Regional integration through energy trade: a case study of Bhutan's hydro power projects

B.P.Veerabhadrappa
Guru Prasad. M.S
Davangere University, Karnataka, India

Keywords
Energy Security, Regional Cooperation, Hydroelectric Project, SAARC, Descriptive Research.

Abstract

This research paper seeks to review the potential and prospects of regional co-operation in energy sector and electric power sector in particular between India and Bhutan. For the past few decades, Bhutan has constructed hydroelectric dams with the help of India to meet its domestic needs and to sell electricity to India this has been based on bi-lateral agreements. This paper will examine the factors which influenced steps to establish regional integration through energy trade and evaluate the prospects on both countries in terms of benefits and factors which have inhibited such trade so far, take note of the favorable scenarios in the region and identify the ways and means that are necessary to increase regional co-operation in energy trade and investment. The objectives of this research are achieved through descriptive as well as diagnostic analysis. Due to export of surplus electricity to India and in reverse India is getting low cost green energy without polluting environment and India has established monopoly on the Bhutanese market. As this paper is based on secondary data provided by Bhutan and India and no primary research is possible, in future social impact study can be done based on how these hydroelectric projects affected the economy can be done through primary research.

1. Introduction

Energy has played a fundamental role in the evolution of human civilization. Energy is described as the amount of work that can be done by a force. Energy cannot be created or destroyed; however, it can change forms. Energy comes in different forms thermal, radiant, kinetic, electrical, chemical, nuclear energy and gravitational energy. There are two types of energy potential energy and kinetic energy. Energy sources are divided into two group's Renewable energy and Nonrenewable energy. There are five main renewable energy sources solar energy, wind energy, geothermal energy, hydropower energy and biomass.

Electricity is the flow of electrical charge. Electricity is occurs in a natural phenomenon and takes different forms. Electricity is most widely used forms of energy. Electricity is vital to the operation of major world economies. Electricity occurs naturally in the world and is also artificially created. Electricity is produced by using sources like coal, natural gas, nuclear, solar, or wind energy which are primary source of energy; hence electricity is a secondary energy source. The sources used to make electricity can be renewable or non-renewable.

Majority countries are increasingly dependent on reliable and secure electricity supplies to achieve economic growth and prosperity. This dependency is set to grow as more efficient and less carbon intensive forms of power are developed and stationed to help de-carbonized economies. Maintaining reliable and secure electricity services while seeking to rapidly de-carbonized power systems is a key challenge for countries throughout the world.

Energy security may be defined as the continuous availability of energy in varied forms, in sufficient quantities, and at reasonable prices without causing hindrance to other securities like social security, food security, and national security of other countries and without detrimental effects on the environment. Energy security includes many aspects however, within this broad framework, each country should define the parameters of its energy security depending on its own energy resources and requirements.

South Asia is three percent of the world's land surface area and it accounts for about forty five percent of Asia's Population or over twenty five percent of the world's population. South Asia experienced a robust economic growth and it has been among the fastest-growing in the world. Growth projected to steadily increase from seven percent in 2015 to eighth percent by 2017 maintaining strong consumption and increase in investment, which demands continuous energy supply like electricity, putting severe pressure on the economies.

Growing demand for electricity in South Asian countries can benefit from inter-regional electricity co-operation and trade by discovering electricity demand patterns, diversity in resources for power generation, and gains from broader market aspect and access. South Asia has seen slow progress in expanding regional electricity co-operation and trade, and in undertaking domestic sector reforms. Although bilateral and multilateral electricity sector co-operation in the region is increasing still numerous regional barriers and domestic sector inefficiencies are there. If the regional and domestic barriers are overcome then it will facilitate automatically electricity trade and broadens the profit sharing among various societies.

In India, electricity is the key input for economic growth, prosperity and the present per capita electricity consumption is about 1010 kWh and power shortage was at its peak at 2.3% in 2015. Since 1990s, India's gross domestic product (GDP) has been growing fast and it is forecast that it will continue to do in the next decades. GDP growth has to be accompanied by increase in consumption of energy as well as electricity. India's population continues to rise & it could reach 1.5 billion by 2045 and increased demand for energy, especially electricity. This needs immediate attention strategy for growth of electricity generation based on all issues related to sustainability, availability of energy resources, diversity of energy supply and technologies, security of supplies, self sufficiency and security of energy infrastructure, effect on local, regional and global environment, health externalities and demand side management.

