
Bangladesh Policy Road Map for Renewable Energy

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About this road map

This report was accomplished on request of Climate Parliament Bangladesh Group of MPs in Bangladesh. It was written after a visit in Dhaka May 1-8, 2015.

The visitor's program in Dhaka started with round tables: Renewable energy experts and senior officials from the business, academic and NGO community gave their input, including Rahimafrooz, Prokaushali Sangsad Ltd, Dhaka University, Bangladesh University of Engineering and Technology (BUET), Bangladesh Renewable Energy Association, Electricity Generation Company of Bangladesh (EGCB), BPDB, Schneider Electric, Clean Energy Alternatives, Green Housing & Energy Limited (GHEL) and a number of NGOs active in the renewable energy field.

Official contacts included Senior Government representatives from SREDA (Sustainable and Renewable Energy Development Authority), Ministry of Power, Ministry of Finance, ministry of IT and independent financial body IDCOL.

The Climate Parliament delegation was in direct contact with development agencies such as GIZ, SDC, UNDP. Individual

meetings with the State Minister of Power, Energy and Mineral Resources Mr. Nasrul Hamid and Minister of State, ICT Mr. Junaid Ahmed Palak were carried out and accomplished the broader picture and policy directions being considered at present. (Hon. Junaid Ahmed Palak is also the Patron of the Climate Parliament network in Bangladesh).

The Climate Parliament Team, along with Mr. Rudolf Rechsteiner, participated in an open discussion on feed-in-tariff regulation organized by the University of Dhaka. The event gave insight into the opinions of major stakeholders on the introduction of a new revenue model for renewable energy projects in Bangladesh.

The visit was organized and accompanied by Mr. Mukul Sharma, South Asia Director and Ms. Sumedha Basu, South Asia Policy Coordinator with organizational assistance from Diksha Kamdar, Delhi office of Climate Parliament.

Compliments

The authors would like to express their special compliments to the members of Climate Parliament Bangladesh who actively facilitated the visit, notably Mr Nahim Razzaq, MP and Convener of Climate Parliament Bangladesh, Mr Tanvir Shakil Joy, Ex-MP and Advisor of Climate Parliament Bangladesh.

The tribute also goes to all the partners who participated in hearings and conferences.

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Executive summary

Part I

Viability of renewable energy in Bangladesh

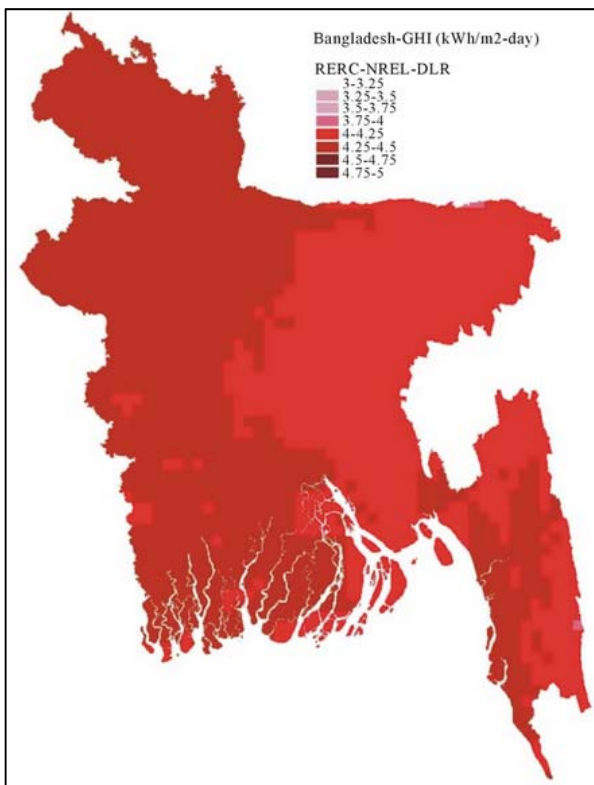


Figure 1
Solar irradiation in Bangladesh [1]

1. Favorable resources

Bangladesh is perceived to be a poor country. But in many aspects, it is rich: in terms of population (more than 150 million) and its eager work force and in its highly dynamic private sector, ambitious to expand manufacturing, technology and services for domestic consumption and exports.

And then there is a rich natural resource today used at a very modest level: solar and wind energy. Bangladesh has a daily solar irradiation exceeding 4 kWh per square meter and, in some regions, a substantial wind resource.

Bangladesh has a coast line of 580 km with many shallow and windy areas in proximity of the Bengal Bay shores, for onshore wind power generation in the short term and offshore in the long run.

Wind and solar power together with proper regulations and investments could satisfy to a large extent domestic power demand. In that way, expenses for imports of diesel, heavy fuel oil (HFO) or coal and the decline of domestic gas sources could be reduced.

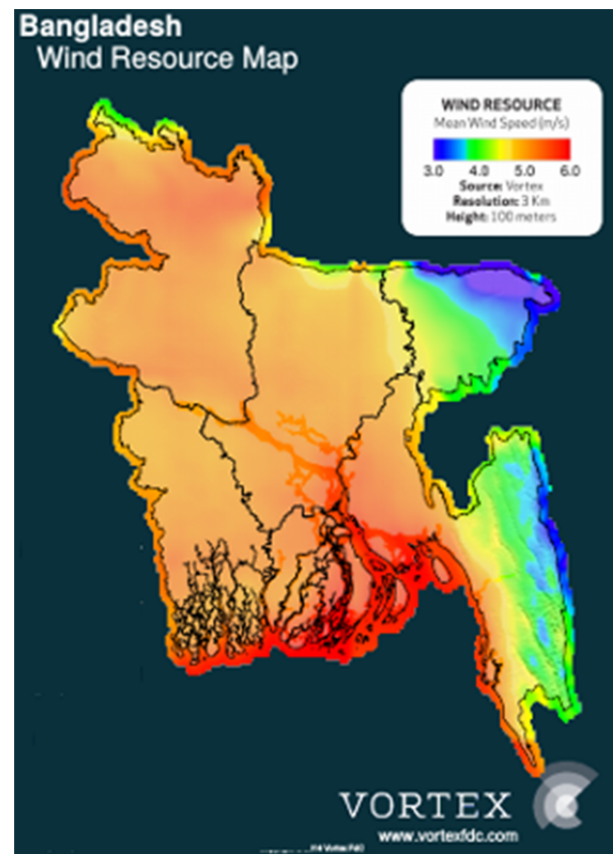


Figure 2
wind resource at 100 m height [2]

Moreover, a significant contribution to avoid greenhouse gases may be achieved. Bangladesh due to its location near sea level is one of the most vulnerable countries regarding climate change risks.

Solar and wind combination complementing

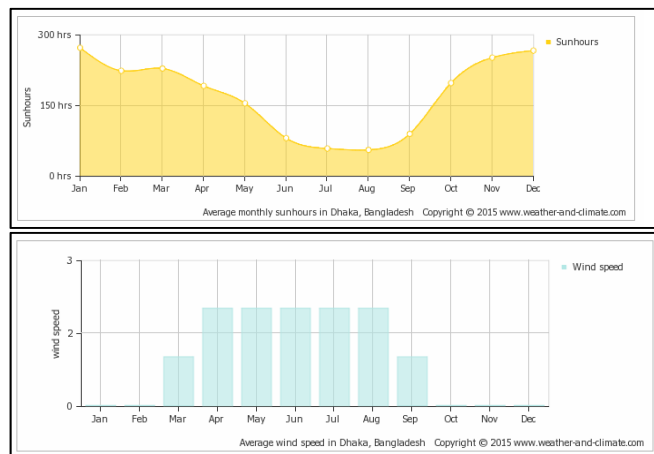


Figure 3

Seasonal profile of solar and wind power

As a matter of fact the seasonal production profiles of solar and wind in Bangladesh complement one another fairly well.

This means that during monsoon season (June-September) reduced solar irradiation could be compensated by wind power provided the investments are done on a sufficient level.

2. Successful applications in rural areas

Positive government attitude

The government's favorable attitude toward renewable energy is demonstrated by the preferred tax and duty treatment of such equipment.

The Bangladesh electric power system is unbundled. The Bangladesh Power Development Board (BPDB) acts as a *single buyer* of electric power. BPDB is the national transmission system operator (TSO). A number of distribution grid companies are in place. Independent power producers have to sell their power legally to the BPDB on request.

The government has supported energy investments by establishing IDCOL (Infrastructure Development Company Ltd), an independent (private) finance body and a key driver in financing power plants and renewable energy investments.

Successful Solar Home Systems

In rural Bangladesh more than 3.5 million households today are owner of a solar home system, probably the highest number worldwide. NGOs, microfinance institutions and private businesses have initiated these investments concentrated in remote areas. An additional 50'000-100'000 households are estimated to get rooftop panels each month. For millions of people, solar power and biogas contribute to a near 100 percent share in energy consumption which is a sustainable way to live, but not without restrictions.

IDCOL was a key factor in financing the rural solar energy expansion. It is working with some 60 partner organizations. To receive loans from IDCOL (which itself is supported by multilateral national and international donors), partner organizations have to follow guidelines regarding repayments, monitoring and quality of investments and products.

Solar home systems capacity goes from 20 to 85 watt peak and the costs stands at 10'000 to 35'000 Taka (\$130-450).

The program was successful due to just few upfront costs of some 10 % of overall investments. Partner companies pay for the rest and get financial credits. Consumers pay back their systems over 8 to 9 years. IDCOL has a technical standard committee that certifies all systems in use. All suppliers and products are tested. Partner organisations also have monitoring service in place. They do operation and management and they have to collect the pay-off.

In recent years the amount of grants has been reduced in favor of credits. Actually there is a collection efficiency of just 90%. The high level of credit defaults or delayed payback – with some 10 percent of credit volumes at risk is perceived as a serious problem by IDCOL partner organizations. [3]

For quality enforcements IDCOL has a three tire monitoring in place with divisional offices in every region and a head of monitoring within IDCOL. More than 100 IDCOL employees are actively monitoring the 3.5 million systems and the partner organizations.

IDCOL aims to finance 6 million SHSs by the end of 2016. Beyond that four more programs are in place by IDCOL [4] :

- rural solar mini-grids
- solar irrigation
- biogas cooking projects
- biogas power generation projects

IDCOL does not finance government (public) projects.

Mini-grids in take-off mode

At least for a couple of years it seemed that Chinese providers have used Bangladesh as their favorite destination for low quality modules. By doing this, the image of solar power as a reliable energy source was damaged seriously.

However, "since two years the module quality evolved to be much better", Mostaq Ahmmed, director of Green Housing & Energy Limited (GHEL) declared. His five years old company gives jobs for more than 300 employees. Its mission is "to deliver clean energy supply to every household at an affordable price". Combined with a microcredit program, supported by IDCOL, the goal is "to support the purchase of every single GHEL product" for low and medium income customers and beyond.

In rural areas, the *buy-for-micro-credit* programs have been successful. But for many households and small and medium-sized enterprises, power demand goes beyond simple lighting, small TV and mobile phone charging. They are asking for power at *grid quality* for household and business items such as fridges, fans, computers, rice mills, small shops and manufacturing devices. These appliances need a reliable electricity system; with this in place, economic growth can expand even in remote rural areas.

For areas in some distance of the national grid, solar mini-grids are an evolving option. They deliver interconnection between different off-grid producers and beside batteries, the mini-grid itself is a powerful storage by networking different consumer's profiles.

