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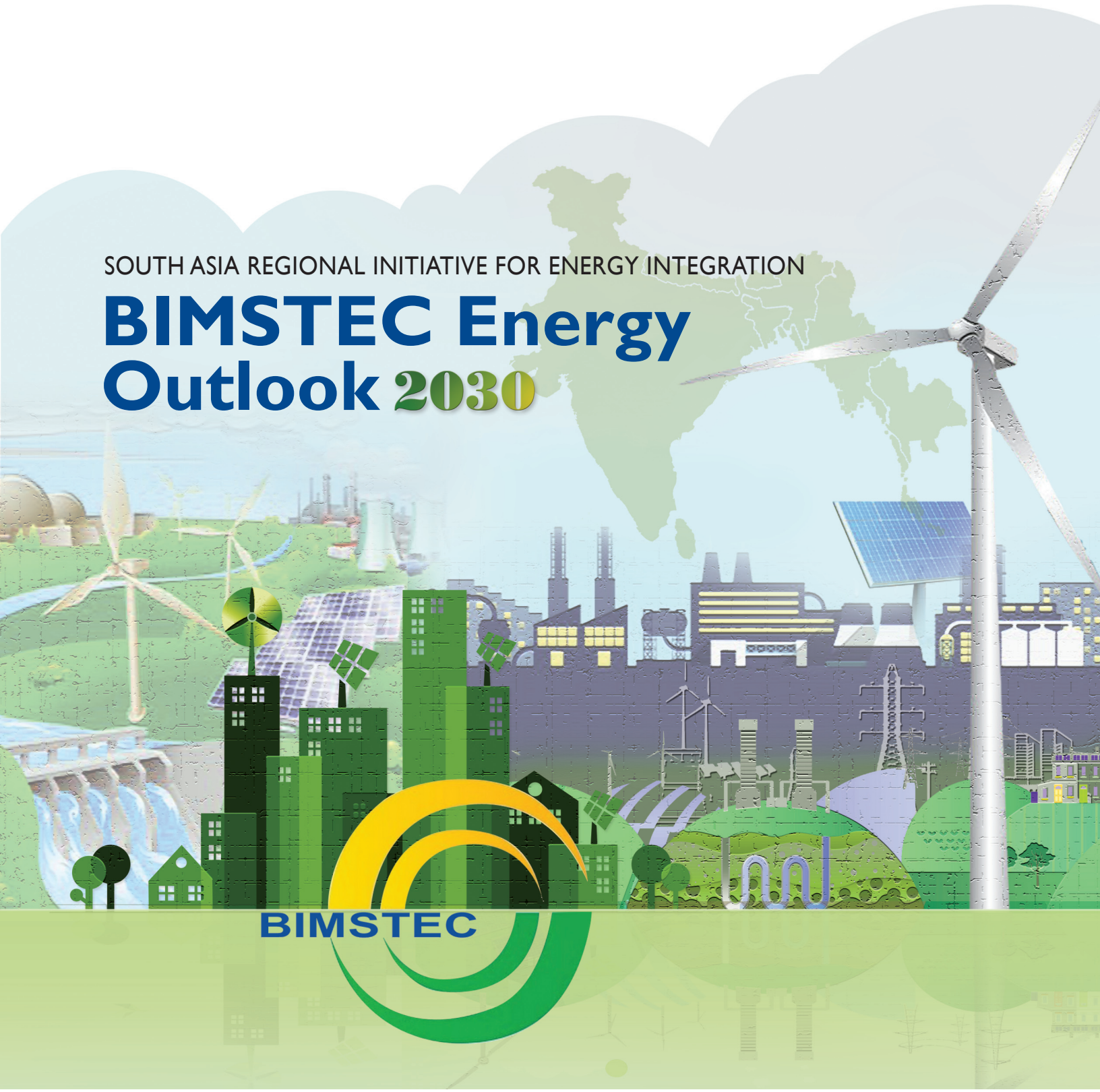
SOUTH ASIA REGIONAL INITIATIVE FOR ENERGY INTEGRATION

BIMSTEC Energy Outlook 2030



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SOUTH ASIA REGIONAL INITIATIVE FOR ENERGY INTEGRATION

BIMSTEC Energy Outlook 2030

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1. About the Study

The *BIMSTEC Energy Outlook* is a comprehensive study, which not only deals with the current energy situation in the BIMSTEC (Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation) region but also focusses on the 'Energy Sector outlook' from now until 2030. The study covers all the seven countries of the region: Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka and Thailand.

This is the first time that such a major study has been undertaken for the BIMSTEC region. The report contains substantial comparative data, detailed sectoral analyses, estimates and projections. It also traces the economic and political background of BIMSTEC in the Introduction and examines the impact of the regional integration process on the region's energy prospects. The idea of *BIMSTEC Energy Outlook* came during a meeting of a SARI/EI delegation with the Honorable Secretary General of the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation on 20 October 2016. During the meeting, it was suggested[1] that, considering energy literacy is very limited among BIMSTEC member countries, there is a need to have a report on 'BIMSTEC Energy Outlook', a biennial flagship publication, which will not only improve energy literacy among BIMSTEC member states but also bring cohesion and sustenance about the energy/electricity cooperation initiatives among BIMSTEC member states over a period of time.

The *Outlook* relies on published reports and publications on the respective BIMSTEC countries to assess the current secenario and project the overall demand and supply projections for the region up to 2030. The document covers country-level energy data, regional economic and energy analysis, sectoral analysis and the energy and investment outlook up to 2030. The energy sector analysis focusses on the region's economies, conventional and non-conventional energy sources and the key issues faced by the different countries. The report also covers comprehensively all the energy interconnections in the BIMSTEC region for oil, gas and electricity.

The respective countries' power/energy sector master plans, system planning documents, publications, annual reports of the utilities and other relevant studies available in the public domain have been used in this study to forecast the demand-supply scenarios. Investment requirements have been estimated using technology-specific capital cost estimates for each country. In order to project the scenario in 2030, the available country-wise trends have been extrapolated on the basis of actual data in certain cases, while the available forecast from country-specific master plans have been used in others. Additional analysis has been undertaken for the purpose of forecasting consumption and supply projections for countries where information is not available up to 2030. The generation capacity additions have been extrapolated based on the compounded annual growth rate for countries where the capacity generation plan was not available for the entire forecasted period. For forecasting energy demand, the projected Gross Domestic Product (GDP) at specific country levels has been used to develop forecasts till 2030. A key assumption for the projection of energy supply is that the energy portfolio remains unchanged unless there is a specific policy direction available for the country.

The *BIMSTEC Energy* Outlook also covers the energy sector institutional structure, latest developments in the energy market liberalisation process as well as the energy security considerations in the BIMSTEC region.

[1] https://sari-energy.org/wp-content/uploads/2017/03/Brief-report-on-SARI-EI-Delegation-to-Bay-of-Bengal-Initiative-for-Multi-Sectoral-Technical-and-Economic-Cooperation-BIMSTEC-Secretariat.pdf

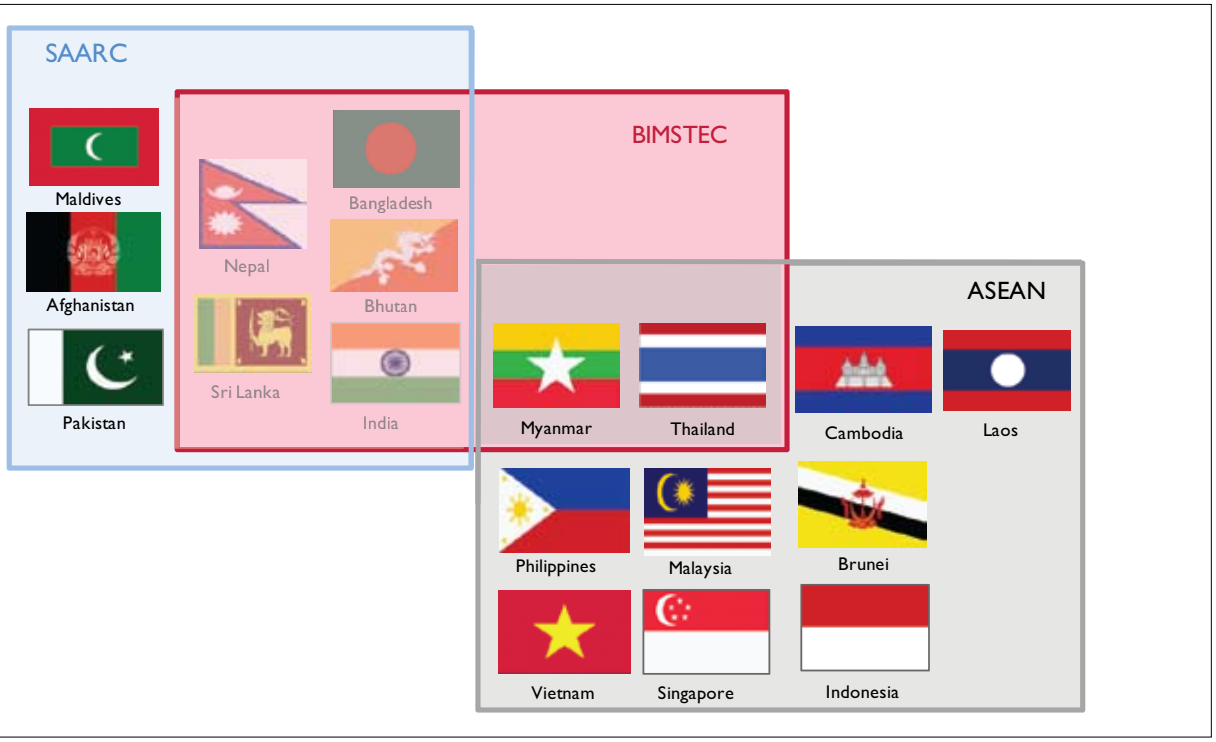
2. Introduction

2.1 Background

The Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) is a regional organisation comprising seven member states around the Bay of Bengal. It was established in June 1997 through the Bangkok Declaration. Initially, the economic bloc was formed with four member states with the acronym 'BIST-EC' (Bangladesh, India, Sri Lanka and Thailand Economic Cooperation). Following the inclusion of Myanmar on 22 December 1997 during a special Ministerial Meeting in Bangkok, the Group was renamed 'BIMST-EC' (Bangladesh, India, Myanmar, Sri Lanka and Thailand Economic Cooperation). With the admission of Nepal and Bhutan at the 6th Ministerial Meeting (February 2004, Thailand), its name was changed to the 'Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation'.

The regional group constitutes a bridge between South and Southeast Asia and represents a reinforcement of relations among these countries. BIMSTEC has also established a platform for intra-regional cooperation between the South Asian Association for Regional Cooperation (SAARC) and the Association of Southeast Asian Nations (ASEAN) members.

Figure 1 **Regional Groupings—South Asia and Southeast Asia**



2.2 Key Objectives of BIMSTEC

The objective of regional integration is to accelerate economic growth through mutual cooperation in different areas of common interests by utilising regional resources and geographical advantages. Unlike many other regional groupings, BIMSTEC is a sector-driven cooperative organisation. Starting with six sectors—trade, technology, energy, transport, tourism and fisheries—for sectoral cooperation in

late 1997, it expanded to embrace nine more sectors, which include agriculture, public health, poverty alleviation, counter-terrorism, environment, culture, people-to-people contact and climate change.

The objectives[2] of BIMSTEC, as stated in its Declaration, are to:

- Create an enabling environment for rapid economic development through the identification and implementation of specific cooperation projects in the sectors of trade, investment and industry, technology, human resource development, tourism, agriculture, energy, and infrastructure and transportation.
- Accelerate the economic growth and social progress in the sub-region through joint endeavours in a spirit of equality and partnership.
- Promote active collaboration and mutual assistance on matters of common interest in the economic, social, technical and scientific fields.
- Provide assistance to each other in the form of training and research facilities in the educational, professional and technical spheres.
- Cooperate more effectively in joint efforts that are supportive of and complementary to the national development plans of member states, which result in tangible benefits to the people in raising their living standards, including generating employment and improving the transportation and communication infrastructure.
- Maintain close and beneficial cooperation with existing international and regional organisations with similar aims and purposes.
- Cooperate in projects that can be dealt with most productively on a sub-regional basis and make the best use of available synergies among BIMSTEC member countries.

2.3 Evolution of BIMSTEC—An Energy Sector Perspective

BIMSTEC is a sub-regional grouping of seven countries in South Asia and Southeast Asia, comprising Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka and Thailand. It brings together over 1.65 billion people or 22 per cent of the world population, and a combined GDP of over US$ 3.0 trillion (2016).

As BIMSTEC is a sector-driven regional cooperation organisation, it began with identified six priority sectors of focussed cooperation, including energy; however, over time, eight more sectors were identified for cooperation.

Given the importance of energy in the economic development of the country, various initiatives were taken in the a) oil and gas sector b) power/electricity sector c) non-conventional sources of energy. To further institutionalise the energy cooperation process in BIMSTEC, the BIMSTEC Energy Centre was constituted during the first Ministerial Conference on Energy Cooperation in 2005. The centre was established to coordinate, facilitate and strengthen cooperation in the energy sector in the BIMSTEC region by promoting experience sharing, capacity building and best practices. Some of the key initiatives taken so far in the area of the a) oil and gas sector b) power/electricity sector c) non-conventional sources of energy are explained here.

[2]http://bimstec.org/home/

2.3.1. Oil and Gas Sector

BIMSTEC initiated various cooperation activities in the oil and gas sector. The Trans BIMSTEC Gas Pipeline Project was identified as one of the key projects under BIMSTEC. Thailand conducted a feasibility study for the Trans BIMSTEC Gas Pipeline Project and organised a Task Force meeting in Bangkok, Thailand, in March 2001 and a pre-feasibility study was completed in late 2004. A Task Force meeting to decide the Terms of Reference for the study on Trans BIMSTEC Gas Pipeline(s) was also held in Bangkok on 28-29 June 2006 together with a workshop on Petroleum Reserves in the BIMSTEC Region.[3] The energy security concern of key BIMSTEC countries drove the need for a BIMSTEC gas grid. The gas grid initiative lost momentum after a few setbacks due to the expectation in the growth of supply and demand for natural gas.

2.3.2. Power/Electricity Sector

BIMSTEC initiated various cooperation activities in the power/electricity sector. The BIMSTEC Trans Power Exchange and Development Project was identified. Thailand was assigned to coordinate a Task Force to initiate the projects and start preparations for the Terms of Reference for the Task Force and Memorandum of Understanding (MoU), which was to be signed among the member countries. In order to establish the BIMSTEC Trans Power Exchange and Development Project, a workshop on the Harmonisation of Grid Standards was held on 6 February 2006 in India and the MoU was drafted. In October 2006, India hosted a workshop on Sharing Experience in Developing Hydro Project, with an emphasis on remote area electrification. Thailand also hosted a regional workshop and study visit on Biomass Gasification for Power Production under BIMSTEC Cooperation from13-14 May 2008.

Between 2005 and 2016, several meetings of the Task Force for BIMSTEC Trans Power Exchange and Development were held. As highlighted earlier, one of the objectives of the Task Force was to finalise the MoU on the broad framework for the implementation of grid interconnections for promoting rational and optimal power transmission in the region. In all, five meetings of the Task Force were held and the draft MoU for the establishment of BIMSTEC Grid Interconnection was finalised on 16 March 2015.

During the BIMSTEC leaders' retreat in Goa, India, in October 2016, the leaders of BIMSTEC welcomed the growing cooperation in energy among the BIMSTEC member states and decided[4] to expedite the signing of the BIMSTEC Memorandum of Understanding on Grid Interconnection. It was also decided that steps for the early operationalisation of the BIMSTEC Energy Centre would be taken. Given the high potential of energy sources in the region, particularly renewable and clean energy sources, the BIMSTEC leaders agreed to accelerate their efforts for developing a comprehensive plan for energy cooperation with a view to augment interconnectivity and promote regional energy trade.

After due consultation among the member countries, during the fourth meeting of the BIMSTEC Senior Officials on Energy, held from 11-12 January 2017, the text of the MoU for the establishment of the BIMSTEC grid interconnection was discussed and finalised. This MoU will provide a broad framework for cooperation among stakeholders for the implementation of grid interconnections for trade in electricity. The MoU on BIMSTEC Grid Interconnection[5] proposes to facilitate the:

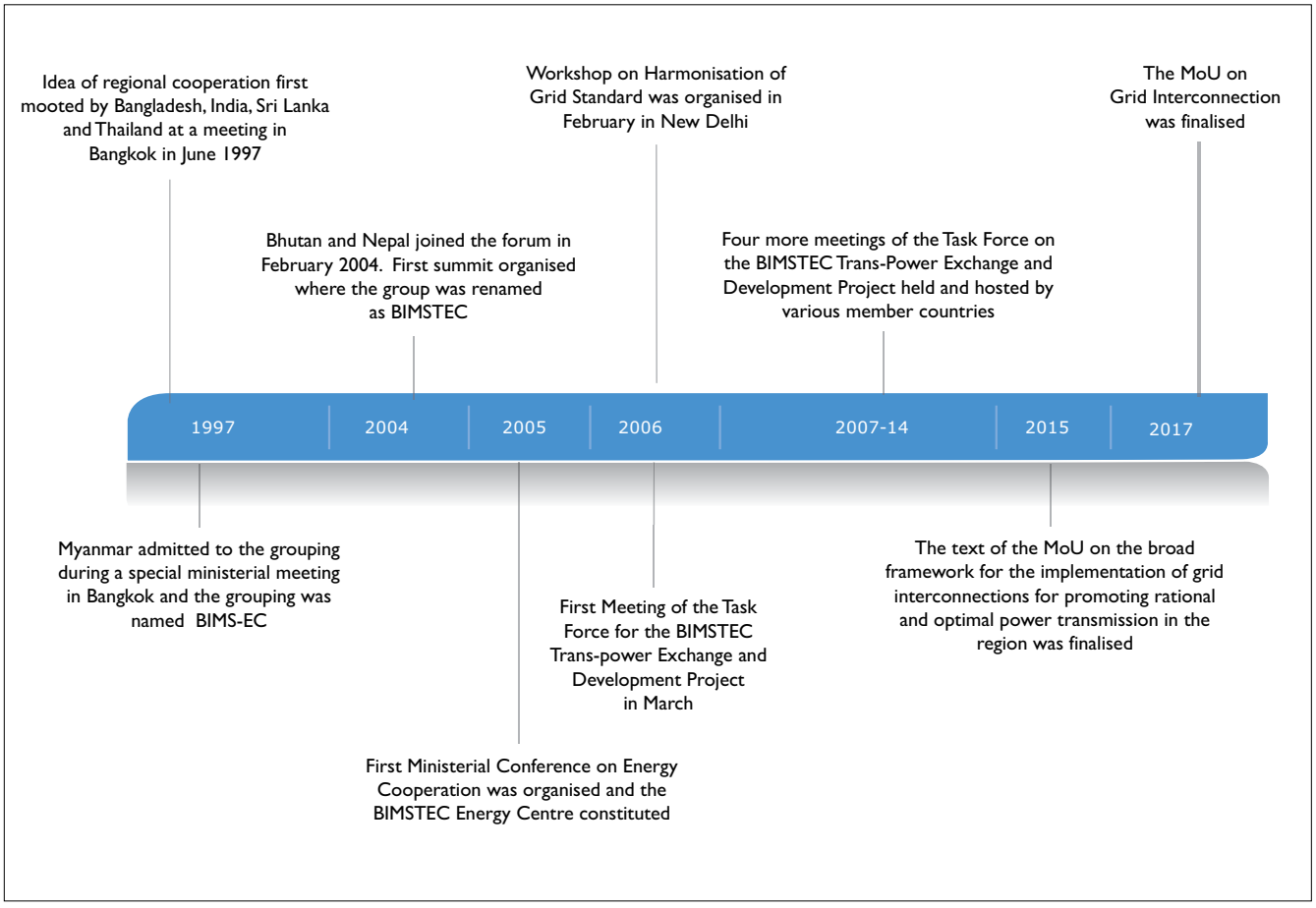
- Optimisation of using the energy resources in the region for mutual benefits on a non-discriminatory basis, subject to the laws, rules and regulations of the respective parties.

[3]http://bimstec.org/sectors/energy/
[4]BIMSTEC Leaders' Retreat 2016 Outcome Document, 16 October 2016, Goa, India
[5]http://pib.nic.in/newsite/PrintRelease.aspx?relid=160976

- Promotion of the efficient, economic and secure operation of the power system needed through the development of regional electricity networks.
- Necessity of the optimisation of capital investment for the generation of capacity addition across the region.
- Power exchange through cross-border interconnections.

The MoU is to be signed by the BIMSTEC member states and, during the 15th BIMSTEC Ministerial Meeting (11 August 2017), it was agreed to complete the internal procedures and to sign the MoU at the earliest.[6] The meeting also recognised the high potential of energy sources in the region, particularly renewable and clean energy and it was agreed to expedite the efforts to develop a comprehensive plan for energy cooperation within the region and to explore the possibilities of promoting energy trade in the region. It was also agreed to organise the third BIMSTEC Energy Ministers' Meeting in early 2018. The meeting emphasised on the early operationalisation of the BIMSTEC Energy Centre in order to strengthen energy cooperation in the region in a comprehensive manner.[7]

Figure 2 **BIMSTEC Evolution—Timeline for the Energy Sector**



[6]http://www.mea.gov.in/bilateral-documents.htm?dtl/28862/Joint+Statement+of+the+15th+BIMSTEC+Ministerial+Meeting+August+11+2017 (Joint Statement of the 15th BIMSTEC Ministerial Meeting, 11 August 2017)
[7]http://www.mea.gov.in/bilateral-documents.htm?dtl/28862/Joint+Statement+of+the+15th+BIMSTEC+Ministerial+Meeting+August+11+2017 (Joint Statement of the 15th BIMSTEC Ministerial Meeting, 11 August 2017)

2.3.3. Non-Conventional Sources of Energy

The BIMSTEC member countries have also taken some initiatives for cooperation in the area of non-conventional sources of energy. The BIMSTEC member countries have participated in various energy sector cooperation activities in accordance with the Declaration of the First BIMSTEC Energy Ministerial Meeting and Plan of Action for Energy Cooperation in BIMSTEC such as a) Development of New and Renewable Sources b) Small Hydro Project c) Rice Husk Co-generation d) Standard and Testing.[8] Thailand hosted the BIMSTEC Regional Workshop and Study Visit on Bio-Fuels Production and Utilisation in June 2012 in Bangkok.[9]

2.4 Structure and Institutional Mechanisms of BIMSTEC

The BIMSTEC Declaration provides for the following institutional mechanisms:

- Annual Ministerial Meetings, to be hosted by the member states on the basis of alphabetical rotation.
- Senior Officials Committee, to meet on a regular basis as and when required.
- BIMSTEC Working Group, the lower tier of the BIMSTEC process comprising Ambassadors/ Representatives from member states to carry on the work in between Annual Ministerial Meetings.
- Specialised Task Forces and other mechanisms as deemed necessary by the Senior Officials to be coordinated by member states, as appropriate.

BIMSTEC has been organising inter-governmental interactions through summits, ministerial meetings, senior officials' meetings and expert group meetings with the help of the BIMSTEC Working Group (BWG) based[10] in Bangkok. The country holding the Chairmanship of BIMSTEC is responsible for the conducting of regular meetings, including the BIMSTEC Summit, Ministerial Meeting, Senior Officials' Meeting and the BIMSTEC Working Group Meeting.

The institutional structure/mechanism of BIMSTEC is shown in Figure 3. After a span of 17 years of the founding of BIMSTEC as a regional organisation, its long cherished permanent secretariat was established in Dhaka, Bangladesh, on 13 September 2014 to serve the BIMSTEC member states.

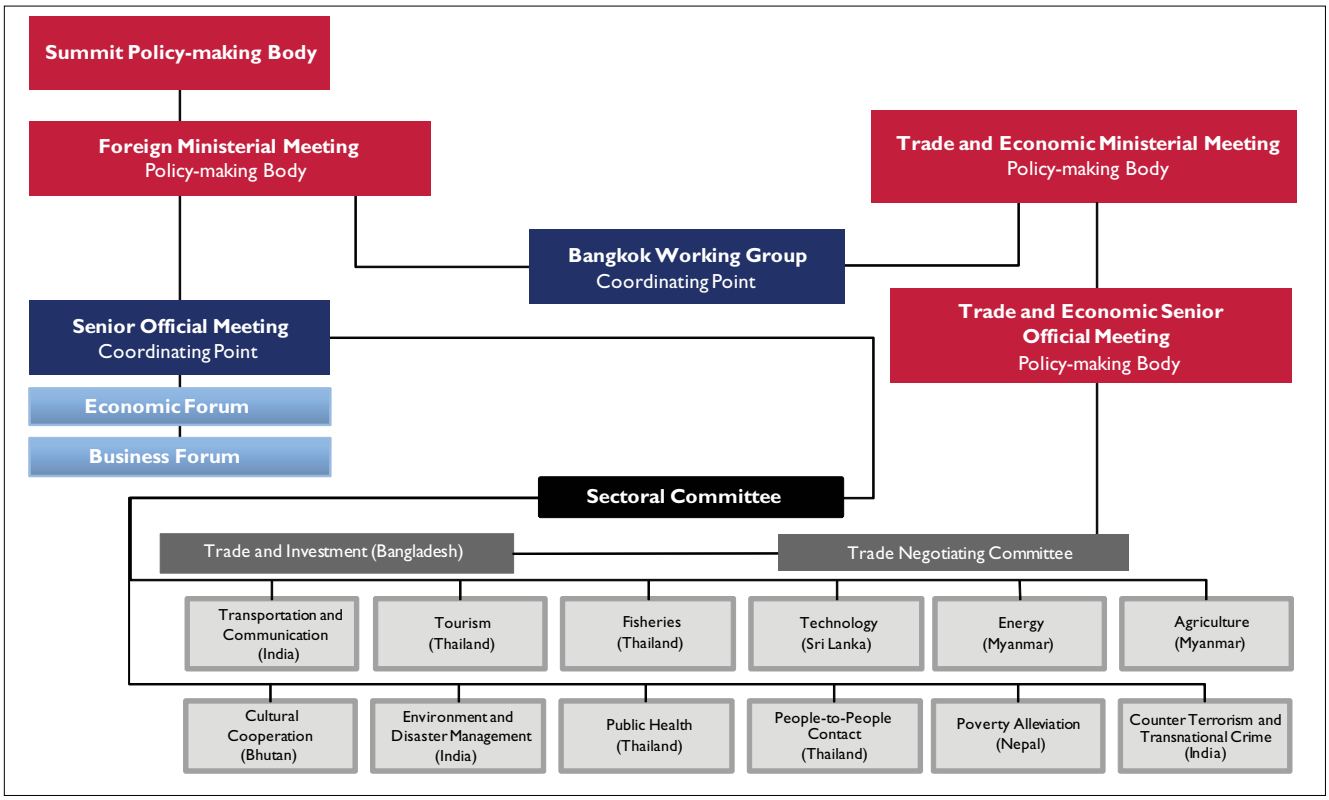
The main working mechanism of BIMSTEC is explained here.

BIMSTEC Summit: The BIMSTEC Summit is the highest policy-making body in the BIMSTEC process. As per the decision of the Sixth BIMSTEC Ministerial Meeting held in Thailand on 8 February 2004, the Summit should be held every two years, if possible. The First Summit Meeting of the Heads of the BIMSTEC Countries was held in Bangkok on 31 July 2004. The Second Summit was held on 13 November 2008 in New Delhi. The Third Summit was held in Nay Pyi Taw, Myanmar, on 4 March 2014. The BIMSTEC Chairmanship rotates among member countries (alphabetically). Myanmar is the Chair of the Group since December 2009; it took over from the previous Chair, India (August 2006-December 2009). Nepal has agreed to be the Chair after the Third Summit.

Ministerial Meetings: The Ministerial Meetings (MM) cover the area of Foreign Trade Affairs (FTA) and Trade and Economic Affairs (TEA). While the Foreign Ministerial Meeting acts as the prime mover, determining the overall policy and making recommendations for the Leaders' Summit, the Trade/

[8]http://bimstec.org/sectors/energy/
[9]https://www.mea.gov.in/Portal/ForeignRelation/BIMSTEC_Brief_February_2014.pdf
[10]https://www.mea.gov.in/Portal/ForeignRelation/BIMSTEC_Brief_February_2014.pdf

Figure 3 **BIMSTEC Institutional Structure**



Economic Ministerial Meetings (TEMM) monitor the progress in the trade and investment sector as well as the FTA policy. So far, 15 Ministerial Meetings have been organised.

Trade/Economic Ministerial Meetings (TEMM): The Trade/Economic Ministerial Meetings consist of the Trade/Economic Ministers of the member states, assisted by the Senior Trade/Economic Officials' Meeting that provides inputs to the MMs. TEMMs are mandated to follow up and accelerate the implementation of economic activities. To date, five TEMMs have taken place:

Senior Officials' Meetings (SOM): Senior Officials' Meetings are divided into the area of foreign affairs and trade and economic affairs. The ermanent secretaries of foreign affairs and trade and economic affairs are the delegations to the respective forums.

The SOM precedes the Ministerial Meeting and is represented by the Senior Officials of the Foreign Ministries of the member states at the Foreign Secretary Level. A representative from the Ministry of Commerce/Trade is also inducted into the delegation. The SOM helps the Ministerial Meeting in monitoring and providing overall direction to the BIMSTEC activities. It is, therefore, the most important policy-level organ of the BIMSTEC Grouping, reporting ultimately to the Ministerial organ. To date, 18 SOMs have taken place.

Senior Trade/Economic Officials' Meetings (STEOM): The Senior Trade/Economic Officials' Meeting is an operational body under BIMSTEC, comprising Senior Officials of the Trade/Commerce Ministry of the member states and representatives from the Ministry of Foreign Affairs. This meeting precedes the Ministerial Meeting and reports to the TEMM. To date, the Senior Trade/Economic Officials of BIMSTEC countries have met four times.

