

Prospects of Cross Border Energy Trade in South Asia

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Abstract:

The majority of South Asian nations use a combination of renewable energy sources like hydro, solar, and wind power together with nonrenewable energy sources like nuclear, coal, and natural gas to generate their electricity. Both of these sources are indigenous to some degree. Every nation in the area benefits from one type of resource or another. In India, coal is available. Natural gas is also abundant in Bangladesh, Pakistan, Nepal, and Bhutan, as well as hydropower. Using panel data from 2001 to 2015, this study examines the relationship between electricity consumption and changes in income, population, and foreign direct investment in Pakistan, India, Bangladesh, Sri Lanka, and Nepal, five South Asian nations. Additionally, the demand for electricity can be satisfied by imports or electrical production. The OLS results confirm that there is significant relationship between electricity consumption and GDP in South Asia. The OLS result further suggests that there is significant positive relation between GDP and electricity imports for India and Pakistan where as Nepal and Bangladesh have significant positive relation between GDP and electricity production. It is therefore concluded that there is a huge potential of cross border energy trade in South Asia and enhance economic growth in the region.

Keywords: Cross border, energy trade, renewable energy, South Asia

Introduction

Over a billion people live in South Asia. The vast majority of them don't have access to electricity. The availability of power is the foundation of modern technology. Electricity is a requirement for modern life and for running machinery that produce goods and services (Dhungel, 2003). The majority of South Asian nations use a combination of renewable energy sources like hydro, solar, and wind power together with nonrenewable energy sources like nuclear, coal, and natural gas to generate their electricity. Both of these sources are indigenous to some degree. Every nation in the area benefits from one type of resource or another. In India, coal is available. Natural gas is abundant in Bangladesh and Pakistan, and hydropower is abundant in Nepal and Bhutan. A fantastic potential exists to generate electricity from these local resources. Among the available resources, coal is heavily utilized, has been a significant source of power for almost a century, and is anticipated to continue to do so in the future. Natural gas and hydro are yet undeveloped. They have not yet been made use of. These resources could benefit South Asian nations' growth if they are used appropriately (Dhungel, 2003). It would give South Asian nations plenty of chances to swap power with one another, bridging the supply and demand gaps in individual nations. It would make room for the integration of regional markets and aid in ensuring energy security. Additionally, HEP potential exists in practically all

nations, albeit availability varies to some extent. This is an example of a renewable energy source. The South Asian countries' main objective is to raise their economic growth rate to a level where it is double digits. However, a double-digit growth rate necessitates massive electricity use. This is currently restricted by an insufficient power source.

Over one billion people live in the South Asian region, which makes up 22% of the global population, of which 30–40% live in poverty. More than half of the population does not utilize commercial energy because the majority of them do not have access to it. It demonstrates how heavily the area depends on the use of conventional energy sources as a whole. It shows, among other things, that these nations' economies have not been able to grow quickly due to the low levels of commercial energy consumption per person. In fact, reducing poverty depends on economic growth. To attain the goal of poverty reduction on a sustainable basis, the countries of the South Asian area continue to focus their efforts on achieving higher economic growth rates. As a result, their economies are making significant progress, with annual economic growth rates in the range of 4 to 6 percent, ranking the region second only to East Asia. The current rate of economic growth is dependent on the accessibility and dependability of the commercial energy sources. There is a significant positive correlation between commercial energy usage and economic progress, according to studies on the subject. This two variables have a very significant positive correlation, which suggests that for greater economic expansion, more commercial energy is required. The South Asian countries are energy-short notwithstanding their development. As was previously mentioned, a region cannot meet the entire demand for commercial energy due to the faster growth rate of the economy. The rising demand for commercial energy, especially for oil, has been satisfied by importing from Gulf nations, although there is volatility in oil supplies because of the clear political unrest in those nations. In order to maintain their economic growth in the future, the South Asian nations must pay a sizable amount of hard currency to import oil, which has severely harmed their current account balances. However, since the area has a lot of potential for energy, these nations do not necessarily need to be completely dependent on imports.

