International Journal of Energy and Environmental Research
Vol.9, No.1, pp.34-47, 2021
ISSN 2055-0197(Print),
ISSN 2055-0200(Online)

CAUSALITY ANALYSIS BETWEEN THE ENERGY CONSUMPTION AND ECONOMIC GROWTH IN SOUTH ASIA: AN EVIDENCE FROM BANGLADESH

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ABSTRACT: *The objective of this study is to explore the causality between electricity use and economic growth of Bangladesh. By using the unit root and granger causality tests from 1971 to 2016, this study finds that energy consumption causes GDP growth in Bangladesh. However, our empirical findings indicate that GDP growth does not causes energy consumption indicating that there is an uni-directional causality between these two variables. The policy implication of the result is that Bangladesh need to pay special attention to utilize the energy consumption and identifying the alternative sources of energy generation in order to promote our economic growth.*

KEY WORDS: energy consumption, economics growth, granger causality, unit root test
JEL classification: O13, Q48, Q43

INTRODUCTION

According to the Sama and Tah (2016), Ojinnaka (2008) and Alam (2006), energy consumption helps to increase the economic growth especially in the developing countries. Energy is considered as one of the most important factors of production in the production processes of all sectors. It is also considered as a strategic commodity in shaping the international economic and political relations. Moreover, per head energy consumption is considered as a vital indicator of the economic development that attracts domestic and international investment. Higher investment causes higher employment opportunities in the economy results higher aggregate demand and ultimately overall economic growth increases. In this study, we explore the causality between energy consumption and economic growth in Bangladesh from 1971 to 2016.

Energy plays a crucial role in the economic growth and development of a country. It increases the productivity of factors of production and improves the living of standards. It is extensively documented that energy consumption and economic development are interdependent (Mastorakis and Yazdi, 2014). In order to fulfill the vision, the Government has given top most priority to the energy sector and has prepared short, medium- and long-term power generation plans using gas, coal, duel fuel, nuclear and renewable energy resources.

Renewable energy will play a vital role in meeting the demand for electricity, especially in the off-grid areas of the country. However, the energy access (74 %) and per capita consumption of 331

kilo watt hour (kWh) electricity is low as compared to many other developing countries.[1] This necessitates the requirement for increasing energy supply and creation of necessary infrastructure to cater to the growing demand, provide better customer services, improve efficiency and support viability of the sector.

One of the most booming economic growth, rapid urbanization, and expanding industrialization including economic zones, industrial parks, increase textile export energy demand in Bangladesh has increased since the last decade. Energy is one of the key elements to alleviate poverty and to improve the socioeconomic condition of Bangladesh. Bangladesh is an energy hungry country. It also reveals that about 1-2% GDP growth declined annually owing to the shortage of energy and poorer ability of power generation. Energy has become one of the most important factors for better economic growth and people's life in Bangladesh. Energy is also an essential factor of production (Stern, 1973). To improve the situation, the Government has adopted a comprehensive energy development strategy to explore supply side options along with demand management that conserves energy and discourages inefficient use (IEA, 2016).

The causal relation between energy consumption and economic growth has been a well-studied topic. Energy is one of essential factors for any country's economic development and therefore plays an important role in economy activities. On the other hand, higher level of economic development could induce more energy consumption. Therefore, it is important to find out the causal relation: whether economic growth (EG) leads to energy consumption (EC) or whether EC leads to EG. Depending upon what kind of causal relationship exists, its policy implications may be significant.

This study aims to explore the causality between electricity use and economic growth of Bangladesh. By using the unit root and granger causality tests from 1971 to 2016, this study finds that energy consumption causes GDP growth in Bangladesh. However, our empirical findings indicate that GDP growth does not causes energy consumption indicating that there is an uni-directional causality between these two variables.
The paper proceeds as follows. Section 2 reviews the energy sector in Bangladesh. The methodology and empirical findings of this study is described in Section 3. Finally, Section 4 provides the conclusion and policy recommendations.

