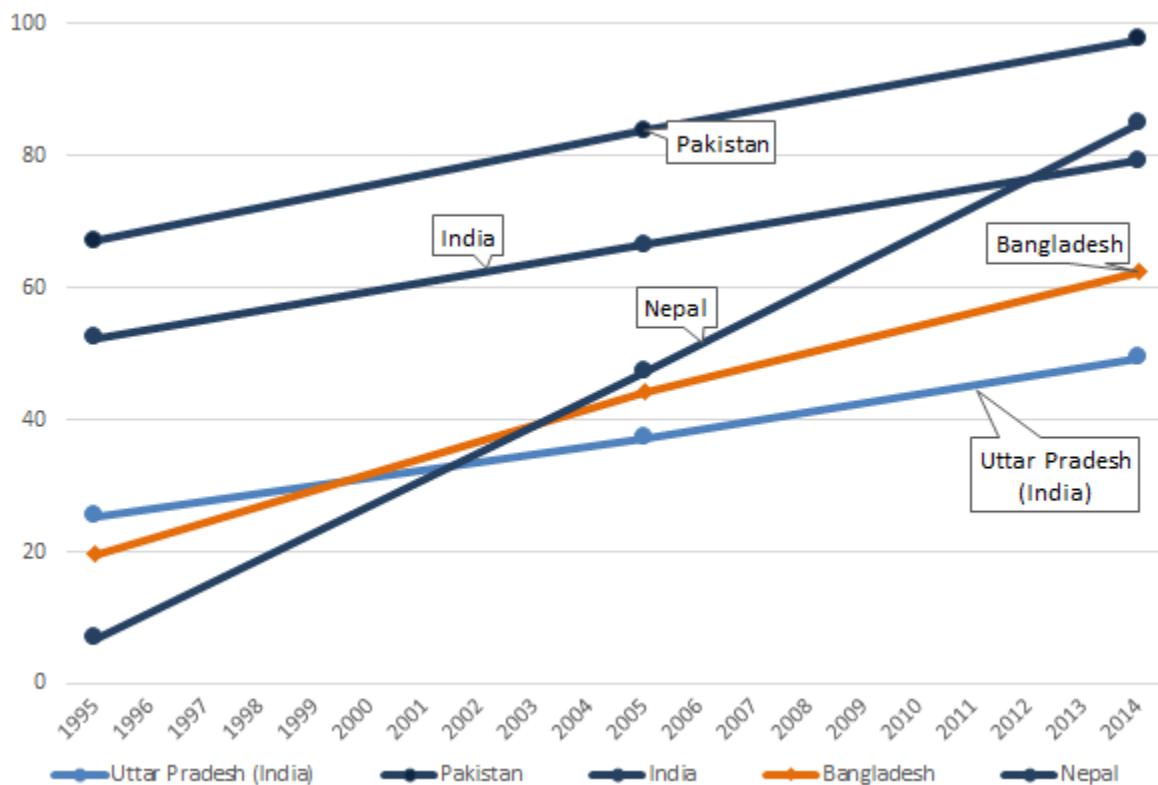
Source: Power Grid Company of Bangladesh (2017)

Bangladesh's distribution network is superior in length per capita to neighboring countries. Bangladesh's distribution lines span a total of 301,654km, of which PBS operate 301,327km.¹⁹ In comparison, Myanmar has 22,570km of distribution lines, which equates to 4.5 times less kilometer of distribution line per capita.

3.3 ACCESS TO ELECTRICITY: MAIN GRID AND MINI GRIDS

The level of access to electricity supply in Bangladesh has increased sharply in the past decade, from 46% in 2007 to 76% in 2017.²⁰ More than 65,000 villages, out of 87,310, are now connected to the main grid, up from 47,612 in 2005.²¹

Figure 3.7: Access to Electricity (% of population), 1995-2014



Roughly half of Bangladeshi households are connected to the main grid and another 15% have access to off-grid electricity. In 2017, 21.8 million customers were connected to the main grid, out of which nearly 16 million were domestic connections.²² Mini grids serve around 2,243 rural customers, providing off grid electricity to 9,106 people.