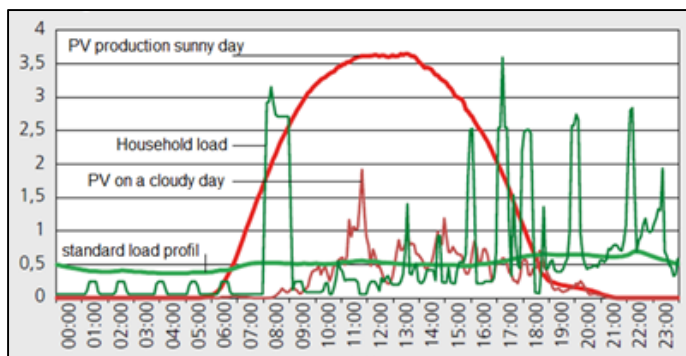


Figure 4
Photovoltaic generation profiles and daily load of typical households in Europe

“Mini-grids are the next big thing in rural areas” says Farzana Rahman, head of IDCOLs renewable energy unit. IDCOL has started to support installation of pilot mini-grids in remote areas, but initial costs are high. Five solar mini-grids are under construction and 10 to 12 solar mini-grids are in planning. Construction periods are between six and eight months.

Mini-grids are in service for normal power use as in cities: mainly lighting, refrigerators, TVs and household facilities. For cooking, cheap natural gas, cow dung and coal is used. There is no electric cooking because it is perceived as an uneconomic option.

GHEL is one of IDCOL's partner organizations who successfully completed mini-grid electrification on Kutubdia Island. There a 100 kW solar system delivers grid quality power for 520 connections with some 1500 power consumers.

Mini-grids need a “best practice” still to be established as was the case with off-grid systems. Mini-grid systems are in take-off mode not only in Bangladesh: In the US, solar leasing leader SolarCity has announced the launch of its GridLogic service – a solar-powered microgrid complete with battery backup, islanding mode, and grid compatibility to be rolled out globally.

The core advantage of a mini-grid system is its ability to black-start in off-grid mode when power from the distribution grid is not available.

Whether grid connection is impossible, intermittent or normal, solar mini-grids increasingly are on their way as a guaranteed go-to power source, under-scored by improving resilience, falling component costs and sophisticated funding methods globally.

With ever cheaper solar PV power, mini-grids enable customers in cities or in rural areas to adopt a larger portion of renewable energy. They also can protect against load-shedding. Communities that have an interest in increasing their share of clean local power generation have a natural interest in mini-grids and should try to focus on it.

3. Grid-connected Solar Struggling

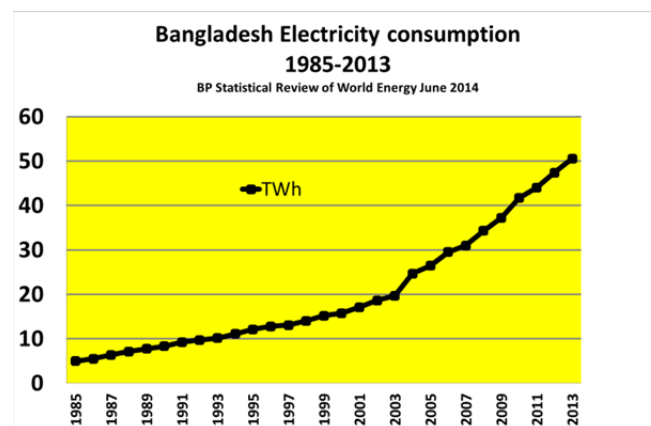


Figure 5
Bangladesh electricity consumption 1985-2013 [5]

In Bangladesh, electric power consumption is rising by 10 per cent each year. To satisfy demand, the government and BPDB has launched a build-up program for conventional power plants.

The dynamic growth of solar off-grid equipment cannot be found as in urban areas with grid connected solar facilities.

In fact there exists a legal obligation to install a photovoltaic (PV) power system on new buildings to be entitled for grid connection by the local grid company. But the legal enforcement of this is pitied. PV systems in cities are unpopular.

Home owners often are just “borrowing” rooftop sets without even connecting them – to get the grid connection entitlement. Once connection is in place they get rid of the PV equipment or it remains on the roof – unconnected.

While rooftop solar is booming in many European and US-markets to save customer's money and to reduce greenhouse gases, solar roofs in Bangladesh enjoy a dubious reputation. They are perceived as expensive and unreliable. There is no basic perception that these facilities could “grid quality power” at any substantial amount.

However, in Bangladesh there indeed is vast experience with mini-grids, but based on diesel powered generators. Due to load shedding, millions of backup systems with fossil fuels are in place for apartment and business buildings in urban areas, for irrigation, households and small businesses in rural areas and for bulk power on a massive scale within BPDB rental power plant program for independent power producers (IPP).

Diesel systems are perceived to be reliable; service companies deliver and maintain these appliances at standard conditions. While generators are rather cheap, diesel fuel is quite expensive compared to rooftop solar power.

Hybrid solar mini-grids with advanced batteries, including power generation, storage and black-starts during load shedding could deliver grid quality power for self-consumption at a lower cost than diesel. And PV systems would deliver daily power injections to the grid while batteries and/or diesel generators could maintain backup security in case of blackouts.

Solar PV is not perceived as a viable option in Bangladesh due to a number of reasons:

- Bangladesh power tariffs are highly subsidized. Households with up to 900 kWh consumption per year pay a tariff of less than 4 Taka/kWh (\$0.05/kWh). Solar PV systems

cannot find investors and finance for self-consumption against these subsidized tariffs.

- Grid connected power cannot be marketed on a gross power market. Therefore, even retail consumers with higher tariffs – such as with 9 Taka/kWh (\$0.115/kWh) for commercial users – are prohibited to buy solar power from distributed generation nearby at a reasonable cost.
- There is no feed-in-tariff and no regular tendering scheme in place yet for power from renewable energy. As a single buyer, the BPDB is compensating IPPs (independent Power Producers) with cost driven prices up to 29.37 Taka/kWh (\$0.38/kWh) for heavy fuel oil powered electricity¹ and up to 28.24 Taka/kWh (\$0.36/kWh) for diesel powered electricity² [6]. No standard tariffs for solar are contracted at regular IPP-conditions with similar power purchase agreements.
- Equipment companies point out that low-quality products delivered from 2010-2012 eroded consumer's confidence.
- Modern batteries who could make a business in load shifting and peak power delivery from solar PV are restricted by high taxes or duties.

Solar PV combined with quality performance batteries could contribute also for backup delivery and frequency respond at a competitive price if a such a market with a level playing field would exist.

4. Power sector subsidies and impacts

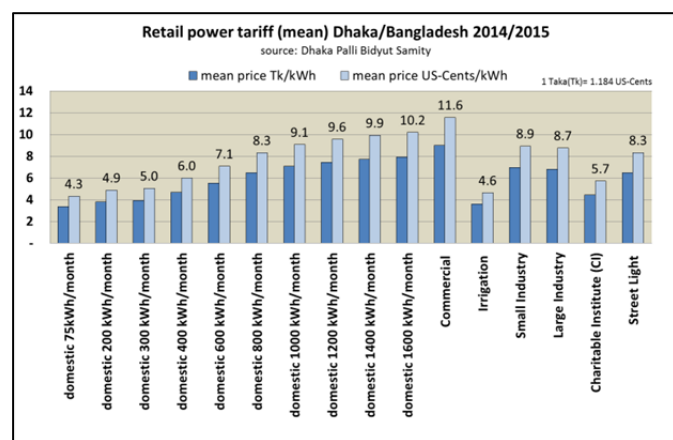


Figure 6

Retail Prices for electric power in Dhaka, Bangladesh⁷

Low rates for electricity are perceived as a necessity by the government, due to the high number of low income people in Bangladesh. These rates in general range far below their generation and distribution costs and make clean energies look “expensive”.

Hence there is no economic incentive for solar investments for self-consumption. Even for grid injection, solar, wind or biogas have not been accepted as a viable option. And despite lengthy discussions of an introduction of feed-in-tariffs (FITs), there is no legal compensation for injections from renewable energy to the grid.

¹ Summit Meghnaghat private power plant produced 126 GWh in 2013/14

² NWPGL Ltd – KHULNA public power plant produced 357 GWh in 2013/14

While solar could deliver day time power for 8-15 Taka/kWh (10-18 US-Cents/kWh) and lower the cost of diesel and HFO paid by the single-buyer BPDB, there is no legal payment scheme in place that would compensate investments for grid connected renewable energy. So far the subsidy system is directed toward fossil fueled power generation only.

Windfall profits and inequality in power access

Low tariffs create a substantial windfall for middle income consumers in urban areas:

- Despite a steady decline in poverty rates since 2000, the World Bank (WB) states that “poverty in rural areas continues to be relatively more pervasive and extreme than in urban areas”. [8] Regarding power rates, people in rural areas are obliged to pay up to 30 Taka/kWh (\$0.39/kWh) for their micro-credit scheme, while most urban consumers get their electric power at some 3-4 Taka (\$0.04-0.05/kWh). Even at 4800 kWh consumption per year the price for households is at only 4.7 Taka/kWh (\$0.06/kWh).
- Winners of this kind of tariffs are not primarily the poor. Their income is just too low to buy advanced electric appliances and living mostly in undeveloped rural areas where grids are missing.
- Rather it is the middle and high income class households in urban areas who take the biggest profits from this.
- Even commercial units such as super-markets, banks or IT Industries get their power at a maximum rate of just 9 Taka/kWh (\$0.116/kWh) that barely cover their full costs.

If these commercial and high income consumers would pay for a power tariff that would mirror full cost of generation, transmission and distribution, distributed solar PV could arise as a competitive option for grid connected self-consumption

A side benefit of this could have been that PV generation would have been combined with urban based batteries that could serve as a backup tool too. With multi-tier-tariffs some of these batteries could find a use for load shifting, too.

“Natural gas crisis”

Subsidies for energy include a flat rate for natural gas despite a “prevailing gas crisis” reported by BPDB in its annual report 2013/2014. Domestic gas is sold unmetered for a bargain lump-sum of 480 Taka (\$6.14) per month and is a main energy source for cooking in urban areas.

At present six gas distribution companies are supplying gas through a gas pipeline network and proven reserves are given at 195 billion m³ while annual consumption is at 23 billion m³. Titas Gas T&D Co. Ltd. (TGTDCL) is the biggest natural gas provider in Bangladesh and sold its gas in 2014 at a price of just \$0.0067/kWh (0.52 Taka/kWh). From its annual report one can learn that “At present, the company is receiving 1,400-1,500 MMCFD gas from different gas fields as against a demand of 2,000 MMCFD, which makes a deficit of about 500 MMCFD. This results low pressure problem at various places within TFA including Dhaka Metropolitan City...under the Holiday Staggering Programme gas supply has been shut-off to Interruptible Industry and Interruptible Captive Power Customers once a day in a week in different areas to solve the on-going gas crisis.” [9]

Natural gas is a main source for electric power generation. The cheapest gas plant is delivering electricity at a price of just 0.81 Taka/kWh (\$0.01/kWh). [10] These low natural gas prices will

not be sustainable without heavy subsidies once natural gas must be imported.

While NGO's and government agencies work hard for energy efficiency in the field of consumer products, these very low fuel and power prices could be seen as an invitation for energy waste. And this comes at a price:

- Natural gas and electric power consume a substantial amount of the national budget. This money could have been used for other goals such as education, health of infrastructure in modern traffic systems;
- in gas distribution networks, a frequency of low gas pressure is reported while a number of domestic gas fields have run into decline;
- a substantial reduction of natural gas extraction is expected to arrive over the next 25 years; a switch to natural gas imports at international prices would bring an increase of price levels.

