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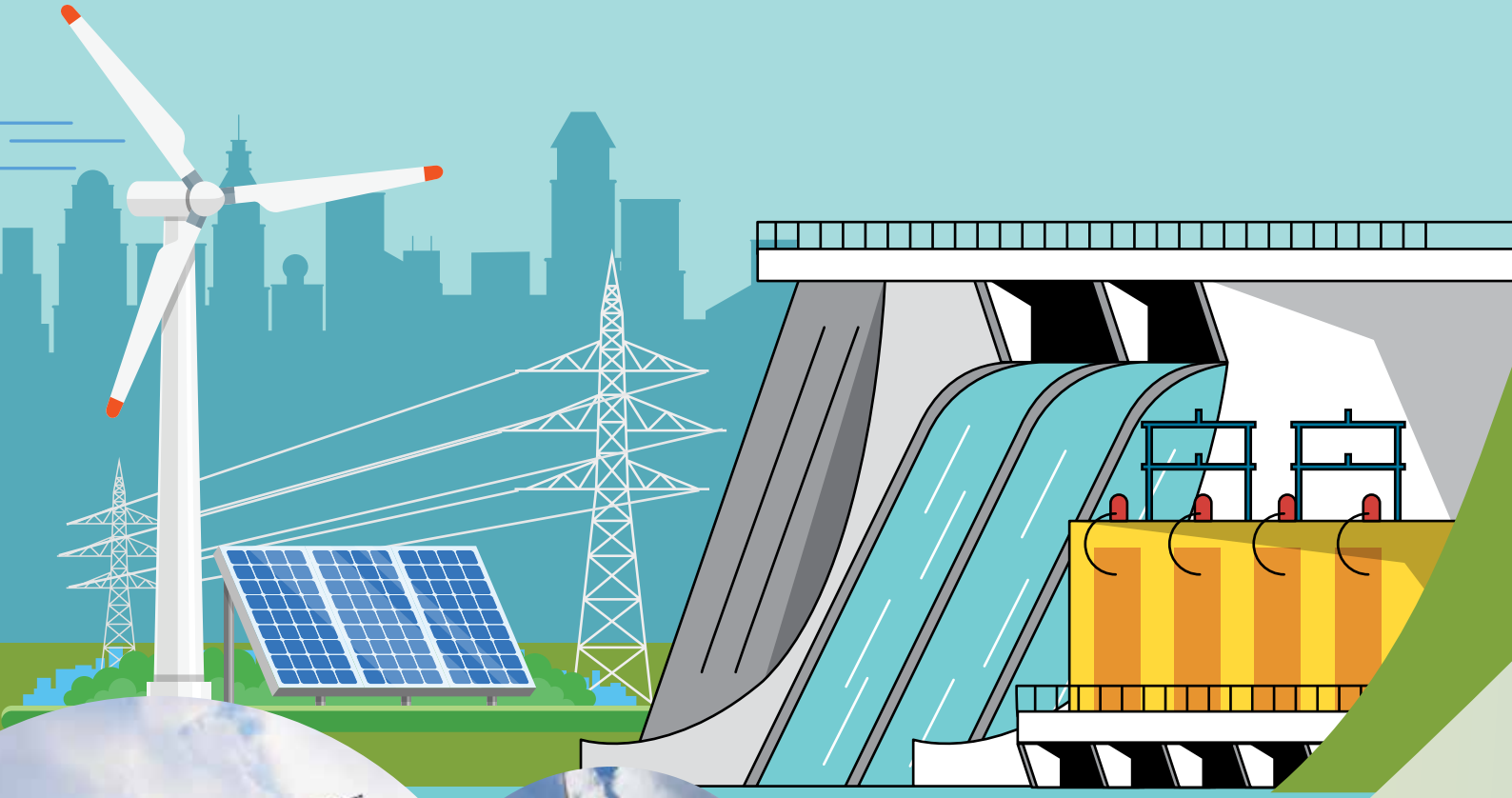
SOUTH ASIA REGIONAL INITIATIVE FOR ENERGY INTEGRATION (SARI/EI)

Prospects of Regional Energy Cooperation and Cross Border Energy Trade in the BIMSTEC Region



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The report and its findings do not necessarily reflect the views of the SARI/EI Project Secretariat. The report can be considered as a base document for further analysis and it aims to stimulate further discussion and analysis for accelerating regional energy/electricity cooperation and facilitating/advancing Cross Border Electricity Trade in the BIMSTEC countries—Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka, and Thailand.

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Prospects of Regional Energy Cooperation and Cross Border Energy Trade in the BIMSTEC Region

INTEGRATED RESEARCH AND ACTION FOR DEVELOPMENT (IRADE)

FEBRUARY 2020

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We also acknowledge and express our appreciation for all those individuals whose names cannot be penned here but who offered invaluable insights and generous support throughout this exercise.

We hope this report will initiate thought-provoking discussions among the BIMSTEC country governments, electricity regulators of BIMSTEC countries, policy and decision-makers, power developers, investors and financial institutions will serve as a valuable resource for promoting CBET in the BIMSTEC countries—Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka and Thailand.

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Preface

We are pleased to present a Background Paper on 'Prospects of Regional Energy Cooperation and Cross Border Energy Trade in the BIMSTEC Region' developed under the South Asia Regional Initiative for Energy Integration (SARI/EI) project supported by USAID.

This Paper is intended to provide a background on the prospects of regional energy cooperation and Cross Border Energy Trade (CBET) in the BIMSTEC Region. The Paper was prepared and is being released in the backdrop of the Workshop on "Enhancing the Regional Energy Cooperation in the BIMSTEC Region" jointly organized by BIMSTEC and USAID's South Asia Regional Initiative for Energy Integration (SARI/EI) program.

I hope that this Background Paper will serve as a starting point for stimulating discussions on enhanced energy cooperation in BIMSTEC, by detailing the current energy scenario, and potential avenues and benefits of regional energy cooperation. The Paper also maps the role played by various Development Partners on regional energy cooperation efforts in the region, and lays down a roadmap for enhanced cooperation in the future.

The Paper describes the potential synergies in energy cooperation such as the diverse energy mix, diversities in demand and generation pattern, sustainable energy generation which would result in improved economics. It is hoped that this Background Paper will help policy makers of all BIMSTEC Member States to take steps to enhance energy integration, accelerate their economy and bring prosperity in the BIMSTEC region.

I am grateful to USAID for supporting the preparation of this Paper. I take this opportunity to thank the Technical team at SARI/EI Secretariat /IRADe, that worked diligently and enthusiastically to deliver this Paper in a short span of time.

Jyoti Parikh.

Dr. Jyoti Parikh

Executive Director, IRADe

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FOREWORD

The U.S. Agency for International Development (USAID) has been working since 2000 to enhance regional energy cooperation in South Asia through its South Asia Regional Initiative for Energy (SARI/E) program. The first three phases of the program focused on building trust, raising awareness and assessing potential transmission interconnections. The current and fourth phase of the program, called South Asia Regional Initiative for Energy Integration (SARI/EI), which was launched in 2012, focuses on promoting regional energy integration through cross-border power trade. This is being implemented by the Integrated Research and Action for Development (IRADe).

The fourth phase of the program also focuses on institutional strengthening by engaging with regional institutions such as BIMSTEC (Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation), that brings together five countries from South Asia (Bangladesh, Bhutan, India, Nepal and Sri Lanka) and two countries from Southeast Asia (Myanmar and Thailand).

USAID through its SARI/EI program earlier partnered with the BIMSTEC secretariat to develop 'BIMSTEC Energy Outlook 2030', which provided insights on potential ways in which an energy market in the BIMSTEC region may transition in the future. This was a first of its kind report in the BIMSTEC region, which provided substantial data, sectoral analysis, investment requirements, demand supply projections to 2030, institutional structure and energy security considerations related to energy, covering all the seven BIMSTEC Member States. The 2nd edition of the study is currently under preparation by SARI/EI.

Before the 2nd edition of the report comes out, we thought it fit to bring out a background paper on 'Prospects of Regional Energy Cooperation and Cross Border Energy Trade in the BIMSTEC Region', as a prelude to the Conference on "Enhancing Energy Cooperation in the BIMSTEC Region", jointly organized with the BIMSTEC Secretariat under the SARI/EI program. The background paper will serve as a baseline document on current energy cooperation initiatives, potential for scale-up and a way forward for eventual transition to a larger regional market within BIMSTEC.

I would like to take this opportunity to acknowledge the excellent work done by the SARI/EI team at IRADe and Deloitte India in developing the background paper. I hope the findings of this Paper will be useful for all the BIMSTEC member countries.

Thank you

Michael Satin
Regional Energy Program Director,
Clean Energy & Environment Office
USAID/India

Secretariat
Bay of Bengal Initiative for Multi-Sectoral
Technical and Economic Cooperation (BIMSTEC)

Secretary General

FOREWORD

The Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation, better known by the acronym BIMSTEC, was established in 1997 with the objective to create an enabling environment for rapid economic development through identification and implementation of specific cooperation projects. Over the years, BIMSTEC has identified 14 sectors of cooperation to build a peaceful, prosperous and sustainable Bay of Bengal region, out of which energy is a key sector.

At the very first BIMSTEC Energy Ministers' Conference held on 04 October 2005, there was an agreement among the Member States on a vision of electric grid connectivity in the region by developing country-to-country grid inter-connections for ultimately facilitating flow of electricity across the region. The need for detailed feasibility studies and techno-economic agreements among participating countries to allow for the optimal utilization of the natural gas resources of the region was also recognized during the conference. Since then, BIMSTEC has been working towards the vision laid out by the Energy Ministers, which resulted in the eventual signing of MoU for establishment of the BIMSTEC Grid Interconnection on 31 August 2018 during the Fourth BIMSTEC Summit held in Kathmandu, Nepal.

In this context, this Background Paper of SARI/EI on "Prospects of Regional Energy Cooperation and Cross Border Energy Trade in the BIMSTEC Region" is a welcome initiative. The timing could not have been more appropriate, as the release of this Paper coincides with the upcoming "Conference on Enhancing Energy Cooperation in the BIMSTEC Region" jointly organized by BIMSTEC and SARI/EI.

I hope that this Background Paper of SARI/EI will stimulate constructive discussions among the BIMSTEC Member States on utilizing the potential for regional energy cooperation for the betterment of economy, environment and people of the Bay of Bengal region and beyond.

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1 Introduction

The Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) is a regional organization comprising seven Member States lying in the littoral and adjacent areas of the Bay of Bengal – Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka and Thailand. Countries in the BIMSTEC region are endowed with diverse energy sources and harnessing the large energy potential can accelerate the development of countries in the region as well as enhance their energy security.

There is already a limited amount of regional energy cooperation among the BIMSTEC Member States. At present, energy trade amongst the BIMSTEC Member States is happening mostly on bilateral basis, in limited capacity. There is scope to expand the regional energy cooperation in terms of size, modes of cooperation and countries involved.

This report is intended to provide a background on the prospects of regional energy cooperation and Cross Border Energy Trade (CBET) in the BIMSTEC Region. The report was prepared in the backdrop of workshop on "Enhancing the Regional Energy Cooperation in the BIMSTEC Region" jointly organized by BIMSTEC and USAID's South Asia Regional Initiative for Energy Integration (SARI/EI) program.

1.1 Background

BIMSTEC was established on 06 June 1997 as a regional organization for countries lying in the littoral and adjacent areas of the Bay of Bengal constituting a contiguous regional unity. Energy has been one of the sectors that BIMSTEC focuses for regional co-operation, right from its beginning.

Cost effective reliable electricity supply is critical for socio-economic development of nations. As BIMSTEC Member States are endowed with diverse natural resources, regional cooperation for energy and cross border energy trade can help in addressing the common regional challenges like energy access, optimized utilization of natural resources, and institutional capacity building.

1.2 Demographics

BIMSTEC region brings together over 1.65 billion people, and a combined GDP of US$ 3.75 trillion. The brief profile of the constituent countries in the BIMSTEC region is presented in following table.

Table 1: BIMSTEC Profile – 2018

Country	Total land area	Total population	GDP at current prices
	Square KM	Million	US$ Billion
Bangladesh	147,570	164	304 #
Bhutan	38,394	1	2
India	3,287,469	1,316	2,780
Myanmar	676,553	53 *	63
Nepal	147,181	29	32
Sri Lanka	65,610	22	89
Thailand	513,120	66	478
BIMSTEC	4,875,897	1,651	3,748

** FY 2017 # CY/FY 2019; All other figures related to CY/FY 2018*

Source: Bangladesh Statistical Yearbook 2018, Bangladesh Economic Review 2019, Bhutan Statistical Year Book 2019, Bhutan National Accounts Statistics 2019, India Statistical Year Book 2018, India National Accounts Statistics 2019, Myanmar Statistical Year Book 2018, Myanmar Statistical Information Service, Nepal Central Bureau of Statistics, Sri Lanka Statistical Pocket Book 2019, Thailand Statistical Year Book 2019

India is the largest country in the region, in terms of geography (67% of the region's area), population (80% of the region's population) and GDP (74% of the region's GDP). Thailand is the second largest in terms of GDP; Myanmar in terms of area and Bangladesh for the population in the region.

1.3 Macroeconomic Environment

1.3.1 Macroeconomic indicators

BIMSTEC countries are in the developing phase. Thailand has the highest per capita income, which is followed by Sri Lanka, Bhutan and India. Bangladesh is the fastest growing economy (in terms of GDP growth). In 2018, global economy grew at the rate of 3.6 per cent. Five out of seven countries of BIMSTEC region grew at faster rate than this rate.

Table 2: Key Country-level Indicators - 2018

Country	GDP (Current Price) Per Capita	GDP (Constant Price) Growth Rate	Consumer Price Inflation	Average Exchange Rate for National Currency	
	US$	(%)	(%)	Per US$	Local Currency
Bangladesh	1,827 #	8.13% #	5.5	83.47	Taka
Bhutan	3,331	3.03%	2.7	68.39	Ngultrum
India	1,899	6.80%	4.9	68.39	Indian Rupee
Myanmar	1,185	6.80%	6.8	1,429.81	Kyat
Nepal	1,034	6.81%	4.1	108.93	Nepali Rupee
Sri Lanka	4,104	3.21%	2.1	162.46	Sri Lankan Rupee
Thailand	7,069	4.00%	1.1	32.31	Baht
BIMSTEC	2,091##	6.46%###			

Source: Bangladesh Statistical Yearbook 2018, Bangladesh Economic Review 2019, Bhutan Statistical Year Book 2019, Bhutan National Accounts Statistics 2019, India Statistical Year Book 2018, India National Accounts Statistics 2019, Myanmar Statistical Year Book 2018, Myanmar Statistical Information Service, Nepal Central Bureau of Statistics, Sri Lanka Statistical Pocket Book 2019, Thailand Statistical Year Book 2019, World Bank's World Development Indicators 2018, ADB

 # - CY/FY 2019; All other figures related to CY/FY 2018

- Weighted average with population as the weight ### - Weighted average with total current GDP as the weight

The larger GDP growth of countries such as Bangladesh and Nepal allow them to improve their per-capita GDP also. A consistently good economic growth has resulted in substantial improvement of per-capita GDP in the case of such countries. If regional energy cooperation initiatives can also bring additional growth, the overall economic indicators in the region are also expected to improve substantially,

1.3.2 Foreign direct investment

Foreign Direct Investment (FDI) and trade are often seen as important catalysts for economic growth in the developing countries. The inflow of investments is considered as a key driver for accelerating the economic growth through employment generation, global capital, global technology transfer, product markets and distribution network.

The below table compares the flow of FDI across various regions in the world. It can be observed that the share of FDI inflow into the BIMSTEC region is small in comparison to the FDIs to the other regions of the world, particularly the developed nations.

Table 3: FDI Inflows in Select Regional Trade Groupings

Grouping	FDI Inflows (USD Billions)	Share in world FDI (%)	FDI Inflows (USD Billions)	Share in world FDI (%)
	2017		2018	
ASEAN	144.2	10%	148.6	11%
BRICS	269.5	18%	261.28	20%
BIMSTEC	54.4	3.6%	61.7	4.8%
SAARC	47.3	3.2%	50.7	3.9%

Source: UNCTAD Country Reports 2018

1.4 Energy resource endowments

The BIMSTEC region is endowed with abundant natural resources comprising of 323 billion tonnes of coal, 664 million tonne of oil, 144 Trillion Cubic Feet (TCF) of natural gas, 11,346 million tonnes of biomass and 331 GW of large hydropower and renewable energy of 1000 GW potential.

Table 4: BIMSTEC Resource Potential

Resources/ Country	Coal (Million Tonnes)	Oil (Million Tonnes)	Gas (Trillion Cubic Feet)	Bio-mass# (MT)	Hydro (GW)	Renewable* (GW)
Bangladesh	3,300	-	5.7	218	-	3.67
Bhutan	1	-	-	625	23.8	12.76
India	3,19,020	600	45.5	4,150	145	1000
Myanmar	120	64.3	41.3	3,303	100	60.7
Nepal	<1	-	-	1,056	42	4.829
Sri Lanka	-	-	-	155.5	2	11.6
Thailand	1,063	-	6.6	1,838	15.2	23.0
BIMSTEC Total	3,23,504	664	99	11,346	328	1,117

Source: BP Statistical Review 2019; Sectoral and National Plans of individual countries, IRENA, UN, ADB, Government Statistic Report, Government Portals, European Journal of Sustainable Development Research

*- Either resource is nil or value less than 0.5; *Solar, Wind & Small Hydro; # Forest & Other Wooded Land)*

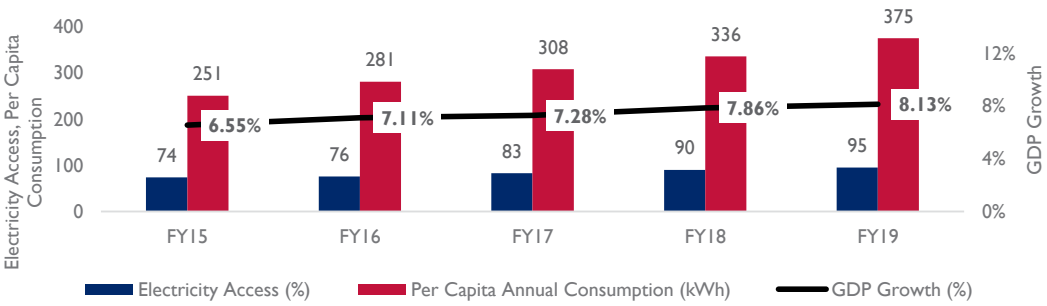
The diversity in these endowments are as important as the quantum of resources. India has large coal reserves allowing both coal exports, and coal based electricity exports to neighbouring countries. Similarly, Myanmar's abundance in gas deposits is already being tapped by Thailand. As regional energy cooperation expands, there will be more such opportunities to achieve synergies in resource utilization.

1.5 Energy and socio-economic development linkages

Access to and the availability of energy, including electricity, is of great relevance to the socio-economic development of nations. In the context of BIMSTEC, this assumes more significance, as some of the BIMSTEC Member States still have considerable challenges in achieving near 100% energy access. Energy access and per capital energy consumption are widely viewed as key drivers of overall growth of a country.

The case of Bangladesh offers one of the best illustrations on the relation between electricity access, per capita consumption and economic growth. In the past years, the country has managed to improve its energy access and per capital consumptions, while recording impressive growth of its GDP.