¹⁹ Asian Development Bank (2016). Rural Electrification in Bangladesh – Structure, Technical Performance, Achievements, and Areas for Improvement. (<https://www.adb.org/sites/default/files/linked-documents/49423-005-sd-01.pdf>) Accessed August 21, 2017)

²⁰ <https://data.worldbank.org/indicator/EG.ELC.ACCTS.ZS?locations=BD> Accessed on 11/15/2017

²¹ <http://www.cems-solarexpo.com/SOLOARBD/Bangladesh%20Power%20Data.pdf> Accessed on 11/15/2017

²² https://energypedia.info/wiki/Bangladesh_Energy_Situation Accessed on 11/15/2017

Table 3.2: Evolution of Population with an Electricity Connection, Grid and Mini grids, 1995, 2005, 2015

		1995	2005	2015
Population		118.43	142.93	161.20
<i>Urban</i>	<i>Million</i>	25.47	37.95	55.25
<i>Rural</i>	<i>Million</i>	92.96	104.98	105.95
Population served by the main grid	Thousand	16,723.8	42,819.5	72,121.4
Population served by mini grids	Thousand	N/A	N/A	9.11

Source: Asian Development Bank (2017), Bangladesh Bureau of Statistics (1996), BPDP (2016), Bangladesh Ministry of Finance (2016), DESCO (2016), DPDC (2015), Power Cell (2006), The Independent (2017), WZPDC (2015)

The tariff for mini grids is more than four times higher than the main grid's. However, many households connected to the main grid suffer from unreliable electricity supply with power outages of up to 14 hours per day.²³ In 2013, electricity supply was unreliable for more than half of people connected to the grid: electrical outages averaged 64.5 per month and lasted 1.2 hour on average.²⁴ Nearly 63% of firms owned or shared a generator, the second highest share in South Asia after Pakistan. Table 3.3 compares customer statistics, tariffs, and quality of service of grid and mini grid supply.

Table 3.3: Mini grid and Main Grid Summary Statistics, 2015

		Main Grid	Mini Grids
Customers served	Thousand	17,763.9	5
Share of total customers served	%	100%	0.01%
Average tariff⁽¹⁾	US\$/kWh	0.05	0.38
Availability of electricity	Hours of service/day	21-22	24

Source: <http://www.worldbank.org/en/news/press-release/2017/04/26/world-bank-supports-bangladesh-in-modernizing-the-power-sector>
<http://energybangla.com/power-outages-throughout-the-country/>

Notes: (1) For the main grid, the tariff corresponds to the residential tariff for the average consumer (497kWh/year as per Table 2.1).

²³ https://energypedia.info/wiki/Bangladesh_Energy_Situation Accessed on 11/15/2017

²⁴ IFC (2016), *Bangladesh Country Profile*

(http://www.ifc.org/wps/wcm/connect/REGION_EXT_Content/IFC_External_Corporate_Site/South+Asia/Countries/Bangladesh/) Accessed 23 August 2017)

4 | POLICY SETTINGS FOR MINI GRIDS

There is no comprehensive legal framework regarding mini grids in Bangladesh. The Government of Bangladesh adopted a regulation by contract approach to the mini grid sector where IDCOL acts as *de facto* regulator. IDCOL follows policy guidelines from the MPEMR.

4.1 A REGULATION BY CONTRACT APPROACH

Private developers setting up mini grids in Bangladesh are regulated by their Implementation Agreement with IDCOL. Mini grids are one of the five areas targeted by the Government to develop solar energy, as part of the Solar Power Development Program (along with utility-scale, rooftop, irrigation, and social infrastructure). In 2013, the Government of Bangladesh adopted a policy exempting mini grids selling electricity up to 5MW to obtain a license.²⁵ In exempting mini grids developers from applying for licenses to BERC, the Government transferred *de facto* most of the regulatory power to IDCOL.

Through the Implementation Agreement, IDCOL controls mini grids tariffs. IDCOL also specifies the equipment and performance standards of the systems. The Government retained some level of oversight by approving potential mini grid locations through SREDA.

4.2 POLICY APPROACH TO NATIONAL TARIFF

There is no national tariff policy in Bangladesh: mini grids charge a different tariff than the main grid's. However, all mini grids charge a similar tariff. Tariffs for the main grid differ according to customer type with incremental block tariffs for domestic users and a single rate for agricultural pumps and street lighting. Small industry and commercial users have flat off-peak and peak rates.

