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EXECUTIVE SUMMARY

The Readymade Garment (RMG) industry generates more than 80 per cent of the Bangladesh's foreign export revenue, and provides formal employment to over 4.2 million individuals, with approximately 60 per cent of whom are female. The global energy crisis due to the Ukraine War has created significant challenges for Bangladesh. The Government of Bangladesh (GoB) has repeatedly raised electricity tariffs that led to increase in production costs for the industries. About 29 per cent of Bangladesh's total electricity demand is for industrial use. Therefore, providing adequate and uninterrupted electricity is crucial for maintaining production of the industrial units. This requires the policymakers to generate energy from sources other than fossil fuel. Renewable Energy (RE) is a potential source for meeting up the energy demand gap of industries.

In this context, the study investigates the feasibility of utilising RE sources for electricity generation in Bangladesh's RMG industry, at least partially, and analyse potential cost-benefit of this partial transition. Using survey data collected by Centre for Policy Dialogue (CPD), the research team found that the current electricity demand for Bangladesh's RMG industry is nearly 6,251 Gigawatt hour (GWh) per year, which is equivalent to 8.2 per cent of country's total electricity consumption and 7.3 per cent of country's total electricity generation. This means that 625.2 GWh of electricity will be required just to redirect 10 per cent of the total RMG electricity demand towards RE.

Analysing the national RE database of the Sustainable and Renewable Energy Development Authority (SREDA), the study finds that 65 RMG firms had installed solar systems with a combined capacity of roughly 8.6 Megawatts (MW) by the end of 2022, with a potential annual consumption of 10.82 GWh. The cost-benefit analysis demonstrates that investing in Net Metering System (NMS) pays positive Net Present Value (NPV) on investment for the RMG firm, with a payback period of about 7 to 9 years. It is also found that under NMS, concessional financing offers the maximum NPV on capital investments. This indicates the importance of financing to encourage investors for sustainable businesses and increasing efficiency.

Unfortunately, given the current level of Photovoltaic (PV) panel efficiency, which is between 20 per cent and 21 per cent, the rooftop and building of the average RMG factory does not have the space for scaling up which is required to generate even 10 per cent of electricity from NMS alone. If the "Virtual Power Purchase Agreement (VPPA)" is allowed in Bangladesh, Independent Power Providers (IPPs) that generate electricity from renewable sources such as solar, wind, and biogas, may contribute to accelerating the process. Also, this process will allow a number of relatively small RMG firms to run their operations by partially diverting their electricity consumption to RE sources and fulfilling their international RE targets under sustainable production practices.

A solar system with an installed capacity of 450 MW to 1800 MW will be required to supply the RMG sector's present electricity consumption. This can accommodate 10 per cent to 40 per cent power output from RE sources. It might need between USD 337.5 million and USD 1,350 million at the current price. This indicates that in order to facilitate RMG firms' transition to green energy and ensure that at least 10 per cent of their electricity demand is met by RE sources, a project needs USD 450 million to mobilise.

For partial transition of the RMG sector towards RE, it is crucial to establish a comprehensive approach among relevant stakeholders. These stakeholders include associations within the Bangladeshi garments industry, government organisations and agencies responsible for funding allocation and mobilisation, government bodies pivotal in fostering international trade and business relationships, and development partners essential for maintaining global connections, advocating for change, and securing financial support.

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ACRONYMS

BB	Bangladesh Bank
BGAPMEA	Bangladesh Garments Accessories & Packaging Manufacturers & Exporters Association
BGMEA	Bangladesh Garment Manufacturers and Exporters Association
BKMEA	Bangladesh Knitwear Manufacturers and Exporters Association
BPDB	Bangladesh Power Development Board
BTC	Bangladesh Tariff Commission
BTMA	Bangladesh Textile Mills Association
CAGR	Compound Annual Growth Rate
COVID-19	Coronavirus Disease 2019
CPTPP	Comprehensive and Progressive Agreement for Trans-Pacific Partnership
CPD	Centre for Policy Dialogue
CTF	Clean Technology Fund
DF QF	Duty-free Quota-free
EACs	Energy Attribute Certificates
ECR	Economic Compliance Review
EE&C	Energy Efficiency & Conservation
EEs	Executing Entities
ERD	Economic Relations Division
EU	European Union
FIs	Financial Institutions
FTA	Free Trade Agreement
FTA	Free Trade Agreement
GCCA	Global Climate Change Alliance
GCF IRM	Green Climate Fund IRM
GCF	Global Climate Fund
GED	General Economics Division

GEEREF	Global Energy Efficiency and Renewable Energy Fund
GEF	Global Environment Facility
GoB	Government of Bangladesh
IDCOL	Infrastructure Development Company Limited
IEA	International Energy Agency
IMED	Implementation Monitoring and Evaluation Division
IPPs	Independent Power Producers
kWh	kilowatt hour
L/C	Letter of Credit
LDCs	Least Developed Countries
LEED	Leadership in Energy and Environmental Design
LNG	Liquefied Natural Gas
MCPP	Mujib Climate Prosperity Plan
MFA	Multi-fiber Arrangement
MoF	Ministry of Finance
MOFA	Ministry of Foreign Affairs
NBR	National Board of Revenue
NDC	Nationally Determined Contributions
NMG	Net Metering Guidelines
NMS	Net Metering System
NPV	Net Present Value
PSMP	Power System Master Plan
PV	Photovoltaic
RE	Renewable Energy
REP	Renewable Energy Policy
RMG	Readymade Garments
SREDA	Sustainable and Renewable Energy Development Authority
SREP	Scaling Up Renewable Energy Program
TA	Technical Assistance
USD	US Dollars
USGBC	U.S. Green Building Council
VPPA	Virtual Power Purchase Agreement

SECTION 1: INTRODUCTION

Bangladesh, with 6.8 per cent of global share of apparel exports, holds the second position following up China, which meets up 30 per cent of global demand for clothing. The sector is considered as the second highest industrial polluter after the oil industry. The use of electricity to produce garments is significantly high both at its backward and forward supply chain (Çay, 2018). Countries heavily rely on gas and fossil fuel-based electricity generation to meet their industrial input demands, and Bangladesh is no exception. In FY2021–22, total electricity demand was 76,667 GWh in Bangladesh (Bangladesh Power Development Board, 2022), of which 28.2 per cent was distributed for industrial use only.

Like many countries in the world, the ongoing Ukraine War has made the global energy market volatile. Bangladesh's energy and power sector continues to rely heavily on expensive imported Liquefied Natural Gas (LNG), coal, and oil (Das et al., 2020). This has created fiscal burden. The Government of Bangladesh (GoB) has passed part of the expenses onto consumers and businesses by raising the price of power. In January 2023, prices have been raised twice. Corresponding to this, power rates (at a flat rate) for large industries went up from BDT 8.45 per Kilowatt Hour (kWh) in December 2022 to BDT 9.32 per kWh in March 2023. The Government also raised gas prices ranging from 14 per cent to 189 per cent across various sectors (Bangladesh Power Development Board, 2023).

The industries that depend on gas, for both their manufacturing processes and captive generation, have been severely affected by gas shortages. The price of captive power generation has increased as a result of this shortage. The cost of gas per kWh of power from a captive unit, which was around BDT 3.5 in January 2023, has now risen to BDT 6.58 in March 2023 (Bangladesh Power Development Board, 2023). Unless this increase in marginal cost is shared by international buyers, Bangladesh's garment industry could lose its profit margin.

The economic justification for expanding RE on grid scale arises from this steep increase in the average electricity generation costs. This expansion will help gain some control over rising power generation costs and address the problems posed by imported fossil fuels. Presently, Bangladesh relies on renewable sources for only 3.7 per cent of its electricity supply (SREDA, 2023). Although increasing RE has been a top priority for the Government since 2008, the pace of RE generation is slow. Bangladesh should now focus on RE-based energy and power infrastructure and mobilise both public and private finance to achieve energy efficiency at a relatively lower cost (Farhana et. al., 2022). Moreover, demand-side energy efficiency initiatives would drastically reduce energy consumption which would reduce the reliance on imported LNG, coal, and oil.

In the above context, this study highlights the potential of a transition from fossil fuel-based energy sources to RE sources by Bangladesh's RMG industry. The study presents the benefits and costs of doing so. As the RMG sector uses a significant amount of primary energy to produce electricity and run its production processes, a partial transition from fossil fuel-based energy use to RE sources may offer businesses a significant cost advantage. This, in turn, may help Bangladesh's RMG sector to remain competitive in the global apparel market.

1.1 Objective of the Study

The overarching objective of the study is to explore the prospect of RE transition in the apparel sector in Bangladesh and discuss possible policy requirements to execute it.

The specific objectives are the following:

(a) Estimate the energy demand of the apparel sector in Bangladesh;
(b) Assess the cost-benefit of a RE transition in the apparel sector;
(c) Identify the potential RE mix for Bangladesh's apparel industry
(d) Develop stakeholder mapping by discussing their potential role in promoting a RE transition in the apparel industry of Bangladesh.
(e) Make recommendations for the RE transition

1.2 Structure of the Report

This paper has six sections including the introduction. The chronological overview and current state of Bangladesh's RMG industry are discussed briefly in Section 2. The methodology and data used in this study is presented in Section 3. Following some key descriptive findings, Section 4 provides

a meta-analysis on the current energy demand in Bangladesh's RMG industry. For the RMG owners to partially switch to RE-based electricity use in their production system, Section 5 estimates and presents analysis of the Net Present Value (NPV) of capital investment. In Section 6, conclusions and a set of policy recommendation are made.