Overview of Energy Sector
Total investment in the sector over the next 15 years is estimated at $70 billion. While installed generation capacity including captive power (as of June 30, 2018) has increased to 18,753 MW, shortfalls exist due to poor distribution infrastructure and a mismatch between the types of energy plants and fuel mix available. Private power production units are approaching half of total installed capacity. Only two-thirds of Bangladesh's population is currently connected to the electricity grid. This indicates an untapped potential market of up to 60 million people connecting to the national grid in coming years as Bangladesh continues its growth trajectory. The fuel mix of Bangladesh's power plants is heavily based on natural gas. The Government of

[1] Throughout the study, we use energy consumption and electricity consumption interchangeably.

Bangladesh plans to reduce dependence on natural gas and move towards coal with plans to generate 50 percent of total electricity using coal-based power plants by 2030 (USCS, 2018). Other solutions include importing electricity from neighboring countries, importing liquefied natural gas (LNG), and expanding use of renewable resources, including solar and wind.

Energy Security

Bangladesh has been able to exploit its abundant natural gas reserves. Around one fourth of its energy supply depends on natural gas. It is anticipated, however, that the gas supply reached its peak in 2018 and gradually decrease thereafter. Therefore, the country cannot build another gas fired power plants. The Government plans to develop Matarbari Island area to build ports and facilities which allow imports of coals and liquefied natural gas (LNG) for power generations from after 2021 and 2022, respectively. The development of other type of power generation (such as nuclear and hydro power generation) awaits negotiation with partner countries, and seems not able to start operation before 2030. Bangladesh imports oil from different countries to fulfill its domestic oil demand. This situation creates grave concerns about energy security. The main threat to energy security is from foreign routes for importing oil, because these might be disrupted at any time due to global conflicts. Moreover, the seaports might also be dysfunctional in the case of war between countries. The political and security situation could significantly affect the energy sector.

Present Situation of Energy Production, Consumption and Import

Bangladesh has been successful in making significant progress in increasing generation capacity as well as actual production and consumption of electricity and increasing access of consumers to electricity. This has been achieved by making higher public investment in electricity generation as well as transmission and distribution, attraction private investment, engaging in cross border power trade, reducing losses and managing demand side of the market. In Bangladesh the sources of energy consumption are Bio-mass (wood, animal and agricultural residues, municipal waste etc.) which contributes about 65% of the total energy consumption and the remaining 35% stands for commercial sources which are natural gas, oil, coal and hydroelectricity Ahmad *et al.* (2001). Production, consumption and import of energy in Bangladesh from 2010-11 to 2016-17 is shown in Table 1.

Table 1. Energy Production, Consumption and Import

Year	Electricity (MKWH)		Gas(BCF)		Petroleum ('000' MT) Imports
	Production	Consumption	Production	Consumption	
2010-11	31355	26652	708.90	714.40	3948.88
2011-12	35118	29974	743.5	751.81	5181.83
2012-13	38229	32740	794.33	798.16	3765.02
2013-14	42195	36233	820.43	828.14	5332.11
2014-15	45856	39624	892.17	877.3	5398 .00
2015-16	52193	45299	973.25	966.9	4762 .00
2016-17	57276	50264	971.6	987.3	5831.00

Source: BBS, 2018

Electricity Demand and Supply

Demand for electricity in Bangladesh is projected to reach 34,000 megawatts (MW) by 2030 and the Government of Bangladesh has plans to increase power generation beyond expected demand to help propel growth in the export-oriented economy and to meet the demands of a growing middle class. However, since its independence from Pakistan in 1971, the country has struggled to generate adequate electricity to meet the demand. The state-owned electricity utilities suffer from large energy shortages. Moreover, due to poor pricing policies and other bottlenecks, the energy sector has also failed to attract adequate private investments in power business. This shortage of investment is a contributing factor toward energy crisis. The present government is committed to ensuring access to affordable and reliable electricity for all citizens by 2021 (BB, 2016). At present, about 85 percent of the population has access to electricity.

