

Assessment of Energy Security Snapshot in Developing Country Bangladesh

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Abstract: This paper presents the historical energy security status from the beginning of 21st century in developing country Bangladesh. Indicator based analysis has been conducted through seven aspects namely; resource availability, resource balance, energy demand, energy expenditure, environmental concern, technological advancement and investment in the energy sector comprising 23 indicators were evaluated. Vision 2020 shows that energy resource availability and resource balance will be decline against the sharp increase of energy demand which reporting the country is going to face serious energy security threats in future. Energy expenditure is found to be steady, environmental impact and technological advancement is found to be improved as per steps has been taken by the government. The country needs special apprehension and policy priority to mature implement such steps to make stable and better strength of energy security status in future.

Keywords: *Energy crisis, energy security, indicators, developing country, Bangladesh.*

I. Introduction

Energy security is the prominent topic to the energy researchers of 21st century. The researchers reported that, there is no concrete definition of energy security due to influence by many drivers varied with geographical background [1]. The most cited definition of energy security is the adequate, affordable and reliable supplies of energy for the modern living [2]. Obviously these parameters are depends on multiple indicators of each country. Distinguish research report shows that, developing countries required significant energy in near future will contribute major share on global energy consumption [3]. On the other hand, the global distribution of fossil energy will be challenging in future, since fossil energy playing a dominant role in the global energy consumption till now. Therefore, self assessment of historical energy security is important for each country. Bangladesh is a developing country has population density of 1100 persons per km² [4] with lower per capita energy consumption compared to South Asian neighbouring countries [5]. The share of energy sources in total energy consumption are gas 55%, coal 11%, oil 12% and renewable 22% [6]. The rapid urbanization and industrialization of the country highlighted the energy requirement increase by 10% per year [7]. The study on energy evaluation of Bangladesh is limited to two current literatures. A study of energy security of Bangladesh is reported by Ref. [8]. The study presented a quantitative assessment of energy security in a descriptive manner. The qualitative assessment is not highlighted and the study was conducted based on limited aspects. Energy policy and regulations are not the issues in the concept of energy security rather they are the tools to achieve the energy security [9]. Another study on energy sector is reported by Ref. [3]. The study discussed only on renewable energy potential and progress of renewable energy technologies (RETs) application in Bangladesh. It is difficult to predict the historical change and projection of energy security in Bangladesh using the existing study by which the policy maker and energy distributor will take the necessary steps for future energy sector development. This study presents the energy security of Bangladesh in a comprehensive manner incorporating many aspects including policy concern as possible. The qualitative and quantitative results are presented in terms of indicators since indicators are more useful for dynamically presenting the trend of energy security situation. The year 2001 is the beginning year of this study as the initiative of 1st technical and institutional reforms in Bangladesh was taken in 1996 to develop the energy sector and implemented in the year 2001 [10]. The study conducted from the year 2001 to now with five year interval as the validity of the elected government in Bangladesh is five years and also projections for the year 2020 as per government vision. Total of 23 indicators are selected for the evaluation. The values of indicators under each aspect are estimated for ending year of each fifth year and present the situation graphically in a comparative manner. The study examines the weak points that need effort to develop the energy sector. The organization of the manuscript is as follows: Section 2 describes the methodology, Section 3 presents the analysis of energy security results and Section 4 presents the conclusions.

II. Methodology

This section describes the methodology used to evaluate the historical trend of energy security situation in Bangladesh from the year 2001 to vision 2020. The section also describes the selection process of the energy security indicators and estimation procedure.

2.1. Selection the energy security indicators

There are no universal accepted energy security indicators that can be applied in any country, since the energy security is a dynamic in nature from country to country and depends on national priorities and national concerns. The most common criteria to select the energy security indicators are published by Ref. [11]. The energy security indicators in this study are identified and selected based on these common criteria and country concerns. The selected indicators and criteria adopted are shown in Table 1. Critical evaluation of each indicator is important to justify the selection and better focus the energy security of the country. The details of the critical evaluations behind the selected indicators are described below.

