Global Journal of Researches in Engineering
Electrical and Electronics Engineering
Volume 12 Issue 10 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

# Power Grid Interconnection of South Asian Region to Retain Sustainable Energy Security and Figure Out The Energy Scarcity

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*Abstract -* South Asian region is enjoying unprecedented booming economic growth. But this booming pecuniary emergence is becoming stifled by significant shortages in energy supply. If the exigent corrective steps are not initiated and implemented, it may be arduous to sustain the achieved growth rates and overall sustainable development. The region's political leaders and its business community are recognizing gradually the need of cross-border energy exchange and promote regional energy trade. The region has available energy resources to produce power and it should be a matured option to interconnect the entire regional grid to mitigate the power crisis. This article identifies the potential and explicates the main opportunities of the south Asian region to cope up the energy crisis through sub continental power grid interconnection.

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*GJRE-F Classification : FOR Code: 090608*


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## I. Introduction

South Asia has undergone a growing lopsidedness between energy demand and its supply from indigenous sources resulting in increased import dependence. No South Asian country is going to be able to meet its energy needs entirely from its own domestic resources. Energy demands is growing at rate of over 6% a year which is far in excess of the region's capacity to meet [2]. Moreover, about 1.5 billion people and half of the regions are out of electricity [4]. There are a lot of natural resources of the region but distributed spatially which has created a need for regional cooperation of cross-border energy exchange especially in electricity. Power grid interconnection can be a matured option to meet energy demand which can be also a best catalyst for the development of the region. By this interconnection one country will be able to export its surplus electricity to another electricity deficient country so that both will be beneficiary. To fulfill the goal firstly a brief scenario of energy resources of the region has been depicted. In the latter part, the energy ring between the south Asian countries to solve the power scarcity has been discussed. Finally some interconnection between South Asian countries has been proposed and also depicted graphically with congruous elucidation.

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## II. Energy Resources In South Asian Region

South Asian region has a great potentiality in energy resources. For the scattered position a huge portion of the resources is still unused. But if the resources are used to generate power and share that by the same power grid then the region will be beneficiary in its social and economical development and overall to uplift the living standard of the citizens.

*Table 1 :* Energy statistics of South Asian region (2010), [6][7][8][9][10]

| Countries | Coal (Million Tones) | Oil (Million Barrels) | Gas (TCF) | Hydro (MW) |
|---|---|---|---|---|
| Bangladesh | 884 | 12 | 8 | 330 |
| Bhutan | 2 | 0 | 0 | 30000 |
| India | 90085 | 5700 | 39 | 150000 |
| Nepal | NA | 0 | 0 | 42000 |
| Pakistan | 17550 | 324 | 33 | 45000 |
| Sri Lanka | NA | 150 | 0 | 2000 |
| Total | 108521 | 6186 | 80 | 269330 |

## III. South Asian Energy Ring To Solve The Energy Crisis

India has a great challenge to meet it's proliferate energy demands. On the other hand Nepal, Bhutan, Pakistan, Myanmar and Sri Lanka face acute power shortages [3]. The region is rich in other sources of energy which are unevenly distributed and untapped. India, Pakistan and Bangladesh have large reserves of gas and coal [2]. Nepal and Bhutan has a great potential of hydro-electric power [2]. To exploit the regional resources an initiative took in 2006 by launching South Asian Association for Regional Cooperation (SAARC) Energy Center in Islamabad [3] [2]. The objective of that is to facilitate and promote energy trading connecting India, Pakistan, Bangladesh, Sri Lanka, Nepal, Maldives and Bhutan to minimize the acute power shortage faced by them. Nepal and Bhutan generate 40,000 megawatts (MW) of hydro-electricity which can be exported to other SAARC countries through common grid stations [2]. India has already grid interconnections with Nepal and Bhutan [2]. If the others

are connected with that grid then all will get benefits of cross-border electricity exchange and trade among the regional states, leading to optimal utilization of regional resources for electricity generation.

| Importing Countries | Exporting Countries | | | | | |
|---|---|---|---|---|---|---|
| | India | Bhutan | Nepal | Bangladesh | Srilanka | Myanmar |
| India | - | Significant quantities of hydropower | Significant hydropower export possible | Significant amount of gas or power possible; some resource uncertainly | Some peak power support possible | Significant gas and power supply possible |
| Bhutan | Dry season support | - | Unlikely, similarity of resources and seasonal shortages | Small amount of thermal power and gas connection via India | No Scope | Unlikely (far off, too small market) |
| Nepal | Thermal power support, dry season support | Unlikely, similarity of resources and seasonal shortages | - | Small amount of thermal power and gas connection via India | No Scope | Unlikely |
| Bangladesh | Sharing resources; Electricity swaps | Some hydropower connection via India | Some hydropower connection via India | - | No Scope | Unlikely (Although some potential in hydropower) |
| Srilanka | Dry season and thermal power support | Unlikely (far off) | Unlikely (far off) | Unlikely (far off) | - | Unlikely (far off) |
| Myanmar | No scope | Uncompetitive | Uncompetitive | Uncompetitive | Uncompetitive | Uncompetitive |

*Fig.1 :* South Asian countries energy export import potentialities [5].