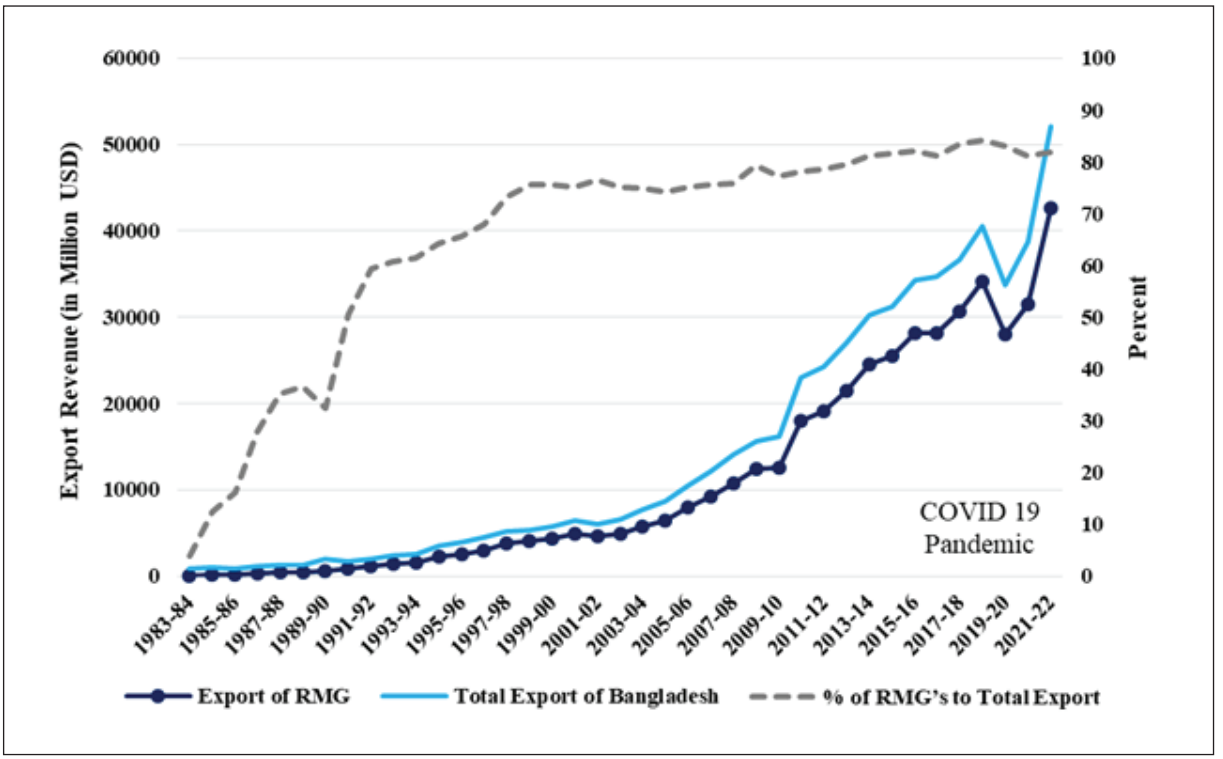
SECTION 2: AN OVERVIEW OF THE RMG SECTOR IN BANGLADESH

The contribution of RMG has been critical to Bangladesh's economic growth and development during the 1980s. With nearly 6.8 per cent of the global export share, Bangladesh's total RMG export value was USD 42 billion in FY2021–22 (Export Promotion Bureau, 2023). Over two decades, the RMG sector contributed over 80 per cent of Bangladesh's total export value and currently provides employment to 4.2 million workers (Haque and Bari, 2021). During the initial stage, the robust RMG industry growth in Bangladesh can be attributed not only to the availability of a low-cost workforce but also to the introduction of the Multi-fiber Arrangement (MFA) in 1974 and supportive government policies. These policies included the provision of bonded warehouse facilities and back-to-back Letter of Credit (L/C) arrangements, which further facilitated the industry's expansion.

Overtime, Bangladeshi RMG entrepreneurs have managed to prove their global competitiveness in the apparel business. Though these were the concerns of the export during the post-MFA period, Bangladesh secured more than seven-fold increase in RMG export earnings[1] between FY2004–05 and FY2022–23 (Figure 1). In this period, Bangladesh's RMG industry continued to grow, despite several set-backs such as accidents in Tazreen and Rana Plaza buildings.

The Coronavirus Disease 2019 (COVID-19) pandemic caused a significant interruption in Bangladesh's apparel industry, as was the case with

Figure 1: Share of RMG export as percentage of total export in Bangladesh



Source: Authors Development from EPB Data, 2023.

[1]Bangladesh's RMG export was USD 6.4 billion in FY2004-05, and it grew to USD 46.9 billion in FY2022-23.

other international apparel producers. RMG factories were shut down in Bangladesh for 34 days during the initial lockdown in April 2020 (Haque & Bari, 2021). Just as when the exports of apparel started to increase after the pandemic, the Ukraine War brought new challenges for the apparel export from Bangladesh. The war caused a global energy crisis, which in turn caused inflationary pressures, disrupted supply chains, and a price surge in the import of raw materials. Bangladeshi RMG exporters faced competition as the production cost went up.

In the coming days, Bangladesh may face further competition due to changes in the context of new trade negotiations among countries and Bangladesh's graduation.Vietnam has made significant diplomatic success in trade negotiations in the recent past. The country signed a few major Free Trade Agreements (FTAs) including Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) in 2018 with several countries. In 2020, it signed with the European Union (EU) (Kikuchi et al., 2018). Bangladesh is expected to graduate from the Least Developed Country (LDCs) group in 2026. Once graduated, Bangladesh will cease to enjoy Duty-free Quota-free (DF-QF) market access for its support in the European market from 2029. If alternative trade agreement is not made, exporters from Bangladesh is likely to face 9.6 per cent additional tariff while exporting RMG products in markets of EU (Razzaque, Akib and Rahman, 2020). This may cause a potential export value loss of 8.0 per cent per annum (Rahman and Bari, 2018). In particular, the potential export decline for the Bangladesh's RMG sector could be as high as 14 per cent (Rahman and Strutt, 2022). It suggests that, in short to medium run, to remain competitive, there is no alternative for Bangladesh's RMG entrepreneurs but to improve efficiency in production process by operational cost reduction and workers' skills development.

Bangladesh's RMG factories have become more compliant by reducing infrastructural bottlenecks, improving labour standards, and introducing trade unions at the factory level following the Rana Plaza incident in 2013, with the help of Accord[2] and Alliance[3], (George 2021; Donaghey and Reinecke, 2018). Currently, Bangladesh's RMG industry is going through a green transition. More than 200 factories have already received Leadership in Energy and Environmental Design (LEED) certification from the U.S. Green Building Council (USGBC). Furthermore, there are over 400 additional factories in the pipeline to receive LEED certification. Factories are investing in green technologies and green activities to make their factories environmentally friendly and resource efficient (Khatun et al, 2023). Even though RMG entrepreneurs do not receive any "premium" price for making green transition, they are investing in RE, waste management, water recycling, effluent treatment etc. to be more efficient and productive while achieving competitiveness and sustainability.

The present study will explore the prospect of a RE transition in the apparel sector of Bangladesh and identify the benefits and costs associated with it. As the RMG industry requires a large volume of primary energy to produce electricity and operate its production activities, a partial transition from fossil fuel-based energy use to RE may provide a significant cost advantage to these firms. Consequently, this transition will help Bangladesh's RMG sector in maintaining its competitiveness in the global apparel market, even after its LDC graduation.

SECTION 3: RESEARCH APPROACH, METHODOLOGY AND DATA

This research is based on both primary and secondary data analyses that are publicly available. A variety of papers, journal publications, and national policy documents were carefully examined, alongside data analysis using meta-analysis and cost-benefit analysis. A comprehensive review of the following national policy documents were made:

(i) Mujib Climate Prosperity Plan (MCPP) up to 2030 (GoB, 2021),

(ii) Power Sector Analysis 2030 based on MCPP (IDCOL, 2021),

(iii) Draft National Solar Energy Roadmap (2021-2041) (SREDA, 2020),

[2]The Accord is an independent, legally binding agreement between brands and trade unions to work towards a safe and healthy garment and textile industry in Bangladesh. For details, see https://bangladeshaccord.org/

[3]The Alliance for Bangladesh Worker Safety (Alliance) is a legally binding, five-year commitment to improve safety in Bangladeshi RMG factories. For details, see https://www.bangladeshworkersafety.org/who-we-are/about-the-alliance

(iv) Energy Efficiency and Conservation Master Plan up to 2030 (SREDA and MPERM, 2015),

(v) Power System Master Plan (PSMP) 2016

(vi) Private Sector Power Generation Policy (PSPGP) (Ministry of Energy and Mineral Resources, 2004),

(vii) Renewable Energy Policy (REP) (MPERM, 2008),

(viii) Net Metering Guidelines (NEG) – 2018 (SREDA and MPERM, 2018),

(ix) 8th Five Year Plan of Bangladesh from July 2020 to June 2025 (GED, 2020).

In the following subsections, methods and data used in meta-analysis to estimate current electricity consumption and cost-benefit analysis for installing solar systems to partially shift to renewable energy from fossil fuel based energy for production, are separately discussed.

3.1 Meta Analysis

A meta analysis is conducted to estimate the current energy demand of the apparel sector in Bangladesh. In doing so, factory and worker level data from 182 RMG factories were collected by CPD through a randomised survey using five modules of a standardised questionnaire. The questionnaire was divided into modules to gather information on the following topics: (a) general factory information, (b) green building and certification, (c) factory management's green orientation, knowledge, belief, and attitude, (d) green investment at the factory level, and (e) worker output and productivity. Also, using a different questionnaire, data on these factories' employees were chosen randomly. Of 182 RMG factories, only 71 factories exported RMG during the past 12 months. Data on these 71 RMG manufacturers were used to determine the current energy demand in the sector. Each of these factories is a member of the Bangladesh Garment Manufacturers and Exporters Association (BGMEA), Bangladesh Knitwear Manufacturers and Exporters Association (BKMEA), or both. In the next section, some of key descriptive statistics are presented to inform further about the primary data used to estimate the current energy demand in Bangladesh's RMG sector.

Descriptive Statistics on Green Transition of RMG Factories

Table 1 presents mode of exports by RMG factories. Nearly 80.3 per cent of the 71 sample factories are involved in direct export, while the rest of the factories do their export shipments through trading firms.

Table 1: Mode of exports by RMG factories

Modality of Export	Number of Factories	Per cent of Factories
Direct Exporter	57	80.2
Through trading firms	8	11.3
Both	6	8.5
Total	**71**	**100.0**

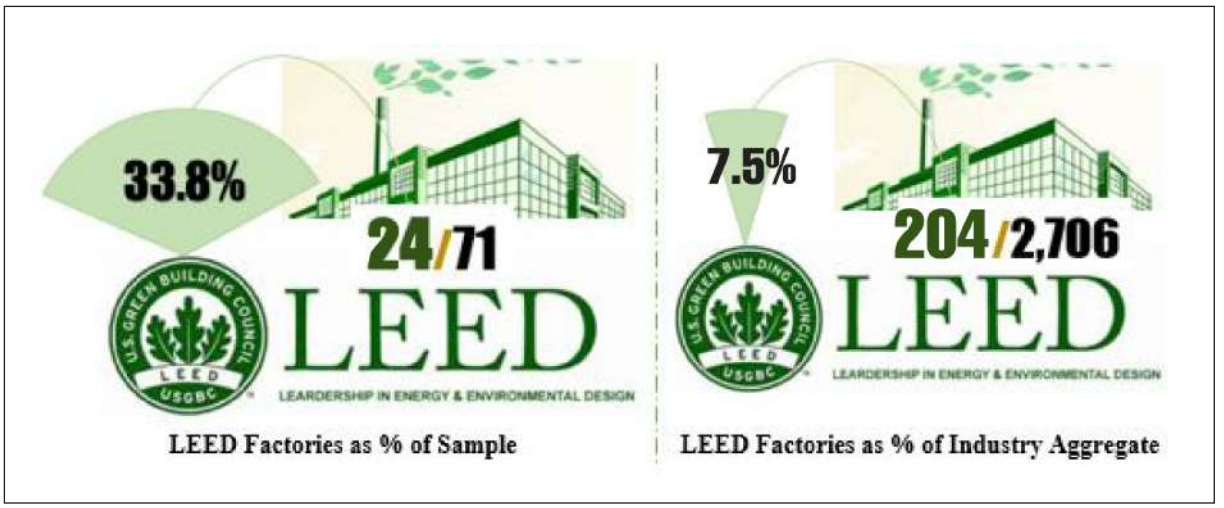
Source: CPD survey on green transition of RMG factories, 2022.