Table 1. Selection the energy security indicators and criteria adopted

Aspects	Indicators selected	Source	Criteria adopted [11]
Resource availability	1. Reserves to consumption ratio of natural gas 2. Reserves to production ratio of Coal 3. Availability factor of conventional thermal electricity 4. Availability factor of non thermal electricity	[9]	(i) Availability of energy resource supply, greater self-reliance/self-sufficiency rate, Sustainable supply, accessibility by all citizen, accessibility to fuel resources
Resource balance	5. Resource diversification index 6. Share of coal in total primary energy supply 7. Share of oil in total primary energy supply 8. Share of natural gas in total primary energy supply 9. Share of renewable energy in total primary energy supply	[9, 11, 12]	(ii) Diversification of energy sources, Diversification of import source countries/suppliers
Energy demand	10. Energy consumption per capita 11. Oil import dependence ratio 12. Energy consumption per GDP	[9]	Criteria (i) and (ii)
Energy expenditure	13. Growth rate of coal price 14. Growth rate of petroleum price 15. Growth rate of electricity price 16. Growth rate of gas price	[9, 11]	(iii) Energy price-affordable price or acceptable price
Environmental concern	17. Per capita CO ₂ emission in Bangladesh 18. Global average per capita CO ₂ emission 19. Share of renewable energy in total electricity generation	[9]	(iv)Mixes in a cost effective manner- production cost reduction (v)Without harming the environment, Good quality energy supply
Technological advancement	20. Average generation efficiency of fossil fuel power plant 21. Crude oil distillation capacity	[9]	(vi)Resilient energy system / withstanding threats /less vulnerable infrastructure
Energy sector investment	22. Investment for power generation 23. Power and energy sector upgrading and renovation investment	[9, 11]	(vii)Securing energy supply for Social activities, defense and other purpose Criteria (vi)

2.1.1. Critiques of availability indicators

Natural gas is the major national source of fossil energy in Bangladesh that accounts 75% of the commercial energy use. Bangladesh has 20.5 trillion cubic feet of natural gas reserve of which 10.4 trillion cubic feet gas already recovered as per the year 2012 reported by the ministry of finance. Conversely, the average daily gas demand was 1996 mmcf in 2010 and at present it is 2500 mmcf emphasis the gas demand increased by 20% [6]. The current gas consumption rate implies the reserves of gas in Bangladesh will be sustained up to 2020. Question arise what will happen after that! where natural gas contributing a major share of total energy consumption of the country. Hence, it is important to assess the status of reserves to consumption ratio of natural gas for the understanding of natural gas resource compared with other types of energy sources in Bangladesh. Coal is the second important fossil energy resource in Bangladesh. Coal reserve is estimated about 3000 million ton which can meet the country energy need conveniently for 50 years [14]. The contribution of coal in energy sector is negligible due to lack of modern technology and suitable method of exploitation. Reserves to production ratio of coal can be an important indicator to be analyzed. Bangladesh is densely populated country. The country is not fully electrified. The electricity access at the end of 2013 has been raised to 62% [6]. Coal, oil and natural gas power plant is the major player in the electricity generation sector of which contribution of gas power plant is significant. It is important to understand how the electricity available for the population from conventional sources. The source of electricity in Bangladesh is mostly from gas. Government

has taken initiatives to increase the contribution of renewable sources for the generation of electricity. Currently, solar PV, wind, hydro are established to deliver electricity and their share is limited. Their capacity is increasing from last ten years and initiatives already taken to increase the capacity. Government also agreed to establish a 2000 MW nuclear plant under the financial aid of Russia [8]. Hence, it is important to analyze how the availability of electricity from renewable sources is increasing. The general expression for the estimation of energy availability factor is shown below:

Energy availability factor = $100 - (\text{Energy unavailability}\%)$

$$\text{Energy unavailability} = \frac{\text{Maximum capacity} - \text{available capacity}}{\text{Maximum capacity}}$$