The supply is also not adequately reliable. Per capita generation of electricity in Bangladesh is now about 252KWh. In view of the prevailing low consumption base in Bangladesh, a high growth rate in energy and electricity is indispensable for facilitating smooth transition from subsistence level of economy to the development threshold. The average annual growth in peak demand of the national grid over the last three decades was about 8.5%. It is believed that the growth is still suppressed by shortage of supply. Desired growth is generation is hampered, in addition to financial constraints, by inadequacy in supply of primary energy resources. The strategy adopted during the energy crisis was to reduce dependence on imported oil through its replacement by indigenous fuel. Thus, almost all plants built after the energy crises were based on natural gas as fuel. Preference for this fuel is further motivated by its comparatively low tariff for power generation.

Electricity supply expansion plan

With the growth of economy, the demand for electricity increases rapidly. The Government has prepared Power System Master Plan 2010 (PSMP) to improve and expand electricity supply to support annual GDP growth of 7 percent. Given such a GDP growth scenario, the electricity demand including captive power is expected to increase, as shown in Table 3.

Table 3. Electricity Supply Expansion Plan

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Domestic Gas	12,163	12,163	11,865	11,558	11,370	10,771	10,442	10,267	9,907	9,032	8,854
Domestic Coal	1,650	2,250	2,850	3,450	4,650	4,650	5,250	6,250	8,250	10,250	11,250
Imported Oil	1,755	1,855	1,955	2,055	2,055	2,155	2,355	2,455	2,555	2,240	2,240
Hydro	841	941	941	1,941	1,941	1,941	1,941	1,941	1,941	1,941	1,941
Cross-Border	500	1,000	1,750	1,750	1,750	2,000	2,000	2,000	2,000	2,000	2,000
Imported Coal	3,600	3,600	3,600	4,200	4,200	4,200	5,400	6,600	6,600	7,800	8,400
Imported LNG	0	0	0	0	0	0	0	0	0	0	0
Nuclear	2,000	2,000	2,000	2,000	3,000	4,000	4,000	4,000	4,000	4,000	4,000
Total	22,509	23,809	24,961	26,954	28,966	29,717	31,388	33,513	35,253	37,263	38,685

Source: PSMP, 2010

Access to Electricity

Electricity helps learning, facilitates household production and keeps agriculture, industry and businesses running. The proportion of population with access to electricity increased to 55.26 per cent in 2010 from 31.2 per cent in 2000. It continued to increase reaching 75.92 per cent in 2016 and increased further to 85.3 per cent in 2017. About 20 percentage points increase between 2010 and 2016 and about 10 per cent points jump in the following year was possible because of heightened efforts of the government to increase supply through domestic production as well as imports.

Table 4. Proportion of Peoples with Access to Electricity

Regions	2000	2005	2010	2016	2017
National	31.2	44.23	22.26	75.92	85.30
Urban	80.4	82.61	90.10	94.01	na
Rural	18.7	31.19	42.49	68.85	na

Source: SDGBPR, 2018

Aggregate Power Demand

If GDP continues to grow at 6% average then the Aggregate power demand is expected to grow by 45% during 2020 and 115% during 2025. It is expected that the aggregate power demand will increase by around 200% during 2030; the demand will be around 27,000 MW against 9000 MW during 2015. The nation's current aggregate power demand is approx. 9000 MW. Major reason for the growth in aggregate demand is increasing industrialization, growing middle-income

household consumption and an overall healthy growth in real GDP. Coal will be the major source of fuel for power generation during 2030. As per PSMP around 50% of the power generation will come from Coal. Coal is expected to become the major fuel for power generation in future, currently the nation imports around 3.5 MnT.

Table 5: Power Demand Forecast

Year	Government Policy Scenario		Comparison GDP (7%) Scenario		Comparison GDP (6%) Scenario	
	Peak Demand (MW)	**Generation (GWH)**	**Peak Demand (MW)**	**Generation (GWH)**	**Peak Demand (MW)**	**Generation (GWH)**
2019	15527	81610	12224	64249	10255	53900
2020	17304	90950	13244	69610	10868	57122
2021	18838	99838	14249	75517	11442	60640
2022	20443	109239	15344	81992	12056	64422
2023	21993	118485	16539	89102	12713	68490
2024	23581	128073	17840	96893	13416	72865
2025	25199	137965	19257	105432	14167	77564
2026	26838	148114	20814	114868	14979	82666
2027	28487	158462	22509	125209	15848	88156
2028	30134	168943	24353	136533	16776	94053
2029	31873	180089	26358	148928	17768	100393
2030	33708	191933	28537	162490	18828	107207

Source: Source: PSMP, 2016

It is believed that in order to meet the aggregate power demand and shortage of Natural gas, the import will rise to 30 MnT during 2030. The adoption scenarios of the power demand forecast in this MP are as shown in the figure below. The figure indicates three scenarios; (i) GDP 7% scenario and (ii) GDP 6% scenario, based on energy intensity method, and (iii) government policy scenario.