## IV. Proposed Bangladesh India Power Grid Interconnection

The Bangladesh economy has grown at about 6% per annum but providing electricity to less than 50% of the population [14]. The country's peak power demand is deficit and nearly 1,500 MW [14]. Moreover, about 90% power is generated by the natural gas which is the cardinal resource of the country [14]. In this backdrop an initiative has been taken to interconnect Bangladesh India power grid. This grid will establish 125 km. 400 kV double circuit cross-border link between the Bheramara of western electrical grid of Bangladesh and the Baharampur of eastern electrical grid of India [1][7]. There will be a 400 kV switching station at Baharampur (India) and a 500 MW back to back high voltage direct current (HVDC) sub-station (400/230 kV) at Bheramara (Bangladesh) [1][7]. The system will facilitate an initial power flow of 500MW into Bangladesh from the Indian grid with a provision to enhance the power flow to 1,000 MW.

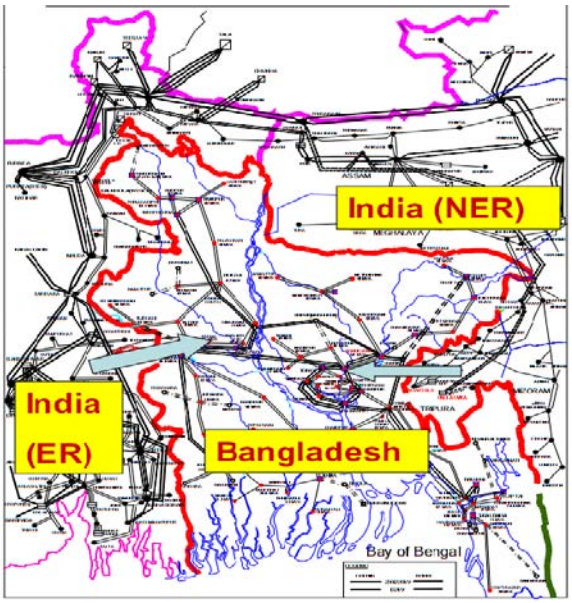


*Fig. 2 :* Proposed Bangladesh and India power grid interconnection [7].

## V. Bhutan India Power Grid Interconnection

Bhutan is the only country in South Asia to have surplus electricity generation. Bhutan exports more than 75 percent of its generated electricity to India and with power export to India contributing 25 percent of the nation's GDP [11]. There are several hydropower projects in Bhutan financed by India. Of them Chhukha Hydropower plant, Tala hydropower plant and Kurichhu Hydropower plant are main plant. Chhukha Hydropower Plant is Bhutan's oldest mega power project and installed capacity is 336 MW [11]. The installed capacity

of Tala hydropower plant and Kurichhu Hydropower plant is 1,020 MW and 60 MW respectively. India and Bhutan have identified 10 projects also, of which three are under construction, and the rest expected to start construction by 2013, to harness 10,000MW by 2020 [11].

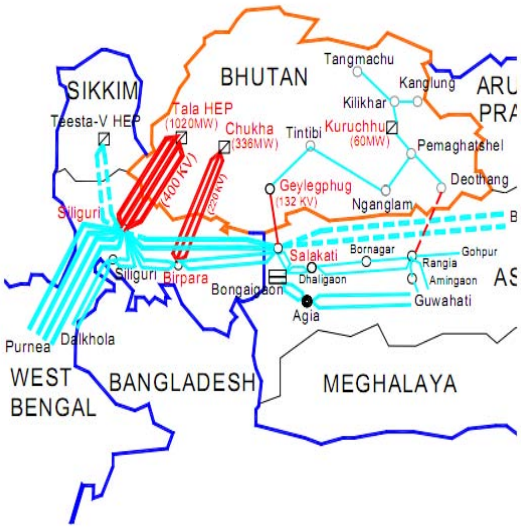


*Fig. 3 :* India and Bhutan power grid interconnection [7].

## VI. Nepal India Power Grid Interconnection

The power exchange agreement between India and Nepal came into operation in 1971. In recent years, the volume of energy exchange between these two countries has increased from 50MW to 150 MW [8][10]. The 'Transmission line Interconnection' project between India and Nepal has three major components namely Dhalkebar-Mujaffarpur, Duhabi-Purnia and Butwal-Gorakhpur, each having a capacity of 400kv. Among them, the first phase construction of Dhalkebar-Mujaffarpur 400kv transmission interconnection is underway. The total length of the transmission line from Dhalkebar to Muaffarpur is 140 km. Only 45 km of this transmission line lies within Nepalese territory. The total length of Duhabi-Purniya line is 112 km of which 22 km lies within Nepalese territory. Similarly, 25 km of the 125 km Butwal-Gorakhpur transmission line lies within Nepal [8][10][13].