2.1.2. Critiques of resource balance indicators

The shares of multiple sources of energy enhance the strength of country's economy and eliminate the dependency on one source of energy. Bangladesh adopted coal, oil, natural gas and renewable sources to meet the country's energy need. It is important to analyze their shares on total primary energy supply for better focus on the balance of resources of the country. Higher the diversified mix of energy sources, higher the strength of energy security. Currently, these terminologies increasingly incline toward investment in renewable energy. The exploitation of renewable energy in Bangladesh is immature, though the country has significant potential for the exploitation of renewable energy. At present, the contribution of renewable energy in the electricity generation sector is 0.5% [6]. Bangladesh has already taken initiatives to increase the contribution of renewable sources as per revised policy in 2008 [3]. The policy includes subsidies, public-private partnership, R&D, energy projects, etc to develop the renewable energy sector. Hence, the assessment of diversification index is important for the understanding of resource balance. The mathematical expression [11] to estimate the diversification index is shown below:

$$\text{Shannon wiener index (SWI)} = H = - \sum S_i \times \ln(S_i)$$

$$\text{Maximum possible diversity } H_{\max} = \ln(S)$$

S = 4 for four types of energy sources

$$\text{Diversification index} = \frac{H}{H_{\max}}$$

2.1.3. Critiques of energy demand indicators

The energy consumption per capita in Bangladesh is lower compared to the average of South Asian neighbouring countries and rapid urbanization and industrialization implies the country's energy demand will increase in the future. Understanding of historical and projected demand and corresponding effort required, energy consumption per capita and energy consumption per GDP could be the indicators to assess such situations. Bangladesh has three locations to discover the oil resource but the quantities are not significant for exploitation [6]. Around 12% of the country's total energy consumption is met by imported oil. The country currently imports 7 million tons of oil per year worth of several billion dollars, putting significant pressure on the economy [45]. The oil import dependence ratio can be an indicator to assess the energy security of the country. It is the ratio of total net crude oil import excluding ethanol, biodiesel and NGL to the net crude oil inputs to refineries [29].

2.1.4. Critiques of energy expenditure indicators

Stable and affordable access to the consumer is an important issue of energy security. To understand such issues, study of energy expenditure indicators is important. Coal, oil, natural gas and electricity are the types of energy needed to be stable and affordable for the people in Bangladesh. The energy price is always increasing in nature and their increasing rates fluctuate with time. Local price is not only dependent on country situation but also depends on international conditions. The rate of change of prices reveals that how energy affords to pay for the people. This aspect adopted the growth rate of coal, petroleum, natural gas and electricity price.

2.1.5. Critiques of environmental indicators

This aspect emphasizes how changing the environmental sustainability of the country using alternative energy sources. Though Bangladesh is not a major contributor to the global environmental emission and it is a local concern. This aspect will demonstrate how the technologies are changing towards energy efficient technology. Electricity generation sector in Bangladesh is mostly fossil fuel based and is responsible for local emission. Higher the contribution of renewable energy implies higher the environmental acceptance to the people and energy security. Around 89% power generation comes from natural gas in Bangladesh. The

contribution of renewable sources in power generation sector is only 0.5% and expected to be increased in future [8]. Hence, the progress of cleaner technologies could represent the environmental issues.

2.1.6. Critiques of indicators relates to technological advancement

The electricity generation plants in Bangladesh are mostly depends on fossil fuel and their contribution is significant in total energy consumption. The involvements of modern technologies in the electricity generation sector are not matured yet. Therefore, the trend of average generation efficiency of these plants is considered to reflect the strength of advanced technologies application. The country has insignificant resources of oil and need to import oil from abroad in terms of crude oil to meet the 12% energy needs by oil. So, the crude oil distillation capacity is an indicator to measure directly the strength of technology in harnessing and utilizing the energy resources. The technological advancement and innovation is strongly related to the investment by the government and NGO's.

2.1.7. Critiques of indicators related to investment for energy sector development

Investment is required to upgrading and renovation the energy sector. Investigation shows that investment for energy sector upgrading get less importance in the annual national budget of Bangladesh. So, it is important to analyze how the government concentrating on energy sector development providing national budget. Power demand is increasing exponentially painted the increase of demand-supply gap in Bangladesh. Though, government passing a difficult time to distribute commercial and residential power but the investment for this issue is less important in national budget. Hence, it is important to understand only on power generation aspect that how the government providing financial support to generate power in Bangladesh.