Of the 71 RMG factories in the sample, 24 are LEED certified factories (Figure 2). This indicates that 33.8 per cent of the sample factories are LEED certified. Industry-wide, over 600 RMG manufacturers have applied to USGBC to become LEED certified factories. Of which, 204 RMG factories have already earned LEED certification as of December 2023. Results from the *Mapped in Bangladesh* study show that there are 2,706 active factories, which are members of either the BGMEA, the BKMEA, or both. Non-member RMG factories that are also fully in operation, and engaged in export were not taken into consideration.

Table 2 shows that 40.2 per cent, 71 factories under the sample, produce knitwear, 42.3 per cent woven clothing, and 16.9 per cent are mixed manufacturing (firms own both knit and woven wear sections within a factory premise). In the sample, half of the mixed RMG factories (knit/sweater and woven) have LEED certification. In the case of knitwear, 31.0 per cent of the sample's factories are LEED-certified RMG factories, while for woven clothing, the corresponding per centage is 30.0.(Table 2).

RMG manufacturers in the sample have an average of 2,905 employees, (Figure 3), compared to the industry average of 1,591 in 2020 (Haque and Bari, 2021). It implies that, the bulk of these RMG factories are large irrespective of their types.

Figure 2: Percentage of LEED certified factories 'sample vs. industry aggregate'



Source: CPD survey on green transition of RMG factories 2022; Mapped in Bangladesh 2022; and USGBC 2022.

Table 2: Types of factories

Factory Type	Number of Factories	Per cent of Factories	Number of factories	% of LEED Factories
Knitwear	29	40.9	9	31.0
Woven wear	30	42.2	9	30.0
Mixed (Knit/Sweater + Woven)	12	16.9	6	50.0
All	71	100.0	24	33.8

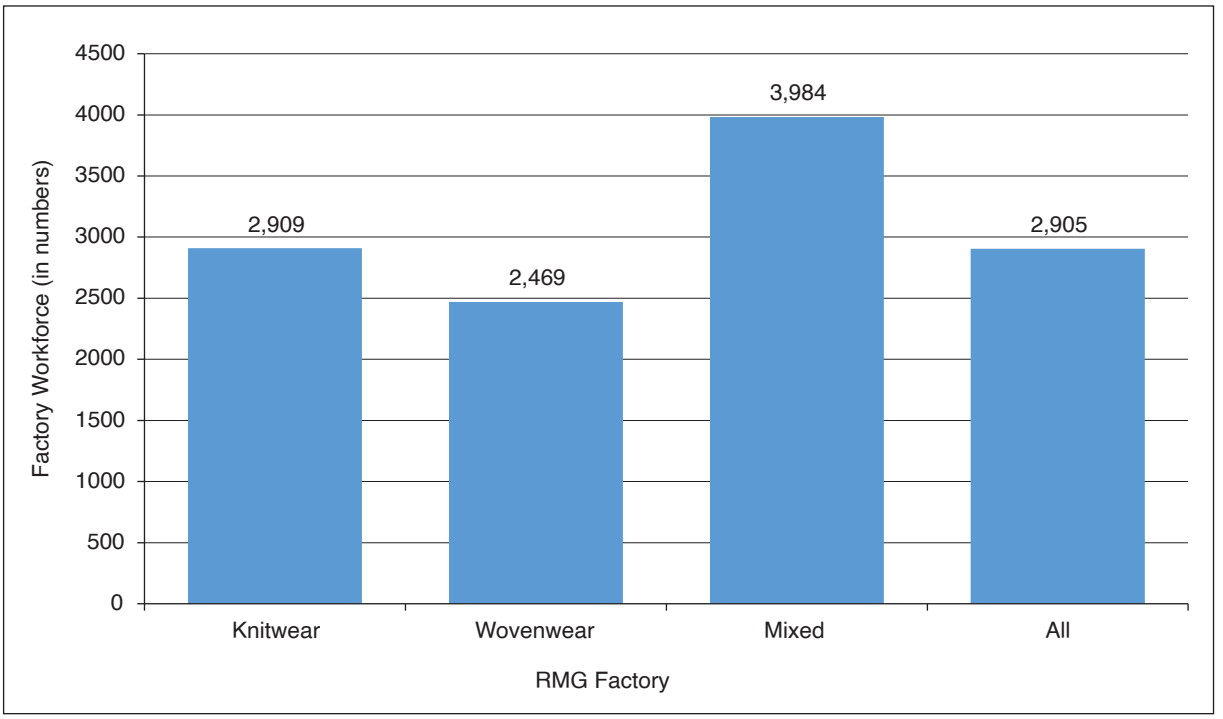
Source: CPD survey on green transition of RMG factories, 2022.

The bottom 5 per cent of RMG factories employed 110 people on average. The average employee size was 643 in the bottom 40 per cent of factories and 1554 in the bottom 70 per cent. The average workforce size of Bangladesh's largest 1 per cent RMG firms was 10,397, compared to 5,017 for large 5 per cent RMG factories (Figure 4).

The sample factories were divided into three categories in order to maintain alignment with the industry average (Table 3). The three categories of RMG factories are: (a) those with fewer than 650 employees (corresponding to the bottom 40 per centile of RMG factories' average worker size); (b) those with more than 650 but fewer than 1,650 employees (corresponding to the bottom 40 to bottom 70 per centile of RMG factories' average worker size); and (c) those with more than 1,650 employees (corresponding to the top 30 per centile of RMG factories' average worker size). Approximately 45.7 per cent of the sample's LEED-certified factories employ more than 1,650 people (Table 3).

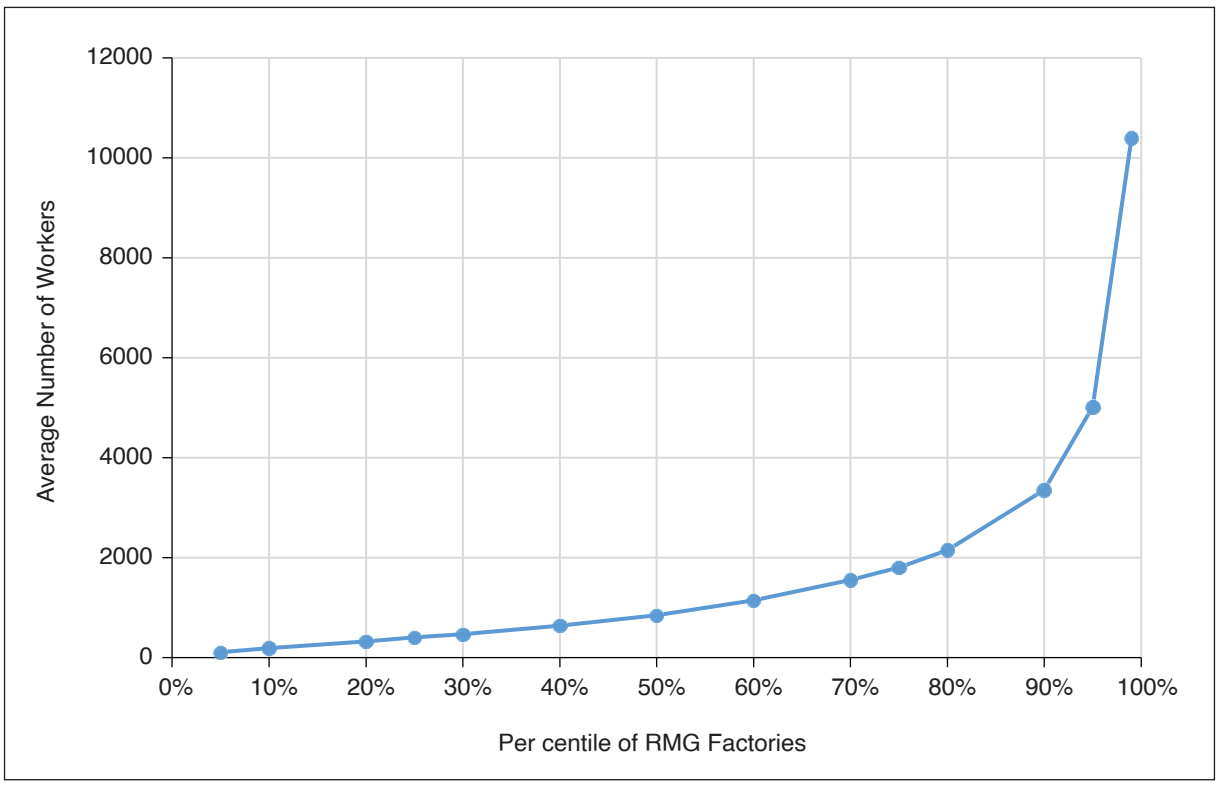
Figure 5 demonstrates that out of 71 sample factories, almost 45.5 per cent were built between 2011 and 2022, and 40.9 per cent were built between 2001 and 2010. The remaining 13.6 per cent of industry buildings were built between 1990 and 2000. This indicates that the structural design of the majority of these factory buildings is very recent.

Figure 3: Size of workforce by RMG factory types



Source: CPD survey on green transition of RMG factories, 2022.

Figure 4: Average size of workers by percentile of RMG factories



Source: Authors compilation from BGMEA Membership Directory Database, 2019.

Table 3: Number of factories by different size of workers

RMG Factories With	Number of Factories	Per cent of Factories	LEED Certified Factories	% of LEED Factories
Less than 650 workers	18	25.4	3	16.7
>650 and <1650 workers	18	25.4	5	27.8
More than 1650 workers	35	49.3	16	45.7
Total	**71**	**100.0**	**24**	**33.8**

Source: CPD survey on green transition of RMG factories, 2022.

3.2: Cost-Benefit Analysis

Cost-benefit analyses are used in this study to determine the Net Present Value (NPV) and payback period of installing solar system under net metering scheme for Bangladesh's RMG enterprises. In this regard, the four investment arrangements listed below are used to calculate NPV and payback time.