The government of Bangladesh heavily subsidizes electricity tariffs on the main grid. Under the BERC Act, BPDB should sell electricity at a cost that covers the expenses it incurs in generating and purchasing power from independent suppliers. However, BPDB sells electricity to distribution companies at lower-than-generation cost. The government subsidizes the difference between the generation cost and the supply tariff via a loan to BPDB at an interest rate that is lower than market rate.²⁶ In 2014, the Government provided USD 800 million in subsidies to BPDB, up from USD 584 million the previous year.²⁷ BERC sets the price distribution companies pay to PGCB.

All mini grids charge roughly the same tariff. Solar mini grids can charge up to BDT32 per kWh (US\$0.40), a tariff cap set by IDCOL in their Implementation Agreement. In practice, most mini grids charge BDT30 per kWh (US\$0.38); only one of the seven operational mini grids charges BDT32 per KWh. As with main grid electricity, tariffs are highly subsidized.

4.3 EXPANSION PLANNING

The expansion of electricity access in Bangladesh follows a plan established by the REB. The REB has identified areas where grid extension is techno-economically optimal, and those that will be served by mini grids. It has established a list of 1,027 areas where mini grids are techno-economically optimal,

²⁵ Enamul Karim Pavel (2016), "IDCOL Renewable Energy Activities"

²⁶ Institute for Energy Economics and Financial Analysis (2016), "Bangladesh Electricity Transition: A Diverse, Secure and Deflationary Way Forward"

²⁷ Sustainable & Renewable Energy Development Authority (2015) "Investment Plan for Bangladesh"

where the grid cannot be expanded or where the ability to pay customers are too few in numbers to justify grid expansion.

Mini grids development in Bangladesh is not centrally planned, but IDCOL and SREDA provide guidance to developers. Developers seeking funding from IDCOL must submit a proposal, and, if the site is not one of the 1,027 identified by SREDA, IDCOL verifies when the grid is expected to reach the proposed site. IDCOL is free to approve the project if the grid is not expected within four to five years. However, only developers targeting remote rural areas are eligible for funding.²⁸

5 | OVERVIEW OF THE MINI GRID SECTOR

There are seven solar PV-diesel hybrid mini grids operating in Bangladesh, connecting around 2,243 customers. Their tariff and quality of supply is regulated through IDCOL.

5.1 MINI GRIDS TECHNOLOGIES

Mini grids in Bangladesh typically refer to 100kW to 250kW solar PV systems with batteries and diesel generators backup, located in isolated off-grid areas. These mini grids ensure continuous grid quality electricity supply, and generally connect 400-1000 customers. Mini grids are standalone AC power plants that comprise: solar PV panels, battery banks with a capacity of 300,000-500,000 Ah, and diesel backup generators ranging from 60kVA to 120kVA to meet the energy demand of the area even on low insolation days.

IDCOL requires that main grid codes are maintained within mini grids to easily supply generated power into the main grid whenever it arrives.²⁹ The energy produced is distributed through a 3-phase, 4-wire distribution system. The number of distribution feeders depends on the position of the loads per customers and the maximum length of each feeder is limited to two kilometers to reduce the loss in distribution.

5.2 BUSINESS MODELS

Private developers build, own, operate, and maintain mini grid systems. Private developers are selected based on the applications submitted to IDCOL or upon receiving clearance from SREDA on a selected area. Private developers funded by IDCOL are provided with 80% of the project costs in the form of grants and soft loans. The concessional loans involve strict requirements of 100% collateral.

Mini grids serve mainly households and small businesses. Some mini grid developers indicated that they seek to supply anchor customer to increase load, such as telecoms towers.³⁰

Providing power all day, without interruption, is an essential part of the mini grids' business model. Operators indicated that customers put a high value on reliability, and could turn against the developer

²⁸ IDCOL, Invitation for Proposal Submission Under IDCOL Solar Mini-Grid Project

²⁹ <http://en.sma-sunny.com/en/electrifying-off-grid-area-in-bangladesh-with-green-energy-and-smart-technology/> Accessed 11/15/2017

³⁰ Meeting with Superstar Group, August 30 2017

and the infrastructure if an outage lasts too long.³¹ Mini-grids must provide IDCOL with monthly reports outlining number of customers, area of coverage, revenue collection, and any event of default.

