SOLAR PHOTOVOLTAIC PUMPING FOR AGRICULTURAL IRRIGATION

ASIA SOLAR ENERGY FORUM (ASEF) - JUNE 05, 2018

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Bangladesh Rural Electrification Board (BREB)

বাংলাদেশ পল্লী বিদ্যুতায়ন বোর্ড

ISO 9001, ISO 14001 &
OHSAS 18001 Certified

Overview of Bangladesh Power Sector

Present Structure of Power Sector (1/5)

Apex Institution

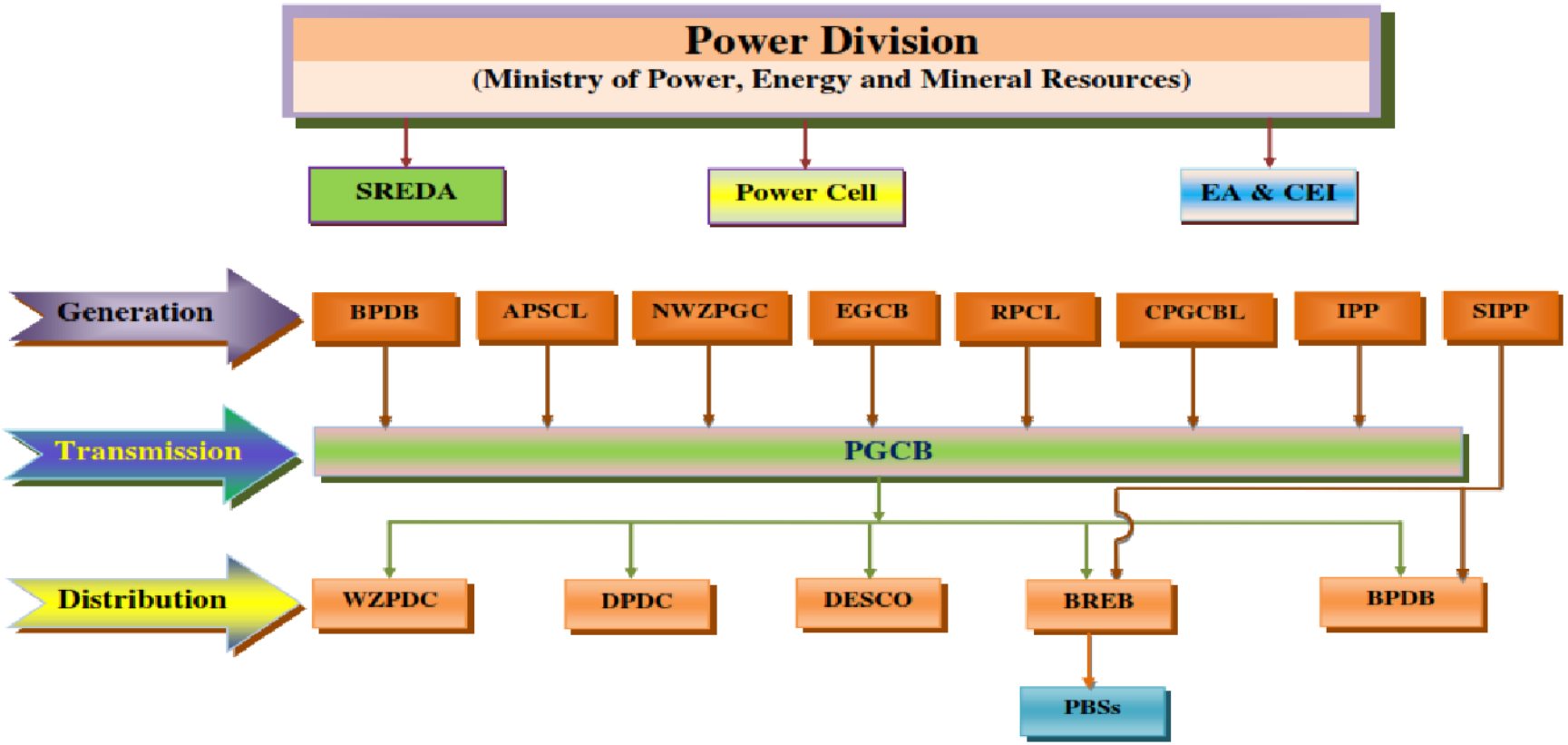
Ministry of Power, Energy & Mineral Resources (MPEMR).

- Energy & Mineral Resources Division
- **Power Division**

Regulator

Bangladesh Energy Regulatory Commission (BERC).

Present Structure of Power Sector (2/5)



[Source: http://www.powerdivision.gov.bd/]

Present Structure of Power Sector (3/5)

Generation

- Bangladesh Power Development Board (BPDB).
- Ashuganj Power Station Company Ltd. (APSCL).
- Electricity Generation Company of Bangladesh (EGCB).
- North West Power Generation Company Ltd. (NWPGCL).
- Rural Power Company Limited (RPCL).
- B-R Powergen Ltd.
- Independent Power Producers (IPPs).

Present Structure of Power Sector (4/5)

Transmission

- Power Grid Company of Bangladesh Ltd. (PGCB).