The effort to establish a common South Asian electricity market is centered on interconnections for transnational electricity flows. Through interconnections, electricity can be exported from nations with relatively low production costs to others with relatively high production costs, improving economic efficiency. As a result of this process, the combined producer and consumer surplus in both nations will rise while prices in the low cost country will decline in the high cost country. Only when the overall surplus is maximized and prices in both nations are equal, or when the interconnection capacity is fully utilized, will the process be complete.

Rationale of the Study

Greater access to dependable, reasonably priced, and environmentally friendly energy can promote regional economic growth and raise living standards. Inadequate access to power paired with an unstable supply caused by a lack of network and generation capacity and poor asset

maintenance are issues in the area. This therefore results in the adoption of pricey, damaging backup fossil fuel generators on a small scale. Key measures for resolving these issues include improving system management and investing in electricity infrastructure.

Finding strategies to utilize the significant operational, economic, environmental, and reliability benefits of power trading across borders in SAR—benefits that are yet largely underutilized—is another crucial step (Chattopadhyay and Fernando, 2011). The South Asian region can gain significant advantages from better regional coordination in capacity investments by stepping up collaboration for cross-border electricity trade. By introducing economies of scale to investments and more cost-effectively expanding the use of renewable electricity, trade can complement domestic investment to boost supply availability and reliability. Due to the diversity of primary energy resources and variations in seasonal patterns of supply and demand, increased electricity trade also enables the region to benefit from complementarities in electricity demand and resource endowments. Regional collaboration can also result in increased competition and increased sector efficiency. In order to increase cross-border cooperation and commerce in the SAR, it is necessary to resolve both regional and domestic electrical sector policy-related constraints. Lack of cost-reflective pricing, constraints in generation capacity, low operational efficiency and service quality, subpar utility financial performance, and minimal private sector participation are some of the obstacles. These characteristics of electricity sectors with minimal reforms are comparatively well-known. The major goal of this study is to identify significant regional and national scale hurdles and describe ways to get through them.

Objectives of the Study

The main objective of the study is to explore the prospects of cross border energy trade in south Asia. However the specific objectives are:

- To examine the changes in electricity consumption with change in income population growth and foreign direct investment in south Asia,
- To determine the relationship between electricity imports, electricity generation and economic growth,
- To explore the prospects of cross border energy trade in south Asia.

Review of literature

In an empirical analysis of the relationship between energy consumption and economic growth, Odhiambo (2014) used the ARDL approach for the Democratic Republic of the Congo (DRC). His findings revealed that energy consumption is driven by economic growth. The study thus supports the idea of energy conservation. Adom uses time series data covering the years 1971–2008 and the Granger Causality test to examine the relationship between Ghana's economic growth and power usage. This study demonstrated that there is a unidirectional causal relationship between economic growth and power usage. In the case of Ghana, this investigation supports the growth-led-energy hypothesis. Adom comes to the conclusion that in order to control electricity demand and consumption as Ghana's economy grows, energy conservation measures are necessary.

For the G7 nations, Narayan et al. (2008) discovered a comparable finding. Aslan also discovered a strong, one-way association between power use and Turkey's economic growth. For rising economies, Bayar and zel looked into the causal link between energy use and growth. In the study, they used the Granger causality test, Pedroni, Kao, and Johansen cointegration tests, and the results revealed that use of electricity spurs growth and that consumption of electricity causes economic growth and vice versa, supporting the feedback hypothesis.

Raza (2016) used time series annual data from 1980 to 2010 to examine the impact of power consumption on economic growth in Pakistan, India, Bangladesh, and Sri Lanka, four South Asian nations. The results of Pedroni's panel cointegration analysis support the existence of a reliable long-term relationship between South Asia's energy consumption and economic expansion. Results of the random effects model point to a positive and considerable influence of electricity usage on South Asian nations' economic development. Four additional sensitivity analyses support the initial positive and significant connection findings' robustness. The panel Granger causality test results show a one-way causal relationship between economic growth and electricity usage. Therefore, he advised the South Asian nations to take into account the development initiative and low-cost manner of production in the region

Becker et al. (2014) analyzed the transmission requirements in Europe for a completely renewable electricity supply across the continent. They took into account high-resolution wind and sun data gathered across Europe over an eight-year span. They discovered that by quadrupling the net transfer capacity (NTC) of the current European interconnections, the demand for balancing energy is reduced by 33%. Such interconnections are more advantageous for wind power than for solar power because "bigger interconnected areas reduce to a great degree weather correlations that contribute to generation."

