Business Case: Solar PV Rooftop System for RMG Factory – CAPEX Model

Support to Safety Retrofits and Environmental Upgrades in the Bangladeshi Ready-Made Garment (RMG) Sector

Rationale for Solar Rooftops:

Renewable energy, especially solar energy, is rapidly emerging as a sustainable power source around the globe. Direct sunlight, which is free, abundant and reasonably reliable, is used to produce power with solar PV panels. To meet the increasing demand of energy in the RMG sector, solar power can be one of the most cost effective and feasible solutions. The energy sources that are currently used by the RMG sector are expected to become more expensive in the future as the government gradually adopts market-based pricing mechanisms for electricity and gas, the price of which always went up in the past. Also, considering the increasing demand, the existing reserve and supply of fossil fuels is no longer able to guarantee the energy sustainability in this sector. On the other hands, brands (e.g. H&M) are focusing more on renewable energy to ensure low carbon emissions, scope 3 emissions with the target to be of climate neutral by 2030 and climate positive by 2040 throughout their supply chains. Incorporation of rooftop solar PV systems can reduce the negative impact on productivity and machineries' life from frequent load shedding in RMG sector.

The main equipment of solar PV power systems, the solar PV panels, can be easily installed on the unused roofs, shades or empty spaces of the factory premise and requires no extra land or space. The installation of solar PV systems on the roofs or unused spaces of industry can be accommodated easily for a wide range of power generation capacities.

Advantages of Solar Rooftop Systems:

With global installed capacity of over 500 GWp and an average annual growth rate of more than 40% over last 10 years [Renewables 2019 Global Status Report, REN 21], solar PV technology has become the fastest growing power solution of the world. This is primarily due to the following noticeable benefits associated with this technology.

Direct Benefits:

Lower energy cost than conventional utilities	The cost of electricity from rooftop solar PV systems is much cheaper than the conventional grid electricity. Considering the present cost trends of solar equipment and concessionary financial facilities available in Bangladesh, the cost of electricity generated from rooftop solar PV systems can be 20~30% less when compared to the commercial tariff rates of utility electricity. This has the potential not only to reduce the average energy cost of the industry, but also bring down the overall consumption from the conventional sources of energy.
Zero fuel cost	The solar energy that is converted by solar PV panels is clean and is available in abundance at no cost. As long as the world exists, the sun will continue to radiate its energy, which will be available for utilization. The RMG industry typically has its peak operational time during the day and the solar energy is also available at the same time.
Low maintenance	Solar PV systems generally do not require heavy maintenance as they have no moving parts. Only regular cleaning of solar PV panels is necessary. The warranty periods of the major system components are quite long, e.g., the solar panel manufacturers give 25 years of output warranty, and the warranty for gird-tied solar inverters is 5~10 years. After covering the initial installation cost of the system, no major investment is required for maintenance and repair of the solar PV systems.
No additional space requirement	For installation of an industrial rooftop solar PV system, no additional space is necessary for PV panel installation. There is no need to vacate a land or invest in buying additional lands to setup a rooftop solar PV systems. Furthermore, installed panels gives an extra layer of protection to the roof building.
Variety of installation options	Solar panel structure comes with many varieties depending on the selected roof area & dimension. Hence, the system can be accommodated in almost any given space, and thus can utilize most of the free space available on the roof.
Net metering	After self-consumption, the excess electric energy generated by the installed solar PV system can be exported to the connected national grid. The exported amount of electricity can offset the portion of consumed electricity from grid.

Photo: Installed rooftop Solar PV panels at the Far East Spinning Mills Ltd. (FESIL) factory building at Uttar Surma, Madhabpur, Habiganj district.