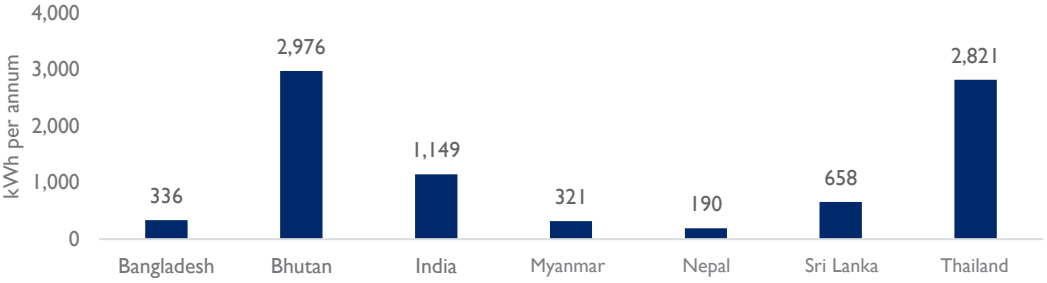
Figure 1: Bangladesh's improvement in energy and economy



Source: BPDB Annual Reports; Ministry of Finance, Bangladesh Economic Review 2019

Similar situations exist in other countries also. BIMSTEC Member states other than Bhutan and Thailand have very low per-capita electricity consumption, and therefore there is substantial potential for improvement in energy supply, thereby improving the economic and social growth.

Figure 2: BIMSTEC Per-capita Electricity Consumption - 2018



Source: BPDB Annual Report 2018, Statistical Year Book of Bhutan 2019, Central Electricity Authority's Executive Summary of Power Sector for March 2019, Myanmar Statistical Year Book 2018, NEA Annual Report 2019, Nepal Central Bureau of Statistics, CEB Statistical Digest 2018, Thailand Energy Policy and Planning Office

All values pertain to CY/FY 2018. Values for Bhutan, Myanmar and Nepal are calculated from sales and population.

Following sections of this document will explore in more detail on how regional cooperation can improve the energy scenario, and thereby the social economic development of the BIMSTEC Member States.

2 Current scenario and status of energy sector in BIMSTEC

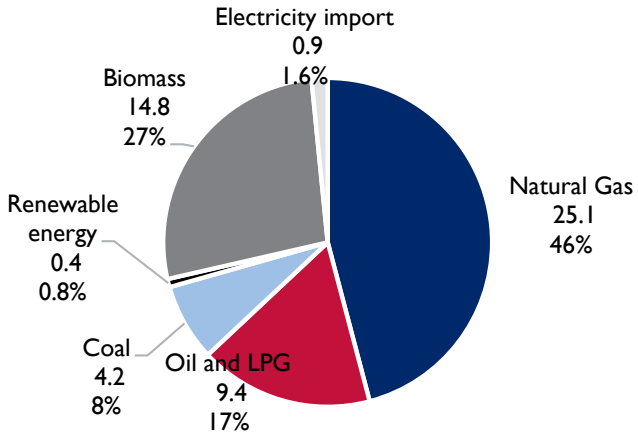
2.1 Bangladesh

Bangladesh is located in South Asia and is bordered by India in the east, west and north and by Myanmar (Burma) and the Bay of Bengal in the south.

2.1.1 Energy Mix

Bangladesh depends mostly on natural gas and biofuels for meeting its primary energy requirements. During July 2018 to June 2019, natural gas contributed to 46% of the overall energy mix, and biofuels contributed to 27%.

Figure 3: Bangladesh – Primary Energy Mix - 2019



Total: 54.6 MTOE

Source: Ministry of Power, Energy and Mineral Resources

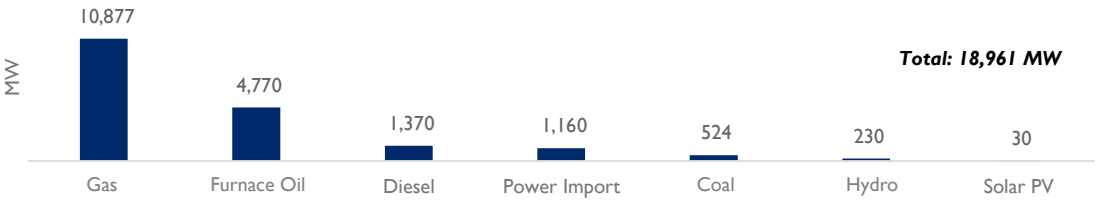
Data pertains to July 2018 – June 2019

Apart from the domestic production of natural gas, Bangladesh imports coal, LNG and crude oil to meet its energy requirements. To meet the growing demand of electricity, the country is also increasing its bilateral electricity trade with India, and has plans to expand the same with Bhutan and Nepal. In 2014, 16.8% of the total energy was imported.[1]

2.1.2 Electricity scenario

As on end of June 2019, the total installed capacity of electricity generation in Bangladesh was 18,961 MW. The capacity mix is skewed towards gas and furnace oil, which together constitutes 82.5% of the total installed capacity.

Figure 4: Bangladesh - Electricity Installed Capacity - 2019



Total: 18,961 MW

During FY 2019 (July 2018 – June 2019), the country imported 9.62% of its annual electricity requirement from India.

As on end of June 2019.

[1] *World Bank, World Development Indicators - https://data.worldbank.org/indicator/EG.IMP.CONS.ZS*

Bangladesh suffers from supply shortages. During FY 2019, 53 Million kWh of electricity could not be served due to various reasons, which was 8.54% of annual electricity sales. However, the country has managed to improve its rural electrification coverage, which stands at 95% as on end of June 2019.[2]

2.1.3 Issues and challenges

The energy sector in Bangladesh faces two important challenges. The primary one is to provide universal electricity access by 2021. The second, but equally important challenge facing the country is that of energy security. Bangladesh has a limited availability of indigenous hydrocarbon resources and faces challenges in exploration and production of natural gases due to its capital-intensive nature.

Bangladesh acknowledges the limitations in these aspects, and views imports as one of the key ways to solve its energy requirements. The Power Sector Master Plan of 2016 recognizes the regional hydro potential and mentions that

"In contrast, there is abundant water power resource potential in the countries surrounding Bangladesh, namely Bhutan, Nepal, Myanmar, and the Indian States of the North East and West Bengal (collectively "neighboring countries"). Thus, it is expected that Bangladesh imports electricity out of such hydropower generation via power interconnections with such neighboring countries for stable base load supply, energy fuel diversification, and climate change mitigation." [3]

To address the gas crisis, two LNG floating storage and regasification units (FSRU) have been commissioned, which enables procuring LNG from international markets. There are also plans for constructing an onshore LNG import terminal, for which expressions of interest were invited in 2019.

2.1.4 Energy sector reform and market development

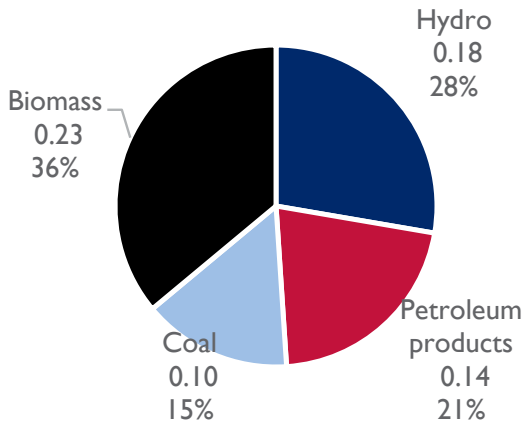
Bangladesh has undergone significant market reform measures in the past, especially in terms of unbundling of vertically integrated utilities and establishment of independent regulatory commission. Currently, the focus is on reform of the Bangladesh Power Development Board, by moving to strategic business unit (SBU) model for BPDB's generation and distribution functions.

2.2 Bhutan

Bhutan is a mountainous, land locked country located in the eastern Himalayas. The country has a long history of regional energy cooperation in utilizing its hydropower potential.

2.2.1 Energy mix

Figure 5: Bhutan - Primary Energy Mix - 2014



Source: Ministry of Economic Affairs

Total: 0.65 MTOE

[2] *BPDB (2019), Annual Report 2019 - https://www.bpdb.gov.bd/bpdb_new/resourcefile/annualreports/annualreport_1574325376_Annual_Report_2018-19.pdf*

[3] *Power Division, Government of Bangladesh (Sep 2016), Power System Master Plan 2016 Summary - https://powerdivision.portal.gov.bd/sites/default/files/files/powerdivision.portal.gov.bd/page/4f81bf4d_1180_4c53_b27c_8fa0eb11e2c1/PSMP2016%20Summary%20%281%29.pdf*

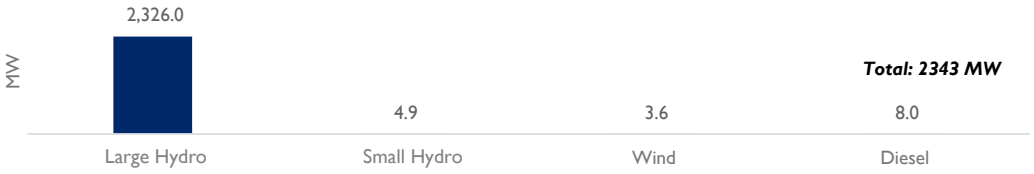
Bhutan's primary energy mix is dominated by biomass (36%, 2014), followed by hydropower (28%, 2014). The requirement for coal and petroleum products are met through imports.[4]

Bhutan is a net exporter of energy, due to abundant availability of hydropower. In 2014, over 73% of the electricity generated in Bhutan was exported to India. Net export of energy was 0.25 MTOE, which was equivalent to 37.7% of total primary energy supply. The export of electricity is also one of the major sources of revenue for the country. Kerosene, diesel, petrol and LPG are entirely imported to the country. Bhutan is a net exporter of energy. [5]

2.2.2 Electricity scenario

Bhutan's electricity generation mix is almost entirely hydropower based, with most of them constructed for export of power. The total installed capacity for electricity generation is 2342.56 MW as on end of 2019, out of which 2326 MW is from large hydro power plants. There are several smaller hydro power plants (4.92 MW), one wind power plant (3.6 MW) and a few diesel power plants (8.9 MW).

Figure 6: Bhutan - Electricity Installed Capacity – 2019



Source: BEA Annual Report 2019, Statistical Year Book of Bhutan 2019

The country has adequate generation resources to meet its demand. In comparison to the large installed capacity, domestic peak load was only 387.66 MW in 2019[6]. However, there is still a small quantum of import of power from India, on a seasonal basis.

Bhutan has reported 100% electricity access, though this includes supply of electricity from off-grid systems. Activities are under-way for improved on-grid electrification.[7]

2.2.3 Issues and challenges

Though Bhutan is a net exporter of energy due to abundant availability of hydro resources, due to non-diverse electricity generation resources, it poses risk on managing load-generation balance due to seasonal variation. However, its bilateral electricity trade is advantageous. The country has also accorded priority to develop storage hydropower projects, to ensure national energy security. [8]

2.2.4 Energy sector reform and market development

Bhutan has undertaken a few of the reform measures including the establishment of a power sector regulator – the Bhutan Electricity Authority (BEA). The Bhutan Power System Operator now works as a separate unit within the Bhutan Power Corporation Limited, and has a separate Managing Director. Bhutan Power System Coordination Committee (BPSCC) has been established, with representation from the ministry, electricity utilities, power plants, system operator and regulator, for efficient coordination, operation and supply of electricity.[9]

[4] *Ministry of Economic Affairs, Government of Bhutan, Bhutan Energy Data Directory 2015 - https://www.moea.gov.bt/wp-content/uploads/2018/07/Bhutan-Energy-Data-Directory-2015.pdf*

[5] *Ministry of Economic Affairs, Government of Bhutan, Bhutan Energy Data Directory 2015 - https://www.moea.gov.bt/wp-content/uploads/2018/07/Bhutan-Energy-Data-Directory-2015.pdf*

[6] *Bhutan Power System Operator (2020), Transmission System Performance Annual Report for 2019 - http://bpso.bpc.bt/wp-content/uploads/2020/01/Annual-Report-2019.pdf*

[7] *Bhutan Power Corporation (2019), Annual Report 2018 - https://www.bpc.bt/wp-content/uploads/2019/05/BPC-Annual-Report-2018.pdf*

[8] *Royal Government of Bhutan (December 2016), Economic Development Policy - https://www.moea.gov.bt/wp-content/uploads/2017/07/Economic-Development-Policy-2016.pdf*

[9] *Ministry of Economic Affairs, Government of Bhutan (February 2018), Establishment of BPSCC - https://www.moea.gov.bt/?p=4153*

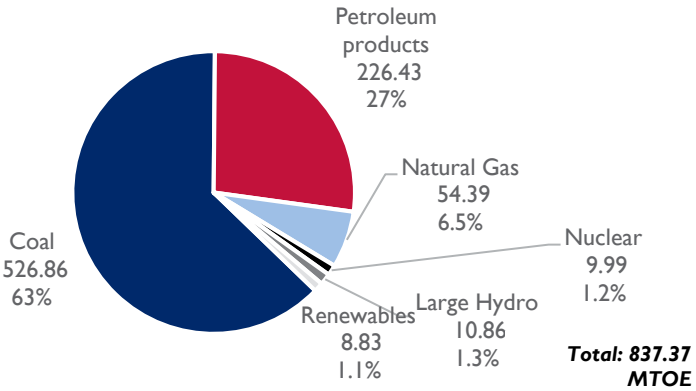
2.3 India

India is the largest country in terms of land area and population, within BIMSTEC. India has close ties with many of the other BIMSTEC Member States on energy cooperation.

2.3.1 Energy Mix

India's primary energy mix is dominated by coal (63%, 2018) and petroleum products (27%, 2018). Coal is the predominant source to meet energy requirement for power generation. Coal, gas and crude oil are produced domestically, and are also imported. India is a net importer of energy. In 2018, net import was 41.5% of commercial primary energy supply.

Figure 7: India - Primary Energy Mix –2018



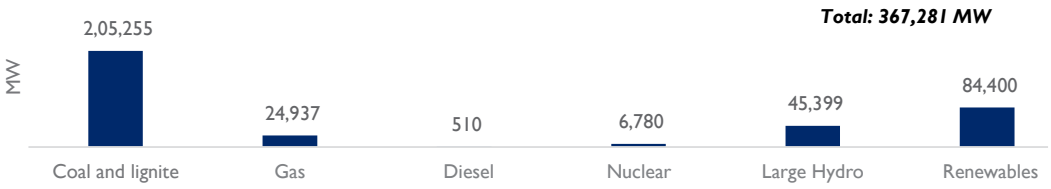
Source: Ministry of Statistics and Program Implementation

Data pertains to April 2017 – March 2018. Only commercial sources of energy are captured.

2.3.2 Electricity scenario

India's installed capacity of electricity generation, as on end of December 2019 was 367,281 MW. The mix is dominated by coal and lignite (56%), following by renewables (23%) and large hydro power plants (12%).

Figure 8: India - Electricity Installed Capacity - 2019



The country has managed to improve the power supply position, and has brought down the shortages to below 1%. During the period of April to December 2019, the overall electricity energy shortage was only 0.5%, and peak shortage was 0.7%.[10] The country has also managed to achieve 99.99% electrification, as per the definitions of Government of India.[11]

2.3.3 Issues and challenges

India plays a key role in driving the energy trade in the region. It imports power from Bhutan, and exports power to Nepal and Bangladesh. The north-eastern region of India is also rich in hydro resources. If exploited, Bangladesh can also import hydroelectricity from this region. India will, however, need the cooperation of Bangladesh to transport hydroelectricity from its eastern states to West Bengal and beyond. Similarly, Bangladesh will need India's cooperation to import electricity from Bhutan and Nepal. Owing to the physical locations of the major hydro potential areas in Bhutan, Nepal and the north-eastern and eastern regions of India, the countries will be

[10] *Central Electricity Authority, Government of India (January 2020), Executive Summary of Power Sector for December 2019 - http://www.cea.nic.in/reports/monthly/executivesummary/2019/exe_summary-12.pdf*

[11] *Rural Electrification Corporation, Saubhagya Portal - https://saubhagya.gov.in/*

net beneficiaries of the exchange of electricity. To implement the program, it will be necessary to expand the capacities of the interconnection of the grids in the region, together with building new generating capacities.

Post Electricity Act 2003, India delicenced power generation business to promote the power supply. This step resulted in increased power supply through participation from the independent power producers. However, high technical and commercial losses, and overall financial losses in power distribution sector remains a concern.

Meanwhile the large increase in intermittent RE generation is creating issues in integration for smooth grid operations. The country is exploring various regulatory reforms, and is experimenting with pilot projects to improve grid integration of RE sources.

2.3.4 Energy sector reform and market development

India has gone through multiple rounds of energy sector reform. This includes unbundling, establishment of independent regulatory commission, removal of price controls, delicensing of generation, introduction of power trading, establishment of power exchanges etc.

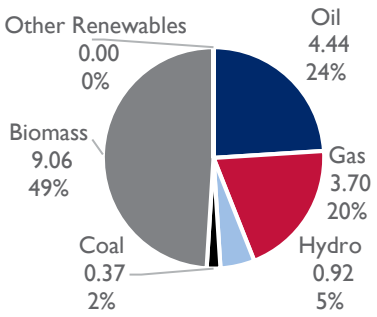
The current level of reforms and market development are focused on creating market for ancillary services, increasing the adoption of renewable energy, improving the commercial viability of distribution utilities and development of strategies for revival of multiple generation projects.

2.4 Myanmar

Myanmar, formerly known as Burma, is a sovereign state in Southeast Asia bordered by Bangladesh, India, China, Laos and Thailand.

2.4.1 Energy Mix

Figure 9: Myanmar – Primary Energy Mix - 2016



Total: 18.48 MTOE

Source: Ministry of Electricity and Energy; and Economic Research Institute for ASEAN and East Asia

Myanmar's primary energy mix is dominated by biomass, followed by oil and gas. The use of biomass is mainly by the residential sector, as fuelwood and charcoal. Country is a net exporter of energy. In 2016, net export of energy was 9.2 MTOE, which is equivalent to nearly 50% of domestic energy supply.

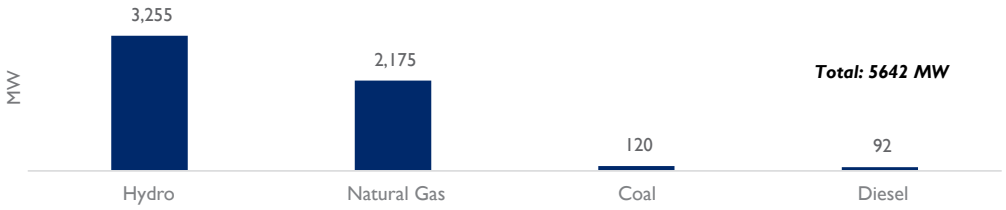
Although Myanmar is rich in gas reserves, more than 70% of Myanmar's domestically produced natural gas is exported to Thailand and more recently to China. In 2016, 78% of the gas production was exported.[12]

2.4.2 Electricity scenario

Myanmar's installed capacity of electricity generation was 5642 MW as on end of March 2018. Most of the generation is based on hydro (58%), followed by natural gas (39%). Bangladesh, India, China, Laos and Thailand.

[12] *Ministry of Electricity and Energy; and Economic Research Institute for ASEAN and East Asia (2019), Myanmar Energy Statistics 2019 - http://www.eria.org/uploads/media/0.ERIA-Myanmar_Energy_Statistics_2019.pdf*

Figure 10: Myanmar - Electricity Installed Capacity - 2018



Source: Ministry of Electricity and Energy

The electrification ratio in the country is only 50%.[13] Many of the areas are not connected to the national grid. There are also reports of electricity shortages of up to 400 MW in April 2019, with possibility of further increase in such shortages.[14]

2.4.3 Issues and challenges

Myanmar faces a large challenge in terms of improving access to electricity, and expansion of the national grid. The electrification ratio as on 2019 stands only at 50%, though the Government is focusing its efforts in this area.