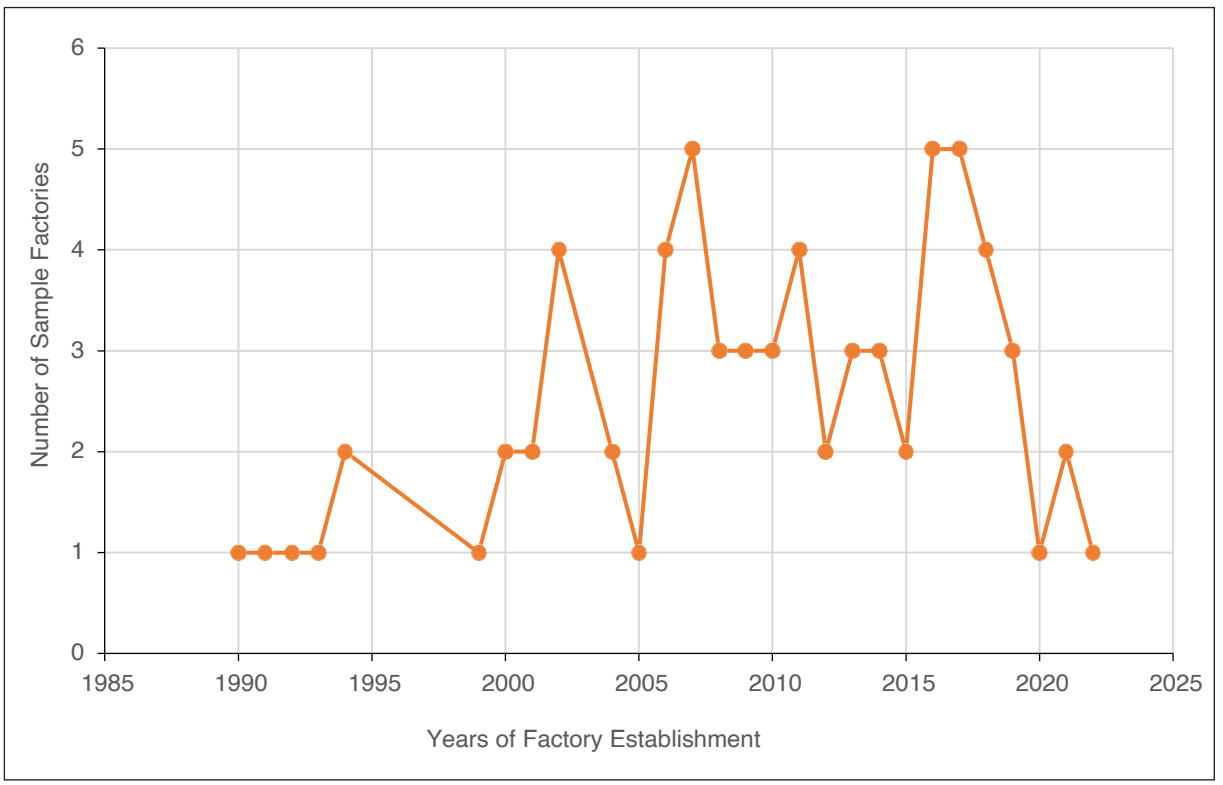
Investment Arrangement A: Investment made by the owner of the RMG to satisfy a 1 MW energy demand at a debt-to-equity ratio of 70 per cent to 30 per cent.

Investment Arrangement B: Investment made by the owner of the RMG to satisfy a 1 MW energy demand at a debt-to-equity ratio of 50 per cent to 50 per cent.

Investment Arrangement C: Investment made by the owner of the RMG to satisfy a 1 MW energy demand at a debt-to-equity ratio of 30 per cent to 70 per cent.

Investment Arrangement D: Investment made by the owner of the RMG to satisfy a 1 MW energy demand at 100 per cent equity.

Figure 5: Number of sample factories by years of establishment



Source: CPD survey on green transition of RMG factories, 2022.

Weighted Average Cost of Capital (WACC)

= % of Debt Share*% of cost of Debt + (1-% of debt share)

*(% of expected return on equity)----------(1)

$$\% \text{ of expected return on equity} = \left[\left(1+\frac{\text{Real Growth Rate}}{100}\right)^{*}\left(1+\frac{\text{Inflation Rate}}{100}\right) - 1\right] * 100 \text{ - - - - - - - - (2)}$$

For the following two loan schedules: (i) term loan and (ii) support from Bangladesh Bank's refinancing scheme, NPV and payback time are calculated in accordance with investment arrangements A, B, and C. By using equation (1) and (2), the WACC is computed under the abovementioned investment arrangements. WACC is calculated for term loans at 12.23 per cent if debt is 30 per cent, 12.16 per cent if debt is 50 per cent, and 12.10 per cent if debt is 70 per cent. In addition, WACC decreased to 10.73 per cent for debt levels of 30 per cent, 9.66 per cent for debt levels of 50 per cent, and 8.60 per cent for debt levels of 70 per cent if the investor could use Bangladesh Bank (BB) refinancing support. In contrast, when an investment is made at 100 per cent equity, WACC is highest (12.32 per cent) (Table 4).

For calculating WACC, the average inflation rate over the prior five years (5.9 per cent) was taken into consideration from (FY2016–17 to FY2021–22). The analysis in this study is based on a 6 per cent real discount rate, as indicated in the research by Kabir et al., 2023. Based on discussions with a number of RMG companies who installed Net Metering System (NMS) between 2020 and 2022, it was found that the current capital cost for installing a 1 MW solar system is close to USD 0.75 million after interacting. And, the average yield of electricity is 1422 kWh from per kW solar system installed. However, this estimation, we considered 10 per cent less efficiency in yield rate — which is 1280 kWh. At present, the flat electricity charge for large industries is BDT 9.78/kWh (BPDB, 2023). According to Bangladesh Energy Regulatory Commission (BERC), in March 2010, average per kWh electricity price was BDT 3.81. In this period, annual compound growth rate in electricity price is calculated to be 7.5 per cent. Although higher electricity price rise was anticipated in planned documents like PSMP 2016, the estimation was conducted based on the sustained historical compounded growth rate. Moreover, annual regular operating costs are estimated to be 0.25 per cent of the initial capital cost. In addition, it is expected that servicing and maintenance costs will be incurred by 2 per cent of initial capital cost in every five years interval (for 3 times in 20 years lifetime of solar system). Furthermore, the rate of reduction in solar panel efficiency is estimated to be 0 per cent for the first five years, 10 per cent during five to ten years, 20 per cent during ten to fifteen years, and 30 per cent during fifteen to twenty years (Table 5).

Table 4: Computed values of WACC under different investment arrangements

Weighted Average Capital Cost	Investment Arrangement
Under Term Loan	
WACC (with 30% debt)	12.23%
WACC (with 50% debt)	12.16%
WACC (with 70% debt)	12.10%
Support from BB Refinancing Schemes	
WACC (with 30% debt)	10.73%
WACC (with 50% debt)	9.66%
WACC (with 70% debt)	8.60%
Self-Investment	
WACC (with 0% debt)	12.32%

Source: Authors Calculation.

Table 5: Parameters used for computing NPV and payback time

Parameters/Conditions	Units
Initial Capital Investment	0.75 million USD/1 MW Solar System Installation
Flat Electricity Charge for large in-dustries from March 2023	BDT 9.78/KWh
Electricity Price growth	7.5% per annum
Exchange Rate	106 BDT/USD
Average energy yield	1280 (KWh/KW)
Inflation Rate	5.97%
Real Growth Rate	6.00%
Regular Operating Cost	0.25% of initial capital cost per year
Servicing and Maintenance Cost	2 % of initial Capital cost in every five (05) years inter-val
Rate of Decline in Solar Panel Effi-ciency	
First 5 years	0%
>5 to <=10 th years	10%
>10 to <=15 th years	20%
>15 to <=20 th years	30%

Source: Authors Calculation.

For all cases, following parameters/ conditions are used to calculate the NPV and payback time using equation (3) and (4).

$$\text{NPV} = -\text{capital investment} + \sum_{0}^{T=20} \frac{\text{Total net cash inflow in system lifespan}}{(1 + \text{nominal discount rate})^{T}} \quad \text{----------(3)}$$

$$\text{Payback time (PBT)} = \frac{\text{Payback time (PBT)}}{\text{Net cash inflow in the system lifespan}} \quad \text{----------(4)}$$

SECTION 4: ESTIMATED ELECTRICITY DEMAND IN BANGLADESH'S RMG INDUSTRY

The current electricity usage per factory per month is calculated using the methodology described in Section 3.1 to be 247.90 MWh (Table 6). The anticipated monthly power usage for LEED certified RMGs is 325.37 MWh, compared to 207.40 MWh for non-LEED RMGs. Additionally, it was determined that the mixed RMG factories under the sample had a monthly electricity requirement of 269.44 MWh. The women manufacturers required 165.11 MWh, and knitwear manufacturers needed 324.17 MWh. Moreover, firms with fewer than 650 employees use about 55.62 MWh electricity each month, while those with more than 650 but fewer than 1650 employees use about 152.87 MWh each month. Besides, firms

Table 6: Electricity consumption per factory per month

Factory Type	Electricity Use Per Month (in MWh)
LEED Certified RMGs	325.37
Non-LEED RMGs	207.40
Knitwear	324.17
Woven (wear)	165.11
Mixed	269.44
Less than 650 workers	55.62
>650 and <1650 workers	152.87
More than 1650 workers	414.71
Total	**247.90**

Source: Author's Calculation from CPD survey on green

with more than 1650 employees use 414.71 MWh electricity per month.

The Mapped in Bangladesh database identified a total of 2,706 RMG factories actively involved in producing direct garment exports from Bangladesh. At the time of the survey, 40 per cent of the sample factories had fewer than 650 employees. It implies that there are currently less than 650 individuals employed in a total of 1082 RMG factories. With the use of the meta-analysis, it was determined that the annual electricity demand for factories that are having 650 workers or less is 722.5 GWh. Similarly, 30 per cent of the sample factories had more than 650 employees but fewer than 1650 workers. It indicates that there is currently a total of 812 RMG factories with more than 650 workers but fewer than 1650 workers, and their aggregate electricity demand is estimated to be 1489.2 GWh per annum. Besides, another 30 per cent of the sample factories had more than 1650 workers. It indicates that there is currently a total of 812 RMG factories with more than 1650 workers, and their aggregate electricity demand is estimated to be 4040.0 GWh per year (Table 7).

RMG factories that are active BGMEA/BKMEA members and also involved in garments exports in the last 12 months are expected to use 6,251 GWh of electricity per year (Table 7). In FY2021–22, the Bangladesh Power Development Board (BPDB) reported that annual power consumption was 76,667 and annual electricity generation was 85,607 GWh. It suggests that, on aggregate, electricity demand for large RMG industries are 8.2 per cent of country's total electricity consumption and 7.3 per cent of country's total electricity generation.

Table 7: Estimated electricity generation (in GWh) demand by Bangladesh's RMG industry

Size of Workers	% of RMG Factories	Number of RMG Factories	Average Electricity Demand (in MWh) per month per RMG factory	Total Electricity Demand of RMG Industry (in GWh) per month	Total Electricity Demand of RMG industry (in GWh) per annum=
Less than 650	40%	1082	55.62	60.2	722.5
Greater than 650 but less or equal to 1,650	30%	812	152.87	124.1	1,489.2
More than 1650	30%	812	414.71	336.7	4,040.0
Total	**100%**	**2706**	**-**	**521.0**	**6,251.7**

Source: Authors' Estimation from CPD survey on green transition of RMG factories, 2022.

4.1 Net Metering System Installed in RMG Factory Buildings and its Potential

At the industry level, there is no consolidated database accessible to determine electricity use. The authors of this study combined the BGMEA/BKMEA data with the SREDA-provided NMS installation data. A total of 1783 systems had been installed by SREDA as of December 2022 and 65 of those were installed in RMG factory buildings (SREDA, 2023). Regardless of the type of factory, the size of the average worker is significantly larger than the industry average. That means that the bulk of RMG factories having NMS installed are significant manufacturers.

