

# **An Overview of the Power Sector of Bangladesh and the Future Plan to Meet the Demand in 2041**

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## **Abstract:**

*Bangladesh is thriving to become a developed nation by 2041 from a middle income country and to make this happen there is no alternative to provide uninterrupted electricity supply. The power sector transformation was taking place for last few decades and currently 97 percent of the population has the access to electricity. The policies to support the power sector is well proven but a constant upgrading and reformation is important according to the increasing demand. In this paper an overview of power sector is discussed and a future prospects of power sector is studied to know where the country stands right now. This paper focuses on the plans to incorporate more renewable energy in the grid and reduce the dependency on natural fuels. The whole world is facing shortage of natural gas and oil and in this situation a detailed study of the power system is needed to support the constant power supply as it has the greatest impact on other fields like agriculture, education in a country like Bangladesh.*

**Key Word:** *Fossil Fuels, Renewable Energy, Micro Grid, Transmission, Distribution, Generation*

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## **I. Introduction**

As Bangladesh is going to emerge as a developed country in the world map by 2041, the demand of electricity is rising dramatically. If this country wants to welcome the fourth industrial revolution successfully then only supplying power is not enough, it is also important to meet the quality and reliability of the supply. Government of Bangladesh (GoB) kept the electricity prices low and highly subsidized for the consumers which results in poor financial and operating performance and certainly lead to poor quality of power. Power sector of Bangladesh needs to reform to increase the access of power and to improve the service quality. It is also important to make the pricing in cost-reflective way to reduce the gap between cost for production and consumption. Moreover, Bangladesh has two types of resources to produce energy, one is renewable and another is non-renewable. From the very beginning Bangladesh is highly dependent on the natural gas to produce power. Around 62.9% of electricity is generated from natural gas, 3% from heavy oil, 5% from coal, 10% from diesel and only 3.3% is generated from the sources of renewables, which clearly indicates that contribution from renewable sources is not significant. For generation of power in non-renewable and renewable energy sectors, Bangladesh invested around US \$17 billion from 2009 to 2018<sup>1,2</sup>. In another study, it was stated that about 65% of the total electricity is generated from natural gas and the remaining natural gas reserve in Bangladesh is 7.25 trillion cubic feet (Tcf) which will be exhausted within a decade as per the report<sup>3,4</sup>. So shifting the power sector from non-renewable to renewable energy sources has become very important. It can be shown clearly, Bangladesh has invested a lot in the power sector but depending on the natural gas does not seem to be a smart solution. And producing power by oil is also not possible as it will increase the production cost of power. Another burning subject is global climate change, the continuous increase in CO<sub>2</sub> emission has put Bangladesh in the list of vulnerable countries because of climate change. Bangladesh ranked 7<sup>th</sup> on the Global Climate Risk index which is considered as a warning for the nation<sup>5</sup>. On the other hand, Bangladesh is on the verge of becoming a developed country by 2041. So for the future of Bangladesh it is important to tackle the climate change and also to do what it takes to become a developed country. To be a developed country by 2041, the production of quality power has no alternative and to do this we must incorporate renewable energy to the grid to reduce CO<sub>2</sub> emission as well. But reducing CO<sub>2</sub> emission for itself will not be enough for Bangladesh, it must get support from the neighboring countries and from the world as well. In Bangladesh, the growth of population is 1.5% each year which is high in case of a small country like this. Among them 37.41% of the total population lives in the urban area<sup>2,6</sup>. If the country becomes developed then the rate of urbanization will also increase with increasing demand in power supply and eventually a gap between generation and consumption will be created which will be an obstacle in the way of urbanization. This gap needs to be addressed with proper planning and proper execution of each step. Bangladesh's economy is the second fastest in the South Asia and fifth-fastest in the world. Bangladesh's gross domestic product (GDP) increased 10 times from 1972 to

2020<sup>7</sup>. So for a country like Bangladesh, uninterrupted power supply is important and it will bring changes to every sector of life.