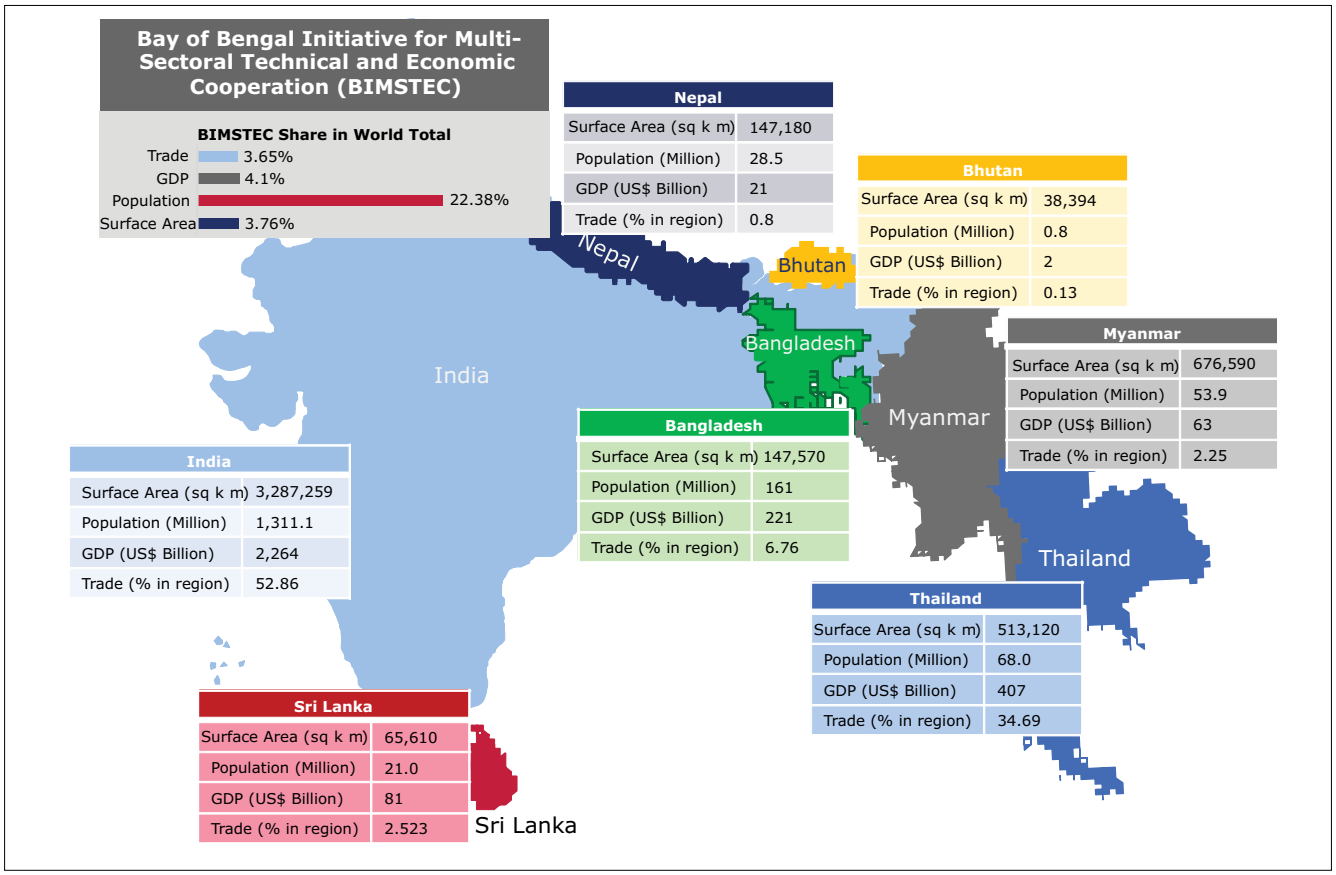
Business Forum and Economic Forum: Two forums, that is, the Business Forum and the Economic Forum under the STEOM, have been formed to allow active participation of the private sector. In the Business Forum, private sector representatives from the BIMSTEC member states meet and discuss various issues. Results from the Business Forum will be forwarded to the Economic Forum where the private sector has an opportunity to hold discussions with representatives from the public sector from member states. The Economic Forum will then reports the outcome of its meetings to the STEOM.

Expert Group Meeting: The Lead Countries of the 13 priority sectors of cooperation and 15 sub-sectors host the expert group meetings of their sectors regularly and report the result to the BIMSTEC Working Group (BWG) in Bangkok. The result is then further reported to the SOM.[11]

2.5 BIMSTEC Regional Profile

BIMSTEC creates a bridge between five South Asian and two Southeast Asian countries, establishing intra-regional collaboration between ASEAN and SAARC. The BIMSTEC region comprises 3.63 per cent of the world's land area and 1.65 billion or 22.30 per cent of the world's total population resides here. India is the largest and most dominant country in the grouping, both in terms of geography (67 per cent of the region's area) and population (approximately 80 per cent of the region's population). The brief profile of the the constituent countries in the BIMSTEC region is shown in Figure 4.

Figure 4 BIMSTEC Countries—Profile, 2016

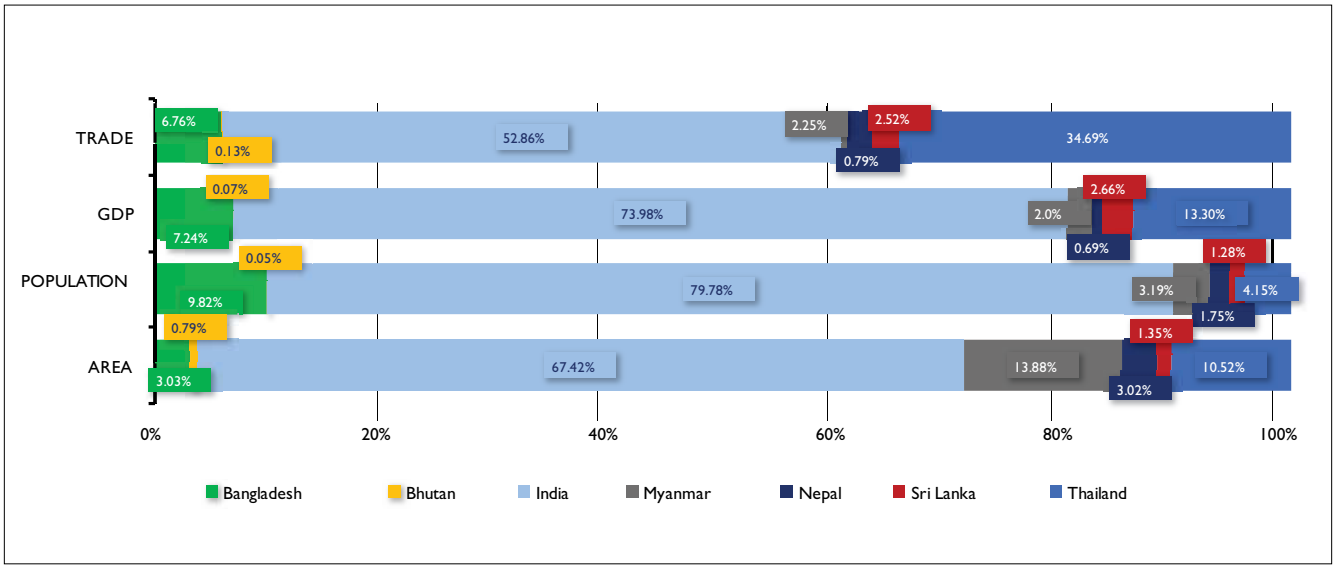


Source: World Development Indicators, 2017

[11] http://bimstec.org/bimstec-mechanism/

India is the largest constituent in terms of area, population and economy size. Thailand is the second largest in terms of GDP; Myanmar in terms of area and Bangladesh for the population in the region. Bhutan, Nepal, Sri Lanka and Myanmar contribute to less than 10 per cent of the GDP of the region, as shown in Figure 5.

Figure 5 **BIMSTEC Profile—Country-wise Break-up, 2016**



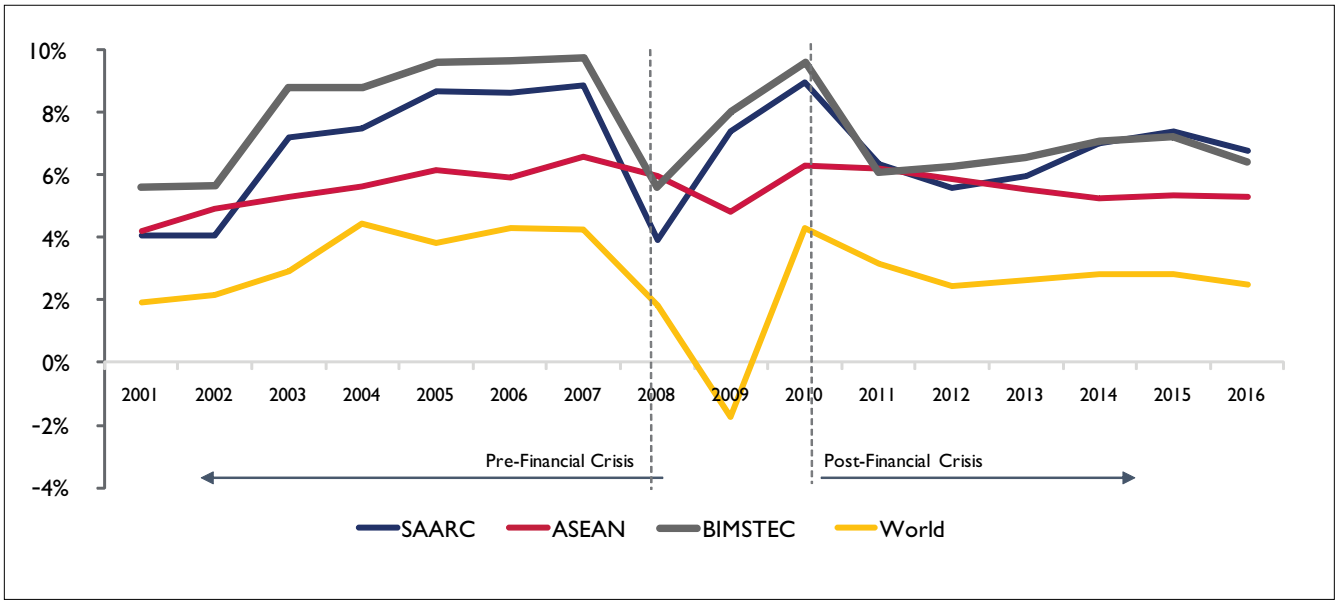
Source: World Development Indicators, 2017

3. BIMSTEC Regional Economic Scenario

3.1 Macroeconomic Overview

The BIMSTEC region has recorded a robust economic growth over the past 15 years. Its GDP growth rate has consistently been better than that reported in the ASEAN and SAARC regions. During the global financial crisis of 2007-09, most of the regions—including SAARC, ASEAN and other developed and developing countries—experienced a downturn in the economic growth. This was mostly due to the downfall of the banking sector in the developed world and the fleeting capital from the emerging economies, which caused a liquidity crunch the world over. The economic growth of the SAARC region dropped from 8 per cent before the financial crisis unfolded to under 4 per cent during the crisis. Similarly, the economic growth of the ASEAN region dropped from 6 per cent to 4 per cent. The biggest blow of the financial crisis was caused at the world GDP, which dropped from over 3.5 per cent to negative growth; that is, the world GDP shrank by almost a percentage point during the crisis. However, the economic growth in the BIMSTEC region was less affected as compared to many other regions across the globe. The economic growth in the BIMSTEC region dropped from over 8 per cent before the financial crisis to 5.5 per cent during the crisis. Some of the key reasons for the region's better performance were limited exposure to foreign investment and a lack of integration to the world capital markets, excluding a few countries. Figure 6 compares the average GDP growth rates for the SAARC, ASEAN and BIMSTEC regions before and after the global financial crisis of 2007.

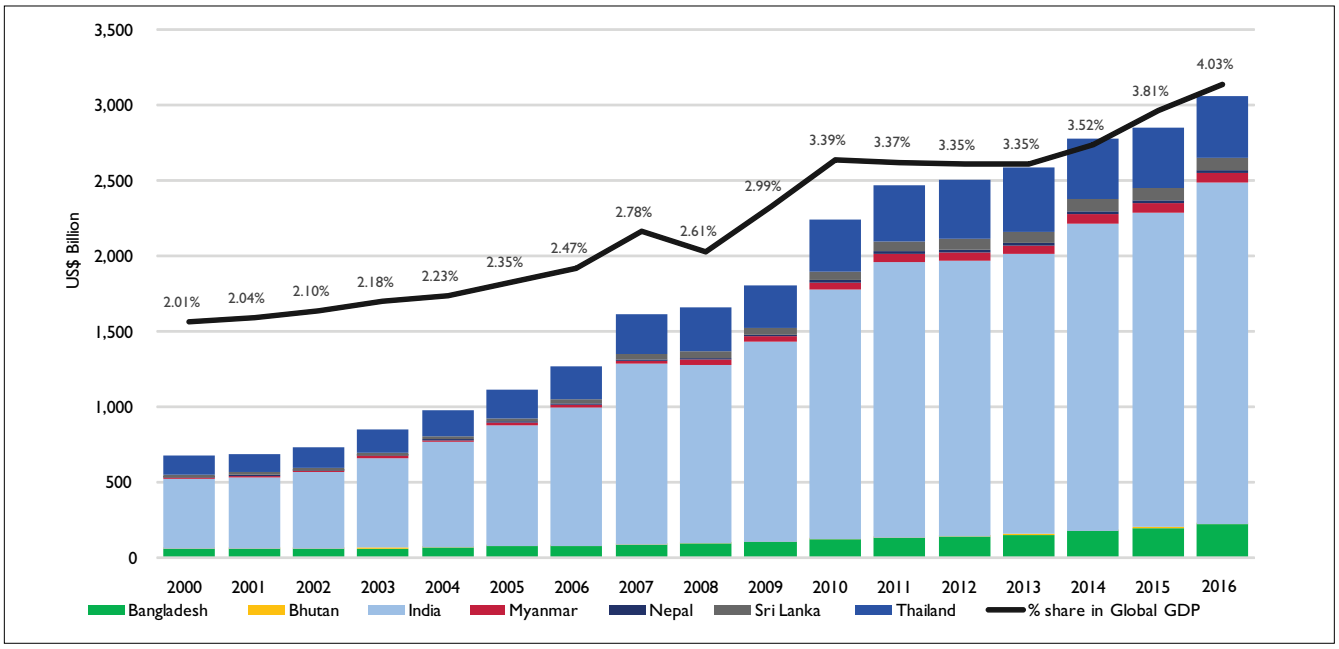
Figure 6 **GDP Growth Rate in the BIMSTEC, ASEAN and SAARC Regions**



Source: World Development Indicators, 2017

The combined GDP (in current US$) of countries in the BIMSTEC region in 2016 was US$ 3.06 trillion; this makes the grouping's contribution to the global GDP at 4.03 per cent. India is the largest economy in the region, contributing 74 per cent of the BIMSTEC region's GDP. The share of BIMSTEC's GDP to the world's GDP has consistently increased over the past 16 years. In 2001, BIMSTEC's share in global GDP was 2.04 per cent, which has doubled to 4.03 per cent in 2016, as shown in Figure 7.

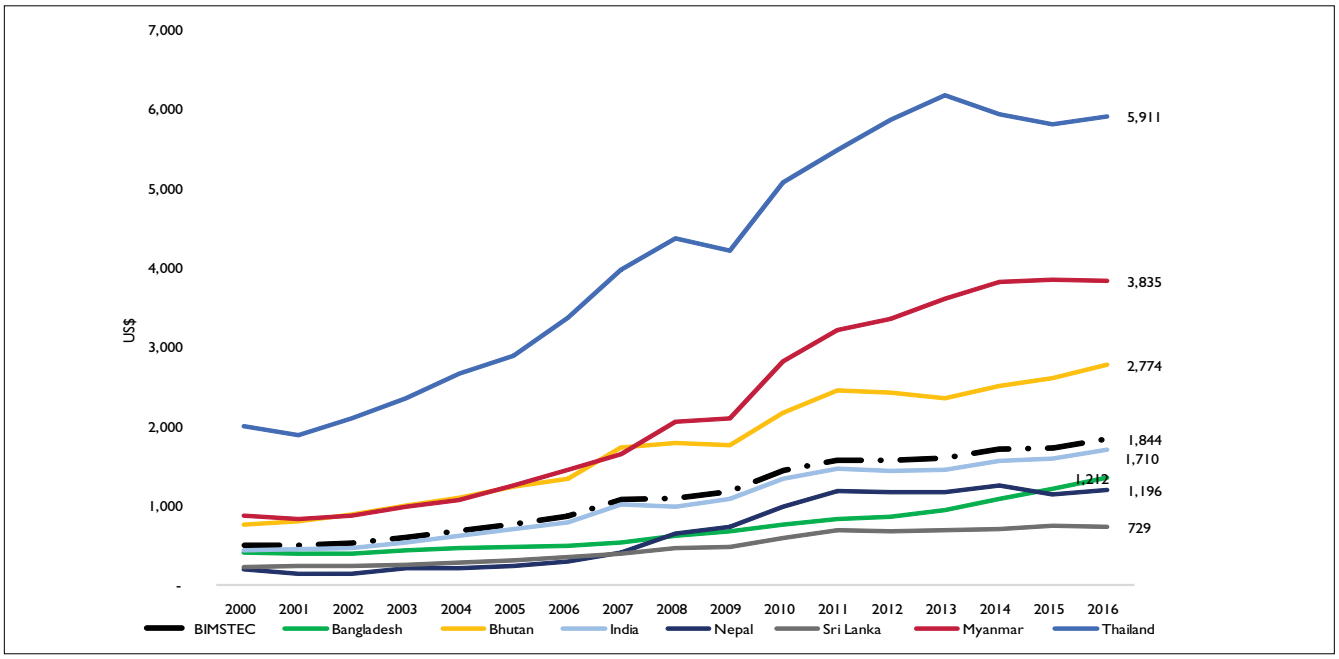
Figure 7 **BIMSTEC's GDP Growth**



Source: World Development Indicators, 2017

The per capita GDP for the region has increased from US$ 502 in 2001 to US$ 1,844 in 2016, an annualised growth rate of 9.1 per cent per annum during the period 2001-16. The growth in per capita GDP has been highest for Myanmar (around 15.4 per cent) and lowest for Nepal (around 7.4 per cent). There is a wide variance in the per capita GDP across member countries, as shown in Figure 8.

Figure 8 **Per Capita GDP in the BIMSTEC Region**



Source: World Development Indicators, 2017

During the period 2001-16, the GDP of the region grew at an annualised rate of 7.67 per cent. The 15-year and 5-year trends for the GDP are shown in Table 1.

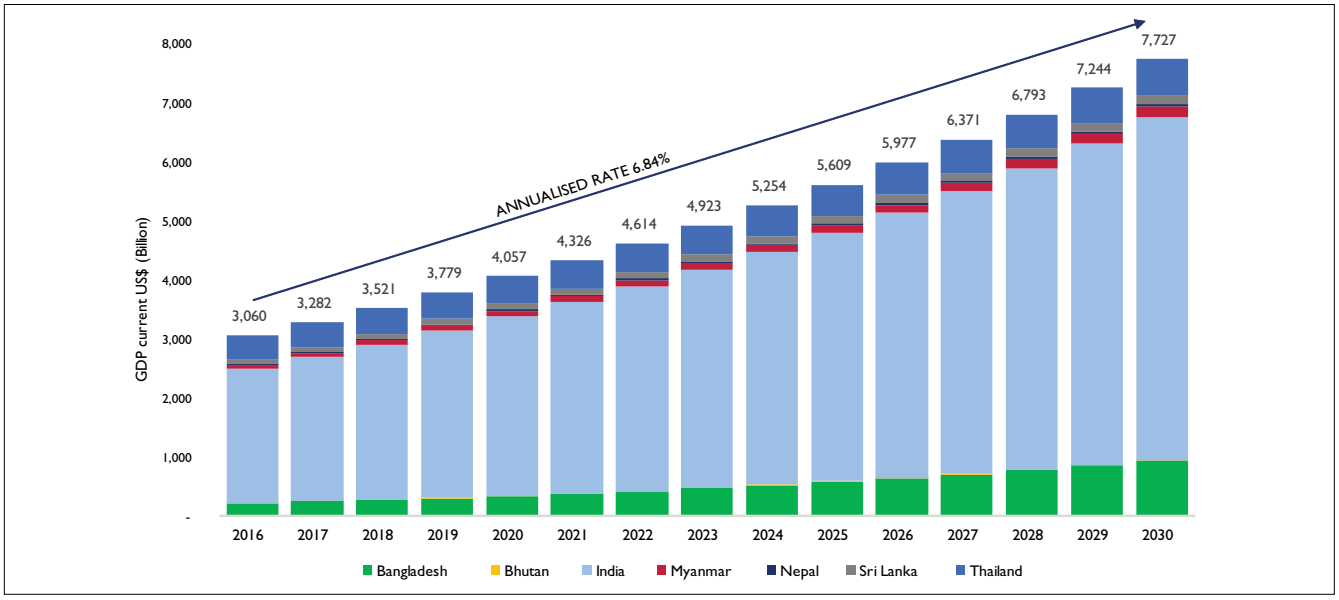
Table 1 Trends in GDP Growth

Annualised Rate (at constant LCU)	2001-16	2011-16
Bangladesh	5.96%	6.45%
Bhutan	7.60%	5.49%
India	7.43%	6.89%
Myanmar	10.01%	7.32%
Nepal	3.75%	3.71%
Sri Lanka	5.90%	5.33%
Thailand	4.01%	3.39%
BIMSTEC	**7.67%**	**6.73%**

Source: World Development Indicators, 2017

The long-term trend of the GDP growth rate achieved in the past is likely to continue going forward, given the huge economic growth potential that exists in this region. Between 2016 and 2030, the GDP of the region is likely to increase from US$ 3 trillion in 2016 to over US$ 7.7 trillion by 2030, growing at an annualised rate of 6.84 per cent. India is the largest country in the region and also holds the largest share of its GDP. Between 2016 and 2030, the share of India in the region's GDP is likely to increase from 74 per cent in 2016 to around 75 per cent by 2030. Bangladesh's GDP contribution is also expected to increase during the projected period; the country's share is expected to increase from 7.1 per cent in 2016 to over 12.2 per cent by 2030. While the share of the other countries in the region's GDP are expected to increase moderately, Thailand's contribution is likely to decrease from 13.3 per cent in 2016 to 7.9 per cent by 2030.

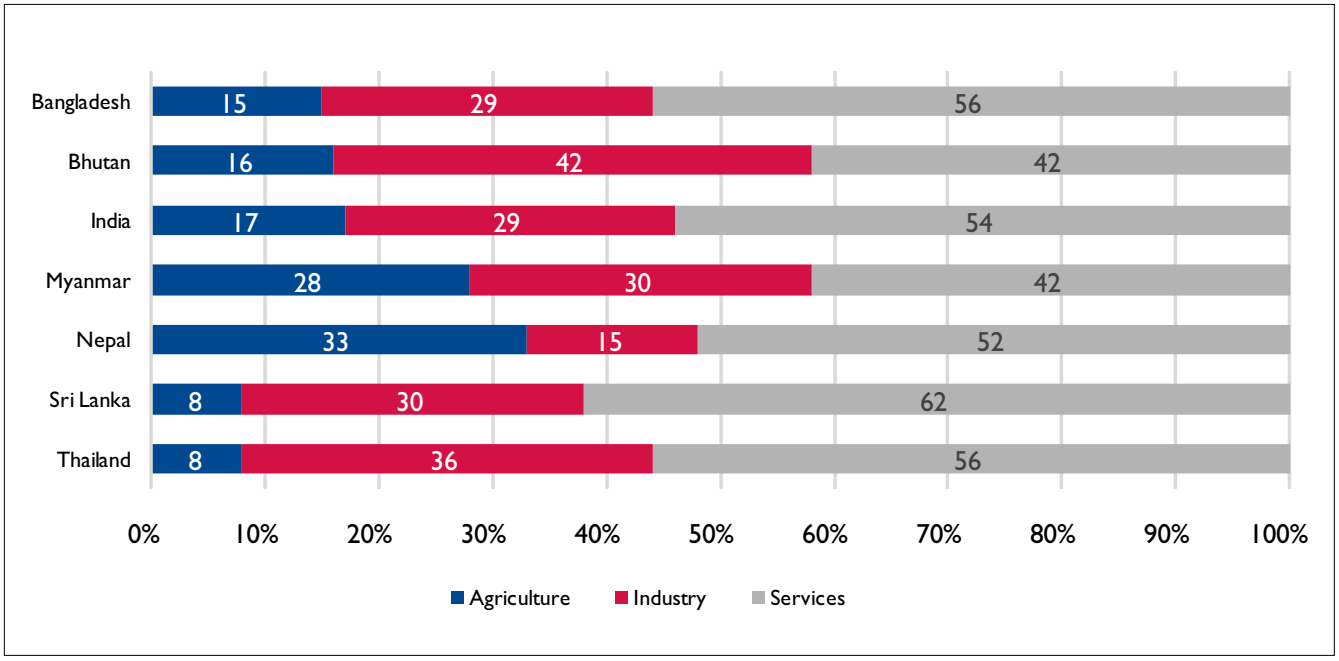
Figure 9 GDP Forecast for BIMSTEC



Source: World Bank, Country-specific Master Plans and SARI/EI Analysis

The sector-wise break up of the GDP for BIMSTEC shows that around 54 per cent of the region's GDP is contributed by the services sector, followed by industry (30 per cent) and agriculture (16 per cent). Nepal has the highest contribution from the agriculture sector in its GDP while Bhutan's economy has a higher share of industry and Sri Lanka has the highest contribution from the services sector.

Figure 10 **Sector-wise GDP Break-up**



Source: World Development Indicators, 2017

3.2 Country Indicators

The countries in the region have maintained an annual growth rate of about 6 per cent to 7 per cent on an average during the period 2011-16. In terms of the GDP growth rate, India has achieved one of the highest growth rates on account of its conducive polices, which have resulted in the better distribution of income, improved labour, an improvement in efficiency institutions and entrepreneurial growth. In terms of inflation, Myanmar, at 10.8 per cent, has recorded the highest inflation in 2016 in the region. It is followed by Nepal where the inflation was recorded at 7.9 per cent. Bangladesh and India recorded an inflation rate of 5.5 per cent and 4.9 per cent, respectively. In terms of currency exchange rate, the Thai bhat is the strongest currency and the Myanmar kyat the weakest in the region. Table 2 provides the key macroeconomic indicators for the BIMSTEC region countries.

Table 2 **Key Country-level Indicators, 2016**

Country	GDP Per Capita	GDP Growth Rate	Inflation Rate	Exchange Rate for National Currency (at average of period)	
	US$	(%)	(%)	Per US$	Local Currency
Bangladesh	1,359	7.1%	5.5%	78.47	Taka
Bhutan	2,774	8.0%	3.3%	67.20	Ngultrum
India	1,710	7.1%	4.9%	67.20	Indian Rupee
Myanmar	1,196	5.9%	10.8%	1,234.87	Kyat
Nepal	729	0.4%	7.9%	107.38	Nepali Rupee
Sri Lanka	3,835	4.4%	3.7%	145.58	SL Rupee
Thailand	5,911	3.2%	0.2%	35.30	Baht
BIMSTEC	**1,844**	**6.4%**	**N.A.**	**N.A.**	

Source: World Development Indicators, 2017

3.3 Key Trade Indicators

During 2016, the member countries together had a total merchandise export value of US$ 537.5 billion and an import value of US$ 643.3 billion. Except for Thailand, the rest of the BIMSTEC member nations have a higher volume of imports than exports. Table 3 shows the major merchandise trade trends for BIMSTEC countries.

Table 3 **Key Trade Indicators, 2016**

	Exports	Imports	Total Trade	Exports to GDP	Imports to GDP	Total Trade to GDP
	US$ Million	US$ Million	US$ Million	%	%	%
Bangladesh	34,971	44,832	79,803	15.8%	20.2%	36.0%
Bhutan	525	1,030	1,555	23.7%	46.6%	70.3%
India	264,402	359,774	624,177	11.7%	15.9%	27.6%
Myanmar	11,240	15,380	26,620	17.8%	24.3%	42.1%
Nepal	696	8,649	9,345	3.3%	40.9%	44.2%
Sri Lanka	10,310	19,400	29,710	12.7%	23.9%	36.5%
Thailand	215,418	194,185	409,603	52.9%	47.7%	100.6%
BIMSTEC	**537,562**	**643,250**	**1,180,812**	**17.6%**	**21.0%**	**42.3%**

Source: World Development Indicators, 2017

3.4 Investment Trends

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 and improved access to managerial expertise, global capital, product markets and distribution network. Table 4 compares the flow of FDI across various regions in the world. The share of FDI inflow into the BIMSTEC region is insignificant in comparison to the FDIs to the other regions of the world, particularly the developed nations. In 2016, the FDI inflow to the BIMSTEC region was US$ 51.5 billion, a decline of around 7 per cent from 2015 levels. BIMSTEC's share in global FDI inflows during the year stood at 3.0 per cent. In comparison, ASEAN's share in the global FDI inflows was 5.5 per cent. Economic instability, high inflation rate, high exchange rate risk and restrictive policies for FDI are some of the reasons attributable to the limited inflows of FDI in the region.

Table 4 FDI Inflows in Select Regional Trade Groupings

Grouping	FDI Inflows (USD Billion)	Share in World FDI (%)	FDI Inflows (USD Billion)	Share in World FDI (%)
	2015		2016	
ASEAN	121.6	6.9	96.7	5.5
BRICS	257.5	14.5	276.8	15.9
BIMSTEC	55.6	3.1	51.5	3.0
SAARC	48.6	2.7	50.3	2.9

Source: UNCTAD Country Reports 2017; UNCTAD ASEAN Report, 2017

The total FDI inflows to BIMSTEC in 2016 was US$ 51.5 billion as against the FDI outflows of US$ 18.6 billion from the region. India had the largest FDI inflows while Thailand had the highest FDI outflows. Table 5 provides FDI trends for member countries and contribution to the respective country's GDP.

Table 5 FDI Trends in BIMSTEC, 2016

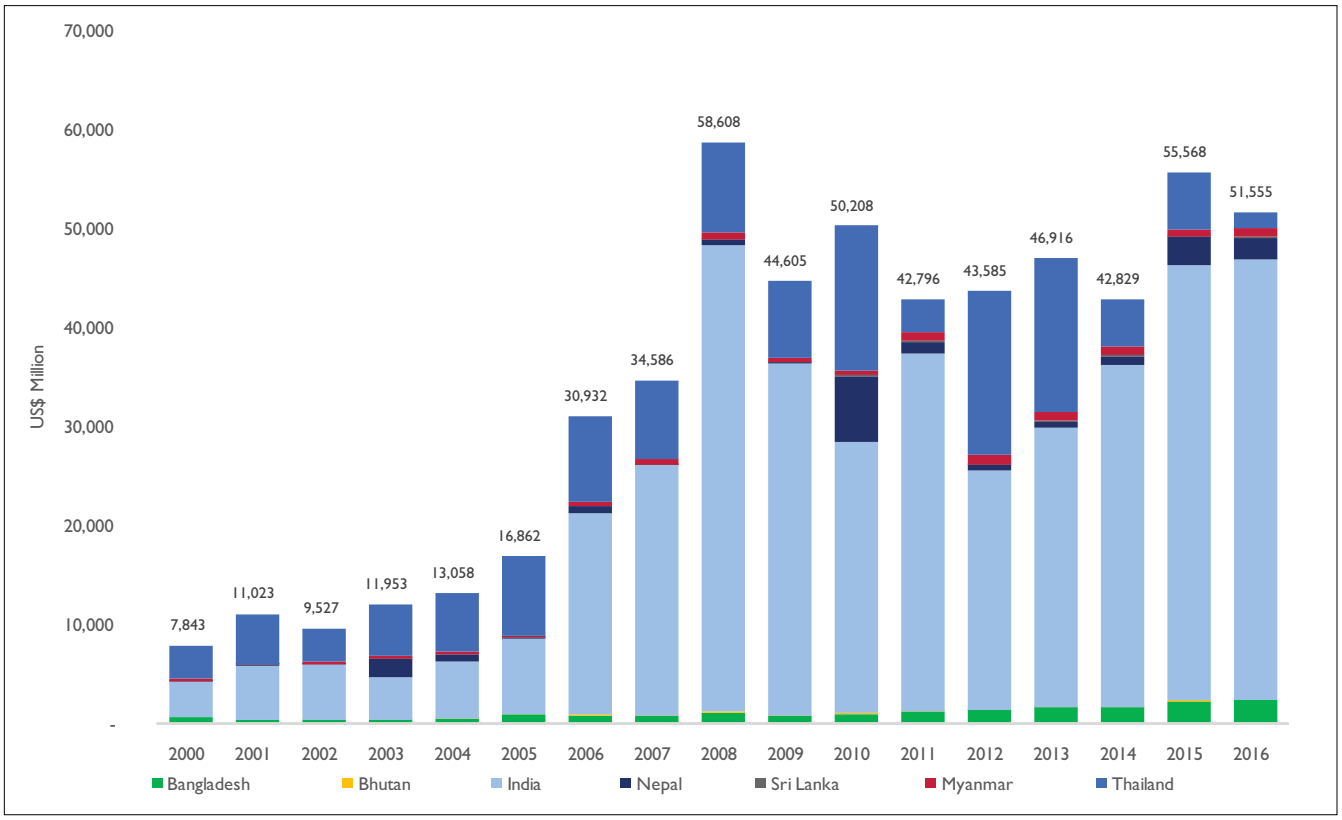
Country	Inflows	Outflows	Inflow as Proportion of the GDP	Outflow as Proportion of the GDP
	US$ Million	US$ Million	%	%
Bangladesh	2,333	41	1.05%	0.02%
Bhutan	-12	-	-0.54%	0.00%
India	44,486	5,120	1.97%	0.23%
Myanmar	2,190	-	3.46%	0.00%
Nepal	106	-	0.50%	0.00%
Sri Lanka	898	237	1.10%	0.29%
Thailand	1,554	13,229	0.38%	3.25%
BIMSTEC	**51,555**	**18,627**	**1.68%**	**0.61%**

Source: UNCTAD Country Reports, 2017

In 2001, the FDI inflows to the BIMSTEC region was about US$ 11.0 billion. Despite a decline in FDI inflows in 2016, the annualised growth during the period 2001-16 for the region has been around 10.8 per cent. In terms of the distribution, India accounted for 70.2 per cent of the total FDI inflows into the region during the period (2001-16), followed by Thailand (21.7 per cent), Myanmar (3.3 per cent), Bangladesh (2.9 per cent) and Sri Lanka (1.6 per cent).