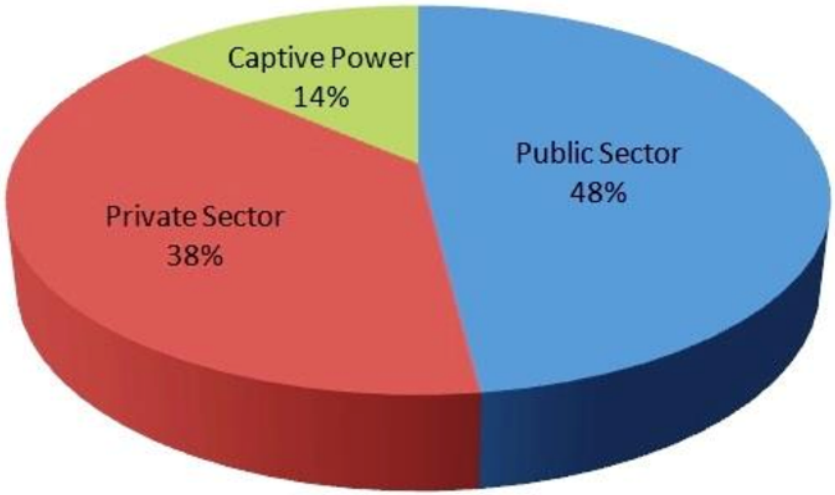
Present Structure of Power Sector (5/5)

Distribution

- Bangladesh Rural Electrification Board (BREB) through Rural Co-operatives (PBSs).
- Bangladesh Power Development Board (BPDB).
- Dhaka Power Distribution Company (DPDC).
- Dhaka Electric Supply Company Ltd (DESCO).
- West Zone Power Distribution Company (WZPDC).
- Northern Electric Supply Company Limited (NESCO).
- Coal Power Generation Company Bangladesh Limited (CPGCBL).