## II. History of Power Sector of Bangladesh

GoB started reforming the power sector in the year 1970 and it is a process that still continues. After the liberation war of Bangladesh in 1971, prominent changes were proposed and Bangladesh Power Development Board (BPDB) was formed in 1972. In the year 1977, Bangladesh Rural Electrification Board (BREB) was formed as another significant step in this process. Then in 1993, it was proposed to finally unbundle the power sector, corporatizing entities and establish an independent regulatory commission. Following this Power Cell was created to facilitate and regularize the changes in power sector and new National Energy Policy was established. In the year 1996, transmission and distribution parts were separated for better performance. The biggest step was taken by GoB in 2000 when it seeks technical assistance from Asian Development Bank (ADB) to corporatize BPDB which finally happen in 2008. After a detailed analysis of ADB the “non-operating holding company with separate single buyer” structure was highly recommended. In the same year, a three-year roadmap was proposed to welcome substantial investments for economic growth and poverty alleviation. Following this roadmap several urban distribution and generation companies were created to improve its efficiency, transparency and governance<sup>8</sup>. Though a lot of initiatives were taken but recent years the reformation has slowed down. But the power market structure of Bangladesh cannot be shifted to multi-buyer system from single-buyer model unless the market become more stable. The initiatives taken for last decades has improved the power sector performance in terms of electricity access and loss reduction. Attractive capital investments from private sector for upgrading transmission and distribution network will help to implement effective and independent regulation system.

## III. Energy Production from Non-Renewable Sources

Bangladesh has achieved some remarkable success in the power sector and it was possible to achieve by following some drastic steps. In 2020 almost 93.5% of the total population had access to electricity while in 2015 it was only 77.9%. It can be assumed that right now the power sector along with the help of the distribution companies in the rural areas may have supplied electricity to the entire population. Over the last four decades with some relentless efforts this target was possible to achieve<sup>9</sup>. As the 65% of the electricity is produced by natural gas, currently only 2700 Million standard cubic feet per day (mmcf) is being supplied with a shortage of 450 mmcf per day<sup>10</sup>. To meet the demand of the gas GoB must take initiatives to find out more gas fields. According to BPDB the electricity generation capacity was reached to 20,000 MW and the possible production was 13,000 MW in the year 2019-2020<sup>11</sup>. The GoB has taken number of policies to meet the rapidly growing demand of the people of Bangladesh and planned to increase capacity to 21,000 MW within 2025. The private sector must be involved in this regard to support this rapidly growing demand of electricity. Below a figure shows the electricity production from non-renewable and renewable energy sources<sup>12</sup>.

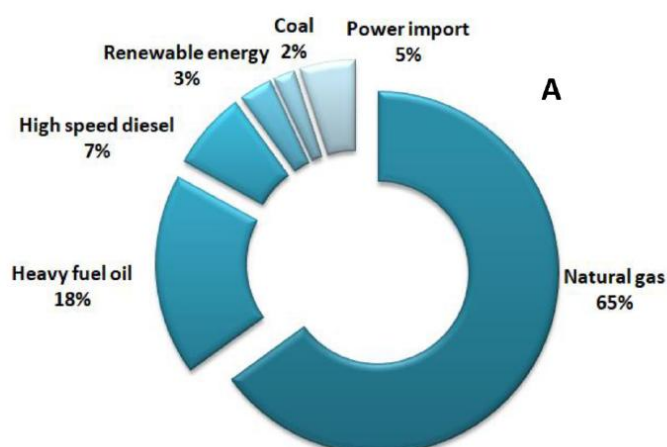


Figure 1: Production of Electricity from different kinds of Fuels

According to the Power System Master Plan, GoB adopted plans to increase the generation capacity to 34,000 MW by 2030 and 60,000 MW by 2041 and it is projected that the power generation from coal will rise from 3% to 50% by the year 2030<sup>12,13</sup>. With this increase in coal contribution we must be ready to deal with the residuals from coal as well. Below in figure 02, the rising demand of electricity within year 2041 is presented<sup>14</sup>.