Renewable Energy

Renewable energy has been a small but rapidly growing sector in Bangladesh economy. Bangladesh present installed power generation capacity is 11,265 MW (excluding captive and solar) out of that installed capacity the highest With the looming exhaustibility of the nonrenewable energy sources and the rapidly growing energy demand, the policy-makers of the country in various policies and institutional arrangements have shifted their focus to renewable energy sources. It is expected that the renewable energy options like solar-power, wind-power, hydro-power and bio-mass will be essentially useful to increase the accessibility to energy and power for all the socio-economic sections of the country. Bangladesh is a developing country, it has probability to progress towards increasing the demand of energy .Now a day, Bangladesh is facing energy crisis. On the other hand climate change puts addition threats to development. To combat these situations, renewable energy technology stands out to be one of the prospective sources to meet its unprecedented energy demand and can contribute to achieve sustainable development as a country has a plentiful supply of renewable sources of energy.

Bangladesh Government has given strong drive to boost renewable electrical energy production. The government has established Sustainable and Renewable Energy Development Authority (SREDA) to promote renewable energy and energy efficiency in 2014. To strengthen international cooperation, Bangladesh became one of the initial members of the International Renewable Energy Agency (IRENA), the only inter-governmental agency working exclusively on renewable energy. Currently renewable energy sources have a very low share of the total generation (<2%). The government of Bangladesh is trying to encourage the use of renewable energy sources and formulated a renewable energy policy (REPB, 20-16).

One of the main focuses of this policy is to scale up contributions of renewable energy to electricity production. The initial goal was to generate 5% power from renewable energy sources by 2015 and 10% by 2020. Renewable energy is the energy which comes from natural resources such as sunlight, wind, rain, tides, water, and geothermal heat, which are renewable (naturally replenished). The prospect of renewable energy in Bangladesh is bright particularly for solar. But in the immediate future, renewable energy will remain a supplement to the conventional energy production. Still renewable energy will play an important role in reaching consumers outside the national grid or in places where grid connection is delayed.

Renewable Energy Share in the Final Energy Consumption

Available renewable energy sources including solar energy, hydropower and wind can be harnessed to provide affordable power supply to off-grid rural areas of the country as well as connect to national grid. Solar photovoltaic (PV) is becoming popular technology mainly in off-grid rural, hill tracts, and coastal areas in the country. The share of renewable energy sources in total final energy consumption is estimated at 2.79 per cent in 2015 (Table 6). Bangladesh has planned to produce 10 per cent of total power generation from renewable sources by 2020. This target seems hard to achieve for two interrelated reasons. On the one hand, renewable energy supply has been increasing but at a slower rate and on the other hand, the supply of electricity from non-renewable sources is increasing at a much faster rate.

Table 6. Renewable Energy Share in the Total Final Energy Consumption (per cent)

2015	2016	2017
2.79	2.85	3.56

Source: SDGBPR, 2018

Empirical Study of Causality between Energy Consumption and Economic Growth

Source of Data and Methodology

All the data used are annual observations of the variables from 1971 to 2016. This study is conducted using the secondary time series data. The variables are per capita GDP as a proxy variable for economic development and per capita energy consumption while the data period is using the annual data from 1971 to 2016. The units of real GDP are measured at constant price. The data for this study was collected from World Development Indicators data.

Analytical Technique

The time series data present a number of methodological problems. It is convenient to estimate relationships through the regression method only if the series are stationary which means mean and variance are constant. Most of the time series data reflect trend, cycle and/or seasonality. Time series that are not stationary and whose properties have not been subjected to an examination could produce invalid inferences. Tests for stationary are well known in the literature as Augmented Dicker Fuller (ADF) test and Phillips and Perron (PP) test are applied to test for stationary and Granger causality has been adopted to investigate the causality between energy consumption and economic development.