2.2. Data and estimation

The indicators, these are appropriate for Bangladesh selected to evaluate the status of energy security. Total of 23 indicators are selected to assess the aspects. The indicators are clusters in to seven aspects. The literatures, survey and questionnaire data are collected and summarized as shown in Table 2. The data are then checked for consistency. The projected data are considered as per government vision for the year 2020. The projection of energy price is drawn from the previous historical data since the prediction of energy price is difficult as it depends on number of fluctuated parameters in national and international concern. The data are collected for the ending year of each five year plan. The collected raw data are used to calculate the indicators under each aspect and the values of indicators are considered for the analysis of each aspect.

Table 2. List of collected raw data and sources

Data	Unit	Sources	2001	2005	2009	2013	2020
Natural gas reserves	mm ³	[13-14]	300158	300158	141584	183747	0.00
Natural gas consumption	mm ³ /yr	[13-14]	10299	13988	19595	21860	0.00
Coal reserves	million ton	[14]	2967	2967	2967	2967	projected
Coal production	million ton/yr	[14-16]	0.00	0.076	0.88	1.00	21.00
Total amount of imported oil (Exclude ethanol, biodiesel, and NGL).	Barrel/day	[15]	67419	78187	92267	104550	projected
Total amount of oil consumed	Barrels/ day	[17]	71000	86000	98000	110000	Projected
Maximum Capacity of power generation using coal, oil and gas fuel	MW	[18-19]	4000	4800	5700	8819	20000
Available Capacity of power generation using coal, oil and gas fuel	MW	[6-7, 20]	3500	3782	4296	6675	18000
Maximum Capacity of power generation using renewable sources (wind, PV, solar home system, biomass, biogas)	MW	[6, 21-23]	0	0	52	50	1480
Available Capacity of power generation using renewable sources (wind, PV, solar home system, biomass, biogas)	MW	[6-7, 21]	0	0	19	33	1800
Share of coal in total primary energy supply	%	[6, 8, 25-26]	0	3.2	7	11	50
Share of oil in total primary energy supply	%	[6, 8, 25-26]	20	12.5	12	12	Projected
Share of gas in total primary energy supply	%	[6, 8, 25-27]	25	35.1	51	55	Vision 2020
Share of renewable energy in	%	[6, 8, 19, 25,	55	49	33	22	17

total primary energy supply		27]					
Share of renewable energy in total electricity generation	%	[6, 24, 28]	0	0	0.43	0.5	10
Energy consumption per capita	kgOe	[29-30]	153	169	200	230	260
Average generation efficiency of fossil fuel power plant	%	Field survey	34	34	34	33	35
Crude oil distillation capacity	Barrel/day	[31-33]	33000	33000	33000	34000	84000
Power and energy sector upgrading and renovation investment	% of total budget	National budget	5.3	6.6	3.8	3.7	2.4
Investment for power generation	% of total budget	National budget	0.7	0.8	0.8	0.4	0.38
Share of renewable energy in total electricity generation	%	[6, 21, 24]	0	0	0.43	0.50	10
Per capita CO ₂ emission in Bangladesh	ton	[13, 30, 34]	0.24	0.26	0.35	0.40	0.88
Global average per capita CO ₂ emission	ton	[6, 35-38].	3.9	4.41	4.80	5.00	5.30
Nuclear energy share on total electricity	%	[6]	0	0	0	0	11
Coal price	BDT/ton	[26, 39-40]	0	3300	7200	10200	projected
Petroleum price	BDT/lit	[18, 41-42]	12	26.8	43.64	79.51	projected
Electricity price	BDT/kWh	[18, 42-43]	1.65	2.12	2.53	5.36	13.88
Gas price	BDT/m ³	[43-44]	2.75	3.00	3.25	3.75	Projected
Energy consumption per GDP	(kgOE/GDP)	[29-30]	0.152	0.145	0.141	0.138	0.134

III. Energy Security Analysis

The historical energy security performance in Bangladesh from the beginning of 21st century is analyzed in this section. The year 2001 is considered as a reference year since the constitutional and technical reform for the energy sector development in Bangladesh was started from this year. The values of indicators for the period 2001-2013 are based on the actual data and values for the year 2020 are based on the historical projection and government vision. The aspects are estimated, analyzed and results are described in the following sections.