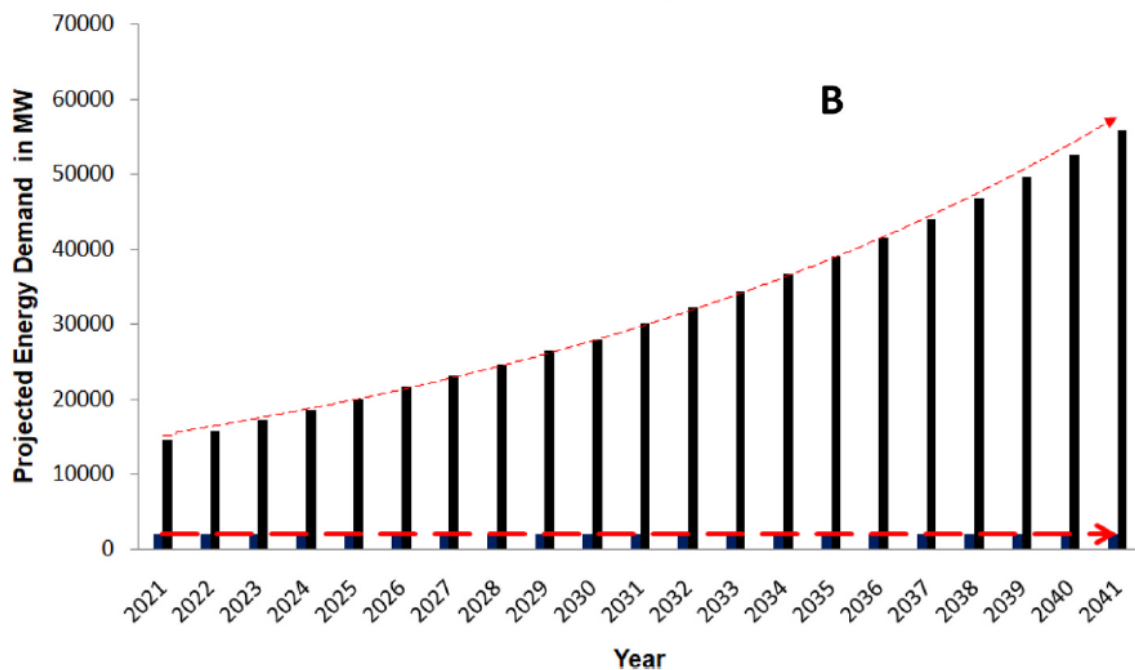


Figure 2: The projected demand of energy by the year 2041

Among this 50% of production from coal based power plants, 20,000 MW was planned to produce from domestic coal but GoB must support coal sourcing, coal handling, port facility to bring more coal in the country. Bangladesh also has oil fired power plants and oil imports has been rising in the recent time as the country desperately needs to reduce the use of natural gas in power production. To handle the power crisis GoB allowed to install 79 oil fired rental and quick power plants<sup>15</sup>. The production cost in these power plants is much higher compared to the coal based power plants. To compensate this high power production cost, the base load power generation should be supported by coal based power plants. The GoB assured to supply oil to this power plants to get uninterrupted generation of 1500 MW across the country<sup>16</sup>. GoB should take furnace oil and rapid diesel from Bangladesh Petroleum Corporation (BPC) and this demand should increase in the year 2020 to 2030 so that the cost of importing oil could be minimized<sup>17</sup>. Finally, it is evident that there are three types of fossil fuel power plant in Bangladesh-coal, diesel and gas based. Bangladesh is also committed to produce power from nuclear power plant by 2040<sup>12</sup>. So the Green House Gas (GHG) emission could be a big problem in the coming years.