Unit Root Test

The Augmented Dickey Fuller (ADF) tests are used to check whether each data series is integrated and has a unit root Dickey and Fuller (1979, 1981). Using the ADF test, the error assumption is homogeneous and independent where the lag should be predetermined unless the error in lag will affect the test results (Dickey and Fuller, 1981). The ADF test is based on the value of t-statistics for the coefficient of the lagged dependent variable compared with special calculated critical values. If the calculated value is greater than the critical value, then we can reject the null hypothesis of a unit root. The unit root does not exist, if our variable is stationary Gujarati (2011). We performed the ADF tests based on the following model:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \lambda_i \sum_{i=1}^{k} \Delta Y_{t-i} + \varepsilon_t \quad (1)$$

Where Δ is first difference operator, Y is a time series data of per capita GDP and energy consumption, t is a linear time trend, k is optimal number lags, ε_t is a disturbance term considered as a white noise error,

Furthermore, we perform another unit root test proposed by Phillips and Perron (1988) which is based on the same equation as the ADF test but without the lagged differences. Using the Phillips and Perron (PP) test, all variables obtained that are not stationary at level hence can be transformed to be stationary by doing the first derived process (first differencing) from the data (Box and Jenkins, 1976). The PP test employs nonparametric statistical methods to test the correlation series with unit root test (Phillips and Perron, 1988). The specification for PP test is

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \varepsilon_t \quad (2)$$

Granger Causality

The use of a simple traditional Granger causality has been identified by several studies (such as Engle and Granger (1987), Toda and Yamamoto (1995). Granger causality test is believed to be much more effective than usual. The Grangers causality equation can be seen below:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + ... + \alpha_p Y_{t-p} + \beta_1 X_{t-1} + \beta_2 X_{t-2} + ... + \beta_p X_{t-p} \quad (3)$$

$$Y_t = \gamma_0 + \gamma_1 X_{t-1} + \gamma_2 X_{t-2} + ... + \lambda_p X_{t-p} + \sigma_1 Y_{t-1} + \sigma_2 Y_{t-2} + ... + \sigma_p Y_{t-p} \quad (4)$$

Granger causality is aimed to measure the strength of relationships between variables and the criteria in determining the causality is seen from the probability value compared to the critical value. The Granger (1969) approach to the question of whether X causes Y is to determine how much of the current Y can be explained by past values of Y and then to see whether adding lagged values of X can improve the explanation. Y is said to be Granger-caused by X if X helps in the prediction of Y, or if the coefficients on the lagged Xs are statistically significant. Note that two-way causation is frequently the case: X Granger causes Y and Y Granger causes X. It is important to note that the statement "X Granger causes Y" does not imply that Y is the effect or the result of X. Granger causality measures precedence and information content but does not of itself indicate causality in the more common use of the term. It is better to use more rather than fewer lags in the test regressions, since the Granger approach is couched in terms of the relevance of all past information. It is necessary to pick a lag length l that corresponds to reasonable beliefs about the longest time over which one variable could help predict the other. If two series are co-integrated, then a Granger causality test must be applied to determine the direction of causality between the variables under consideration. The critical value used in this study is 5%. If the estimation of both variables stating that the probability value is less than 0.05, this indicates there is causality relation on the variable.

The following models are used to estimate the causality:

$$\Delta \ln EC_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} \Delta \ln EC_{t-i} + \sum_{i=1}^{p} \alpha_{2i} \Delta \ln GDP_{t-i} + \varepsilon_1 \quad (5)$$

$$\Delta \ln GDP_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta \ln GDP_{t-i} + \sum_{i=1}^{p} \beta_{2i} \Delta \ln EC_{t-i} + \varepsilon_2$$

(6)

where Y_t and X_t are defined as Y and X observed over t time periods, Δ is the difference operator, p represents the number of lags, α and β are parameters to be estimated; and ε represents the serially uncorrelated error terms. Granger causality is aimed to measure the strength of relationships between variables and to indicate the direction of the causal relationship on X Y or Y X or X Y. The test is based on the following hypotheses:

H_0: $\alpha_{2i} = \beta_{2i} = 0$ for all i's.