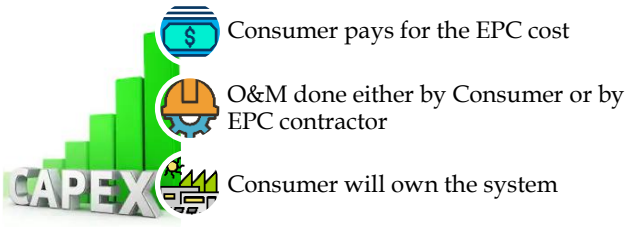
Indirect Benefits:

Low carbon emission	Solar PV based electricity has a very low carbon footprint. While producing electricity from solar energy, no Greenhouse Gas (GHG) is emitted. Thus, it offsets GHG emission. On the other hand, no smoke or smog is produced. Therefore, the technology is environmentally benign.
Reduced cooling demand of the factory building	Solar PV installation in the industrial roofs reduces ambient temperature inside the shade by some extent, which further reduces the electricity required for cooling purposes.
Employment opportunity	The installation & commissioning works of a solar PV project create local jobs, and thus help develop the solar industry as an entirely new sector. Therefore, widespread implementation of solar PV systems can exert significant impact on the overall economy of the country.

Photo: Installed solar PV panels on the roof of FESIL factory building at Madhabpur, Habiganj district.

Capex Model:

In this model, the industries themselves own the solar power system and the required investment is made through a combination of debt and equity. A solar EPC company is generally hired to provide turnkey (i.e. ready to use) solutions to the industries. Electricity generated by the solar PV system is cheaper than grid electricity and the owner can get its benefit over the systems for 20-year of its operating life. The operation and maintenance of the system can be done either by the owner's own technical team, or it can be outsourced to the EPC contractor under an O&M agreement.



Net Energy Metering Solutions:

Net Energy Metering (NEM) refers to a policy mechanism that allows prosumers [Consumers of electricity who also produces electricity] to connect their renewable energy (RE) systems to the distribution grid. As a result, any excess electricity (after self-consumption) generated from renewable sources can be supplied to the distribution grid.

The electricity generated in the weekly holidays or other holidays can be exported to the national grid. In exchange, the prosumer can either import an equivalent amount of electricity from the grid, or accumulate credits for net exported electricity on a monthly basis and receive the price of it by the end of the settlement period, as per the *Net Metering Guidelines-2018* approved by the Government of Bangladesh. In the NEM system, electricity consumed from the grid and exported to the grid are both recorded separately.

Eligibility Criteria for becoming a Net Energy Metering Consumer:

A consumer shall be considered eligible when the following clauses are complied with:

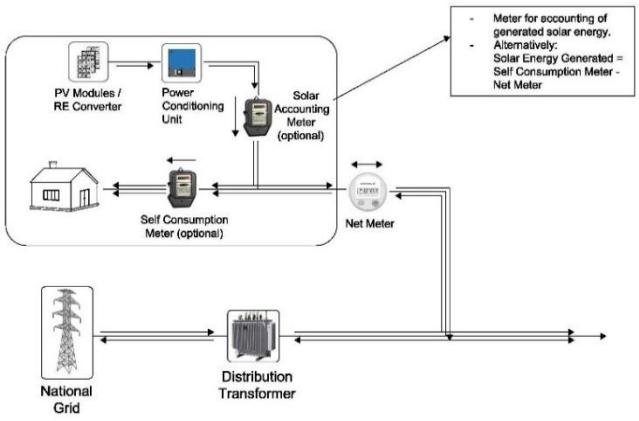


Figure: Typical Net Energy Metering Architecture.

- The prosumer should be a current customer of the utility that is responsible for the supply of electricity in the area;
- The applicant should not have any outstanding arrears prior to making the application;
- Electricity produced ONLY from renewable energy sources are eligible;
- The applicant must either be the legal owner or have the legal permission from the owner(s) or their legal representative(s) for installing the proposed renewable energy system in the premise;
- Any empty space on the roofs or facades of buildings, car parking areas, garages, factory or industrial buildings or sheds or similar buildings, or at land within the own premise of the consumer, or any other suitable area accepted by Utility where the Utility meter exists, is consider as the rooftop of the consumer and is suitable for the installation of solar PV systems for the net energy metering scheme;
- The prosumer shall consume the electricity at the point of renewable electricity generation, and only export the excess amount to the grid;
- Interconnection standards shall comply with the interconnection rules and standards set by the Utility or other relevant governing authority.