Legal, Regulatory, and Policy Framework of Energy in South Asia

ADB (2017) Afghanistan is now creating its electrical rules and regulations, according to an analysis of south Asian countries' energy legislation. As a result, there is a chance to conform the nation's laws and regulations to those necessary for the framework agreement's implementation. Bangladesh has established some provisions in its energy policy because it just began importing electricity from India, and it intends to import some of the electricity it needs from nearby nations to cover a portion of its demand. To encourage regional power commerce, Bhutan and Nepal have added complex measures to their laws and regulations governing electricity. For the purpose of regulating sector operations in these nations, India and Pakistan's electricity laws and regulations are fairly comprehensive. However, in order to include cross-border trade, the laws' purview must be expanded. In order to create an electrical market and engage in international electricity commerce, Sri Lanka must remove the barriers in its electricity laws and regulations. The Maldives may shortly take the appropriate steps with regard to the framework agreement's provisions that are pertinent to its participation in the said agreement.

The region's saving grace is that the current organization of the power industry and its institutional framework meet the criteria needed to place cross-border electricity trade on a solid legal and regulatory basis. Additionally, it will be quite simple to extend the reach of current laws and regulations to include the regional power trade with the appropriate amendments or to strengthen the authority of existing institutions. All of these nations must agree to harmonize their electrical laws, rules, and policies because they are all signatories to the framework agreement, which is necessary for its implementation.

Methodology

The availability of data for the selected five south Asian nations of Bangladesh, India, Nepal, Pakistan, and Sri Lanka will determine the study period the most. This analysis spans the years 2001 to 2015 based on the availability of annual time series data for all the nations under consideration. The study's variables include gross domestic product (GDP), foreign direct investment (FDI), population (POP), and electricity consumption (EC). Key Development Indicators, World Development Indicators, and the doing business report of the World Bank are used to get annual statistics on per capita GDP in PPP US dollars, FDI, population, and EC in per capita KWh, after which they are expressed in logarithm.

In this study, we use the following ordinary least square energy consumption model i.e.,

$$\ln EC_{it} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln POP_{it} + \beta_3 FDI_{it} + e_{it}$$

Where 'ln' represents the natural logarithm.

Where electricity consumption is the dependent variable, GDP, population and FDI are explanatory variable. I is index for country, t is index for year, e_{it} is error term.

These factors were chosen due to their critical significance to a rising area like SAARC. In the international conversation about global warming and the reduction of greenhouse gas emissions, for instance, the issue of how energy conservation regulations impact economic activity is one that is of great concern. Despite extensive research into the causal link between energy consumption and economic growth, no agreement on this so-called energy consumption-growth nexus has yet been found. According to Tang and Tan, FDI has an impact on energy demand as well as economic growth; therefore an increase in FDI will result in the introduction of more sophisticated technology, which will then increase energy consumption in emerging nations. Since it is widely acknowledged, a positive GDP coefficient is anticipated. Economic growth is a crucial factor in influencing energy consumption; hence an increase in GDP would result in a rise in energy usage. Similar to this, it is anticipated that the correlation between relative pricing and FDI and energy consumption will be positive because these two factors should have a significant impact on energy consumption in the SAARC region, To hasten the process of economic development, governments should support the growth of strong local entrepreneurship, establish a stable macroeconomic framework, and enhance the environment for profitable investments.