3.1. Resource availability

Figure 1 shows the historical trends of resource availability indicators from the year 2001 to 2020. It is seen that, availability of coal and natural gas was significant in 2001 and is declining with year (Figure 1a). The availability of oil is insignificant. The vision 2020 shows that the availability of natural gas going to zero and the utilization of coal would be negligible to meet the energy demand where at present, natural gas contributing more than 50% of total primary energy demand of the country. This alarming report pinpointing the country is going to face the challenge of energy threats in future. On the other hand, average trends of availability factor of thermal and non thermal electricity is not positively changed until the year 2013 (Figure 1.b).

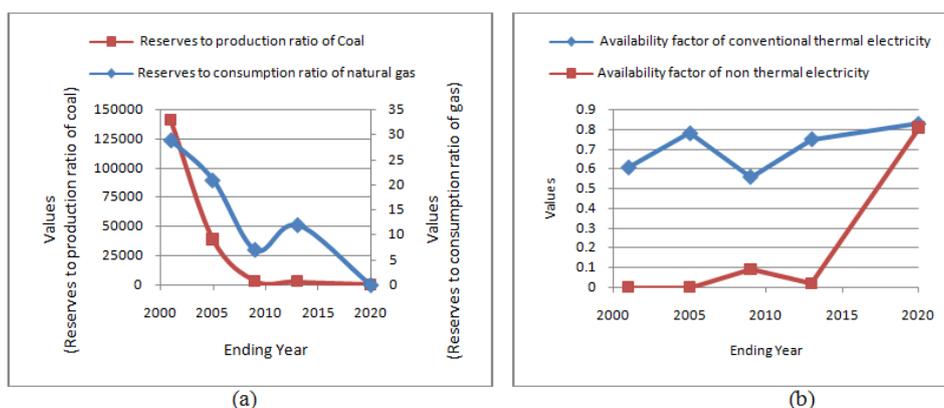


Figure 1. Changing trends of availability indicators

The vision 2020 shows the increasing trend of availability factors due to exploitation of national coal, newly installed coal power plant using clean coal technology and contribution of renewable energy in the electricity generation sectors in future. But question is that, how much this contribution would be able to tackle

the current load supported by the natural gas? Since the reserves of natural gas would be zero in 2020. Ultimately government will concentrate on imported sources if any other alternative way is not found to defend such situations result is increase the energy price.

3.2. Resource balance

Figure 2 shows the shares of energy sources in total primary energy supply. Coal, oil, natural gas and renewable sources are the types of options that supply the energy demand of Bangladesh. In 2001, the country was significantly depended on imported energy. Though, discovery of national coal is late fifties and natural gas is 1980's [46] but their utilization was not mature at that time. The initiative for the utilization of national resources in the energy sector was very unfortunate until the year 1996. Initiatives for the institutional and technical changes were made in the period 1996-2000 to improve the energy sector [10] and their impacts started from the year 2001.

Findings of huge amount of natural gas and its exploitation during the year 2001-2013 made the government less concentrate on renewable source and oil import to meet the energy demand. So, the trends of natural gas and coal are increasing from the year 2001 to 2013 whereas trends of renewable source and oil are decreasing. The trend of diversification index shows that, though the resource balance is going to better until the year 2013 but the trend is declining in the year 2020 since the availability of natural gas going to be zero. In addition, utilization of coal and renewable energy in 2020 will not be able to take full load of natural gas. Hence, the overall resource balance will be decline in future.