Bangladesh has not yet entered the era of renewable energy fully and all power plants are running depending on fossil fuels. But if the electricity could be generated from clean energy then there could be a chance to produce low-carbon footprint. Renewable energy could help to reduce carbon emission. The use of smart grid could be another solution in this regard. Along with the use of the fuel, this country must also concentrate on digitalizing power sector, using artificial intelligence, follow some higher demand response mechanism, find out solution for high battery storage. As the country is going to become a developed country, the issue with reduction of gases like SF<sub>6</sub> will become important. Sulfur hexafluoride (SF<sub>6</sub>) has the highest global warming potential and it is extensively utilized in the electrical industry which could be more dangerous than any carbon substance. SF<sub>6</sub> can stay in the atmosphere in more than 100 years<sup>18</sup>. In the figure below the major decarbonization technology for power sector is shown<sup>19</sup>.

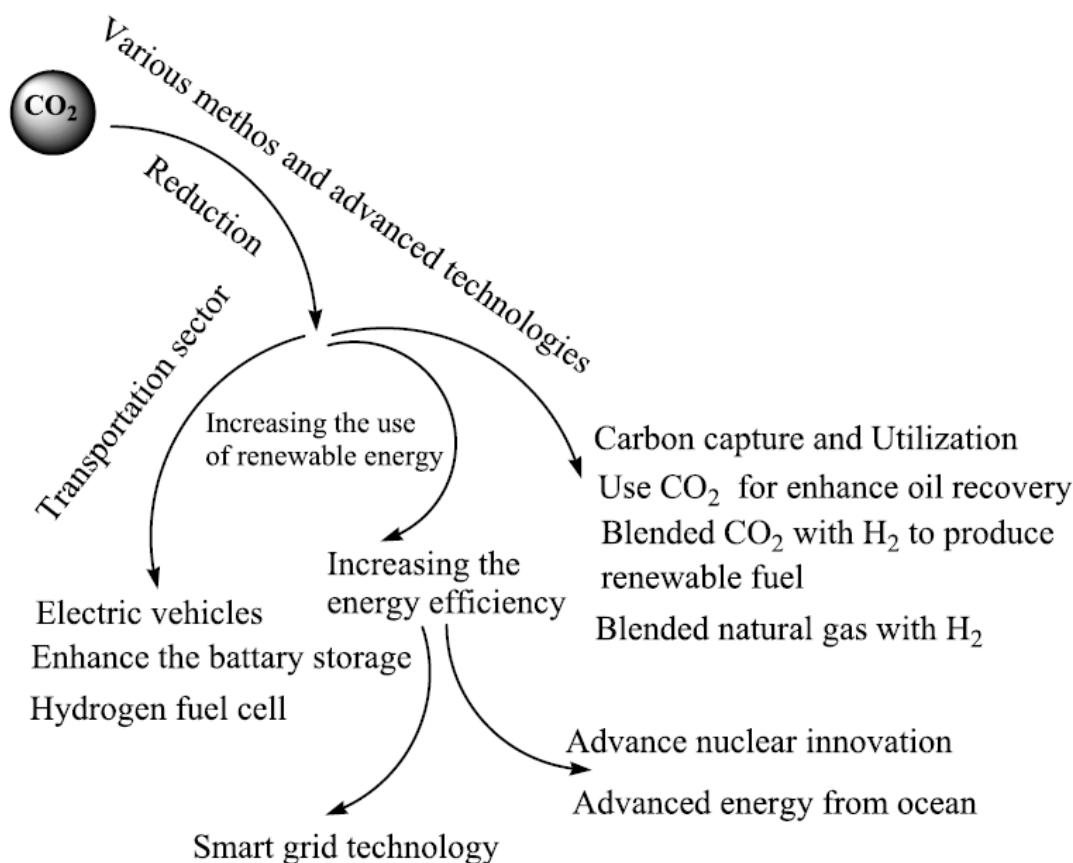


Figure 3: The major technology to reduce carbon substances in power sector

#### IV. Energy Production from Renewable Sources

The renewable energy has great prospect in Bangladesh but not utilized so far in great extent. In 2009, GoB planned to produce 5% of the total energy demand from renewable sources by 2015 and 10% by 2020. This target is not achieved as this production of energy is very costly and comparatively very new technology. But the Government hope to produce 30% of the total energy demand from renewable by 2030 and 40% by 2040. But looking at the conditions the Government again planned to 15% by 2030 and 40% by 2050<sup>20,21</sup>. But according to these plans we must keep in mind that the old transmission and distribution system of electrical network cannot give support to integrate renewable energy in the grid. It needs to reconstruct the transmission and distribution network to support this kind of power supply.