Further the demand for electricity can be fulfilled by electricity generation or through the imports. In order to analyze the prospects of cross border energy trade in south Asia we use the following model.

$$GDP_{it} = \beta_0 + \beta_1 \ln ELECIMP_{it} + \beta_2 HYDROGEN_{it} + e_i$$

These factors were chosen because, despite development, South Asian nations lack adequate energy supplies. As was previously mentioned, a region cannot provide the entire demand for power due to the greater growth rates of economies. The rising demand for electricity might be satisfied by importing from nations with abundant hydropower resources.

In order to maintain their economic growth in the future, the South Asian nations must pay a sizable amount of hard currency to import oil, which has severely harmed their current account balances. However, because the region has a lot of energy potential, these countries do not necessarily have to rely entirely on imports.

In a similar vein, every nation save Afghanistan has the ability to produce hydropower. Moreover, coal reserves exist in Pakistan and India. However, given that these energy sources are dispersed around the region, how is it possible to cut imports? The energy commerce between the nations of the region is one answer to this topic. Energy commerce between these nations is crucial to supplying the world's expanding energy needs. For instance, Nepal might satisfy its demand for coal, natural gas, and oil from other nations by selling their surplus power to them.

Results and Discussion

Table 1 reports the descriptive statistics for the natural logarithm of electricity consumption, FDI, Population and economic growth. The FDI range from 6.59 to 11.23 . On an annual basis, GDP and FDI reached their maximum values respectively in 2008 and 2009, while the highest peak in electricity consumption observed in 2010. The empirical results in Table 1 also indicate a medium to high correlation between the variables meaning that there is a strong positive association between the variables. A positive correlation exists between electricity consumption and population growth. FDI and GDP are positively correlated with electricity consumption. A positive correlation is found between population growth and electricity consumption. The previous findings regarding the correlation between our variables indicate that rising GDP increases electricity consumption. In addition, higher levels of population and FDI lead electricity consumption to move up which, in turn, improves economic growth

Table 1

Descriptive Statistics and Correlation

Variables	lnEC	lnGDP	lnFDI	lnPOP
Count	70	70	67	70
Mean	2.45	11.57	9.53	8.03
Maximum	2.91	12.84	11.23	9.11
Minimum	1.81	10.58	6.59	7.28
St. Dev	0.30	0.67	0.98	.64
Correlation Analysis				
lnEC	1.00			

lnGDP	0.72	1.00		
lnFDI	.522	0.834	1.00	
lnPOP	0.720	-0.893	0.54	1.00

Table 2 presents the regression results of panel data as well as country specific regression results. The results show that GDP, FDI population has a significant positive relationship with Electricity consumption. The regression result show that the GDP contributes more to electricity consumption followed by population and FDI contributes less to electricity consumption.

Further the regression result show that there is positive income elasticity of electricity demand. The results show that one percent increase in GDP increases electricity consumption by 0.91 percent. Similarly one percent increases in FDI increases the electricity consumption by 0.07 percent. The results also show that the increase on population also have significant positive relationship with electricity consumption. It shows that a percent increase in population increases electricity consumption by 0.75 percent.

The R square of the result is 81.41 which show that 81.81 percent of the regression result is explained by the independent variable where as remaining by the error terms.

Owing to the Growth rate of south Asian economies projected by World Bank. The growth rate is expected to grow by 6.3 percent in 2020 and by 6.21 percent by 2021. These data show that the GDP of the south Asian economies will be in increasing trend so that the electricity consumption will be growing in the coming years.

Table 2

Panel data Result

Variables	Coefficient	significance
C	-2.827	.000
lnGDP	0.916	.000
lnFDI	0.077	.000
lnPOP	0.75	.000
		.000
		.000
R²	97.5	
F statistics	81.41 (0.000)	

Table 3 presents the country specific regression, this analysis is done to identify the majors factors in that contributes more in electricity consumption in each country. In Case of Nepal population contributes more to electricity consumption. The regression result show that in

case of Nepal one percent increase in GDP increases electricity consumption by 0.45 percent. Similarly 1 percent increase in FDI increases electricity consumption by 0.014 percent. The population have a higher impact on electricity consumption, the result reveals that 1 percent increase in population in Nepal increases electricity consumption by 1.66 percent.