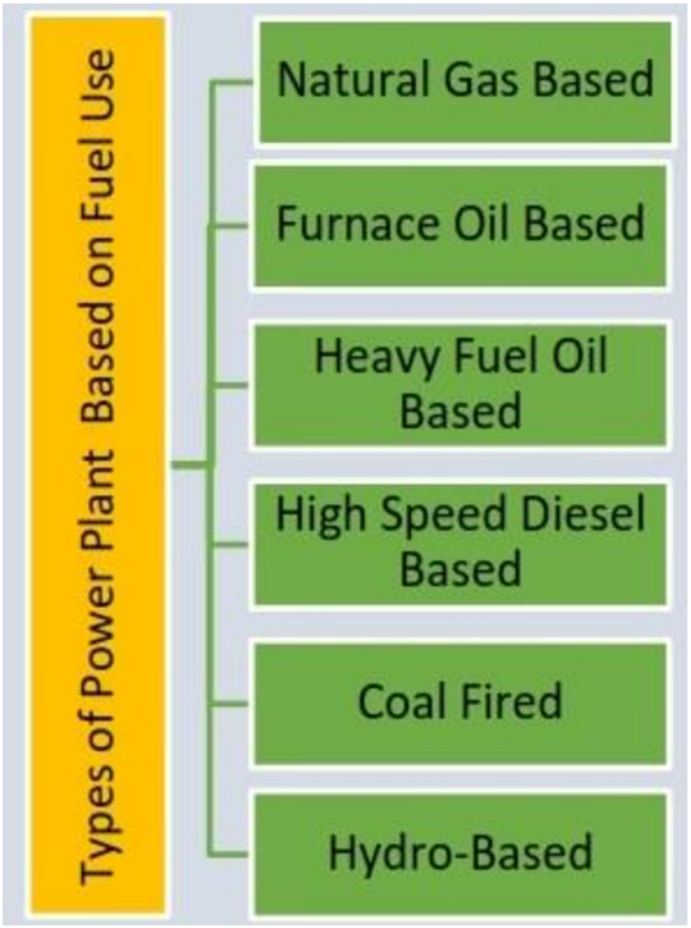
Present Installed Generation Capacity

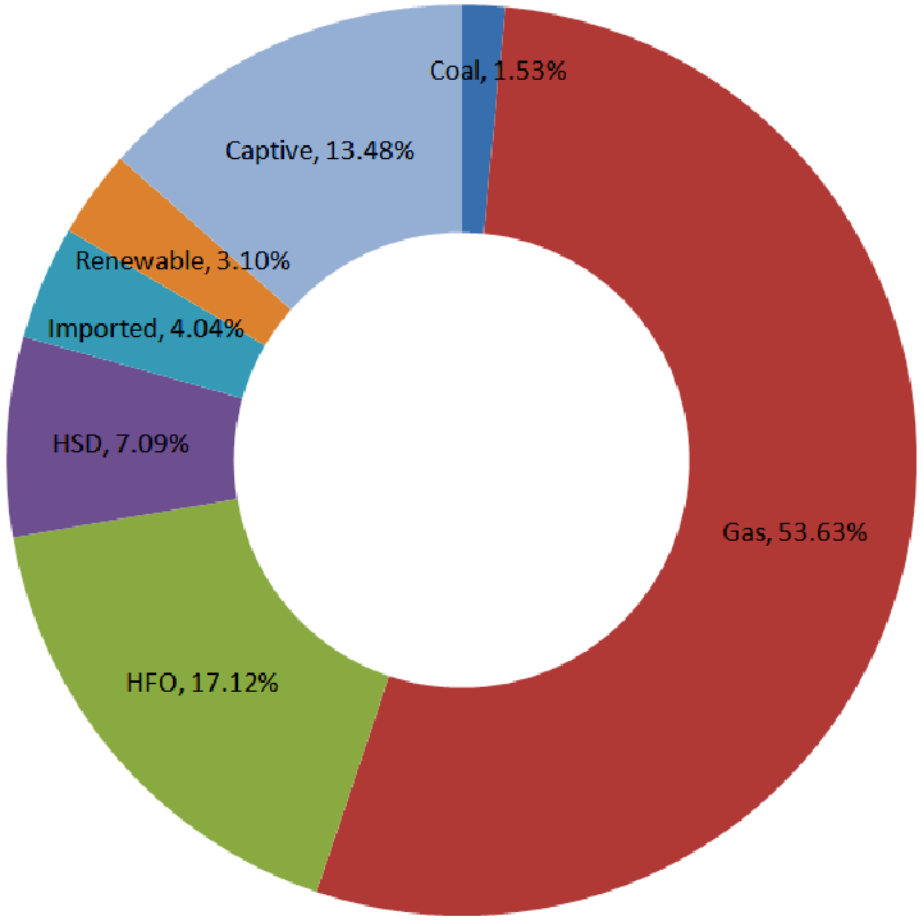
Sector	Owner	Installed Generation Capacity (MW)
Public Sector	BPDB	4402
	APSCL	1508
	EGCB	622
	NWPGCL	718
	RPCL	287
	BPDB-RPCL JV	150
	Subtotal:	**7701**
Private Sector	IPPs	3245
	SIPPs (BPDB)	99
	SIPPs (REB)	251
	15 YR. Rental	169
	3/5 YR. Rental	1721
	Power Import	660
	Subtotal:	**6145**
Captive Power	Captive	2200
	Subtotal:	**2200**
	Grand Total:	**16032**



Source: http://www.powerdivision.gov.bd

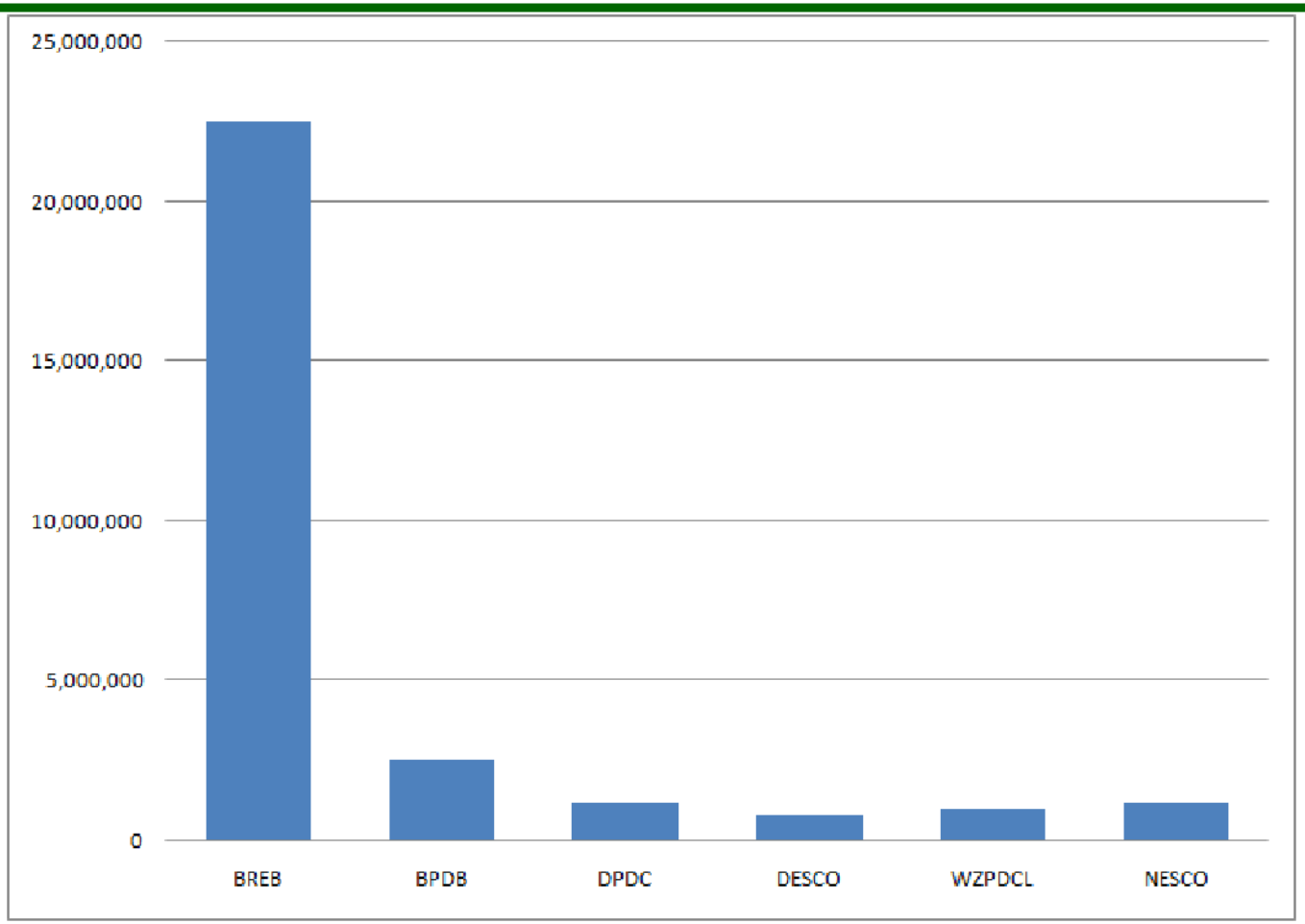
Power Generation by Fuel Mix (MW)