The FDI inflows in the region have grown at an annualised rate of 3.8 per cent over the last five years (2011-16). While Bangladesh and Myanmar have attracted the maximum inflows, the inflows into Thailand and Sri Lanka have experienced a negative growth rate. The FDI trends in BIMSTEC are shown in Figure 11.

Figure 11 FDI Trends in BIMSTEC



Source: UNCTAD World Investment Reports

While the overall FDI investments have been healthy, cooperation among the member countries is of utmost importance to strengthen intra-regional investments for achieving industrial and market integration. At the same time, the countries have to strengthen their productivity and competitiveness to attract FDIs.

3.5 Intra-regional Trade and Investments

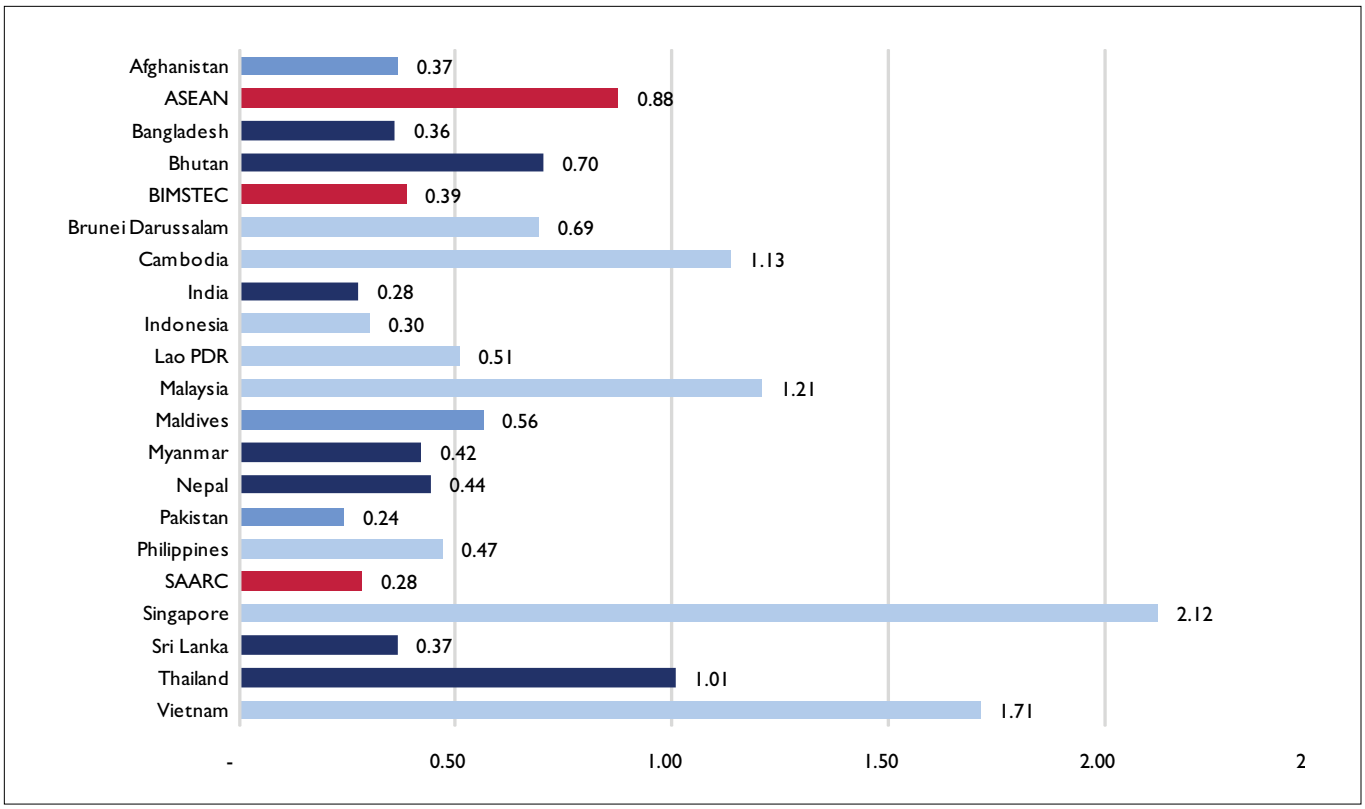
The intra-regional trade in BIMSTEC was only US$ 37 billion in 2014[12] and is significantly lower compared to many other regional blocs. In 2014, the intra-regional trade among BIMSTEC countries was 2.86 per

[12]Source: 'Prospects for Economic Integration of BIMSTEC: Trade and Investment Scenario' by Mohammad Masudur Rahman and Chanwahn Kim

cent as against 7 per cent among the SAARC countries; 7.5 per cent among the Asia-Pacific Trade Agreement (APTA) countries and 29 per cent among the ASEAN countries.

Figure 12 compares the trade dependency ratio of various countries in the South Asian and Southeast Asian countries. This ratio has been arrived at by using the aggregated value of exports, imports and GDP. A higher ratio indicates the relative importance of international trade in the economy of a country and also measures the openness of a country to international trade. As shown in the figure, the countries that form the ASEAN region have a higher trade dependency ratio than those that form the BIMSTEC region.

Figure 12 Trade Dependency Ratio



Source: World Development Indicators, 2017

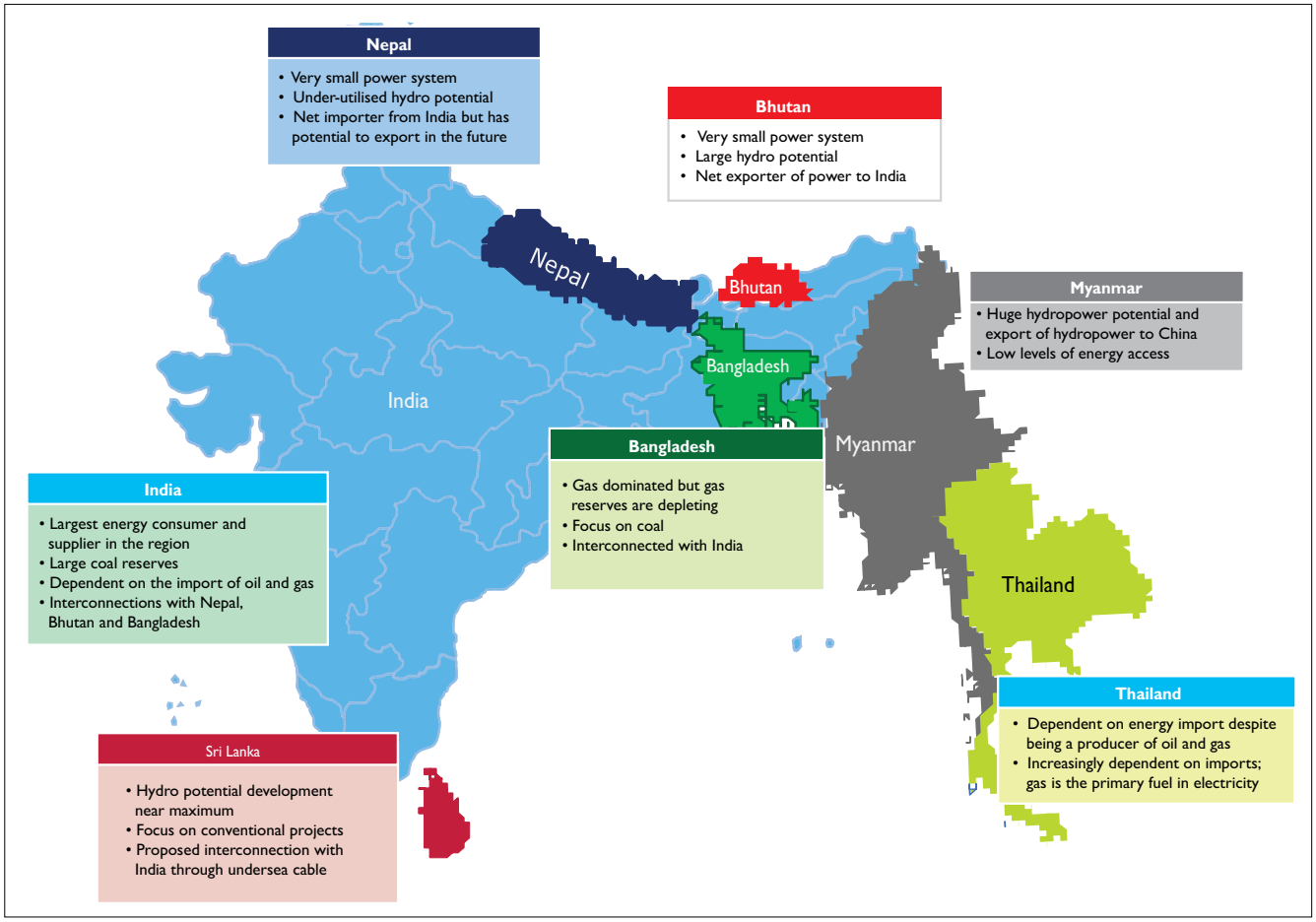
As most BIMSTEC economies are relatively smaller, there is a limitation to their ability to undertake economic activities that could exploit the substantial economies of scale. However, significant benefits can be derived by the BIMSTEC economies by adjoining and sharing the factors of production and the huge marketplace through preferential trading policies.

Investments in the trade bloc would largely depend on governance, transparency, accountability and the predictability of policies, rules and regulations relating to investments, both in the public and private sectors. In order to achieve an increased intra-regional FDI and portfolio investment flow, member countries should further reinforce macroeconomic environments, leading towards liberalising and harmonising their investment regime. Robust native fiscal structures and the deregulation of domestic monetary and capital markets are vital for drawing private investment as well as for intra-regional investment.

4. Regional Energy Profile

BIMSTEC has identified 14 priority areas where a member country takes the lead. Energy is one of these priority areas, with Myanmar leading the region. The areas of energy where BIMSTEC countries are focussing are: oil and gas, power and non-conventional sources of energy. Some of the key initiatives undertaken in the energy sector are the development of an energy trading network between members which includes the Trans BIMSTEC Gas Pipeline Project and the BIMSTEC Power Grid Interconnection Project; the setting up of the BIMSTEC Energy Centre; the expansion of regional hydrocarbon and hydropower generation; and so on. Figure 13 shows the energy profile of the BIMSTEC countries.

Figure 13 **BIMSTEC Country Profile**



4.1 Resource Potential

The BIMSTEC region is endowed with abundant natural resources comprising 65 billion tonnes of coal, 6.4 billion barrels of crude oil, 87 trillion cubic feet (TCF) of natural gas, 243 million tonnes of bio-mass and 390 GW of hydropower potential. All the countries are, however, energy deficit and depend on imports of various energy resources to meet their requirements. India is the largest country in the region with huge natural resource reserves and still, due to its scale of consumption, it also depends on imports to meet its energy requirement. Therefore, the countries in the region as a whole can mutually benefit by promoting energy/electricity trade among themselves.

Table 6 **BIMSTEC Resource Potential**

Resource	Coal (million tonnes)	Oil (million barrels)	Gas Reserves (TCF)	Bio-mass (MT)	Hydro Potential (GW)
Bangladesh	3,300	12	8	^	^
Bhutan	2	-	-	27	30
India	60,600	5,749	53	139	150
Myanmar	466	459	17	38	108
Nepal	-	-	-	27	83
Sri Lanka	-	150	-	12	2
Thailand	1,239	405	8	-	17
BIMSTEC Total	**65,607**	**6,775**	**86**	**243**	**390**

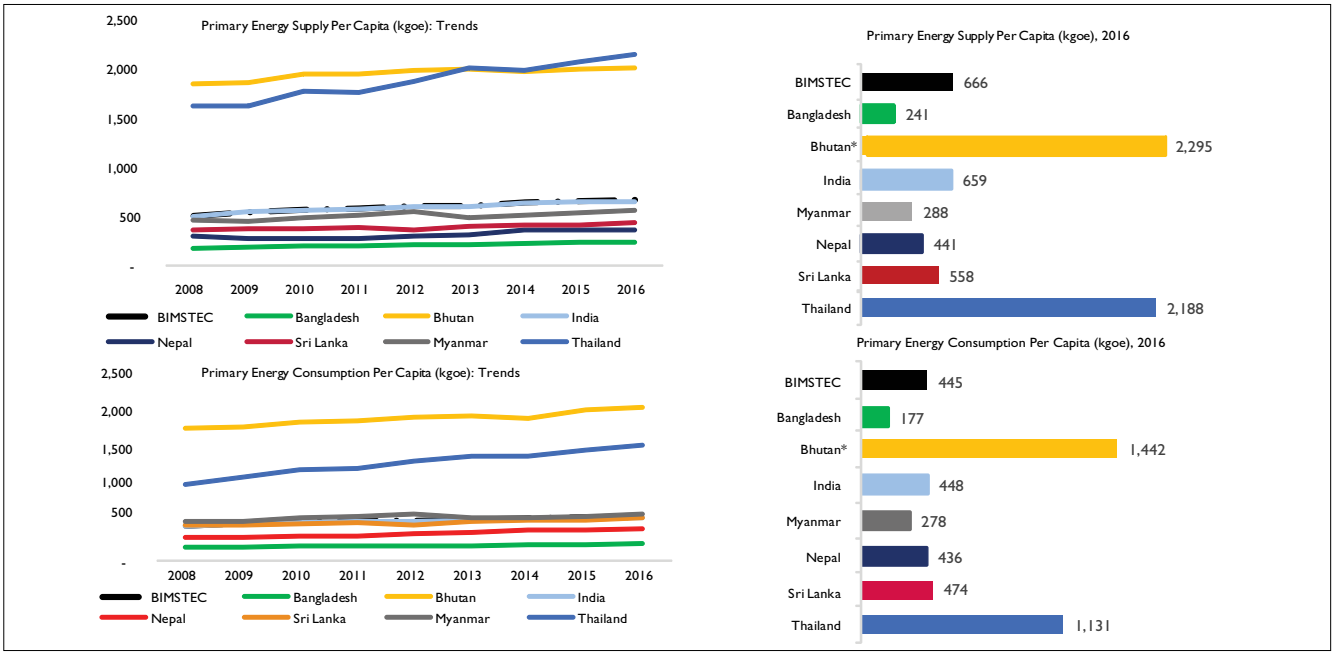
^ *Value less than 0.5*

Source: BP Statistical Review, 2016; IRADe Presentation, September 2016; Myanmar Energy Master Plan 2015

4.2 Primary Energy Supply and Consumption

The primary energy supply in the BIMSTEC region has increased continuously since 2008, the period for which information is available for all member countries. Bangladesh recorded the highest increase of 33 per cent in per capita total primary energy supply during this period. India and Thailand also recorded an increase in excess of 30 per cent during the period. On an average, the per capita primary energy supply in the BIMSTEC region marked an increase of 29.4 per cent, with an annual average growth of 3.27 per cent.

Figure 14 **Per Capita Primary Energy Supply and Consumption in the BIMSTEC Region**

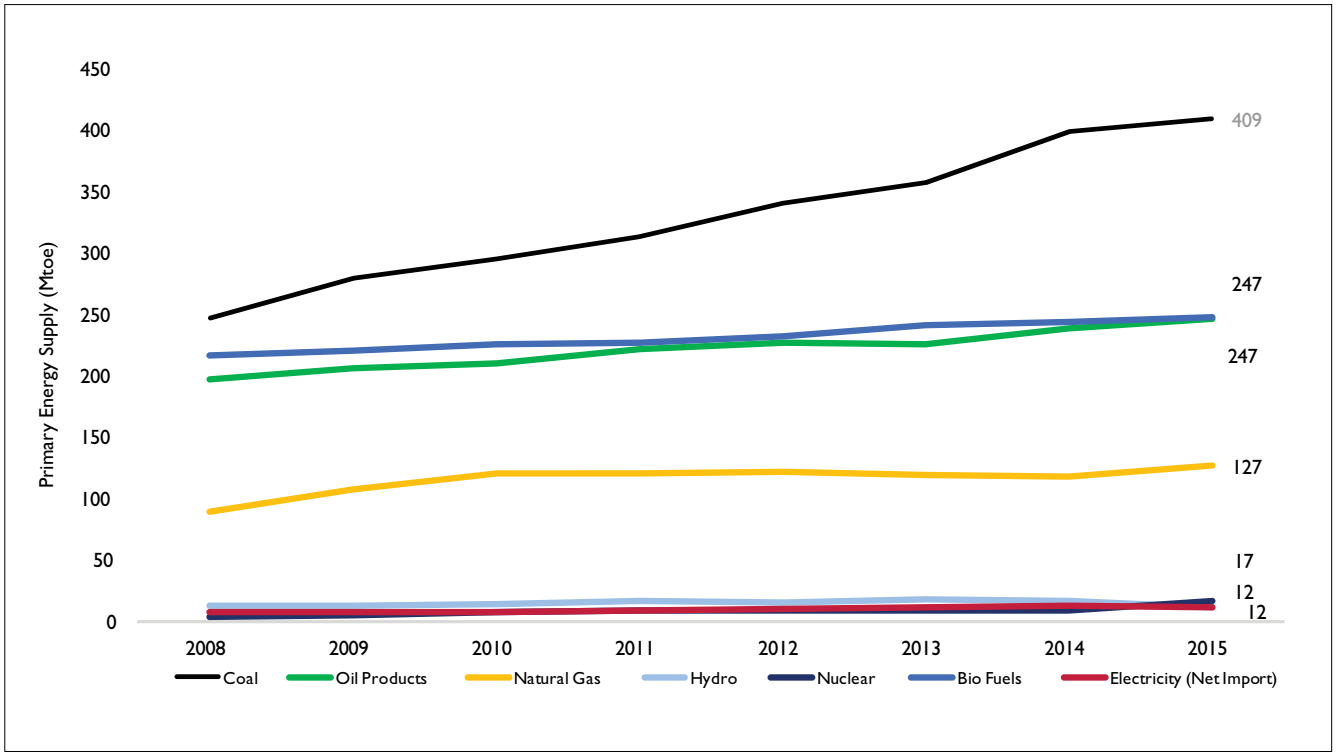


Source: International Energy Agency Statistics, 2016 and World Development Indicators, 2017;*
Bhutan (2013)—SAARC Energy Report

Note: Primary energy data for the period before 2008 is not available for all the member countries.

The fuel-wise total primary energy supply for the region is shown in Figure 15.

Figure 15 Primary Energy Supply in the BIMSTEC Region—Fuel-wise (Mtoe)



Source: IEA, 2015

Note: Primary energy data for the period before 2008 is not available for all the member countries.

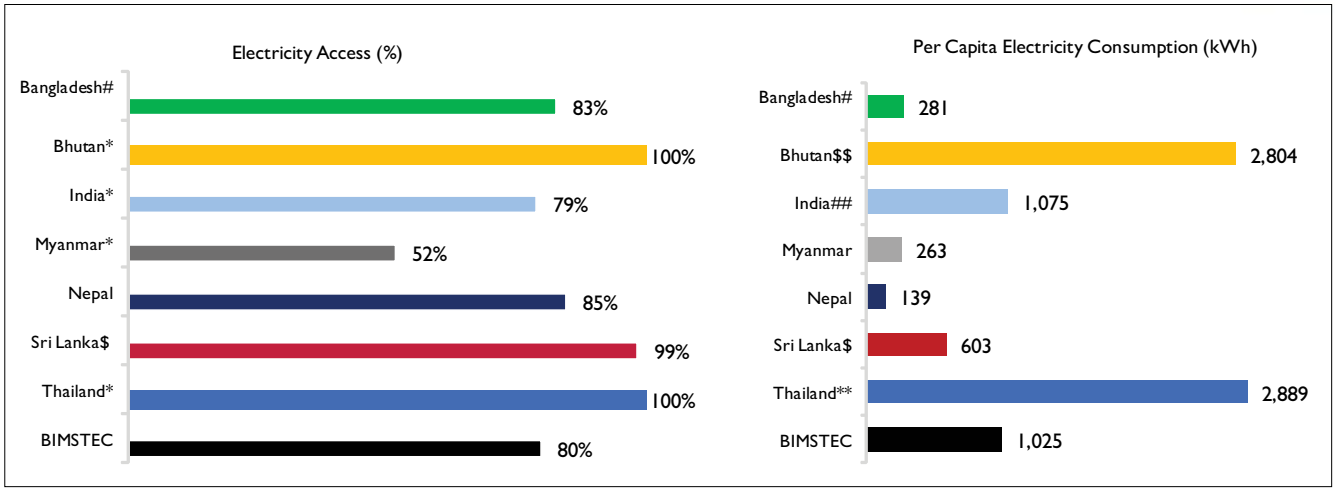
4.3 Electricity Sector

4.3.1 Energy Access

The per capita electricity consumption of the BIMSTEC region in 2016 was 1,025 kWh per person. This varies significantly from one country to another and ranges from 139 kWh for Nepal to 2,889 kWh per person for Thailand. Bhutan also has a high per capita consumption of around 2,804 kWh, due to low population density.

Myanmar has the lowest electricity access in the region with only 52 per cent of the population having access to electricity. Bhutan and Thailand have 100 per cent electrification.

Figure 16 **Energy Access and Per Capita Consumption in the BIMSTEC Region**

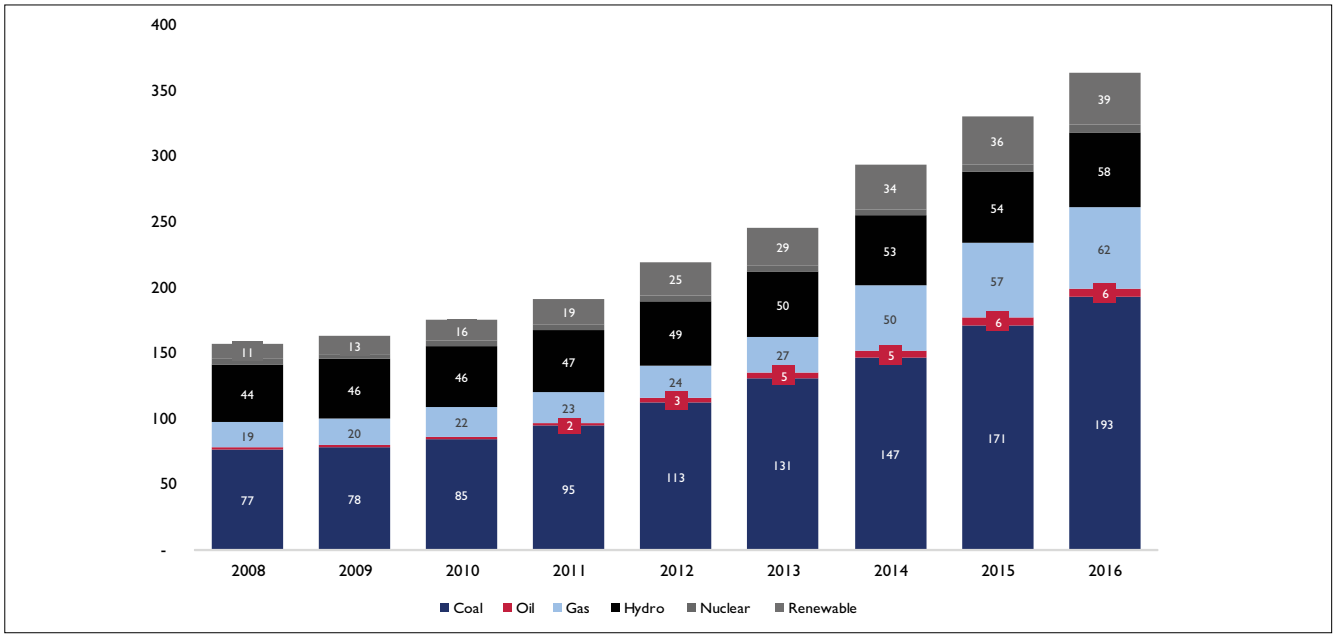


Source: * 2014, World Development Indicators; # 2016, Bangladesh Power Cell website; $ 2016, CEB Long-term Generation Plan 2018-37; ** 2016, Energy Balance of Thailand 2016; ## 2016, CEA Report 2017; $$ 2016; National Statistics Book, 2016

4.3.2 Energy Generation

The overall installed capacity in the BIMSTEC region has more than doubled since 2008. During the period 2008–16, more than 205 GW of installed capacity has been added, that is, 33 per cent more than the region's overall installed capacity in 2008. Almost 55 per cent of the incremental generation capacity has come from coal, followed by gas and renewable, which contributed 20 per cent and 17 per cent, respectively. Though the region is endowed with huge hydropower potential, it contributed only 4.8 per cent to the capacity addition programme during this period.

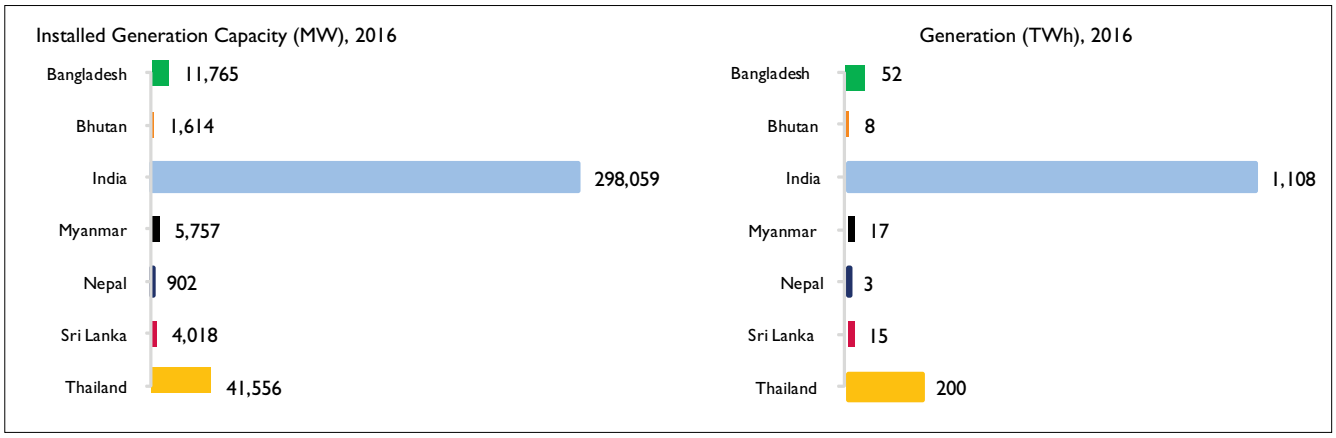
Figure 17 **Electricity Generation Mix (GW) in the BIMSTEC Region**



Source: Ministries' Websites, Annual Reports, Country-specific Master Plans; Central Statistical Organisation

The overall installed capacity in India is the highest at 298 GW, which is around 82 per cent of the entire grid size of the region, followed by Thailand (40 GW). India and Thailand together accounted for 93 per cent of the region's installed capacity in 2016. Nepal has the lowest installed capacity of 0.90 GW. In generation terms, India has the highest share with over 1,100 TWh electricity generation (79 per cent), followed by Thailand with approximately 200 TWh electricity generation (14 per cent). Owing to its low installed capacity, Nepal has the lowest electricity generation in the region.

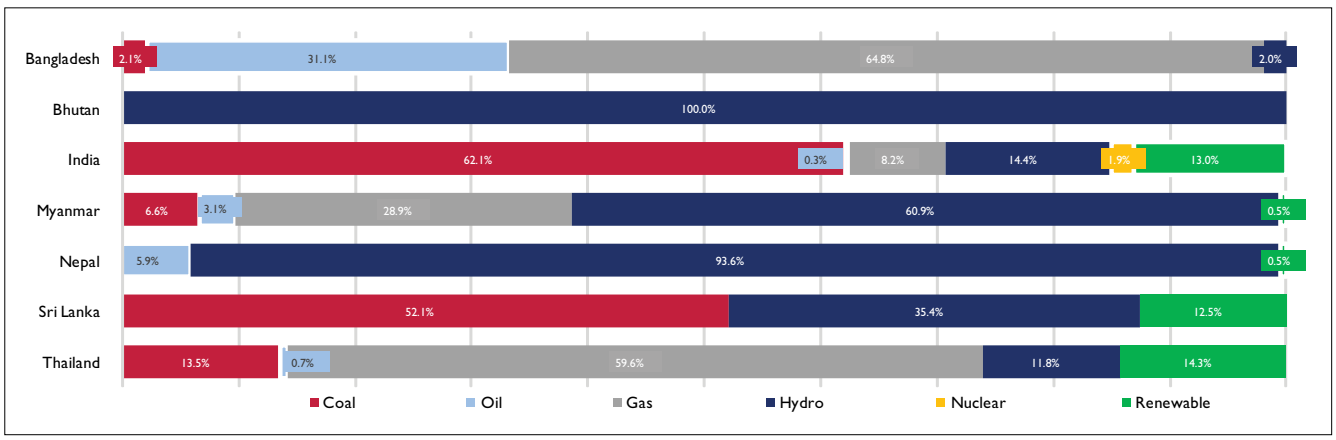
Figure 18 **Installed Generation Capacity and Supply**



Source: Ministries' Websites, Annual Reports, Country-specific Master Plans, Central Statistical Organisation

The countries in the BIMSTEC region with an electricity mix differ significantly from one another; they have been driven by the objective to optimally utilise the domestic energy resource of the country. Coal is the main source of electricity supply in India and Sri Lanka and constitutes approximately 62 per cent and 52 per cent, respectively, of the electricity mix. In comparison, gas dominates the electricity mix in Bangladesh and Thailand where the gas-based capacity constitutes approximately 65 per cent and 60 per cent, respectively, of the mix. Hydropower is the main source of electricity supply in Bhutan, Nepal and Myanmar and constitutes 100 per cent, 61 per cent and 94 per cent, respectively, of the electricity mix.

