

The BIMSTEC Supergrid

Renewable Energy Mix and Regional Economics

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Abstract—Regional Integration of Economy and Energy can't be complete without Interconnection Transmission Lines. This is more true if member nations are endowed with diverse and complementary energy resources. BIMSTEC Supergrid's relevance can be seen in this light. Renewable Energy is a significant component of energy mix of BIMSTEC member nations, and with the addition of sizeable chunk of Variable Energy Sources (VES) like Solar Power and Wind Power, especially in India's context, Grid Balancing is going to be a challenge. From this perspective also Enhanced Transmission line among neighbouring countries are inevitable. BIMSTEC is an emerging economy and hence per capita electricity consumption is going to increase substantially in the near future. Capacity addition in a short duration by an individual country will be a drain on its economy, hence power pooling as a tool will work as a boon.

Keywords- supergrid; renewable; BIMSTEC; economics

I. INTRODUCTION

The Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) with seven member states, five from South Asia and two from Southeast Asia, is an important link between South Asia and South East Asia. Countries belonging to this group are: Bangladesh, Bhutan, India, Sri Lanka, Nepal, Myanmar and Thailand. Void due to ineffectiveness of South Asian Association for Regional Cooperation (SAARC) amidst political differences amongst member nations has been filled by this new grouping. Further China's One Belt One Road (OBOR) and the USA's counterbalancing New Silk Road, linking South Asia and Southeast Asia, have overt and covert elements of cooperation and convergence amidst rivalry and divergence. Against this backdrop and challenges to be faced in near future due to increased penetration of Variable Energy Sources (VES) like Solar Power and Wind Power, Grid Balancing and Energy trading amongst BIMSTEC nations will be worth exploring. Broadly speaking, Grid Balancing can be achieved in four ways. These are: Flexible Generation, Transmission and Distribution Enhancements, Demand Side Management and Energy Storage. Conventionally Hydropower and Natural Gas based Power Plants have served as Flexible Generation. Electric Vehicle, Industry Demand and Appliance Demand participate in Demand Side Management. Pumped Hydro

Storage and Electrical Energy Storage are examples of Energy Storage. Currently 97 per cent Energy Storage of the world is catered by Pumped Hydro whereas Other Advanced Energy Storage, this includes Electrical Energy Storage also, is providing 3 per cent of total Energy Storage [1]. Electrical Energy Storage in its infancy has bright future growth prospect. The interconnection transmission lines between group members i.e. enhancement of Transmission lines amongst neighbouring countries envisages Supergrid plan. Interconnection is existing and positively influencing many regions. European Interconnection is one of them. During Solar eclipse in Germany in 2015, the interconnection Transmission line between Germany and Europe played very prominent role. Steep decrease of solar power from 13 GW to 4.8 GW in very short time during solar eclipse and further steep rise from 4.8 GW to 19 GW was managed well by Germany, and Interconnection was one of the ways used for Grid Balancing [2].

Conceptualization is a first step towards realization. Some of the Supergrid envisaged are: Asian Supergrid, Southeast Asian Supergrid, European Supergrid. BIMSTEC Supergrid is another regional effort in this direction with active participation of BIMSTEC member countries. Memorandum of Understanding (MoU) signed by member nations in this regard is a positive signal towards the fructification of this goal.

II. ECONOMY AND ENERGY MIX

A. Economic Status

BIMSTEC has witnessed encouraging average annual growth of 6.5 per cent during last five years [3]. The same impressive growth is continuing at present and likely to continue in the future also. The economic growth of India, Bangladesh, Myanmar and Bhutan for the year 2016 reflects this sentiment as can be seen in Tab.1. Thailand witnessed 7.5 per cent growth rate between 1960 and 1996, though its economic growth hovered around 3.5 per cent during 2005 and 2015. Nepal's current economic growth of 0.6 per cent is largely due to devastating earthquake of 2015. Earlier between 2008 and 2014, Nepal's growth was 4 per cent plus. By and large these economies are integrated to the global economy but the regional integration is yet to flourish [4].

TABLE I. COUNTRY WISE ECONOMIC PARAMETERS ^A

Country Name	GDP Growth % (2016)	kWh per capita (2014)	HDI Rank (2016)
Bangladesh	7.1	310	139
Bhutan	6.2	2,799	132
India	7.1	806	131
Myanmar	6.5	217	145
Sri Lanka	4.4	531	73
Thailand	3.2	2,540	87
Nepal	0.6	139	144

a. World Bank data

What does this growth story convey? How this Growth is linked to access to energy and energy growth of a nation? The answer lies in relationship between per capita energy consumption and United Nation's Human Development Index (HDI). Per capita Energy consumption has strong correlation with HDI. Barring Bhutan and Thailand with per capita energy consumption of 2799 and 2540 respectively, the per capita Electricity consumption for BIMSTEC countries is less than thousand. Further this HDI's link to per capita energy consumption is visible when per capita energy consumption is within 5000 kwh. BIMSTEC has to aspire to ameliorate its HDI. Focusing on Energy sector and prioritizing right Energy Mix are way forward. Here lies the need, opportunity and challenge to make significant stride in the domain of energy.