Mini grids use prepaid meters and charge a tariff of BDT30 to BDT32 per kWh to all customers for the first five years of operation. There is also a service monthly charge of BDT100 to BDT150. Some mini grid operators use mobile money to recharge customers' meters;³² others use physical money.³³

Many developers have other business lines related to solar power. For example, 70% of Solargao's business is solar irrigation. GTech Solar has a business of solar charging stations for electric rickshaws, and a 10MW solar plant backed by a PPA with BPDB.³⁴

6 | AUTHORIZING MINI GRID OPERATORS

It is unlawful to engage in power generation, transmission or distribution in Bangladesh without a license, or without being exempt from having one by the BERC. The BERC Act of 2003 established the BERC as the single entity in charge of granting licenses and exemptions. BERC has the power to exempt specific persons for a specified period of time. BERC determined conditions to obtain a license or an exemption of license through the BERC License Regulations 2006. The Act also gives BERC power to control the tariffs of licensees.³⁵

Solar mini grid system operators with a capacity of less than 5MW are exempted from obtaining a power generation license under Bangladesh's Renewable Energy Policy of 2008.³⁶ The "Guidelines for the Implementation of Solar Power Development Program" define two tiers of mini-grids:

- Solar mini grid systems with capacity up to 250kW must simply inform the BERC with a letter.
- Solar mini grid systems with capacity between 250kW and 5MW must obtain a waiver certificate from BERC.³⁷

However, the Renewable Energy Policy does not seem to have been turned into law, implying that mini grids operate against the BERC Act of 2003 and the subsequent License Regulations of 2006. The BERC indicated that it has not developed any specific framework for mini grids; despite the Government's policy, mini grids still needed to obtain a license. However, it lacks enforcement power.³⁸ IDCOL indicated that it has an agreement with the Power Division of the MPEMR regarding mini-grid license exemptions.³⁹ While mini grid system operators are exempted of license BERC requires that they still observe the same conditions as a licensee: they must efficiently produce, transmit, and supply energy.

³¹ Meeting with Solargao, 31 August 2017

³² Meeting with Superstar Group, 30 August 2017

³³ Meeting with GTech Solar, 1 September 2017

³⁴ Meeting with GTech Solar, 1 September 2017

³⁵ Bangladesh Gazette, "Act No 13 of 2003", Article 27, 29, and 34

³⁶ Ministry of Power, Energy and Mineral Resources Government of the People's Republic of Bangladesh (2013) "Guidelines for the Implementation of Solar Power Development Program"

³⁷ Ibid

³⁸ Meeting with BERC, 29 August 2017

³⁹ Meeting with IDCOL, 31 August 2017

Additionally, the Department of Environment changed the category of solar mini grid systems from ‘Red’, which is the category of power projects, to ‘Orange A’.⁴⁰ This recategorization spares mini grid developers from completing an Environment Impact Assessment to receive their mandatory Environmental Clearance Certificate.

Table 6.1: Mini-Grids’ installed capacity

Mini-grid	Capacity (kW)
Chittagong, Sandwip, Enam Nahar	100
Narsingdi, Rajpura, Paratoli	141
Cox's bazar, Kutubdia	100
Rajshahi, Bagha	141
Kurigram, Nageshwari, Narayanpur	158
Rajshahi, Godagari	149
Bhola, Monpura	177
Kushtia, Daulatpur, Chilmari	188
Manikganj, Daulatpur, Baghutia char	228
Sirajganj Sadar, Sirajganj	130

Sources: <https://fr.slideshare.net/e4sv/dhaka-aug15-solar-minigrids-in-bangladesh-opportunities-challenges>

https://ac.els-cdn.com/S1876610216315028/1-s2.0-S1876610216315028-main.pdf?_tid=db1de3d2c93911e794f30000aacb35d&acdnat=1510663778_ec987f434f7b61e2270e4fadb4caa5c