The seasonal price and income elasticities of electricity demand in the residential sector of all urban areas of India show electricity demand is income and price inelastic in all three seasons, and that household, demographic and geographical variables are significant in determining electricity demand Massimo Filippini, Shonali Pachauri (2004) again the major share for electricity consumption in India are commercial and large industrial sectors are income elastic (>1), while residential, agricultural and small and medium industries are income inelastic (<1) Bose, R. K., & Shukla, M. (1999) however Pachauri, S., & Jiang, L. (2008) residential energy consumption in China is twice that in India, in aggregate terms.

In addition, Chinese households have almost universal access to electricity, while in India almost half of rural households and 10% of urban households still lack access. On aggregate, urban households in China also derive a larger share of their total energy from liquid fuels and grids (77%) as compared to urban Indian households (65%). Especially The most direct and significant result of economic growth in India and China is the amazing improvement in quality of life (or at least spending power) for an increasing share of the population Hubacek, K., Guan, D., & Barua, A. (2007) to repeat the population growth especially changing lifestyles, urbanization, development of industries in developing countries are creating more demand for electricity, electricity is the fuel for economic development. In recent years, it has become increasingly evident that socio-economic variables are the important predictors of energy use. Income, education and occupation have now become the measures used to measure electricity demand (Sudhakar reddy, 2004)

Along with the demand for electricity, the role of GDP and electricity consumption show the long-run relationship indicate that a sufficiently large supply of electricity can ensure that a higher level of economic growth Chen et.al (2007) in addition Aqeel, A., Butt, M.S., 2001 infer that economic growth causes total energy consumption and thus expands employment in Pakistan. In the same way it is found that the expected increase in economic output due to increased electricity supply plays a crucial role in the economic growth of Sri Lanka, Morimoto, R.,Hope,C.,(2004). To repeat results show that there is unidirectional causality from per capita GDP to per capita electricity consumption in Bangladesh (Pallab Mozumder , Achla Marathe, 2007) moreover the results indicate that there is a bi-directional causality between electricity consumption and economic growth in Malaysia and Singapore. This means that an increase in electricity consumption directly affects economic growth and that economic growth also stimulates further electricity consumption in the two countries. However, unidirectional causality runs from economic growth to electricity consumption in Indonesia and Thailand without any feedback effect (Yoo, S. H., 2006).Finally it is the smooth flow of electricity supply ensures economic growth is assessed by research papers.

Having known about the importance and pressures the demand for electricity is going to impact economy, the specific objectives are given below:

1. To investigate Indian investment on Hydropower projects of Bhutan

2. To understand the profit of Bhutan through Indian investment in hydropower projects.
3. To portray the mechanism of inter-regional energy trade.

2. Country Specific Information

A) Bhutan Data Base.

Bhutan is a small kingdom in the eastern Himalayas, extending over an area of 38,394 square kilometers. The country is bordered by India and China. Despite being landlocked, with difficult terrain and widely dispersed population, Bhutan has made rapid socioeconomic progress. The country's annual economic growth averaged about 7-8 per cent over the last two decades and grew by 11.73 per cent in 2010. Bhutan's per capita has risen from $239 in 1980 to $1,523 in 2006.

Table 1: Share of Major Economic Sectors (in %)

Sectors	2009	2010	2011	2012	2013
Primary	18.23	16.80	16.33	15.96	16.18
Secondary	41.97	42.78	40.98	41.62	42.30
Tertiary	39.81	40.42	42.69	42.42	41.52

* http://www.nsb.gov.bt/publication/files/pub3sp4293ry.pdf

Secondary sector, which is composed of manufacturing, electricity and water supply constituted major share to GDP, hydropower development and the export of surplus electricity to India has largely sustained this robust growth and fundamentally transformed the structure of Bhutan's economy. Through prudent macroeconomic management the country is performing well and the Government's investment in social and human development has raised hopes of Bhutan meeting several of the Millennium Development Goals.