2.4.4 Energy sector reform and market development

Myanmar's energy sector is controlled by the Ministry of Energy and Electricity (MOEE). The electricity sector has been partly unbundled. Private involvement is present in the electricity generation sector. The power market works on single buyer model with all electricity aggregated by the Electric Power Generation Enterprise (EPGE), which is owned by the Government.

The most significant reform measure in the recent past has been the increased focus on improving electrification. Government has launched a National Electrification Plan to achieve universal access to electricity by 2030.

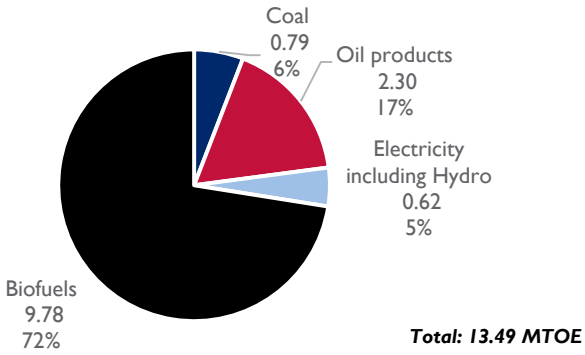
2.5 Nepal

Nepal, officially the Federal Democratic Republic of Nepal, is a landlocked country located in South Asia. A large portion of the land is part of the Himalayan mountain ranges.

2.5.1 Energy Mix

Biofuels dominate the energy mix of Nepal, which needs to be seen in the context of limitations in rural electrification. All petroleum products and coal are imported.

Figure 11: Nepal – Primary Energy Mix - 2017



Source: Based on IEA data from IEA (2020)

In 2014, 16.7% of the total energy was imported.[15] There is possibility of this being higher by now, due to the increased quantum of electricity import in the recent years.

[13] *Myanmar President's Office (14 December 2019), President U Win Myint celebrates 50% nationwide electrification in Nay Pyi Taw - https://www.president-office.gov.mm/en/?q=briefing-room/news/2019/12/14/id-9775*

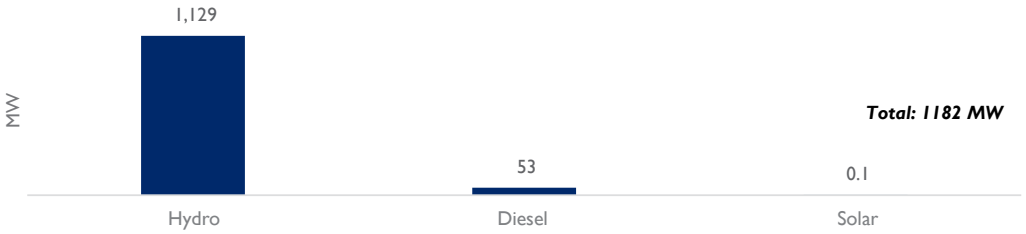
[14] *The Irravady (May 2019), Gov't to Buy Electricity from China to Cover Shortfall - https://www.irrawaddy.com/news/burma/govt-buy-electricity-china-cover-shortfall.html*

[15] *World Bank, World Development Indicators - https://data.worldbank.org/indicator/EG.IMP.CONS.ZS*

2.5.2 Electricity scenario

As on end of July 2019, the installed electricity generation capacity of Nepal was 1182 MW, with 95.5% of it based on hydropower.

Figure 12: Nepal - Electricity Installed Capacity - 2019



Source: Nepal Electricity Authority

Even though there was a history of electricity deficit, and interruptions in the past, the country has now managed to bring such interruptions to 0.43% in FY 2019 (Nepal's FY starts from Mid-July). Planned load shedding as a tool to manage power supply deficit has also been discontinued. This was facilitated mainly through an increase in imports from India. During FY 2019, 37.35% of annual electricity requirements were met through imports from India. The total population with access to grid electricity has reached about 78% as on end of FY 2019.[16] However, a part of the remaining population also has some level of access to off-grid electrification.

2.5.3 Issues and challenges

Nepal's energy sector faces the following key issues:

1. Being a land locked country, Nepal is dependent on transport of petroleum products from India by road. This creates concerns on energy security for the country. To address this challenge, a new cross border petroleum pipeline has already been commissioned and there are plans for an LPG pipeline.
2. Dependence on water from snow fed mountains for hydropower generation creates dependence on imports from India to meet the power demand during winter season. Even in other seasons, there is import of power from India. However, the country is expected to turn power surplus with the commissioning of large HPPs like Arun-III and Upper Tamakoshi, which are currently under construction.
3. Many of the rural areas are electrified through off-grid mode, and therefore for non-lighting purposes, the rural population is still dependent on traditional sources of energy. There is still scope for increased access to grid electricity.
4. The country faces challenge in accessing foreign investment in energy sector. The government continues to work through the Investment Board of Nepal (IBN) to bring more foreign investment in the energy sector.

2.5.4 Energy sector reform and market development

In 2019, Nepal's Electricity Regulatory Commission started functioning, which was a major milestone for energy sector reforms in the country. A new Electricity Act is being discussed by the Government, which will pave the way for introduction of power trading licensees, open access to transmission lines and the eventual unbundling of vertically integrated Nepal Electricity Authority (NEA).

2.6 Sri Lanka

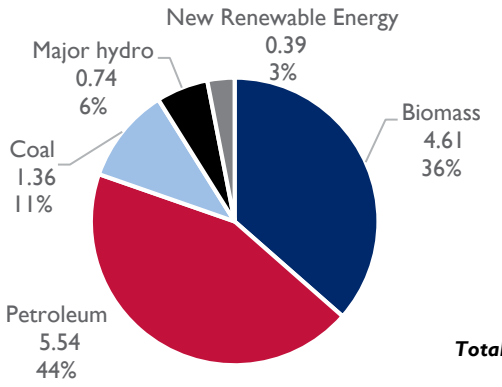
Sri Lanka is an island nation south of India in the Indian Ocean. The country was one of the founding members of BIMSTEC.

[16] *Nepal Electricity Authority (2019), Annual Report - https://www.nea.org.np/admin/assets/uploads/supportive_docs/annual_report_2076.pdf*

2.6.1 Energy Mix

Petroleum products and biomass are the main sources of energy supply in Sri Lanka. In 2017, petroleum products contributed to 44% of energy supply.[17]

Figure 13: Sri Lanka – Primary Energy Mix - 2017



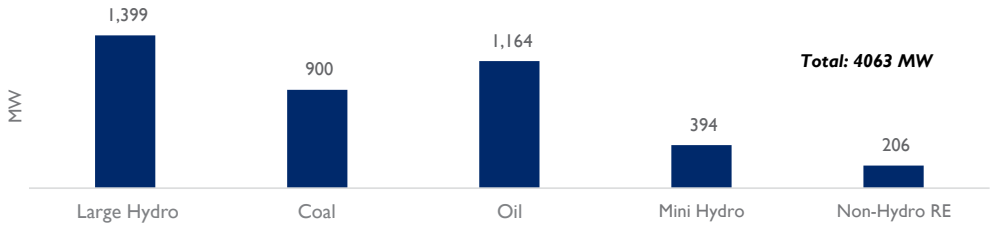
Source: Sri Lanka Sustainable Energy Authority

Sri Lanka is a net importer of energy. In 2017, imports constituted 57.5% of primary energy supply. LPG, diesel, gasoline, aviation fuel, crude oil and coal requirements are entirely met through imports.

2.6.2 Electricity scenario

Installed electricity generation capacity in Sri Lanka was 4063 MW as on end of 2018. The capacity mix is dominated by large hydro (34%) followed by oil (29%) and coal (22%) power plants.

Figure 14: Sri Lanka - Electricity Installed Capacity - 2018



Source: Ministry of Power, Energy and Business Development

Sri Lanka has reported an electrification rate of 99.9%.[18] The country is usually able to supply electricity without any planned load restrictions. However, there were instances, such as in 2019, when reduction in hydropower generation necessitated power outages for a short period.[19]

2.6.3 Issues and challenges

Sri Lanka achieved a national electrification of more than 99 per cent. This achievement resulted in an increased demand for electricity. The energy sector however is currently struggling with the high cost of electricity emanating from poor generation mix and inadequate level of reliability. Being an island country with limited fossil fuel resources, there is a large import dependence for the energy sector.

2.6.4 Energy sector reform and market development

The Public Utilities Commission of Sri Lanka (PUCSL) regulates the energy sector, while larger policy decisions are undertaken by the Ministry of Power and Energy. The Ceylon Electricity Board (CEB), which is a legacy vertically integrated utility acts as the single buyer, procuring power from all generating stations, for supply to distribution companies.

[17] *Sri Lanka Sustainable Energy Authority (2019), Sri Lanka Energy Balance 2017 - http://www.energy.gov.lk/images/energy-balance/energy-balance-2017.pdf*

[18] *Ministry of Power, Energy and Business Development (2019), Performance for 2018 and Programme for 2019 - http://powermin.gov.lk/english/wp-content/uploads/2019/04/03.-English.pdf*

[19] *Ceylon Electricity Board, Demand Management Schedule - http://colombogazette.com/wp-content/uploads/2019/03/CEB.pdf*

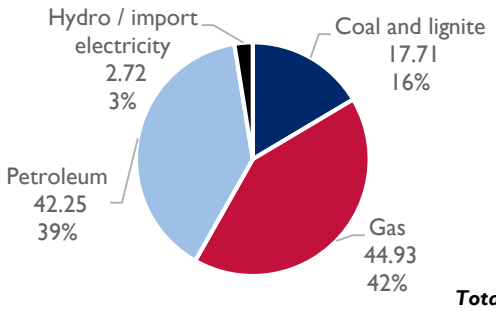
2.7 Thailand

Thailand is located in the heart of the Southeast Asian region. The country has a history of regional energy cooperation, with import of electricity from Malaysia and Laos PDR; and import of gas from Myanmar.

2.7.1 Energy Mix

Commercial energy supply in Thailand is primarily from gas and petroleum. Along with natural gas, LNG is also imported and utilized.

Figure 15: Thailand - Primary Energy Mix - 2019



Source: Energy Policy and Planning Office, Ministry of Energy

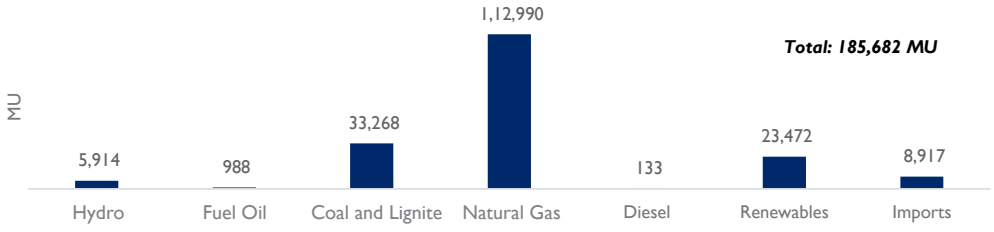
Only commercial energy sources are considered. Data pertains to Dec 2018 – Nov 2019

Thailand is a net importer of electricity. During Dec 2018 – Nov 2019, 64% of primary energy was met through imports.

2.7.2 Electricity scenario

As on November 2019, Thailand's installed capacity of electricity was 48,450 MW, inclusive of imports of 5367 MW. The generation mix is dominated by natural gas, followed by coal and lignite power plants. During Jan – Nov 2019, out of total energy generation of 185682 Million kWh (MU), 61% of energy was from natural gas based power plants, and 18% from coal and lignite power plants.

Figure 16: Thailand - Electricity generation by fuel - 2019



Source: Energy policy and planning office, Ministry of Energy

Data pertains to the period of Jan – Nov 2019

Thailand has achieved 100% electricity access.[20] The country also does not seem to have any substantial shortage in electricity, and there are no reports of any major load shedding and restrictions in the recent past.

2.7.3 Issues and challenges

Thailand's energy supply is heavily dependent upon the import of crude oil and natural gas, which exposes it towards more import dependency and higher tariffs. However, Thailand is targeting to increase the share of renewable energy consumption to 30% by year 2036, under its Alternative Energy Development Plan (AEDP) 2015. [21] Higher RE penetration in the grid

[20] *The World Bank, Data Bank - https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS*

[21] *Ministry of Energy (2015), Alternative Energy Development Plan 2015 - http://www.eppo.go.th/images/POLICY/ENG/AEDP2015ENG.pdf*

will reduce dependence of Thailand upon import of fossil fuel, However, the country needs to develop framework and practices for cost effective grid integration of RE for reliable grid operations.

2.7.4 Energy sector reform and market development

The first level of reforms in energy sector of Thailand was undertaken in the 1990s. In January 2018, the National Energy Reform Committee issued an Energy Reform Plan, which will reform Thailand's energy production and consumption by promoting renewable energy and good governance in the energy sector. The plan has reform components such as opening up of LNG business, deregulation of distributed power generation and implementation of building energy codes.[22]

The Thailand Power Development Plan was developed by the Ministry of Energy, and endorsed by the National Energy Policy Council on 14 May 2015. The plan emphasize on improving power system reliability by reducing dependence on natural gas power generation, increasing a share of coal power generation via clean coal technology, importing power from neighboring countries, and developing renewable energy.[23]

[22] *National News Bureau of Thailand (2018), National Energy Reform Committee explains its five-year reform plan - http://thainews.prd.go.th/th/website_th/news/print_news/WNECO6101190010009*

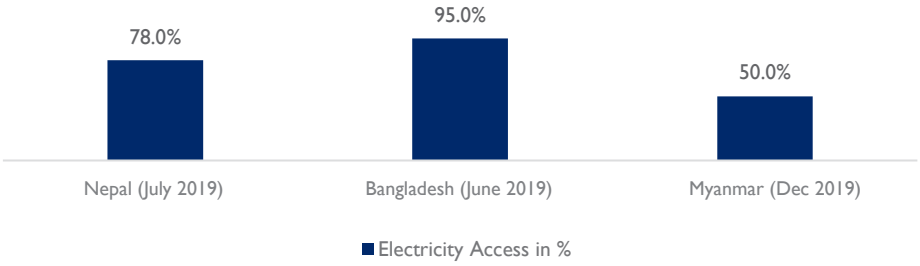
[23] *Ministry of Energy, Thailand Power Development Plan 2015 - http://www.eppo.go.th/index.php/en/policy-and-plan/en-tieb/tieb-pdp*

3 Drivers of Regional Energy Cooperation in BIMSTEC Region

3.1 Access to Electricity

A few of the BIMSTEC Member States, such as Nepal, Myanmar and Bangladesh still lack in terms of access to electricity. Even though these countries made rapid progress in the last few years, such as in the case of Bangladesh, there is still a large population that is left without access to electricity.

Figure 17: Countries with low electricity access in BIMSTEC



Source: NEA Annual Report, BPDB Annual Report, Press Release of Myanmar's President's Office

** Nepal's figure is related to grid-connected electricity. If off-grid electrification is included, the figure will be higher.*

A low access to electricity offers potential for regional energy cooperation, including:

1. Import power from other countries in the region, if access issue is related to power deficit;
2. Extend the grid from other countries in the region, if access issue is related to difficulties in accessibility in border areas; and
3. Access financial assistance from other countries in the region, if access issue is related to financial difficulties.

In case of BIMSTEC, there are already examples of countries utilizing regional energy cooperation for solving access to electricity problems. For example:

1. India built multiple 11 KV and 33 KV lines that supply power across the border, enabling Nepal to easily expand access to electricity in the border areas. The history goes at least as far back as 1950s, when power was supplied to Nepal from a 6.8 MW hydropower plant installed in India's Kataiya;[24]
2. Mynamar's border town of Tamu is supplied electricity from India, as the town is not connected to Myanmar's national grid; and
3. Tachileik, a town in Myanmar border is supplied electricity from Chaing Rai in Thailand.

As countries go ahead to move for 100% electricity access, the same also drives increased regional energy cooperation, especially in the case of extending access to border areas.

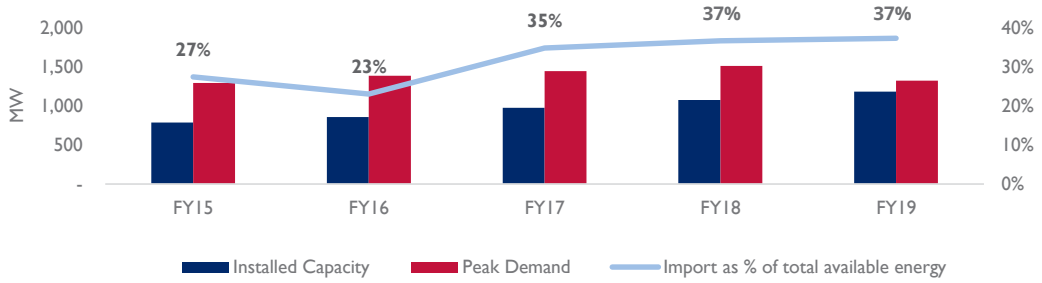
[24] *IPPAN and CII (2006), Research on Nepal India Cooperation on Hydropower - https://cii.in/WebCMS/Upload/CII%20-%20Nepal%20India%20Cooperation%20on%20Hydropower.pdf*

3.2 Demand – Supply Gap

Regional energy cooperation allows countries with power supply shortages to import power from other countries in the region that has a surplus. This already acts as a driver for regional energy cooperation in BIMSTEC, in the case of Nepal's import of power from India.

In the following figure, it can be seen that the installed electricity generation capacity, even if they operate on 100% load, is not sufficient for meeting the peak load. This lack of adequate domestic generation capacity has led the country to seek for enhanced quantum of electricity imports from India.

Figure 18: Nepal's electricity shortages and imports



Source: NEA Annual Reports

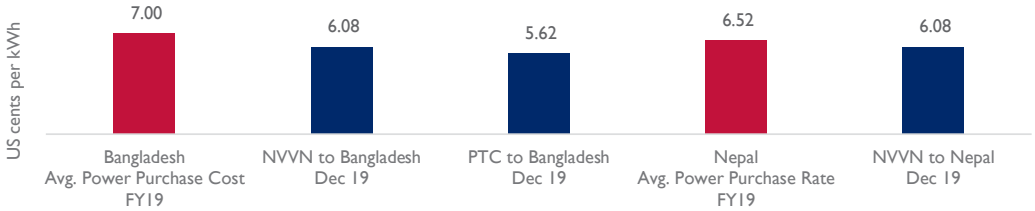
** Nepal's Financial Year starts from mid-July.*

Similar is the case of Bangladesh, which imports power to meet its own demand. There is potential to scale this up and expand it to other countries also including Myanmar.

3.3 Cheaper cost of electricity

When power is available at a regional level, countries can decide on importing cheaper power rather than relying on costly domestic generation. The cheaper cost of electricity already acts as a driver in the case of import of power by Nepal and Bangladesh, from India.

Figure 19: Cheaper cost of imports



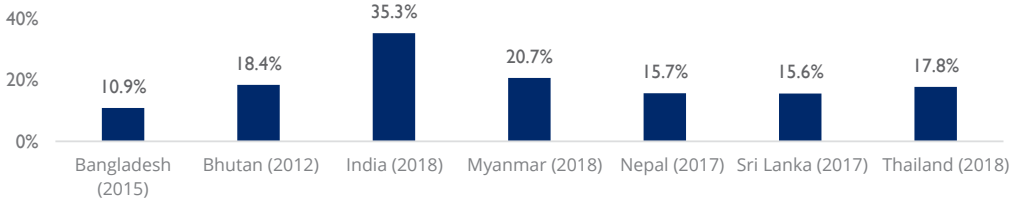
Source: BPDB, NEA, NVVNL, PTC India

In the above graph, it can be seen that electricity import of both Bangladesh and Nepal is at a rate lower than their overall average power purchase cost.