Table 8 Shows, out of the 65 RMG enterprises with NMS installed, 32 knitwear factories are equipped with solar panels, having a combined installed capacity of 4,974 kW. In addition, 20 woven manufacturers with NMS installations have a combined installed solar panel capacity of 1,737 kW. A total of 1,961 kW of solar energy has also been installed by 13 mixed garment producers (e.g., producing knit and woven clothing simultaneously) under NMS. Together, as of December 2022, 8,672 kW of solar capacity has been built under NMS at RMG factories alone. This represents approximately 16.2 per cent of the total 53,506 kW of PV capacity deployed under SREDA's rooftop NMS programme.

Figure 6 shows that about 79 per cent of RMG factories, including those in Gazipur and Narayanganj, are located in the Dhaka Zone, 17 per

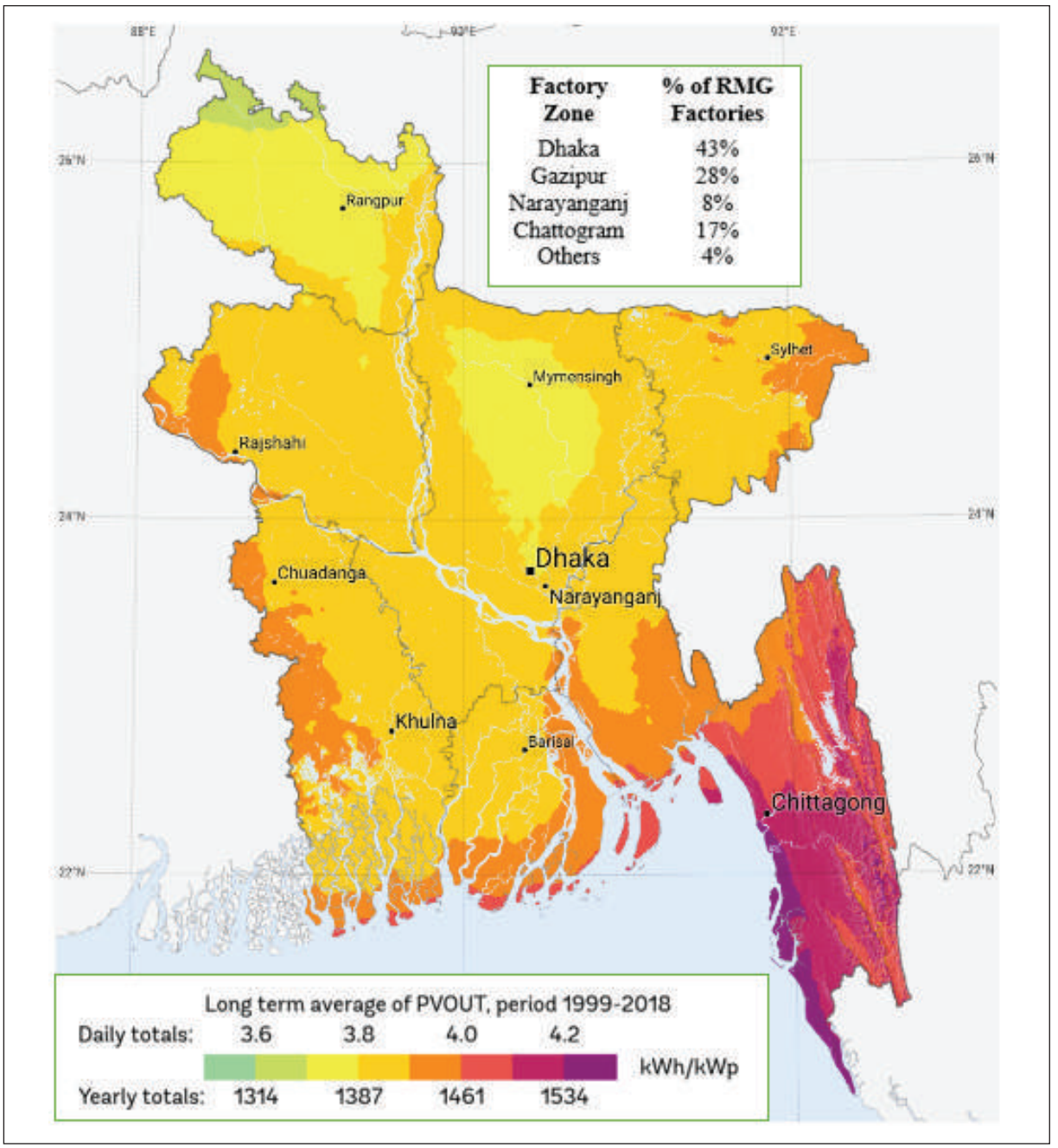
Table 8: Installed solar systems with net metering by types of RMG factories

Factory Type	Number of Factories with NMS	Average Workers Size Per Factory	Average Electricity Demand (in MWh) per month per RMG factory	Total Installed Solar Panel capacity (in KW)	Annual Potential Electricity Generation Capacity (in GWh)
Knitwear	32	3,557	4,974	6.21	722.5
Woven	20	3,632	1,737	2.17	1,489.2
Mixed	13	4,349	1,961	2.45	4,040.0
Total	**65**	**3,689**	**8,672**	**10.82**	**6,251.7**

Source: Authors' Calculation from SREDA Database, 2022.

cent are located in Chattogram and 4 per cent in other regions of Bangladesh. The average irradiance rates in Dhaka and Chattogram from 1 kW of installed PV capacity are, respectively, 1461 kWh and 1534 kWh, according to the World Bank's PV potential map for Bangladesh. According to Kabir et al. (2023), the average irradiation rate is 1464 kWh/kW in Dhaka and 1499 kWh/kW in Chattogram. The average irradiation rate for RMG enterprises is calculated to be 1470 kWh/kW when location wise weights are taken into account. RMG plants in Bangladesh usually operate 26 days per month. The total number of hours of sunlight per year is approximately 26 x 4 x 12 = 1,248 hours if each solar panel is exposed to bright sunlight for an average of 4 hours per day. Consequently, with the present installed NMS, the potential energy generated (installed capacity x no. of hours of operation at full capacity) in knitwear factories is 6.21 GWh annually, compared to 2.17 GWh in woven manufacturers and 2.45 GWh in mixed manufacturing factories. This implies that the total potential electricity generation is estimated to be 10.82 GWh annually with NMS implemented in 65 RMG factories as of December 2022.

Figure 6: Solar irradiation and PV power potential Map in Bangladesh



Source: Authors' Compilation using the World Bank's PV Power Potential Map in Bangladesh.

SECTION 5: COST-BENEFIT ANALYSIS OF RE-BASED ELECTRICITY TRANSITION IN THE RMG INDUSTRY

Solar energy conversion has been extensively used to generate power and heat since 2007–2008 (Figure 7). According to the International Energy Agency (IEA), solar system installations will meet about 45 per cent of the global energy demand in 2050. It was discovered that industrial uses for solar thermal are becoming remarkably popular. It can be utilised in a variety of industries, including the production of textiles and clothing. On the other hand, the industrial buildings are also using solar electricity extensively for power lights, pumps, engines, fans, freezers, and water heaters. Over the years, the price of solar panels has declined significantly; in 2012, it was less than USD 1 per watt, while it is over USD 0.26/watt in 2022 (IRENA, 2023).

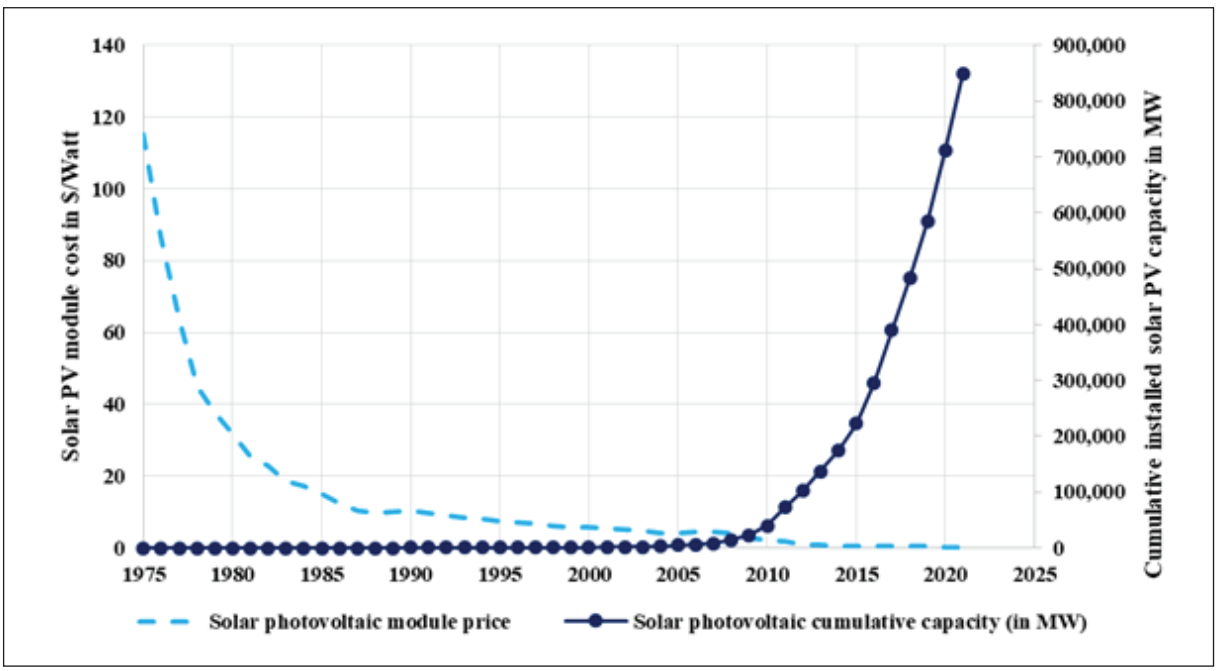
Bangladesh adopted net metering policy in 2018. Although PV installation was initially slow at the industrial level, and then hindered by the COVID-19 pandemic, a sizable number of businesses have now started to install NMS in their factories as it is financially beneficial. It is found that installing PV under the NMS scheme yielded positive NPV on investment for all four investment scenarios that used the cost benefit technique described in Section 3.2.

The results of the cost-benefit analysis show that investment arrangement A (to install a 1 MW NMS in the factory premise or rooftop) yields a positive NPV equivalent to USD 0.91 million and a payback time of 7 years when debt is received under BB's existing refinancing facility (Figure 8 and Figure 9).

In contrast, when debt is received as a regular term loan from a bank or non-bank financial institution, under investment arrangement A, it yields a positive NPV equivalent to USD 0.51 million and the payback time is found to be 8.5 years (Figure 8 and Figure 9). Under the BB's refinancing facility, loanable funds are accessible at 7 per cent interest rate while under regular term loan, the rate is 12 per cent.