B. Power Sector Overview

BIMSTEC has diversified portfolio of energy. Further, due to the gap between demand and supply of energy, some BIMSTEC member countries are energy surplus and some energy deficit. Due to various reasons demand pattern amongst member nations varies. Hydropower is prominently placed in the energy mix of India, Bhutan, Nepal, Myanmar and Sri Lanka (Tab. 2 and Tab.4). Hydropower with reservoir is Dispatchable generation whereas Hydropower run-on-river is variable generation. Hydropower generation currently for these nations is the mixed baggage of Dispatchable and Variable generation, and accordingly their capability to the Grid Balancing mechanism as Flexible Generation and Transmission Interconnection can be recognized. Hydropower potential and their current exploitation, and future prospect may impact energy mix of the region positively.

TABLE II. COUNTRY-WISE HYDRO POTENTIAL ^A

Country Name	Theoretical Hydro potential (in MW)
Nepal	84,000
Bhutan	30,000
India ^b	1,45,000
Sri Lanka	2,250
Mynamar	1,00,000

a. International Hydropower Association data

b. Indian Power Ministry data

Another important resource in the arsenal of BIMSTEC member nations is the Natural Gas. Bangladesh, Myanmar, Thailand and India are endowed with natural gas. Presently whatever Natural Gas Bangladesh produces, it consumes itself. Myanmar is the net exporter of Natural Gas. India and Thailand are net importers of Natural Gas. Bangladesh's Natural Gas resource is likely to be consumed by 2031. Therefore, suggestion of exporting gas to earn foreign revenue is not wise one. In the meantime, Bangladesh will have to move to cleaner energy instead of Furnace Oil or Coal energy. Exploring other alternatives may include import of electricity at competitive prices from neighbouring countries. Interconnection amongst BIMSTEC member nations will prove an ideal solution.

TABLE III. PRODUCTION, CONSUMPTION AND TRADE OF NATURAL GAS (BILLION CUBIC METRE/YEAR) ^A

Country Name	Production	Consumption	Trade
Bangladesh	27.5	27.5	0
Bhutan	0	0	0
India	27.6	50.1	-22.5
Myanmar	18.9	Not available	
Sri Lanka	0	0	0
Thailand	38.6	48.3	-9.7
Nepal	0	0	0

a. BP Statistical Review 2016

India's economic growth has been phenomenal during this decade and its impact on energy sector is more than visible. Recent transition of India from power deficit nation to power surplus nation is the expression of economic prowess of India, and her commitment towards energy growth. Presently Fossil Fuels are dominant in energy mix (70%). This situation is going to be altered by 2030, and Fossil Fuels contribution in India's energy mix will come down to 60%. Further this target has been revised to be achieved by 2027.

Thailand, Myanmar, Sri Lanka, and Bhutan are working to change their existing Energy mix, and shift is likely to be towards Solar energy and other renewables.

TABLE IV. COUNTRY-WISE ELECTRICITY GENERATION INSTALLED CAPACITY ^A

Country Name	Energy Mix
Bangladesh	Natural Gas (62%), Furnace Oil (22%)
Bhutan	Hydropower (99%)
India	Coal (59%), Natural Gas (7.6%), Large Hydropower (13.6%), Renewable Energy Sources (small hydro and other renewables like solar, wind, biomass) (17.4%)
Myanmar	Hydropower (75%), Natural Gas (21%), Coal (4%)

Country Name	Energy Mix
Sri Lanka	Thermal (51.4%), Hydropower (37.1%), Renewable Energy Sources (11.4%)
Thailand	Natural Gas (56%), Coal (22.7%), Hydropower (21.5%)
Nepal	Primarily Hydropower

a. Ministry website of respective country

C. Renewable Energy Mix and Grid Interconnection

Renewable Energy mix of BIMSTEC member states is skewed towards Hydropower. Theoretical potential of hydropower conveys the same (Tab.2). But the exploitation of this resource is still wanting. For example, Nepal with Hydropower potential of 84,000 MW hasn't exploited even 1 per cent of its potential. Further 86 per cent share of run-of-river hydropower is responsible for Nepal's energy shortage as rivers dry in winter [5].