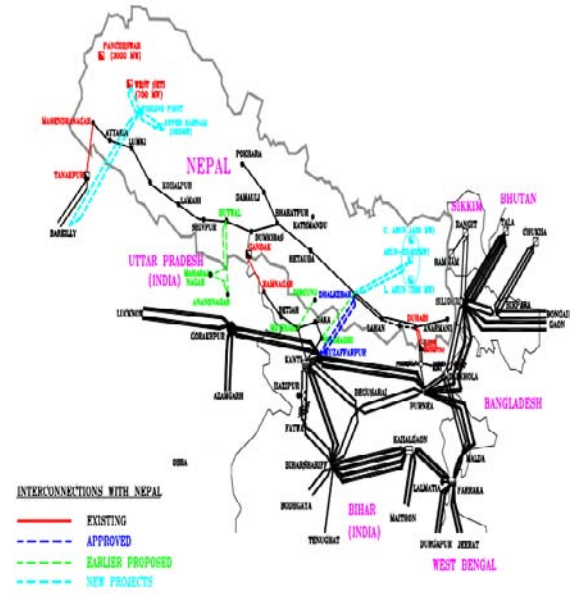


*Fig. 4 :* India-Nepal power grid interconnection [7].

## VII. India and Sri Lanka Proposed Power Grid Interconnection

A HVDC Grid Interconnection is a proposed to link the national grids of India and Sri Lanka. The grid will be connected from Madurai in southern India to Anuradhapura in central Sri Lanka, through the Palk Strait [7][10]. The link will be 285 kilometers in length and is proposed to exchange about 500 MW power [7][10].

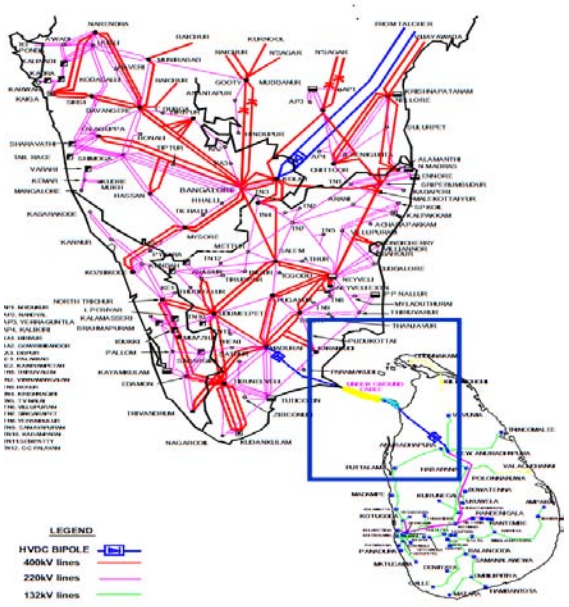


*Fig. 5 :* Proposed India and Sri Lanka power grid interconnection [7].

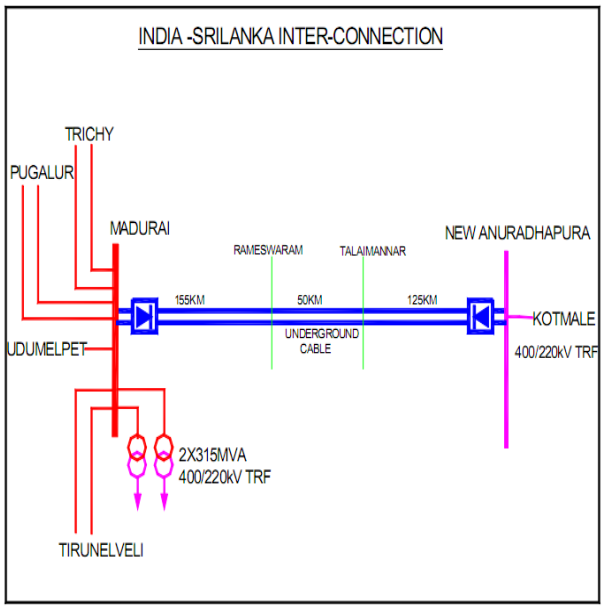


*Fig. 6 :* Single line diagram of India and Sri Lanka proposed power grid interconnection [10].