Figure 19 **Fuel-wise Break-up of Installed Capacity, 2016**



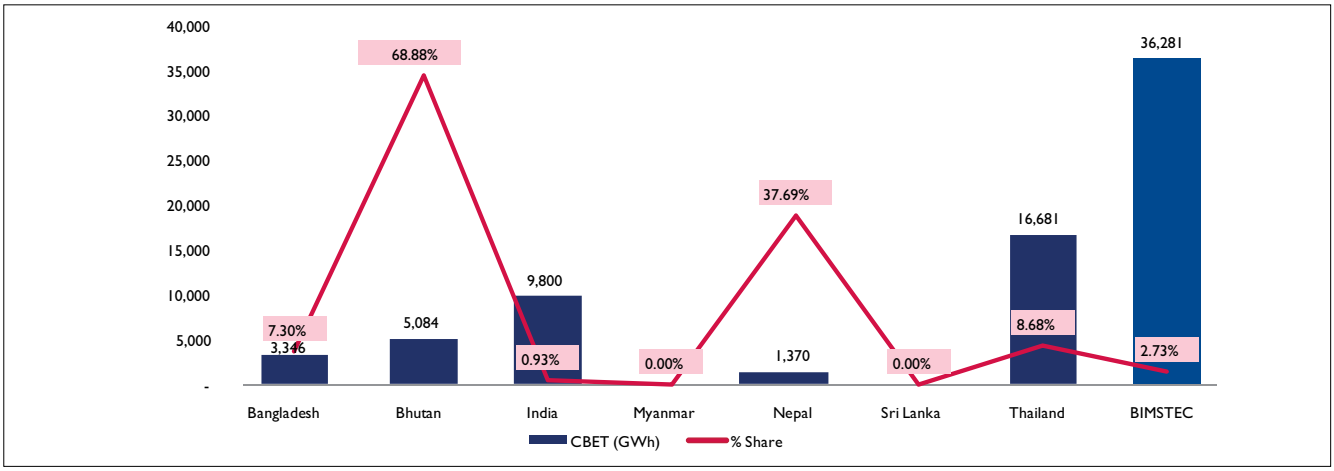
Source: Government Data, Country-specific Master Plans

4.4 Intra-regional Electricity Trade

Within BIMSTEC, Bhutan has the highest percentage of Cross-Border Electricity Trade (CBET), expressed as a percentage of the total generation. It has strong trade relationships with India in the electricity sector. Similarly, Nepal is currently dependent on India to meet its electricity demand due to lack of adequate development of its large hydropower potential. Bangladesh also imports over 7 per cent of its electricity requirement from India. CBET has also been established between India and Myanmar. Presently, India is exporting around 3 MW of electricity to Myanmar through a bilateral trade arrangement.

BIMSTEC member countries are also trading electricity with their neighbouring countries. Owing to a high domestic demand, Thailand purchases power from Laos and Malaysia. The total electricity imported by Thailand is almost 8 per cent of its generation. Sri Lanka imports fuel to meet its energy demand but, anticipating high demand projections in the future, it is also focussing on electricity trade with India.

Figure 20 **Cross-Border Electricity Trade in the BIMSTEC Region**



Source: SARI/EI Analysis

India has become a net exporter of electricity in 2016 along with Bhutan as shown in Table 7.

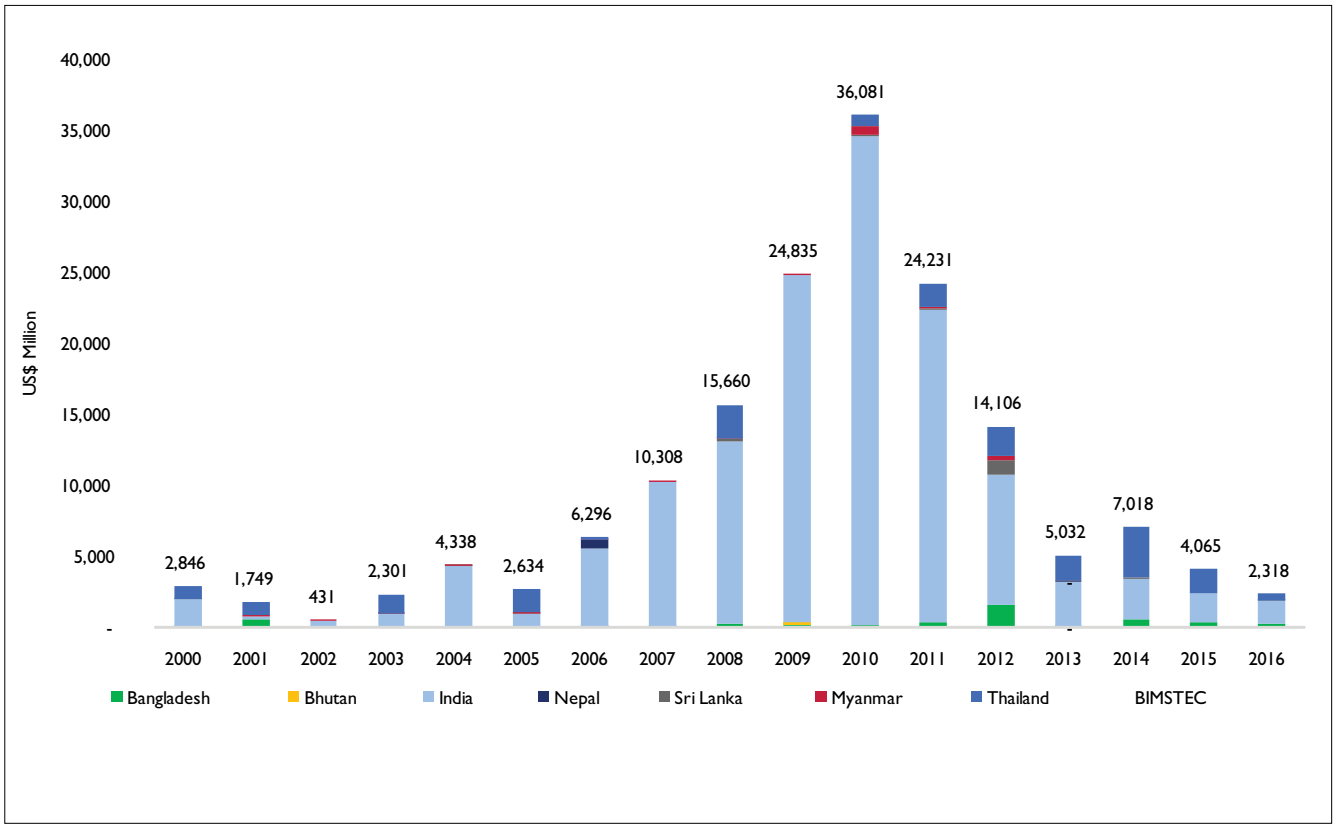
Table 7 **Export and Import of Electricity by BIMSTEC Countries, 2016**

From/To (GWh)	Bangladesh	Bhutan	India	Myanmar	Nepal	Sri Lanka	Thailand	Others	Total Export
Bangladesh		-	-	-	-	-	-	-	-
Bhutan	-		5,427	-	-	-	-	-	5,427
India	3,764	110		Not Av.	1,778	-	-	-	5,652
Myanmar	-	-	-		-	-	-	-	-
Nepal	-	-	-	-		-	-	-	-
Sri Lanka	-	-	-	-	-		-	-	-
Thailand	-	-	-	-	-	-		1,385	1,385
Others	-	-	-	-	-	-	19,825		19,825
Total Import	**3,764**	**110**	**5,427**	**-**	**1,778**	**-**	**19,825**	**1,385**	

4.5 Private Participation in the Energy Sector

Private sector participation is an important factor in analysing the policy and regulatory environment of any country with respect to investment. It shows the trust of the private players in the country's growth and certainty with respect to returns. Private participation in BIMSTEC shows a fluctuating trend on account of the changes in the global investment environment. In addition, the country-specific issues such as economic liberalisation of policies, clarity on regulatory aspects and visibility of future returns have also impacted the private sector investments in the energy sector. Post-2010, there has been a reduction in private investments due to the overall global downturn in the economy and a reduction in demand growth.

Figure 21 **Private Participation in Energy (current US$ million)**



Source: World Development Indicators, 2017

4.6 Regional Energy Cooperation

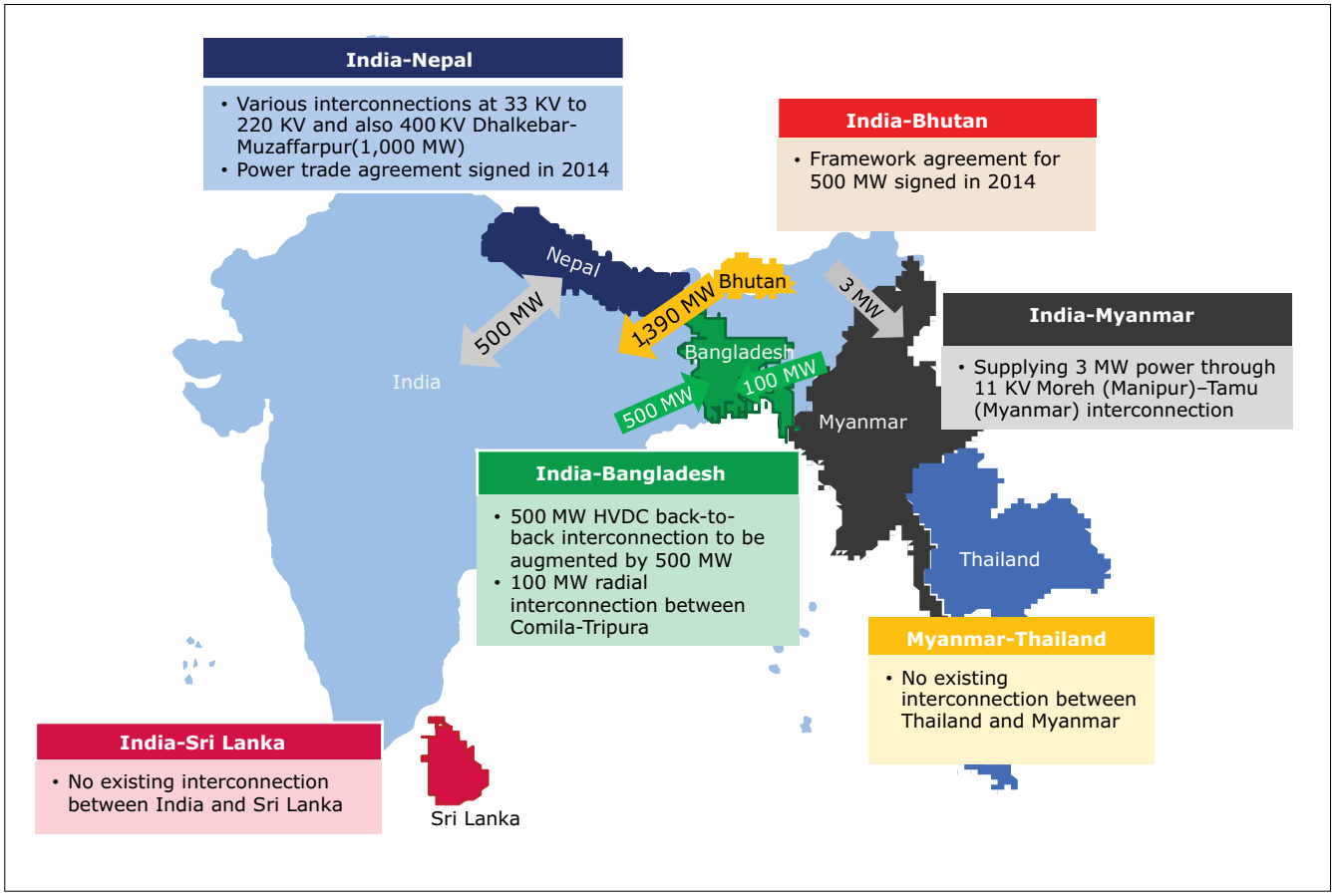
4.6.1 Electricity Trade

The bilateral electricity trade initiatives among the BIMSTEC countries have progressed well over the last decade. Cross-border power connectivity has emerged as the most significant bridge of association between the countries in the BIMSTEC region. Some of the key milestones that were achieved in the energy cooperation among the BIMSTEC nations, over the past five years, include:

- **2013:** India-Bangladesh 500 MW HVDC link commissioned.
- **2014:** India-Nepal power trade agreement signed; SAARC framework agreement on energy (electricity) cooperation signed; project development agreement for Upper Karnali and Arun signed. Three projects in Nepal to supply power to India signed with Indian developers.
- **2015:** Dagachhu Hydropower Project commissioned in Bhutan for supply to India.
- **2016:** Tripura (India)-Comilla (Bangladesh) 400 KV transmission interconnection commissioned and 100 MW power is being exported to Bangladesh; the Government of India (GoI) issued guidelines[13] for Cross-Border Trade of Electricity; MoU for cooperation in the power sector signed by India and Myanmar; India–Myanmar connectivity (3 MW) established for supply of power to Tamu from the state of Manipur (India).
- **2017:** Reliance Power, an Indian company, signed an agreement with Bangladesh for the first phase (750 MW) of the 3,000 MW power project at Meghnaghat in Bangladesh. Another Indian company (Adani Power Ltd.) concluded an agreement to supply 1,600 MW of power from its plant in Jharkhand to Bangladesh. Tripartite MoU for developing a project in Bhutan through a joint venture with a Bangladesh utility is under active consideration.
- The Central Electricity Regulatory Commission of India issued the Draft[14] Central Electricity Regulatory Commission (Cross-Border Trade of Electricity) Regulations, 2017.
- The Central Electricity Authority of India issued a) Conduct of Business Rules[15] for facilitating the process of approval by the Competent Authority under the Guidelines on Cross-Border Trade of Electricity and b) Draft Conduct of Business Rules (CBR)[16] of the Designated Authority (DA) for facilitating the Cross-Border Trade of Electricity.
- Acknowledging the advantages of sub-regional cooperation in the areas of power, water resources, trade, transit and connectivity for mutual benefit, a trilateral Memorandum of Understanding between Bangladesh, Bhutan and India for cooperation in the field of hydroelectric power had been worked out and it is expected to be signed[17] at an occasion when leaders of all three countries would be present together.

[13] http://powermin.nic.in/sites/default/files/webform/notices/Guidelines%20for%20Cross%20Boarder%20Trade.pdf
[14] http://www.cercind.gov.in/2017/draft_reg/Noti16.pdf
[15] http://www.cea.nic.in/reports/authorities/pspa2/cbte/competent/cbr.pdf
[16] http://www.cea.nic.in/reports/authorities/pspa2/cbte/designated/cbr.pdf
[17] http://www.mea.gov.in/bilateral-documents.htm?dtl/28362/India++Bangladesh+Joint+Statement+during+the+State+Visit+of+Prime+Minister+of+Bangladesh+to+India+April+8+2017 (India-Bangladesh Joint Statement during the State Visit of the Prime Minister of Bangladesh to India, 8 April 2017)

Figure 22 **Cross-border Interconnections in the BIMSTEC Region**



4.6.2 Cooperation in the Renewable Energy and Energy Efficiency Sectors

Renewable energy development in the BIMSTEC countries has been driven by the respective country's renewable energy (RE) policy. Countries such as India have been quite successful in scaling-up the renewable energy development in almost all technologies. There is a lot of scope for cooperation and collaboration in terms of knowledge transfer and leveraging.

The countries in the BIMSTEC region are collaborating on energy efficiency. Multilateral donor agencies such as GiZ have been supporting regional programmes to coordinate and increase capacity development and knowledge exchange activities in energy efficiency among India, Bangladesh and Nepal. The scheme for the replacement of incandescent bulbs with light-emitting diodes (LEDs) has been successfully implemented in India, leading to a drastic cost reduction in the procurement of LEDs. The same scheme is now proposed to be replicated in Nepal and Bangladesh through the support of implementing agencies in India.

5. BIMSTEC Country Profiles

5.1 Bangladesh

Bangladesh is located in Southeast Asia and is bordered by India in the east, west and north and by Myanmar (Burma) and the Bay of Bengal in the south. The country is spread over a total area of 147,570 square kilometres, of which approximately 13.35 percent (Monthly Statistical Bulletin, Aug-2017-Bangladesh Bureau of Statistics) is forest land. It has a total population of about 161 million people. The country was mostly considered as an agricultural economy, however, due to continuous industrialisation, the contribution of the industrial sector to the economy has improved over the years.

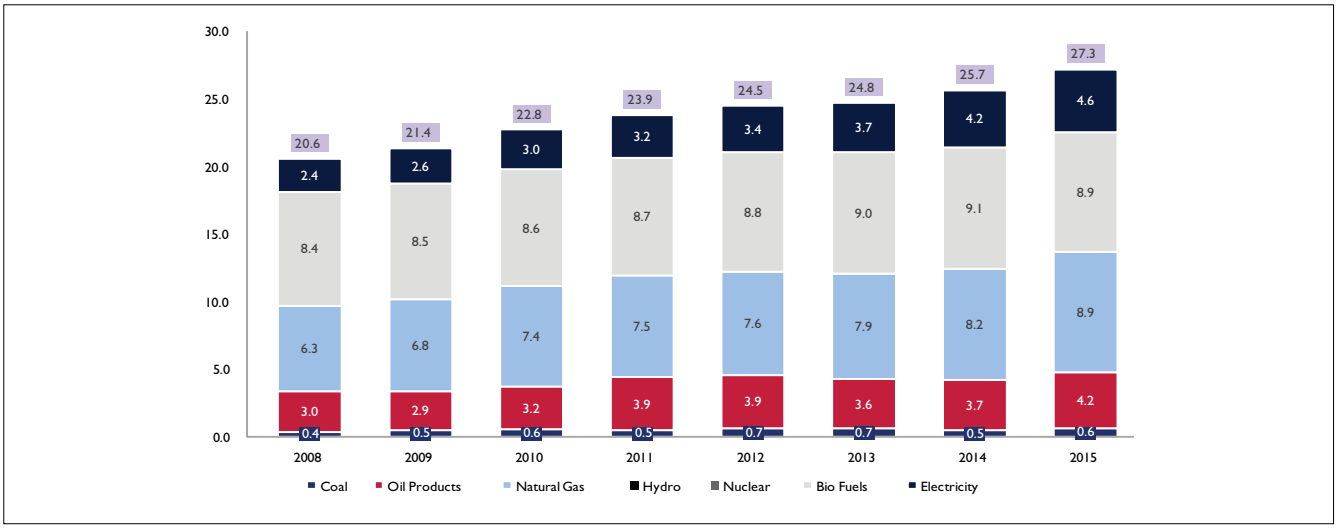
5.1.1 Primary Energy Consumption and Supply Trends

The total primary energy consumption in Bangladesh has been steadily increasing at an annualised rate of 4.3 per cent since 2008. The consumption of energy has gone up from 20.6 Mtoe in 2008 to around 27.3 Mtoe in 2015. The residential sector is the largest energy end user, consuming 51 per cent of the total energy supplied in the country, followed by the industrial sector, which accounts for 24 per cent. The transport sector uses 12 per cent and others (including agriculture/forestry and the commercial sector) account for 13 per cent of the overall consumption.

The natural gas and bio fuels contribute to more than 65 per cent of the total primary energy consumption in 2015, with each providing around 32.6 per cent. The consumption of bio-fuels has been high in the rural areas where most of the energy needs (domestic, commercial and industrial) are met from the traditional bio-mass fuels. The consumption of natural gas in Bangladesh has steadily increased to meet the requirements of the power generation and industrial sectors.

The share of electricity in the primary energy consumption portfolio has shown the highest annualised growth rate, around 10 per cent for the period 2008–15. The consumption of oil products has also shown a steady increase since 2008, growing at an annualised rate of 5 per cent. The transport sector is the largest consumer of oil products in Bangladesh, followed by residential, agricultural/forestry and industry.

Figure 23 **Total Primary Energy Consumption (Mtoe) in Bangladesh**



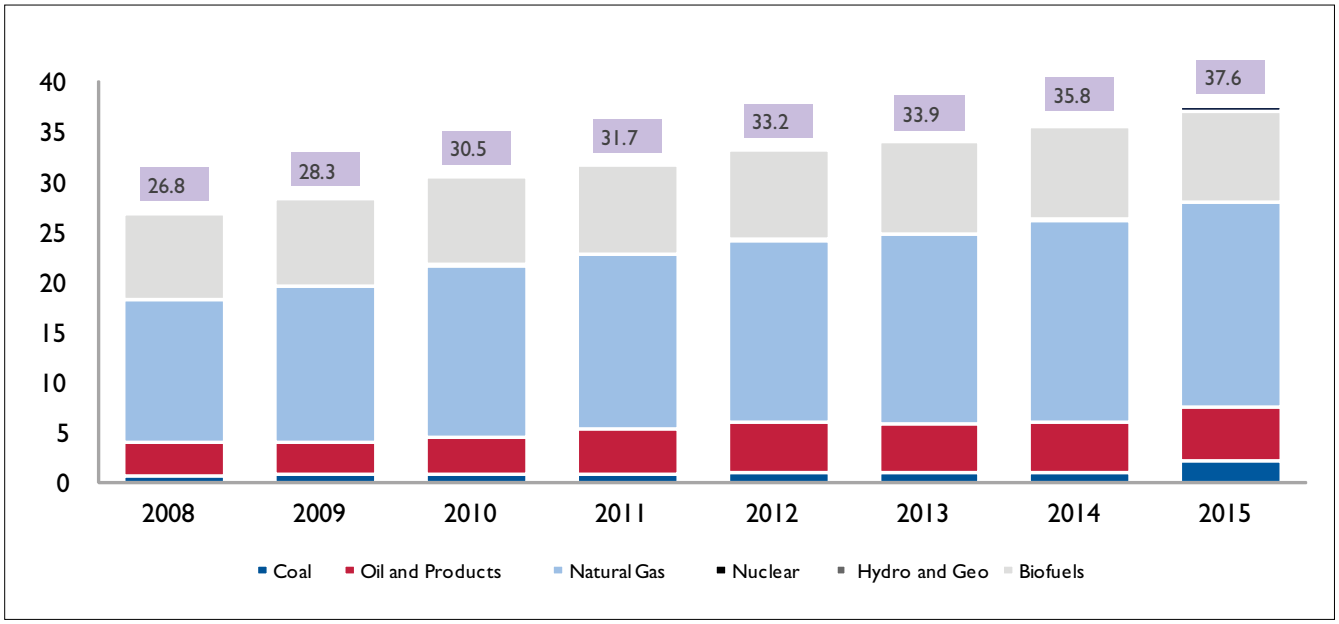
Source: IEA, Power System Master Plan 2016 and SARI/EI Analysis

The Total Primary Energy Supply (TPES) in Bangladesh has grown at an annualised rate of 4.9 per cent between 2008 and 2015. Natural gas is the principal source of energy in the country, accounting for over 54 per cent of the TPES in 2015, followed by bio-energy, which accounted for over 24 per cent of the energy supply. The share of oil and oil products was approximately 14 per cent.

The main issue concerning the energy supply in Bangladesh is the possible decline in domestic production of natural gas which at present accounts for more than half of the country's energy supply. The ratio of natural gas in the total supply of primary energy has been increasing since 2000. However, the domestic production of natural gas has not kept pace with the increasing demand since 2011. The import of electricity from India has been able to address the supply-side deficit to an extent. The electricity imports from India have been increasing since 2014 and the trend is likely to continue in future as well.

The share of imports in the energy basket has increased from 15 per cent in 2009 to over 17 per cent in 2014, as per recent estimates, and is likely to further increase as the domestic production of natural gas tapers. Crude and oil products constitute 92 per cent of imports, while the remaining 8 per cent of the imports is in the form of coal.

Figure 24 **Total Primary Energy Supply (Mtoe) in Bangladesh**



Source: IEA, Power System Master Plan 2016 and SARI/EI Analysis

5.1.2 Resource Potential

Commercial energy in Bangladesh includes natural gas, imported oil, coal, hydro and solar energy. Non-commercial energy sources such as wood fuel, animal waste and crop residues account for about 50 per cent of the total energy consumption. Bangladesh had good deposits of natural gas, most of which have, however, been exhausted. There has not been any discovery of new gas fields in Bangladesh in the recent past. The resource-wise potential for Bangladesh is shown here.

Resource	Coal	Oil	Natural Gas	Bio-mass	Hydropower
Potential	Million Tonnes	Million Barrels	Trillion Cubic Feet	Million Tonnes	Gigawatts
Bangladesh	3,300	12	8	0.08	0.33

Source: BP Statistical Review, 2016; IRADe Presentation, September 2016

Coal

According to the Bangladesh Power System Master Plan 2016 (PSMP-2016) report, the country has reserves of bituminous coal, known as Godwin coal, spread across five coal fields situated between the River Jamuna and the River Padma in the northwestern part of Bangladesh. The measured and probable coal reserves total 3.3 billion tonnes, while 884 million tonnes of reserves have been identified. Coal in Bangladesh is generally characterised as having a low ash and sulfur content, which is favourable to the environment. By 2030, the share of coal in the overall generation mix will increase from the current levels of 4 per cent to approximately 50 per cent. Almost 43 per cent of the coal generation capacity will be based on imported coal. The country will thus have to explore import options as domestic resources will be inadequate to meet its energy requirements by 2030.

Oil and Gas

Bangladesh holds a modest amount of oil and gas reserves. As per the PSMP-2016, it has an estimated 12 million barrels of oil reserves and 8 trillion cubic feet of proven gas reserves.

The country's gas sector started its journey in the 1960s, but its rapid expansion and integration started to accelerate in the early 1970s, spurred by the rising oil prices. The natural gas reserves in Bangladesh have been depleting, with no new gas discoveries in the recent past. Up until now, 26 gas fields have been discovered and around 20 are in production, with 97 wells. Gas production from the current domestic gas fields in 2015 was 2,700 mmcfd and is expected to reach a peak production by 2018-19. However, the gas demand in Bangladesh will continue to increase and the demand and supply gap is likely to be met by liquefied natural gas (LNG) imports.

The energy sector in Bangladesh faces two important challenges. The primary one is to provide universal electricity access by 2021 that, at present, is marred by a lack of service and inadequate infrastructure. 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 the form of natural gas depletion and bio-mass availability. It has been estimated that Bangladesh's natural gas reserves will begin to deplete in 2020 if no new gas reserves are discovered or if technology does not allow a higher rate of extraction from existing gas fields.

Hydroelectricity

The assessed hydropower potential in Bangladesh that can be economically exploited is limited. The Karnafuli Hydropower Station, with a capacity of 230 MW, is the only major hydropower plant in the country. It is operated by the Bangladesh Power Development Board (BPDB) and there are plans to increase its capacity to 330 MW. Due to the country's flat terrain and potentially large social and environmental impacts, the scope of hydropower generation is limited[18] to small-scale hydro (mostly in the hilly regions of the northeast and southeast parts). PSMP-2016 recognises the regional hydro potential

[18]Energy Security Study-http://powerdivision.portal.gov.bd/sites/default/files/files/powerdivision.portal.gov.bd/page/c96429b5_a481_4ee3_8095_6746b376dcfd/TA%208839_Revised%20Draft%20Final%20Report%20on%20Energy%20Security%20%28Appendix%20C%29_Submission_29th%20June%202016.pdf

and mentions that "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 'neighbouring countries'). Thus, it is expected that Bangladesh imports electricity out of such hydropower generation via power interconnections with such neighbouring countries for stable base-load supply, energy fuel diversification and climate change mitigation."

Renewables

Bangladesh's coastline has a high wind generation potential, which is estimated to be around 2 GW. Solar is also a potential resource for the country but availability of land could pose a major challenge in developing large-scale projects. The average solar radiation in Bangladesh is about 4.5 kWh/m^2/day and the average peak sunshine hours per day is 4.5 hours, and the annual operational days is more or less 340 days.[19]

Bio-mass is the other renewable resource that has a huge potential, given the agrarian nature of the economy.

The Government of Bangladesh (GoB) has two sets of directives for its renewable energy programme. The first is the 500 MW solar programme, which was developed in 2012 with the objective of adding 500 MW of solar generation capacity by 2016 through financing and implementing solar-powered projects in both the public and private sectors. The GoB has also set renewable energy development targets for several technologies for each year from 2015 to 2021. Most of the new capacity will be provided by solar (1,676 MW, or 54 per cent) and wind (1,370 MW, or 44 per cent). There are also targets for waste-to-energy (40 MW), bio-mass (7 MW), bio-gas (7 MW) and hydro (4 MW).

5.1.3 Electricity Sector

Generation Capacity

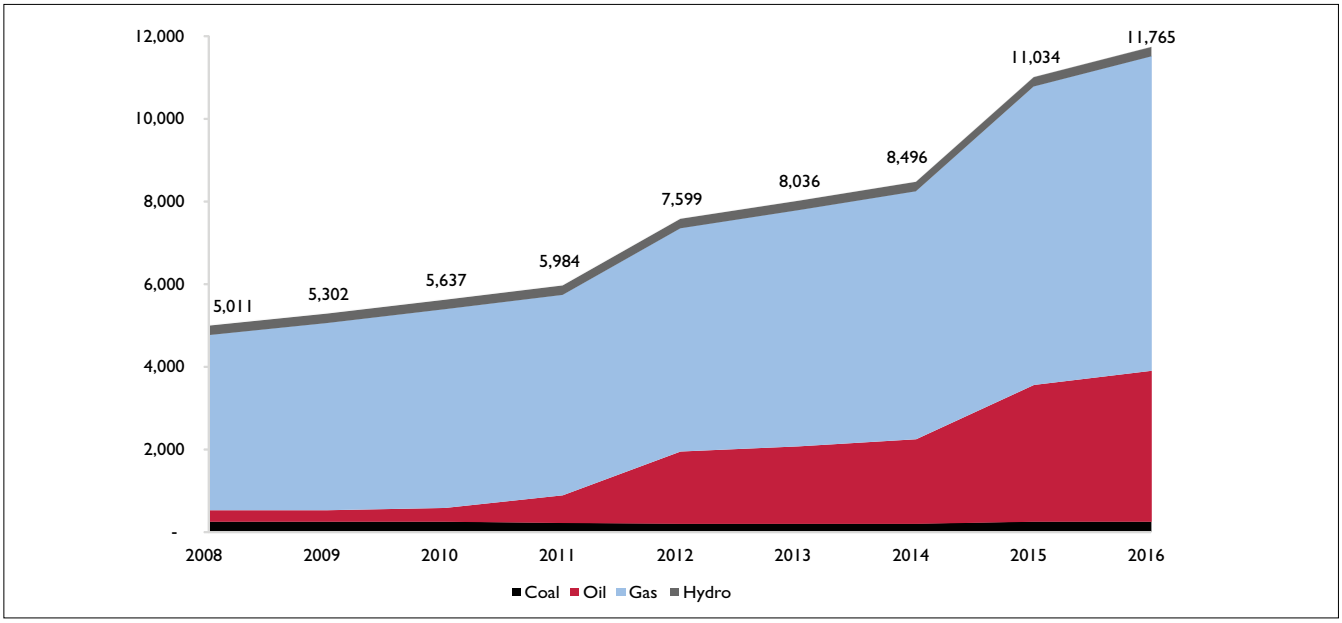
There has been an impressive achievement in the power sector in Bangladesh in recent years, both in terms of private sector participation and installed capacity addition. The former has grown rapidly over the past few years. The share of private sector, including both large and small independent power producers, was approximately 25 per cent in 2016, an increase of 3 per cent over 2015.