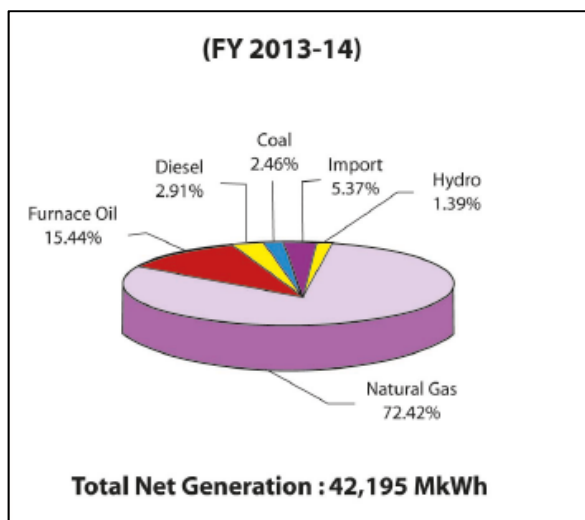


Figure 7
Bangladesh power generation fuel mix 2013/14

Today, natural gas is the main fuel that drives Bangladesh power plants. Additionally a number of public and rental power plants regularly make use of diesel and heavy fuel oil that brings an elevated cost of 15-35 Taka/kWh (\$0.20-0.45/kWh) for electric power.

The role of IPP's

Reliable energy provision has been a government priority for years. Part of this policy was the expansion of generation by "rental power plants" based on power purchase agreements with IPPs.

These plants were financed by the private sector. They were able to deliver instant additional power on request of Bangladesh TSO (BPDB) who legally is the single buyer of electricity.

Moreover BPDB has built a number of public fossil power plants. Many sources therefore report a significant improvement of supply and a reduction of load shedding.

There is no doubt that this policy had its benefits for the economy overall, visible in an annual economic growth rate of some 6 percent over past years.

Since 2010 power tariffs have been increased repeatedly, but still BPDB reports an official annual loss of some 6.5 billion Taka (83.6 million US\$) in fiscal year 2013/14.

Additionally BPDB "is losing \$769 million a year by buying electricity at higher prices from privately-owned power plants and

selling it on at lower prices", Reuters News Agency reported in 2014.[11]

The IDAM discussion paper on feed-in-tariffs states that "The import of gas have substantially gone up in the last few years" and "the rising import bill of liquid fuels has resulted in import bill of around USD 2 billion." [12]

BPDB and the whole power sector received financial help over decades including deficit coverage for power plants and distribution grids, natural gas exploration, production and pipeline investments. The cost for this was paid by the government. The finance ministry repeatedly has rejected the advice from World Bank to cut subsidies for the power and energy sectors [13].

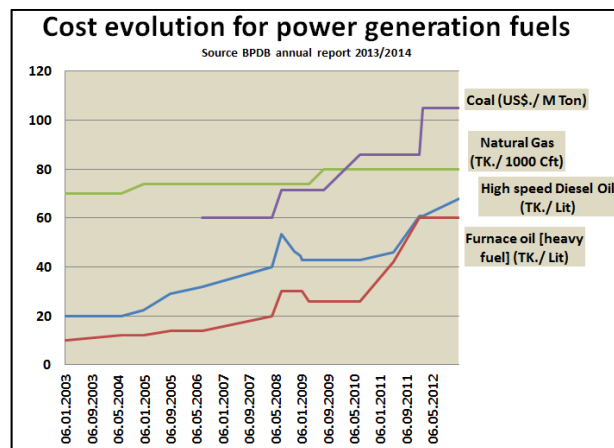


Figure 8
Fuel cost evolution of power generation in Bangladesh (BPDB)

The reliance on gas, imported liquid fuels and coal has made the system more vulnerable. Over recent years, the cost of fuels bought by BDPB was on an upward trajectory and could do even more so when natural gas needs to be imported in growing amounts.

New coal plants

A new plan of adding another 10,400 MW capacity by 2021 has been expressed by the government. Due to "prevailing gas crisis" and to prevent "future grim scenario of gas sector developments", the BPDB annual report confesses that in diversifying "for base load demand, coal is the near-term option whether indigenous or imported."

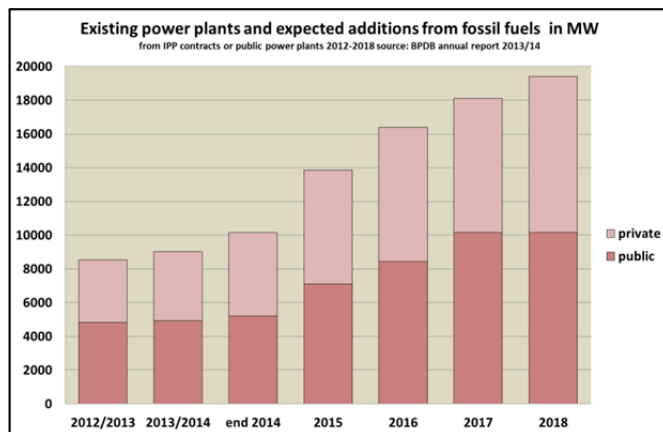


Figure 9
BPBD Power expansion plans 2014-2018 based on fossil fuels

At present 32 Power projects of capacity 7361 MW are under construction, whereof 2500 MW of coal. Of course greenhouse gas emissions are on the same upward trajectory as is the production of fossil power generation although Bangladesh is one of the most vulnerable nations from climate change.

However, there are also plans to realize nuclear power stations built, financed and operated by Russian companies. [14]

5. Cost effective segments for solar

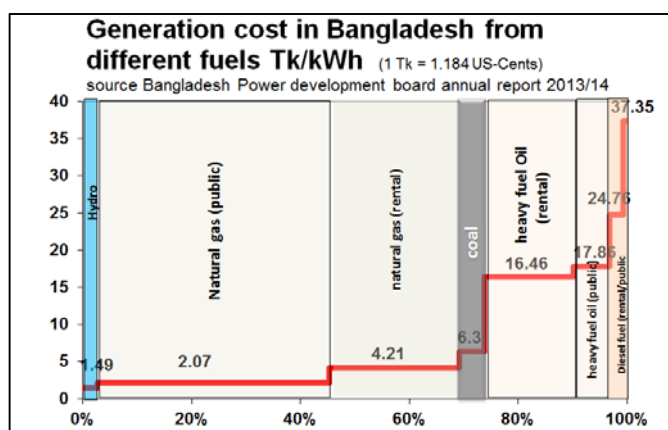


Figure 10
Generation costs along fuel options (merit order)

Actually the most expensive segment of power generation are liquid fuels bought for public and rental power plants. For more than two dozen plants electricity comes at a price of 16.46-37.35 Taka/kWh (\$0.20-0.47/kWh) according to the annual report 2013/14 of BPDB.

Over this price range, professional wind and solar energy could have delivered at a lower cost. Substantial amounts of money could be saved when solar and wind power could substitute parts of expensive HFO and diesel generation.

But even by substituting coal or – later on – imported natural gas – solar and wind power could become competitive provided that capital costs – interest rates - can be controlled.

In terms of missed HFO and diesel substitution Bangladesh pays a high price. The creation of a solar and wind market would bring benefits to power sector and the economy as a whole, including:

- job creation, profits from manufacturing and capacity building for technology companies manufacturing solar and wind equipment;
- distributed solar in urban areas could reduce power loads during sunny, hot days when a growing number of air conditioners are connected to the grid;
- distributed generation could defer some grid investments when power generation (and storage) would be put in place “behind the meter”;
- distributed generation could reduce grid congestions and losses within the distribution and transmission systems;
- solar PV and wind power in combination with hybrid systems could bring relief in case of forced load shedding;

- battery storage on household or grid level in combination with renewable energy could be a backup solution in case of black-outs and brown-outs.
- Solar powered batteries could replace costly diesel systems and save money.

6. Government road map for renewables

The Bangladesh energy policy has a target of achieving 5% (about 800 MW) by 2015 and 10% (2000 MW) from renewable energy by 2020. Under the government’s adopted action plan for energy efficiency a target of 10%, 15% and 20% energy conservation has been set for 2015, 2020 and 2030 respectively. And by 2030 all cooking stoves will be converted to clean cooking stoves by 2030. [15]

renewables existing	MW	capacity factor	est. power generation GWh/a
Solar Home System	141	0.16	198
Solar Irrigation	2	0.16	2
Solar Roof Top (Residential Building)	11	0.16	15
Solar Roof Top (Office Building)	2	0.16	3
Solar Mini Grid	1	0.16	1
Hydro	230	0.29	587
Wind	2	0.10	2
total existing	388		807

Figure 11
Renewable power existing (SREDA/BPDB)

Renewable power generation in planning	MW	capacity factor	est. power generation GWh/a
solar projects	500	0.16	701
unspecified solar	1'500	0.16	2'102
micro hydro	4	0.5	18
Wind	1370	0.2	2'400
Biomass	47	0.5	206
waste to energy	61	0.6	321
Total renewables in planning	3482		5747

Figure 12
Renewable power expected 2014-2020, (SREDA/BPDB)

Renewables as a share of total power generation	GWh/a
renewables expected by 2020 (SREDA)	6567
Overall consumption expected 2020	101'000
expected renewables share	6.5 %

Figure 13
renewable energy share to be expected by 2020 with no additional planning/enforcement

Observers point to the fact that at actual planning stage the declared goal to have a 10% renewables share by 2020 seems out of reach. A “business as usual policy” will keep renewable energy at a low level of just 5-7 percent of overall power consumption by 2020 und achieving official goals of 10 percent by 2020 would become “impossible”.³

³ For details see Appendix, „power plant statistics“

Government officials from SREDA and from BPDB so far followed a project-by-project perspective by listing a number of plants and their capacities that are in planning stage.

The renewable share sometimes is defined in terms of *capacity* while official goals were declared to be a share of power *generation*. Due to lower capacity factors, an additional megawatt of wind or solar power will not create the same amount of energy (kWh) as from additional fossil fuel plants.

Incentives and new market scheme in need

In Bangladesh renewable energy megawatt-size projects so far have been realized by a project approach. The private sector delivered land and finance and the government set the tariff for power injection based on PPAs.

In countries with successful renewable energy growth including Germany, Spain, China or India, central authorities did not follow project-by-project contracts. They installed a market approach driven by incentives and standard power injection conditions. By setting feed-in-tariffs, renewable energy premiums (who are given as an extra along with market price for power) or by continued tendering of renewable energy PPAs, it is up to the private sector decided when and where to invest.

And the result of these programs has been tremendous over the past ten years regarding market penetration of renewable energy and cost reductions.

In China or Japan, solar power additions stand at more than 12'000 megawatt and 7'000 megawatt respectively each year.

cost of technology (\$/MW) and cost of access to capital (level of interest rates).

Continuous cost reductions led solar and wind power to take center stage globally, as a key enabler for producing clean and sustainable power to meet growing needs. This is driven by wind and solar energy's characteristics of short construction periods, low carbon emissions and distributed nature. Every year, more markets turn toward solar and wind power in exchange of conventional plants.

In Germany solar feed-in-tariffs for PV power injections started at €0.57/kWh (49Tk/kWh) in 2004, followed by steep reductions of payments for new installations.