3.4 High and Growing Dependence on Fossil Fuel Import

Most of the BIMSTEC Member States, barring Bangladesh are heavily dependent on import of fossil fuels for their energy and transportation needs.

Figure 20: Fuel imports as % of merchandise imports



Source: World Bank World Development Indicators

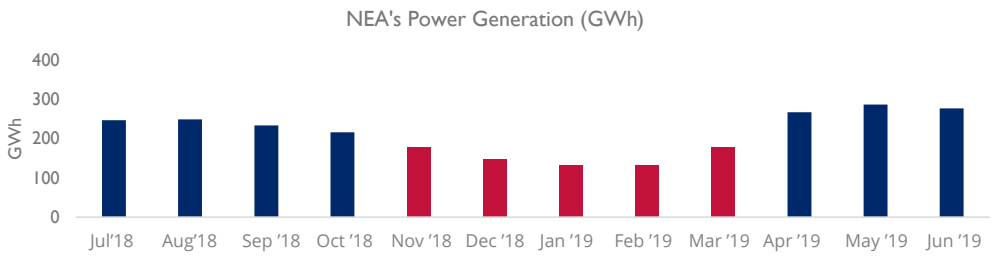
These imports are on a rising trend for most of the countries. For example, in case of India, fuel imports as % of merchandise imports was only 26.8% in 2016, which increased to 35.5% in 2018.

Regional energy cooperation allows BIMSTEC countries to avoid at least a portion of their fossil fuel imports by switching to non-fossil fuel generation such as wind, solar and hydropower. India's support to Bhutan for setting up multiple hydropower plants in Bhutan, for eventual power export to India is a case in example.

3.5 Demand diversity and Resource Complementarity

The diversity in seasonal demand and generation resource patterns is one of the key drivers of regional energy cooperation in the BIMSTEC region. In countries where hydropower is generated from snow fed rivers, during winter season, the rivers freeze thereby leading to a large drop in hydropower generation. However, during the same winter season, countries with largely thermal power plants witness a drop in demand, thereby allowing the excess available generation to be exported to the hydro dependent countries. One of the best illustrations of this is the power transfer between India and Nepal, and India and Bhutan.

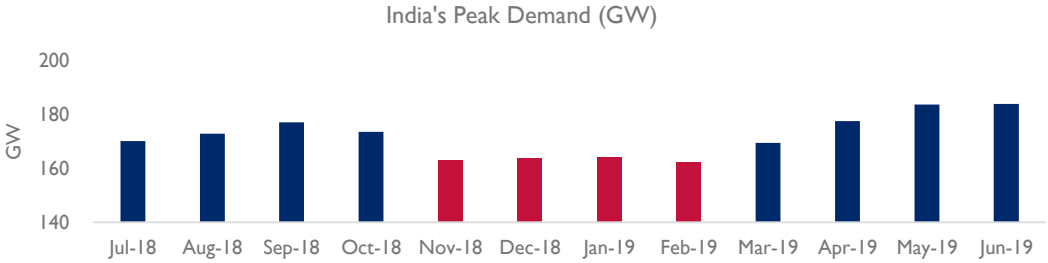
Figure 21: Nepal's Seasonal Generation Pattern



Source: NEA Generation Directorate Annual Report, 11th Issue

It can be seen in the above figure that the generation drops drastically in the months of November – March in Nepal.

Figure 22: India's Seasonal Peak Demand Pattern



Source: Central Electricity Authority's Power Supply Reports

At the same time, November – February is the winter season in countries like India. During these months, the demand drops substantially, thereby building a case of energy cooperation with neighbouring countries like Nepal and Bhutan.

3.6 Climate Change and need for sustainable power sector development

In line with global shift towards sustainable energy and climate friendly policies, BIMSTEC Member States have also made policy commitments for adoption of green energy. At the same time, not all the countries have adequate resources to develop such green generation resources. This leads to the possibility of utilization of cross border trade for access to green power. For example, India finds it difficult to develop new large hydropower plants in its territory. Therefore, it has helped to construct export oriented hydro power plants in Bhutan and Nepal. On the other hand, the large capacity of solar and wind power plants in India provides a chance for neighbouring countries such as Bangladesh to buy power from such plants, rather than waiting to develop similar resources in their country.

News report: Bangladesh plans to buy 2000MW solar power from India

"Bangladesh wants to buy at least 2,000MW of solar power from India to meet the growing demand of electricity in the country. The power will be bought from large solar power projects coming up in Gujarat and Rajasthan states, reports the Livemint quoting Prime Minister's Energy Adviser Tawfiq-e-Elahi…"

Source: Dhaka Tribune (18 April 2018), Bangladesh plans to buy 2000MW solar power from India - https://www.dhakatribune.com/bangladesh/power-energy/2018/04/18/bangladesh-plans-buy-2000mw-solar-power-india

3.7 Synergies in system development and operation, RE integration, and grid balancing

BIMSTEC Member States have synergies in power system development, operation, RE integration and regional grid balancing. The geographically interconnected region allows rerouting of new high capacity transmission lines through another country if there are right of way / other issues in direct point-to-point connection. This is already being explored in the case of 'India – Bangladesh power corridor', which is reported to be able to transport 6000 MW of power from India's North East to Bangladesh and Indian load centres.

On the other hand, the currently RE rich countries like India do not have adequate storage hydro and gas power plants for grid balancing, in their domestic energy mix. This presents the possibility of utilization of storage based hydro power plants in countries like Nepal, Bhutan and Myanmar; and gas power plants in countries like Myanmar and Bangladesh for RE integration through regional grid balancing. There are already established global models in similar regional grid balancing for RE integration, in the case of Denmark and Norway, where Norway's hydro power plants are utilized to balance Denmark's wind power capacity. Similar models in BIMSTEC are expected to become a key driver of regional energy cooperation.

3.8 Energy technology transfer

With new technologies such as smart grid, electric mobility and electricity storage moving from technology demonstration phase to commercial implementation, there is scope for energy technology transfer as one of the drivers of regional cooperation. This could vary from sharing of best practices to supporting the implementation of commercial scale projects.

One of the best examples of such technology transfer is the case of Rooppur Nuclear Power Plant which is under construction is in Bangladesh. Even though the plant is of Russian technology, and being built by Russian companies, the fact that similar technology was deployed and commissioned successfully in India's Kudankulam Nuclear Power Plant was a key point of comfort for the Bangladesh. In fact, as per a deal signed in 2018, even Indian companies are involved in some of the non-critical parts of the plant construction.[25]

3.9 Energy technology research and development

BIMSTEC Member States can undertake joint research and development of new energy technologies, which could act as an enabler of regional cooperation. This could be on topics that are relevant to the region, such as clean coal, sustainable hydropower, and renewable energy integration. The research institutions in BIMSTEC can collaborate with each other on areas of interest. There is already some level of coordination and collaboration in a few cases. For example, on 26 February 2020, senior officials from BIMSTEC Member States will be attending a seven-day conference on 'Scaling Up of Renewable Generation' at India's National Institute of Wind Energy (NIWE).[26]

[25] *Mint (01 March 2018), India, Russia, Bangladesh sign pact for Rooppur atomic plant - https://www.livemint.com/Industry/QD5ex7YkwRkooAmYgWPVHK/India-Russia-Bangladesh-sign-pact-for-Rooppur-atomic-plant.html*

[26] *NIWE, Scaling up of Renewables (Wind and Solar) Generation, specifically for BIMSTEC countries - https://niwe.res.in/assets/Docu/BIMSTEC/BIMSTEC_Brochure.pdf*

3.10 Regional stability and peace

Regional energy cooperation has geostrategic implications, and often has interlinkages with political stability and peace. In regions where relations between the countries are not cordial, it is difficult to start or sustain energy cooperation. On the other hand, almost all the well-established examples of regional energy cooperation have the underlying factors of regional stability and peace as one of the enablers and drivers, be it European Union, South African Power Pool or Gulf Cooperation Council.

One of the major advantages of BIMSTEC regional grouping is that there is no significant political enmity or a history of adverse relations between the Member States. The region is peaceful, and free from any major international conflicts. Even within the individual Member States, there is political stability. Member States with a history of political unrest such as Nepal, Sri Lanka and Myanmar have also now become more stable. This aspect serves as a key driver of regional energy cooperation, and serves as an opportunity for strengthening the cooperation.

4 BIMSTEC Regional Power and Gas Grids

4.1 Existing agreements and proposed vision of BIMSTEC Power Grid and Gas Grid

In the first BIMSTEC summit held in Bangkok on 31 July 2004, energy was identified as one of the sectors for focussed cooperation. The summit deliberated upon various options and strategies for expanding and strengthening cooperation in energy sector and adopted a Ministerial Declaration in this regard on 04 October 2005. It also approved a Plan of Action to implement the decisions of the Conference.

As part of the Ministerial Declaration, the BIMSTEC Energy Ministers agreed to a vision of electric grid connectivity in the region by developing country-to-country grid inter-connections for ultimately facilitating flow of electricity across the region (BIMSTEC Power Grid). The summit also recognized the need for detailed feasibility studies and techno-economic agreements between and among participating countries to allow for the optimal utilization of the natural gas resources of the region (BIMSTEC Gas Grid).[27]

Thereafter, there have been three key developments relating to regional cooperation in energy sector within BIMSTEC[28]:

1. The Joint Ministerial Statement adopted at the Second BIMSTEC Energy Ministerial Meeting (2nd BEMM) held in Bangkok, Thailand on 05 March 2010 decided to commence a BIMSTEC Grid Interconnection Master Plan Study.
2. On 22 January 2011, the Member States signed the Memorandum of Association (MoA) for the establishment of a BIMSTEC Energy Centre (BEC) in Bengaluru, India.
3. On 31 August 2018, a Memorandum of Understanding (MoU) for establishment of the BIMSTEC Grid Interconnection was signed at the Fourth BIMSTEC Summit held in Kathmandu, Nepal. The MoU has entered into force on 07 April 2019.

The MoU for establishment of BIMSTEC Grid Interconnection[29] provides a broad framework for the BIMSTEC Member States to cooperate towards the implementation of cross border grid interconnections for trade, with a view to promoting rational and optimal power transmission. The MoU also recognizes the need to have a BIMSTEC Grid Interconnection Coordination Committee (BGICC) to actively coordinate for the successful implementation of grid interconnections and trade in electricity.

Table 5: Key contents of MoU for establishment of BIMSTEC Grid Interconnection

Clause	Summary
Article 1: Purpose of the MoU	The purpose of this Memorandum of Understanding (MoU) is to provide a broad framework for the Parties to cooperate towards the implementation of grid interconnections for the trade in electricity with a view to promoting rational and optimal power transmission in the BIMSTEC region.

[27] *Ministry of External Affairs, Govt. of India (04 October 2005), First BIMSTEC Energy Ministers' Conference - https://mea.gov.in/press-releases.htm?dtl/5330/First+BIMSTEC+Energy+Ministers+Conference*

[28] *BIMSTEC, Salient Facts on BIMSTEC Energy Cooperation - https://bimstec.org/?page_id=2538*

[29] *BIMSTEC, MoU for establishment of BIMSTEC Grid Interconnection - https://powermin.nic.in/sites/default/files/uploads/BIMSTEC_MoU.pdf*

Clause	Summary
Article 2: Principles and Objectives	The Parties accept that their relationship be based on the following principles: a) Cooperation: The issues related to regional interconnections be handled in a spirit of cooperation and mutual benefit that the Parties have sovereign equal rights and obligations, act in solidarity, and refrain from taking advantage of one another. Each Party agrees to cooperate and implement the principle set forth in this MOU in accordance with the laws, rules and regulations of the Member States. b) Sustainable Development: The BIMSTEC Trans-Power Exchange and Development Projects be implemented through strengthening of bilateral and intra-regional cooperation within the framework of relevant laws, rules and regulations of the Member States.
Article 3: Institutional Arrangements	The Parties recognize the need to have an appropriate structure referred to as the BIMSTEC Grid Interconnection Coordination Committee (BGICC), to actively coordinate, for successful implementation of grid interconnections and trade in electricity. The BGICC may engage BIMSTEC Energy Sector Committee of Experts/Officials, Task Force for BIMSTEC Trans-Power Exchange and Development Projects, BIMSTEC Energy Center and other institutions to provide technical support.
Article 4: Dispute Settlement	The Parties implementing this MOU shall seek amicable resolution through negotiation/consultation if there is any divergence in interpretation or implementation of this MoU. In the event that the divergence continues, it will be referred to BGICC. If BGICC is unable to resolve the differences, that issue shall be referred to the BIMSTEC Senior Officials' Meeting on Energy for resolution.

In line with the MoU, the fourth BIMSTEC summit declaration[30] expressed the commitment of Member States in removing barriers to grid interconnections and ensuring early establishment of a BIMSTEC Grid.

"Energy
15. Recognize the high potentials of energy resources in the region, particularly renewable and clean energy sources, and agree to expedite our efforts to develop a comprehensive plan for energy cooperation by working closely with each other within the region and decide to constitute an intergovernmental group of experts to enhance energy cooperation including in hydro-power and other sources of renewable energy.

16. Remain committed to providing uninterrupted and affordable power supply for the economic development of our peoples, including through energy trade; welcome the signing of the Memorandum of Understanding on BIMSTEC Grid Interconnection and instruct the relevant agencies to take concrete measures to initiate harmonization of technical, planning and operational standards for removing barriers to grid interconnections and also ensure early establishment of a BIMSTEC Grid and call for an early operationalization of the BIMSTEC Energy Centre in order to strengthen energy cooperation in the region."

[30] *BIMSTEC, Fourth BIMSTEC Summit Declaration - https://mofa.gov.np/wp-content/uploads/2018/08/Fourth-BIMSTEC-Summit-Declaration-final.pdf*

4.2 Current status of power grid interconnection, gas grid interconnection and trade

Within BIMSTEC, power grid interconnections are currently operational between India-Nepal, India-Bangladesh, India-Bhutan and Myanmar-Thailand.

Table 6: Status of power grid interconnections

Countries	Power grid interconnection	Power trade
India – Nepal	Multiple lines at 400 KV (currently charged at 220 KV), 132 KV and lower voltages connected under synchronous mode. This includes: • 400 KV D/c Dhalkebar-Muzzafarpur line (presently it is charged at 220 KV) • 132 KV lines: Kataiya – Duhabi, Raxaul-Parwanipur, Kataiya-Kushaha, Gandak East – Gandak/Surajpura, Tanakpur - Mahendranagar	• On an annual net basis, power is imported by Nepal from India. • Export, at least on a seasonal basis is expected to become a significant quantum in future with commissioning of new large hydro power plants.
India – Bangladesh	Primarily connected through an HVDC link. However there is also another AC interconnection at 132 KV. • 400 KV Bheramara – Baharampur HVDC (2x500 MW) • 400 KV Surjyamaninagar - South Comilla AC line (currently charged at 132 KV)	• Bangladesh buys power from India under medium and long term PPAs.
India – Bhutan	Multiple lines at 400 KV, 220 KV, 132 KV and lower voltages connected under synchronous mode. This includes: • 400 KV Tala HEP - Siliguri • 220 KV Chukha HEP - Birpara • 132 KV Geylephu – Salakati • 132 KV Deothang - Rangia	• Net export from hydro power plants in Bhutan to India on an annual basis. • However, during dry season when river flows reduce due to low temperature, there is import of power from India.

In addition to the above, there is an 11 KV line from India, which supply power to Myanmar's border town of Tamu. However, the quantum of supply is very low, usually limited to a maximum of 3 MW. Similarly, Tachileik, a town in Myanmar border is supplied electricity from Chaing Rai in Thailand.[31]

In comparison to the power grid interconnections, gas grid interconnections within BIMSTEC are still at a very nascent stage. The only cross border pipelines that are currently operational are the pipelines that supply gas from Yadana, Yetagun and Zawtika gas fields in Myanmar to Thailand[32]. There is also a petroleum pipeline between Motihari in India and Amlekhgunj in Nepal.

[31] *Economic Research Institute for ASEAN and East Asia (2013), On-the-Ground Conditions and Key Issues Relating to Rural Electrification in Myanmar - http://kwrintl.com/library/2013/Phase1-KWR-ERIA-MyanmarElectrification.pdf*

[32] *Petroleum Economist, Gas Exports Up and Running - https://www.petroleum-economist.com/articles/misc/misc/2001/gas-exports-up-and-running*

4.3 Future plans for BIMSTEC Power Grid

Power grid interconnections in BIMSTEC are planned to be strengthened and expanded. A brief profile of the CBET interconnections in the BIMSTEC region that are proposed to be developed is provided below.[33]

1. India – Bhutan
   - Punatsangchu HEP – Alipurduar 400 KV Double Circuit (D/c): 170 km
   - Jigmeling – Alipurduar 400 KV D/c: 198 km
   - Alipurduar – Siliguri 400 KV D/c line and Kishanganj – Darbhanga 400 KV D/c line

2. India – Nepal
   - Upgradation of Dhalkebar-Muzzafarpur line to 400 KV (presently charged at 220 KV)
   - 400 KV New Butwal-Gorakhpur
   - 400 KV evacuation lines for export oriented hydropower plants such as Arun-III and Upper Karnali

3. India – Bangladesh
   - 765 KV Bornagar (India NER) – Parbotipur (Bangladesh) – Katihar (India ER)

4. India – Sri Lanka
   - Undersea HVDC cable or overhead transmission line, from Madurai in India to Anuradhapura in Sri Lanka, with a planned capacity of up to 1000 MW

5. Thailand – Myanmar
   - Depends on the progress of the below generation projects:
     - Mai Khot – Mae Chan – Chiang Rai (369 MW)
     - Hutgyi – Phitsanulok 3 (1190 MW)
     - Ta Sang – Mae Moh 3 (7000 MW)
     - Mong Ton – Sai Noi 2 (3150 MW)
6. Bangladesh – Myanmar
   - Cox's Bazar – Myanmar (500 MW).

4.4 Future plans for BIMSTEC Gas Grid

New cross-border cooperation initiatives are also planned in the oil and gas sectors where initial agreements/MoUs among the countries have been initiated. Some of the key developments in the BIMSTEC region include:

1. **India – Bangladesh**
   The construction of 130 KM India – Bangladesh Friendship Pipeline Project was jointly inaugurated by the Prime Ministers of Bangladesh and India on September 2018. Once completed, the pipeline will transport refined diesel from India to Bangladesh.

2. **India – Bangladesh - Myanmar**
   India's Oil and Natural Gas Corporation (ONGC) and Bangladesh Petroleum Corporation (BPC) are in talks to build a 6900 km gas pipeline that will link Bangladesh, Myanmar and India's north-eastern states. This pipeline would link Sitwe in Myanmar's Arakan to Mizoram and Tripura in northeast India and Chittagong in Bangladesh. The pipeline would extend to West Bengal on the Indian mainland and Assam and other north-eastern states on the eastern side.

3. **India – Nepal**
   A Joint Working Group on cooperation in the oil and gas sectors is considering advancing cooperation in areas such as the construction of a LPG pipeline from Motihari to Amlekhgunj and the construction of a natural gas pipeline from Gorakhpur to Sunwal.

[33] *National Electricity Plan for Transmission of India, Power System Master Plan of Nepal and Power System Master Plan of Bangladesh*

4.5 Development of BIMSTEC Regional Energy Market

Despite the plans for BIMSTEC Power Grid and BIMSTEC Gas Grid, the power trade and gas trade continue to be mostly bilateral. Broader regional energy market mechanisms such as power pools, regional power exchanges and gas markets are currently not under serious consideration. However, as the power grids and gas grids expand in the BIMSTEC region, there is possibility for wider acceptability for the concept of development of more coordinated and connected regional energy markets.