H_1: $\alpha_{2i} \neq 0 and \beta_{2i} = 0$ for at least two i's.

At this point, it is necessary to examine the criteria for causality. The hypothesis would be tested by using t-statistics. If the values of the α_{2i} coefficient are statistically significant but those of the

β_{2i} are not, then, then X causes Y (X→Y). On the contrary, if the values of the β_{2i} coefficients are statistically significant but those of the α_{2i} coefficients are not, then Y causes X (Y→□X). If both α_{2i} and β_{2i} are significant then there exists bidirectional causality between X and Y (X↔Y).

Empirical Findings of Causality between Energy Consumption and Economic Growth

Unit Root Test

We checked the stationary of each variable by using the Augmented-Dickey–Fuller (ADF) and Philips–Perron (PP) unit root tests, the results are shown in Table 7. The criteria to decide on a stationary or non-stationary series are dependent on the test statistics and probability values of the variables. The results of both tests the ADF and PP highlight that all of the variables of the models are non-stationary at the level. However, these variables are converted to be stationary at the first difference with a I(1) order of integration. The estimated ADF and PP values are greater than the critical values at the 5% level of significance, as shown below are reported in Table 7. The Result from table 6 provides strong evidence of non-stationary in levels. This can be seen by comparing the observed values (in absolute terms) of the ADF test statistics with the critical values (also in absolute terms) of the test statistics at the 1% and 5% level of significance. If the probability value is below $\alpha = 5\%$ then the data does not have the unit root and the data is stationary, otherwise if the probability value is greater than $\alpha = 5\%$, then the data has unit root but it is not stationary.

Table 7. Empirical Results of a Unit Root Tests

Variable	Augmented Dickey Fuller test				Phillips –Perron test			
	Level	Prob.	FD	Prob.	Level	Prob.	FD	Prob.
lnEC	-0.172	0.002	-1.253	0.000	1.019	0.000	-0.315	0.045
lnGDP	-0.213	0.001	-1.171	0.000	1.024	0.000	-0.170	0.050

Granger Causality Test

The results of Granger causality between per capita energy consumption and real GDP, as well as the computed F values and their respective probabilities for the data of those series during the period 1971-2016 with specific lag period, as calculated through equations (5) and (6), are presented in Table 9. To assess whether the null hypothesis is to be accepted or rejected, a significance level of 5 per cent is chosen. The lag lengths were chosen by using Akaike's information criterion and Schwarz Information Criterion (SIC) are given in Table 8. AIC criterion has been used to determine the lag length in an AR(p) model. It is useful both nested and non-nested models. In comparing two models, the model with the lowest value of AIC is preferred. Like AIC, SIC has been used to compare in sample or out of sample forecasting performance of a model. SIC imposes a harsher penalty for adding regressors to the model than AIC.

Table 8. Lag Order Selection Criterion

Lag	AIC	SIC
1	-10.6826*	-10.4187*
2	-10.5964	-10.1566
3	-10.4628	-9.847
4	-10.4658	-9.67403
5	-10.569	-9.60129
6	-10.5123	-9.36869
7	-10.4945	-9.1749
8	-10.3863	-8.89076

* **Indicates lag order selected by the criterion. AIC indicates Akaike Information Criterion ; SIC indicates Schwarz Information Criterion.**

Both results were calculated using one lag period on the basis of AIC and SIC. The relationship between economic growth and energy consumption has unidirectional causal relationship, where energy consumption affects economic growth while otherwise economic growth has no effect on energy consumption.

The Granger causality is found to run from energy consumption to GDP. The null hypothesis of "energy consumption does not Granger cause GDP" is rejected at the 5 per cent level of significance in Table 9 where the value of F statistics is 4.5438 with probability 0.0172. The null hypothesis "GDP does not Granger cause electricity consumption" is accepted, where the value of F statistics is with probability 0.5142. This indicates that GDP does not Granger cause energy consumption, as the value of the test statistic is not significant at the 5 per cent level of significance.