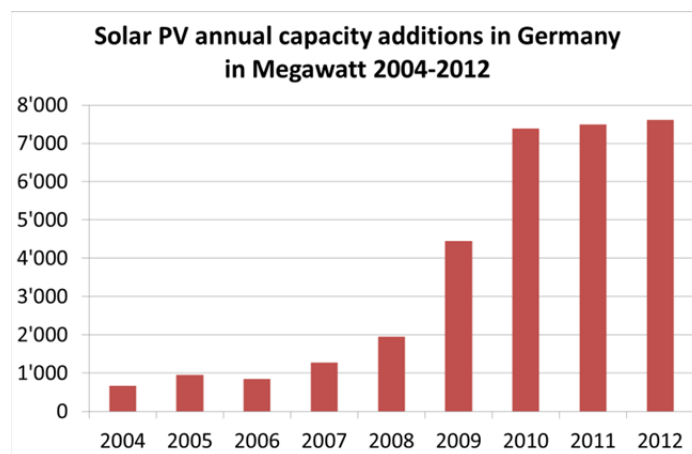


Figure 15 German solar capacity additions after introduction of feed-in-tariffs (2004) [17]

7. Cost trends and innovation in solar PV

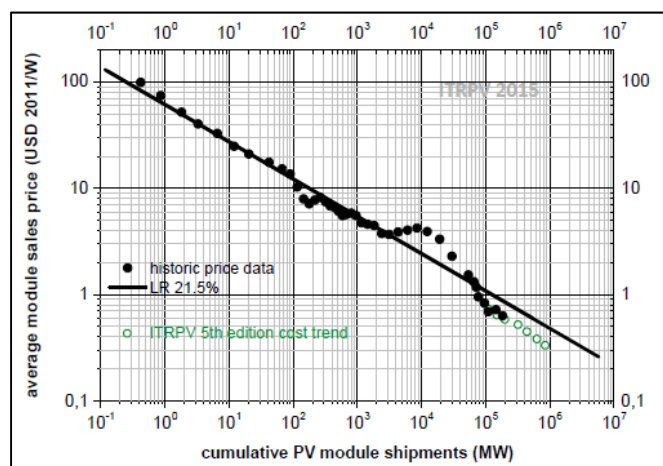


Figure 14

Learning curve of module price as a function of cumulative PV module shipments [16]

Prices for solar PV power modules followed a function of cumulative module shipments. Historic price data deliver a regular price reduction of 21.5% with each doubling of global cumulative shipments. Cost reductions have also been observed for balance of system costs including mounting systems, inverters and cabling.

With renewable energies such as wind and solar, the primary energy is free. The Levelized cost of energy (LCOE) mirrors resource quality (solar irradiation, wind speed and frequency),

From 2004-2012, a total of 32.5 GW was connected to the grid thereafter within a very short period of time. This was done by purely private investments, assisted by loans from KfW bank (a public lender with revolving funds) at commercial (but moderate) terms.

Feed-in-tariffs have been reduced since by 86 percent. They stand at some €0.08-0.12/kWh (7-10 Tk/kWh) today for new investments depending on the size of individual installations.

For large MW investments, Germany and EU members are turning toward tenders (while feed-in-tariffs and premium systems stay in place for installations at <1 MW). The first bids for ground mounted PV in Germany ended in April 2015 with 25 arrays at an average 6.25 MW size going to be realized at €0.0917/kWh.[18]

Average global horizontal irradiation per year in Germany is at 900-1000 kWh while in India and Bangladesh it is at 1400-1800 kWh. In countries with less cloudy weather generation costs could be much lower than in Europe.

High cost of solar energy generation proved to be the Achilles Heel in low income countries to adopt solar power. High costs have their origin in the high cost of funding. In India or Bangladesh, lending rate is at 12-15% compared to 4-5% per annum in Europe. Besides there is a shorter loan tenure of 10 years as against the availability of 15-17 year lending in Europe.

Hence, access to funding is the single most important issue for turning toward cost competitive renewable energy. External and domestic funding at moderate cost could significantly lower solar and wind energy costs.

Considering that thermal energy delivered cost predetermines additional costs for transmission losses & charges, whereas

solar is distributed, an overall view of cost is necessary, including system costs.

Solar energy generated and consumed locally at peak load time could lower overall energy costs in cities. A finance program similar to the efforts of IDCOL given for solar home systems in rural areas could enable rapid adoption of cleaner grid connected solar power in cities at a low price, especially if compared with costly diesel and HFO rental power plants.



Figure 16 Dubai multi-MW solar PV plant

Many countries with reliable funding frameworks report record-low generation costs for electricity from solar PV. *Cleantechnica* reports: [19]

“The year [2014] started with Recurrent Energy signing up a deal to sell solar electricity for 5 cents/kWh in Austin, Texas, without any support from the state. Even after accounting for the federal tax credit, the actual price would have been just about 7 cents/kWh. Later this year, in just a few weeks from each other, India and then Brazil announced low-cost solar power — within a band of 8–10.3 cents/kWh. This was without any subsidy whatsoever. (...)

The state utility company of Dubai, the Dubai Electricity & Water Authority (DEWA), had opened a tender for a 100 MW solar power plant for the second phase of the Mohammed bin Rashid Al Maktoum Solar Park early this year. The park is located on a patch of 40 square kilometers of land just south of Dubai. Its ultimate goal is to grow up to a gigantic 1,000 MW solar park by the summer of 2017. DEWA had called on solar project developers to submit their bids for a fixed tariff over a 25-year period under a Build-Own-Operate (BOO) model. Of the 24 solar developers who started, only 10 remained till the final round of the bidding. Riyadh-based Acwa Power (owned by eight Saudi conglomerates) bid a record low tariff of just 5.98 cents/kWh. Acwa Power did not just stop at bidding for the 100 MW project which was up for grabs. But it also provided alternative bids in which it proposed to immediately build the complete 1,000 MW at a tariff of 5.4 cents/kWh — again, the lowest solar bid in the world.”

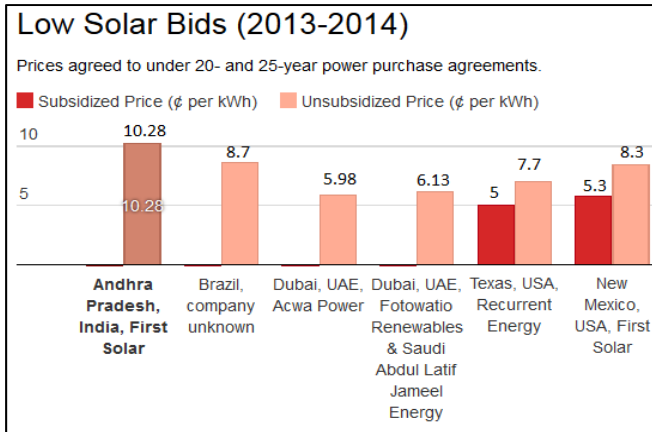


Figure 17
Results of solar bids 2014/2015 (US\$-Cents)

Dubai’s solar expansion was rumored to be based on low-wage-labor from Nepali workers and low cost of finance. To get costs of less than \$0.06/kWh a number of important conditions worked in favor of investors:

- Dubai Electricity & Water Authority was considered as a trustworthy power purchase agreement partner.
- Dimension of equipment was at 100+Megawatt -level
- Permission and grid access were offered by grid-operator.
- Access for land was assured by the authorities

Low-cost financing was a key ingredient. In a politically stable environment such as Dubai, project developers have been rumored to secure loans at a margin of 175 basis points [1.75%] over LIBOR, on a floating rate basis. Assuming 300 bps for the hedge to fix the interest rate, this would mean a 5% fixed-rate cost of debt. [20]

	06/2012	12/2012	12/2013	12/2014	12/2016	12/2018	12/2021	12/2024
Cum. volume shipped	92	110	144	184				
Price at end of period (US\$/Wp)	0.95	0.69	0.72	0.63				
Assumed cum. volume shipped (GW)	92	110	150	200	320	440	630	850
Avg. Wp increase (period to period)			3%	3%	3%	4%	5%	5%
Cost reduction (period to period)			6%	6%	8%	10%	10%	10%
ITRPV 5 th edition cost trend (US\$/Wp)	0.83	0.73	0.64	0.58	0.52	0.45	0.38	0.33

Figure 18
Average module sales volumes and prices 2012-2024 [16]

Recently published SEMI/DMA study *International Technology Roadmap for Photovoltaic* expects average module sales prices to fall from \$0.58/W (2014) to \$0.33/W in 2024.

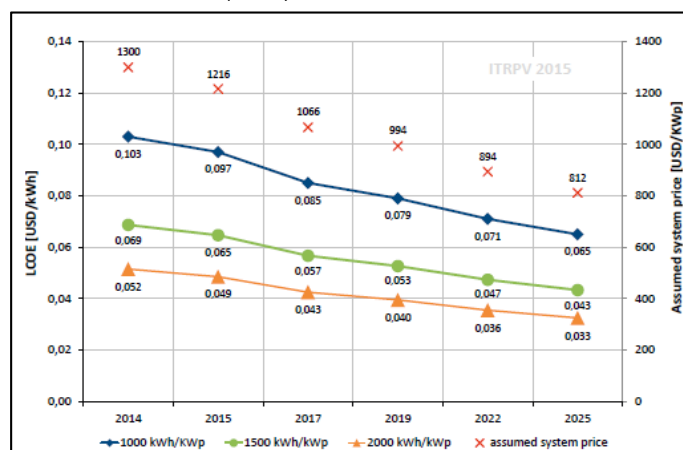


Figure 19
Calculated LCOE values for different insolation conditions [16]

The average cost of power from PV at 1500 kWh/kWp per year is expected to drop by 38 percent between 2015 and 2025. At financial conditions of 80% debt, 5%/a interest rate, 20-year loan tenor, 2%/a inflation rate and a 25 years usable system service life, costs of \$0.069/kWh would drop to \$0.043/kWh by 2025. This would mean that with an averaged 1500 hours/a solar global irradiation the cost of solar would be cheaper than power from new coal plants wherever such favorable terms of finance would apply.

8. Cost trend and innovation in Wind power

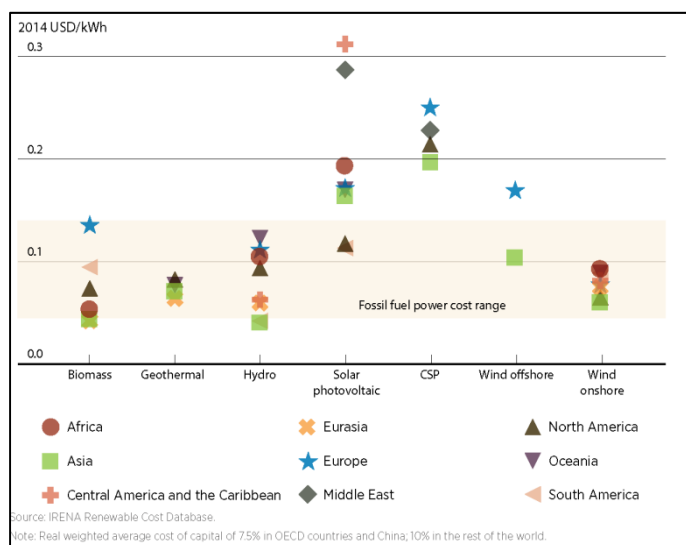


Figure 20
Levelised cost of electricity from utility-scale renewable technologies (WACC 10%) [21]

Continuous expansion, innovation and economies of scale have dramatically reduced power generation costs from wind. The trend for higher towers (90-140 m), longer blades (40-80 m) and advanced electronic power devices have led to higher capacity factors. Hence, sites with moderate wind resource can be exploited now – including sites that were perceived uneconomic a decade ago.



Figure 21
minimal consumption of area by onshore wind farms (Australia, Mac Arthur wind farm) [22]

Regions that did not qualify for wind turbines before start to offer new, profitable sites. Turbines now can be placed closer to population centers and therefore cost of transmission is falling too. Onshore wind power results to be a least cost technology in many regions of the world.