According to World Bank data the annual population growth rate of Nepal is 1.65%, which indicates that the demand for electricity in the future years will be in increasing trend.

The regression results of Bangladesh also show that population has a greater impact on electricity consumption followed by GDP and then FDI. The results show that 1 percent increase in FDI increases the electricity consumption by 0.55 percent. Similarly one percent increase in FDI increases electricity consumption by 0.035 percent. the increase in population by 1 percent increases electricity consumption by 2.94 percent. The annual growth rate of population of Bangladesh is 1.05 percent so the increase in population increase in population increases the electricity consumption by more than double percentage.

In case of India, the increase in GDP has greater impact on electricity consumption the regression result show that one percent increase in GDP increases electricity consumption by 0.99 percent. FDI have lower impact on electricity consumption, 1 percent increase in FDI increases the electricity consumption by 0.13 percent. Similarly, a percent increase in population increases electricity consumption by 0.44 percent.

According to the recent projection of World Bank, the Indian economy will grow by 5.1 percent in the upcoming years so there will be greater demand for electricity in India in the future.

Electricity consumption in Sri Lanka is guided by population. The regression results show that a percent increase in GDP increases electricity by 0.14 percent and a percent increase in FDI increases electricity consumption by 0.10 percent. The result shows that there is no major impact of GDP and FDI in electricity for Sri Lanka. The results show that the population has a major impact on electricity consumption in Sri Lanka, a percent increase in population increases electricity consumption by 4.5 percent.

The average growth rate of population of Sri Lanka is 1.36 percent so there will be huge demand for electricity in Sri Lanka in the future.

GDP plays a major role for electricity consumption for Pakistan the results show that a percent increase in GDP increases the electricity by 0.312 percent. FDI and Population Growth has less role in electricity consumption in Pakistan, the result show that a percent increase in FDI and population increases electricity consumption by .061 and .092 percent.

Table 3

Cross Country Results

Variables	Coefficient
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<u>Nepal</u>	
C	7.821
lnGDP	0.453
lnFDI	0.014
lnPOP	1.663
<u>Bangladesh</u>	
C	17.494
lnGDP	0.555
lnFDI	0.035
lnPOP	2.94
<u>India</u>	
C	-5.579
lnGDP	.988
lnFDI	.013
lnPOP	.446
<u>Sri Lanka</u>	
C	-33.06
lnGDP	.149
lnFDI	.109
lnPOP	4.519
<u>Pakistan</u>	
C	-2.422
lnGDP	.312
lnFDI	.061
lnPOP	.092

The paper further investigates the prospects of cross border energy trade in south Asia. The growing Consumption of electricity can fulfilled either from electricity generation or through imports of electricity.

The study takes into account the generation of electricity through hydro power resources only because Essence of RES is derivation from natural processes so the energy is sustainable and never run out. Truly, renewable energy is really important and necessary to human beings when fossil fuels are more and more exhausted. With the never-ending supply of renewable, we would feel secure when having abundant supply of energy to last our planet, our human race and our economies, for generations and ever. Khemani (2011) says: “As long as human life is there, there will be earth, sun, wind and water, and the energy from these sources will also be available as long as they are there”. With the abundance from many renewable resources and development of science and technology, he strongly believes that renewable energy can meet the world’s energy needs today and tomorrow.

One of the greatest alternative energy benefits is that it is so much better for environment than the use of fossil fuels that contribute heavily to issues such as acid rain, smog and global warming. On the contrary, renewable energy has little or no waste products such as carbon dioxide or other chemical pollutants. Renewable energy systems produce much lower carbon dioxide emissions as opposed to carbon-intensive fossil fuels such as oil, coal and natural gas while they are being used only a small amount of fuel during the manufacturing of equipment.

Another benefit of renewable energy is a diversified energy mix. It is an important and necessary supplement for global energy security while fossil fuel sources are more and more running out. In some circumstances, renewable energy can be more reliable than other forms of electricity.