7 | TECHNICAL AND SERVICE STANDARDS

Mini grids are subject to IDCOL’s specified technical and service standards. IDCOL specifies through its financing contract that solar mini grids must provide grid quality electricity and ensure the uninterrupted supply of electricity. Mini grids must follow main grid standards as described in the Electricity Grid Code 2012 and the Distribution Code 2012. The modules for solar mini grids must follow technical standards such as:

- The mini grid must operate its diesel generator for adequate hours to fulfil the demand for electricity of the customers.
- PV Modules must be tested and certified from IEC accredited laboratories following International Electrotechnical Committee.
- PV Modules must have a peak power output of minimum 250Wp.
- PV Module efficiency must be 15% at a minimum.

IDCOL’s financing contracts set stringent technical requirements that developers perceive as barriers to expansion. IDCOL also specifies that developers must use a competitive process to select their suppliers, and submit at least three quotes for major pieces of equipment.⁴¹ However, some requirements are so stringent that developers are forced to use one single supplier: this is the case for inverters, which

⁴⁰ Ibid

⁴¹ Meeting with IDCOL, August 31, 2017

developers can only procure from the supplier SME Group.⁴² Such stringent technical requirements might be hindering mini grid system expansion in Bangladesh, because they add significantly to developers' costs. Some developers planning on using a DC distribution system, instead of an AC one, had to adapt their plans to meet IDCOL's requirement and use an AC grid, when the DC system could have been half as expensive.⁴³ Poles only would contribute to 25% of capex for developers.⁴⁴

8 | TARIFFS, FINANCING, AND SUBSIDIES

IDCOL regulates the tariff that mini grids can charge to their consumers. This tariff regulation comes through the Implementation Agreement that developers sign to obtain the standard financing package from IDCOL. BERC does not intervene in tariff setting of suppliers with a system capacity of less than 5MW.

8.1 SETTING RETAIL TARIFFS

The Implementation Agreement between IDCOL and private developers establishes the electricity tariff between BDT30 and BDT32 per kWh for the first years of operation. The Implementation Agreement provides for a tariff increase, subject to IDCOL's approval. Most mini grids can request to increase their tariffs every five years, while some can request a tariff increase every two years.⁴⁵ However, no mini grids have increased their tariffs to date, and some operators have even lowered their tariff to increase demand.⁴⁶

Table 8.1: Evolution of Tariffs, Isolated and Connected Mini grids, 2011-2015

		2011	2012	2013	2014	2015
Isolated mini grids	BDT/kWh	32	32	32	31	29
	US\$/kWh	0.41	0.40	0.41	0.39	0.37
Connected mini grids	BDT/kWh	N/A	N/A	N/A	N/A	N/A
	US\$/kWh	N/A	N/A	N/A	N/A	N/A

Source: Global Climatescope

The level of the tariff may not allow mini grids to make a profit, although IDCOL calculated the tariff to allow a return on equity between 13 and 15%. This is because the tariff is calculated *ex ante*, with little room to adjust the tariff once the project is implemented. SBEL, the sponsor of the mini grid project on Monpura Island, has complained that its revenues are much lower than anticipated, because the performance of the equipment is lower than anticipated.⁴⁷

⁴² Meeting with GTech Solar, September 1 2017

⁴³ Meeting with GTech Solar, September 1 2017

⁴⁴ Meeting with Solargao, August 31 2017

⁴⁵ "Financing Agreement between Super Star Renewable Energy and IDCOL" (2015), and IDCOL, "Sample Financing Agreement" (2017)

⁴⁶ Meeting with Solargao, 31 August 2017

⁴⁷ Meeting with SBEL, 28 August 2017

8.2 TYPE OF SUBSIDIES AVAILABLE

Table 8.2 shows the different types of subsidies available to developers. IDCOL provides all of the explicit subsidies.