Offshore wind power is more expensive than onshore. But the cost per kWh has started to decline and could bring opportunities for Bangladesh by 2020. Eastern Bengal Bay has a substantial wind resource that could bring power supply supplemental of solar and with delivery at night and peak delivery during monsoon periods when solar delivery is restricted.

Offshore wind power offers sites close to load centers such mega-cities, an example being the London Array wind farm near the British capital. Offshore wind power capacity factors can exceed 50 percent. For the Chittagong area, near-shore wind farms should be explored seriously and might soon be a viable option with costs below \$0.10/kWh (9 Tk/kWh).

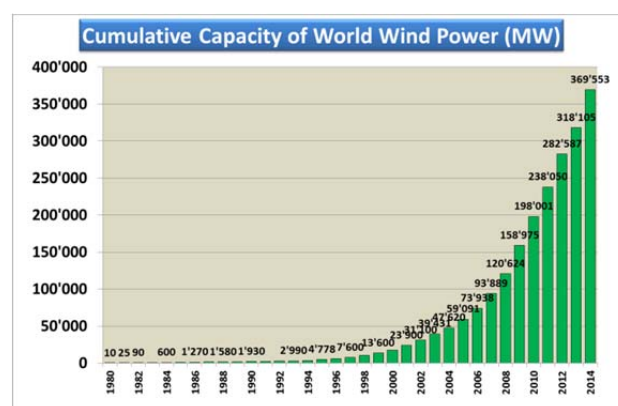


Figure 22
wind power globally
(cumulative installations 1980-2014) [23]

The continuous trend for cheaper wind technology has directly been transformed into exponential growth of wind power generation. Recent auctions in Brazil and Uruguay showed a price of less than \$0.05/kWh for onshore power generation.

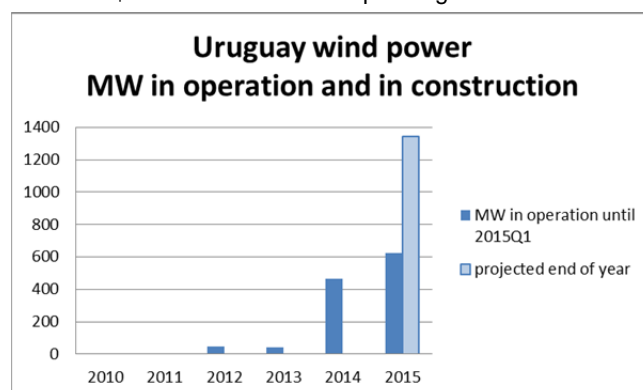


Figure 23
explosive growth of windpower example: Uruguay, Latin America

The Uruguay state-owned National Administration of Power Plants and Electrical Transmission (UTE) has decided to switch

1.34 GW or 30 percent of its power generation to wind power within three years. Tenders for wind power injections to the grid resulted in costs of \$0.04-0.05/kWh (3.1.3.9 Taka/kWh) while at the same time lowering overall power generation costs by 30 percent.[24]

9. Cost trends and innovation in storage technology

In many countries, solar PV equipment delivers power during peak load hours. This is not so in Bangladesh. Here power consumption regularly peaks in the evening, driven by lighting demand.

The need for storage emerges in relation to the amount of weather related renewable electricity (wind and solar), the amount of inflexible must-run capacity within the system and the amount of peak demand.

In Bangladesh, natural gas plants dominate power generation. Due to their high flexibility a very high share of the daily can be covered by renewable energy without conflicting with these power plants. With daily loads and consumption on a steep trajectory, peak solar capacity of 10'000-15'000 MW could well be absorbed by 2020.

A conflict between renewable energy and conventional plants could evolve when base-load plants from coal or nuclear are added to the grid. At a 10-GW-demand and 10-GW-supply curve from solar, the picture could look like next figure.

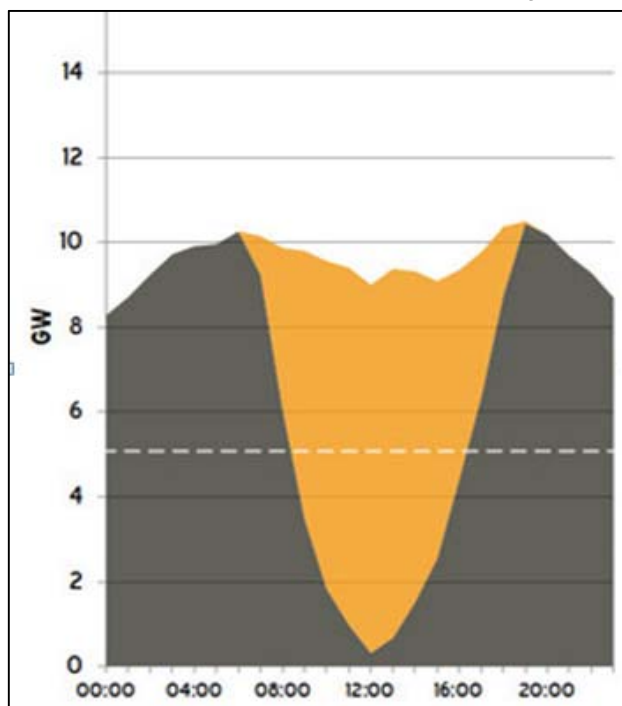


Figure 24

Supposed high solar penetration without storage [25]

Normally, a high number of solar arrays at noon will barely exceed 70 percent of its cumulated rated peak capacity due to temperature influences and diversity in directional positioning. With a growing share of modules positioned in East-West-direction, less than 60 % of cumulative solar peak capacity will be measured as maximum delivery.

However, storage of solar power will help “peak shaving” and it also will help to substitute costly diesel and HFO generated

electricity for power demand peaks in the evening and for off-grid systems.

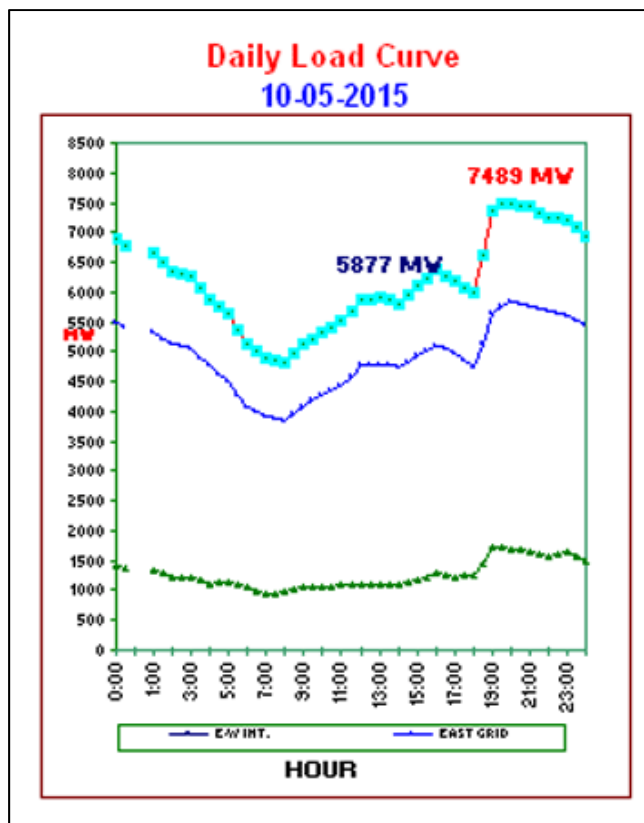


Figure 25

BPDB load curve May 5, 2015 [26]

Cost-effective storage of bulk power

In the US, energy storage for off-grid, distribution grids and bulk power is in growth mode. A study by US Electric Power Research Institute (EPRI) inspected the cost-effectiveness and benefits of storage

- for transmission-connected bulk energy
- for short-duration energy storage to provide ancillary services
- for distribution-connected energy located at a utility substation.

The study showed breakeven capital cost of storage ranging from \$1,000 to \$4,000/kW installed.[27] Costs for stationary energy storage projects have fallen rapidly in recent years, making the technology more competitive at scale.

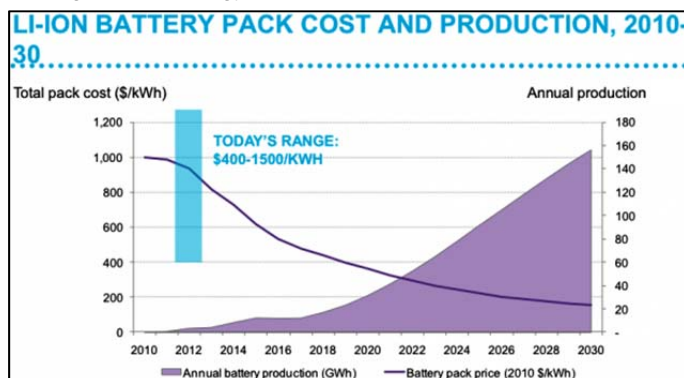


Figure 26

Li-ion battery pack cost reductions and production expectations 2010-2030 (BNEF) [28]

California based Tesla Company has announced the sale of Li-ion battery packs at just \$350/kWh.

US providers such as SolarCity launched new micro-grid services, designed to integrate grid-connected distributed solar with battery storage and load management services for use in remote communities, municipalities, military bases and even U.S. hospitals. This equipment is also perceived as a preventive against blackouts during storms. [29]

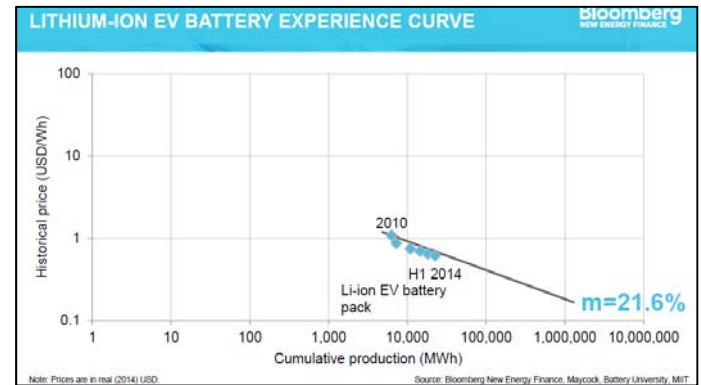
Recently, SunEdison announced plans to purchase up to 1,000 vanadium flow batteries from Imery Power Systems to support Indian PV powered mini-grid projects. The non-toxic nature of vanadium makes it a viable alternative to Li-ion or lead acid, and Imery claims that its unique chemistry removes the need for consumers to replace electrolytes any time soon, and makes these types of batteries more scalable. [30]



Figure 27 Belectric 948 kWh storage facility at solar power plant Alt Daber, Germany

German PV developer Belectric presented an Energy Buffer Unit (EBU) that has been successfully prequalified for 1.3MW frequency response by the transmission network operator (TNO) 50Hertz. Battery storage can improve the safety of grids, even during heavy fluctuations. German prototype Alt Daber energy storage system is marketed as part of its frequency response pool. The battery based energy storage system is offered in a container solution, shipped with power inverter and medium voltage transformer. It features a nameplate power between 800kW and 1400kW. It has a storage capacity of 948 kWh and its price tag is given at 560,000 EURO (€590/kWh or \$660/kWh). [31]

Evolving new Technologies



**Figure 28
experience curve for Li-ion-batteries**

Lithium-ion batteries dominate the expanding large-scale storage space currently, due to a combination of cost, flexibility and quantifiable, commercially available performance data. Li-ion batteries based on lithium iron phosphate (LFP) and lithium-titanate (LTO) technology is cited to work for more than 20 years, with a high number of cycles. [32]

The growing demand of lithium-ion among leading electric vehicle manufacturers will serve to lower its cost further and extend its reach into utility, grid-scale storage markets and into middle- and low-income countries. An experience curve as with solar PV was identified – with a 21.6 percent reduction in price with every doubling of cumulative global shipments.