B) Role of Hydro Power Sector in Bhutan

Hydropower has been Bhutan's main engine of growth over the last two and half decades since the full commissioning of the first mega project in 1988. Glacial Mountains of the Great Himalayas Range in the northern Bhutan provide an important renewable source of water for the country's river systems. Bhutan's fast flowing have been tapped to build run-of-river hydropower plants that have in turn driven economic growth and greatly boosted progress in meeting many of the country's socio-economic development objectives. As a source of energy that is clean and sustainable, hydropower has far-reaching implications on the overall wellbeing and prosperity of Bhutan, well in line with the country's overarching development philosophy of Gross National Happiness.

The tapping of hydropower in Bhutan has also been a story of successful bilateral Cooperation and energy trade between Bhutan and her most steadfast development partner India. Three out of the four current mega-hydropower plants were constructed with financing from the Government of India through a mixture of grants and loans. Tariffs for hydropower exported to India are fixed on a cost-plus basis that takes into account all costs including depreciation as well as a net return of 15 percent. India will continue to be Bhutan's most important partner in developing hydropower projects – construction on three more mega projects with GOI financing are already underway while an intergovernmental agreement. The below table give information about the bilateral cooperation and investment on various hydropower plants:

Out of an estimated 24,000 megawatts (MW) of techno-economically feasible hydropower potential, a little over 1,480 MW or about 6 percent of that potential has been harnessed so far. Hydropower is Bhutan's top export, accounting for 31.2 percent of overall exports and 9.8 percent of GDP (FY13/14). Revenue earnings for the Government from the hydropower sector come from dividends and corporate income tax from Druk Green Power Corporation (DGPC), corporate income tax from Bhutan Power Corporation Limited (BPCL) and royalty. The hydropower sector contributed 20 percent to the national exchequer in FY13/14, amounting to Nu.4.7 billion, increasing from 17.5 percent in 2012/13.The below given table shows the revenue generated through export of electricity to India in Bhutan.

Table 3: Hydro Power Exports and Revenue: 2006/07 – 2013/14

	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Total Exports(Nu Millions)	6903.8	10123.1	10434.9	9953.2	10349.8	9798.3	10323.4	10247.9
Chukha Hydro Project Authority	3759.3	3690.5	3638.5	3668.2	3616.2	3385.4	3232.6	3456.8
Kurichu Hydro Project Authority	473.3	352.4	330.5	305.8	300.7	283.7	251.5	284.0
Tala Hydro Project Authority	2671.1	6080.2	6465.9	5979.2	6432.8	6129.2	6839.3	6507.1
Annual Growth (%)	96.7	46.6	3.1	(4.6)	4.0	(5.3)	5.4	(0.7)
Exports in % of GDP	17.0	20.5	19.1	16.3	14.3	11.5	10.6	9.8
GDP (Nu Millions)	40676.5	49456.6	54744.3	61220.6	72496.6	84950.0	97453.0	104378.1
Contribution to National Revenue (Nu Millions)	2641.0	2725.0	3795.5	3790.0	3817.9	3612.0	3705.2	4721.4
Druk Green Power Corporation**	2641.0	2616.1	3532.9	3545.0	3471.8	3143.1	3279.7	4281.4
Bhutan Power	0.0	108.9	262.6	245.1	346.1	313.3	296.3	336.0
Royalty	0.0	0.0	0.0	0.0	0.0	156.2	129.2	104.0
% of National Revenue	26.0	21.9	26.8	24.1	21.5	17.5	17.3	20.0
National Revenue (Nu Millions)	10147.5	12428.2	14158.5	15749.1	17729.1	20652.1	21448.5	23659.9

*Net of Imports. **Includes dividends, transfer of profits etc from Department of Energy & Hydropower projects before 2009/10. *NU-Ngultrum (Bhutanese currency)

Table 2: Summary of Operation: Major Hydropower Plants including Indian Investment