4.6 Bilateral cooperation initiatives

Almost all the current cross border gas and power trade arrangements in BIMSTEC region have been originally developed under bilateral cooperation. Along with those specific project initiatives, there have also been a few separate bilateral initiatives that plays a role in current and future growth of regional energy cooperation in BIMSTEC region. For example, the India – Nepal Power Trade Agreement of 2014 played a key role in enhancing of power trade between India and Nepal. Similar initiatives are expected to contribute towards regional energy cooperation in the future also.

5 Prospects for Regional Energy Cooperation

5.1 Scale-up of existing Cross Border Electricity Trade

Within the BIMSTEC region, there are multiple projects that are planned or ongoing, for strengthening of existing cross border electricity transmission links, and for building new cross border grid interconnections. In the western side, the import of electricity from Bhutan and Nepal to India and also Bangladesh will be the key drivers for developing the transmission infrastructure.

News: Bangladesh issues letter of intent to purchase 500 MW from Upper Karnali hydro project

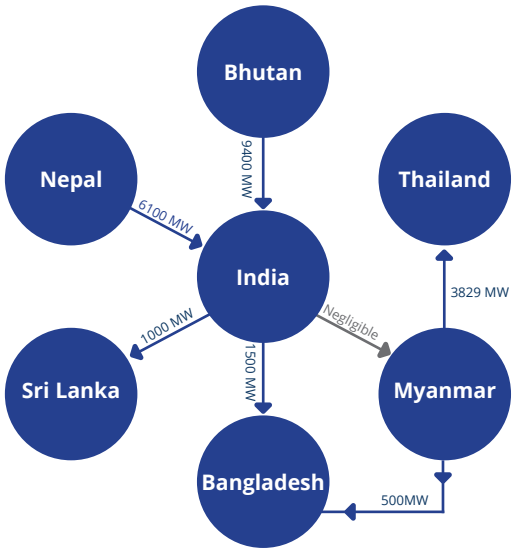
Bangladesh has issued a letter of intent to GMR Group, expressing its interest to enter into a contract to purchase 500 megawatts of electricity from its 900 MW Upper Karnali hydropower project in Nepal, the project officials said on Sunday.

More details available at: Kathmandu Post (09 Feb 2020) - https://tkpo.st/2SrMyGq

The connectivity from the northeast part of India to the rest of the country (the northern and eastern regions) is proposed to be strengthened through a HVDC link passing through Bangladesh, which would also allow the supply of electricity to Bangladesh. In the eastern side, while the planning for India–Myanmar interconnections is yet to take shape, it is likely that future policies for both countries would include these interconnections. Similar activities can also be expected in Myanmar – Thailand border.

Another factor for scale up of cross border trade is the cross border investments in generation projects. Bangladesh plans to invest in hydropower projects in Nepal, for ultimate delivery of power to Bangladesh from Nepal. This also brings intervening countries such as India also to such trade. The below figure shows the likely cross border electricity transmission capacities that would be developed by 2030-35.

Figure 23: Proposed cross border interconnection capacities by 2030-35



Source: National Electricity Plan for Transmission of India, Central Electricity Authority's note on perspective transmission plan, Electricity Generating Authority of Thailand, Bangladesh Power Division

 # - Bhutan, Bangladesh, Nepal based on 2027 projections in India's National Electricity Plan.
** - Sri Lanka based on estimates of Central Electricity Authority, for 2034*
Myanmar – Bangladesh as per Bangladesh Revisiting PSMP 2016. Myanmar-Thailand based on estimates of EGAT

On cross border trade of gas, the scale-up is expected to be primarily driven by the India – Bangladesh – Myanmar gas pipeline, and the development of new gas pipelines transporting gas the fields in Myanmar to Thailand. Those lines will be part of the Trans ASEAN pipeline project, which could involve connectivity with other non-BIMSTEC ASEAN countries also.

5.2 New avenues for energy cooperation

While cross border energy trade is one key aspect of energy cooperation, there are other new avenues also, especially on mobilization of investments for generation and transmission investments, cooperation in clean energy technology, smart grid initiatives, energy efficiency and electric mobility. For example, India's Energy Efficiency Services Ltd (EESL) has utilized its expertise in energy efficiency to assist Bangladesh and Maldives, including:

- Deputation of resources in Ministry of Environment & Energy to advise and support government in Energy Efficiency;
- Installation of LED street lights and supply of LED street lights, Maldives;
- Installation of LED street lights under a pilot scheme in Tungipara Municipal Corporation, Bangladesh;
- Installation of solar LED street lights in Cox Bazaar, Bangladesh; and
- Supply of 52,500 LED street lights, Bangladesh.[34]

On the energy technology front, today various new technologies in the area of renewable energy, long range and high voltage power transmission, power generation, hydrogen energy, fuel cell, clean coal technologies, energy storage and electric vehicles etc. are on the verge of breakthrough. The BIMSTEC Member States can also cooperate among each other for introduction and advancement of such new technologies. A MoU has been signed between Maldives and India in March 2019, on cooperation in energy efficiency and renewable energy.[35]

5.3 Knowledge sharing

The BIMSTEC countries can cooperate among each other to identify the emerging renewable energy technologies and policy frameworks relevant in the regional context and leverage domestic learnings from other countries in order to commercialise the renewable energy technologies both for domestic and regional purposes. BIMSTEC countries can learn from each other from various best practices in the area of sustainable hydropower development and various business models associated with it.

The proposed BIMSTEC Energy Center could have played a key role in knowledge sharing, though there has been no substantial progress in its establishment so far. Meanwhile, there have been bilateral initiatives on knowledge sharing within the region. For example, India and Bangladesh signed an agreement on Cooperation in the Peaceful Uses of Nuclear Energy, on 08 April 2017. The agreement envisages cooperation between the countries on various knowledge sharing activities such as:

- Transfer and exchange of knowledge, expertise and technology as appropriate, sharing of resources and experience, training of personnel and capacity building;
- Exchange of operation and maintenance experiences between utilities; and
- Technical training and education.[36]

[34] *Energy Efficiency Services Limited (April 2019), Smart Grid Innovation in the Sub-region & Learnings for Bangladesh - http://events.development.asia/system/files/materials/2019/04/201904-smart-grid-innovation-sub-region-and-learnings-bangladesh-energy-efficiency-services-limited.pdf*

[35] *Ministry of External Affairs, Government of India (08 June 2019), India-Maldives Joint Statement during the State Visit of Prime Minister to Maldives - https://www.mea.gov.in/bilateral-documents.htm?dtl/31418/IndiaMaldives+Joint+Statement+during+the+State+Visit+of+Prime+Minister+to+Maldives*

[36] *Government of India and Government of Bangladesh (08 April 2017), Agreement on Cooperation in the Peaceful Uses of Nuclear Energy - http://www.mea.gov.in/Portal/LegalTreatiesDoc/BG17B3020.pdf*

6 Benefits of BIMSTEC Regional Power Grid

A BIMSTEC regional power grid, extending from India to Thailand offers multiple benefits to the BIMSTEC Member States. While some of these are applicable to any regional grid, there are also a few benefits that are specific to the region due to the complementarity in demand patterns and generation resources.

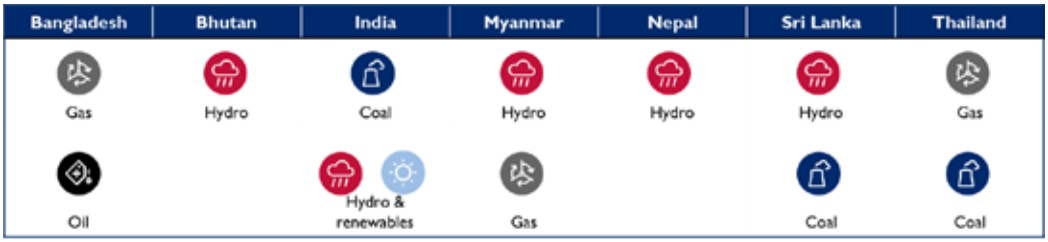
It may be noted that unlike the case of a few regional power grids such as Gulf Cooperation Council (GCC) or Central American Interconnection, a BIMSTEC regional power grid does not envisage an entirely new high voltage grid developed specifically for regional connectivity. The grid is expected to consist of large capacity cross border interconnections between the grids of member states, with associated market mechanisms that enable trade. The benefits of such a grid of grids is discussed below.

6.1 Technical and Operational Benefits

Access to wider range of generation resources

It is in the interest of energy security and flexibility to have a country's power produced from multiple sources / fuels. Presence of a regional grid allows the countries to access power even from resources that it lacks domestically.

Figure 24: Dominant fuel sources in domestic electricity generation mix of BIMSTEC Member States



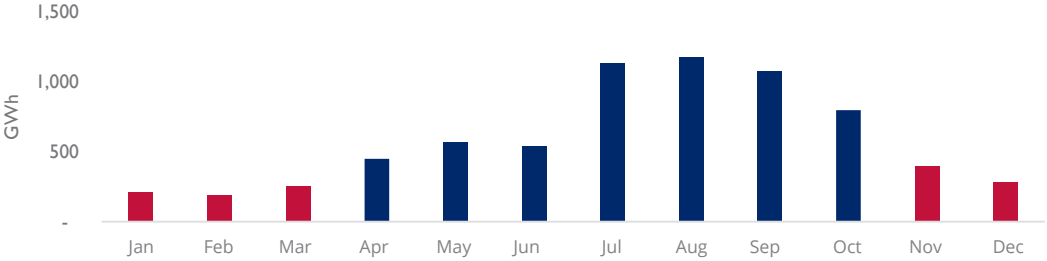
Source: IRADe analysis, based on official data on electricity generation by fuel

For example, Bangladesh imports power from India's coal power plants, while it lacks its own coalmines. India buys or plans to buy hydropower from large hydro power plants located in Bhutan and Nepal respectively, as it finds difficult to construct new large hydro power plants in its territories due to environmental and social issues. Thailand imports natural gas from the gas fields located in Myanmar, for use in Thailand's power plants.

Seasonality of generation in hydropower dependent countries

In countries such as Nepal and Bhutan, during winter season the water sources freeze resulting in reduction of generation from hydropower sources. In comparison, in countries such as India, demand is lower in winter season, therefore leaving enough excess generation for trade with hydro dependent countries.

Figure 25: Generation profile of Bhutan's major hydro power plants in 2019



Source: IRADe analysis, based on PLF data from Bhutan Power System Operator

Difference in time zones

Due to the difference in time zones, there is a diversity in the exact time of peak demand among the BIMSTEC Member States. This offers the possibility of meeting peak demand with less peak generation capacity coupled with CBET, instead of each country trying to meet peak demand entirely on its own.

Figure 26: Time zones in BIMSTEC

Sri Lanka	India	Nepal	Bangladesh	Bhutan	Myanmar	Thailand
GMT + 5:30	GMT + 5:30	GMT + 5:45	GMT + 6:00	GMT + 6:00	GMT + 6:30	GMT + 7:00

Optimum alignment of transmission lines

In some countries, geographic factors might limit the possibility of new transmission lines between two locations, which can be solved by routing the line through nearby countries, if there was a regional grid.

For example, India has been facing difficulties in planning new transmission lines from large hydropower plants being planned in its northeast region, to major load centres. However, India's north east region and rest of its mainland is connected by a narrow corridor, with a width of only 22 KM. A solution being explored is the routing of lines instead through Bangladesh, which will also help Bangladesh in importing power.

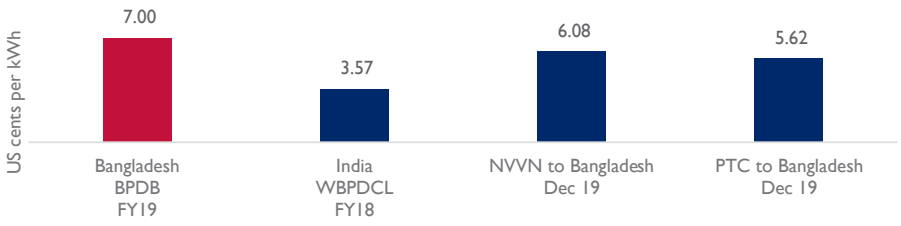
6.2 Economic and Financial Benefits

Access to cheaper power sources

In the presence of a regional power grid, it becomes possible for countries to access cheaper generation sources in neighbouring countries. Bangladesh's import of power from India is an example for the same.

In Bangladesh, the cost of power generation in FY19 was 7.00 US cents per kWh. In comparison, cost of generation in WBPDCL, the generation utility in neighbouring Indian state of West Bengal was only 3.57 US cents per kWh. Bangladesh now purchases power from the Indian power trading licensees, NVVN and PTC at rates cheaper than their domestic power generation.

Figure 27: Difference in cost of power in India and Bangladesh



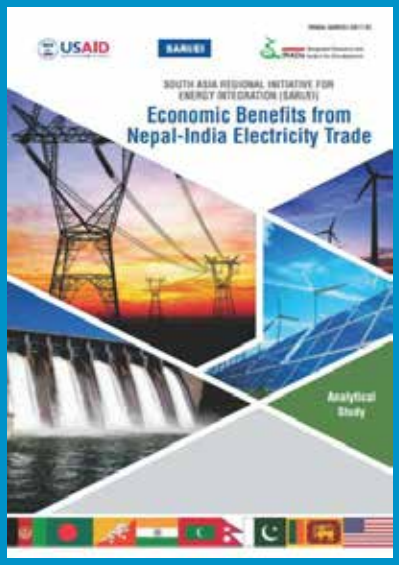
Source: BPDB, WBPDCL, NVVNL, PTC India

SARI/EI studies on economic benefits of cross border electricity trade

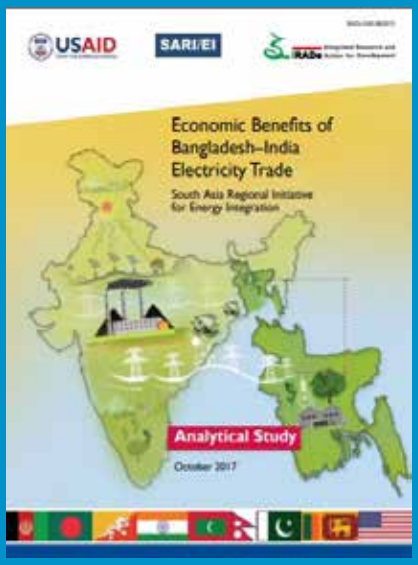
There are separate detailed studies undertaken by SARI/EI on economic benefits of India-Nepal and India-Bangladesh CBET, which describe in more detail about the macroeconomic impacts, including increase in GDP, inflow of foreign exchange and per capita electricity consumption.

As per these studies, Nepal-India electricity trade is expected to improve Nepal's GDP by 39%, by 2045; and reduce India's CO2 emissions by 5.4%. Similarly, Bangladesh-India electricity trade is expected to reduce power purchase costs of Bangladesh, and to increase foreign exchange inflow for India.

For more details, please refer to the following studies:



SARI/EI (2017), Economic benefits of Nepal-India Electricity Trade

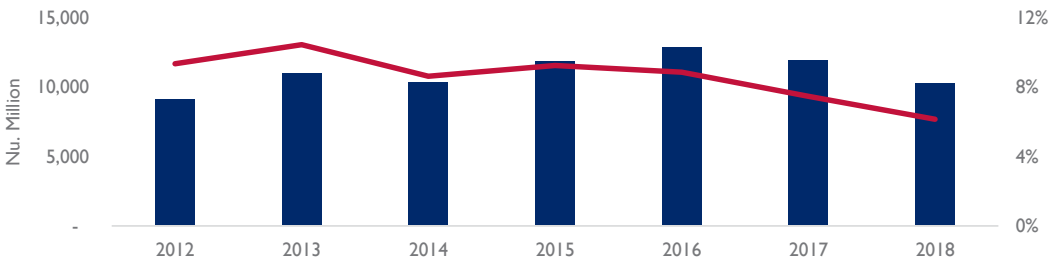


SARI/EI (2017), Economic benefits of Bangladesh-India Electricity Trade

Foreign exchange revenues

A regional power grid allows BIMSTEC Member States with surplus electricity to sell to other Member States that require such energy, in a commercially profitable manner. One of the best illustrations of such a trade is the sale of hydropower from Bhutan to India. Revenue from power exports of Bhutan is estimated to be in the range of 6-10% of its GDP during 2012-2018.[37] [38]

Figure 28: Share of revenue from electricity export in Bhutan's GDP



Source: National Statistics Bureau and Ministry of Economic Affairs, Government of Bhutan

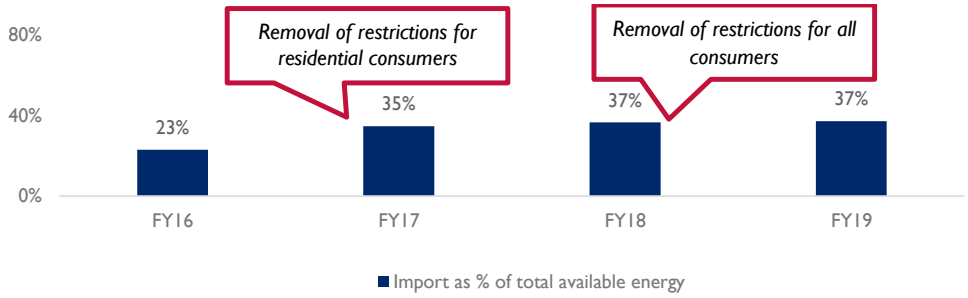
[37] *National Statistics Bureau, Government of Bhutan (2019), National Accounts Statistics 2019 - http://www.nsb.gov.bt/publication/files/pub9hg6641iz.pdf*

[38] *Ministry of Economic Affairs, Government of Bhutan (2019), Annual Trade Statistics 2018 - https://www.moea.gov.bt/wp-content/uploads/2017/10/ANNUAL-TRADE-STATISTICS-2018.pdf*

Utilization of surplus generation of one country in another
Countries like Nepal and Bangladesh currently do not have enough generation sources to meet the power demand all-around the year. In comparison, there are countries like India and Bhutan, which has surplus generation sources available. CBET allows trade between surplus to deficit countries, resulting in optimum utilization of generation assets, and availability of electricity to aid the economic growth.

One of the best examples is the case of Nepal wherein increased electricity imports have resulted in withdrawal of electricity load restrictions to all categories of consumers. Till 2017, there were electricity shortages, due to which supply was curtailed for up to four hours every day for all consumers. The commissioning of 400 KV Dhalkebar-Muzaffarpur transmission line on February 2016, though charged at a lower voltage, enabled increase of electricity imports from India. In 2017, the restrictions on residential consumers were removed. During 2018, planned curtailments for all categories of consumers were removed. [39]

Figure 29: Nepal - Electricity import from India



Source: NEA Annual Reports

Economic extension of grid
In border areas, it might be economical to supply power from a neighbouring country instead of extending the domestic grid over large distance and rough terrain. A case in example is India providing supply to Myanmar's border town of Tamu, which is not linked to Myanmar's power grid.

6.3 Renewable energy and environmental benefits

Potential for large-scale hydropower plants in countries like Bhutan, Nepal and Myanmar, coupled with demand for large-scale clean power in India, Thailand etc.
In densely populated countries like India, it is no longer possible to plan for new large hydro power plants without risking large-scale population displacement and ecological impacts. In comparison, countries like Bhutan, Nepal and Myanmar offers possibility of setting up large-scale export oriented hydro power plants, which can meet the requirement of clean energy for India, Thailand, Bangladesh etc.

Similarly, Bangladesh has constraints on land for utilization of solar power, thereby providing a possibility of import of solar power from neighbouring countries.