Hence the battery industry is evolving to offer a cost-effective alternative to expensive peak demand charges. Such solutions could be a model for Bangladesh peak power coverage during the evening when very expensive HFO and diesel power plants are in service today.

New ways for grid connected storage

Around the world, the discussion about storing solar power focuses on on-site consumption. Adding storages in households to address every residential unit's particular load individually does not address the issue in a cost efficient way. On the contrary, this approach will add storage where none is needed for the grid. And there are risks: batteries will fill up in the morning, with gigantic amounts of PV rushing onto the grid when battery packs are full – whether the grid needs that electricity or not.

What is in need – supposed we have a “swarm” of individual storage systems in place – is a focus on what the grid needs regardless of on-site consumption. That is why some experts are arguing that homeowners, farmers and businesses should own the PV array, with utilities owning inverters and storage. That way, grid operators could tailor power storage systems to what the overall power supply needs. In this way a giant number of small storage units could be put to work for overall stability. [33]

If by 2025 an overall price of 200 \$/kWh can be expected, including programs and power electronics, a cost effective solar storage system for generation shifting should be possible:

	US \$	Taka
Battery cost per kWh	200	15576.324
cycles over lifetime	10000	10000
IRR	0.05	0.05
capital cost per year	13.7	1066
maximum discharge rate	80%	80%
daily stored power kWh	0.8	0.8
power annually stored	292	292
capital cost/ kWh stored	0.047	3.65
O&M cost incl. losses	0.01	0.77
total cost per kWh	0.057	4.4

Figure 29
Estimated cost of storage per kWh in 2025

Better grids, interconnection and demand response could also help manage variability of wind and solar. But the PV sector too has a role to play to enhance flexibility, particularly through making use of sophisticated converter functionality. PV plants can offer grid support through fault ride-through, voltage regulation and active power controls. Plant design and siting are significant elements for a stable grid.

The way to go for Bangladesh

Considering

- renewable energy's contribution cheaper year by year
- high peak generation costs after sunset from diesel and HFO
- battery prices coming in lower and lower and
- to avoid generation conflicts within the grid

storage could evolve as a very important element of the supply mix in Bangladesh with renewable energy exceeding 10 per-

cent of power delivery as planned by the government road map for renewable energy.

With price trends for solar, wind and storage in a downward mode storage options should be examined as a cost effective tool for grid management and power shifting as well.

There is vast experience with off-grid storage in Bangladesh, especially from lead-acid batteries. But these technologies might be out-done by Li-ion-systems with better performances and, at some time, lower costs.

We can conclude that renewable energies with storage will be ever more attractive in financial terms for covering peak load in demand and peak shaving in generation.

However a precondition for successful expansion is the availability of viable programs including

- easy availability of equipment at low taxes / low duties
- credit programs for reduction of up-front costs and funding at a modest interest rates
- professional operation and maintenance

This provided, solar and wind power with storage could be a cost competitive alternative for diesel and HFO powered power generation. Additionally avoided costs for transmission and losses should be considered in case of thermal generation from fossil fuels.

Today, night time peak generation costs of 20-30 Taka/kWh (\$0.26-0.38/kWh) from liquid fuels. Wind power generated at night would be a viable alternative even without storage. And solar PV shifted from noon time into night time by batteries should be tested as a business case by grid companies and BPDB soon.

Part II

Policy road map to achieve renewable energy goals

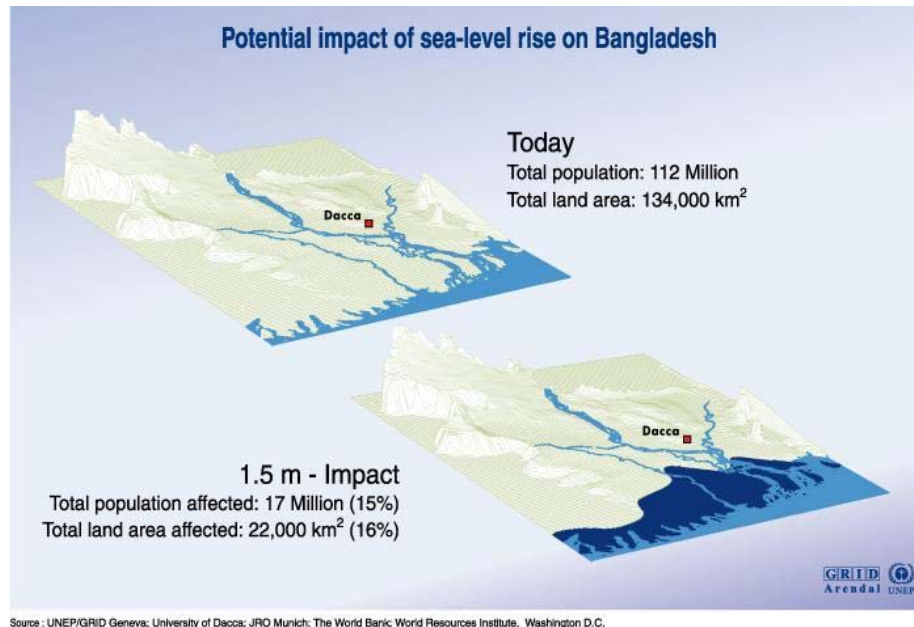


Figure 30

**Sea level rise of 1.5 meters would affect 17million people
and 22'000 km² of land area (UNEP/University of Dhaka)**

Introduction

Two recent key reports – The Intergovernmental Panel on Climate Change's 'Fifth Assessment Report' and World Bank's 'Turn Down the Heat' – reveal long-term implications for Bangladesh and its people from probable catastrophic impacts of climate change. Both reports paint a very dismal scenario of the future if climate change continues unabated.

The Bangladesh government has been allocating resources for climate change adaptation initiatives in research of saline-resistant crop, seeds involving shorter harvest cycle and adaptation of livelihoods, including migration of people displaced due to climate change. Despite these initiatives, as all studies point out, Bangladesh remains most vulnerable and its people will face severe economic hardships from climate change impacts in the coming years.

Bangladesh therefore will need to ask all nations for a transition to a low-carbon economy based mainly on renewable energy supply. It can do so with good credibility provided that its own transition toward a climate neutral economy will go ahead. The Bangladesh Government has come up with a number of path breaking policies such as the Renewable Energy Policy 2008, with its 500 MW solar program.

However, *"there has to be a follow up implementation mechanism in place which gives clarity to the developers. Besides,*

there has to be strict timelines for every policy or regulatory work taken up. We understand, there is a Draft RE Policy (2014) in the process of getting its final approval which would possibly address many relevant issues faced by the stakeholders." These words found in the final discussion paper on the introduction of a feed-in-tariff (FIT) framework for renewable energy describe the state of process.

The discussion paper together with the updated BERC draft regulation on feed-in-tariffs (dating May 2015) are major breakthroughs within Bangladesh energy discussion. Together with reductions of investment costs in renewable energy, a solid ground for energy diversification can be built now, with lower cost for consumers as a start for energy transition over next decades.

Regarding these new and solid policy initiatives – which are reflecting a new stage of progress of Bangladesh renewable energy policy – the following comments have been elaborated to support the work started some time now. We thereby acknowledge that with the feed-in-tariff discussion paper and the BERC draft regulation, a high quality groundwork has been delivered and in this regard, the following comments and recommendations should be understood as complementary.

10. FiT-regulation: a clear priority

The Introduction of the *BERC regulation on feed-in-tariffs* is perceived as the single most important step to advance renewable energy in Bangladesh. It will give an important signal and fundament for new investments. With fair management by the responsible authority it will improve the conditions for grid connected power generation that can bring benefits for all consumers of electric power in Bangladesh.

Due to rich renewable energy resources in Bangladesh, solar and wind power can deliver competitive power compared with public, and rental grid connected power plants that use liquid fuels. These power sources in 2014 received payments of up to 37 Taka/kWh (\$0.48/kWh).

While there was no legal compensation for solar and wind injections so far, both sources could substitute expensive and volatile diesel and heavy fuel oil (HFO) power as soon as a payment scheme is in place that would compensate for the capital and operational costs of these investments. At a tariff of some 11 Taka/kWh solar and wind power are a bargain compared to Diesel and HFO.

Due to price reductions, solar and wind power on the long run can also be perceived as cost competitive compared to power from imported coal. Two aspects should deserve attention regarding this

- Wind and solar quality equipment can have an operational life time beyond 30 years. As must-run-facilities solar and wind power will reduce the cost of power sourcing by BPDB along the merit order dispatch for many years beyond the tariff period provided that a value based tariff, covering the operational costs is enacted for the time after the tariff period.
- As shown by many countries, once a professional installation business for grid connected solar and wind is in place, mounting costs and operational costs tend to fall. Feed-in-tariffs for new installations then might be reduced in real terms.

Grid connected solar and wind power will change the power system toward a more load oriented siting. This can bring relief against power and grid deficits and against high costs from imported liquid fossil fuels.

As a general condition, terms of payments per kWh need to bear commercial interest from all kind of investors: households, SME, business community or independent power producers with utility scale entities.

Investors of renewable energy systems need long term security to recover their expenses and to maintain operations of their systems.

The draft regulation published by BERC in May 2015, prepared by IDAM and including comments and contributions from a number of stakeholders, seems to integrate all important aspects to be considered in such a framework.

However, the most important aspect of any scheme for distributed generation is its reliability and trustworthiness. Investments need a benign long term relationship between owners of these facilities on one hand and the distribution or transmission grid operators who will buy the power generated on the other hand.

This trustworthiness has to be proved in the long term and should not be affected by political instability or regime change. It should include all legal and contractual terms such as grid access security, grid reliability and necessary extensions, regular payments of power injected, non-discriminatory practices and fair treatment in general.

Under BERC B Act, 2003 Bangladesh Energy Regulatory Commission is empowered to regulate the tariff for all the generating stations including the renewable energy power plants. Accordingly, the BERC is envisaging to decide on feed-in-tariff regulations for energy covering wind and solar energy to begin with. *"Large-scale deployment of renewable energy can help Bangladesh in addressing four of the most important challenges it faces today i.e. Energy Security, Economic development, Energy Access and Emission Reduction,"* the very solid IDAM FiT-report tells us. [34]

11. Solar power as an industry

Due to abundant labor force in Bangladesh and with an ever more professional approach from investors, with training of labor, with more experienced operation and maintenance, solar power should be seen to evolve as a main industry in Bangladesh – one that will be competitive to unsubsidized fossil power – and one that should be able to flourish as an export industry.