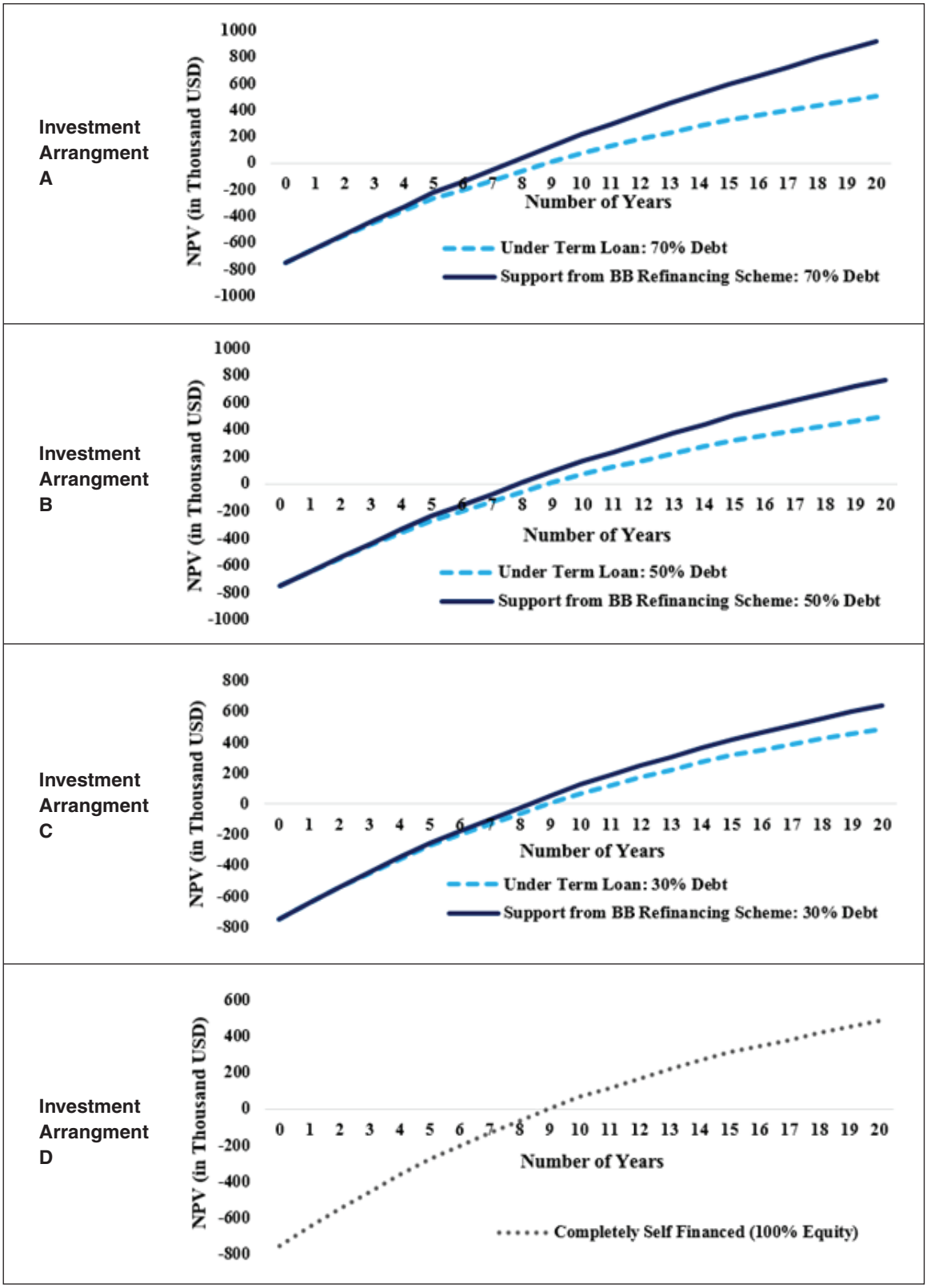
Similarly, investment arrangement B yields a positive NPV equivalent to USD 0.76 million and a payback time of 8 years when debt is received under BB's existing refinancing facility. In contrast, when debt

Figure 7: Trend of solar panel (photovoltaic) prices vs. cumulative capacity (1975-2021)



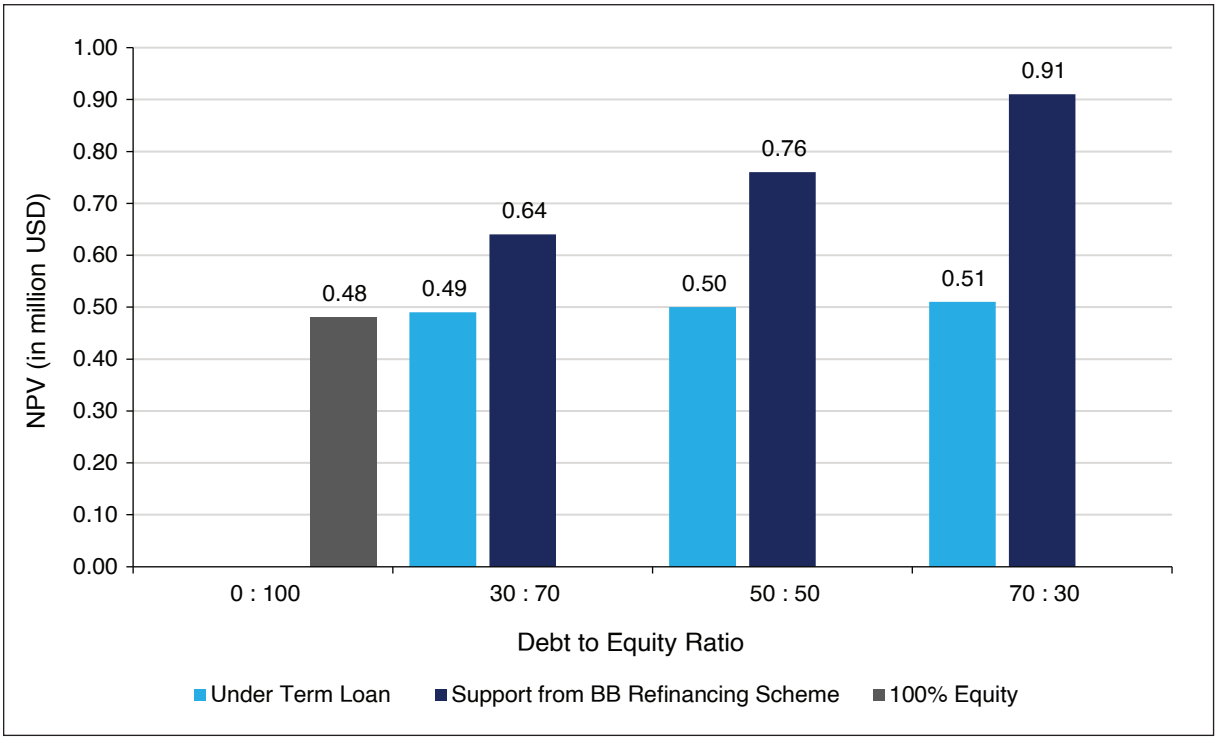
Source: Nemet (2009); Farmer & Lafond (2016); International Renewable Energy Agency (IRENA).
Note: Data is expressed in constant 2021 US$ per Watt.

Figure 8: Results of NPV analyses to 1 MW Solar System under different investment arrangements



Source: Authors Calculation

Figure 9: NPV by types of investment arrangement



Source: Authors' Calculation

is received as a regular term loan from a bank or non-bank financial institution, under investment arrangement B, it yields a positive NPV equivalent to USD 0.50 million and the payback time is found to be 8.5 years (Figure 8 and Figure 9).

At the same time, investment arrangement C yields a positive NPV equivalent to USD 0.64 million and a payback period of 8 years when debt is received under BB's existing refinancing facility. In contrast, when debt is received as a regular term loan from a bank or non-bank financial institution, under investment arrangement C, it yields a positive NPV equivalent to USD 0.49 million and the payback time is found to be 9 years (Figure 8 and Figure 9). Investment arrangement D yields a positive NPV equivalent to USD 0.48 million and a payback time of 9 years when investment is made using 100 per cent equity by the company itself (Figure 8 and Figure 9).

It demonstrates that investment scenario A, in which the investor obtained 70 per cent of the debt through BB's refinancing programme, is the most beneficial from promoting NMS installation. Even in investment scenario A, an investor who secures BB's refinancing scheme, will see a net return that is nearly twice as high as that of a standard term loan. In addition, the cost of capital payback period is one year earlier than the term loan arrangement. It emphasises how critical financing is to motivating investors to put money into sustainable businesses and to increase efficiency in the process.

SECTION 6: DISCUSSION

Based on the findings of the meta-analysis and cost-benefit analysis, the following policy issues are discussed in this section: (i) the potential of the RE mix to partially meet Bangladesh's RMG sector's electricity demand; and (ii) the possibility of a financing source to hasten the pace of industry-wide investment in RE-based electricity generation. In addition, this section will attempt to identify the potential list of stakeholders and their roles to accelerate the RE transition in Bangladesh's RMG industry.

6.1 Potential RE Mix to Partially Support RMG Sector's Electricity Demand

Results of the meta analysis indicate that the estimated electricity demand in Bangladesh's RMG

industry currently stands at 6,251 GWh. This means that about 625.2 GWh of electricity will be required just to redirect 10 per cent of the total RMG electricity demand toward RE. In relation to the national commitment of producing 40 per cent of the country's electricity from renewable sources by 2041, even with the current level of demand, over 2500 GWh of electricity will be needed from these sources to meet the demand for the RMG sector alone. Only 8.6 MW equivalent solar systems, with a capacity to produce 10.82 GWh annually, have been installed through NMS in the RMG factories as of December 2022. It shows that the average RMG factory rooftop and building space is insufficient to accommodate the scaling up required to generate this much of electricity from NMS alone, given the current level of PV panel efficiency (which is between 20 per cent and 21 per cent). Using alternate strategies for increasing RE electricity generation is necessary to satisfy even 10 per cent of the RMG sector's electricity needs. To fulfill even the 10 per cent electricity demand for RMG sector from RE, the alternative methods of expanding RE electricity generation must be explored.

In this context, Independent Power Producers (IPPs) that produce electricity from renewable sources including solar, wind, and biogas may help to hasten the process if 'Virtual Power Purchase Agreement (VPPA)' is approved in Bangladesh. VPPA is a multi-year bilateral financial renewable energy contract between producer and consumers where the power producer (vendor) does not physically transfer energy to customers. (Hundt, 2021). The agreement excludes dispatch fees since that power plants are not directly connected to the customer's power supplier, but it still allows RMG enterprises to take advantage of having Energy Attribute Certificates (EACs). For instance, under the VPPA, the electricity producer sells its generated electricity at the market rate, allowing entities such as groups of companies or RMG factories to purchase RE. The consumer only receives the EACs as green energy credits associated with the traded electricity in exchange for the strike price[4], which is the predetermined VPPA contract price. The actual price agreement between the power producer and the user (i.e., RMG enterprise), however, is based on the discrepancy between the strike price and the wholesale market rate.