The generation segment of the power sector has also increased rapidly since early 2000. The overall installed capacity in the country has more than doubled, from 5,011 MW in 2008 to 11,765 MW in 2016.[20] In addition, 600 MW of power is being imported from India through two transmission links. The current generation mix is dominated by natural gas, which constitutes around 65 per cent of the overall fuel source, followed by furnace oil and diesel, which meet 31 per cent of the country's electricity requirements. Coal and hydropower together constitute 4 per cent of the country's electricity mix.

[19]Energy Security Study http://powerdivision.portal.gov.bd/sites/default/files/files/powerdivision.portal.gov.bd/page/c96429b5_a481_4ee3_8095_6746b376dcfd/TA%208839_Revised%20Draft%20Final%20Report%20on%20Energy%20Security%20%28Appendix%20C%29_Submission_29th%20June%202016.pdf

[20]As on 13 December 2017, the total generation capacity is around 16,046 MW, including captive power plants

Figure 25 **Installed Capacity (MW) in Bangladesh**



Source: BPDP Annual Report, 2016-17

The overall installed generation capacity in Bangladesh is likely to reach 35,232 MW, around three times the 2016 levels. The rapid expansion in generation capacity will be required to meet the growing electricity needs of the economy and improving the electricity access to rural areas. The electricity mix will also change significantly in the next decade-and-a-half. As per the planned capacity addition programme, the share of coal in the electricity mix will increase from 2 per cent in 2016 to 53 per cent in 2030. During the same period, the share of natural gas and oil in the electricity mix will decrease from 65 per cent and 31 per cent to 28 per cent and 11 per cent, respectively. The GoB is also planning to expand the renewable energy portfolio and it is expected that, by 2030, its share in the electricity mix will increase to 7 per cent or 2,470 MW.

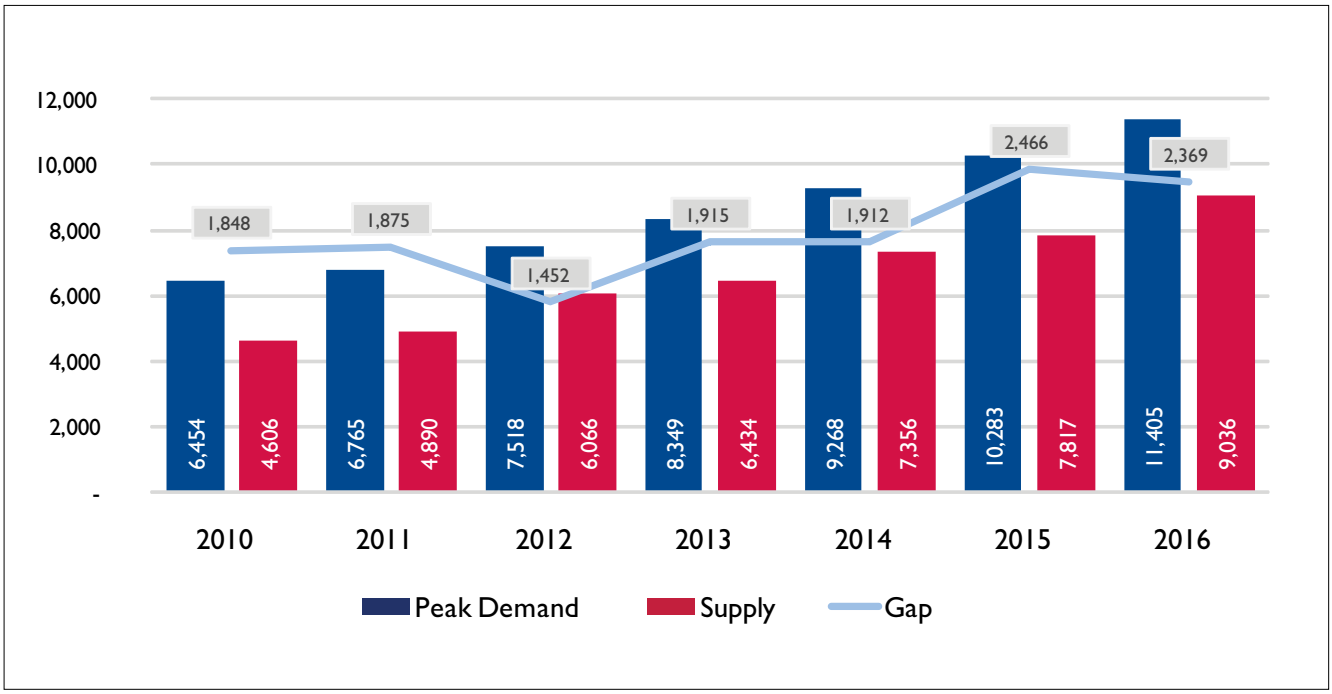
Demand

The electricity demand in the country is increasing rapidly due to growing economic activities. From 2005 to 2016, the demand went from 19 TWh to 45 TWh, an increase of 2.4 times, which is far higher than the increase in the total energy consumption, which went up 1.57 times. The industrial and residential sectors are the biggest drivers of this demand. Together, these two sectors consumed more than 85 per cent of the overall electricity demand in Bangladesh.

Nationwide, 83 per cent of the population has access to electricity in 2016, up from only about 20 per cent in 1990. The electrification rates are the highest in the urban areas, where only about 1 per cent lack access to electricity. In the rural areas, around 34 per cent do not have electricity. These rates have improved in recent years because of the rapid acceleration of the grid connection to the rural areas, coupled with the installation of solar home systems.

One of the biggest issues facing the electricity sector in Bangladesh is the increasing demand-supply deficit. Despite the huge capacity addition programme, the demand of electricity continues to outstrip supply. From 2010 to 2016, the gap between peak demand and supply has grown from 1,848 MW to 2,369 MW, an increase of 28 per cent since 2010.

Figure 26 **Peak Demand Supply Scenario (MW) in Bangladesh**

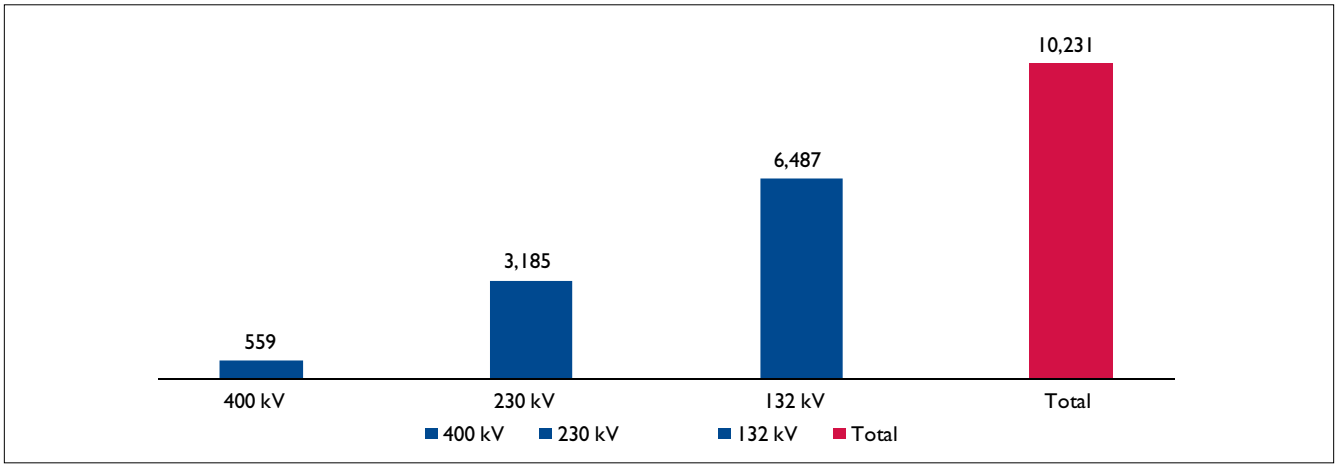


Source: BPDP Annual Reports

Transmission and Distribution

The power network in Bangladesh operates at a voltage below 230 KV and 132 KV, except for the 400 KV double circuit line (Bangladesh part), which is 221 ckm in length and connects Tripura to Comilla and the 500 MW HVDC link to India that became operational in 2014 at Bheramara. Many existing power stations have a capacity of below 100 MW, using domestic gas, currently distributed across the nation. Figure 27 shows the current national power network system of Bangladesh, which consists of 400 KV, 230 KV and 132 KV lines that are distributed across the nation.

Figure 27 **Transmission System Profile (cKM) in Bangladesh**



Source: Power Grid Company of Bangladesh, capacity as of December 2016

The country is planning to enhance its transmission network by augmenting 400 KV and 230 KV system lines. While the Power Grid Company of Bangladesh has showed a significant improvement in grid extension between 2003 and 2016, it needs to step up its grid expansion to meet the power expansion plan of 2030. To achieve this target, Bangladesh will need to add 6,175 km of 230 KV lines and 3,920 km of 400 KV lines.

Cross-border connections have been established to import power from India and other neighbouring countries. Presently, Bangladesh is importing 500 MW and 100 MW of power from India through the Baharampur-Bheramara and Tripura-Comilla interconnections, respectively. Bangladesh is also planning to import another 100 MW[21] from the Manarchak Thermal Power Plant in West Tripura.

India and Bangladesh are exploring several additional interconnection proposals to augment the existing transmission capacity for increased power transfer between the two countries. These include:

- Capacity augmentation of the existing Bheramara HVDC Station by 500 MW

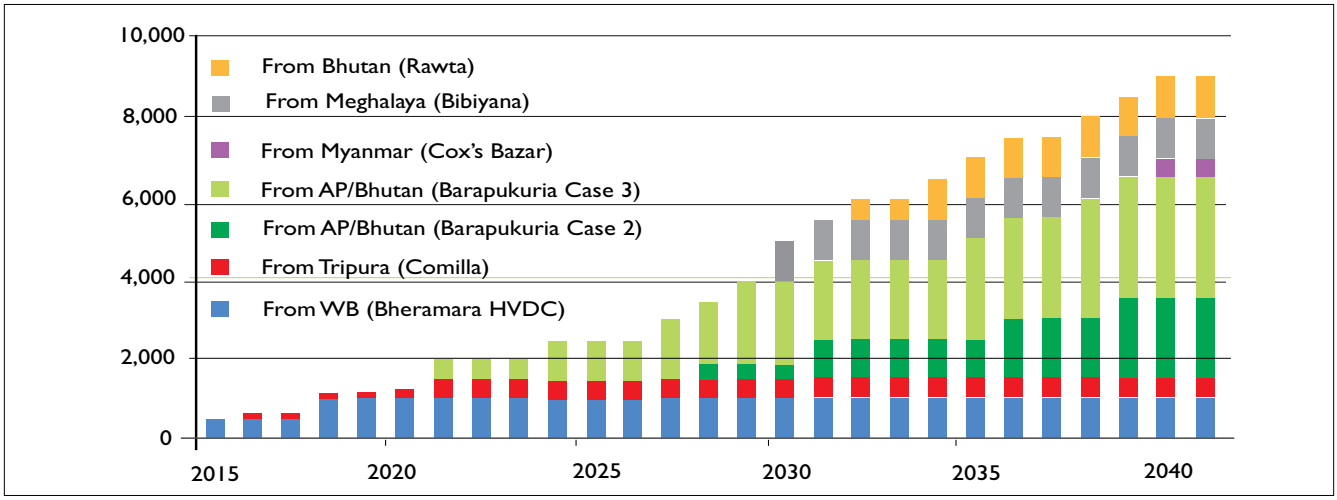
This link will also enable Bangladesh to participate in the Indian power trading market and execute power trades with generation stations in Bhutan, India and Nepal over the Indian transmission network. The construction for this transmission project started in January 2015 and is slated for completion by June 2018.

- Interconnection with the northeastern states of India

The master plan for the evacuation of power from hydro projects in Arunachal Pradesh foresees the construction of high capacity High Voltage Direct Current (HVDC)/High Voltage Alternating Current (HVAC) lines from the northeastern region to the other parts of India. In view of the Right of Way (RoW) constraints in the narrow stretch of the Indian land between Bangladesh, Bhutan and Nepal (the Siliguri corridor), the possibility of routing the line through Bangladesh is being explored. Bangladesh intends to import 2,000 MW from this line.

Bangladesh plans (PSMP-2016) for various cross-border interconnections for importing power from various neighbouring BIMSTEC countries of around 8,500 MW by 2040.

Figure 28 **Bangladesh Power Import (MW) from BIMSTEC Countries by 2040**



Source: Bangladesh PSMP-2016

[21] http://www.business-standard.com/article/news-ians/tripura-to-supply-additional-100-mw-power-to-bangladesh-116042300388_1.html

On the distribution side, the system comprises a network of 33 KV, 11 KV and 415 KV, originating from the grid and zone substations and connecting to the distribution transformers. The BPDB has extended about 1,315 km distribution lines as a part of the continuous improvement of the system. During FY 2016, the BPDP distribution zones imported a total of 12,159 GWh energy and sold 10,820 GWh to consumers, thereby resulting in a distribution loss of 11.01 per cent.

5.1.4 Renewable and Energy Efficiency Initiatives

The development of renewable energy is one of the important strategies adopted as part of the Fuel Diversification Programme. In line with the Renewable Energy Policy 2009, the focus is on facilitating both public and private sector investment in renewable energy projects to substitute indigenous non-renewable energy supplies. The Renewable Energy Policy envisions that 10 per cent of the total energy production will be achieved by 2020. Several initiatives in the solar segment, including mini grids, solar irrigation pumps, solar water heating in industries, solar rooftop systems in government and industrial establishments on a commercial basis as well as wind resource mapping programmes are in progress across various locations in Bangladesh.

The Energy Efficiency and Conservation Master Plan 2015 provides the roadmap for the several energy efficiency programmes and initiatives that are proposed to be taken up. These include:

- **Energy Efficiency (EE) labelling programme:** EE rating for home appliances, manufacturing of EE products.
- **EE building programme:** Compliance with the new version of the Bangladesh National Building Code; developing Green Building Guidelines.
- **Energy Efficiency & Conservation (EE&C) finance programme:** Subsidy and low interest rates for EE&C investment.

Efficient energy end-use has emerged as a viable option to sustain economic growth, even as a gas shortage continues in Bangladesh. The textiles and the steel re-rolling sectors hold the greatest opportunity for savings. There have been several initiatives, supported by multilateral donor agencies, targeted at specific segments such as the LED tubelight project in a readymade garments (RMG) factory under the Energy Services Company (ESCO) model; the promotion of improved rice parboiling systems (IRPS) for rice mills and so on. The initiatives for the residential segment include the compact fluorescent lamp (CFL) distribution programme of BPDB, solar powered security lighting in urban buildings and the replacement of diesel/electric pumps by solar irrigation pumps.

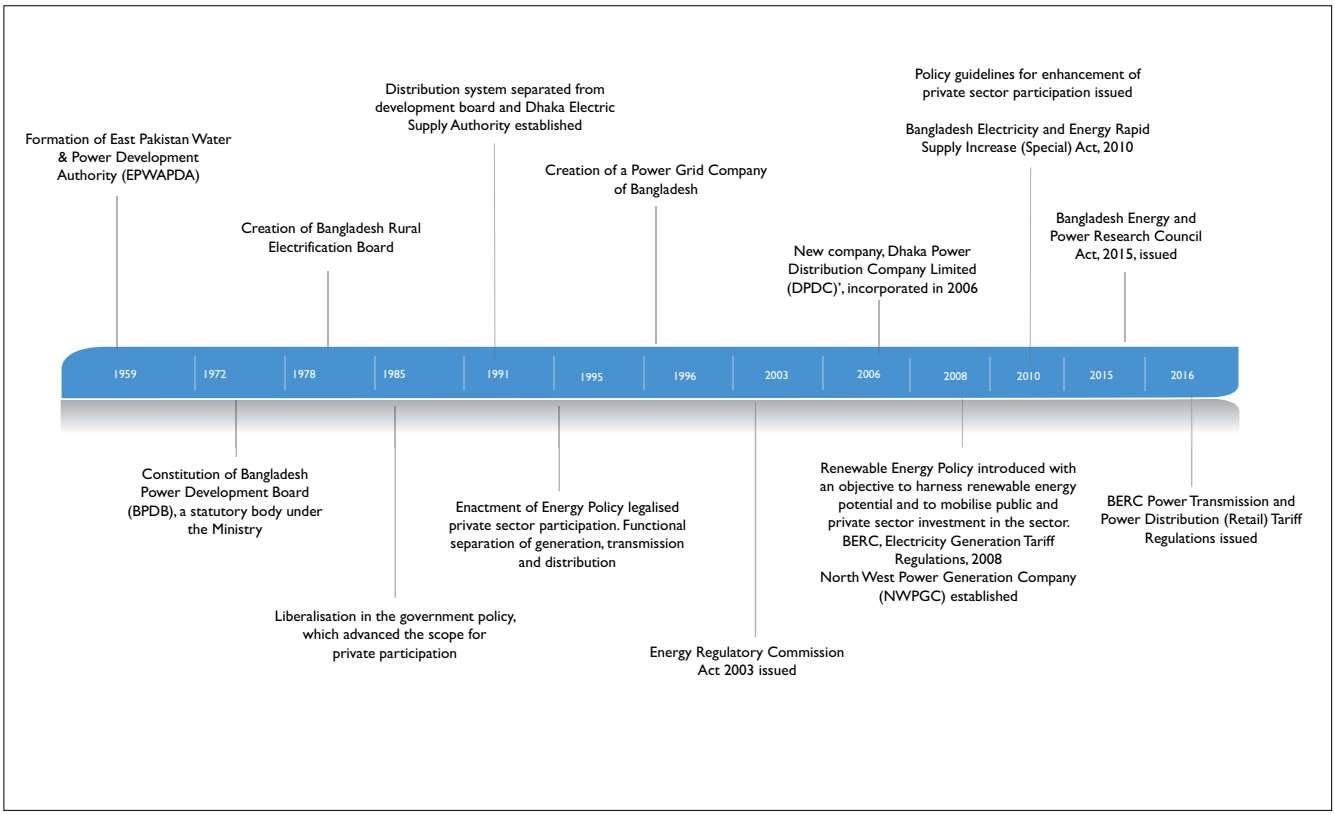
5.1.5 Reforms and Restructuring

While the generation segment of the power sector witnessed some improvement, the rural population continued to suffer on account of limited access to electricity. To improve the electrification rate across the country, particularly the rural areas, the Government constituted the Bangladesh Rural Electrification Board (REB) in 1978. The decision to open up the sector for private sector participation was taken in 1985 when the GoB liberalised the sector by excluding it from the reserved category. However, private sector participation was only legalised in 1995 under a new energy policy, which also allowed for the functional separation—generation, transmission and distribution—of the integrated utility.

In 1996, the GoB took the initiative of splitting the transmission segment and formed the Power Grid Company of Bangladesh (PGCB). PGCB has taken over the transmission assets from BPDP fully and is responsible for the construction of all new transmission assets. In 1998, the Power Division was established under the Ministry of Power, Energy and Mineral Resources (MPEMR); it has been entrusted with the responsibility of the overall management of the power sector in Bangladesh. Subsequently,

the Bangladesh Energy Regulatory Commission (BERC) was established on 13 March 2003, through a legislative Act of the Government to regulate the gas, electricity and petroleum products of the country. In April 2004, the Regulatory Commission was established. There have been notable changes in the electricity sector pattern as a result of this restructuring.

Figure 29 **Evolution of the Electricity Sector in Bangladesh**



5.1.6 Institutional Framework

The institutional framework of the Bangladesh energy sector is headed by MPEMR, which is responsible for the overall planning, development and management of the different types of commercial energy resources and the overall power supply value chain. It also formulates power sector policies.

BPDB is responsible for the generation and distribution of electricity, mainly in the urban areas. The Planning & Development (P&D) division within BPDB is in charge of the overall power system planning and procurement for the country. The division is also in charge of procurement planning, covering the quantum of power purchase, catering to base and peak load demands, grid support and so on.

The generation sector is open to private sector participation and Bangladesh has several independent power producers (IPPs). The country has one transmission utility, namely, the Power Grid Company of Bangladesh Ltd (PGCB), which is responsible for the transmission network, its operation & maintenance (O&M) and development. The country has five distribution companies (discoms)—BPDB, the Dhaka Power Distribution Company (DPDC), the Dhaka Electricity Supply Company (DESCO), the West Zone Power Distribution Company Ltd (WZPDCL) and the Rural Electrification Board (REB)—which own and operate the country's distribution network and supply electricity to the end users.

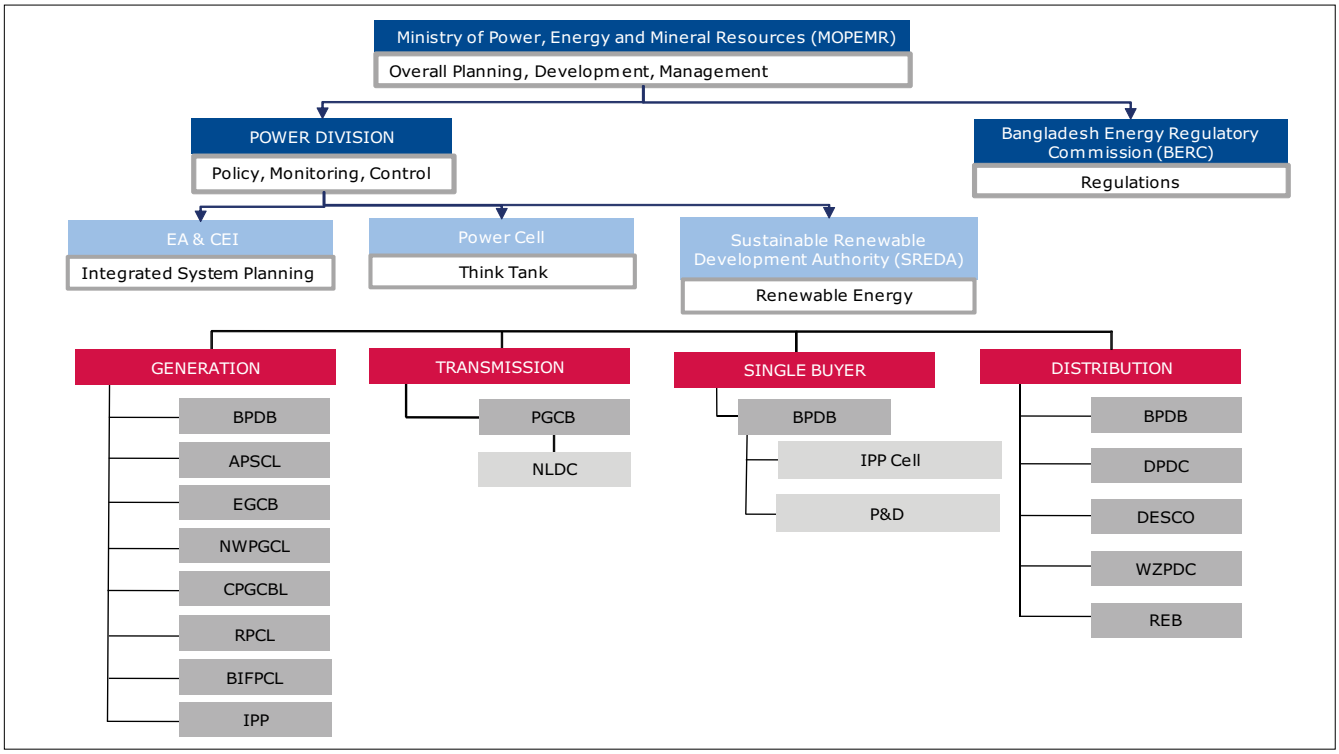
The power sector of Bangladesh is primarily governed by the Electricity Act 1910 and the Bangladesh Electricity Regulatory Commission Act 2003. The Bangladesh Energy Regulatory Commission (BERC) was created under the BERC Act 2003. It is an independent commission with a mandate to regulate the energy sector (gas, electricity and petroleum products) in Bangladesh, including the fixing of electricity tariffs, pricing of gas and petroleum products, and drafting of regulations, codes and standards.

The Bangladesh power sector operates under a single buyer model. BPDB acts as the single buyer of the electricity generated in Bangladesh and it sells bulk electricity to all the distribution utilities. There is no separate power trading entity and this role is being performed by BPDB. To put research and development of power and energy sector into a fast lane, the Government of Bangladesh has enacted the Bangladesh Energy & Electricity Research Council Act, 2015 and formed Bangladesh Energy and Power Research Council (EPRC). The main purpose of the council is to coordinate practical and implementable research work in the power and energy sectors through finding and motivation, identifying the potential areas for energy diversification, conducting research work to implement long-term plans, inventing new technologies and incorporating local and international experts into the research activities of EPRC.

For promoting renewable energy, the Government of Bangladesh has enacted the Sustainable & Renewable Energy Development Authority (SREDA) Act, 2012 and has formed SREDA.[22]

The Government issued policy guidelines in 2008 to promote private sector participation in the Bangladesh power sector. These guidelines aim at encouraging competition and enhancing public-private-partnership in the power sector. One of its objectives is that the transmission and distribution lines of PGCB and distribution licensees should provide access to their system on a non-discriminatory basis for the availing of power produced by the commercial power plants, existing as well as new.

Figure 30 **Institutional Framework in Bangladesh**



[22]http://www.sreda.gov.bd/d3pbs_uploads/files/acts_6_sustainable_and_renewable_energy_development_authority_act_english.pdf

5.2 Bhutan

Bhutan is a mountainous country located in the eastern Himalayas; Thimphu is its capital city. The country is landlocked between China in the north and India in the east, west and south. It is spread over 38,394 square kilometres and is home to about 800,000 people (as on 2016). The country is subdivided into 20 districts or administrative regions.

The Bhutanese community is predominantly agrarian with 69 per cent of the country's population living in the rural areas. People have, however, started moving into the urban areas.

5.2.1 Primary Energy Consumption and Supply Trends

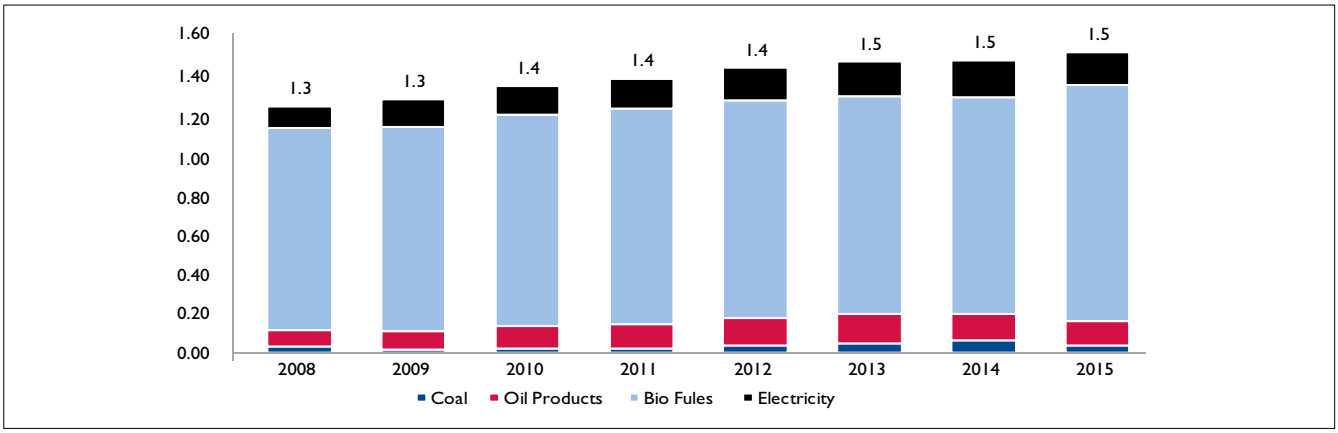
The per capita energy consumption in Bhutan is relatively high as compared with that of its neighbouring countries in the BIMSTEC region. However, in terms of the overall volume, the energy consumption in the country is one of the lowest in the region.

The total primary energy consumption in Bhutan has grown from 1.3 Mtoe in 2008 to 1.5 Mtoe in 2014, an increase of 2.6 per cent per annum since 2008. The household and other consumer sectors are the largest energy end users, consuming 75-80 per cent of the total energy supplied in the country, followed by the industrial and construction sector, which consumes 10-12 per cent and the transport sector (7-8 per cent).

The fuel consumption basket in Bhutan is dominated by bio-energy, followed by electricity. The consumption of bio-energy increased at an annualised rate of 0.8 per cent between 2008 and 2014, expanding from 1.05 Mtoe in 2008 to 1.1 Mtoe in 2014. In 2014, the share of bio-energy in the consumption of energy was 75 per cent, declining by approximately 10 percentage points since 2008. The key reason for the high share of bio-mass is its easy availability as about 70 per cent of Bhutan's land is covered by forest and a majority of the population lives in rural areas. All the primary and derived bio-mass energy is consumed by the household and other consumer segments.

The share of oil products in the energy basket is gradually increasing. The consumption of oil and oil products has increased at an annualised rate of 10.9 per cent during 2008 and 2014, increasing from 0.07 Mtoe to 0.14 Mtoe during the same period. Similarly, the consumption of coal has increased from 0.03 Mtoe in 2008 to 0.06 Mtoe in 2014, expanding at an annualised rate of 12 per cent. The share of both oil and coal has increased since 2008 and was approximately 4 per cent and 9.3 per cent, respectively, in 2014.