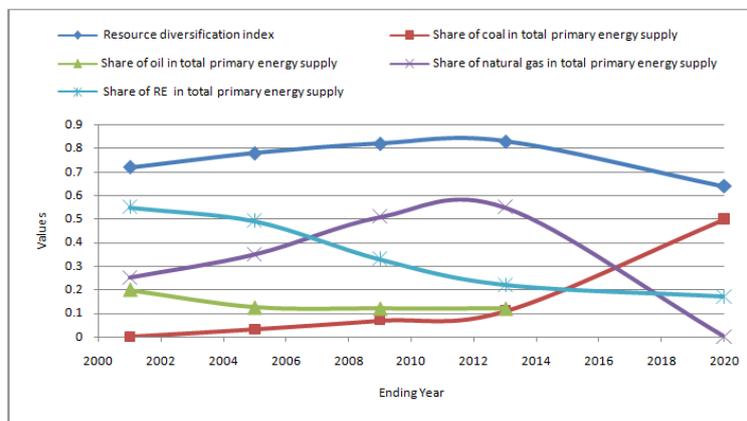


Figure 2. Changing trends of resource balance indicators

3.3. Energy demand

The characteristics of energy demand indicators are shown in Figure 3. During the year 2001-2008, significant institutional and technical reforms were taken to strengthen the energy sector in Bangladesh. The new energy sources were not found during the period 2001-2005 and contributions of national energy (natural gas) on total primary energy supply were increased and reduce the dependency on imported oil.

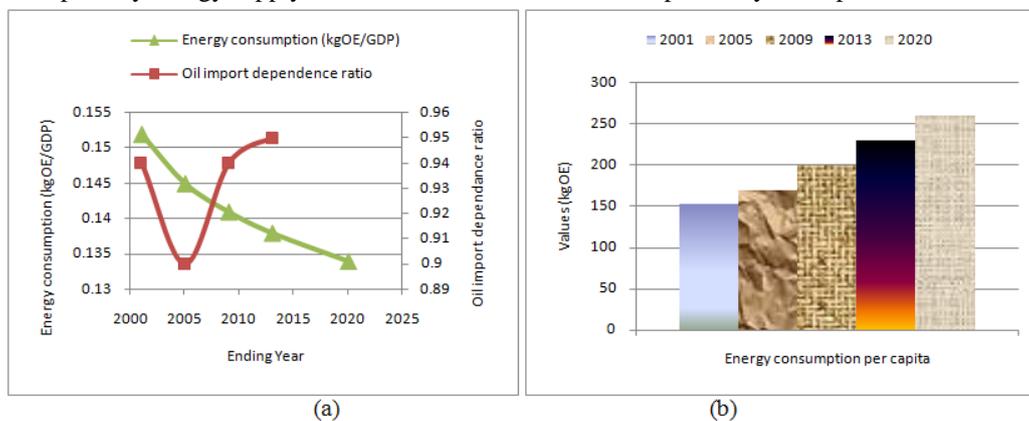


Figure 3. Changing trends of energy demand indicators

The oil import and consumption trends are increased for the other years but it is essential to decline the trend for better energy security. Declining the trend of energy consumption per GDP implies the positively

change of energy security. Figure 3 b shows the energy consumption per capita is increasing at a uniform rate shows the energy demand will be increase in future.

3.4. Energy expenditure

The trend of indicators adopted in energy expenditure is presented in Figure 4. It is difficult to understand the fluctuation of energy price due to it depends on many factors of the country. This study adopted the local market prices for the analysis. The coal price in 2001 was set as USD 61.5 per ton by planning commission and is two folds increases as per decision of power development board and energy and mineral resource division. In spite of increasing the coal price, government has taken a plan to incorporate the energy share about 50% by using coal in 2020. The feasibility of such plan is challenging and needs special care to make it practical. Bangladesh import petroleum from abroad. Since the price of petroleum is greatly influenced by the international protocols, the fluctuations of such issues are not easy to understand. The country has limited reserves of oil shell but the exploitation is not matured yet due to lack of modern facilities. Gas price is increased by 10% from the year 2001 due to lack of gas tariff adjustment during the period 2005- 2008.