- (1) Once the feed-in-tariff regulation is operational, new capacity could be added at a much faster rate, because it does not require allocation processes and policies. The distributed solar market including battery storage can make a real dent into Bangladesh's diesel consumption from gen-sets and therefore it could save high amounts of money. **To take off, consumer finance solutions (such as equal monthly payments), certifications for suppliers to improve product quality should be extended from the off-grid to the grid connected sector and a revoking of existing malfunctioning subsidy schemes are required.**
- (2) To create a home grown solar industry, the financing environment should reduce the risks of investors. **The strength of the off-take, regulated by BERC is related to the question of the reliability of financing the feed-in-tariff regime** which is key to the bankability of projects.
- (3) The government should focus all efforts on lowering the cost of solar and wind: **the policy of no domestic duties and tariffs on equipment should be extended toward storage equipment including Li-ion batteries to cover peak power demand during**

evenings. Once the market is ramped up from the current project based level of a few MW per year to several hundred MW per year, manufacturing in Bangladesh will follow naturally. **Then the government should explore if, within special credit programs such as IDCOL, a domestic procurement obligation as in Brazil will make sense.**

- (4) To create a level playing field the government should eliminate direct capital subsidies and tax benefits for non-renewable power plants. Instead, **if there is a persisting desire to reduce power prices for social reasons, it should be done by reducing retail prices in a technology-neutral way.** No preference should be given for non-renewable (imported) energy. If there is a desire to attract more investment for power plants, introducing the feed-in-tariff regulation by BERC will be the single best step forward. **Additional programs could focus on reducing the lending cost through direct loan subsidies for renewable energies and storage and for grid reinforcements as well.** Lowering the cost of debt is the strongest lever for reducing the cost of renewable energies.
- (5) Provide excellent market information. The more transparent and easily accessible information is, e.g. feed-in-tariff policies, land acquisition, debt conditions and options, investment, generation of existing plants, technology options, etc., the more professionalism will drive the market.
- (6) So far current policies point in the direction of larger plants (utility scale solar and wind). However, solar is ideally suited as a distributed, consumer technology to factories and households, irrigation pumps, telecom towers, water purifiers, mobile chargers or lights. This market should grow in a stable, sustainable environment and it would hit roadblocks such as land availability, grid access and local grid imbalances at a lesser extent.
- (7) On paper, utility scale installations from wind and solar may look less expensive than small distributed units. However, utility scale installations might need grid extension and the distance to consumers might be larger than for small units which comes at a cost. Therefore regulators should provide all type of installations the same attention, and **utility scale units will need close collaboration with grid companies.**
- (8) Encourage entrepreneurship and international investment. It could be favorable to open up the market entirely: to entrepreneurs and to international investors. This requires a simplification of procedures, accounting and taxation regulations and financial regulations. **The government could set up highly service-oriented offices across the country to help entrepreneurs and investors.**
- (9) Strengthen R&D. **If Bangladesh will be one of the leading solar markets, it should also become a knowledge and technology leader.** There is rich

experience from solar home systems and an educated young generation of engineers. Results from real plants in the off-grid sector should be adapted and transferred to the grid connected sector and to micro grids. It would be wrong to spend research budgets on making better cells and modules, as this would require huge amounts of capital for catching up with China. It would be easy though for Bangladesh to ask leading cell and module manufacturers to set up shop once the market has gained a certain size.

Bangladesh's edge could be in solar applications and programming. It could become an innovative place for developing the solutions the country needs: **hybridization of solar with storage and the grid; smart grid and metering technologies at the distributed level; new online and offline solar business models.** For that to happen, industry and research, educational and training institutions together with early-stage financing network and micro-credit-programs should work together. [35]

12. On Goals and means

Bangladesh indeed has an enormous potential of renewable energy, but official goals of 5, 10 and 20 percent by 2015, 2020, 2030 are not operational as part of enforcement proceedings, including legal incentives, capital and power procurement and planning for sites and interconnection.

	power consumption total	renewable share (goal)	renewable share in TWh
2013	50.5	0%	0.8
2015	61.1	5%	3.1
2020	98.4	10%	9.8
2025	158.5	15%	23.8
2030	255.3	20%	51.1

Figure 31
Outlook on power consumption 2013-2030 and renewable energy share

- (10) To monitor minimum achievements, a comprehensive policy is needed including fine tuning of incentives. If goals cannot be achieved, an improvement of incentives must be applied and an analysis of bottlenecks should be mandatory.

13. Suggestions regarding tariffs

Introduction

BERC's May 2015 draft regulation is a solid groundwork, opening new inroads for clean and cheaper power plant installations. These draft proposals should be backed by BERC and by policy experts.

The proposal of a generic feed-in tariff for each type of RE technology determined by BERC on suo-motu basis will open the window for new investors beyond the project-by-project approach applied so far. The method of different FiT for different technologies has delivered positive results in many countries and is able to minimize windfall profits.

The surge of a professional business with proper regulation will allow FiT reductions over time for new installations, following the experience curve of each technology separately.

A right for grid access and a liberal license system for renewable energy are crucial for expanding the use of solar PV and wind power.

Land usage schemes should be developed in cooperation with land owners. In case of public lands, local people should be able to benefit, too, from tax revenues or revenues from power generation. Land scarcity and agricultural cooperation within renewable energy allotments should be taken into consideration early.

It is positive that the draft FiT regulation (3.3) is enacting that no licence fee shall be applicable for renewable energy power plant with installed capacity up to 1 MW.

Where private land is used, tenancy agreements should cover the operational life expectancy of equipment.

Suggestions regarding reduction of financial risks for investors

A main objective of feed-in-tariffs is risk reduction for investors. The determination of a one-level tariff for a period of 15 and 25 years for wind and solar is a good framework to start incentivizing investments.

But investors will ask: where can I sell the power generated after the tariff has expired? With BPDB as a single buyer, this may become a difficult question.

Furthermore, there might be a large number of existing facilities, some of them off-grid so far, that have no contract and no tariff for injection who well could inject their power, e.g. solar plants for irrigation that might not be in use during monsoon period.

A general rule enacted for injections outside of official feed-in-tariff could enhance the position of all distributed generation units and thereby reduce power shedding risks also.

Wind and solar power equipment represent a substantial economic value even after 15 or 25 years respectively, because their debt burden might be zero and their variable cost of generation may be below 3-5 Taka/kWh, including operation and maintenance, technical updates and so on. Power injections from these old installations may be at a bargain and a valuable substitute for more expensive power supply, procured by BPDB and local distribution grids.

(11) We recommend to introduce a compensation rule for all injections from renewable energy installa-

tions (a) who have no right for a feed-in-tariff, (b) whose right for feed-in-tariff has expired.

(12) The “outside-of-FiT-compensation” should be determined on a value-based approach. For example, it could be determined annually as the statistical price per kWh that BPDB was paying for electricity generated from imported coal as published in the BPDV annual report.

The price of coal powered generation is recommended because imported coal is the favorite way to diversify power generation by the BPDB board as expressed in the annual report 2013/2014. [36]

To further enhance financial attraction of investors, the following measures should be taken into consideration:

(13) There should be no retro-active reduction of tariffs or change of rules for existing facilities under contract. Due to innovation, feed-in-tariff for will and should be reduced over time, but only for new investments.

(14) To identify each single installation correctly, a registry should be created (by SREDA e.g.) that publicly registers type of equipment, year of installation/grid connection, expiry date of Fit-contract. This registration should be declared “protective” against retroactive changes by law or regulation.

(15) Regarding the vulnerability of Bangladesh an advanced willingness from industrialized countries may be suggested to endow the feed-in-tariff program with capital on a soft loan level. Capital acquired in this way should be disseminated to the private sector by experienced actors such as IDCOL with a goal to advance the solar and wind program as fast as possible.

IDCOL finance services should be expanded with services as for the successful solar home systems program, including

- Financial support by soft loans from multilateral donors.
- Monitoring and testing of useful equipment including publishing of results as a guide for independent investors.

(16) Create a legal base to sell electricity to your own company.

(17) Create a legal base to sell electricity to private storage facilities within the same distribution grid.

Suggestions regarding storage and peak power demand

Storage is the next big growth area for renewable energy and due to the nightly peak within the Bangladesh elec-

tricity system it should get all attention by PBDB and government officials:

- (18) To facilitate power shifting toward nightly peak demand periods create a tariff that combines solar/wind production with storage and peak demand delivery to reduce dependency of power deliveries from more expensive imported diesel and HFO plants.
- (19) A master plan for storage within the grid should be created in parallel with renewable energy deployment. Beside private investments (which should be allowed and get an injection tariff), grid companies together with BPDB should evaluate a storage system with batteries that can fulfill multiple goals including
- system service (frequency response, primary reserve)
 - power storage,
 - peak power shaving,
 - peak load delivery (during night) and
 - backup service in case of blackouts.
- (20) For deliveries during peak hours or for off-take during off-peak hours, the average compensation for injections or price for storage from storage facilities should be stretched up and down respectively.
- (21) acquisition of new coal power plants should be suspended or it should undergo a re-evaluation because they are in a structural conflict with the expansion of investments for solar, wind and storage capacities.
- (22) Duties and taxes on Li-ion batteries should be reduced or abolished to enhance peak load delivery/peak power shaving in spite of expensive diesel power generation.
- (23) Battery recycling should be enhanced by regulation and tariff systems (charge/deposit on new batteries as an incentive for recycling).

FiT for wind power

SWERA study has identified “fairly good amount wind potential in coastal areas and offshore areas of Chittagong, Cox Bazaar and moderate wind potential inland on locations around Barisal and Rampur. [37]

	strong wind	low wind	moderate wind
rated power [MW]	2.5	3	2.3
rotor diameter [m]	85	115	120
hub height [m]	90	140	145
specific rated power [W/m ²]	441	289	203
specific investment including civil works [€/kW]	1275	1600	1930

Figure 32
investment cost estimation for strong and moderate wind regimes in Germany [38]

Regulation authorities should be aware that with a moderate resource investment costs would be up to 50% higher per turbine compared to regions with strong winds.

These additional costs, derived from higher hub heights and longer blades, should be reflected in the feed-in-tariff.

- (24) To avoid costly and complicated wind measurements we recommend to explore a more structured performance based tariff for wind power, reflecting site specific power potentials and CUF (capacity utilization factor) on a scaled ground [39].

Therewith no additional wind measurements would be needed to reflect site specific productivity. For most countries with feed-in-tariffs, the number of full-load-hours per year is a good single indicator. – and with a stepped tariff with diminishing scale based on delivery per rated capacity (kWh/kW) sites with better than average wind speeds and frequencies will have no windfall profits.

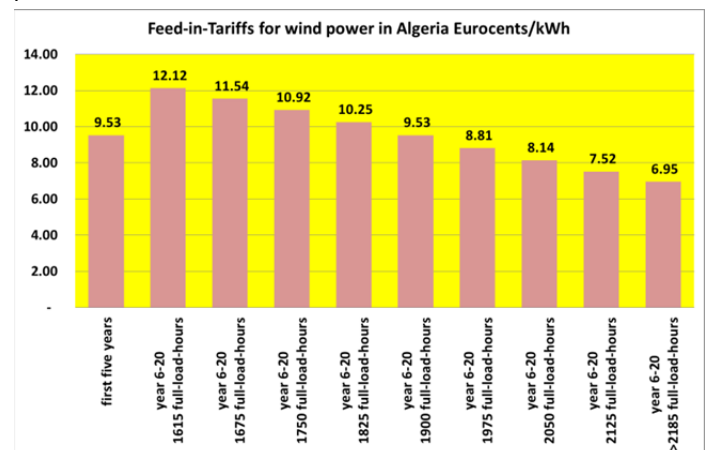


Figure 33
Example: Structured feed-in-tariff for wind power in Algeria: after five years the FiT is determined derived from real power generation during years 1-5. [40]

A FiT determination driven by real performance, based on a normalized tariff, will reward all sites in an equal approach.

Risks and chances for profits would be with investors who spend the money for their plants. Investors would arrange wind measurements themselves and choose the sites that would be apt for production at a given tariff including tariff reductions for additional full-load-hours.

- (25) BERC should determine a feed-in-tariff or a tender system for offshore wind power. Initial tariff could be set by applying tariffs from other countries or by tendering a series of wind installations; as in Germany, distance from the coast and depth of sea water could be taken in consideration when determining the tariff.

- (26) For offshore wind, BERC should take into consideration a proper regulation on grid connection with respect (a) to the substantial amount of energy that could be provided from the sea at night, substituting the high cost of diesel power plants and (b) the need for substations within or nearby the sea shores, including environmental aspects and protection of sensitive marine fauna.