Sharing of variable generation source at regional level, for system balancing under high rates of RE penetration
Hydropower plants with large reservoirs are utilized as a balancing source in regions with high share of renewable energy, such as Denmark and Norway. However, in BIMSTEC Member States such as India where there is a large quantum of RE (and significantly higher quantum of RE planned for future) the availability of standalone hydropower plants (not linked with irrigation) is limited. A regional power grid offers the possibility of utilizing flexibility of large hydro power plants in other countries in the region, for accommodating the variability of RE in India.

[39] *Kathmandu Post (14 May 2018), Entire country is now free of loadshedding - https://kathmandupost.com/money/2018/05/14/entire-country-is-now-free-of-loadshedding*

6.4 Regional Energy Market Development

Enabler of regional market development

A BIMSTEC power grid will enable the eventual development of BIMSTEC regional power market also. A regional grid facilitates cross border transactions beyond bilateral mode, such as allowing power trade between two countries that are not directly connected. The availability of such a capable grid allows the introduction of new agreements and new market products thereby enabling regional energy market development.

6.5 Mobilising of Investment in the BIMSTEC Region

Cross border investments

A regional power grid allows countries to have access to foreign direct investment for developing their generation sources. For example, India is building the 900 MW Arun-III hydropower project in Nepal, which is one of the largest FDI projects in Nepal. A part of the generation can be utilized by Nepal, which rest will be exported to India through cross border lines. Such investments in FDI mode also frees up the capital of host countries, which can then be used for alternate purposes.

7 Regional Energy Cooperation: International Experiences & Lessons learned

There are multiple examples of regional cooperation in energy sector across the globe, from which BIMSTEC can derive inspiration and learnings. A few of such examples are discussed below.

7.1 European internal market for electricity

The European Union (EU) is an economic and political union between 28 EU countries that together cover much of the European continent. The countries together constitute a single market (also known as the 'internal' market) through a standardised legal system that apply in all member states.

The internal market of European Union also contains a single internal market for electricity. The market focuses on providing market access to third parties and on ensuring competition on wholesale and retail markets. The market hosts day ahead, intra-day, forward and balancing products. In 2018, the traded volume of electricity in the market exceeded 12000 Billion Units.[40] This was equivalent to 4% of total electricity generation in 2018. [41]

The European internal market may be considered as a market of markets, as there are multiple regional markets (Central West Europe, Central Eastern Europe, Baltic market, Iberian market etc.) and power exchanges (European Power Exchange, Energy Exchange Austria, Independent Bulgarian Energy Exchange etc.) within it.

Some of the key factors behind the success of the internal market includes:

1. Strong overall framework on cooperation provided by the European Union;
2. Detailed legal framework for energy cooperation, issued as a set of directives by the European Commission; and
3. Institutional framework for cooperation between Transmission System Operators (TSOs) and regulators.

One of the key coordination bodies within the European internal market is the European network of transmission system operators for electricity (ENTSO-E). Its tasks include:

- Elaborating rules (network codes) for the operation of the electricity transmission networks;
- Coordinating grid operation through the exchange of operational information; and
- Development of common safety and emergency standards and procedures.

[40] *European Commission (2019), Quarterly report on European Electricity Markets Volume 13 - https://ec.europa.eu/energy/sites/ener/files/quarterly_report_on_european_electricity_markets_q_3_2019.pdf*

[41] *Eurostat, Electricity Generation Statistics - https://ec.europa.eu/eurostat/statistics-explained/pdfscache/9990.pdf*

ENTSO-E is also responsible for drafting a 10-year network development plan every two years, which is then reviewed by the Agency for Cooperation of Energy Regulators (ACER).

7.2 Greater Mekong Sub-region (GMS)

The South East Asian countries commenced energy co-operation under Greater Mekong Sub-region (GMS)'s intergovernmental agreement (IGA) on regional power trade in 1992. The Greater Mekong Sub-region (GMS) comprises Cambodia, the People's Republic of China (PRC), Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, and Vietnam. Currently, there are over 1700 MW of export oriented power plants, supplying power across the country borders within GMS.[42] There are multiple cross border transmission lines, such as those Lao PDR-Thailand and Cambodia-Vietnam. In 2016, total power trade in GMS was 21000 Million Units, which was 2.6% of total power supply in the region. [43]

GMS model has been successful due to the emphasis that has been placed on ensuring a gradual evolution of the regional market from bilateral contracts to a more complex, centralized regional trading system. The roadmap for development of power market in the GMS has been laid out by the World Bank and ADB in four stages:[44]

- Stage 1 – Enabling country to country transactions
- Stage 2 – Enabling trading between any two GMS countries using transmission lines of a third country.
- Stage 3 – Third parties other than national power utilities are allowed to utilize regional interconnections
- Stage 4 – Establishment of multi-buyer and multi-seller regional market

There are four institutions that play a key role in supporting the GMS power market:

1. The **Sub regional Electric Power Forum,** which serves as an advisory body to the GMS Ministerial Meetings on sub regional power issues;
2. The **Regional Power Trade Coordinating Committee** which undertakes the coordination activities; and
3. The **Focal Group and Planning Working Group** which undertakes activities such as planning and system operation studies.

7.3 Gulf Cooperation Council (GCC)

The Gulf Cooperation Council Interconnection Authority (GCCIA) has commissioned a 400-kV grid that connects the electrical power networks of the Arabian GCC countries of Bahrain, Kuwait, Qatar, Oman, United Arab Emirates (UAE) and Saudi Arabia. This interconnection enables electrical energy exchange and emergency support among these countries. Physical infrastructure between countries consist of 50 Hz AC interconnection between Kuwait, Bahrain, Qatar, UAE and Oman with a back-to-back High Voltage Direct Current (HVDC) interconnection to the 60 Hz Saudi Arabian system.

In 2018, the energy traded under GCC interconnection was 1236 MU. GCCIA estimates the annual savings from the interconnection to be over 1 billion USD.[45]

[42] *Asian Development Bank (2013), Assessment of GMS Subregion energy sector development - https://www.adb.org/sites/default/files/institutional-document/33872/files/assessment-gms-subregion-energy-sector-development.pdf*

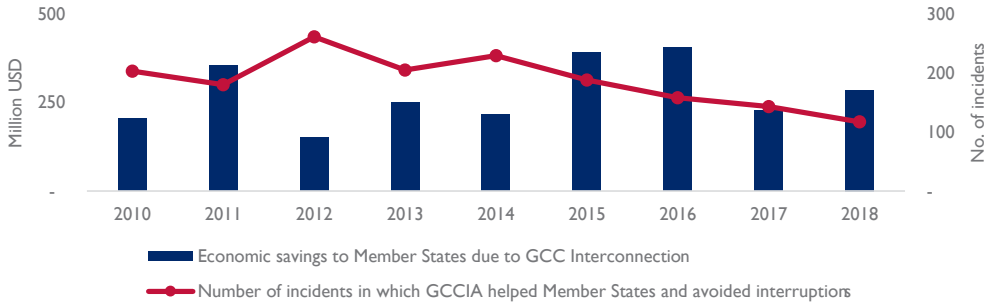
[43] *GMS Secretariat, GMS Statistical Database - https://www.greatermekong.org/statistics/index-static.php*

[44] *Asian Development Bank (September 2012), Greater Mekong Subregion Power Trade and Interconnection - https://www.adb.org/sites/default/files/publication/29982/gms-power-trade-interconnection.pdf*

[45] *GCC Interconnection Authority (2019), Annual Report 2018 - https://www.gccia.com.sa/Data/Downloads/Reports/FILE_24.pdf*

The GCC electricity scheme was envisaged primarily to allow participating countries to share reserve capacity to minimize overall investment in peaking plant, and minimize interruptions. Active trade in electricity through the interconnector is only a secondary function.

Figure 30: Estimated benefits of GCC Interconnection



Source: GCC Interconnection Authority

GCCIA is established as a joint stock company owned by the electricity ministries in the six GCC states. A General Agreement, signed at the Ministerial level of the member states, sets out the rules and regulations governing the high-level relationships among the member states in relation to the interconnection scheme. A Power Exchange Trading Agreement (PETA), signed by the transmission entities in member countries, governs the terms & conditions, connectivity & usage, technical & commercial rules of the electricity trade.

7.4 Nile Basin Initiative (NBI)

The Nile Basin Initiative (NBI) is an intergovernmental partnership of 10 Nile Basin countries, namely Burundi, DR Congo, Egypt, Ethiopia, Kenya, Rwanda, South Sudan, The Sudan, Tanzania and Uganda. NBI was established on 22 February 1999, to provide a forum for consultation and coordination among the Basin States for the sustainable management and development of the shared Nile Basin water and related resources for win-win benefits.

The Initiative supports regional cooperation in power sector directly, and through East African Power Pool. Catalysed by the support of NBI, cross border generation projects of 170 MW and cross border transmission capacity of 8500 MW are planned.[46]

The highest decision and policy-making body of NBI is the Nile Council of Ministers (Nile-COM), comprised of Ministers in charge of Water Affairs in each NBI Member State. The Nile-COM is supported by the Nile Technical Advisory Committee (Nile-TAC), comprised of 20 senior government officials, two from each of the Member States. The Nile Basin Sustainability Framework (NBSF), which is approved by Nile-COM lays down NBI's approach to developing guiding principles for water resource management and development across the Nile Basin countries. [47]

7.5 South East Europe (SEE)

The South Eastern European (SEE) region consists of the nine countries of Albania, Bosnia and Herzeovina, Bulgaria, Greece, Kosovo (without prejudice to its recognition or lack of recognition by various countries), North Macedonia, Montenegro, Romania and Serbia. Due to the legacy of erstwhile Yugoslavia, the countries had transmission interconnections from the past[48]. However, market coordination mechanisms were not robust, as there were different utilities and no common laws and agreements governing regional market for electricity.

[46] *Nile Basin Initiative, Powering the Nile Basin - https://www.nilebasin.org/documents-publications/53-powering-the-nile-basin-digital/file*

[47] *Nile Basin Initiative, Who we are - https://www.nilebasin.org/nbi/who-we-are*

[48] *South East Europe Electricity Roadmap, South East Europe Regional Report 2017 - https://rekk.hu/downloads/projects/SEERMAP_RR_SEE_A4_ONLINE.pdf*

The countries were able to progress on regional energy cooperation, by becoming members to the European Community Treaty in May 2006, which provides a common model for regional energy cooperation. The Treaty was developed to extend the EU internal energy market to SEE and beyond, on the basis of a legally binding framework. In 2018, the traded volume of electricity was over 67000 Million Units. [49]

Along with a binding legal framework, another key feature in SEE energy cooperation is the creation of institutions. On top, there is a Ministerial Council that meets once a year, and then there is a Permanent High Level Group which meets every three months. There is an Energy Community Regulatory Board which serves as the coordination body of the national energy regulators. In addition, there are three discussion forums in the areas of electricity, gas and oil.[50]

7.6 Southern Africa Power Pool (SAPP)

The Southern African Power Pool was established in 1995, comprising 12 Southern African Development Community (SADC) member countries (Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe) of which nine are operating members whose interconnected grid carries about 97% of the power produced by SAPP countries. In 2017-18, 2124 MU of energy was traded in SAPP, with USD 106.6 Million exchanged over the competitive market. The energy trade corresponds to 0.7% of the total energy generation in the region.[51]

SAPP is the most advanced power pool in Africa. Trading under SAPP consists of both bilaterally negotiated contracts, and competitive trade (day ahead, intra day, forward physical market - monthly and forward physical market - weekly. The competitive trade is executed through a market trading platform SAPP-MTP.

A major economic and political reason for the development of SAPP has been South Africa's aspiration to meet future energy supplies from low cost hydropower supplied by its neighbours. The overall aim was to optimize the use of available energy resources in the region and support one another among with Southern African countries during emergencies.

SAPP's guiding structure is based on intergovernmental memorandum of understanding (MOU) that authorizes and guarantees inter-utility MOU and operating agreements - Inter-utility MOU (IUMOU) deals with the issue of ownership and rights among the participants whereas the Agreement between operating members (ABOM) defines the interaction between the utilities with respect to operating responsibilities. Further, the Operating guidelines (OG) sets out the arrangement for cost sharing and functional responsibilities for plant operations, maintenance and safety rules. The Regional Electricity Regulators Association of Southern Africa (RERA) facilitate synchronization of regulatory policies, legislation, standards and practices among the SAPP countries and to be a platform for effective cooperation among energy regulators within the region.

7.7 South Asia

Even though coming under the South Asian Association for Regional Cooperation (SAARC),

[49] *European Commission (2019), Quarterly report on European Electricity Markets Volume 13 - https://ec.europa.eu/energy/sites/ener/files/quarterly_report_on_european_electricity_markets_q_3_2019.pdf*

[50] *Energy Community, Who we are - https://www.energy-community.org/aboutus/whoweare.html*

[51] *South African Power Pool (2019), Annual Report 2018 - http://www.sapp.co.zw/sites/default/files/30955_Sapp%20Annual%20Report%202018.pdf*

and in spite of agreements such as SAARC Framework Agreement for Energy Cooperation, and institutions such as SAARC Energy Center, regional energy cooperation in the South Asian region developed mostly through bilateral agreements. Political and geographic constraints also limits the energy cooperation between western and eastern regions of SAARC.

On the eastern side, regional energy cooperation centres around India, due to its large market size. Bhutan exports power to India, through Indian power trading entities, from large hydro stations. The present power transfer capacity between Bhutan and India is around 2,500 MW. Nepal has been importing power from India at least since 1970s, with the power from India playing a crucial role in the dry months of December – April, when the hydropower generation in the country falls very low. Imports from India accounted for nearly 34% of the annual electricity supply of the country in FY 2015-16. Bangladesh buys more than 1100 MW of power from India. In total, in the eastern side, the overall electricity trade is over 13652 Million Units, if the small quantum of supply to Myanmar is ignored.[52]

India to Nepal
2813
MU

India to Bangladesh
6786
MU

Bhutan to India
4053
MU

On the western side of South Asia, cross border trade is conducted mostly between SAARC and non-SAARC countries, such as in the case of Pakistan – Iran, Afghanistan – Tajikistan, Afghanistan – Turkmenistan, Afghanistan – Iran, and Afghanistan – Uzbekistan.

7.8 ASEAN Power Grid

The ASEAN Power Grid (APG) is an initiative to construct a regional power interconnection to connect the ASEAN region, first on cross border bilateral terms, and then gradually expand to sub-regional basis and then to a total integrated South East Asia power grid system. As one of the physical energy infrastructure projects in the Master Plan of the ASEAN Connectivity, the APG project is expected to enhance electricity trade across borders that would provide benefits to meet the rising electricity demand and improve access to energy services in the region.[53]

Nine bilateral interconnections are operational, linking countries such as Singapore, Malaysia, Thailand, Cambodia, Lao PDR and Vietnam. The capacity of these lines are estimated to be 5200 MW. Six more cross border lines are under construction. An interconnection masterplan study for ASEAN Power Grid estimated the overall benefits on account of interconnections at 1.9 Billion USD. [54]

10 Countries

9 Cross Border Transmission Lines

6 Cross Border Transmission Lines under construction

An MoU signed by the respective Governments in 2007 played a key role in the formation of ASEAN power grid.[55] ASEAN Power Grid's lead coordination body is called as HAPUA - the Heads of ASEAN Power Utilities/Authorities. There are also coordination mechanisms such as "Ministers of Energy Meeting" organized under ASEAN.

The ASEAN Ministers of Energy Meeting of 2014 endorsed the ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 which is the blueprint for energy sector cooperation. This was the third such plan being adopted by ASEAN. The ASEAN Center for Energy (ACE) is another key component, which serves as a data hub and knowledge centre.

[52] *Annual reports of BPDB (2019), NEA (2019) and DGPC (2018)*
[53] *ASEAN, ASEAN Power Grid- https://www.asean.org/storage/images/2015/October/outreach-document/Edited%20APG-3.pdf*
[54] *ASEAN Power Grid Consultative Committee (June 2016), ASEAN Power Grid: Route to multilateral trade - https://d2oc0ihd6a5bt.cloudfront.net/wp-content/uploads/sites/837/2016/03/ADB-2015-Manila-ASEAN-POWER-GRID-WAY-to-MULTILATERAL-ENERGY-TRADE.pdf*
[55] *ASEAN (23 Aug 2007), Memorandum of Understanding on the establishment of ASEAN Power Grid - http://agreement.asean.org/media/download/20140119102307.pdf*

8 Institutional Efforts for the Energy Sector Integration in BIMSTEC Countries

8.1 USAID funded South Asia Regional Initiative for Energy Integration (SARI/EI)

Over a decade, the US Agency for International Development (USAID) has been consistently striving for the promotion of energy security and regional energy integration in the South Asian nations. The USAID launched the South Asia Regional Initiative for Energy (SARI/E) program in 2000 covering eight countries of Afghanistan, Bangladesh, Bhutan, India, The Maldives, Nepal, Pakistan and Sri Lanka. The first three phases of the program focussed on the areas of:

1. Cross-border energy trade (CBET)
2. Energy market formation and
3. Regional Clean Energy development

The South Asia Regional Initiative for Energy Integration (SARI/EI) Phase IV, the final phase was launched in 2012 to advance regional energy integration and increasing CBET. The program is implemented by Integrated Research and Action for Development (IRADe).

The SARI/EI program is working towards promoting integration of energy systems and enhance Cross Border Energy Trade among the participating South Asian countries. Some of the key areas of focus of SARI/EI relating to regional energy integration are listed below.

Table 7: Key areas of focus of USAID's SARI/EI program

Coordination of Policy, Legal and Regulatory Issues	Defining ground rules for allocation of cost and risks, and creating an enabling environment for investors both in generation and transmission
Advancement of Transmission Systems Interconnection	Technical and operational aspects related to implementation of sub-regional bilateral transmission interconnections in the eastern sub-region of South Asia.
Establishment of South Asia Regional Electricity Markets	Exploring market-driven commercial practices in power trading (including long term contractual instruments and short term power trade in exchanges)
Other activities	Macroeconomic studies and modelling on benefits of CBET Compilation of country energy data Organization of workshops, study visits and trainings

Source: SARI/EI - https://sari-energy.org/about-sariei/sariei-phase-iv/

Along with numerous studies on promotion of CBET in South Asian region, SARI/EI has also undertaken a detailed study on BIMSTEC Energy Outlook 2030.

Figure 31: A few study reports of SARI/EI

All the study reports of SARI/EI are available at https://sari-energy.org/

8.2 Asian Development Bank (ADB)

ADB had launched multiple projects, mainly for providing technical assistance, on activities to promote cross border energy trade in South Asia and South East Asian regions. A list of key projects and activities related to the same, undertaken by ADB in the past five years are listed below.

Table 8: Key projects of ADB on regional cooperation in energy in BIMSTEC

South Asia Subregional Economic Cooperation Regional Energy Cooperation, 2018	The regional knowledge and support technical assistance (TA) will prepare development master plans and enhance capacity development for the energy sector's regional cooperation and integration (RCI) under the South Asia Subregional Economic Cooperation (SASEC) program. It will cover Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal, and Sri Lanka.
Harmonizing the Greater Mekong Subregion Power Systems to Facilitate Regional Power Trade, 2014	This regional technical assistance was designed to support the continuous work of the Regional Power Trade Coordination Committee and other entities of GMS subregion. Interventions include harmonizing performance standards and grid codes dictating the technical rules for the coordinated planning and operation of the regional electricity market; and harmonizing regulatory framework, pricing, legal framework for third party access to the grid and wheeling obligations all towards a unified, fair and transparent regional electricity market.
South Asia Economic Integration Partnership - Power Trading in Bangladesh and Nepal, 2014	• Conduct feasibility studies on establishing power trading companies in Bangladesh and Nepal; • Develop databases from Bangladesh and Nepal to for the South Asia Sub-regional Economic Cooperation (SASEC) Regional electricity transmission plan; and • Support to improve networking of Bangladesh and Nepal officials with their counterparts in other SASEC countries.
South Asia Subregional Economic Cooperation Cross-Border Power Trade Development, 2014	Identify the most economical cross-border power transmission options along with the selected power generation development plans.