Total Installed Capacity: 16,032 MW (Source: http://www.sreda.gov.bd/)

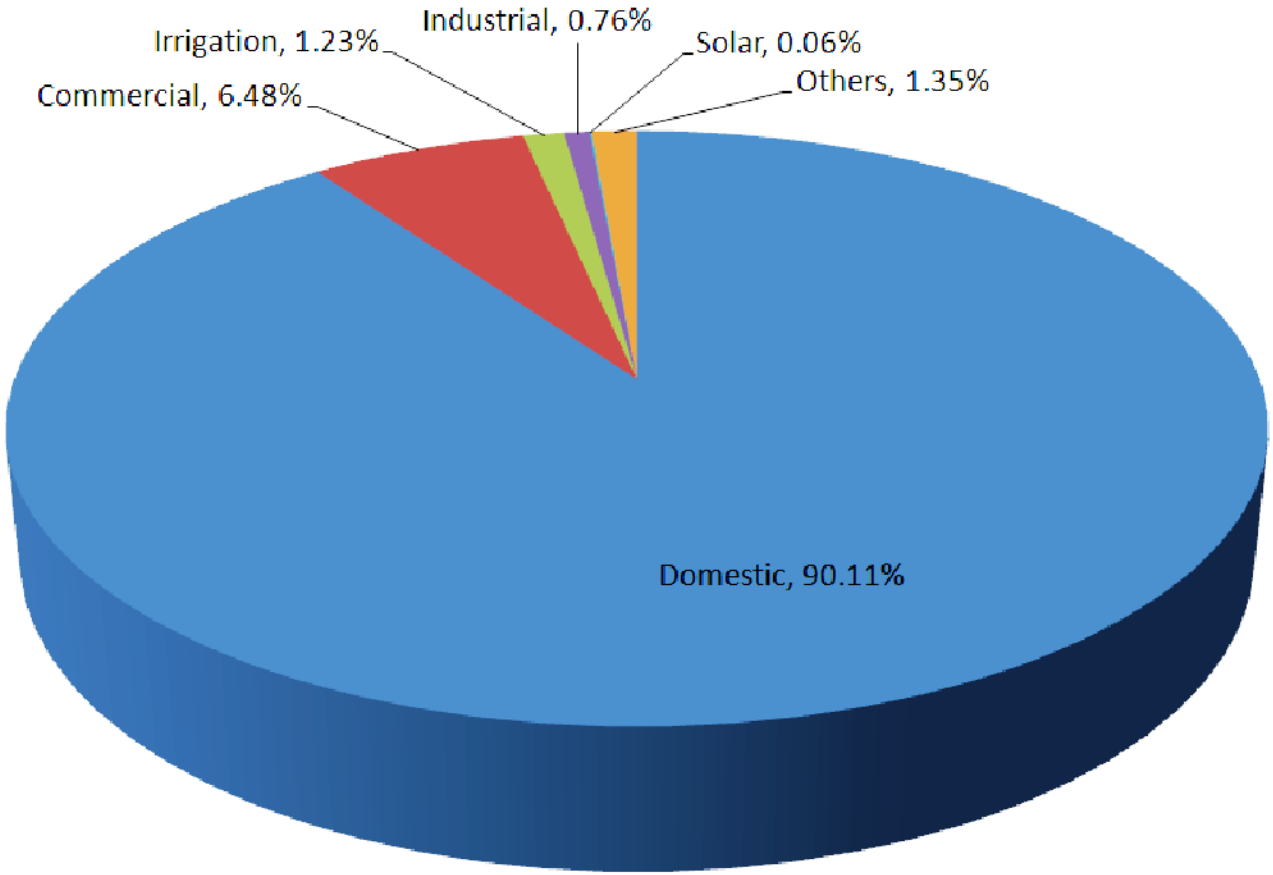
Consumer of Different Entities



Total Consumer: More than 29.2 Million (up to May 2018)

Bangladesh Rural Electrification Board (BREB)

Consumer Mix of BREB



Total Consumer: More than 22.5 Million (up to May 2018)

BREB At A Glance

01.	Inception	1977
02.	Total PBSs	80 Nos.
03.	Line constructed	3,96,364 Km
04.	Number of 33/11KV Sub-station	804 Nos.
05.	Capacity of Sub-station	9,775 MVA
06.	System loss (80 PBSs)	9.91%
07.	Peak demand	6,200 MW
08.	Consumer	2,25,00,000 (Irrigation 3,20,000)
09.	Access to Electricity	83%