Table 8.2: Overview of Subsidies Available

Project stage	Explicit Subsidies	Implicit Subsidies
Design	None	For foreign investors, exemption from taxes on technical assistance fees
Finance	Concessional loan of 30% of the project cost for domestic or foreign investors	For foreign investors: <ul style="list-style-type: none"> Exemption from taxes on interests of foreign loans, Exemption from tax on earnings of capital gain from shares sales, Exemption from double taxation on foreign investors' income.
Construction	Grants of 50% of the project cost	Renewable energy equipment and related raw materials are exempted from 15% VAT For foreign investors, exemption from income tax for foreign employees for three years.
Operation	None	Diesel subsidies allow the Bangladesh Petroleum Corporation to sell diesel at below cost-recovery price

IDCOL receives funds from the Government and donor agencies (including International Development Association, Japan International Cooperation, Kreditanstalt für Wiederaufbau, International Bank for Reconstruction and Development, United States Agency for International Development) to finance solar mini grid systems. IDCOL offers a standard subsidy package to solar powered mini grids, made of:

- Grants, up to 50% of the project cost. IDCOL disburses the grant in different tranches, corresponding to different milestones of the project's construction.
- Concessional loans, up to 30%, to mini grid developers. The loan may have a maximum tenure of 10 years including a two-year grace period. The applicable interest rate is 6% per annum. The developer must provide 100% collateral in the form of bank guarantee or land mortgage covering the full loan, kept in a bank account offering a rate of return (around 12% annually).⁴⁸

⁴⁸ Meeting with IDCOL, 31 August 2017

The Implementation Agreement between IDCOL and the developer states the total amount of loan and subsidy that the project will receive. This means that the share of the grant and of concessional loans is based on estimated costs for the project. If the project goes over budget, the developer has to provide additional equity.

Additionally, all renewable energy equipment and related raw materials acquired by the private developer are exempted from 15% VAT.⁴⁹

8.3 ELIGIBILITY TO GET SUBSIDIES AND SOURCES OF MONEY FOR SUBSIDIES

Private developers must seek to set up solar mini grid systems in remote rural areas of Bangladesh to receive subsidies from IDCOL, preferably islands, or remote areas. Developers must have prior experience in implementing small to medium scale projects in any sector, and provide minimum 20% of total project cost as equity. Additionally, all mini grid equipment must be approved by IDCOL. Developers must submit quotes for every major piece of equipment and run a competitive tender amongst their suppliers. If there is a change in supplier, the developer must notify IDCOL and seek approval.

Table 8.3 details all subsidy eligibility requirements established by IDCOL.

Table 8.3: Eligibility and Sources of Funds, by Subsidy

Subsidy	Conditions	Eligibility	Sources of Funds
Concessional loans	<ul style="list-style-type: none"> ▪ Applicable to solar mini grid projects ▪ Maximum tenure of 10 years with 2 years grace period ▪ 6% applicable interest rate 	<ul style="list-style-type: none"> ▪ Prior experience in implementing small to medium scale projects ▪ Must be a private limited company such as NGO, MFI or any other organization with similar institutional set up ▪ Must have clean banking credit history ▪ Must demonstrate capability to operate and maintain solar mini grid projects in rural settings ▪ Must be able to provide minimum 20% of total project cost as equity ▪ Must provide collateral in the form of bank guarantee or land mortgage covering the full loan 	IDCOL

⁴⁹ Power Division of MPEMR (2008) "Renewable Energy Policy of Bangladesh"

Subsidy	Conditions	Eligibility	Sources of Funds
		<ul style="list-style-type: none"> ▪ In case of joint venture with foreign sponsors, local counterparts must have minimum 51% of shares 	
Capital grants	Same as Concessional Loans	Same as Concessional Loans	IDCOL

Source: IDCOL "Invitation for Proposal Submission under IDCOL Solar Mini-Grid Project"

8.4 LEVEL OF SUBSIDIES

IDCOL's standard subsidy package provides mini grid developers in Bangladesh with a 76% subsidy ratio. IDCOL's subsidy package consists of a capital grant of up to 50% of project costs and a concessional loan of up to 30% of project costs. If mini grid developers were not able to access this subsidy package, they would have to finance their capital expenditure through commercial loans. At current interest rates for commercial loans in Bangladesh, and with a 5-year loan tenure, this would drive the project's Net Present Value to be more than four times higher than with IDCOL's subsidies.⁵⁰

8.5 REGULATORY TREATMENT OF SUBSIDIES

IDCOL targets a similar return on equity for all developers of subsidized systems but does not allow developers to charge different tariffs in the initial 5-year period of operation. IDCOL acts as a mini grid regulator by setting the tariff of the mini grid through its Implementation Agreement with the developer. Subsidies are considered in the allowed retail tariff, which is consistent across all customers. The cost of generation on a system by system basis, however, is not. It is unlikely that all mini grids have the same return on equity as they have different generation costs but must charge the same subsidized tariff.