	Basochhu (Upper)	Basochhu (Lower)	Chukha	Kurichu	Tala
Installed Capacity	24MW	40MW	336MW	60MW	1020MV
Export Tariff Per Unit	-	-	Nu 2.25	Nu 1.8	Nu`1.8
External Financing	Govt. of Austria 37.74% Grant 48.96% Loan	Govt. of Austria 2.80% TA Grant 90.7% Soft Loan 2.79 % interest	Govt. of India 60% Grant 40% Loan	Govt. of India 60% Grant 40% Loan 10.75% interest	Govt. of India 60% Grant 40% Loan 9% interest
Loan Outstanding as of 30 Sep 2014	Euro 10.29 Million	Euro 21.87 Million	Debt fully paid back by Dec. 2007	INR 280 Million	INR 6.04 Billion
Construction Schedule	Nov. 1997- Oct. 2001	Mar. 2002 – Sep 2004	1974-1988	Sep. 1995 – May 2002	Oct. 1997 - Mar. 2007
Project Cost	Euro 30.23 Million +Nu. 192.84 Milli0n *(RGOB) (Total Nu 1.44 Billion)	Euro 31.95 Million + Nu.33.97 Million (RGOB) (Total Nu.1.84 Billion)	Nu.2.5 Billion	Nu.5.6 Billion (GOI) + Nu.40 Million additional contribution from (RGOB)	Nu.42.35 Billion
Initial Outlay & Estimated Cost	Euro 25.44 Million	Nu.1.42 Billion		Nu.2.50 Million	Nu.14.08 Billion (1993 prices)

*Export tariff for Chukha was revised in February 2014 from Nu 2 to 2.25 per unit with retrospective effect from 1 Jan 2013

Since surplus power after domestic consumption is exported to India, the revenue earned through export depends, among other things, on the level of domestic consumption. In 2013/14, export earnings fell by Nu.75.6 million while domestic sales more than doubled to Nu.1, 849.4 million.

C) India Energy Database

During the period 1981-2000, India witnessed GDP growth rate of around 6% per year. Indian economy is the 7th largest in the world GDP per capita $1,688 and PPP $6,209 in the year 2015. "India has the potential to show the fastest growth over the next 30 to 50 years. Growth could be higher than over the next 30 years and close to 5% by 2050 if development proceeds successfully" Dominic Wilson and Roopa Purushothaman (2003). Government of India has taken steps in the recent and policies aimed at improving energy, transport and communication infrastructure vital for sustainable economy. The Electricity Act – 2003, is one such important initiative. All these are the steps towards achieving an average annual growth of 8% in GDP.

Table 4: GDP Growth

Year	GDP Growth	Annual Growth in Power Generation
2008-09	3.9	2.7
2009-10	8.5	6.6
2010-11	10.3	5.56
2011-12	6.6	8.11
2012-13	5.1	4.01
2013-14	6.9	6.04
2014-15	7.4	8.43

https://worldbank.org/indicator&powergeneration

Analysis of the above table data using Pearson correlation coefficient shows there is a moderate positive correlation (R= 0.5177) between GDP growth and annual growth in power generation. In simple terms GDP growth always depend on annual growth in power generation. It gives clear picture that growth of economy is dependent on power sector.

India as a largest democratic country in the world with an estimated population of about 1.04 billion is on rapid growth in economy. The growth prospective of the Indian economy is moderately positive due to its growing economy and increasing integration into the global economy, booming domestic market, industries and investment rates. In its 2015 revision report the United Nations (2015) reported that India's population will probably surpass China's by 2022 and it will reach 1.38 billion. But it also throws light on the many challenges the nation will have to overcome, including the creation of infrastructure like basic network of water, electricity, sanitation, health and social services and to respond to shifts in the population.

Life styles are changing rapidly due to accelerated economic growth. The population structure is changing, thereby offering the country with the potential to reap the population dividend. India is urbanizing rapidly, and the growing middle class is fuelling consumerism by imbibing global life styles, due to media influence is ever increasing. These changes are likely to have significant impact for energy demand in future. Energy is needed for economic growth, for improving the quality of life and for increasing opportunities for development.