Figure 31 Total Primary Energy Consumption (Mtoe) in Bhutan



Source: IEA, UN Statistics, Energy Balance 2008-2014 and SARI/EI Analysis

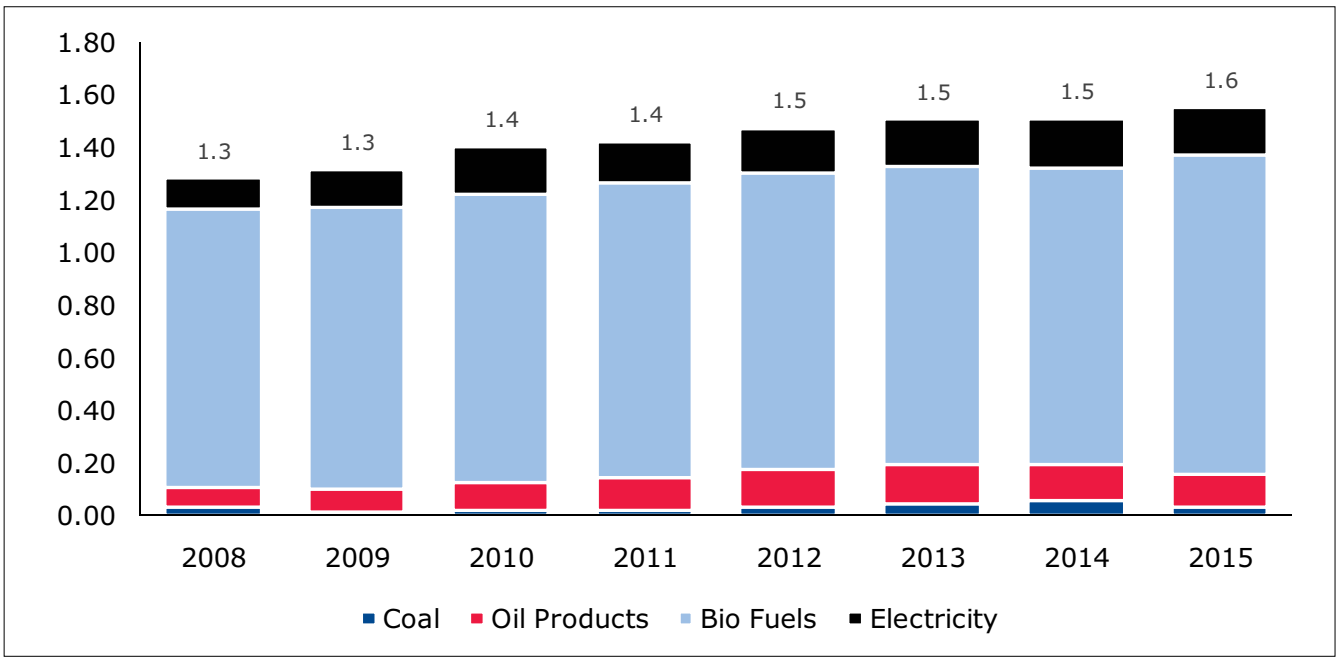
The TPES in Bhutan grew at an annualised rate of 4.5 per cent between 2008 and 2014, reaching a record high of over 1.5 Mtoe in 2014.

Bio-energy is the largest source of energy in the country, accounting for over 74 per cent of the TPES in 2014, followed by electricity, which accounted for over 12 per cent of the energy supply. The share of oil and oil products was approximately 10 per cent; coal accounted for 3 per cent.

The share of bio-energy in the overall energy supply basket has decreased from 80 per cent in 2008 to 73 per cent in 2014. Contrary to this, the share of electricity and oil products in the energy mix has increased from 9 per cent and 6 per cent, respectively, in 2008 to over 12 per cent and 10 per cent, respectively, in 2014.

Bhutan is a net exporter of energy, as most of the energy consumed in the country is supplied through domestic production, with the exception of oil products. It imports almost all its requirement of oil products from India. The import of oil products has increased from .08 Mtoe in 2009 to over 0.14 Mtoe in 2014 and is likely to go up still further. Since 2009, Bhutan has been exporting 0.5 Mtoe of electricity each year to its neighbouring countries, mainly India. Electricity and coal are the main sources of energy export. Almost 70 per cent of the electricity generated in Bhutan is exported to India and the remaining 30 per cent is consumed within the country. The export of electricity is also one of the major sources of revenue for the country.

Figure 32 **Total Primary Energy Supply (Mtoe) in Bhutan**



Source: IEA, UN Statistics: Energy Balance 2008-2014 and SARI/EI Analysis

5.2.2 Resource Potential

Bhutan has no petroleum or natural gas reserves but it has a large hydro potential, which is estimated to be over 30,000 MW. The kingdom has 2 million tonnes of coal and extracts only about 1,000 tonnes per year for domestic use. Bhutan also imports oil at about 1,000 barrels per day, mostly for the transport sector.

The resource-wise potential for the various natural resources is shown here.

Resource	Coal	Oil	Natural Gas	Bio-mass	Hydropower
	Million Tonnes	Million Barrels	Trillion Cubic Feet	Million Tonnes	Gigawatts
Bhutan	2	0	0	26.60	30.00

Coal

The kingdom has some 2 million tonnes of coal reserves, but extracts only about 1,000 tonnes of coal annually, which is entirely for domestic consumption. Coal is primarily used in industries. The overall contribution of coal in the energy supply mix is only about 4 per cent. Locally produced coal is mainly used for reduction processes in the industries and for exports to neighbouring countries.

Oil and Gas

Bhutan does not have oil and gas resources and depends exclusively on importing refined petroleum products from India. Its total oil and petroleum product imports were 170 million litres during 2016.

Hydroelectricity

Bhutan has a huge hydropower potential, estimated to be 30,000 MW, of which 23,500 MW has been identified as techno economically viable. Around 10 per cent of the total potential has been exploited so far, almost all of it being through run-of-the-river projects. The domestic electricity generation is mostly dependent on hydropower sources. Around 67-70 per cent of the electricity generated is exported to India.

Renewables

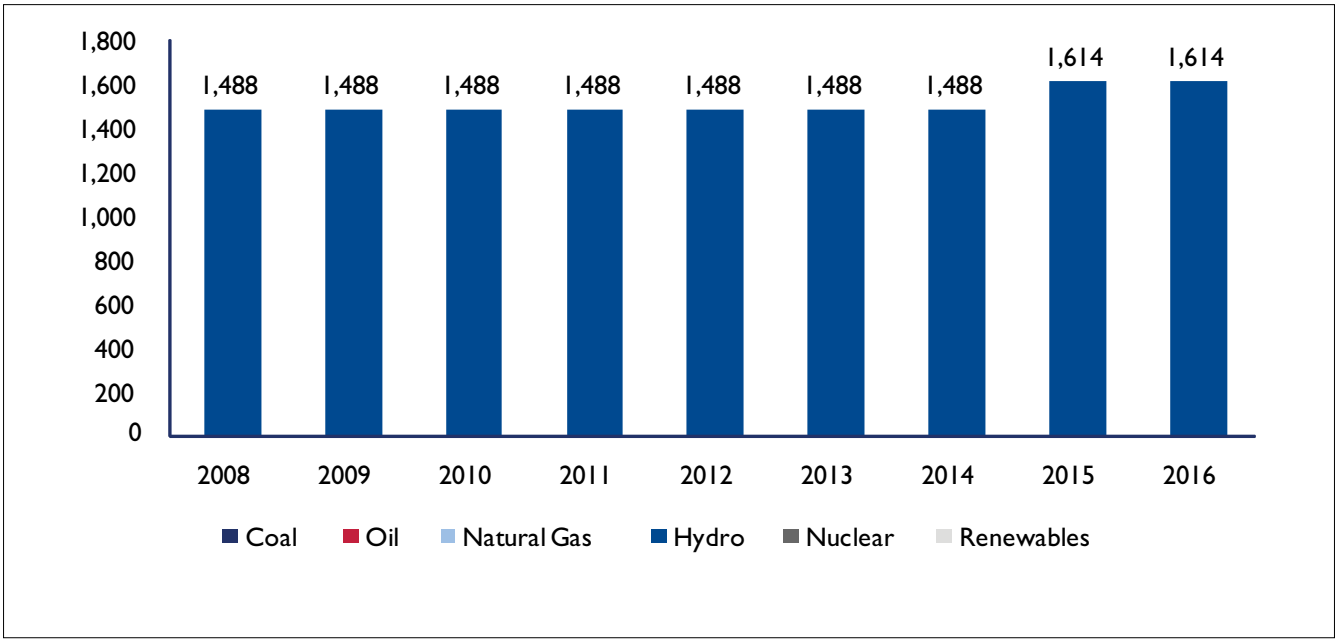
Bhutan is endowed with various sources of renewable energy potential; wind, bio-mass and solar are the main renewable energy sources, apart from the small and large hydropower projects. Based on initial estimates, it is believed that Bhutan has a renewable energy potential of 50 GW (solar); 30 GW (hydro); 4 GW (wind) and 4 GW (bio-mass). In order to harness this potential, the Government of Bhutan has set a preliminary renewable energy target of 20 MW by 2025. This is to be achieved through a mix of renewable energy technologies in the Renewable Energy Policy of 2013. The minimum target may be increased, following a more detailed evaluation of the resource potential. Specific targets include 5 MW each of wind, solar and bio-mass.

5.2.3 Electricity Sector

Generation

Hydropower is the mainstay of Bhutan's electricity mix. The installed capacity in the kingdom has increased at an annualised rate of 11 per cent, from 1,488 MW in 2008 to over 1,600 MW in 2015. Several projects that are under construction have been delayed and are likely to be commissioned by 2025. In addition, Bhutan also has a very small amount of diesel-based generation, which is in the range of 8-10 MW, as of 2015. Apart from hydropower and diesel generation, there is no other source of electricity generation.

Figure 33 **Installed Capacity (MW) in Bhutan**

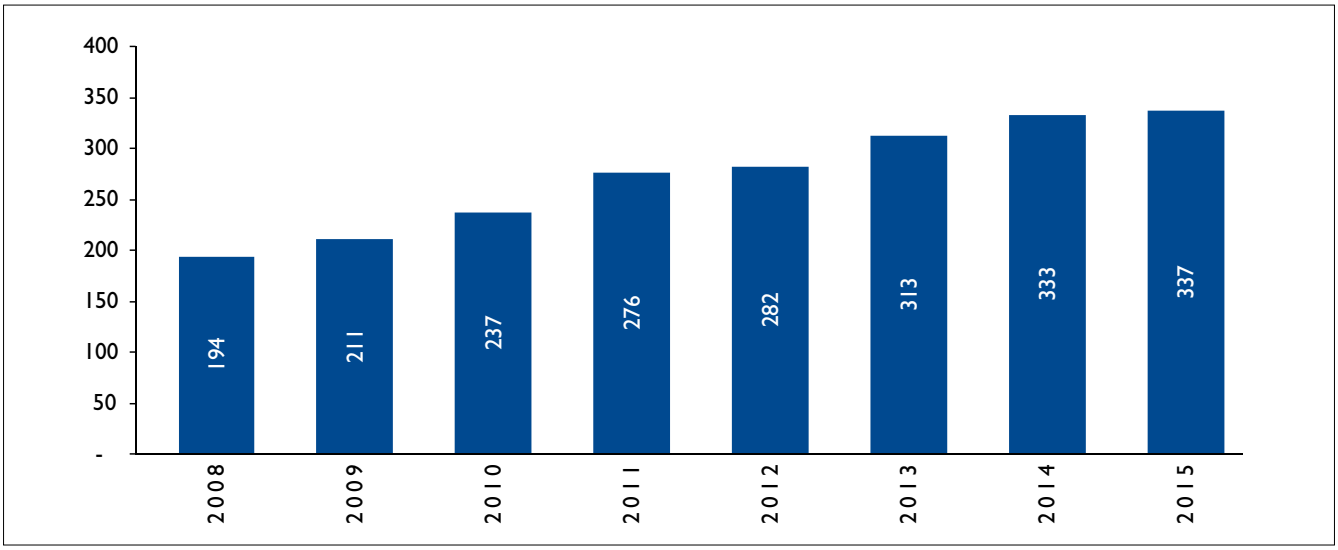


Source: National Transmission Grid Master Plan, prepared by the Central Electricity Authority (CEA), GoI

Demand

The electricity demand in Bhutan is increasing owing to the ongoing emphasis on rural electrification programmes. Between 2011 and 2015, the per capita consumption of electricity has increased from 2,419 kWh to 2,804 kWh. The demand for electricity is likely to grow still further due to economic activity and also because the Government is committed to reducing the dependence on fuelwood as a source of energy. By 2030, the peak demand in the country is expected to increase to 2,500 MW.

Figure 34 **Peak Demand (MW) in Bhutan**



Source: National Transmission Grid Master Plan, prepared by CEA, GoI, 2012

Transmission and Distribution

The power transmission system in Bhutan is over 5,810 km in length, as per FY 2015 estimates, and operates at different voltage levels of 400 KV, 220 KV, 132 KV and 66 KV. The country has planned to add an additional transmission infrastructure of 1,897 km, at a line voltage of 400 KV, 220 KV, 132 KV and 66 KV, to augment its existing network. This will increase its ability to evacuate power from the new power plants to India and to connect them to Bhutan's domestic transmission network for supply to its domestic consumers.

Cross-border interconnection capability exists between Bhutan and India; the present power transfer capacity between the two countries is around 2,500 MW. India imports around 1,542 MW power from hydro stations located in Bhutan through Chukha (Bhutan) to Birpara (India): 220 KV transmission line; Kuruchu: Geylegphug (Bhutan) to Salakati (India): 132 KV S/C and Tala (Bhutan) to Siliguri (India): 400 KV 2x D/C line.

The governments of both the countries are planning the expansion of this capacity to serve the future development of hydro projects in Bhutan. Towards this end, the following interconnections are under implementation:

- 3,000 MW HVDC terminal at Alipurduar, along with a 6,000 MW NER-NR/WR interconnector.
- Punatsangchu-I HEP: (Bhutan portion) Punatsangchu - Lhamoizingkha (Bhutan border) 400 KV 2x D/C; (Indian portion): Lhamoizingkha - Alipurduar 400 KV D/C (quad), Jigmeling - Alipurduar 400 KV D/C (quad) line.

5.2.4 Renewable and Energy Efficiency Initiatives

The Royal Government of Bhutan is committed to remain carbon neutral. The promotion of renewable energy is seen as a strategic use of the nation's endowment of large renewable energy resources such as hydropower, solar, wind and forest cover. While the focus continues to be on the development of medium to large-size hydropower projects, the Department of Renewable Energy's Alternative Renewable Energy Policy (AREP), 2013, has been tasked with promoting clean renewable energy technologies in Bhutan. These include solar, wind, bio-mass, geothermal, pico/micro/mini/small hydropower plants up to 25 MW in size and waste-to-energy technologies.

Several initiatives have already been undertaken for energy efficiency, targeted at the end consumers. These include the Energy plus programme to replace the incandescent bulbs with LED bulbs. The National Energy Efficiency and Conservation Policy of 2017 aims to create the framework to promote, incentivise, govern and monitor various actions and behaviour on the EE&C front. The policy provides for developing an energy efficiency roadmap covering the building, appliances, industry and transport sectors.

A Renewable Energy Development Fund (REDF) has been established under AREP 2013, which will be utilised for funding the energy efficiency initiatives.

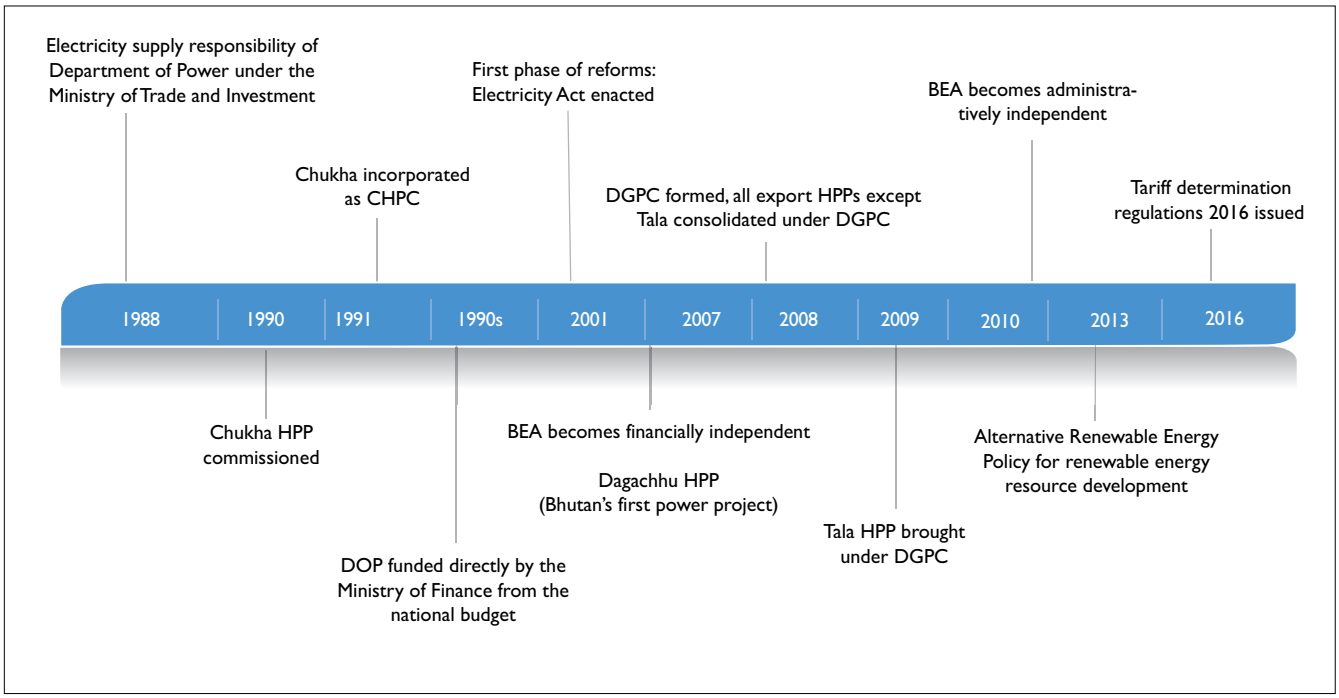
5.2.5 Reforms and Restructuring

In 2002, Bhutan's energy sector went through a major restructuring process to separate its management and ownership from the Government. Following these reforms, the policy-making body on energy has been the Ministry of Economic Affairs, which includes three departments relevant to the sector—the Department of Hydropower and Power Systems (DHPS); the Department of Renewable Energy and the Department of Hydromet Services (established on 1 December 2011).

The state-owned Bhutan Power Corporation (BPC) is responsible for the transmission and distribution of electricity, while the Druk Green Power Corporation (DGPC), also state-owned, looks after power

generation. DGPC is the holding company of all existing hydropower companies. As the power sector regulator, the Bhutan Electricity Authority (BEA) is responsible for setting tariffs; establishing and enforcing technical, safety and operational standards; issuing licences; and monitoring other regulatory functions. While the electricity tariffs are regulated by BEA on a cost-reflective tariff structure, actual retail prices are cross-subsidised in the value chain of the power sector in a transparent manner. Before power exports, DGPC gives 15 per cent of the power it generates as an energy royalty to the Government, which sells it to BPC at a discounted price. Electricity is supplied to domestic consumers at affordable tariffs that are substantially cross-subsidised by power exports. Both BPC and DGPC have maintained efficient operations and healthy financial positions.

Figure 35 Evolution of the Electricity Sector in Bhutan



5.2.6 Institutional Framework

DHPS reports to the Ministry of Economic Affairs. It is the government body leading and coordinating the activities of the various organisations involved in the planning and development of the country's large hydropower resources (over 25 MW). It is also responsible for formulating national policies and guidelines related to hydropower development; implementing institutional reforms for efficient planning and the management of the sector; providing an enabling environment for the participation of the public and private sectors in the development of hydropower resources; and ensuring that hydropower exports generate the maximum revenue for the nation. DHPS consists of three divisions: Planning and Coordination, Hydropower Development and Transmission and Power Systems.

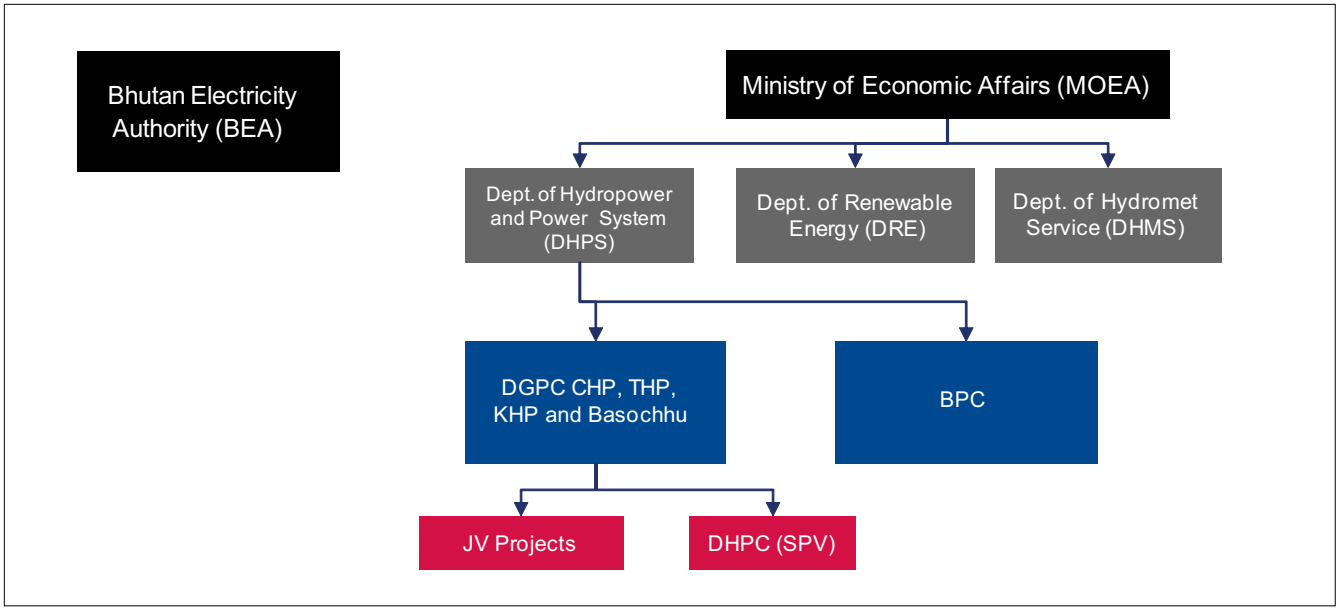
BPC is responsible for distributing electricity throughout the country and providing transmission access for generating stations for domestic supply as well as export. It has the mandate to ensure that a reliable and adequate electricity supply is available to all consumers within Bhutan. DGPC is a wholly-owned corporate entity of the Government. It is an autonomous body that operates and maintains the large hydropower assets of the nation and is also responsible for promoting and developing new hydropower stations in the country.

The Electricity Act 2001 defines the legal framework of the power sector in the country, which ensures the healthy growth of the sector through a clear provision for all key stakeholders. The Act defines the role of the key stakeholders involved in the business of power generation, transmission and distribution. Under the Act, BEA is empowered to take on the role of an electricity regulator in the country. It is responsible for developing regulations, standards, codes and procedures for performance standards, technical and safety requirements for construction, O&M for generation and transmission and distribution facilities.

Bhutan's Hydro Development Policy 2008 focusses on the development of hydropower in the country though public and private partnership. Matters related to the off-take of electricity are dealt with by the Bhutan Hydro Sustainable Hydro Power Development Policy 2008.

In Bhutan, tariff determination for power projects is governed by the Tariff Determination Regulation 2007 (updated in 2013), which determines the tariff for all power transactions except the import/ export of power to other countries.

Figure 36 Institutional Framework in Bhutan



5.3 India

India is one of the oldest civilisations, the seventh largest country by area and the second most populous country in the world with over 1.3 billion people. The country has witnessed socioeconomic development in all spheres over the last 70 plus years of its independence. India stands apart from the rest of Asia, marked off as it is by mountains and the sea, which give the country a distinct geographical entity. Bound by the Himalayas in the north, it stretches southwards and, at the Tropic of Cancer, tapers off into the Indian Ocean between the Bay of Bengal on the east and the Arabian Sea on the west.

5.3.1 Primary Energy Consumption and Supply Trends

India's total primary energy consumption has been steadily increasing over the past few years, growing from 423.4 Mtoe in 2008 to over 574 Mtoe in 2015. The industrial sector is the largest energy end user, consuming 56 per cent of the total energy supplied in the country, followed by the residential sector (10 per cent), transport sector (7 per cent) and other non-specified sectors (18 per cent).

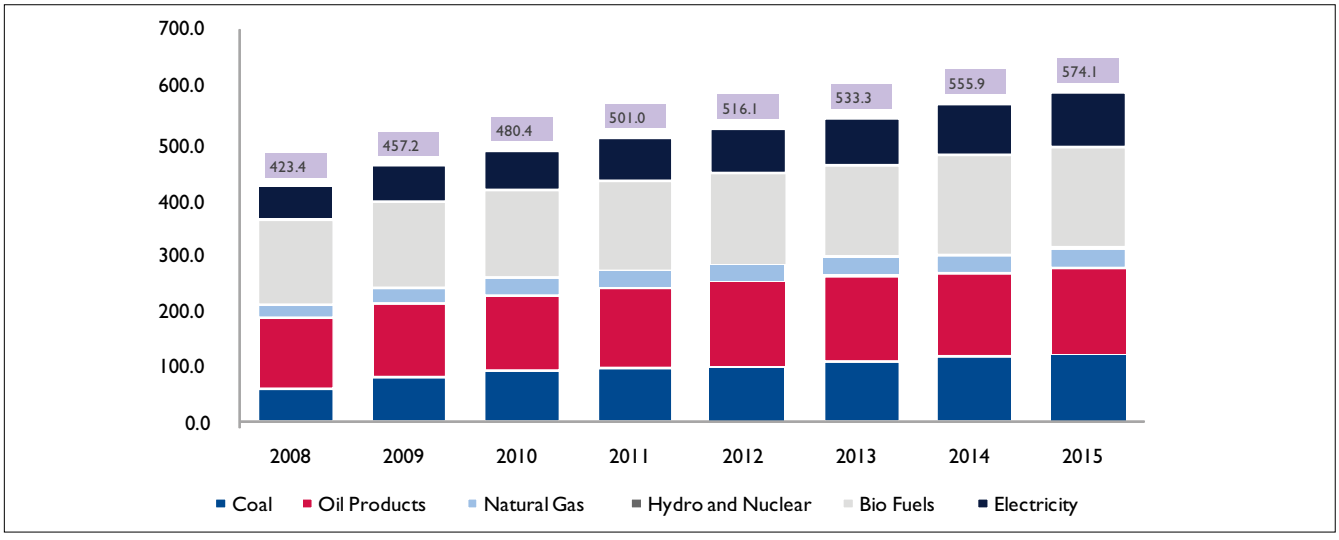
The fuel consumption basket in India is dominated by bio-energy, followed by oil and oil products and coal. The consumption of bio-energy grew at an annualised rate of 1.3 per cent between 2008 and 2015, expanding from 161 Mtoe to 176.8 Mtoe during the same period. In 2015, the share of bio-energy in the energy consumption was 31 per cent, down by 7 per cent since 2008. Bio-energy takes an overwhelmingly large share in energy consumption due to the fact that more than 70 per cent of the energy used in households in India is for cooking (whereas cooking constitutes less than 5 per cent of residential energy demand in Organisation for Economic Cooperation and Development [OECD] countries). Two-thirds of the Indian population rely on solid bio-mass as their cooking fuel (Government of India, 2012). However, the share of bio-fuels as a source of cooking fuel has been decreasing as more and more people are switching to liquefied petroleum gas (LPG) or other available and affordable alternatives.

The consumption of oil and oil products has grown at an annualised rate of 3.6 per cent during 2008 and 2014, increasing from 125 Mtoe to 160 Mtoe during the same period, although the share of oil reduced from 30 per cent to 28 per cent in the total Primary Energy consumption basket The increasing consumption of coal is the key contributor to the declining share of oil and oil products in the country. The transport sector is the single largest consumer of oil products in India and accounts for 47 per cent of the total consumption, followed by the industrial and residential sectors, which account for 15 per cent of the overall consumption.

Coal is currently the dominant source of energy for the industry. The consumption of coal has increased from 63 Mtoe in 2008 to over 116 Mtoe in 2015, expanding at an annual rate of 9.2 per cent. The industrial sector is the single largest consumer of coal and consumes 87 per cent of the overall coal in the country, followed by the commercial and residential sectors, which account for 5 per cent and 3 per cent, respectively, of the overall coal consumption in the country.

Natural gas is also becoming an important source of fuel in India's energy basket. Between 2008 and 2015, the consumption of natural gas increased from 20 Mtoe to 31.5 Mtoe, expanding at an annualised rate of 6.7 per cent per annum. Most of the natural gas in India is utilised for non-energy purposes, of which chemicals/petrochemicals consume 70 per cent of the overall gas in the country. The industrial sector is the second largest consumer of natural gas and consumes 16 per cent of the overall natural gas, followed by the transport and residential sectors, which consume 8 per cent and 2 per cent, respectively.

Figure 37 Primary Energy Consumption (Mtoe) in India



Source: India Energy Statistics, International Energy Agency and SARI/EI Analysis

The TPES in India grew at an annualised rate of 5 per cent between 2008 and 2015. It reached a record high of over 848 Mtoe in 2015, an increase of 3 per cent, as compared to the previous year.

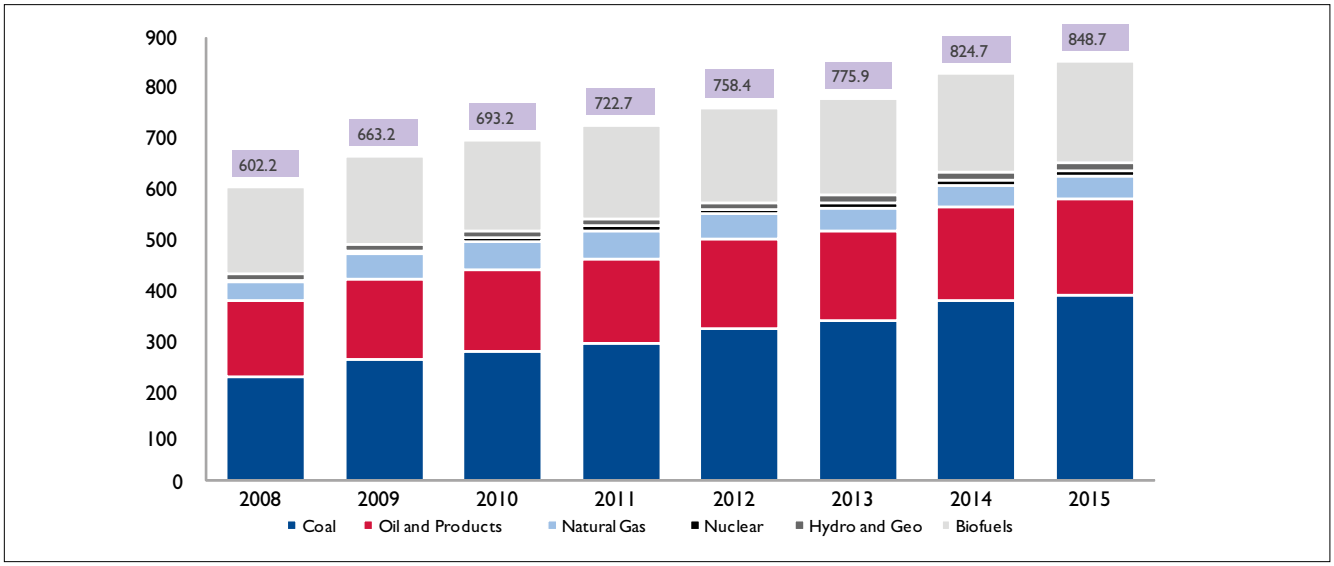
Coal is the largest source of energy supply in the country, accounting for over 46 per cent of the TPES in 2015, followed by bio-energy (23 per cent). The share of oil and oil products was 22 per cent, followed by natural gas and electricity, including nuclear, which accounted for 6 per cent and 1 per cent, respectively.

The supply of coal increased at an annualised rate of 7.7 per cent between 2008 and 2015, expanding from 230 Mtoe to 387 Mtoe during the same period. Coal as a source of fuel has gained importance in the energy mix of the country, and its share increased from 36 per cent in 2008 to 46 per cent in 2015. The increase in the production of domestic coal was one of the key contributing factors to the increasing share of coal in the supply mix. Of the overall coal supplied in the country, 69 per cent was domestically produced and 31 per cent was imported. The export of coal was .2 per cent or 0.8 Mtoe in 2015.