Photo: NET energy meter along with conventional electric tariff meter.

Capacity and Energy Export Limits of the Net Metering Policy:

- Any three-phase consumer can be considered eligible for the net metering system.
- A consumer can install (capacity of solar PV system) up to 70% of his sanctioned load.
- The maximum output AC capacity of the installed RE system for NEM can be up to 10 MW.
- For a medium Voltage (MV) consumer, the installed capacity of the RE system can be a maximum of 70% of the rated capacity of the distribution transformers.

Project cost (considering 1 MWp system):

There are many variable factors that determine the project cost. The cost of module mounting structure varies depending on the installation area (ground mounted or rooftop system). The cost of mounting structure also varies depending on the type of roof (RCC or Metal Industrial Shade). The efficiency of the solar PV module, the load profile of the consumer, captive generation, project capacity, equipment brand and country of origin/manufacturing etc. are also important factors that play a vital role in the project cost.

The area requirement for installing one Megawatt (peak) of solar PV panels is approximately 8,000 square meters. It may vary according to the pattern of the roof (roof tilt, roof orientation etc.). The unit panel size is in general 2 meters by 1 meter and the capacity of each panel varies according to the efficiency of the solar PV panels. At present, 400Wp to 500 Wp panels are available in the market. An approximate cost estimation of a 1 MWp grid tied rooftop solar PV system with standard equipment is given below [The project cost reference has been taken from recently approved rooftop solar PV projects of similar size in Bangladesh]:

Project cost components	*Price (BDT)*	*% of project cost*	*Unit Cost*
Solar PV Module (1 MWp), Product and output warranty: 25 years	*24,000,000*	*46.15%*	
Module Mounting Structures	*8,200,000*	*15.77%*	
Solar Grid connected Inverter	*7,800,000*	*15.00%*	
Hybrid/Fuel Save controller for PV-Generator-Grid	*800,000*	*1.54%*	
Monitoring & Communication System	*500,000*	*0.96%*	
Energy Meter	*100,000*	*0.19%*	
Cleaning system and cable trays	*1,200,000*	*2.31%*	
Combiner Box	*600,000*	*1.15%*	
Earthing/Lightning protection, with High voltage, 500KV cable and maintenance free chemical earthing	*900,000*	*1.73%*	*BDT 52/Wp*
Cables and Connectors (UV protected)	*4,000,000*	*7.69%*	
Spares	*400,000*	*0.77%*	
Service walkways	*600,000*	*1.15%*	
Safety Equipment for O&M	*500,000*	*0.96%*	
Transportation, Installation & Interconnection, Commissioning	*1,000,000*	*1.92%*	
Design & Consultancy	*800,000*	*1.54%*	
Legal & Other costs	*300,000*	*0.58%*	
Environmental Consultancy	*300,000*	*0.58%*	
Total Project Cost	***52,000,000***	***100%***	

Annual Savings from the Investment:

The project cash flow table below has been prepared considering the following assumptions (Current market prices of similar types of rooftop solar PV projects):