Bangladesh Renewable Energy Initiative

Potential of Solar Energy

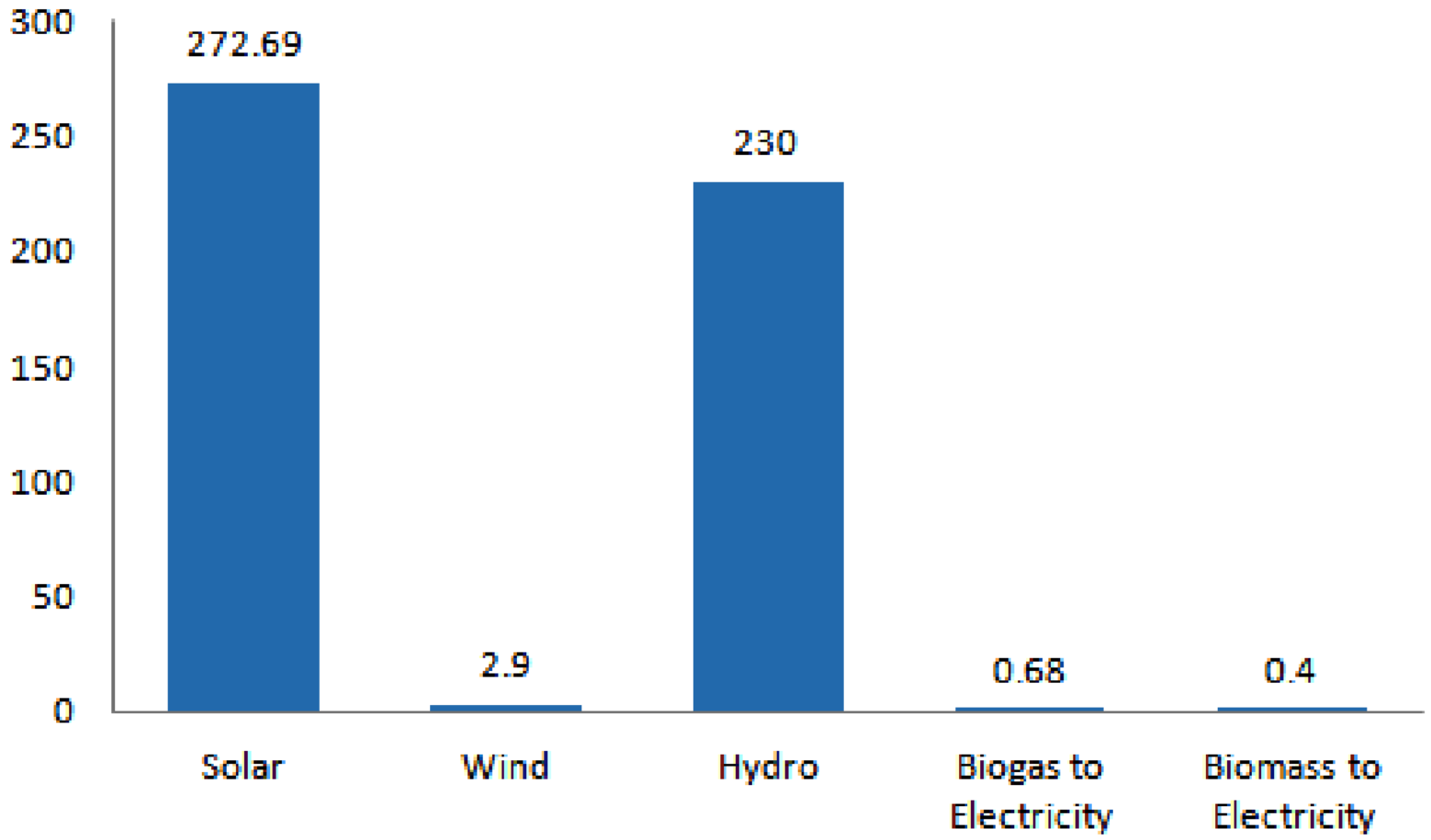
- Being a tropical country, Bangladesh is endowed with abundant supply of solar energy.
- The insolation in Bangladesh varies from 3.8 kWh/m^2/day to 6.4 kWh/m^2/day at an average of 5 kWh/m^2/day.
- Rainy days may be upto a few days at a time.
- These indicate that there are good prospects for Solar PV and Solar Thermal.

Renewable Energy Policy

- Effective from 2008.

- Objective:
  - Harness the potential of renewable energy resources;
  - Enable, encourage and facilitate investment in renewable energy projects;
  - Develop sustainable energy supplies;
  - Scale up contributions of renewable energy;
  - Promote use of renewable energy;

Installed Renewable Energy (MW)



Total: More than 500 MW (Source: http://www.sreda.gov.bd/)

Renewable Energy (BREB)