Currently nine solar plant IPPs with a combined capacity of 261 MW are in operation. Another eight solar-based IPPs, with a combined installed capacity of 551.5 MW, are in the implementation phase. Additionally, twenty-three IPP solar parks, totaling 1394.2 MW, are in the development stages. (Table 9). It indicates that 1,945.7 MW of solar power capacity, which has the potential to produce more than 2700 GWh of electricity to the national grid, is likely to be installed in Bangladesh within the next few of years. Besides, two wind power plants with a combined capacity of 62 MW are already in operation, while planning is ongoing for seven more wind power projects with a combined capacity of 295 MW. Moreover, three biogas plants totaling 49.5 MW are in the planned stages (Table 9). If VPPA is allowed in Bangladesh, then it will allow all industries including RMG to have some form of RE mix to generate electricity beyond solar power.

Many may contend that the Bangladeshi market is not prepared yet to create a VPPA market mechanism. However, keeping this clause in place will enable Bangladesh to expedite the process of achieving its

Table 9: Current on-grid mix of installed capacity by sources of RE

	In Operation	Implementation Ongoing	Under Planning	Total
Installed Capacity (in MWp)				
Solar Park	261.0	551.5	1374.2	2186.7
Wind	0.9	62.0	295.0	357.9
Hydro	230.0	-	-	
Biogas to Electricity	-	-	49.5	49.5
Total	**491.9**	**617.2**	**1718.7**	**2594.1**

Source: SREDA, 2023.

[4]A strike price is the agreed price between the electricity generator (e.g., IPPs) and their clients.

goal of generating 40 per cent of its electricity from renewable sources by 2041. This arrangement may entice private investors to invest in the energy sector, thus fulfilling their commitment to creating sustainable products. Additionally, a developed RE market of Bangladesh might attract Foreign Direct Investment (FDI). Moreover, it does not require any physical land preparation costs at the individual level and may also enable a lot of enterprises to transition 10 to 15 per cent of their electricity demand from conventional to RE sources with relatively lower investment.

Under VPPA, when the market rate is greater than the strike price, the power producer will reimburse the 'RMG enterprise or group of companies' for the difference (Hundt, 2021). When the market price is lower, the RMG enterprise or group of companies must pay the difference. The RE generator then transfers the corresponding green credits to its client. This procedure will also enable a number of relatively small RMG firms to operate their businesses by partially redirecting their electricity demand to RE sources and meet their global renewable energy commitments under sustainable production practice.

6.2 Potential Source of Financing

As mentioned above, Bangladesh's RMG industry will need 625.2 GWh of electricity from renewable sources just to meet 10 per cent of its present electricity demand. The industry will need to produce roughly 2500 GWh of power from RE sources in order to match the 40 per cent of 'Nationally Determined Contributions' (NDC) target. To accommodate this need for power generation from RE sources, a solar system with an installed capacity from 450 MW to 1800 MW will be needed. At current valuation, it may require an amount from USD 337.5 million to USD 1,350 million to facilitate green energy transition of RMG sector under NMS system. The caveat is that, while the RMG industry's electricity needs are likely to rise, prices for PV solar panels are predicted to fall in the future, possibly offsetting part of the increased quantity effect by decreasing price effect.

According to the climate funds updated data, a total of USD 46.74 has been pledged to the global climate fund as of February 2023 (Climate Funds Update, 2023). Only 24.6 per cent of the total amount that was committed has actually been distributed, and almost USD 16.4 billion worth of funds are still subject to negotiation. For instance, out of the USD 9.1 billion that was pledged globally for mitigation purposes, USD 6.7 billion has already been paid out; leaving the remaining USD 2.4 billion subject to negotiation.

Recently, Bangladesh received USD 256.8 million fund from Global Climate Fund (GCF) for a project titled "*Promoting private sector investment through large scale adoption of energy saving technologies and equipment for Textile and Readymade Garment sectors of Bangladesh*". These funds are supposed to be disbursed under the following four components:

(i) USD 133.00 million financing for Energy Saving Equipment & Technology for Textile sector,

(ii) USD 3.05 million from GCF Technical Assistance (TA) to create enabling environment for Executing Entities (EEs) investment in the textile sector,

(iii) USD 200.00 million financing for Energy Saving Equipment & Technology for the RMG sector

(iv) USD 2.30 million GCF TA to create enabling environment for EEs investment in the RMG sector,

(v) USD 1.15 million from GCF TA to strengthen regulatory and institutional framework at the national level to overcome the operational constraints related to implementing Energy Efficiency & Conservation (EE&C) in the country.

In case of Component (iii), IDCOL will mobilise funds from GCF in the form of loan, to the EEs e.g., Banks/ Financial Institutions (FIs) to lend directly to the RMG manufacturers. The EEs will seek disbursements from IDCOL for pre-defined energy efficient equipment and technology according to their loan application pipeline every year over the programme implementation period.

Result of this particular study suggests a similar project proposal is required to mobilise USD 450 million in financing support for RMG manufacturers to smooth their green energy transition with regards to meeting at least 10 per cent of their electricity demand from RE sources. Despite its potential, Bangladesh could only manage to receive USD 653.14 million from GCF, including the abovementioned project, which is only 5.5 per cent of the total fund disbursed through the GCF window. Lack of expertise in proposal writing, creation of project profiles, and negotiations are key reasons why Bangladesh could not access many of these climate funds. Thus, Bangladeshi officials should seek out negotiation channels to get money through

Table 10: List of potential sources of global funds for RE projects

Source of Funds	Focus of the Fund	Fund Type	Pledge Amount (Million USD)
Clean Technology Fund (CTF)	Mitigation - Gen-eral	Multilateral	7,901.56
Scaling Up Renewable Energy Programme (SREP)	Mitigation - Gen-eral	Multilateral	779.34
Global Energy Efficiency and Renewable Energy Fund (GEEREF)	Mitigation - Gen-eral	Multilateral	281.50
Partnership for Market Readiness	Mitigation - Gen-eral	Multilateral	131.50
Amazon Fund	Mitigation - REDD	Multi Donor National	1,288.23
Green Climate Fund IRM (GCF IRM)	Multiple	Multilateral	10,322.03
Green Climate Fund (GCF-1)	Multiple	Multilateral	10,001.04
Global Climate Change Alliance (GCCA)	Multiple	Multilateral	1,652.83

this window to encourage investment in installation of solar and wind power projects. The generation of electricity from renewable energy sources is one of the mitigation strategies to address the problems caused by climate change. In this respect, funds may be directly obtained from the following global sources:

(a) The Clean Technology Fund (CTF);

(b) The Scaling Up Renewable Energy Programme (SREP);

(c) The Global Energy Efficiency and Renewable Energy Fund (GEEREF); and

(d) The Partnership for Market Readiness.

Bangladeshi policymakers may also apply for funding from the Amazon Fund, Green Climate Fund IRM, (GCF IRM) Green Climate Fund (GCF-1), Global Climate Change Alliance (GCCA), and Global Environment Facility (GEF5 to GEF8) in this purpose (Table 10).

6.3 List of Key Stakeholders and their Potential Role to Accelerate RMG Sector's RE Transition

Four criteria may be used to identify key stakeholders to expedite the RMG sector's RE transition:

(a) Relevant associations of Bangladesh's garments industry;

(b) Government agencies, as they are in charge of mobilising and disbursing funds;

(c) Government agencies which promote foreign trade and business;

(d) Development partners who help to secure funds and maintaining international liaison.

The list of key stakeholders (Table 11) to accelerate RMG sector's RE transition is provided below:

Around 25 per cent of RMG factories in Bangladesh have LEED certification currently, or have applied to secure the certification (USBCG, 2023). When negotiating with buyers, the four associations that represent Bangladesh's textile and RMG industries may take advantage of such green certification. When Bangladesh graduates from the LDC status, the Economic Relations Division (ERD), the Ministry of Finance (MoF), and the Ministry of Foreign Affairs (MOFA) can bargain for lower tariffs for the country's RMG industry by highlighting the green initiatives taken by the RMG entrepreneurs of Bangladesh.

For facilitating investment in RE, a number of policies and four refinancing programmes created by BB are available. Even though BB organises the fund's facilitation, it solely serves as an executing agency since the fund was initially negotiated by the ERD of the Bangladesh, MoF. It implies that additional resources might be used to facilitate loan at concessional rate for RMG firms to use power from RE if the ERD can

Table 11: List of key stakeholders to accelerate RMG sector's RE transition

Private Sector Actors	Public Sector Actors
Private Sector/Associations Linked to Garments Industry	Financing and Project Execution
Bangladesh Garment Manufacturers and Exporters Association (BGMEA) Bangladesh Knitwear Manufacturers and Exporters Association (BKMEA) Bangladesh Garments Accessories & Packaging Manufacturers & Exporters Association (BGAPMEA) Bangladesh Textile Mills Association (BTMA)	Implementation, Monitoring and Evaluation Division (IMED), Ministry of Planning Ministry of Finance Sustainable Finance Division (SFD), Bangladesh Bank National Board of Revenue (NBR) Bangladesh Tariff Commission (BTC) Bangladesh Power Development Board (PDB) Sustainable and Renewable Energy Development Authority (SREDA) Bangladesh Export Processing Zones Authority (BEPZA)
Development Partners	Trade and Business Promotion and Negotiation
High Commissions/Embassies Buyers Group World Bank European Union (EU) International Labour Organization (ILO) etc.	Ministry of Foreign Affairs Ministry of Commerce Export Promotion Bureau Ministry of Industries Ministry of Environment, Forest and Climate Change Ministry of Labour and Employment

Source: Prepared by Authors.

secure more successful negotiations on international platforms.

The Government should arrange workshops and training sessions to equip relevant officials with the knowledge necessary to 'prepare project proposals' that will enable Bangladesh to access climate funds which are available from international source.

In accordance with the NDC aim, National Board of Revenue (NBR) and Bangladesh Tariff Commission (BTC) should streamline the duty and tariff structures and offer incentives to companies, especially RMG industries, to encourage the use of electricity from RE sources in their manufacturing processes.

To enable the provision of VPPA in Bangladesh, private associations should pursue discussions with the government, and urge SREDA and BPDB to assist them with the process. Following the procedure, corporate tax incentives related to Environmental Compliance Review (ECR) should be created to encourage companies, such as RMG manufacturers, to adopt RE-based energy use for industrial production more quickly.

Coordination between the Ministries of Industries, Environment, Forest, and Climate Change, and Labour and Employment will be crucial when it comes to compliance on environmental and labour issues to avoid inconsistencies in their internal policies and assist the RMG sector in implementing its green growth strategies.

While the EU, the US, and other developed countries make significant investment in clean technologies and other transition strategies, Bangladeshi policymakers and RMG entrepreneurs must explore external support which can facilitate a smooth energy transition in the RMG sector.

CONCLUSIONS

The study explored the possibility of electricity use by RMG industry in Bangladesh from renewable energy sources and analysed the potential cost-benefit to this partial transition.