- The factory owner invests the capital cost.
- Tariff of electricity: BDT 8.97 [Industrial tariff of REB at 11 kV]
- Tariff Escalation: 5% per year [considering the previous year's tariff trend of the country]
- Project life: 20 years
- Specific energy yield: 1250 kWh/kWp/Year
  [Generation from solar PV system depends mainly on the following five parameters:
  - **Location of the system:** Solar irradiance varies according to the geographic location. For example, in Bangladesh higher solar energy insolation is in the Chittagong and Rajshahi regions and lower solar insolation are in Panchagarh and Sylhet regions.
  - **Orientation of the roof (Azimuth)**: South facing roofs receive the highest solar irradiance whereas east, west and north facing roofs receive relatively lower solar irradiance.
  - **Roof angle (Tilt angle)**: If the roof is not concrete roof (flat roof), then generally the solar PV panels are installed at an angle equal to the angle of the roof. The amount of solar irradiance depends on the angle of the roof (i.e. the angle of solar PV modules). With a tilt angle of local latitude (For Bangladesh it is between 21° to 26°) facing towards south receives the highest solar irradiance.
  - **Availability of grid:** Almost all the rooftop solar PV systems are grid tied systems. The solar system can generate electricity only when there is solar radiation and the grid is present. During the load shedding hours or the outage hours for grid maintenance, the solar PV system cannot generate electricity.
  - **Dusts on the solar panels:** Solar PV panels are keep in the open roof to get solar insolation. So, dusts accumulates on it. The panels needs to be cleaned on a regular basis. If dusts accumulates on panels, it reduces the solar energy fall onto the solar cells and thus the output energy.
    In optimum conditions: south facing panels with tilt angle equal to local latitudes and no load shedding or grid outage and with premium quality products the annual energy yield can be as high as 1500 kWh/kWp/year.
    Here we have considered annual generation of electricity of the installed PV system 16.67% less than optimum conditions (as an example)]

- Performance degradation of the solar PV system: First year degradation is 2.5%; after that there is 0.7% linear degradation each year. This value is guaranteed by the panel manufacturers.
- Yearly maintenance cost is considered to be 2% of the initial investment cost. Maintenance cost escalates at a rate of 5% per year. The maintenance cost is an approximate value from the market reference.

Year	Energy produced from PV systems (kWh/yr.)	Grid electricity tariff, BDT	Gross savings from Utility bills	Maintenance cost	Net savings from Utility bills	Accumulated Net savings, BDT
Y 1	1,250,000	8.97	11,212,500	1080000	10,132,500	10,132,500
Y 2	1,218,750	9.42	11,478,797	1134000	10,344,797	20,477,297
Y 3	1,210,000	9.89	11,966,204	1190700	10,775,504	31,252,801
Y 4	1,201,250	10.38	12,473,655	1250235	11,223,420	42,476,221
Y 5	1,192,500	10.90	13,001,936	1312747	11,689,189	54,165,411
Y 6	1,183,750	11.45	13,551,861	1378384	12,173,477	66,338,887
Y 7	1,175,000	12.02	14,124,273	1447303	12,676,970	79,015,857
Y 8	1,166,250	12.62	14,720,047	1519668	13,200,378	92,216,236
Y 9	1,157,500	13.25	15,340,087	1595652	13,744,436	105,960,671
Y 10	1,148,750	13.92	15,985,332	1675434	14,309,897	120,270,569
Y 11	1,140,000	14.61	16,656,751	1759206	14,897,544	135,168,113
Y 12	1,131,250	15.34	17,355,348	1847167	15,508,181	150,676,295
Y 13	1,122,500	16.11	18,082,163	1939525	16,142,638	166,818,933
Y 14	1,113,750	16.91	18,838,271	2036501	16,801,770	183,620,703
Y 15	1,105,000	17.76	19,624,785	2138326	17,486,459	201,107,162
Y 16	1,096,250	18.65	20,442,854	2245242	18,197,612	219,304,774
Y 17	1,087,500	19.58	21,293,669	2357505	18,936,164	238,240,938
Y 18	1,078,750	20.56	22,178,457	2475380	19,703,078	257,944,016
Y 19	1,070,000	21.59	23,098,491	2599149	20,499,342	278,443,358
Y 20	1,061,250	22.67	24,055,081	2729106	21,325,975	299,769,333

Accumulated (cumulative) savings in electricity bill in project life (in 20 years): BDT 299,769,333

Net Savings in project life:

Savings in electricity bill – project cost = BDT 247,769,333

Payback period is less than 5 years (in simple calculation)

Lead Time for Procurement and Implementation:

The key components (solar PV panels, inverters, DC cables, etc.) of the solar PV systems are generally imported from different countries of Europe, China, India etc. The local market (Bangladeshi) avails and ensures the quality of other components like protection systems, combiner boxes, AC cables etc. Therefore, the Mega-Watt scale solar PV projects' procurement can be categorized into two parts: the local and the foreign procurement with LC. The lead time for foreign procurements is typically around 30 to 90 days from the opening of the LC. On the other hand, local procurements can be completed within 2 or 4 weeks from the work order placement.