The above regression results show that the electricity consumption increases with the increase in population, GDP and FDI. The results show that population and GDP has a major impact on electricity consumption. So owing to the increasing demand for electricity, the demand can be fulfilled either from electricity generation or through the imports.

The model was formed taking GDP as a dependent variable and electricity import and Hydroelectricity generation as independent variable.

Table 4 presents the regression results of the panel data of four south Asian countries. the Result depicts that there is significant positive relation of electricity imports on GDP whereas Hydroelectricity generation has a negative impact on GDP in South Asia, which is insignificant. The regression result show that 1 percent increase in electricity import increases the GDP of south Asian countries by 1.35 percent. the increase in Hydropower generation by all countries in South Asia decreases the GDP by .36 percent. So the results show that it not beneficial for the region to generate the hydropower by all countries in the region.

Table 4

Panel Data

Variables	Coefficient	significance
C	10.187	.000
lnELECIMP	1.35	.002
lnHYDROGEN	-.368	.015
R²	97.5	
F statistics	81.41 (0.000)	

Owing to the regression results of Panel data i.e. the generation of hydroelectricity by all countries in the region has negative impact on GDP of the region. Therefore, the paper analyses the cross country results in order to find out the countries which should generate the

hydroelectricity and the countries that should import the electricity so that promotes the economic growth in the region.

Table 5 shows the cross-country results of the south Asian countries. in case of Nepal both hydroelectricity generation and electricity imports have a positive impact on economic growth electricity imports and hydropower generation has a positive impact on GDP but the impact of hydroelectricity generation has more contribution in GDP. The result show that the increase in electricity imports by 1 percent increases the GDP by 0.47 percent where as the increase in hydroelectricity generation by 1 percent increase the GDP by 1.97 percent.

In case of Bangladesh also both hydropower generation and electricity imports has a positive relation with GDP but the contribution of Hydroelectricity generation has more positive impact on GDP then imports.

In case of India and Pakistan electricity imports has positive impact on GDP where as Hydroelectricity generation has negative impact on GDP. Therefore, the results show that Nepal and Bangladesh should increase their hydro electricity generation and India and Pakistan should import electricity from Nepal and Bangladesh so that it will enhance economic growth in the region.

Conclusion

The region's countries must trade energy if they are to increase economic growth. The current rate of economic development is dependent on the accessibility and dependability of the available commercial energy sources. The current rate of economic growth is dependent on the accessibility and dependability of the commercial energy sources. South Asian nations have high economic growth aspirations, which naturally mean that more commercial energy is required for greater economic growth. The fact that the nations in the South Asian region would be transformed into some of the countries in the region have extensive land borders. They can travel via road to get from one nation to another. If the transmission lines are built, Bangladesh and Nepal can export hydroelectricity to India and Pakistan. The necessity for international energy commerce has arisen as a result of the power constraints in the South Asian nations. Joint ventures for the construction of gas transmission and pipeline lines should be looked into and developed in order to accomplish this. Energy commerce between these nations is crucial to supplying the world's expanding energy needs. Nepal can sell the surplus electricity it produces to other South Asian nations and then purchase coal, natural gas, and oil from those nations in return.

The potential for intra-regional energy commerce depends on the political leaders of these nations' fervent ambition and will. The core of regional resource management is the exchange of energy among South Asian nations. Greater regional economic integration will result from it. The energy trade will aim to integrate them with global markets by assisting in meeting their regional energy needs. Additionally, there is great potential for furthering regional

economic development through the flow of energy among the nations of the South Asian region. The countries of the region can maximize benefits from the potential financial gains from energy trade. They have the scope of developing their indigenous sources of energy. Governments in the South Asian region support regional energy trade initiatives by signing small-scale bilateral electricity trade agreements, although the frequency of these agreements is increasing. It has been determined that the bilateral electricity trade programs between India and Nepal and Bhutan are successful. Therefore, it can be said that there is a great deal of room for cross-border energy trade in South Asia, which would help the area's economy flourish.

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