FiT for solar power

- (27) Due to land scarcity, Bangladesh should incentivize installations that do not reduce agricultural productivity.

- Special installations such as floating PV, PV combined with permaculture or PV on rooftops and roadsides should get a premium compared to ground mounted solar installations on open land.

- pilot programs for mixed use of land and for technical advancements of floating PV and PV on roadsides should be accompanied by scientific evaluation regarding power production, influence on neighbors and else.

- (28) Collection efficiency from IDCOL solar home off-grid systems is at just 90 percent. To allow for grid connected solar installations as a bankable collateral, a second hand market for modules and balance-of-systems equipment (inverters, cables etc.) should be put in place in each region, together with testing facilities where quality of old and new equipment could be analyzed.

Permitting procedures

- (29) A pro-active and liberal permission system for private renewable energy investments without hurdles; all permissions should be cost-free. Small and medium solar installations (<1MW) should be permission-free, but grid-code conformity and metering of grid injections should be secured by the local distribution grid company.
- (30) IDCOL and its partner organizations have a rich experience in deployment and quality assessment of renewable energy facilities, including testing, finance structuring, monitoring and maintenance. IDCOL therefore should launch programs for grid connected solar within cities and villages, including negotiations with house owners and street managers regarding use of roofs, façades and roadsides.
- (31) A main objective of FiT regulations is the “bankability” of projects and easement of access to credits and land for the private sector. To facilitate non-recourse financing of solar PV and wind, a market should be created for PV and wind projects and for equipment and permitted sites as

well. In Texas, the system of “competitive renewable energy zones” accompanied by grid connection offers, was highly successful. The goal would be to attract investors and have equipment and sites/permits accepted as a collateral for loans.

Initial price and real cost

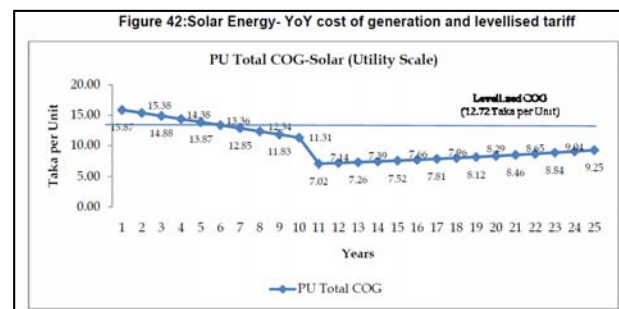


Figure 34
Feed-in-tariff IDAM proposal for solar PV power:
12.72 Taka/kWh

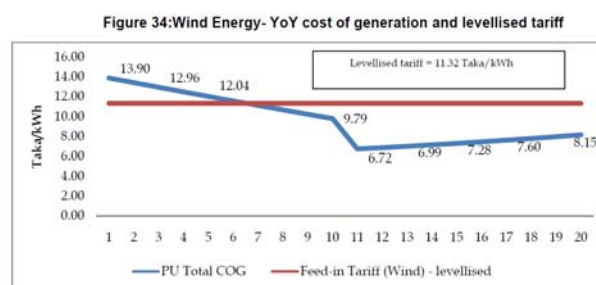


Figure 35
Feed-in-tariff IDAM proposal for wind power:
11.32 Taka/kWh

The specific costs of generation paid by FiT may be higher than from gas at the beginning of a project, but actually it should surely lower than for rental power from HFO and diesel.

The IDAM 2015 report on FiT indicates that 12.72 Taka/kWh would be paid for solar power injected during 25 years and 11.32 Taka/kWh for wind power during 20 years.

This seems very reasonable but might look expensive to outsiders. A number of caveats should be expressed regarding real costs for rate payers:

- Compared with diesel, HFO or power imported natural gas, the price of solar and wind power is a bargain.
- Distributed solar and wind power dispersed all over Bangladesh can reduce interconnection costs regarding extension of national and distribution grids.
- Solar and wind power are able to reduce natural gas consumption from domestic sources; cheap domestic natural gas may be available over a much longer period than without wind and solar, and this might facilitate the expansion of renewable energy in a benign way, with long term profits for all.

The fact that inflation is at an average of some 7 percent per year in Bangladesh makes the power from solar or wind origin cheaper, year by year.

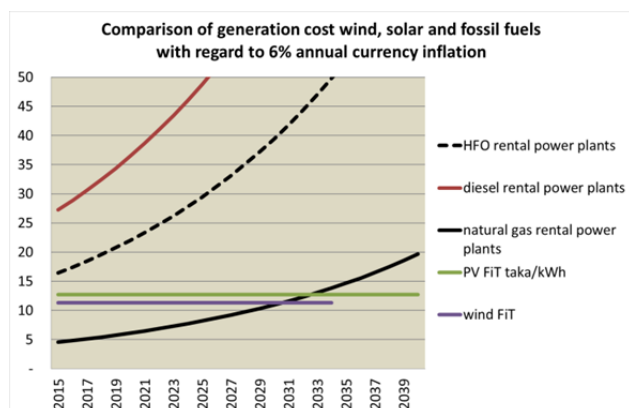


Figure 36
Cost comparison of fossil fuel power generation at 7 percent inflation with cost of wind, solar

The full operational life expectance of solar and wind equipment is around 30 years. Therefore, what might look more expensive in the beginning might be a least cost option over the entire operational life time.

Imported diesel, heavy fuel oil and natural gas will follow international prices. With inflation at 7 percent per year, the Bangladesh Taka with purchase power parity is expected to lose some 5-7 percent of its value against hard currencies such as the US\$. These hard currencies will determine the price of liquid fossil fuel imports.

By introducing FiT for RE technologies, BERC should consider these benign long-term impacts of renewable energy on retail tariffs in Bangladesh. also, the IDAM report recommended that *“the impact should be holistical-ly viewed”* while *“during the initial years, the impact may be notable. However, over a period of time, as the market matures for RE, RE FITs should approach grid parity thereby posing minimal impact on retail tariffs.”*

The fact that Energy Purchase Agreements (EPA) for renewable energy will not follow a burdensome increase of fuel import costs over time gives room for expectations that renewable energies will reduce power generation costs over time and therefore reduce the cost for consumers and state budgets too.

Moreover, building new renewable energy facilities will create local income and investors who get money for the from injection from small and medium installations to the grid will generate spending and taxes in areas where investments in generation takes place.

Regarding currency value and debt, there are investor types with different risk exposures:

- There are private investors who will rely on the Bangladesh capital market with a rather high interest rate, due to inflation and low credit availability.
- There are investors that will rely on foreign debt and/or on soft loan programs at low interest rates.

In the FiT draft regulation (23.1) BERC stipulates that “The Commission shall take into consideration any incentive or subsidy offered by the Government, if availed by the generating company, for the renewable energy power plants while determining the tariff under these Regulations. Provided further that in case any Government notification specifically provides for any Generation based Incentive over and above tariff, the same shall not be factored in while determining Tariff.”

The tariff structure defined in BERC’s FiT regulation draft seem to mirror type (a) investors who will rely on capital markets or savings. This is a good starting point because the goal of regulations should be that *all* private people as investors should make use of their roofs for rooftop solar and contribute to the overall power supply.

- In case of reductions of tariffs due to soft loans from multi-lateral donors, denominated in foreign currency, tariffs should consider currency valuation changes in case of foreign debt.**

The reduction of FiT in case of soft loans might be justified, but in case of devaluation of Taka a modification of payments should be envisaged, covering the real cost of investors and currency up-valuations.

Priority program for irrigation

The 2014 MPEMR road map identified diesel irrigation to have a “tremendous potential” for solar powered pumps. Bangladesh Agricultural Development Corporation (BADC) numbered 1.42 million diesel irrigation pumps to consume 1 million metric tons imported diesel per year. Electricity demand for 0.33 million electric operated irrigation pumps amounts to about 1700 MW.

The fuel costs of 1 million metric tons of diesel for water pumps can amount to 450-800 million US-Dollar annually, depending on the price of oil:

price per barrel of oil	annual cost in million US\$
60	439.8
70	513.1
80	586.4
90	659.7
100	733
110	806.3

Figure 37
Cost of diesel irrigation pumps with 1 million MT of diesel consumed, depending on oil price (1 MT=7.33 million barrels of oil)

Solar PV indeed would be an attractive alternative instead of diesel. While the solar resource is cost free, the real cost largely depend on access for capital and interest rates.

Distributed solar powered irrigation is cost competitive against diesel pumps with oil price at 60 \$/barrel and therefore should be enhanced beyond actual planning. It could save Bangladesh millions of dollars per year if oil prices again return beyond 60\$/barrel of oil.

- (11) Due to high cost of diesel, solar irrigation programs should be a priority.
- (12) To prove its full potential PV systems for irrigation should be switched to rural grids or batteries in times when no irrigation is necessary.
- (13) To keep cost of systems moderate, priority access to capital and microfinance, monitoring and supervising by IDCOL or similar institutions is recommended for irrigation.

14. Suggestions regarding scarcity of land

With more than 1000 persons per km² Bangladesh is very densely populated and cultivated land is in high demand. Hence renewable energy should be used in a way that does not stress availability of usable land.



Figure 38
Mixed use of solar and cattle

Expansion for renewable energy needs to adapt to local conditions:

- **Putting unused areas to work.** Thousands of roofs or roads and some waste land could be declared as a priority for solar PV tenure by the government. If land scarcity should be a central issue for PV, an obligation for building and street owners should be explored to offer new roofs, façades and roadsides for professional solar PV programs or self-generation, with feed-in-contracts.
- **Minimizing area impacts.** Oversized access roads for wind farms should be dismantled after construction; or they should be planned for dual use for transport infrastructure to enhance overall productivity and market access of such areas for agricultural products.
- **Dual-use surfaces.** Fish ponds and green-houses have started to be popular for PV installations in China and Japan [41]. Some plantations show increased productivity with irradiation reduced by some PV on the field. Fish ponds or shrimp farms should be a test bed for surface of floating PV that

can be deployed without compromising sea food or fish production.

- **Canals, rivers, lakes.** Surface water areas cover more than 10,000 square kilometer in Bangladesh. With an expected power consumption of 100'000 GWh by 2020, just 290 km² or three percent of these areas would be needed to cover 50% of power demand. For such high productivity PV from lakes, canals and rivers should have an East-West-orientation of installations where 1.15 MW/ha is possible as shown by a 300-MW project in southwest France [42]. When ground mounted PV systems are constructed to cover irrigation canals, side benefits such as lower water evaporation can be expected.



Figure 39
Floating PV in Japan [43]

New mounting systems and the combination of agriculture, fish culture and PV should be tested and evaluated by universities and the power sector. Results of these studies should made public.



Figure 40
Solar power generation and permaculture combined in La Réunion [44]

Over the past five years, a myriad of floating systems have evolved in varying degrees for use in ponds, reservoirs, canals, rivers and oceans. Among the benefits of using floating PV systems is the water-cooling effect on silicon solar cells, the natural reflectivity of the water surface, the potential reduction in algae growth due to

reduced sunlight penetration, and a lower water temperature in the areas below the arrays.

Suggestions

- (1) **Responsible authorities should examine the introduction of preferential feed-in-tariffs**
 - a. **for installations that do not use productive land**
 - b. **for floating installations to speed up mass dissemination of floating PV installations**

- (2) **Responsible authorities should publish on their website test results or statistical findings from special applications such as floating PV, PV on roadsides, PV on rivers and lakes and else. These results should include investment cost, O&M cost, annual production per kW, reports on risks and technical feasibility.**

15. End notes

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