Solar Energy is one of the primary sources of renewable energy. It was planned to have an on-grid power plant but to have that much land was a challenge. This country has good potential to establish solar power plants as there is sun almost all year long. Another idea was to install floating power plants on different water location and produce 10% of the total electricity demand<sup>20</sup>. Sustainable and Renewable Energy Authority (SREDA) reported that if 1% of the water surface could be used then it was possible to produce 500 MW of electricity from solar panels<sup>22</sup>. It must be noted that the country's solar energy was primarily dominated by off-grid Solar Home System (SHS) with almost 6.02 installations nationwide generating 263 MW of electricity<sup>23</sup>. Producing 263 MW of power in the rooftop to producing 10% of the total energy demand of the population is a huge step. To support this the necessary infrastructure needs to be built first. The figure below shows the projected solar energy installation in Bangladesh<sup>19</sup>.

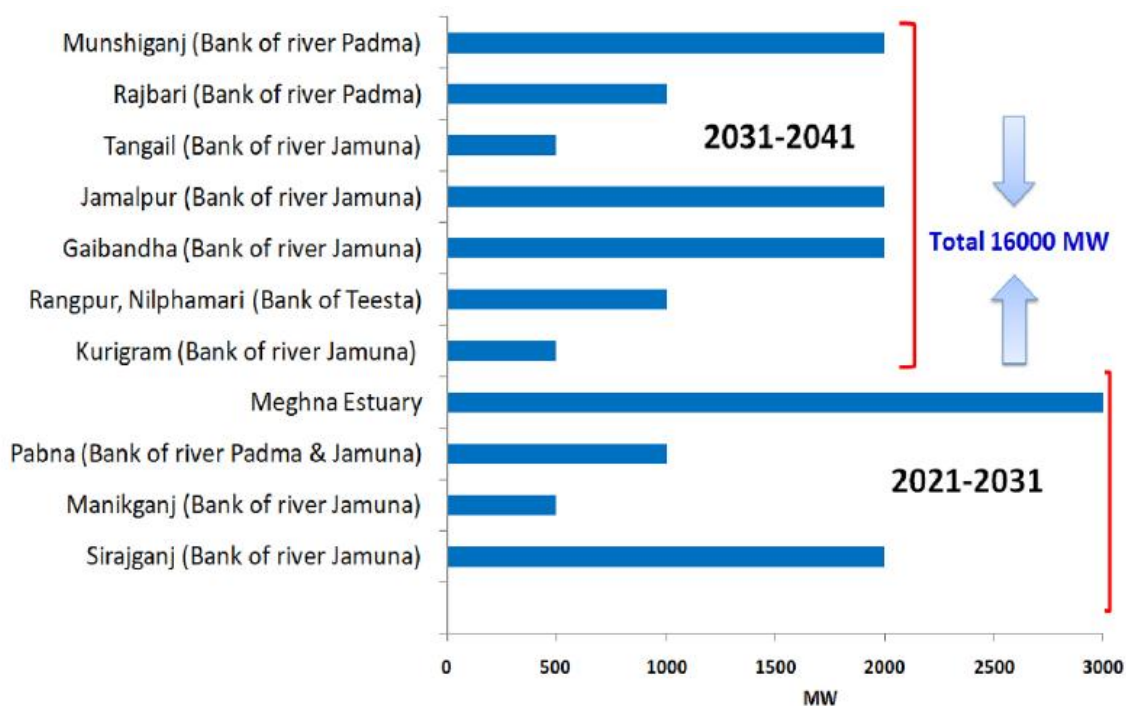


Figure 4. The projected solar power generation in large scale

Wind Energy could be another renewable energy source to produce power which has great potential in the offshore area. The wind speed is increasing around the world so in Bangladesh Wind energy in the coastal areas of Bangladesh has some satisfying wind speed as high as 120 m high and wind speeds 7 per second (m/s) which should be sufficient for power generation. Though Bangladesh has higher potential to produce electricity from wind, it only produces 2.9 MW of electricity from wind sources<sup>24,25</sup>. Bangladesh only produces 230 MW of hydropower which is lowest in South Asian Region<sup>19</sup>.