Results of study reveal that current electricity demand for RMG industry is nearly 6,251 GWh per year, which is equivalent to 8.2 per cent of country's total

electricity consumption and 7.3 per cent of country's total electricity generation. This suggests that, in order to shift 10 per cent of the total RMG electricity demand toward RE, 625.2 GWh of electricity will be needed. It was found that, by the end of 2022, sixty-five RMG firms had installed solar systems with a total capacity of around 8.6 MW, and with potential yearly consumption of 10.82 GWh under SREDA's NMS programme. The results of cost benefit analysis revealed that investing in NMS pays positive NPV on investment with or without concessional financing for the RMG firm, with a payback period of about 7 to 9 years. However, return NPV is higher under existing BB's refinancing scheme than that of regular term loan. Despite having a positive NPV, industry-wide RMG firms may struggle to redirect even 10 per cent of their electricity demand from RE sources under NMS alone due to space constraints.

In this context, if the VPPA is allowed in Bangladesh, IPPs that generate electricity from renewable sources such as solar, wind, and biogas may contribute to accelerating the process. Moreover, this will enable relatively small RMG manufacturers to obtain ECRs as proof of their dedication to sustainable production. Additionally, this will make it possible to expand the RE mix beyond solar systems to hasten Bangladesh's RMG sector's seamless transition to a sustainable and green production process. Beyond securing finance, for the partial transition of RMG's electrification, it is crucial to establish and maintain coordination among relevant private associations, government ministries and agencies, and development partners.

REFERENCES

Bangladesh Power Development Board (2022). *Annual report 2021-22*. https://bpdb.portal.gov.bd/sites/default/files/files/bpdb.portal.gov.bd/annual_reports/7b792f67_bf50_4b3d_9bef_8f9b568005c9/2022-11-29-05-22-0dea17e09d8a84e72a63312df6b5bdc6.pdf

Bangladesh Power Development Board (2023). *Tariff Rate*. https://www.bpdb.gov.bd/site/page/c413c44f-9611-4320-82da-b298fe69157e/%E0%A6%9F%E0%A7%8D%E0%A6%AF%E0%A6%BE%E0%A6%B0%E0%A6%BF%E0%A6%AB-%E0%A6%B0%E0%A7%87%E0%A6%9F

Çay, A. (2018). Energy consumption and energy saving potential in clothing industry. *Energy*, *159*, 74-85.

Das, N. K., Chakrabartty, J., Dey, M., Gupta, A. S., & Matin, M. A. (2020). Present energy scenario and future energy mix of Bangladesh. *Energy Strategy Reviews*, *32*, 100576.

Donaghey, J., & Reinecke, J. (2018). When industrial democracy meets corporate social responsibility—A comparison of the Bangladesh accord and alliance as responses to the Rana Plaza disaster. *British Journal of Industrial Relations*, *56*(1), 14-42.

Export Promotion Bureau (2023). *Export Data*. http://epb.gov.bd/site/view/epb_export_data/-

Farhana, K., Kadirgama, K., Mahamude, A. S. F., & Mica, M.(2022). Energy consumption, environmental impact, and implementation of renewable energy resources in global textile industries: an overview towards circularity and sustainability. *Materials Circular Economy*, *4*(1), 15.

General Economics Division, Bangladesh Planning Commission. (2020). *8th five year plan: July 2020-June 2025*. https://oldweb.lged.gov.bd/UploadedDocument/UnitPublication/1/1166/8FYP.pdf

George, G. (2021). *Technology transfer in Bangladesh to accelerate energy transition*. South Asia Democratic Forum (SADF). https://fid4sa-repository.ub.uni-heidelberg.de/4546/1/77_Focus-77.pdf

Government of Bangladesh.(2021). *Mujib Climate Prosperity Plan Decade 2030*. https://mujibplan.com/wp-content/uploads/2021/12/Mujib-Climate-Prosperity-Plan_ao-21Dec2021_small.pdf

Green Climate Fund. (2023). Climate Funds Update 2023. https://www.greenclimate.fund/countries/bangladesh#documents

Haque, A.E & Bari, E (2021). *Garments workers in Bangladesh: Social impact of the garments industry.* Asian Center for Development. http://acdonline.org/wp-content/uploads/2021/03/ACD-Report-on-garment-workers2020.pdf

Hundt, S., Jahnel, J., & Horsch, A. (2021). Power purchase agreements and financing renewables: An interdependency. *Journal of Structured Finance*, *27*(1), 35-50.

Infrastructure Development Company Limited. (2021). Power sector analysis: *Mujib climate prosperity plan decade 2030*. https://mujibplan.com/wp-content/uploads/2022/03/MCPP_Power-Sector_MAR.pdf

International Renewable Energy Agency.(2023).*Renewable-energy-statistics-2023*.

Kabir, M. A., Farjana, F., Choudhury, R., Kayes, A. I., Ali, M. S., & Farrok, O. (2023). Net-metering and feed-in-tariff policies for the optimum billing scheme for future industrial PV systems in Bangladesh. *Alexandria Engineering Journal*, *63*, 157-174.

Khatun, F., Kamal, M., Kabir, F.A., Nawrin,N., Hoque, M.S. (2023). *Securing Green Transition of the Textile and RMG Sector.* Centre for Policy Dialogue (CPD).

Kikuchi, T., Yanagida, K., & Vo, H. (2018). The effects of mega-regional trade agreements on Vietnam. *Journal of Asian Economics*, *55*, 4-19.

Ministry of Energy and Mineral Resources. (2004). Private sector power generation policy of Bangladesh. https://policy.asiapacificenergy.org/sites/default/files/PSEPGPB.pdf

Ministry of Power, Energy and Mineral Resources of Government.(2008).Renewable energy policy of Bangladesh. https://policy.thinkbluedata.com/sites/default/files/REP_English.pdf

Rahman, M. M., & Strutt, A. (2022). Costs of LDC graduation on market access: Evidence from emerging Bangladesh. *Economic Systems Research*, 1-22.

Rahman, M., & Bari, E. (2018). Pathways to Bangladesh's sustainable LDC graduation: Prospects, challenges and strategies. In Rahman, M., & Bari, E. (Eds.), *Bangladesh's graduation from the least developed countries group* (pp. 109-152). Routledge.

Razzaque, M. A., Akib, H., & Rahman, J. (2020). Bangladesh's Graduation from the Group of LDCs: Potential Implications and Issues for the Private Sector. In Razzaque, M. A. (Eds.), *Navigating new waters: Unleashing Bangladesh's export potential for smooth LDC graduation*.

Sustainable and Renewable Energy Development Authority and Power Division & Ministry of Power, Energy and Mineral Resources of Government of the People's Republic of Bangladesh (2015). *Energy Efficiency and Conservation Master Plan up to 2030*. https://policy.asiapacificenergy.org/sites/default/files/EEC_Master_Plan_SREDA_2.pdf

Sustainable and Renewable Energy Development Authority and Power Division & Ministry of Power, Energy and Mineral Resources of Government of the People's Republic of Bangladesh. (2018). *Net Metering Guidelines – 2018.* https://policy.asiapacificenergy.org/sites/default/files/Net%20metering%20Guidelines%20-%202018.pdf

Sustainable and Renewable Energy Development Authority and Power Division. (2020). *National Solar Energy Roadmap, 2021 – 2041 (Draft Report).* https://climateportal.ccdbbd.org/wp-content/uploads/2021/03/National-Solar-Energy-Roadmap.pdf

Sustainable and Renewable Energy Development Authority and Power Division. (2023). *National Database of Renewable Energy.* http://www.renewableenergy.gov.bd/index.php?id=7

USGBC (2023). In *LEED Certified Projects: Bangladesh.* United States Green Building Council. https://www.usgbc.org/projects?Country=%5B%22Bangladesh%22%5D

ANNEX A

Annex Table 1: List of RMG factories installed NMS as of December 2022

Your Fashion Sweater Ltd.	Oshan Sweater
AKH Knitting & Dying LTD.	Tasrif Industries Ltd.
Epyllion Limited	Mondal Knit Wares Ltd.
Shin Shin Apparels Ltd	Alam Textile & Garments
Epyllion Knitwears Ltd.	GreenTex Composite Mills Ltd.
Blue Sky Fashion Ltd.	Arunima Sports Wear Ltd.
Khan tex Fashions Ltd	Vision Apparels Ltd.
Irish Fabrics Ltd.	EMS Apparels Ltd.
Inter Stof Clothing Ltd.	Big Boss Corporation
Snowtex Wear Ltd.	Fakir Fashion Ltd.
Tasniah Fabrics Limited	NZ Denim Ltd.
Aswad composite Ltd.	Pakiza Wear Ltd.
New Urmi Garments Ltd.	Momo Fashion Ltd.
Alim Knit BD Limited	Rising Industries Ltd.
Jeans Manufacturing Co. Ltd.	Pakiza Apparels
AB Apparels Ltd.	Wear Industry Ltd.
Liz Fashion Industry Ltd.	R K Knit Dyeing Mills Ltd.
Donglion Apparels BD Ltd.	Tarasima Apparels Ltd.
Jinnat Fashion Ltd.	Southern Garments Ltd.
Metro knitting Ltd.	Messers Cotton Textile & Apparels
Mamsons knit Wear Ltd.	Classic Composite Ltd.
Ritzy Apparels Ltd	Snowtech Out Ware
Susuka Knit Ltd.	R S Composite
Kimia Garments Ltd.	Nasa Super Garments Ltd.
New Age Garments Ltd.	Bay Creation Ltd.
New Generation Apparel Ltd.	Cute Dress Ltd.
Reveyara Composite	Genesis Fashion
Bravo Apparels Manufacture Ltd.	Agami Apparels
Simftex Apparels Ltd.	Deco Garments Ltd.
Hannan Knit & Textile	Laila Styles Fashion Ltd.
R K Knit Dyeing Mills Ltd.	Columbia Washing Plant Ltd.
Hera Sweaters Ltd.	Energy Pac Fashion Ltd.
Ajmat Apparels	-

Source: Authors Compilation from SREDA NMS Database.

In Bangladesh, the Readymade Garment (RMG) industry stands as the backbone of the nation's economy, driving over 80 per cent of its foreign export revenue. However, the recent global energy crisis, spurred by the Ukraine War, has cast a shadow over this vital sector. The Government of Bangladesh's response to the crisis, marked by escalating electricity tariffs, has intensified production costs for industries, imperiling their sustainability.

Recognising this situation, this study delves into the feasibility of integrating Renewable Energy (RE) sources into Bangladesh's RMG industry. This paper underscores the pivotal role of RE in bridging the energy demand gap, crucial for sustaining industrial production. While significant strides have been made, with some RMG firms embracing solar systems, scalability remains a challenge. However, innovative solutions like the Virtual Power Purchase Agreement (VPPA) hold promise in accelerating the transition to green energy.

Yet, the journey towards sustainable energy practices demands a collaborative effort. It necessitates a comprehensive approach involving stakeholders ranging from industry associations and governmental bodies to development partners. With an estimated investment of USD 450 million, the vision of powering at least 10 per cent of RMG electricity demand through RE sources represents a pathway to a greener, more sustainable future.

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