Procurement categories:

- Foreign Procurement
  - Solar PV Modules
  - Module Mounting Structures (can also be local)
  - Solar Grid-tied Inverters
  - Hybrid/Fuel Save Controllers for PV Generator (optional)
  - Monitoring & Communication Systems
  - DC Cables

- Local Procurement
  - Earthing/Lightning Protection systems
  - AC Cables and Connectors
  - Safety Equipment for O&M
  - Combiner Boxes / Distribution boards
  - Service Walkways
  - Energy Meters
  - Cable Trays

After procurement, installation and commissioning works usually take 1-3 months for a 1 MWp system. This may vary depending on the system design, location of the project etc.

Key Information Required for Implementation of Solar PV systems:

Before implementing any solar project, the following key information is required for the systems design:

- Total suitable area for the installation of solar PV panels.
- Type of roof available in the premise for the solar PV panels installation (RCC or Metal Industrial Shade).
- Tilt (slope) angel & azimuth (orientation) of the roofs.
- Sanctioned load of the factory.
- Factory's hourly (day) and monthly (year) load profile.
- Source of power: Grid power, captive power or both.
- Load shedding frequency and duration.
- Feasible evacuation points of solar power in the factory.
- Net metering requirements and eligibility.
- Previous 12 months electricity consumption and bills.

Photo: Installed Inverter below the installed solar PV panels.

Possible Sources of Funds:

SREUP credit line could be a good source of financing for such an investment.

Main Feature of SREUP Credit Line	
Loan Type	Normally Term Loan
Discount	Provision and possibility of 20% discount from loaned amount
Loan Tenure	3-5 years in general and in special case up to 7 years
Loan Limit	Normally up to 1 Million Euro and can be increased up to 3 Million Euro in special cases
Interest Rate	7% p.a. (maximum)
Grace period. Debt: Equity Ratio. Repayment	All are subject to agreement between borrower and lender

Infrastructure Development Company Ltd. (IDCOL) is also providing concessional financing for solar rooftop projects. Key financing parameters of IDCOL financing are as follows:

Loan Type	Term Loan
Loan Tenor	10 years
Loan Amount	Maximum 80% of Project Cost
Debt : Equity ratio	Maximum 80 : 20
Grace Period	1 Year (principle only)
Repayment	Monthly
Interest Rate	6% p.a. (fixed)

Case Study Spotlight (CAPEX model): Far East Spinning Industries Ltd. (FESIL)

Far East Spinning Industries Ltd. is a sister concern of Far East Group. The group was established in 1994. The group has evolved from a small garments manufacturing plant, into one of the leading composite textiles companies in the country, with integrated, knitting, high end dyeing, finishing (tubular & open width), state of the art printing, pigment dyeing & garment washing

Photo: Installation ground mounted solar PV panels (890 kWp) at FESIL factory premise at Madhabpur, Habiganj district.

Description of the Solar PV Project:

Factory Name: Far East Spinning Industries Ltd. (FESIL).
Location: Uttar Surma, Madhabpur, Habiganj.
GPS Co-ordinates of project site: 24.1347°N, 91.3505°E
Capacity: 1.1 MWp (DC)
Major Equipment:
Panel: Jinko solar (320Wp)
Inverter: Tabuchi Electric (25 kWp)
Investment cost: BDT 8.9 Crore
Land development, Construction & Installation Period: 8 Months (March '18 - October '18)
COD: 31 October 2018.