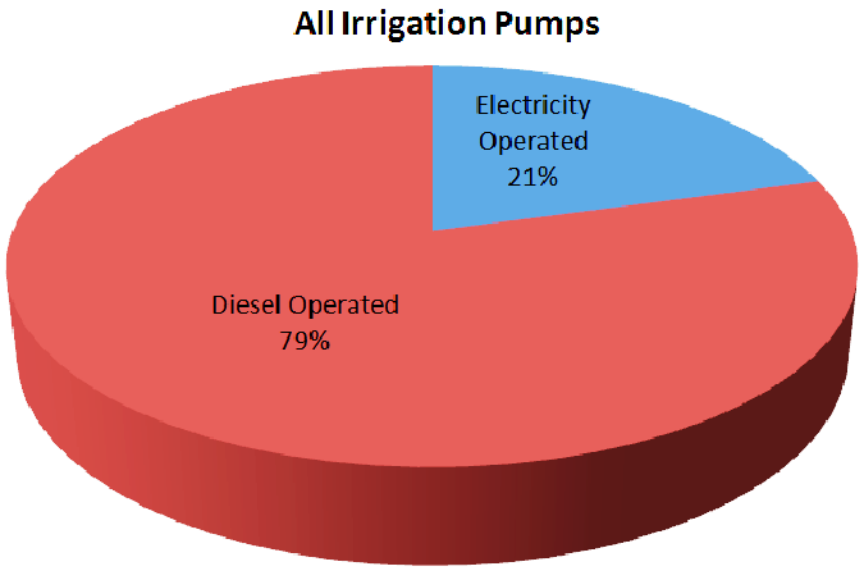
Sl. No.	Description	Quantity Installed (Nos.)	Installed Capacity (kWp)
01.	SHS Installed under different projects	15,250	825.50
02.	SHS against PBS New Consumer Connection as per govt. rules (up to 30-04-2018)	30,946	5,933.95
03.	Roof Top Solar Plant: BREB H/Q Training Academy Building	1	49.00
04.	Roof Top Solar Plant: Upazila Complex Building	15	450.00
05.	Solar Powered Irrigation Pump	40	239.00
06.	Roof Top Solar Plant: At PBS Offices	21	44.41
07.	Solar Charging Station	9	198.00
	Total Installed Capacity of PV System:		**7,739.86**

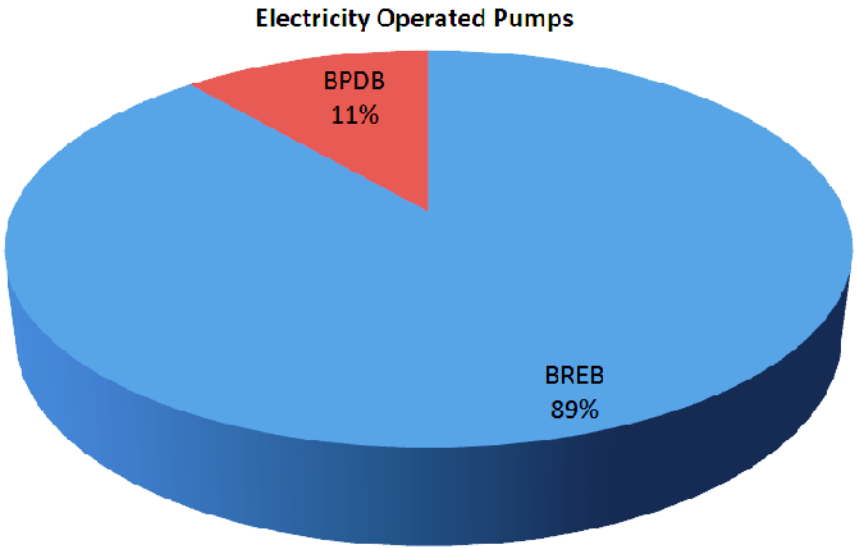
Potential of Solar Irrigation Pump

Potential of Solar Irrigation Pump (1/3)

- Bangladesh is based on agricultural economy which contributes about 20% of the GDP.
- More than 70% of Bangladesh's population and 77% of its workforce lives in rural areas.
- 87% of rural households rely on agriculture.
- In Bangladesh about 60% land is suitable for cultivation, of which 90% land is dependent on irrigation.
- Currently there are more than 1.4 million diesel-run pumps for agricultural irrigation, consuming about 0.9 million tons of diesel per year to run these pumps at a subsidized rate, while emitting more than 31 million tons of CO_2 per year.

Potential of Solar Irrigation Pump (2/3)





Source of information: Summary of irrigation equipment used, area irrigated and benefited farmers: 2016-17, BADC.

Potential of Solar Irrigation Pump (3/3)

- In addition, there are more than 350,000 grid connected electric irrigation pumps.
- During the peak irrigation season 2000 MW of power demand is solely required for running the electricity operated pumps which is provided at a subsidized rate.
- A significant amount of subsidy shall be reduced if a portion of diesel & electricity driven pumps could be replaced by solar irrigation pump gradually.

Advantage of Solar Powered Irrigation

- Financing and cost of solar panels continue to drop.
- Rural electrification and access to renewable energy.
- Independence from volatile fuel prices and unreliable and costly fuel supplies.
- Reduced cost for water pumping in the long run.
- Potential for increasing agricultural productivity and income due to improved access to water.
- Potential for income diversification due to multiple uses of energy.
- Potential for new and innovative forms of financing and service models.

Source: The benefits and risks of solar-powered irrigation – a global review.

Solar Irrigation Experience

Cheerful kids playing with water

Fulfilling the need for drinkable water

Golden field – wonder of solar irrigation pump

Evolution of Solar Irrigation System in Bangladesh (1/2)

1997 – Introduction of solar pump in Bangladesh by BREB.

2002 – Introduction of solar irrigation pump in Bangladesh.

2005 – First solar submersible pumps at four villages in Barindro.

2008 – First solar drip irrigation pump.

2009 – First successful demonstration of rice irrigation (BADC, Savar).

2010 – First farmer community owned solar pump project at Barguna (8.4 KWp, Commercial Bank Loan, NGO Implementation).

– Trial solar irrigation project with grant (IDCOL, Chapai Nawabganj).