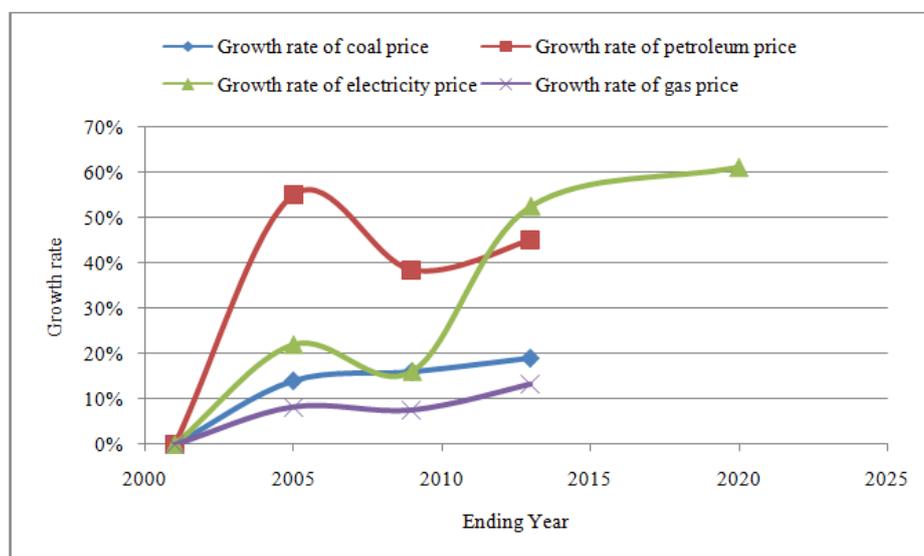


Figure 4. Changing trends of energy expenditure indicators

The gas prices remain unchanged in 2009 and increased in 2013 to prevent wastage the national resource. The share of national gas for the electricity generation in 2009 was significant but due to vulnerability of gas supply and concerning limited reserve government had suddenly imported the oil that causes oil share jump to 21% in 2013 and the electricity price has increased. The future projection declares that the electricity price will be increase due to unavailability of national gas reserves in the year 2020.

3.5. Environmental concern

Figure 5 shows the indicators adopted in environmental issues for the selected ending years. Though Bangladesh is not a major carbon contributor on global carbon emission but it is a national concern to ensure the better air quality under the people will live. The trend shows that (Figure 5a) per capita CO₂ emission is increasing in both globally and locally for the selected ending years. Though, per capita CO₂ emission in Bangladesh is much lower than that of global average value but it needs control to further local emission. Government has frequently taken the steps to incorporate the renewable sources in the energy sector but observation shows the implementation of such steps are still immature until the year 2013 (Figure 5b).