9 | HANDLING THE RELATIONSHIP WITH THE GRID

The main grid has not reached any of the seven mini grid systems in operation in Bangladesh. Mini grids in the country are set in isolated off-grid areas where main grid extension is unlikely foreseeable in the next 5 to 10 years.

9.1 WHAT HAPPENS WHEN THE GRID ARRIVES

The mini grids must become small power producers when the grid arrives. According to the "Solar Guidelines" of 2013, "the project operator will be allowed to feed the electricity generated from renewable energy sources into the grid for rest of the project period. In that case tariff will be determined upon negotiation with the power purchaser considering the operational, maintenance, and

⁵⁰ The World Bank Data Base sets lending interest rate in Bangladesh at 10.4% in 2016.

other administrative cost of the project and 15% return on equity. This arrangement will be continued up to its project life.”⁵¹ The tariff would also include the depreciated value of the distribution asset.⁵²

The mini grid has to take some risk of grid expansion. The policy is only valid “if the Government extends the grid line to the project area after 5 years of its completion.” This means that for the first five years, the main grid can connect to the mini grid without having to buy electricity from the mini grid owner. The Government seems to have back tracked from this policy and “agreed, in principle, to purchase electricity even if the grid is extended within 5 years.”⁵³

These policies have not yet been adopted into law or regulation. SREDA is working on a feed-in-tariff policy that has not yet been issued.

9.2 WHOLESALE TARIFF SETTING

BPDB sets the bulk tariff rate following a rate of return pricing. BPDB then sells electricity to distribution utilities based on BERC’s regulated wholesale tariff rates. However, as of now, no mini grid has had to buy power from, or sell it to the large utilities. It did not appear from field interviews that the PBS scheme used for rural electricity cooperatives acting as distribution companies (see section 3.1) is applicable for mini grids.

9.3 OBLIGATION OF UTILITY TO PURCHASE OUTPUT

The utility must purchase the mini grid’s output if it reaches the site after 5 years of a mini grid system’s completion. The mini grid’s operator can then inject the electricity produced into the main grid for the rest of the system’s lifetime. The five-year period incentivizes operators to select remote areas where the grid is not expected to be extended in the medium-term.

9.4 POWER PURCHASE AGREEMENTS

PPAs have not been designed since the main grid has not yet reached any of the operating mini grid system in Bangladesh.

10 | LESSONS LEARNT

Bangladesh provides an interesting example of a lending agency undertaking the role of regulator. This arrangement provides for regulation by contract, and allows the regulator to condition subsidies to specific metrics of performance.

The case of Bangladesh also presents regulatory impediments to the development of mini grids. IDCOL’s stringent technical requirements, and the need for mini grid developers to provide 100% collateral to IDCOL loans, might be hindering mini grid system expansion in Bangladesh. Additionally, the level of the

⁵¹ Power Division, Ministry of Power, Energy, & Mineral Resources (2013) “Guidelines for the Implementation of Solar Power Development Program”, paragraph 3.8

⁵² Mr. Zubair Sadeque, SREDA, by email on April 7, 2017

⁵³ Md. Enamul Karim Pavel, IDCOL (2017) “Bangladesh experience in encouraging private sector for mini-grid scale up”

tariff may not allow mini grids to make a profit, as the tariff is calculated *ex ante*, with little room to adjust the tariff once the project is implemented.

Mini grids in Bangladesh are potentially operating illegally. Mini grid developers operate without licenses as they have been exempted by the MPEMR under the Renewable Energy Policy of Bangladesh. However, the Ministry's policy has not been translated into law or regulation, to the best of our knowledge. This could imply that mini grids are operating illegally, as the BERC Act 2003 requires that "no person engage himself in the following business [power generation; energy transmission] unless he is empowered by a license or exempted from having it under this Act or any other Act".⁵⁴

⁵⁴ Bangladesh Gazette (2003) "BERC Act"