## V. The Future of Micro Grid System

The current grid system of Bangladesh is not developed to integrate renewable energy to the grid which is a big problem to incorporate renewable energy to the grid. To support renewable energy production electronics converter as well as strong battery storage system advanced metering system, protecting devices to protect sensitive equipment used to produce power from renewable sources is necessary. In this section some parts of micro grid are discussed.

Power Electronics Converter (PEC) stages are very important part for providing flexible interconnection between the grid and the load. Semiconductor devices of broad bandgap need to be considered in this regard<sup>26</sup>. Power electronics based Flexible Alternating Current Transmission Systems (FACTS) devices should be used in the grid for the efficient grid system. Another productive investment can be to use Battery Energy Storage System (BESS). This system can improve the system's stability and supply power at the peak hours when instant generating power is not enough<sup>27</sup>. BESS can also be installed with wind power system to supply power when there is not enough wind. Smart measuring system can be another solution to the micro grid system where power can flow inward or outward at the customer end. A smart measuring system needs to be installed to see how much power is surplus at the customer end and to see if that power can be used by someone else<sup>28</sup>. Protection is another important part of this kind of grid system. The two most important kind of protection system of micro grid are voltage-based protection and total harmonic distortion based protection. Moreover, a communication based protection system could be of more useful for the micro grid system in terms of improving performance matrices. The Point of Common Coupling (PCC) is in the point where the micro grid and the utility grid interacts. For the proper operation of PCC, current flow between the micro grid and the utility grid need to be adequate and absence of information in the neighboring micro grid can be a problem. Micro grid resilience is another important point to be addressed. Fault may occur in any grid but it is essential to address that fault immediately. In this respect a 3-D droop concept is applied in a hybrid micro grid system to increase system stability and improve power quality<sup>31</sup>. An Energy Management System (EMS) framework is a requirement in managing and scheduling distributed generations and conventional power from micro grid to the consumer. EMS can be used in any nature, centralized or decentralized<sup>32</sup>. Below we can see the smart grid architecture following IEEE 2030-2011 standards from<sup>33</sup>.

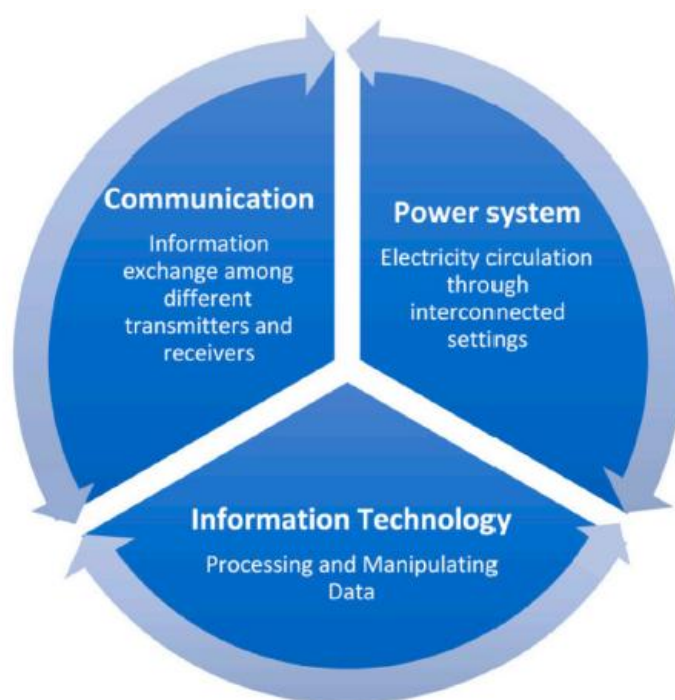


Figure 5: Possible Smart Grid Architecture following IEEE standards

The management of micro or smart grid depends on the data management, cyber security and the whole communication architecture. Micro grid will ensure system security, reliability and supply of quality power. The communication system should maintain quality of service to maintain the uninterrupted performance of the power system. Bangladesh is already on the verge of digitalization so inserting Internet of Things (IoT) could be an advanced solution to detect any fault as early as possible, to predict the demand increase and for the security as well. The grid should be protected from cyber-attack and for that IoT has a vital role to play.