Source: ADB Projects Page - https://www.adb.org/projects/country/reg/sector/energy-1059?page=2

8.3 The World Bank

The World Bank has played a key role in promoting and supporting regional energy trade within BIMSTEC, through its Nepal-India Electricity Transmission and Trade Project. The project aims to establish a high voltage cross-border transmission link between India and Nepal of about 1,000 MW to facilitate electricity trade between the two countries.

As part of the project, the World Bank has provided financing for the construction of 400 KV Dhalkebar – Muzaffarpur cross border transmission lines, Hetauda-Dhalkebar-Inarwa Transmission Line and Substations and a few related activities. More than 80 million USD of financial assistance has been disbursed so far.[56] The 400 KV Dhalkebar – Muzaffarpur cross border transmission line played a key role in solving the energy deficit of Nepal, by allowing it to import energy from India. World Bank has also undertaken a study on how cross-border electricity will trade stimulate hydropower development in South Asia[57].

[56] *The World Bank (July 2019), Nepal-India Electricity Transmission and Trade Project (P115767) ISR - http://documents.worldbank.org/curated/en/771751563888979873/pdf/Disclosable-Version-of-the-ISR-Nepal-India-Electricity-Transmission-and-Trade-Project-P115767-Sequence-No-16.pdf*

[57] *The World Bank (July 2018), How Would Cross-Border Electricity Trade Stimulate Hydropower Development in South Asia? - http://documents.worldbank.org/curated/en/714401531237858109/pdf/WPS8513.pdf*

8.4 BIMSTEC Grid Interconnection Coordination Committee (BGICC)

BIMSTEC had envisaged the creation of a BIMSTEC Grid Interconnection Coordination Committee (BGICC) to actively coordinate and represent parties involved in the regional energy trade. In the first meeting of the BIMSTEC Expert Group on Energy which was held in Myanmar on 28-29 March 2019, draft Terms of Reference (TOR) of BGICC was finalized.[58] The commencement of meetings and activities of BGICC in the near future is expected to provide a forum of discussion and coordination on activities related to regional energy cooperation within BIMSTEC.

8.5 Other initiatives

There have been efforts at the level of SAARC to promote energy sector co-operation in the region. The most significant achievement of SAARC in this regard was the signing of SAARC Framework Agreement for Energy Cooperation (Electricity) by the SAARC Member States in November 2014. The Framework Agreement lays down the guiding principles for enabling cross-border trade of electricity on voluntary basis, between 'Buying and Selling Entities' of the SAARC Member States. As per the Framework Agreement, the "Member States may enable cross-border trade of electricity on voluntary basis subject to laws, rules and regulations of the respective Member States and based on bilateral/ trilateral/ mutual agreements between the concerned states".

There have also been a few activities that were undertaken by the National Association of Regulatory Utility Commissioners (NARUC). For example, in 2014, NARUC organized multiple workshops to supplement the dialogue already occurring in the region on creating an ASEAN Power Grid, by ensuring that regulators had a platform to collaborate to advance regional market development.[59]

[58] *BIMSTEC (13 June 2019), The First Meeting of the BIMSTEC Expert Group on Energy - https://bimstec.org/?event=the-first-meeting-of-the-bimstec-expert-group-on-energy*

[59] *NARUC, Southeast Asian Regulators Work to Advance Energy Security - https://www.naruc.org/international/news/southeast-asian-regulators-work-to-advance-energy-security/*

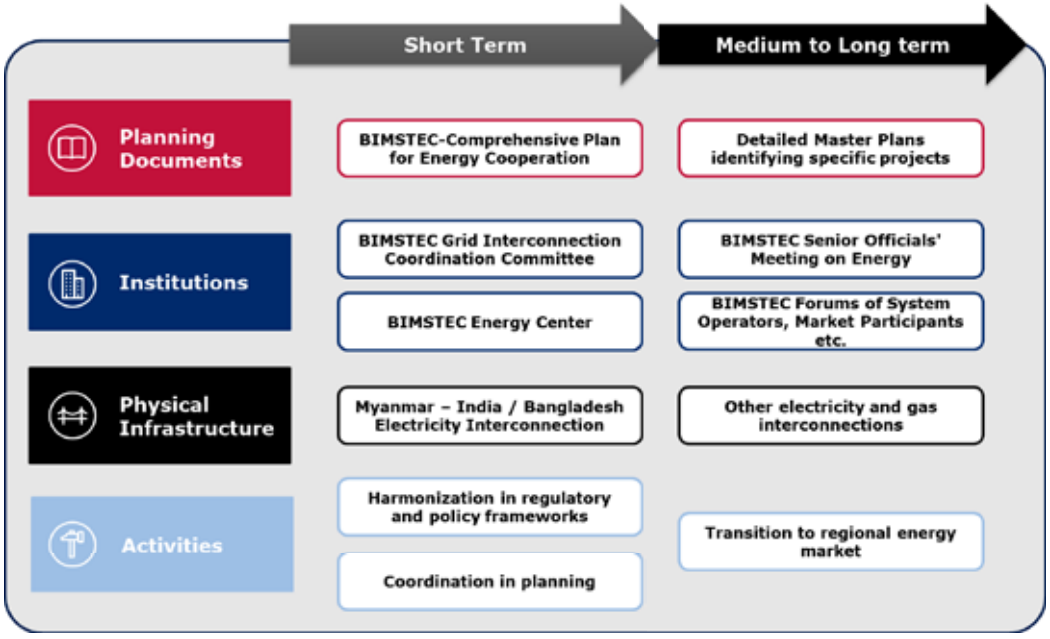
9 Strategy and Roadmap for Energy Sector Integration in BIMSTEC

International experiences in regional energy cooperation point out the following key components that have played a key role:

1. A common inter-governmental agreement for energy cooperation;
2. Coordination mechanisms / institutions at regional level; and
3. Physical infrastructure for cross border energy trade.

Considering the learnings from international experience, and characteristics of BIMSTEC, a roadmap for energy sector integration is illustrated in the following figure. This depicts the macro level, short term, medium term and long term transition of plans, institutions, infrastructure and activities in BIMSTEC for regional energy integration.

Figure 32: Roadmap for energy sector integration



Planning documents

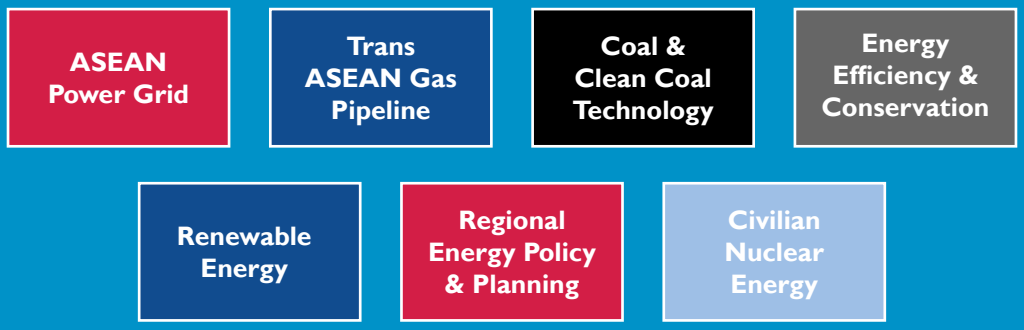
In the context of BIMSTEC, there is already a MoU for establishment of the BIMSTEC Grid Interconnection. If there is a strong governmental backing, even a MoU can form a good basis for regional cooperation. Such governmental backing comes from a political consensus across the region, which is sometimes difficult to come by. In such a scenario, it becomes important to strengthen the regional cooperation agreements with a further detailed plan.

In the context of BIMSTEC, a BIMSTEC-Comprehensive Plan for Energy Cooperation (BIMSTEC-CPEC) can be developed to augment interconnectivity and promoting regional energy trade. Such a plan could then form the basis for further detailed master plans that could identify specific projects for implementation, and modalities for implementation. Once the plan is adopted by the BIMSTEC Member States, the projects in the plan would not face significant hurdles during the implementation stage especially in terms of governmental approvals.

Example: ASEAN Plan of Action for Energy Cooperation (APAEC)

The ASEAN Plan of Action for Energy Cooperation is usually developed for a four or five year period. The current plan for 2016-2020 is the third such plan developed by ASEAN Center for Energy.

The current version of plan identified seven key strategies:



The plans lays down the key program areas, implementation arrangements, monitoring mechanisms, and phase wise implementation plan.

Source: ASEAN Center for Energy (December 2015), ASEAN Plan of Action for Energy Cooperation https://aseanenergy.org/2016-2025-asean-plan-of-action-for-energy-cooperation-apaec/

Institutions

The proposed institutional coordination mechanisms such as BIMSTEC Grid Interconnection Coordination Committee (BGICC) and BIMSTEC Energy Center (BEC) also need to be established at the earliest. This is one of the areas which has the potential to produce visible outcomes in regional cooperation. In the long term, the institutional cooperation framework can be extended to include coordination between system operators, market participants etc. The institutions will provide forums for discussion on development of physical infrastructure, and other energy cooperation initiatives.

Physical infrastructure

On the physical infrastructure, it is important to focus on linking the South Asia and South East Asia sections of BIMSTEC, through cross border energy trade infrastructure between Myanmar and Bangladesh / India. Without such a linkage, the vision of BIMSTEC energy cooperation may remain unfulfilled. A long-term strategy could also involve the use of BIMSTEC energy grids to link South Asia and the entire South East Asia.

Activities

To enhance CBET among BIMSTEC countries, there is a need to have common/coordinated set of regulations, policies and legal frameworks, which facilitate/address the mechanism of cross border interconnection, recognizes the CBET, open access to transmission network, licensing, imbalance settlement mechanism, coordinated procedures for integrated system operation, dispute resolution, etc. In the BIMSTEC countries regional context, the risks associated with forging an intraregional, CBET project would be greatly minimized if each participating country adopts complementary regulatory frameworks to facilitate cross border interconnection and electricity trade.

Once the institutional mechanisms such as BGICC are made operational, coordination in electricity and gas grids and other energy cooperation activities can be undertaken. In the long term, the aim may be the transition to a multilateral energy market, moving ahead from the current bilateral trade mechanisms.

10 Conclusions and Recommendations

BIMSTEC as a regional grouping can play an important role in channelling the country level initiatives to provide a platform for securing affordable, sustainable and reliable supply of energy/ electricity by integrating the energy resources vis-à-vis socio-economic development of the region. A recap of some of the benefits of regional energy cooperation is illustrated below.

Table 9: Benefits of energy cooperation

Access to wider range of generation resources All countries	**Access to cheaper power sources** Nepal, Bangladesh, Sri Lanka	**Potential for large-scale hydropower plants** Bhutan, Nepal
Seasonality of generation in hydropower dependent countries Bhutan, Nepal	**Foreign exchange revenue** Bhutan, Nepal, Myanmar	**Sharing of variable generation source for RE balancing** India
Difference in time zones All countries	**Utilization of surplus generation of one country in another** India	**Regional energy market development** All countries
Optimum alignment of transmission lines India, Myanmar	**Economic extension of grid** Myanmar	**Mobilization of investments at regional level** All countries

The prospects of energy cooperation includes scaling-up of cross border trade, cooperation in new energy technologies and knowledge sharing. Cross Border Energy Trade requires a high-level political commitment, large investment in infrastructure, addressing institutional barriers, the development and harmonisation of standards and regulations etc. These will have to be achieved through creating platforms at the regional level.

Table 10: Proposed platforms and institutions

BIMSTEC Grid Interconnection Coordination Committee (BGICC)	**BIMSTEC Energy Center (BEC)**	**Forums of system operators, market participants etc.**

The existing success stories in CBET, energy efficiency measures and renewable capacity additions need to be replicated across the region. To materialise these investment a conducive and cooperative political, economic and investment friendly environment is required in the BIMSTEC region.

There are certain initiatives which can be taken up for enhanced energy cooperation in BIMSTEC region, such as:

1. Strengthening of existing MoUs on energy cooperation through a separate BIMSTEC-Comprehensive Plan for Energy Cooperation (BIMSTEC-CPEC);
2. Development of detailed master plans for energy cooperation, identifying the regional level projects and implementation modalities; and
3. Commence the operations of regional coordination institutions such as BIMSTEC Grid Interconnection Coordination Committee (BGICC) and BIMSTEC Energy Center (BEC).

Once these basic aspects are implemented, the next phase of regional coordination, including the development of a seamless energy market will be easier to get adopted and implemented, as supporting policy, institutional and physical framework will already be available.

In parallel to the efforts for BIMSTEC energy grids and energy markets, the BIMSTEC Member States can also cooperate among each other on sharing of leading practices and successful strategies for implementation of energy efficiency measures, distributed generation, smart grid initiatives, fuel cell, clean coal technologies, energy storage, electric mobility and renewable energy integration. There is a need for energy technology cooperation and transfer of energy technologies among BIMSTEC countries to help each other in modernising the energy system and building futuristic climate friendly energy stem in the region. Technology cooperation on energy technologies for collective development and transfer of energy technologies among BIMSTEC will help in addressing the energy needs of BIMSTEC Member States.

11 References

Due acknowledgment is provided to all the below sources and their authors, for providing enabling inputs for this study.

Common references and sources

SARI/EI (2018), BIMSTEC Energy Outlook 2030 - https://sari-energy.org/publications-list/sari-ei-report-bimstec-energy-outlook-2030-final-design-version-14-3-2018-rajiv/

SARI/EI (2018), Regional Investment Framework and Guidelines for promoting investment in South Asian Power Sector & in Cross Border Electricity Trade Projects in South Asian Region - https://sari-energy.org/publications-list/sari-ei-report-regional-investment-framework-and-guidelines-for-promoting-investment-in-sa-region-report-low-resolution-march-9-2018-final-design/

SARI/EI (2018), Formulation of Model set of electricity regulations for implementation of the SAARC Framework Agreement for Energy (Electricity) Cooperation (SFAEC) and for advancing electricity trade in the SAARC countries - https://sari-energy.org/wp-content/uploads/2019/04/Report-Formulation-of-Model-set-of-electricity-regulations-for-implementation-of-the-SAARC-Framework-Agreement-for-Energy-Electricity-Cooperation-SFAEC.pdf

The World Bank, World Development Indicators - https://data.worldbank.org/

International Energy Agency, IEA Data - https://www.iea.org/data-and-statistics

Chapter 1

Bangladesh Bureau of Statistics, Government of Bangladesh (2019), Bangladesh Statistical Yearbook 2018 - http://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/b2db8758_8497_412c_a9ec_6bb299f8b3ab/SYB-2018.pdf

Ministry of Finance, Government of Bangladesh (2019), Bangladesh Economic Review 2019 - https://mof.portal.gov.bd/sites/default/files/files/mof.portal.gov.bd/page/f2d8fabb_29c1_423a_9d37_cdb500260002/6. Socio-Economic Indicators.pdf

National Statistics Bureau, Government of Bhutan (2019), Bhutan Statistical Year Book 2019 - http://www.nsb.gov.bt/publication/files/SYB_2019.pdf

National Statistics Bureau, Government of Bhutan (2019), Bhutan National Accounts Statistics 2019- http://www.nsb.gov.bt/publication/files/pub4dv5802vj.pdf

Ministry of Statistics and Program Implementation, Government of India (2019), India National Accounts Statistics 2019 - http://www.mospi.gov.in/sites/default/files/reports_and_publication/statistical_publication/National_Accounts/NAS19/NAS 2019.pdf

Myanmar Statistical Information Service (2019), Myanmar Statistical Year Book 2018 - https://www.mmsis.gov.mm/sub_menu/statistics/fileDb.jsp?code_code=001

Myanmar Statistical Information Service, Popular Statistics - http://www.mmsis.gov.mm/

Nepal Central Bureau of Statistics (2019), Nepal in Figures - https://cbs.gov.np/wp-content/upLoads/2019/07/Nepal-in-Figures-2019.pdf

Department of Census and Statistics, Government of Sri Lanka (2019), Sri Lanka Statistical Pocket Book 2019 - http://203.94.94.89/mainsite/Pocket Book/index.html

National Statistical Office, Thailand (2019) - Thailand Statistical Year Book 2019 - http://service.nso.go.th/nso/nsopublish/pubs/e-book/SYB-2562/files/assets/basic-html/index.html#1

The World Bank, World Development Indicators - https://data.worldbank.org/

UNCTAD, Country Reports of 2018 - https://unctad.org/en/Pages/Home.aspx

Bangladesh Power Development Board, Annual Reports - https://bpdb.gov.bd/bpdb_new/index.php/site/new_annual_reports

Bangladesh Ministry of Finance (2019), Bangladesh Economic Review 2019 - https://mof.portal.gov.bd/sites/default/files/files/mof.portal.gov.bd/page/f2d8fabb_29c1_423a_9d37_cdb500260002/Ch-02%20%28English-2019%29.pdf

BP Statistical Review of World Energy, 2019 - https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2019-full-report.pdf

Petro Bangla (February 2018), Gas Sector Master Plan 2017 - https://mpemr.gov.bd/assets/media/pdffiles/Bangladesh_GSMP_Final_Report.pdf

Government of Nepal, Coal resources and their status in Nepal - https://www.saarcenergy.org/wp-content/uploads/2018/05/Coal%20Resources%20and%20Their%20Status%20in%20Nepal,%20BASKOTA,%20Shiv%20Kumar,%20Nepal%20.pdf

Planning and Statistic Branch, Minister's Office, Ministry of Electricity and Energy, Myanmar, Role of Hydropower - https://myanmar.gov.mm/documents/20143/0/role_of_hydropowe_Paper_%2811-1-18%292.pdf/ed427517-34a0-fce5-fb24-bab8b077e5db

Office of Investment Board of Nepal (March 2017), Energy Sector Profile - https://www.ibn.gov.np/uploads/files/Sector/Energy%20Sector.pdf

Ceylon Electricity Board, Long Term Generation Expansion Plan - https://www.ceb.lk/front_img/img_reports/1532407706CEB_LONG_TERM_GENERATION_EXPANSION_PLAN_2018-2037.pdf

Energy Policy and Planning Office, Thailand Energy and Natural Resources - http://www.eppo.go.th/images/policy/PDF/docs/Thailand_Energy_Brief.pdf

Power Division, Government of Bangladesh (Sep 2016), Power System Master Plan 2016 Summary - https://powerdivision.portal.gov.bd/sites/default/files/files/powerdivision.portal.gov.bd/page/4f81bf4d_1180_4c53_b27c_8fa0eb11e2c1/(E)_FR_PSMP2016_Summary_revised.pdf

Ministry of Power, Government of India, FAQs on Hydropower - https://powermin.nic.in/en/content/faqs-hydropower

Central Electricity Authority, Government of India, Note on cooperation with Bhutan - http://www.cea.nic.in/reports/monthly/hydro/2019/bhutan-04.pdf

IRENA (Dec 2019), Renewables Readiness Assessment, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Dec/IRENA_RRA_Bhutan_2019.pdf

European Journal of Sustainable Development Research, Overview of RE sources and potential - https://www.ejosdr.com/download/an-overview-of-renewable-energy-sources-and-their-energy-potential-for-sustainable-development-in-3951.pdf

IRENA (2017), RE Outlook Thailand - https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Nov/IRENA_Outlook_Thailand_2017.pdf