The supply of bio-energy increased from 170 Mtoe in 2008 to 194 Mtoe in 2015, expanding at an annual rate of 1.9 per cent. While the supply of bio-energy has increased in absolute terms, its share in the supply mix has decreased by five percentage to 23 per cent in 2015. Similarly, though the consumption of oil has increased in absolute terms by 40 Mtoe between 2008 and 2015, its share has also declined by three percentage to 22 per cent, as compared to the 2008 levels. Almost 17 per cent of the overall crude oil supplied in India is domestically produced, while 83 per cent is imported. In terms of oil products, 70 per cent is used for exports and 30 per cent is imported, mainly for domestic consumption.

The main issue regarding the energy supply and demand in India is that, whereas the energy demand has been growing and is expected to continue growing rapidly, the domestic production of coal, oil and natural gas has not kept pace with the increasing demand and hence the gap is being met through imports. The share of imports in meeting the energy demand of the country has hence increased from 37 per cent in 2009 to over 43 per cent in 2014. Crude oil and coal constitute 90 per cent of imports, while the remaining 10 per cent of the imports is in the form of natural gas, oil products and electricity, as per 2014 figures. In terms of export, India is a net exporter of oil products. The export of oil products has increased from 54 Mtoe in 2009 to 67 Mtoe in 2014.

Figure 38 **Total Primary Energy Supply (Mtoe) in India**



Source: India Energy Statistics, International Energy Agency and SARI/EI Analysis

5.3.2 Resource Potential

India is the largest country in the region both in terms of population (1.2 billion) and area (3,287,590 sq km). It has substantial deposits of coal (60,600 million tonnes) and a huge hydro potential (150,000 MW). It also plans to import natural gas through pipelines from the Middle East. India is investing heavily in nuclear power and solar energy. Its northeastern grid is linked to those of Bangladesh, Bhutan and Nepal. The eastern region of India is also rich in hydro resources. If exploited, Bangladesh can 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 northeastern and eastern regions of India, the countries will be net beneficiaries of the exchange of electricity. To implement the programme, it will be necessary to expand the capacities of the interconnection of the grids in the region, together with building new generating capacities.

Resource	Coal	Oil	Natural Gas	Bio-mass	Hydropower
	Million Tonnes	Million Barrels	TCF[23]	Million Tonnes	Gigawatts
India	60,600	5,749	53	139.00	150.00

Source: BP Statistical Review, 2016; IRADe Presentation, September 2016

Coal

India has the third largest hard coal reserves in the world (roughly 12 per cent of the world total), as well as significant deposits of lignite. The identified coal reserves in the country are around 60 BT. In addition to coal reserves, the estimated total reserve of lignite is 56 BT, of which 14 per cent is proven, 59 per cent is indicated, and the remaining 27 per cent falls in the category of inferred reserves.

Oil and Gas

India has a modest amount of oil and gas reserves and depends on imports to meet its domestic crude and petroleum requirements. The estimated potential of crude oil is 5,749 million barrels and that of natural gas is 53 TCF. Most of the crude oil reserves are located in the western offshore (Mumbai High) followed by Assam in the eastern part of the country. On the other hand, most of the natural gas reserves are located in the eastern part of the country, followed by the western offshore.

Hydroelectricity

India's hydropower potential, which can be economically exploited, is estimated at around 150 GW. The current installed hydropower capacity is around 45 GW, of which over 90 per cent is large hydro and represents a little under a third of the assessed resource. Much of the remaining potential is in the north and northeastern parts of the country.

Renewables

India has abundant renewable energy resources such as bio-mass and hydro (both large and small), wind and solar power. There is a technical potential for the development of 405 GW of wind energy, particularly in the western and the southern parts of the country. In the case of solar power, the overall potential is estimated at 748 GW. As for bio-mass and small hydro, the estimated potential is expected to be 17 GW and 19 GW, respectively.

[23]Trillion cubic feet

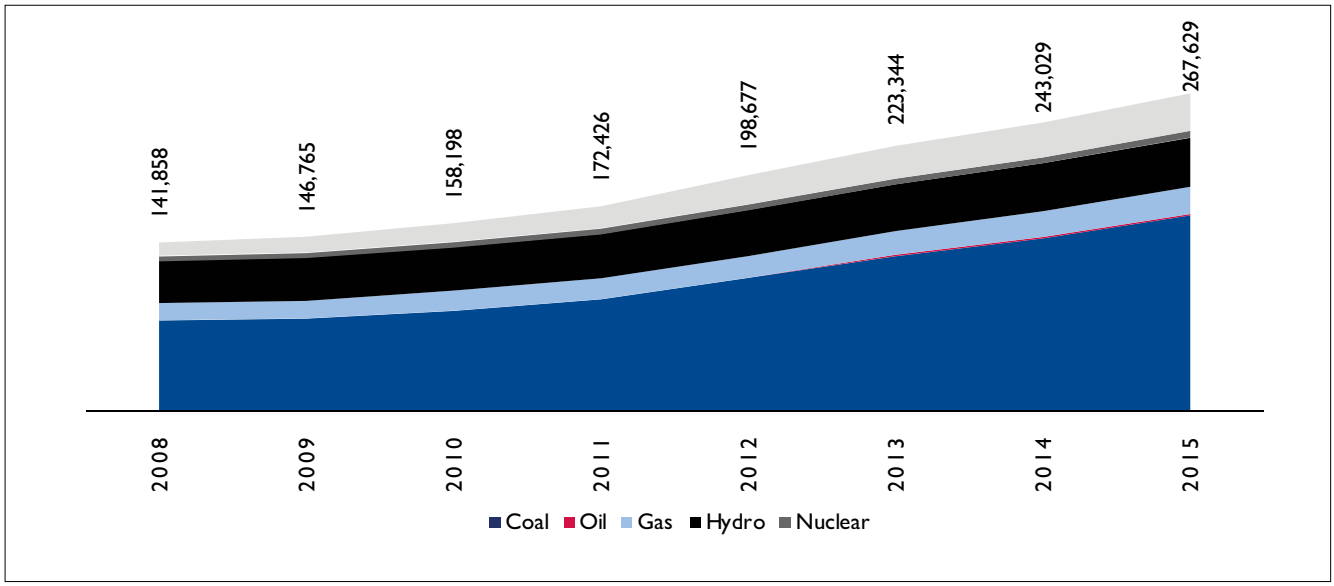
5.3.3 Electricity Sector

Generation

There has been an impressive growth in the power sector in India, both in terms of private sector participation and overall installed capacity addition, in recent years. The participation in the private sector has grown rapidly and the share of the private sector, including both large and small independent power producers, has increased from 13 per cent in 2008 to 38 per cent in 2015.

The installed generation capacity in India has grown significantly in 2008-15. During this period, the generation capacity in the country almost doubled from 141 GW to 267 GW. The coal sector has been the biggest beneficiary of the huge capacity addition programme and continues to remain the mainstay of the country's electricity mix, as it constitutes almost 61 per cent of the overall installed capacity. The share of renewables in the electricity mix has also increased. Since 2000, the share of renewables has grown from just below 1 per cent to over 12 per cent in 2015. Although hydropower is an important source of electricity in the country, its share in the electricity mix has decreased from 24 per cent in 2000 to below 15 per cent in 2015.

Figure 39 **Installed Capacity (MW) in India**



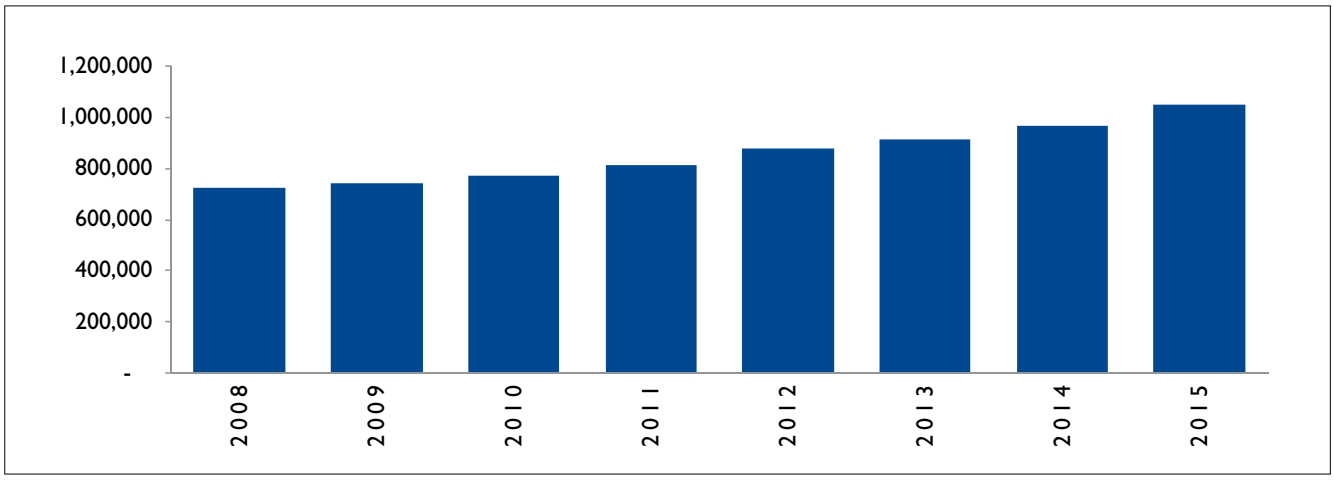
Source: National Electricity Plan, draft, CEA and SARI/EI Analysis

Demand

While the electricity demand has increased from 376 TWh in 2000 to over 984 TWh in 2015, growing at an annual rate of more than 6 per cent, the per capita consumption of electricity in the country is the lowest in the region, given the size of the economy. The per capita electricity consumption was 883.64 kWh at the beginning of 2012 and increased to 1,010 kWh in 2015.

The industrial sector is the major consumer of electricity as it uses 44 per cent of the overall electricity produced in the country. Residential or domestic consumers are the second largest consumers of electricity (24 per cent). Agricultural/forestry consume 9 per cent, while the transport sector uses just below 2 per cent of the overall electricity.

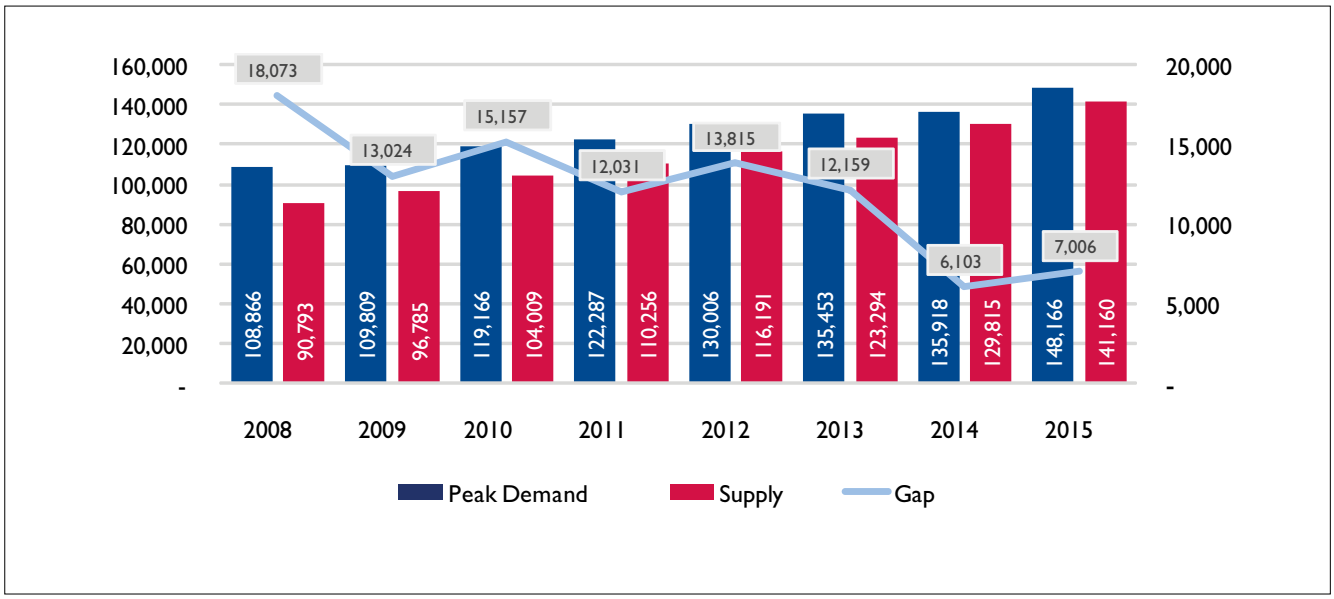
Figure 40 **Energy Requirement (GWh) in India**



Source: National Electricity Plan, Consultant's Analysis

Figure 41 shows that the country has been experiencing peak shortages. However, the peak demand-supply deficit has almost halved from 18 GW in 2008 to 7 GW in 2015. This is mainly on account of the increase in capacity addition.

Figure 41 **Peak Demand-Supply Gap (MW) in India**

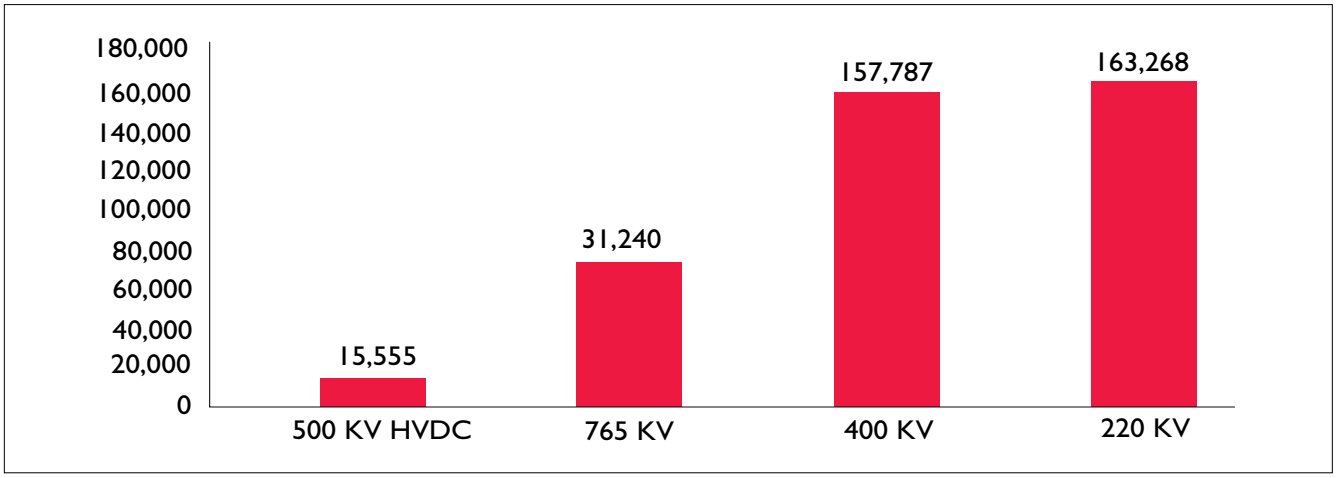


Source: CEA Report 2016

Transmission and Distribution

India has developed an extensive network of transmission lines over the years to evacuate power from the source of generation to demand centres across the country. By March 2017, the transmission sector comprised 15,556 cKM of +500 KV HVDC lines, 31,240 cKM of 765 kV lines, 157,787 cKM of 400 KV lines and 163,268 cKM of 220 kV lines.

Figure 42 **Transmission Network Profile (cKM) in India**



Source: Ministry of Power

Multiple cross-border interconnections have been established between India and the neighbouring countries such as Bangladesh, Bhutan, Myanmar and Nepal to promote cross-border electricity trade within the region. Approximately 16 links at 11/33/132/400 KV exist between India and Nepal through which 400 MW power is exported to Nepal. There is a 400 KV and HVDC link with Bangladesh through which 600 MW of power is exported by India. In 2016, an 11 KV link from Manipur in India to the border town in Myanmar was established, which exports 3 MW power to Myanmar. India imports around 1,450 MW power from Bhutan through interconnections from Tala, Chukha and Kurichu. These interconnections are at a voltage level of 400/220/132 KV.

5.3.4 Renewable and Energy Efficiency Initiatives

India has taken the lead in the renewable energy sector in the world with solar power as the key driver of its renewable policy framework. The GoI, in its submission to the United Nations Framework Convention on Climate Change on Intended Nationally Determined Contribution (INDC), has stated that India will achieve 40 per cent cumulative power capacity from non-fossil fuel-based energy resources by 2030. The Government has also set an ambitious target of reaching 175 GW of renewable energy capacity by 2022. It is playing an active role in promoting the adoption of renewable energy resources by offering various incentives, such as generation-based incentives (GBIs), capital and interest subsidies, viability gap funding, concessional finance, fiscal incentives and so on. The National Solar Mission (NSM) targets have been revised from 20 GW to 100 GW by 2022. This is being supported by several initiatives such as:

- Scheme for development of large ultra mega and mega solar parks.
- Development of solar cities programme.
- Rooftop solar programme targeted at the residential and commercial categories.
- Off-grid solar projects.
- Green Energy Corridor project.

The first phase of NSM focussed on capturing the low hanging options in solar, on promoting off-grid systems to serve rural populations and a modest capacity addition in grid-based systems. This was partly foreseen as a learning experience for further, more ambitious goals. Now, in the second phase,

an aggressive capacity ramp-up is targeted. The aim is to create favourable conditions for up-scaled and competitive solar energy penetration in both, centralised and decentralised levels.

The National Mission for Enhanced Energy Efficiency (NMEEE) is one of the eight missions under the National Action Plan on Climate Change (NAPCC). NMEEE aims to strengthen the market for energy efficiency by creating a conducive regulatory and policy regime by fostering innovative and sustainable business models. The Perform Achieve and Trade (PAT) scheme is one of the initiatives under NMEE to enhance cost-effectiveness in improving energy efficiency in energy-intensive industries through the certification of energy saving, which can be traded. Similarly, the Super-Efficient Equipment Programme (SEEP) has been designed to bring accelerated market transformation for super-efficient appliances by providing innovative financial stimulus.

The Ministry of Power, Government of India, through the Bureau of Energy Efficiency (BEE), has started a number of energy efficient initiatives in the areas of household lighting, commercial buildings, standards and labelling of appliances, demand side management in agriculture/municipalities, small and medium enterprises (SMEs) and large industries. The key schemes to promote energy conservation and energy efficiency include:

Standards and Labelling
The Bureau initiated the Standards and Labelling programme for equipment and appliances in 2006 to realise the cost-saving potential of 19 equipment/appliances—room air conditioners, fluorescent tubelights, frost-free refrigerators, distribution transformers, induction motors, direct cool refrigerators, electric storage type geysers, ceiling fans, colour television sets, agricultural pump sets, LPG stoves, washing machines, laptops, ballast, floor standing air conditioners, office automation products, diesel generating sets and diesel operating pump sets.

Energy Conservation Building Codes
The Energy Conservation Building Code (ECBC) was developed for new commercial buildings in 2007. It sets minimum energy standards for new commercial buildings with a connected load of 100 kW or contract demand of 120 KVA and above. BEE has developed a voluntary star rating programme for four categories of buildings (day use office buildings/BPOs/shopping malls/hospitals), which is based on the actual performance of a building.

Agriculture Demand Side Management Scheme
The Agriculture Demand Side Management (AgDSM) programme has been initiated with an objective to induce energy efficiency in the agriculture sector by creating a market-based framework for the adoption of energy-efficient pump sets (EEPS). Few states have mandated the use of BEE star rated pump sets for every new agricultural connection.

Municipal Demand Side Management Scheme
BEE initiated the Municipal Demand Side Management (MuDSM) programme with the objective to improve the overall energy efficiency of the Urban Local Bodies (ULBs), which could lead to substantial savings in electricity consumption.

The GoI also launched the National Mission on Electric Mobility (NMEM) in 2011 and subsequently the National Electric Mobility Mission Plan-2020 (NEMMP) in 2013.[24] The vision of the NEMMP-2020 is to encourage reliable affordable and efficient mild hybrid, strong hybrid, plug-in hybrid and pure electric technologies (collectively termed as xEV) that meet the performance and price expectations of vehicle

[24] http://dhi.nic.in/writereaddata/Content/NEMMP2020.pdf

users. The NEMMP-2020 aimed at bringing the rapidly growing vehicle population in India to consist of about 5-7 million electric/hybrid vehicles by 2020.

5.3.5 Reforms and Restructuring

The Indian power sector has come a long way since the laying down of the basic framework in 1910 right up to the Electricity Act of 2003, which brought about necessary changes. Over the decades, the sector has moved from being mostly a vertically integrated structure with the State Electricity Boards (SEBs) owning the generation, transmission and distribution businesses to a more unbundled corporate structure.

When India gained independence from British colonial rule in 1947, private companies or local authorities supplied more than four-fifth of the total generation capacity in the country, which amounted to slightly less than 1,400 MW. Subsequently, the Electricity Supply Act 1948 was enacted by the GoI, leading to the establishment of State Electricity Boards, which took over the licensees operating in the private sector. Thus, by virtue of enacting the Electricity Supply Act, the Government limited the provisions of the Electricity Act 1910 that allowed public and private companies to participate in the generation business.

The period between 1948 and 1991 witnessed remarkable development in the electricity sector, particularly the generation segment, in the country. During this time, the generation capacity grew by over 50 times, at a breakneck speed of 9.2 per cent. The availability of electricity not only supported the rapid economic expansion in the infrastructure sector, but also improved the electrification rate in the country.

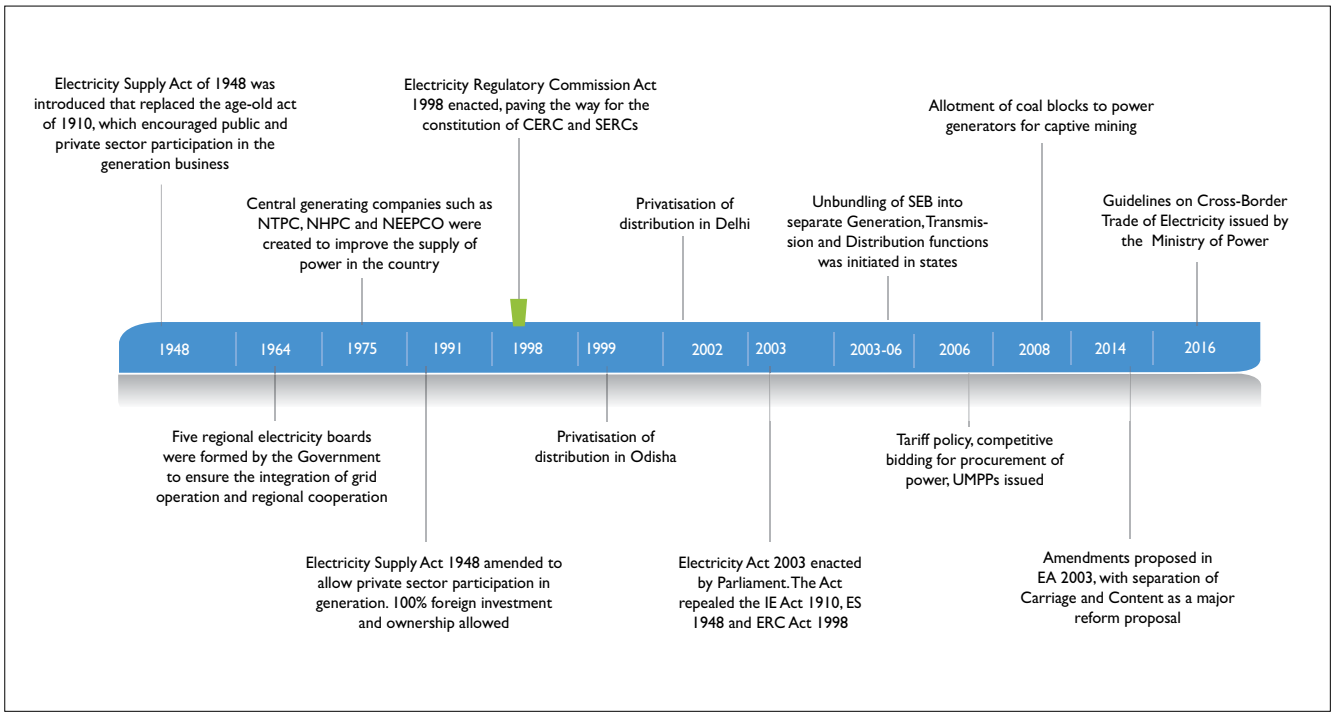
While in this phase of power sector reforms, the Government focussed at adding more power generation capacity in the country, it largely neglected the distribution sector. Structural inefficiencies that had crept into the sector on account of continued political interference and subsidised electricity without adequate compensation, led to financial difficulties for the SEBs. The inefficiencies in the distribution sector also began to manifest themselves in the form of poor quality of power, both in terms of availability and fluctuations, brownouts and blackouts, which not only rankled but also caused inestimable financial losses to all users. Considering the state of the sector, by the end of the 1980s there was broad consensus that the power sector was in dire straits, and that major reform was needed to change its functioning.

The year 1991, therefore, became a watershed of sorts in the history of the Indian power sector. The Ministry of Power published a notification permitting private entities to establish, operate and maintain generating power plants of virtually any size and to enter into long-term power purchase agreements with SEBs.

The period following 1991 has witnessed multiple reforms across the value chain. The first in the succession was the passage of the Orissa Electricity Reform Act, which was considered as a landmark measure, as it marked a departure from the common framework with regard to the functioning of the sector. Though what transpired in Odisha, post the power sector reforms, is far from the textbook outcome, it succeeded in the decentralisation of responsibilities from one bundled entity with an attendant improvement in the performance of the sector.

By the late 1990s, several other states had initiated reforms along the same lines as Odisha but the establishment of a Regulatory Commission in 1998 paved the way for the independent functioning of the sector with virtually no role for the Government. This measure was followed by another landmark one in the form of the Electricity Act 2003 in which all other rules and laws related to the power sector were subsumed.

Figure 43 **Evolution of the Electricity Sector in India**



5.3.6 Institutional Framework

The Indian power sector has a federal structure where both the centre and the state have the authority to make rules in their respective jurisdictions. The Ministry of Power (MoP) is the apex body for decision-making in the Indian power sector. At the central level, CEA and BEE are responsible for formulating policy and act as planning advisors to the MoP. The Central Electricity Regulatory Commission (CERC) and the State Electricity Regulatory Commissions (SERCs) are regulators at the central and state levels. The central level has both, power generation and power transmission, but it does not have any distribution player under it. The states have separate transmission, generation and distribution entities. Private players also have their presence in the transmission, generation and distribution sectors.

Power sector policies are developed by the MoP at the central level and by the state energy ministries at the state level. These policies become the governing blocs for the sector. Based on these policies, various rules and regulations are issued by the respective authorities, including the CEA, CERC, SERCs and so on.

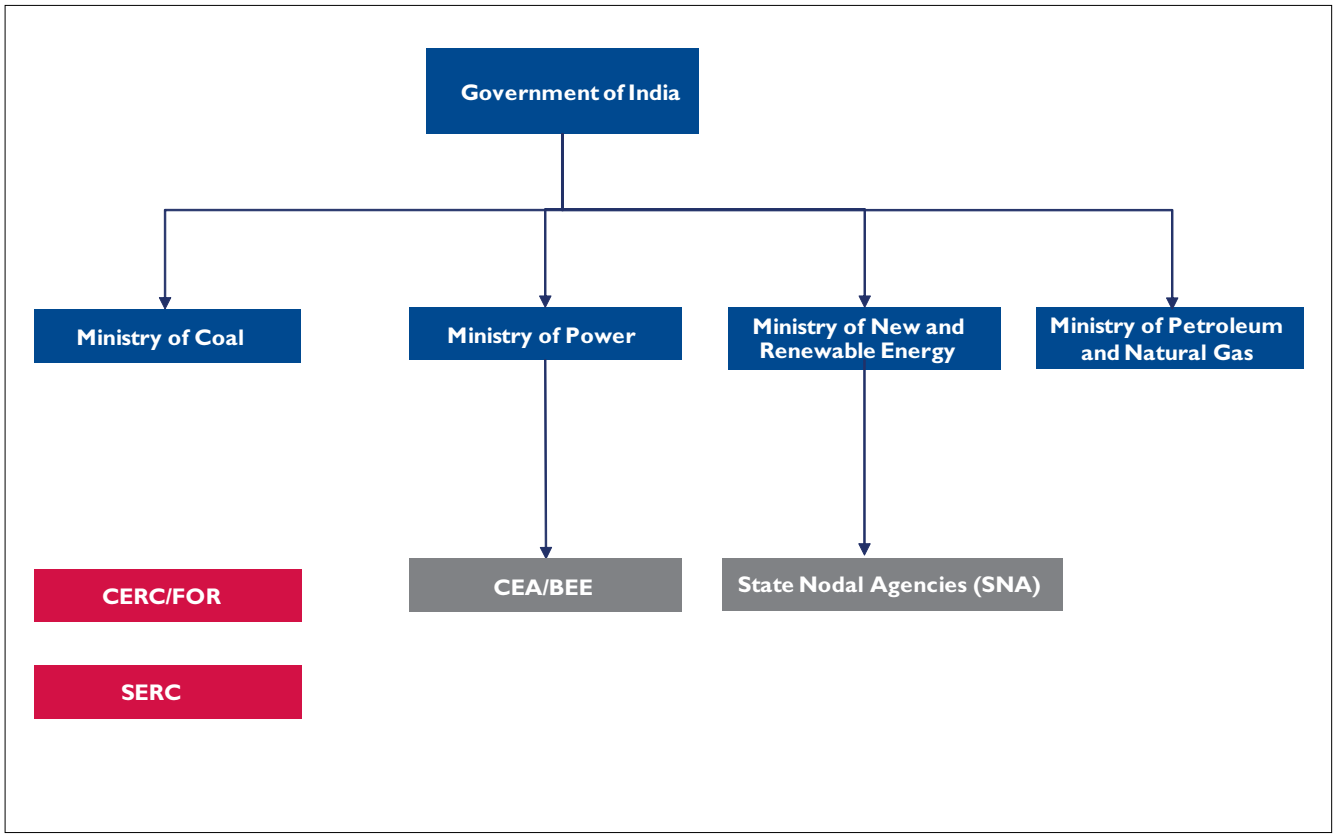
India has the most evolved policy and legal framework for power generation, transmission and distribution among the South Asian countries. The Electricity Act 2003 provides the legal foundation of the power sector in the country. The Act was introduced to promote competition in the Indian power sector. It triggered a process of transformation in the sector, changing it from a vertically integrated power market to an unbundled one.

In terms of policy framework, India has several policies for the development of different sections of the power sector, including the National Tariff Policy, 2016, issued by the MoP to add new generation capacity and enhance the per capita availability of electricity. Further, it focusses on the development of RE in the country through enabling provisions for the off-take and inter-state sale/purchase of RE. Under the National Action Plan on Climate Change, India is focussing on the development of its

RE capacity through Renewable Purchase Obligation (RPO) targets. India has set a target of 175 GW to be achieved by 2022. To revamp the distribution sector, the country has recently initiated a scheme called UDAY, to ensure 24x7 power to all. The scheme focusses on the improvement in operational efficiencies and incentivising them, based on the reduction in Aggregate Technical and Commercial (AT&C) losses.