Photo: Installation works of ground mounted solar PV system at FESIL factory premise Madhabpur, Habiganj district.

Project Development:

The development process for the 1.1 MWp solar PV project took approximately 1 year. It is a megawatt-scale rooftop solar PV project developed under the CAPEX model in the RMG/Textile sector in Bangladesh. The energy price trend is on the rise, and so it makes more sense for the industries to implement grid-tiled rooftop solar PV systems to offset the grid electricity bills.

This project implementation started in December 2017 and the process was segregated into the four following phases:

- Land development (for ground mounted systems),
- Civil construction & local procurement,
- Foreign procurement & start of installation work.
- Installation & commissioning.

It took the first two months of 2018 to sign the financial agreement & process the documents for loans. From the third month, land development started for ground mounted structure installation. The second phase started from April 2018 that comprised of civil construction, local procurement of the mounting structure & installation. LC of major equipment opened in July of that year, while the RCC base work & metal structure installation was started and followed through till August 2018. The final phase of implementation started from September 2018 with the installation of aluminum rail placement. All installation, testing & commissioning was finished by October 2018 and 31st October was the start of commercial operation of FESIL 1.1 MWp solar project.

Photo: Production line of FESIL factory Madhabpur, Habiganj district.

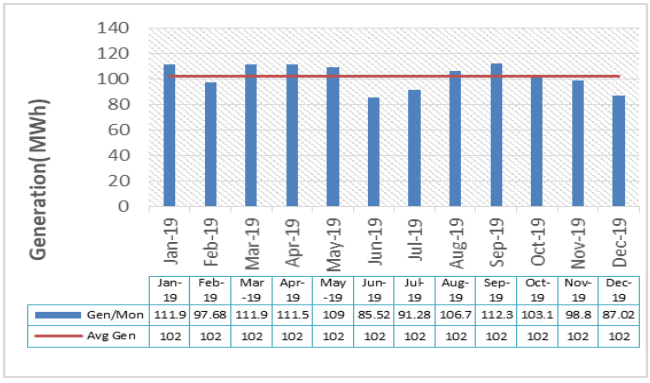
In July 2018, the Ministry of Power, Energy and Mineral Resources approved the *Net Metering Guidelines-2018* for the country. According to the provisions of this guideline, FESIL has been identified as an eligible prosumer. So, after applying to the concerned utility (BREB in this case), FESIL became one of the earliest factories in Bangladesh which had implemented the net metering scheme (as early as November 2018). In the same month, FESIL inaugurated the project upon completion.

Photo: Substation building of FESIL factory at Madhabpur, Habiganj district.

Generation Analysis:

The solar rooftop project of Far East Spinning Industries Ltd. (FESIL) has started their commercial operation from 31 October 2018.

Generation data of the year 2019 has been recorded for the performance analysis of the plant.



	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19
Gen/Mon	111.9	97.68	111.9	111.5	109	85.52	91.28	106.7	112.3	103.1	98.8	87.02
Avg Gen	102	102	102	102	102	102	102	102	102	102	102	102

Photo: Mounting structure installation works of solar PV panels at the factory rooftop of FESIL at Madhabpur, Habiganj district

The generation report has been taken from the online monitoring system of TABUCHI (Inverter) cloud installed for this project. Data shows that throughout the year, maximum peak generation is observed during the month of September (112,276 kWh) and the lowest generation in June (85,519 kWh). Average generation per month in 2019 was 102,234 kWh and total generation through the year was 1,226,810 kWh. According to this data, yield of this project was 1115.28 kWp/kWh. This project is located at Habiganj, Bangladesh, an area that receives low solar irradiance when compared to other parts of the country. Given the location, the generated energy can still be regarded as satisfactory. However, generation can be increased with more frequent cleaning schedules of the panels. Also, there were times when the project remained at standby mode for testing and maintenance purposes and few occasions of load shedding.

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