Food & Agriculture Organization, United Nations (2015), Global Forest Resource Assessment - http://www.fao.org/3/a-i4808e.pdf

BPDB, Annual Report 2018 - http://www.bpdb.gov.bd/bpdb_new/resourcefile/annualreports/annualreport_1542104191_Annual_Report_2017-18_2.pdf

Nepal Electricity Authority (2019), Annual Report - https://www.nea.org.np/admin/assets/uploads/supportive_docs/annual_report_2076.pdf

Central Electricity Authority, Govt of India (March 2019), Executive Summary of Power Sector for March 2019 - http://www.cea.nic.in/reports/monthly/executivesummary/2019/exe_summary

Ceylon Electricity Board, Statistical Digest 2018 - https://www.ceb.lk/front_img/img_reports/1567487133Statistical_Digest_2018.pdf

Energy Policy and Planning Office, Thailand Energy Indicators - http://www.eppo.go.th/epposite/images/Energy-Statistics/energyinformation/Energy_Statistics/Energy_indicators/T10_02_06.xlsx

Chapter 2

Ministry of Power, Energy and Mineral Resources, Government of Bangladesh (January 2020), Bangladesh Energy Scenario 2018-19 - http://hcu.portal.gov.bd/sites/default/files/files/hcu.portal.gov.bd/publications/1eb522c0_8f5f_4f34_b133_d617b3d5c9ef/2020-01-15-11-06-d59870a995b81533dcc5d88fdf19318c.pdf

World Bank, World Development Indicators - https://data.worldbank.org/indicator/EG.IMP.CONS.ZS

Bangladesh Power Development Board (2019), Annual Report 2019 - https://www.bpdb.gov.bd/bpdb_new/resourcefile/annualreports/annualreport_1574325376_Annual_Report_2018-19.pdf

Power Division, Government of Bangladesh (Sep 2016), Power System Master Plan 2016 Summary - https://powerdivision.portal.gov.bd/sites/default/files/files/powerdivision.portal.gov.bd/page/4f81bf4d_1180_4c53_b27c_8fa0eb11e2c1/PSMP2016%20Summary%20%281%29.pdf

Ministry of Economic Affairs, Government of Bhutan, Bhutan Energy Data Directory 2015 - https://www.moea.gov.bt/wp-content/uploads/2018/07/Bhutan-Energy-Data-Directory-2015.pdf

Bhutan Electricity Authority (2019), Annual Report 2018-19 - https://www.bea.gov.bt/wp-content/uploads/2020/01/Annual-Report-2018-19.pdf

National Statistics Bureau, Government of Bhutan (October 2019), Statistical Yearbook of Bhutan 2019 - http://www.nsb.gov.bt/publication/files/SYB_2019.pdf

Bhutan Power System Operator (2020), Transmission System Performance Annual Report for 2019 - http://bpso.bpc.bt/wp-content/uploads/2020/01/Annual-Report-2019.pdf

Bhutan Power Corporation (2019), Annual Report 2018 - https://www.bpc.bt/wp-content/uploads/2019/05/BPC-Annual-Report-2018.pdf

Royal Government of Bhutan (December 2016), Economic Development Policy - https://www.moea.gov.bt/wp-content/uploads/2017/07/Economic-Development-Policy-2016.pdf

Ministry of Economic Affairs, Government of Bhutan (February 2018), Establishment of BPSCC - https://www.moea.gov.bt/?p=4153

Ministry of Statistics and Program Implementation, Government of India (2019), Energy Statistics 2019 - http://www.mospi.gov.in/sites/default/files/publication_reports/Energy%20Statistics%202019-finall.pdf

Central Electricity Authority, Government of India (January 2020), Executive Summary of Power Sector for December 2019 - http://www.cea.nic.in/reports/monthly/executivesummary/2019/exe_summary-12.pdf

Rural Electrification Corporation, Saubhagya Portal - https://saubhagya.gov.in/

Ministry of Electricity and Energy; and Economic Research Institute for ASEAN and East Asia (2019), Myanmar Energy Statistics 2019 - http://www.eria.org/uploads/media/0.ERIA-Myanmar_Energy_Statistics_2019.pdf

Government of Myanmar (December 2015), Myanmar Energy Master Plan - http://www.burmalibrary.org/docs22/2015-12-Myanmar_Energy_Master_Plan.pdf

Myanmar President's Office (14 December 2019), President U Win Myint celebrates 50% nationwide electrification in Nay Pyi Taw - https://www.president-office.gov.mm/en/?q=briefing-room/news/2019/12/14/id-9775

The Irravady (May 2019), Gov't to Buy Electricity from China to Cover Shortfall - https://www.irrawaddy.com/news/burma/govt-buy-electricity-china-cover-shortfall.html

Nepal Electricity Authority (2019), Annual Report - https://www.nea.org.np/admin/assets/uploads/supportive_docs/annual_report_2076.pdf

Sri Lanka Sustainable Energy Authority (2019), Sri Lanka Energy Balance 2017 - http://www.energy.gov.lk/images/energy-balance/energy-balance-2017.pdf

Ministry of Power, Energy and Business Development (2019), Performance for 2018 and Programme for 2019 - http://powermin.gov.lk/english/wp-content/uploads/2019/04/03.-English.pdf

Ceylon Electricity Board, Demand Management Schedule - http://colombogazette.com/wp-content/uploads/2019/03/CEB.pdf

Energy policy and planning office, Ministry of Energy, Thailand, Energy Statistics - http://www.eppo.go.th/index.php/en/en-energystatistics/electricity-statistic

Ministry of Energy, Government of Thailand (2015), Alternative Energy Development Plan 2015 - http://www.eppo.go.th/images/POLICY/ENG/AEDP2015ENG.pdf

National News Bureau of Thailand (2018), National Energy Reform Committee explains its five-year reform plan - http://thainews.prd.go.th/th/website_th/news/print_news/WNECO6101190010009

Ministry of Energy, Thailand Power Development Plan 2015 - http://www.eppo.go.th/index.php/en/policy-and-plan/en-tieb/tieb-pdp

Chapter 3

Nepal Electricity Authority, Annual Report for FY2019 - https://www.nea.org.np/admin/assets/uploads/annual_publications/Generation_2076.pdf

Bangladesh Power Development Board, Annual Report for FY2019 - https://www.bpdb.gov.bd/bpdb_new/resourcefile/annualreports/annualreport_1574325376_Annual_Report_2018-19.pdf

Myanmar President's Office (14 December 2019), President U Win Myint celebrates 50% nationwide electrification in Nay Pyi Taw - https://www.president-office.gov.mm/en/?q=briefing-room/news/2019/12/14/id-9775

Nepal Electricity Authority, Annual Reports for FY18, FY17 and FY16 - https://www.nea.org.np/annual_report

PTC India (2020), Form IV for December 2019 – https://www.ptcindia.com/wp-content/uploads/2020/01/FORM-IV-DEC19-1.pdf

NVVNL (2020), Form IV for December 2019 - http://www.nvvn.co.in/Form%20IV/NVVN_Form_IV_201912.pdf

Nepal Electricity Authority, Generation Directorate Annual Report 11th Issue - https://www.nea.org.np/admin/assets/uploads/annual_publications/Generation_2076.pdf

Central Electricity Authority, Power Supply Reports - http://www.cea.nic.in/monthlyarchive.html

Dhaka Tribune (18 April 2018), Bangladesh plans to buy 2000MW solar power from India - https://www.dhakatribune.com/bangladesh/power-energy/2018/04/18/bangladesh-plans-buy-2000mw-solar-power-india

Mint (01 March 2018), India, Russia, Bangladesh sign pact for Rooppur atomic plant - https://www.livemint.com/Industry/QD5ex7YkwRkooAmYgWPVHK/India-Russia-Bangladesh-sign-pact-for-Rooppur-atomic-plant.html

NIWE, Scaling up of Renewables (Wind and Solar) Generation, specifically for BIMSTEC countries - https://niwe.res.in/assets/Docu/BIMSTEC/BIMSTEC_Brochure.pdf

Chapter 4

Ministry of External Affairs, Govt. of India (04 October 2005), First BIMSTEC Energy Ministers' Conference - https://mea.gov.in/press-releases.htm?dtl/5330/First+BIMSTEC+Energy+Ministers+Conference

BIMSTEC, Salient Facts on BIMSTEC Energy Cooperation - https://bimstec.org/?page_id=2538

BIMSTEC, MoU for establishment of BIMSTEC Grid Interconnection - https://powermin.nic.in/sites/default/files/uploads/BIMSTEC_MoU.pdf

BIMSTEC, Fourth BIMSTEC Summit Declaration - https://mofa.gov.np/wp-content/uploads/2018/08/Fourth-BIMSTEC-Summit-Declaration-final.pdf

Economic Research Institute for ASEAN and East Asia (2013), On-the-Ground Conditions and Key Issues Relating to Rural Electrification in Myanmar - http://kwrintl.com/library/2013/Phase1-KWR-ERIA-MyanmarElectrification.pdf

Petroleum Economist, Gas Exports Up and Running - https://www.petroleum-economist.com/articles/misc/misc/2001/gas-exports-up-and-running

National Electricity Plan for Transmission of India, Power System Master Plan of Nepal and Power System Master Plan of Bangladesh

Chapter 5

Kathmandu Post (09 Feb 2020), Bangladesh issues letter of intent to purchase 500 MW from Upper Karnali hydro project - https://tkpo.st/2SrMyGq

Power Division, Government of Bangladesh (Sep 2016), Power System Master Plan 2016 Summary - https://powerdivision.portal.gov.bd/sites/default/files/files/powerdivision.portal.gov.bd/page/4f81bf4d_1180_4c53_b27c_8fa0eb11e2c1/PSMP2016%20Summary%20%281%29.pdf

Power Division, Government of Bangladesh (Nov 2018), Revisiting PSMP 2016 - https://powerdivision.portal.gov.bd/sites/default/files/files/powerdivision.portal.gov.bd/page/4f81bf4d_1180_4c53_b27c_8fa0eb11e2c1/Revisiting PSMP2016 %28full report%29_signed.pdf

Electricity Generating Authority of Thailand (2013), ASEAN Power Grid - https://www.unescap.org/sites/default/files/EGAT_ASEANPowerGrid.PDF

Central Electricity Authority, Government of India (January 2019), National Electricity Plan: Transmission - http://www.cea.nic.in/reports/others/ps/pspa2/nep_transmission.pdf

Central Electricity Authority, Government of India, Brief note on perspective transmission plan - http://www.cea.nic.in/reports/committee/scm/allindia/notices/3rd_briefnote.pdf

Ministry of Energy, Water Resources and Environment, Government of Nepal (July 2018), Transmission System Development Plan of Nepal - http://rpgcl.com/images/category/TSMPN_RPGCL_GoN.pdf

Energy Efficiency Services Limited (April 2019), Smart Grid Innovation in the Sub-region & Learnings for Bangladesh - http://events.development.asia/system/files/materials/2019/04/201904-smart-grid-innovation-sub-region-and-learnings-bangladesh-energy-efficiency-services-limited.pdf

Ministry of External Affairs, Government of India (08 June 2019), India-Maldives Joint Statement during the State Visit of Prime Minister to Maldives - https://www.mea.gov.in/bilateral-documents.htm?dtl/31418/IndiaMaldives+Joint+Statement+during+the+State+Visit+of+Prime+Minister+to+Maldives

Government of India and Government of Bangladesh (08 April 2017), Agreement on Cooperation in the Peaceful Uses of Nuclear Energy - http://www.mea.gov.in/Portal/LegalTreatiesDoc/BG17B3020.pdf

Chapter 6

Bhutan Power System Operator (2020), Transmission System Performance Annual Report for 2019 - http://bpso.bpc.bt/wp-content/uploads/2020/01/Annual-Report-2019.pdf

SARI/EI (2017), Economic benefits of Nepal-India Electricity Trade – https://sari-energy.org/wp-content/uploads/2017/06/Report-on-Economic-Benefits-from-Nepal-India_Electrcity-Trade_AS-Report_27-04-2017_LR-1-RP-.pdf

SARI/EI (2017), Economic benefits of Bangladesh-India Electricity Trade - https://sari-energy.org/wp-content/uploads/2018/09/Economic-Benefits-of-Bangladesh---India-Electricity-Trade-Full-Report-.pdf

Bangladesh Power Development Board (2019), Annual Report 2019 - https://www.bpdb.gov.bd/bpdb_new/resourcefile/annualreports/annualreport_1574325376_Annual_Report_2018-19.pdf

West Bengal Power Development Corporation (2019), Annual Report 2018 - https://wbpdcl.co.in/irj/go/km/docs/documents/PDCL/FINAL/uploads/annual-reports/WBPDCL%2033rd%20Annual%20Report.pdf

PTC India (2020), Form IV for December 2019 – https://www.ptcindia.com/wp-content/uploads/2020/01/FORM-IV-DEC19-1.pdf

NVVNL (2020), Form IV for December 2019 - http://www.nvvn.co.in/Form%20IV/NVVN_Form_IV_201912.pdf

Nepal Electricity Authority, Annual Reports for FY18, FY17 and FY16 - https://www.nea.org.np/annual_report

National Statistics Bureau, Government of Bhutan (2019), National Accounts Statistics 2019 - http://www.nsb.gov.bt/publication/files/pub9hg6641iz.pdf

Ministry of Economic Affairs, Government of Bhutan (2019), Annual Trade Statistics 2018 - https://www.moea.gov.bt/wp-content/uploads/2017/10/ANNUAL-TRADE-STATISTICS-2018.pdf

Chapter 7

European Commission (2019), Quarterly report on European Electricity Markets Volume 13 - https://ec.europa.eu/energy/sites/ener/files/quarterly_report_on_european_electricity_markets_q_3_2019.pdf

Eurostat, Electricity Generation Statistics - https://ec.europa.eu/eurostat/statistics-explained/pdfscache/9990.pdf

Asian Development Bank (2013), Assessment of GMS Subregion energy sector development - https://www.adb.org/sites/default/files/institutional-document/33872/files/assessment-gms-subregion-energy-sector-development.pdf

GMS Secretariat, GMS Statistical Database - https://www.greatermekong.org/statistics/index-static.php

Asian Development Bank (September 2012), Greater Mekong Subregion Power Trade and Interconnection - https://www.adb.org/sites/default/files/publication/29982/gms-power-trade-interconnection.pdf

GCC Interconnection Authority (2019), Annual Report 2018 - https://www.gccia.com.sa/Data/Downloads/Reports/FILE_24.pdf

Nile Basin Initiative, Powering the Nile Basin - https://www.nilebasin.org/documents-publications/53-powering-the-nile-basin-digital/file

Nile Basin Initiative, Who we are - https://www.nilebasin.org/nbi/who-we-are

South East Europe Electricity Roadmap, South East Europe Regional Report 2017 - https://rekk.hu/downloads/projects/SEERMAP_RR_SEE_A4_ONLINE.pdf

Energy Community, Who we are - https://www.energy-community.org/aboutus/whoweare.html

South African Power Pool (2019), Annual Report 2018 - http://www.sapp.co.zw/sites/default/files/30955_Sapp%20Annual%20Report%202018.pdf

Nepal Electricity Authority, Annual Report for FY2019 - https://www.nea.org.np/admin/assets/uploads/annual_publications/Generation_2076.pdf

Bangladesh Power Development Board, Annual Report for FY2019 - https://www.bpdb.gov.bd/bpdb_new/resourcefile/annualreports/annualreport_1574325376_Annual_Report_2018-19.pdf

Druk Green Power Corporation, Annual Report for 2018 - https://www.drukgreen.bt/wp-content/uploads/2019/06/Annual-Report-2018-1.pdf

ASEAN, ASEAN Power Grid- https://www.asean.org/storage/images/2015/October/outreach-document/Edited%20APG-3.pdf

ASEAN Power Grid Consultative Committee (June 2016), ASEAN Power Grid: Route to multilateral trade - https://d2oc0ihd6a5bt.cloudfront.net/wp-content/uploads/sites/837/2016/03/ADB-2015-Manila-ASEAN-POWER-GRID-WAY-to-MULTILATERAL-ENERGY-TRADE.pdf

ASEAN (23 Aug 2007), Memorandum of Understanding on the establishment of ASEAN Power Grid - http://agreement.asean.org/media/download/20140119102307.pdf

Chapter 8

SARI/EI, SARI/EI Phase IV - https://sari-energy.org/about-sariei/sariei-phase-iv/

SARI/EI (March 2019), Brochure - https://sari-energy.org/wp-content/uploads/2019/10/SARI-EI-Brochure-v4-26032019-1.pdf

Asian Development Bank, Projects - https://www.adb.org/projects/country/reg/sector/energy-1059?page=2

The World Bank (July 2019), Nepal-India Electricity Transmission and Trade Project (P115767) ISR - http://documents.worldbank.org/curated/en/771751563888979873/pdf/Disclosable-Version-of-the-ISR-Nepal-India-Electricity-Transmission-and-Trade-Project-P115767-Sequence-No-16.pdf

The World Bank (July 2018), How Would Cross-Border Electricity Trade Stimulate Hydropower Development in South Asia? - http://documents.worldbank.org/curated/en/714401531237858109/pdf/WPS8513.pdf

BIMSTEC (13 June 2019), The First Meeting of the BIMSTEC Expert Group on Energy - https://bimstec.org/?event=the-first-meeting-of-the-bimstec-expert-group-on-energy

NARUC, Southeast Asian Regulators Work to Advance Energy Security - https://www.naruc.org/international/news/southeast-asian-regulators-work-to-advance-energy-security/

Chapter 9

ASEAN Center for Energy (December 2015), ASEAN Plan of Action for Energy Cooperation https://aseanenergy.org/2016-2025-asean-plan-of-action-for-energy-cooperation-apaec/

About SARI/EI

The US Agency for International Development (USAID) initiated the South Asia Regional Initiative for Energy (SARI/E) program in the year 2000 to promote Energy Security in the South Asia region, working on three focus areas: Cross Border Energy Trade (CBET); Energy Market Formation; and Regional Clean Energy development. The program covers the eight countries in South Asia, viz. Afghanistan, Bangladesh, Bhutan, India, The Maldives, Nepal, Pakistan and Sri Lanka. The fourth and current phase of the program, called South Asia Regional Initiative for Energy Integration (SARI/EI), is aimed at advancing regional grid integration through cross border power trade. This phase is being implemented by Integrated Research and Action for Development (IRADe), leading South Asian Think Tank. SARI/EI program was recently extended to 2022 and is a key program under USAID's Asia EDGE (Enhancing Growth and Development through Energy) Initiative. In its extended phase, SARI/EI will focus on moving the region from bilateral to trilateral and multilateral power trade, and establishing the South Asia Regional Energy Market (SAREM).

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The United States Agency for International Development (USAID) is an independent government agency that provides economics, development and humanitarian assistance around the world in support of the foreign policy goals of the United States. USAID's mission is to advance broad-based economics growth, democracy, and human progress in developing countries and emerging economies. To do so, it is partnering with governments and other actors, making innovative use of science, technology, and human capital to bring the profound results to a greatest number of people.

About IRADe

IRADe, located in Delhi, is a non-profit and fully autonomous institute for advance research. IRADe's multidisciplinary research and policy analysis aid action programs. It is a hub for a network of diverse stakeholders. Established in 2002, the institute is recognized as an R&D organization by the Department of Scientific and Industrial Research and Ministry of Science and Technology of the Government of India. The Ministry of Urban Development has accorded IRADe the status of Centre of Excellence for Urban Development and Climate Change. Through the SARI/EI program, IRADe is pushing the envelope for sustainable energy access through experts and members from South Asia.

For more information, please visit the SARI/EI project website:

https://sari-energy.org/