2011 – 3 Solar irrigation pumps in Barishal, Magura and Jamalpur (BARI, GoB fund).

Evolution of Solar Irrigation System in Bangladesh (2/2)

2011-12 – Commercial replication of private bank loan model: 10+ pumps.

2012 – 20 trial large solar irrigation pump full grant project (BREB, CCTF).

– 20 large solar irrigation pump full grant project (BREB, KOICA).

– 7 large solar irrigation pumps with buried pipe networks (BADC, GoB fund).

– Installation of 16 large solar irrigation pump (IDCOL).

– 200 pump project under IDCOL implementation process.

Solar Irrigation Program in Bangladesh

Sl. No.	Organization	Solar Pump Installation
1.	BREB	40 Nos.
2.	IDCOL	923 Nos.
3.	BMDA	105 Nos.
4.	BADC	38 Nos.
5.	Other agencies (e.g. DOE, RDA, DAE, BRRI, BARI, etc.)	10 Nos.
	Total:	1,116 Nos.

Solar Irrigation Experience of BREB (1/2)

Until now, BREB installed 40 Solar Irrigation Pumps, handed over to PBSs. PBSs are the owner of the pumps and responsible for O&M.

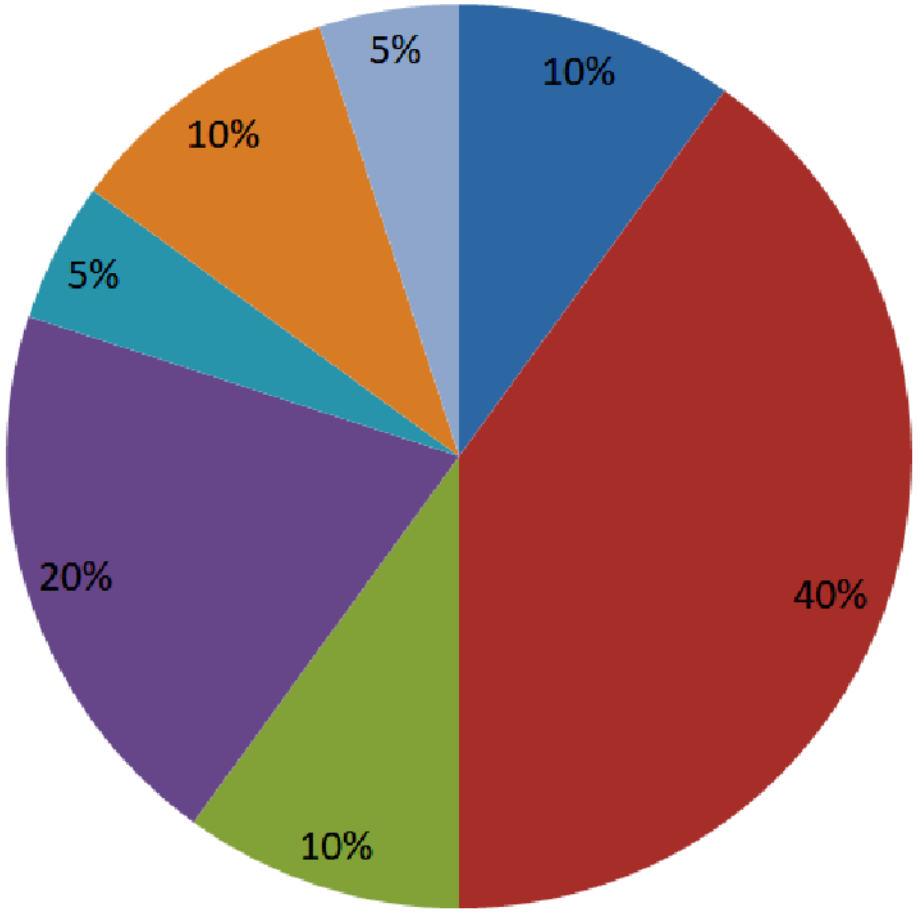
Description	SPIP	CCTF
Funding	KOICA	GOB
Pumps	20	20
SHS	1250	300
Cost	3.83 MUS$	1.34 MUS$

Solar Irrigation Experience of BREB (2/2)

BREB developed a beneficiary community & they are responsible for:

- Safety & security of the pump from any damage or pilferage.
- Pay for the replacement of any component when necessary.
- Pay Tk. 6000 per season.
- Regular pump operation.
- Recording the pump operational data.
- Proper Utilization of pump water.
- Tax payment of land (pump site).

Solar Pump Components



- Submersible Pump Set with controller
- Solar PV Modules
- Inverter
- Structures
- Cable & Other Accessories
- Civil Construction, Land Development, Boaring
- Installation and Commissioning

Challenges in the Adoption of the Technology in Rural Bangladesh

Challenges in the Adoption (1/3)

- Still relatively high initial investment costs.
- Finance is not accessible or affordable for all.
- Banks often perceive that SPIS have high risk, due to unfamiliarity with technology.
- Sustainable Business Model – affordability & economic viability of solar-powered irrigation systems.
- Tariff fixation in accordance with project cost and revenue collection.
- Proper site selection based on regional crop pattern, soil properties & water level. .