## VIII. Bangladesh, Bhutan, India and Nepal Proposed Power Grid Interconnection

There is a mismatch between energy demand growth and energy resource endowments in the South Asian region. Relatively smaller economies like Nepal, Bhutan and Myanmar has lots of hydropower and hydrocarbon resources which can supply to others energy demanding countries like Bangladesh, India, Pakistan and Sri Lanka. Energy exports can make significant contribution to the GDP growth of lower economies and enhance energy security to the growing economics. For instance Bhutan's electricity export in financial year 2007 is expected to constitute nearly 25 percent of its GDP and 60 percent of its state revenues [11]. India and Pakistan are two geographic clusters centered on the south Asia which can serve as pillars of regional integration of power system. In the Eastern zone Bangladesh, Bhutan, India, Nepal, Sri Lanka can work together to share power from the same grid. Latterly the India has bilateral electricity trade with Bhutan. Bangladesh, Nepal and Srilanka can join to this trade with India and Bhutan power grid. On the other hand in the Western zone Afghanistan, Pakistan and India can join in the same grid and import low cost power from the Central Asia by using their natural resources. Under the USAID sponsored SARI-E program Nexant during 2001-2002 conducted a study which suggested connecting Siliguri (India) to Anarmani (Nepal) and Thakurgaon (Bangladesh) initially by 132 kV lines, capable of being upgraded to 220 kV as the volume of interchange increases [13]. It also suggested the alternative of connecting Purnea (India) to Duhabi (Nepal) and Ishurdi (Bangladesh) [13]. Connections from Chhukha (Bhutan) to Siliguri and then on to Purnea which already exist.

| Country | Interconnection Status | Grid Structure in the Country | Federal Level Transmission Utility Name | Organizational Structure | Installed Capacity | Voltage Profile | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Bi Pole | 765 kV | 400 kV | 220 kV | 132 kV | 66 kV |
| India | Externally interconnected with Nepal & Bhutan and with Sri Lanka is under development | Federal level & State level Transmission Utilities | Power Grid Corporation of India Limited (PGCIL) | Public Limited | 141,000 MW | Yes | Yes | Yes | Yes | Yes | Yes |
| Bangladesh | Currently no external interconnections | Single entity | Power Grid Corporation of Bangladesh (PGCB) | Public Limited | 5,255 MW | | | | Yes | Yes | Yes |
| Bhutan | Externally interconnected with India | Vertically Integrated Utility | Bhutan Power Corporation (BPC) | National Utility | 4,484 MW | | | Yes | Yes | Yes | Yes |
| Nepal | Externally interconnected with India Nepal | Vertically Integrated Utility | Electricity Authority (NEA) | National Utility | 618 MW | | | | | Yes | |
| Sri Lanka | No external Interconnections, interconnection with India is under development | Vertically Integrated Utility | Ceylon Electricity Board | National Utility | 2,435 MW | | | | Yes | Yes | Yes |

*Fig. 7 :* Power system overview of different South Asian countries (2010) [13][14].

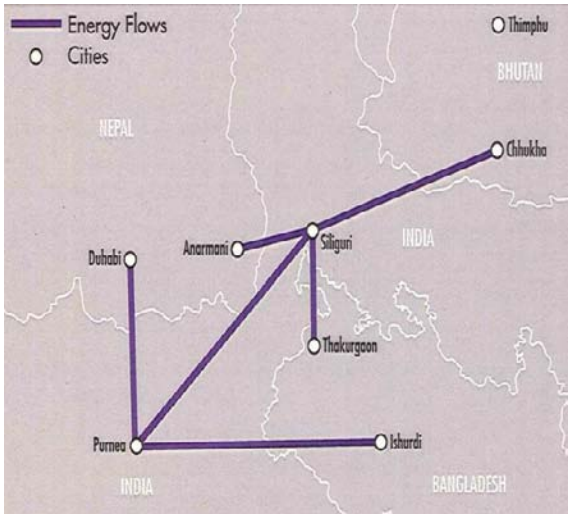


*Fig. 8 :* Suggested interconnection between Bhutan, India, Bangladesh and Nepal. [11][12].

## IX. Conclusion

The overall energy need for South Asia is prophesied to be three fold that of today within the next 15 to 20 years. Energy trade and power grid interconnection in the region can be a best reliable solution to meet up the energy deficit, sustain security and resilience of the networks. Furthermore, Reliable energy supply can act as a catalyst to alleviate poverty and achieve sustainable economic growth. The benefits of grid interconnection include pooling of generation, resulting in lower generation costs; pooling of load, for significant equalizing effects; common provisioning of reserves, resulting in cheaper primary and secondary reserve power costs; and mutual assistance in the event of disturbances. This paper's aims to provide a comprehensive, objective portrait of the South Asian electric grid, focused research and demonstration, the challenges and opportunities it is likely to face over the next decade and sharing of important data can facilitate meeting the challenges and seizing the opportunities that the grid will face.

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