Bhutan has potential of 30,000 MW hydropower and installed hydropower capacity is 1615 MW and Bhutan exports power to India and in turn an important source of revenue for the government of Bhutan. Sri Lanka has limited hydropower potential of 2550 MW and installed capacity of Hydropower is around 1400 MW, thus exploiting more than 50 per cent hydro power resources. Hydro potential for India is 1,45,000 MW and total installed capacity of Hydropower is around 44,614 MW which is around 13.6 per cent of total installed capacity. (Tab.2 and Tab.4)

Presently focus is shifting to Renewables other than big Hydro's. India's installed capacity of Renewables other than big Hydro's (Renewables from now) is 57,260 and it is 17.5 per cent of total installed capacity. The share of Variable Energy Sources (VES) like Solar and Wind power is around 77 per cent of total Renewables (56 per cent Wind Power and 21 per cent Solar Power) [6]. India's ambitious target of integrating Renewable Energy of 175 GW consisting of 100 GW of Solar Power and 60 GW of Wind Power by 2022 will significantly increase VES in Renewable Energy mix. Grid Balancing will crop as an important issue. Power pooling or interconnection among neighbouring countries is one of mechanisms for Grid Balancing. Interconnection of Germany to other European nations helped in fighting crisis in the year 2015 solar eclipse in Germany. Likewise BIMSTEC Supergrid will be a boon not only for India but other member countries also. Power traded in the energy exchange in view of VES will bring power tariff down and competitive.

Myanmar, Thailand and Sri Lanka are adding Solar Power in their Renewable mix. Myanmar plans 15%-20% share of renewable energy by 2020 in the total installed capacity [7].

Though Renewable mix of BIMSTEC is dominated by Hydropower except India with sizeable installed capacity of Solar Power and Wind Power, the composition is bound to change towards VES like Solar Power and Wind Power. Grid interconnection amongst member countries will help in smoothing Variability. Further Energy Surplus nations and Energy Deficit nations will complement each other. Power Tariff will be more competitive. Access to Electricity will be more even. These are a few benefits that will accrue with Interconnections and new envisaged Renewable mix.

III. CHALLENGES AND WAY FORWARD

BIMSTEC is all set for Grid Integration. The evidence and intent lie in the signing of MoU on grid integration by BIMSTEC member nations. Thus, the roadmap is ready. The question is when it is going to fructify, and what may be the challenges to fulfil this whole task. The bilateral grid interconnections between India-Nepal, India-Bhutan, India-Bangladesh, and Thailand-Lao of People's Democratic Republic are enough motivation to move from bilateral interconnection to multilateral interconnection. Evidences from European Interconnections and their effectiveness and their subsequent efforts towards European Supergrid should be sufficient motivation towards BIMSTEC Supergrid.

Challenges for grid integration may be in the form of technical, commercial, legal and regulatory. Grid interconnection may be synchronous, asynchronous and radial. High Voltage Direct Current (HVDC) interconnection permits asynchronous interconnection and beneficial for transmission of large amounts of power over very long distances. Further HVDC can work for networks that are incompatible to each other. So technical issues of distance and compatibility of networks to be interconnected may be taken care of. The issues of feasibility and affordability can always be worked out.

Trading of energy is an important aspect. Therefore, shape of regional energy market that has to evolve and work is important. Of course, transparency is one of the central criteria around which the whole effort of unfolding of energy market should unfold. The ultimate objective should be to evolve multilateral energy market where there are multi-buyer and multi-seller. To begin with energy market based on mutual acceptance should be evolved. As the trust and with that need evolves, shift towards multilateral energy market will take place.

IV. CONCLUSION

This is the Age when a country is global as well as local simultaneously. Therefore, interactions on economic, trade and energy fronts are unavoidable. This interaction may be bilateral, regional or on some common convenient grounds. BIMSTEC member nations are aware of these dynamics of interdependence and far reaching benefits out of this interaction. Energy security is crucial to the development; and capacity addition involves cost and time. India-Bangladesh, India-Nepal and India-Bhutan bilateral energy exchange has exposed these nations to the importance and necessity of interconnection. Further Thailand-Lao People's Democratic Republic (Lao PDR) has bilateral hydro interconnection. Thus, the concept of bilateral interconnection and its efficacy in the vicinity of region is not difficult to comprehend and appreciate. So multilateral interconnection is not an arbitrary conceptualization but a very practical idea for fruition. BIMSTEC member nations with diverse resources but common objective of sustainable economic growth is capable of energy security and grid balancing. With the increase of India's share of Variable Energy Sources in her energy mix, Grid Balancing is certainly an important challenge. BIMSTEC member nations endowed with Hydropower and Natural Gas based power can always be useful for one another. Likewise, India, Sri Lanka, Myanmar can exchange surplus power from power deficit countries. Of course, the path to the Supergrid needs multilateral energy market for transparency. This role

may be played by Indian Energy Exchanges to begin with. Regulations are ever evolving and BIMSTEC nations are in one way or the other progressing in this direction.

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