Table 9. Granger-Engel Test Result

Null hypothesis	F statistic	p value	Decision
lnELEC doesn't Granger cause lnGDP	4.5438 (1)	0.0172	Reject**
lnGDP doesn't Granger cause lnELEC	0.67733 (1)	0.5142	Do not reject

Note: **indicates the rejection of the null hypothesis at 5% significant level and figures in the parentheses are number of lags.

The finding of our study is on the line with earlier findings of Ahamad and Islam (2011); as they revealed the causality from energy consumption to GDP for Bangladesh. Our result is also consistent with the finding of Asaduzzaman and Billah (2008) as they claims higher level of energy use led to higher level of growth in Bangladesh. The findings of our study also partly consistent with the findings of Buysse et. al. (2012) as their results indicate that uni-directional causality exists from energy consumption to economic growth both in short and long run while bi-directional long run causality exists between electricity consumption and economic growth but no causal relationship exists in short run. However, our result is totally conflicting with the finding of

Mozumder and Marathe (2007) because they reveal that there is unidirectional causality from GDP to electricity consumption for Bangladesh over the period 1971 to 2016. This contradiction can be argued upon with a plausible view that the time series are different.

CONCLUSIONS AND POLICY IMPLICATIONS

This study has investigated the relationship between economic growth and energy consumption during 1971-2016. The Granger-Engel method was used to estimate the results. The study has found causal relationship between energy consumption and economic growth in Bangladesh. The implication of our findings is that increase in energy consumption likely to increase our economic growth in Bangladesh. There is no alternative for economic growth than to go for generation of more power for Bangladesh, which is needed especially for transforming into a developed country by 2041. Bangladesh is considered one of the most moving energy growth nations in the world. But around 15% of Bangladesh's 166 million people still have no access to electricity. To meet up the huge demand of electricity government of Bangladesh plans to set up the different power plants with pubic private partnership.

At the same time renewable energy technology has a huge potential to solve electricity problem in Bangladesh. Yet even with the best efforts of the Government, the entire area of Bangladesh cannot be brought under national electricity grid connectivity. Approximately 10 per cent of the remote areas will remain off the national grid. We will have to depend on renewable energy for attaining sustainable energy targets in Bangladesh. The energy provided by the sun (solar energy) is many times greater than the current electricity demand. Therefore, it is important for the policymakers to set appropriate policies in order to boost our economic growth by using electricity consumption. The combined effect of slow increase in renewable energy and fast increase in non-renewable energy is very slow rise in the share of renewable energy in the total final energy consumption. This makes it difficult for the share of total renewable energy in the total energy consumption to reach the target of 10 percent in 2020.

Access to affordable, reliable and sustainable energy is not only a global goal in its own right but is also fundamental to achieving many of the SDGs from poverty eradication through advancement in health, education, water supply, industrialization and environmental sustainability to mitigating the impact of climate change. It would be a great relief to fund hungry power projects. The Government has made efforts to overcome the problems in the power sector. We firmly believe that we will be able to meet our electricity demands in a sustainable way. However, by and large, action-oriented national commitment from all stakeholders, including regulatory bodies, as well as support from development partners, are the key to success in achieving the Government's declared vision of "Electricity for all by 2021".

Thus, for developing countries like Bangladesh high economic growth requires energy infrastructure particularly electricity. Economic growth rate will in turn increase the consumption of commercial energy. Development of nuclear power projects to generate electricity is one of the best infrastructure options. However, it requires a huge investment and significant amount of time to construct but it would generate long term benefits in the economy. Policymakers in Bangladesh

need to pay special attention to utilize our energy consumption as well as identifying the alternative sources of energy generation in order to promote our economic growth. This implies that the supply of electricity is vitally important to meet the growing energy consumption, hence to sustain economic growth in Bangladesh and achievement of various other objectives like human welfare goals, sustainable development goals, higher growth, there is an urgent need to remove the power sector inefficiencies. To remove administrative bottlenecks steps should be taken towards unification of various policies at national and local level and to ensure effective implementation of these policies. At the same time various other alternatives like public private partnership, clean technologies and diversified energy resources should also be explored in effective manner for sustainable development.

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