Challenges in the Adoption (2/3)

- Design needs to be fit-for-purpose – e.g. ensuring water delivery during winter morning.
- Standardization and quality control of products and services.
- Grid feeding mechanism.
- Use of surplus power in non-irrigation season.
- Water and energy management
- Installation of the system, operation and maintenance – optimal operation and maintenance of SPIS requires a certain degree of technical knowledge and skill.

Challenges in the Adoption (3/3)

- Ownership transformation.
- Long term O&M policy formulation.
- Lack of trust between farmers, utilities, service providers and government to try innovative forms of finance and of FITs;
- Vulnerable to theft and hence often not covered by insurance.
- Alternate use of the PV system during non-irrigation periods e.g. Grid Feeding, Rice Husking, Battery Charging, etc.

Solar Photovoltaic Pumping for Agricultural Irrigation Project

Proposed Project Summary

Project Title	: Solar Photovoltaic Pumping for Agricultural Irrigation.
Sponsoring Ministry/Division	: Ministry of Power, Energy & Mineral Resources/ Power Division
Implementing Agency	: Bangladesh Rural Electrification Board (BREB).
Development Partner/ Donor Agency	: Asian Development Bank (ADB) [ADB Loan 2769-BAN, Part B (iv)]

PROJECT FINANCING

Loan – US$ 20.00 Million [Loan 2769-BAN (iv)]

Grant – US$ 25.442 Million

US$ 22.220 Million (SREP grant, confirmed through email)

US$ 3.000 Million (Output based Aid grant)

US$ 0.222 Million (Additional from SREP for consulting service)

Objective

Main Objective:

Diffusion of solar PV pumping system for agricultural irrigation and reduction of sudden thrust on grid power during irrigation season in project area.

Specific Objective:

- To install 2000 nos. of solar PV irrigation pumping systems in project area.
- To generate electricity using solar PV systems.
- To introduce a long term O & M strategies with effective return of investment.

Usage

- Irrigation for paddy, vegetables, aquaculture farming, mixed crops etc.
- Use of generated electricity in the locality during off season (no demand of water) for various purposes beneficial to the locals.

Project Scope

SL	Irrigation System		Panel Capacity (kWp)	Land Required for Panel (Decimal)	Irrigation Area	Pumping Sets
	kW	HP				
a)	2.2	3.0	4.32	0.99	21.33	490
b)	4.0	5.5	7.56	1.74	38.80	530
c)	5.5	7.5	10.80	2.48	53.36	500
d)	7.5	10.0	14.08	3.22	72.74	320
e)	11.0	15.0	20.52	4.71	106.66	160

Project Area

Sl. No.	Name of PBS
1	Thakurgaon
2	Dinajpur-1
3	Rangpur-2
4	Bogura-1
5	Naogaon-2
6	Gopalgonj
7	Faridpur
8	Madaripur
9	Comilla-2
10	Feni

- Project will be implemented in 10 districts.
- 10 PBSs are primarily proposed as reference based on the feasibility study conducted by ADB consultant.
- Final site would be selected after consultant's recommendation during project preparation period.

Project Phases (1/2)

- **Project Preparation Phase**
  - Appointment of Management & Supervision Consultant.
  - Detailed Feasibility Study and Finalization of Business Model.
  - Social & Environmental Safeguard Policy.
  - Public awareness Programs.
  - Identification of Location and Users.
  - Formation of Farmers' community.
  - Agreement between PBS and Community.
  - System Design, Specification, BOQ and Bid Document Preparation.

Project Phases (2/2)

- **Project Implementation Phase**
  - Tendering Process
  - Installation of Pumps through turn-key solution.
  - Operation through Farmers' community.
- **Project Operation & Maintenance Phase**
  - Dedicated O&M set-up at each PBSs.
  - Service through contractors up to warranty period.
  - Monitoring and evaluation.

Sponsor/Location Selection Criteria

- Present underground water level (static water level) and projection of water table depletion in the next 20 years;
- Quality and quantity of water for irrigation;
- Solar irradiance level;
- Crop pattern;
- Income levels of farmers;
- Transportation infrastructure to major cities to supply the crops;
- Local community's knowledge about solar pumping systems;
- Potentials to work cluster wise;
- Mixed grid and off-grid areas; and
- Presence of suppliers in the areas.

Business Model (1/2)

- 15% of the effective cost as down payment and rest amount in equal instalment.
- BREB/PBS will be the owner of a solar pumping system before the ownership transfer.
- Ownership of a solar pumping system will be transferred after the sponsor/farmer pays all the instalments.
- The cost of the system (excluding grant portion) will be recovered within 10 years.

Business Model (2/2)

- Sponsor/Farmer's Income:
  - Water charge of BDT 3000/Bigha/Year.
  - Alternate use of the PV system during non-irrigation periods e.g. Rice Husking, Battery Charging, etc.
- The implementation and supervision consultant will finalize the business model.

O & M

- The systems will be under 3-5 years warranty from the EPC (Turn-key) contractor.
- Training will be provided to sponsor's/farmer's for O & M.
- If needed, pump will be replaced every five years and inverter will be replaced every ten years from the project cost under O & M.
- BREB/PBS will support/assist the sponsor for O & M but it will be the sponsor's responsibility.

Conclusion

- Success of this pilot project will encourage large scale implementation of solar photovoltaic irrigation pump projects.
- Cooperation and continuous support from ADB and other stakeholders is very crucial for successful implementation, operation and maintenance of the project.

THANKS