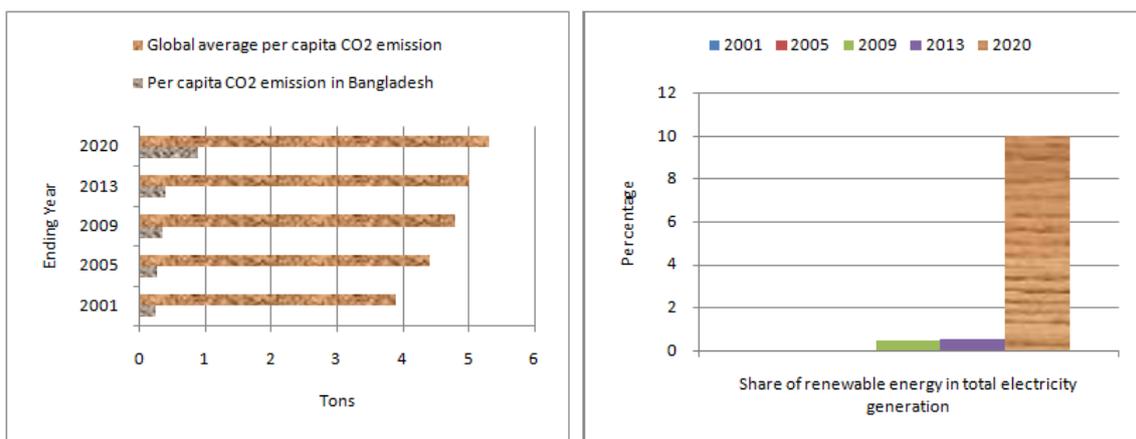


Figure 5. Changing trends of the indicators adopted in environmental issue

Steps have been taken for the vision 2020 through addition of more renewable sources in the policy implication with an aim to reduce the energy crisis and environmental impact. The revised policy in 2008 implies that, 10% power demand will be met using renewable energy sources by the year 2020 [44]. Though significant involvement of clean combustion fuel and renewable energy technologies has been considered by the government for the vision 2020, excessive price is the barrier to implement such technologies within the country. On the other hand, the government has already engaged with the private sector to implement the policies. The public-private sector partnership and collaboration with development partners has strengthened within the country. The infrastructure development company limited (IDCOL) synchronizing the partnerships to faster implementation of the RETs. The funding of such implementation is coming from different foreign agencies. In addition, different renewable energy projects like SHS, wind, hydro and biomass funded by ADB are expected to be completed within the year 2020. Though, significant RETs would be added in the future, this implies the reduction in the possibility of national environmental impact but due to the absence of natural gas, the country will think of an alternative way to meet the demand. The country already planned to increase the contribution of coal from 11% to 50% in 2020, which tells us that the future environmental impact would be increased as coal is an emission-intensive energy source. Hence, proper environmental regulations and monitoring are required to minimize such issues in the future.

3.6. Technological Advancement

Table 3 shows the values of indicators adopted in the technological development of Bangladesh. Table 3 shows that adaptations of efficient technologies are not improved until the year 2013. During the period 2005-2009, contributions of national coal and natural gas to the total primary energy supply were increased. The renewable energy technologies like solar systems and wind were also added in the electricity generation sector within this period. But due to the inclusion of inefficient technologies in the industrial sectors and less policy prioritization, the energy sector upgrading and overall impacts seem not improved.

Table 3. Values of indicators adopted in technological advancement

Indicators	2001	2005	2009	2013	2020
Crude oil distillation capacity (Barrel/day)	33000	33000	33000	34000	84000
Average generation efficiency of fossil based power plant (%)	34	34	34	33	35

During the year 2009-2013, further technical and institutional reforms were taken to improve the energy sector through the power system master plan 2010, consisting of demand side management, fuel diversification, elimination of system loss, and enhance the exploration activities. In addition, the application of solar and wind technologies, efficient cook stoves were also significant. The government has also undertaken initiatives to install efficient technology-based coal power plants, initiatives for other energy sectors, and expected to be completed within the year 2020. Consequently, the 2020 vision shows significant improvement will be achieved compared to the current year. Hence, successful implementation of such efficient plan to develop the technologies requires special monitoring by the government.

3.7. Capital investment for energy sector

Table 4 shows the values of indicators adopted in capital investment for energy sector. Table shows that, investment for power generation is increasing and in 2013 was the maximum investment.

Table 4. Values of indicators adopted in energy sector investment

Indicators	2001	2005	2009	2013	2020
Investment for power generation (USD)	525	789	1210	1281	1222
Power and energy sector upgrading and renovation investment (Million USD)	22750	42860	43100	83110	---

It is usual notion that, increasing the energy demand cause increase the infrastructure development result is increase the budget for the sectors. But the amount of budget allocated for the energy sector development is usually varies from 5-6% of total budget which is not remarkable to upgrade the energy sector with modern facilities. So, Government should take more and more attention on energy sector investment in future challenge of energy distribution within the country.

IV. Conclusions

This paper evaluated the historical energy security status of Bangladesh and future energy security projection. Indicators based analysis is presented through seven dimensions in line with the policy reflection. The energy security has been evaluated from the year 2001 to now and future projection considering the government vision for the year 2020. Analysis shows that the findings of energy resource availability will be challenging in future and also overall resource balance will be decline without sufficient backup to meet the energy demand. On the other hand, energy demand will be increased in future and at the same time energy price will be also increase that will make the vulnerability of energy access to the people. In addition, the environmental impact will be increased due to acceleration the utilization of national coal. The government has taken a number of initiatives jointly with private organization under foreign finance to improve the energy sector and confident to complete the initiatives within the year 2020. To achieve the goal, country needs special attention on alternative energy sources like bio-fuel, biomass, solar etc has the huge potential in Bangladesh. Moreover, investment on renewable energy exploitation is a great challenge for the private sector. The participation of private sector is important but it needs business friendly policy. Furthermore, extensive reform is required in the power sector development. The future research could be done to check how effective was the initiatives during the implementation period. The information from this analysis is useful to the energy researchers, energy distributor, policy makers and energy technology developers in national and international level to take appropriate steps in target to eliminate the energy crisis as well as energy sustainability in cities and communities.

Acknowledgement

Authors would like to express that, there is no conflict of interest with other persons or organizations in publication of this study.

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