Table 5: Census India 2011

Census Year	Population	% Change	Census Year	Population	% Change
1951	361,088,000	-----	1981	683,329,000	24.7
1961	439,235,000	21.6	1991	846,387,888	23.9
1971	548,160,000	24.8	2001	1,028,737,436	21.5
			2011	1,210,726,932	17.7

Table 6: Major electricity demanding sector are like this (in TWh)

Sectors	2012	2022	2030	2047
Industry	336	494	703	1366
Residential	175	480	842	1840
Commercial	86	142	238	771
Agriculture	136	245	336	501
Others	29	71	121	233
Total	**762**	**1433**	**2,239**	**4712**

Source: https://neetiaayog.gov.in/reports

The below table gives clear picture about the availability of electricity in terms of surplus/deficits and make us to think why India is investing in neighbouring countries especially in Bhutan and also the cost of production in table:7 is high and overall the subsidy given by various state governments is draining the treasury.

Table 7: The power supply position in the country during 2009-10 to 2014-15

Year	Energy				Peak			
	Requirement	Availability	Surplus(+)/Deficits(-)		Peak Demand	Peak Met	Surplus(+) / Deficits(-)	
	(MU)	(MU)	(MU)	(%)	(MW)	(MW)	(MW)	(%)
2009-10	8,30,594	7,46,644	-83,950	-10.1	1,19,166	1,04,009	-15,157	-12.7
2010-11	8,61,591	7,88,355	-73,236	-8.5	1,22,287	1,10,256	-12,031	-9.8
2011-12	9,37,199	8,57,886	-79,313	-8.5	1,30,006	1,16,191	-13,815	-10.6
2012-13	9,95,557	9,08,652	-86,905	-8.7	1,35,453	1,23,294	-12,159	-9.0
2013-14	10,02,257	9,59,829	-42,428	-4.2	1,35,918	1,29,815	-6,103	-4.5
2014-15	9,03,104	8,68,591	-34,513	-3.8	1,48,166	1,41,160	-7,006	-4.7

Source: https://cea.gov.in/power sector at a glance

As elsewhere in the world, the energy and electricity growth in India is closely linked to growth and to effectively counter the growing demand for electricity from different sectors Government of India (GOI) has developed energy mix of all the resources available including renewable. At the same time to investment on friendly neighbouring countries hydroelectric projects are paying dividends.

3. Mechanism of Inter-Regional Energy trade

The mechanism of electricity trade between India and Bhutan can be understood with the help of how and at what price hydropower is exported to India. Currently Bhutan is exporting at Nu.2.25 per unit from Chukha (the export tariff for Chukha was increased in February 2014 with retrospective effect from January 2013. The last revision was from Nu.1.5 to Nu.2 per unit with effect from January 1, 2005). The export tariff for Kurichhu and Tala are currently set at Nu.1.80 per unit (tariff for Kurichhu was increased from Nu.1.75 per unit from January 1, 2008 and is now pegged to the Tala export tariff). The DGPC sells power for domestic consumption to the BPC – 15 percent of the total annual generation, known as royalty energy, is provided to the BPC for onward distribution at subsidized rates to low and medium voltage consumers. From October 2013, royalty energy is being provided free of cost while a nominal tariff was charged prior to that. Domestic sale beyond the 15 percent royalty energy is sold at Nu.1.20 per unit. The lower per unit cost of electricity to the government of India reflects the viability and feasibility of investment made through different inter-regional trade in Bhutan specifically in terms of hydropower in Bhutan. This sort of regional energy trade not only showing the political relationship but economically interdependence in the era of globalization.

5. Conclusion

In the present era of globalization it is evident that how Indian investment in various hydro power projects of Bhutan reflects mutual benefits and co-operation between two neighboring countries. As the investment made in the different hydropower projects of Bhutan like CHPA, CHPA, KHPA, THPA, amounting 2.5 billion for CHPA, 5.6 billion for KHPA and 42.35 billion for THPA from the Bhutan's point of view the investment made in Bhutan in multiple hydro power projects allows to harness the natural resource in terms of hydro power projects of Bhutan and reaping the benefits through exporting the electricity to the investing country. At last but not the least the investment and export relationship between India and Bhutan is pointing out the inter-trade relationship in the area of hydro power projects it is not only economic relationship but it is rejuvenating the historical and cultural relations between India and Bhutan flowing through wires.