## **VI. Policies for Energy Production in Bangladesh**

In this section, the energy policies are discussed from the very beginning of the energy sector reformation in Bangladesh. It is very clear that for decades several steps were taken to reform this sector and currently 97% of the total population is under electricity coverage. In Bangladesh, currently BPDB is the single buyer, purchasing power from small rental power plants, from several established power station companies across the nation and even from the Government owned generation companies. BPDB sell this power to five distribution companies and to some of its own distribution zones. As a result, there is no competition in terms of wholesale or retail. In 1996, the transmission side was separated by introducing Power Grid Company of Bangladesh (PGCB) which added a new era in regulating the transmission network. In terms of transmission huge changes were made by separating the distribution part and named it Dhaka Electricity Supply Authority (DESA) in 1991 to manage supply in Dhaka and neighboring zones. But unfortunately it did not work properly and later some part of its network was taken by Dhaka Electricity Supply Company Ltd (DESCO) in 1996. In 2008, Dhaka Power Distribution Company (DPDC) started its commercial operation. Later more distribution companies were introduced to handle the distribution side and more corporatization and commercialization was welcomed. BREB is the largest distribution company in Bangladesh who is serving almost 31 million customers. Allowing private sector to invest power sector was a very crucial decision which was paid off as currently 50% of power in Bangladesh is produced by the private sector. But still there is gap between power generation and power demand which must be addressed<sup>8</sup>. Bangladesh has huge potential in renewable energy sector, according to US National Renewable Energy Laboratory (NREL), Bangladesh' solar power generation potential is approximately 240 GW and wind power potential is 30 GW. Report shows that Bangladesh has potential to produce 100% power from renewable energy by 2019<sup>34</sup>. But the available renewable power is not near to this number. Moreover, Bangladesh is running power plants based on subsidy by the Government as the gas supply has reduced drastically. So it is not possible to offer more subsidy to support renewable energy in this context.

Bangladesh should take initiatives to welcome power mix which allows renewable energy to integrate with the power generation from fossil fuel. This needs a tremendous upgrading of the grid and it also needs a lot of investments. But GoB should propose some policies to allow energy mix to meet the electricity demand by the year 2041. Bangladesh government should also deploy policies and infrastructure for carbon capture and storage<sup>5</sup>. This country is vulnerable to climate change so producing power from non-renewable sources will raise the sustainability issues. This country is also a country of agriculture so policies should match not to harm the environment at all. Another possible solution could be to welcome Foreign Direct Investment (FDI) from foreign investors which has already started. Bangladesh has taken five big projects in producing power using renewable energy and one third investment is made by foreign investors<sup>1</sup>. FDI can have both positive and negative influence on power sector so GoB should plan all possible options to alleviate any negative impact on the power sector.

## VII. Conclusion

In Bangladesh, the need to reform the power sector was a matter of time and many drivers were considered to do it. The country is the fastest growing economy so a pressure to supply enough power was a basic condition in the way of economic growth. But there was lack of state funds, huge subsidies, high loss, poor policy and corrupt and inefficient processes. Gradually, it has reached to a point from where a developed Bangladesh can be dreamt off and the main drive for this is the overall coverage of power supply. In 2041, when the country becomes a developed country there will be excess of power. If the power generation could be managed or could be sold out to some neighboring countries, then GoB may not need to give a huge subsidy in the future. The target of the Government should be to reduce the gap between the cost of generation and consumption, otherwise no such policy could be sustainable.

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