References

Aqueel, A. and M.S, Bhatt. (2001). The relationship between energy consumption and economic growth in Pakistan. *Asia-Pacific Development Journal*, 8(2), pp.101-109.

Bhattacharyya, S. (2015). Influence of India's transformation on residential energy demand. *Applied Energy*, 143, pp.228-237.

Bose, R. and Shukla, M. (1999). Elasticities of electricity demand in India. *Energy Policy*, 27(3), pp.137-146.

Chen, S., Kuo, H. and Chen, C. (2007). The relationship between GDP and electricity consumption in 10 Asian countries. *Energy Policy*, 35(4), pp.2611-2621.

Country Strategy Paper. (2015).

Filippini, M. and Pachauri, S. (2004). Elasticities of electricity demand in urban Indian households. *Energy Policy*, 32(3), pp.429-436.

How Can India Capitalize on its Population. (2015). [online] Available at:
http://www.dw.com/en/how-can-india-capitalize-on-its-population-growth/a-18691742 [Accessed 8 Oct. 2015].

http://planningcommission.nic.inhttp://planningcommission.nic.in, (2015). *Energy Sector*. [online] Available at: http://planningcommission.nic.in/sectors/index.php?sectors=energy [Accessed 5 Oct. 2015].

http://www.eia.gov, (2015). *International Analysis/India.pdf*. [online] Available at:
http://www.eia.gov/beta/international/analysis_includes/countries_long/India/india.pdf [Accessed 3 Oct. 2015].

Hubacek, K., Guan, D. and Barua, A. (2007). Changing lifestyles and consumption patterns in developing countries: A scenario analysis for China and India. *Futures*, 39(9), pp.1084-1096.

Ministry of Finance India, (2015). *Census Population*. [online] Available at: http://Ministry of finance/Census of India [Accessed 1 Jan. 2015].

Mozumder, P. and Marathe, A. (2007). Causality relationship between electricity consumption and GDP in Bangladesh. *Energy Policy*, 35(1), pp.395-402.

Pachauri, S. and Jiang, L. (2008). The household energy transition in India and China. *Energy Policy*, 36(11), pp.4022-4035.

Reddy, S. (2015). Economic and social dimensions of household energy use: A case study of India. In: *Advances in Energy Studies*. Campinas: SP, pp.469-477.

Wilson, D. and Purushothaman, R. (2003). Dreaming with BRICs: The Path to 2050. *Global Economics*, [online] Paper No: 99. Available at: http://www.gs.com/insight/research/reports/99.pdf [Accessed 5 Oct. 2015].

www.cia.gov, (2015). *The World Factbook*. [online] Available at:
https://www.cia.gov/library/publications/resources/the-world-factbook/geos/in.html [Accessed 6 Oct. 2015].

www.eia.gov, (2015). *Energy Explained*. [online] Available at:
http://www.eia.gov/energyexplained/index.cfm?page=about_home [Accessed 9 Oct. 2015].

www.iea.org, (2015). *What is Energy Security*. [online] Available at:
http://www.iea.org/topics/energysecurity/subtopics/whatisenergysecurity/ [Accessed 3 Oct. 2015].

www.rbi.org.in, (2015). *Handbook of Statistics on Indian Economy*. [online] Available at:
https://www.rbi.org.in/scripts/AnnualPublications.aspx?head=Handbook of Statistics on Indian Economy [Accessed 6 Oct. 2015].

www.worldbank.org, (2015). *South Asia Region Overview*. [online] Available at:
http://www.worldbank.org/en/region/sar/overview# [Accessed 4 Oct. 2015].

Yoo, S. (2006). The causal relationship between electricity consumption and economic growth in the ASEAN countries. *Energy Policy*, 34(18), pp.3573-3582.