India has seen multiple power sector reforms. In short, the period of 1991-2014 could be termed the liberalisation era with legislative and policy initiatives (1991), private sector participation in generation, enactment of the Electricity Regulatory Commissions Act (1998) for establishing CERC and SERCs and the Electricity Act (2003), the introduction of the Accelerated Power Development Reforms Programme (APDRP)/Restructured Accelerated Power Development Reforms Programme (RAPDRP)/Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) to improve electrification in India. Post 2014 could be referred to as an accelerated growth period, where India observed the highest coal production, the highest increase in power generation and transmission capacity addition, the implementation of the Integrated Power Development Scheme (IPDS) and the Deen Dayal Upadhyay Gram Jyoti Yojana (DDUGJY) and the launch of the world's largest LED movement and the UDAY scheme.

Figure 44 **Institutional Framework in India**



5.4 Myanmar

Myanmar, officially the Republic of the Union of Myanmar and earlier known as Burma, is a sovereign state in Southeast Asia bordered by Bangladesh, India, China, Laos and Thailand. About one-third of Myanmar's total perimeter of 5,876 km forms an uninterrupted coastline of 1,930 km along the Bay of Bengal and the Andaman Sea.

Despite economic sanctions since the late 1980s, the country's economy has maintained a relatively steady growth rate of 3.83 per cent during 2010-15 and an annualised growth rate of 15 per cent during 2000-15. The economy is predominantly agriculture-based, with agriculture contributing approximately 36 per cent of the overall GDP, down from 57 per cent in 2001. In comparison, the contribution of the industrial sector in the country's GDP has more than doubled to 26 per cent. The liberalisation of the economy and the opening up to FDI has prompted the rapid growth of the industrial sector, notably the export of natural gas.

5.4.1 Primary Energy

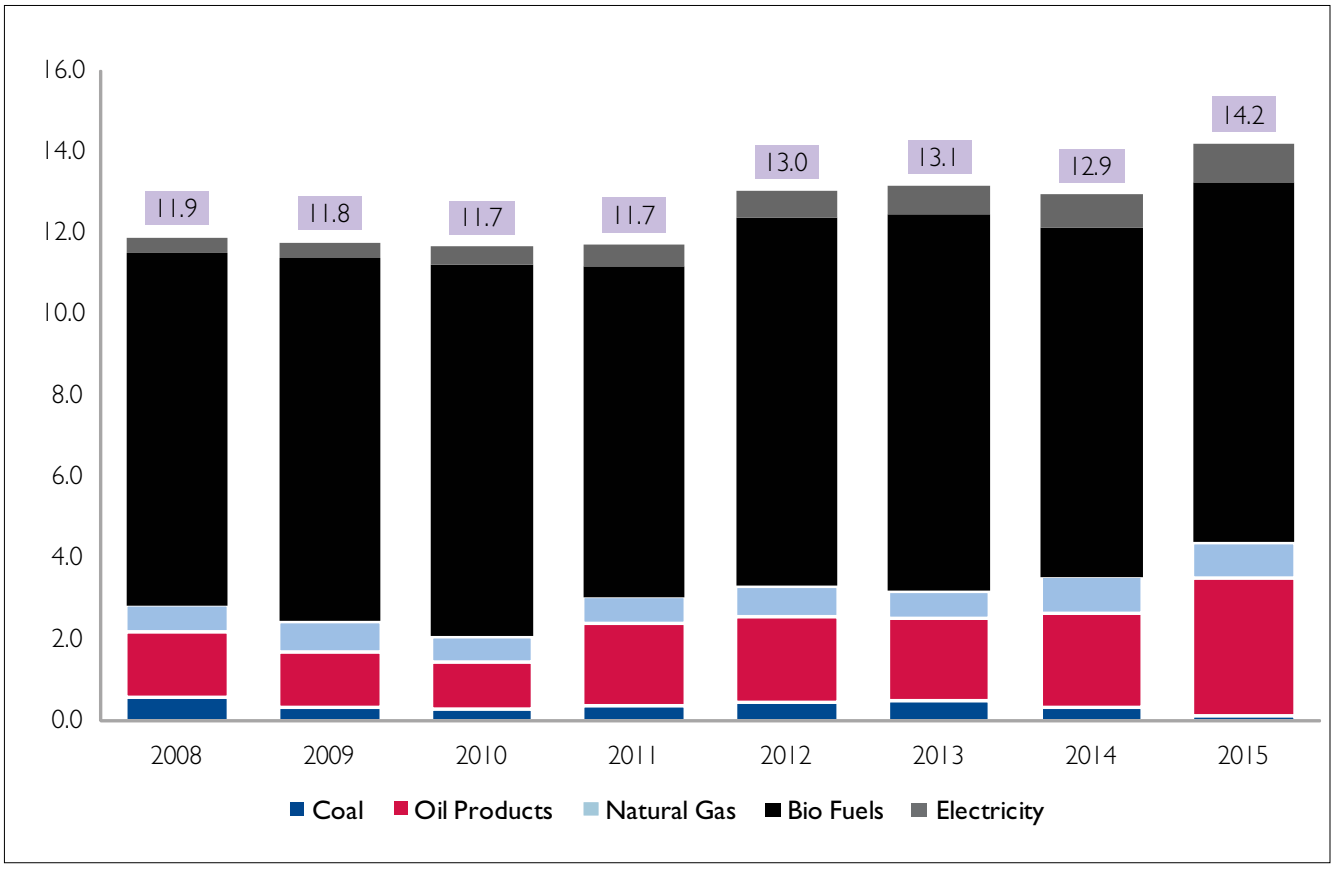
Between 2008 and 2015, Myanmar's total primary energy consumption increased from 11.9 Mtoe to 14.2 Mtoe, growing at an annualised rate of 2.56 per cent. The residential sector is the largest consumer of energy, consuming 60 per cent of the total energy supplied in the country, followed by the industrial and transport sectors, which account for 12 per cent and 24 per cent of the overall consumption, respectively. Between 2014 and 2015, the share of the residential sector in the overall primary energy consumption had decreased by 3 per cent and that of the industrial sector had dropped by 1 per cent. Contrary of this, the share of the transport sector in the overall energy consumption has increased by 5 per cent.

The breakdown of the energy consumption pattern since 2008 shows that bio-fuel and oil products have been the main fuels for energy consumption. Bio-fuel and bio-waste took an overwhelmingly large share (62 per cent) in energy consumption in 2015. This was due to the fact that a large number of the country's total population live in rural areas, meeting most of their energy needs (domestic, commercial and industrial) from traditional bio-mass fuels and that 73 per cent of the population do not have access to electricity.

The consumption of oil and oil products as a source of energy is the second largest in Myanmar, after bio-fuel, and has increased from 13.4 per cent in 2000 to over 24 per cent in 2015. The transport sector is the single largest consumer of oil in Myanmar, accounting for 62 per cent of the total oil consumption. The industrial sector is the second largest consumer of oil (17 per cent). The major petroleum products consumed in Myanmar are gas/diesel oil, motor gasoline and jet kerosene. Gas and diesel oil constitute some 59 per cent of the petroleum demand, followed by motor gasoline (24 per cent) and jet kerosene (5 per cent).

Although Myanmar is rich in gas reserves, the share of gas in the country's primary energy consumption mix has been fairly limited. Between 2008 and 2015, the consumption of natural gas has increased from 0.5 Mtoe to 0.9 Mtoe, growing at an annualised rate of 8 per cent. This is due to the fact that around 75 per cent to 80 per cent of Myanmar's domestically produced natural gas is exported to Thailand and more recently to the People's Republic of China (PRC). Domestically, the industrial sector accounts for 54 per cent of the overall gas consumption whereas the transport sector accounts for 25 per cent.

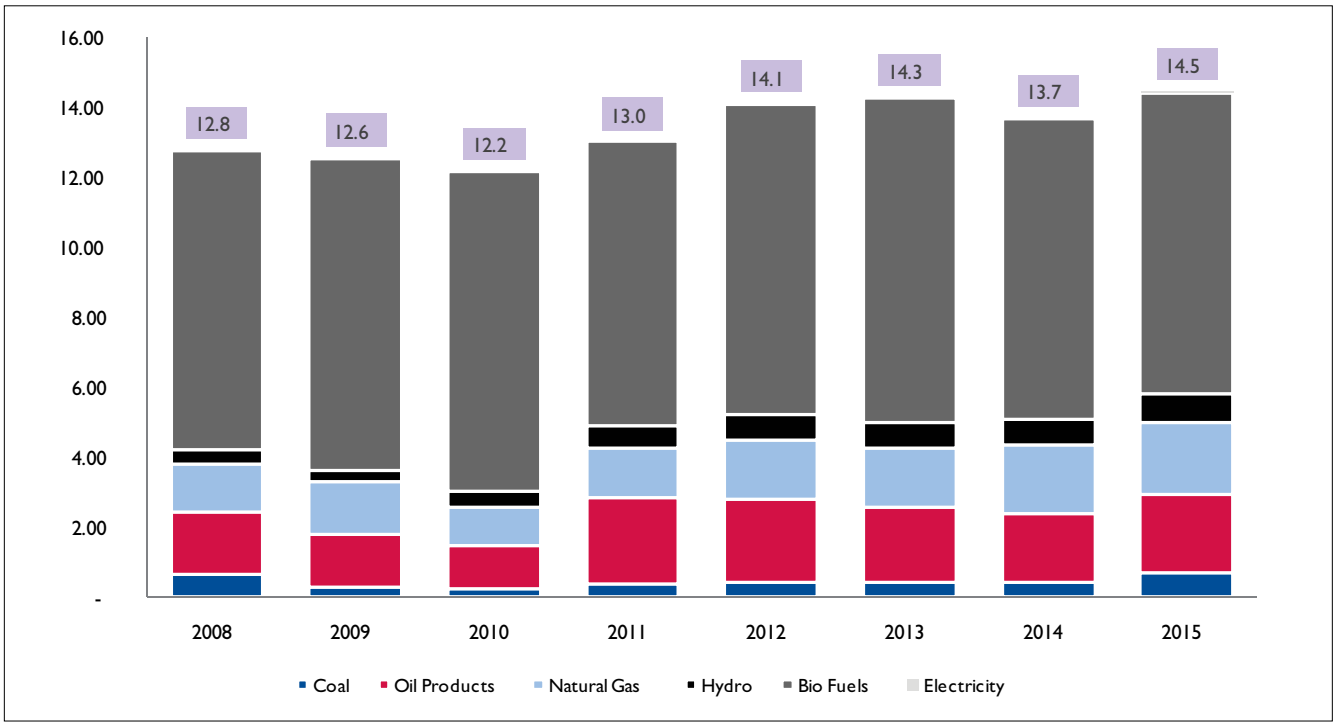
Figure 45 **Total Primary Energy Consumption (Mtoe) in Myanmar**



Source: International Energy Agency, Myanmar's Energy Master Plan 2010

The total primary energy supply in Myanmar increased from 12.8 Mtoe in 2008 to 14.5 Mtoe in 2015, an increase at an annualised rate of 2.47 per cent during the period. The country's primary energy supply consists of coal, oil, gas, hydropower and bio-mass. In 2015, bio-energy made up 60 per cent of the overall primary energy supply, whereas coal, oil, natural gas and hydro accounted for 5 per cent, 15 per cent, 14 per cent and 6 per cent, respectively. Clearly, natural gas is less dominant as a source of domestic fuel supply in the TPES as the majority of gas produced is exported. The use of petroleum products have trended up in the last five years with an increase in imported diesel. The majority of the bio-mass is fuelwood, with charcoal being the other main source.

Figure 46 Total Primary Energy Supply (Mtoe) in Myanmar



Source: International Energy Agency, Myanmar's Energy Master Plan, 2010

5.4.2 Resource Potential

Myanmar has significant deposits of natural gas, coal, oil and bio-mass. The resource-wise potential for Myanmar is shown here.

Resource	Coal	Oil	Natural Gas	Bio-energy	Hydropower
	Million Tonnes	Million Barrels	Trillion Cubic Feet	Million Tonnes	Gigawatts
Myanmar	466	459	17	38	108

Source: BP Statistical Review, 2016; Myanmar Energy Master Plan 2015

Coal

Myanmar has identified 34 major coal deposits with a total proven reserve capacity of 468 MT. The largest coal reserves are located in the Sagaing division and Shan state—northwest and central east of Myanmar.

Oil and Gas

Myanmar possesses large reserves of natural gas, both onshore and offshore, while it does not have significant oil resources. The estimates for the natural gas reserves vary and, with proven reserves of around 16.6 TCF, the recoverable gas reserves could be around 52 TCF.[25] The country's proven oil reserves (offshore and onshore) are estimates at 459 million barrels (mmbbl).

[25]http://www.burmalibrary.org/docs22/2015-12-Myanmar_Energy_Master_Plan.pdf

Hydroelectricity

Myanmar also has great hydropower potential through its major rivers, which drain the four main basins of Rivers Ayeyarwaddy, Chindwin, Thanlwin and Sittaung; the capacity is estimated to be about 108 GW. As per the long-term generation expansion plan, the Government has identified 58 projects with a total capacity of 45 GW for development.

Renewables

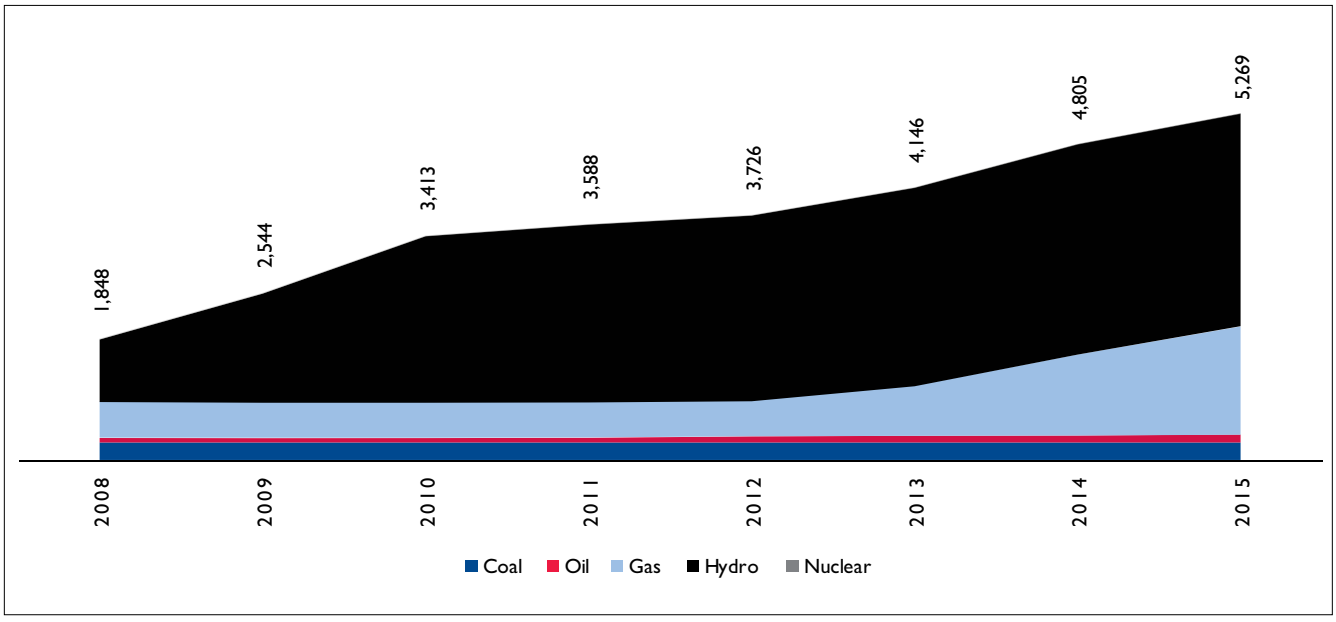
Myanmar has abundant renewable energy resources such as bio-mass and hydro, wind and solar power. The overall solar potential is estimated at 51,973 TW-hours per year. The country has significant resources of wind energy, estimated to be 365 TWh as the technical potential per year (Myanmar Energy Master Plan, 2015). Renewable energy in Myanmar has recently been a focus area in order to bring clean energy sources to non-electrified villages through off-grid means.

5.4.3 Electricity Sector

Generation

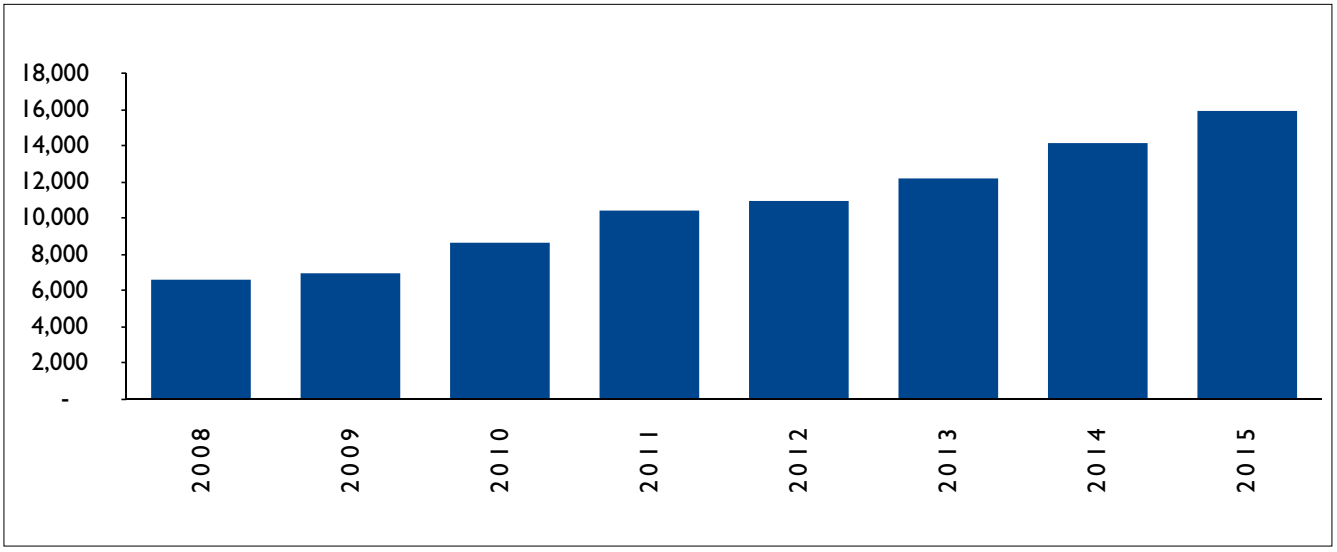
Between 2008 and 2015, the overall installed capacity in Myanmar has increased from 1,848 MW to 5,269 MW, growing at an annualised rate of over 16 per cent. Hydropower is the major source of electricity generation in Myanmar and it accounts for 61 per cent of the electricity generation mix, followed by natural gas (32 percent). The hydro generation capacity almost doubled between 2008 and 2011 with the commissioning of several large hydro projects: Shweli-1 (600 MW), Yeywa (790 MW) and Dapein-1 (240 MW). Coal and oil are the other sources of electricity generation in the country; however, their share in the electricity mix is limited. Between 2008 and 2011, the overall coal-based capacity remained stagnant, at 285 MW, which resulted in the share of coal declining from 15 per cent in 2008 to 5 per cent in 2015. By 2015, the overall oil-based generation stood at just over 100 MW, increasing at an annualised rate of 8.5 per cent. Despite this growth rate, the share of oil in the electricity mix is 2 per cent.

Figure 47 Installed Capacity (MW) in Myanmar



Source: Energy Master Plan 2015, Central Statistical Organisation, Department of Electric Power Planning, Myanmar

Figure 48 Energy Requirement (GWh) in Myanmar



Source: Central Statistical Organisation, Myanmar and Myanmar's Energy Master Plan, 2010

Demand

Electricity consumption has increased significantly between 2008 and 2015, from 6,621 GWh to 16,000 GWh, growing at an annualised rate of over 13 per cent. The industrial, residential and commercial sectors are the major end users of electricity (in descending order). The industrial sector has had an annual average growth rate of 15 per cent over the last few years, followed by 13 per cent in the commercial sector and 11 per cent in the residential sector.

5.4.4 Transmission and Distribution

Myanmar's national grid consists of 250 transmission lines operating at different voltage levels of 500 KV, 230 KV, 132 KV, 66 KV, 33 KV and 11 KV. The transmission system is concentrated around the major load centres, conveying electrical energy from the more remotely located generation sources in the north and south. The network comprises more than 44 overhead lines at 230 KV with a total length of 3,979 km; 41 overhead lines at 132 KV with a total length of 2,334 km; 100 overhead lines at 66 KV with a total length of 3,729 km; 11 overhead lines at 33 KV, with a total length of 27 km, among others.

Cross-border connections have been established to export power from the 600 MW Shweli-1 Hydropower Plant and the Dapein Hydropower Plant to China. A study of future cross-border power connections within the Greater Mekong sub-region suggests that potential export from Myanmar to China may reach 100 TWh, which would require between 20–30 GW of transmission capacity. However, authorities have made no definite decision on the specific routes or the schedule of construction (ADB 2013c). Thailand may also import more power in the future; the same study noted that some 6,000 MW of transmission capacity will be required if the additional export of power should materialise.

5.4.5 Renewable and Energy Efficiency Initiatives

Myanmar does not have a policy specific to renewable energy though some of the existing policies relate to the RE sector. The National Energy Policy (NEP), 2015, includes points relating to the implementation of programmes for RE, comprising solar, wind, hydro, geothermal and bio-energy resources. The Government has not set any specific RE targets although there are plans for developing small hydro and

bio-fuels. It is developing a comprehensive energy policy, in particular, to extend electrification to the rural population.

The energy efficiency initiatives in Myanmar are still in the initial phase of development. The Government is aiming to establish the legal and regulatory framework and dedicate resources for the energy efficiency and conservation initiatives.

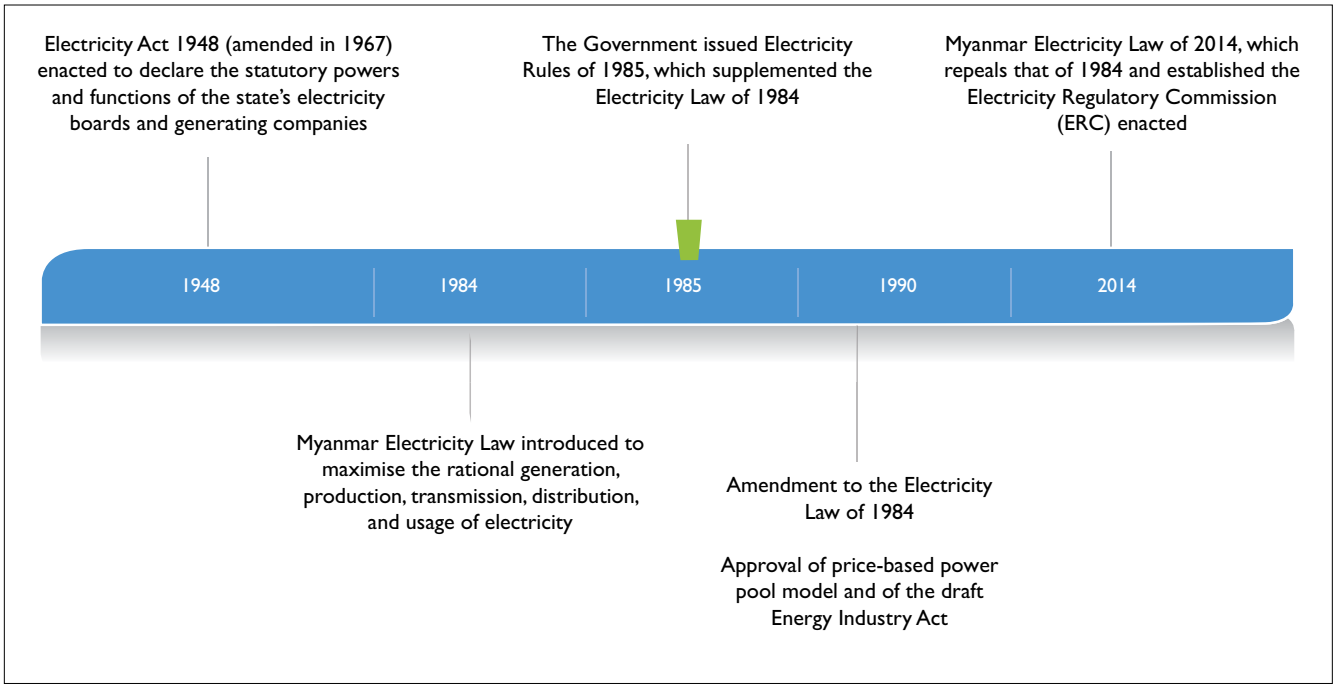
5.4.6 Reforms and Restructuring

The electricity sector in Myanmar was historically governed by the Electricity Law (1984), which was amended in 1990 until it was replaced by the new Electricity Law 2014. The old electricity law was enacted during Myanmar's socialist period and lacked the legal framework to include private sector participation in power projects and independent power producers. It empowered the Government to grant rights to specified organisations, including foreigners, to participate in the sector. In addition, the old law placed importance on the electricity inspector by making the Electrical Inspection Department responsible for settling disputes between the producers and consumers of electricity.

The new Myanmar Electricity Law was enacted by the Myanmar Parliament on 27 October 2014, replacing the law of 1984. This law has been enacted with an aim to introduce a legal framework that would reflect current international standards and encourage foreign and domestic investments in Myanmar's power projects. One of the main features of the new law is to establish the Electricity Regulatory Commission (ERC) to supervise the monopolistic electric power entities. This law provides a limited grant of regulatory responsibilities to the ERC.

The law gives the Ministry of Electric Power (MOEP), region and state governments and leading bodies of Self-Administrated Zones (SAZ) and Self-Administrated Divisions (SAD) the power to grant permits to allow persons to engage in electricity-related works, including the generation, transmission and distribution of power.

Figure 49 Evolution of the Electricity Sector in Myanmar



5.4.7 Institutional Framework

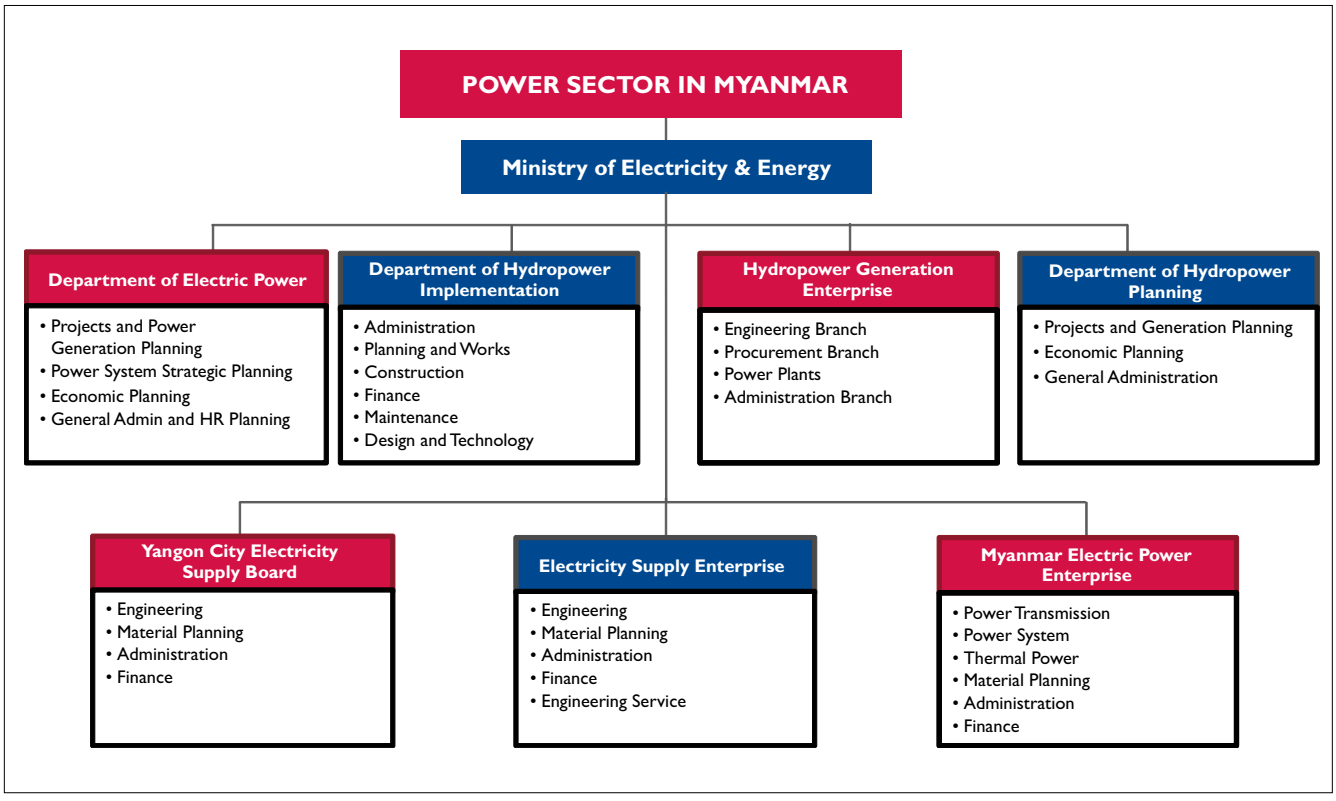
In Myanmar, eight ministries are liable for the overall functioning of the energy sector. The Ministry of Energy spearheads the entire sector in the country. MOEP takes care of the policy formulation in the sector.

The Myanmar Electricity Law of 2014 governs the power sector of Myanmar. It institutionalises the ERC and awards it some regulatory duties. The law authorises the MOEP, region and state governments, and leading bodies of SAZs and SADs the power to grant permits to entities to engage in electricity-related works such as generation, transmission and distribution.

The power sector of Myanmar is governed by the following policies:

- Effective utilisation of the power generated from available resources such as thermal, hydro, solar, wind and other alternative resources by the expansion of the national power grid.
- Conduct the socio-impact analysis for generation and transmission projects to minimise undesirable impact.
- Restructure the power sector to encourage the participation of local and foreign investments and the formation of competitive power utilities.
- Boost the growth and development of power generation, transmission and distribution throughout the country and the employment of PPP in each sector.
- Conduct electricity generation, transmission and distribution in accordance with progressive technologies, and develop private participation in regional distribution activities.

Figure 50 Institutional Framework in Myanmar



5.5 Nepal

Nepal is a landlocked country located in South Asia between China on the eastern side and India on the western and northern sides. It covers a total area of 147,180 sq km and its boundary is 2,926 km in length, bordered by China (1,236 km) and India (1,690 km). Of Nepal's total land mass, forest occupies 40.36 per cent while 4.38 per cent is covered by shrubs.

5.5.1 Primary Energy

The energy consumption in Nepal has been growing consistently over the past few years. Between 2008 and 2015, it grew from 9.5 Mtoe to 11.7 Mtoe. Bio-fuels and waste are the main source of energy consumption in the country. This is due the fact that the majority of the population resides in the rural areas and depends on bio-fuels and waste to meet their energy requirements. Though in absolute terms, the consumption of bio-fuels has increased from 8.4 Mtoe in 2008 to 9.6 Mtoe in 2015, its share has come down from 88 per cent to 81 per cent during the same period.

The availability and increase in the consumption of alternative sources of fuels, such as electricity, oil products and coal, are some of the main reasons for the decreasing share of bio-fuels in the country. In addition, increasing household and village electrification has contributed to the replacement of bio-fuels as a source of fuel consumption.

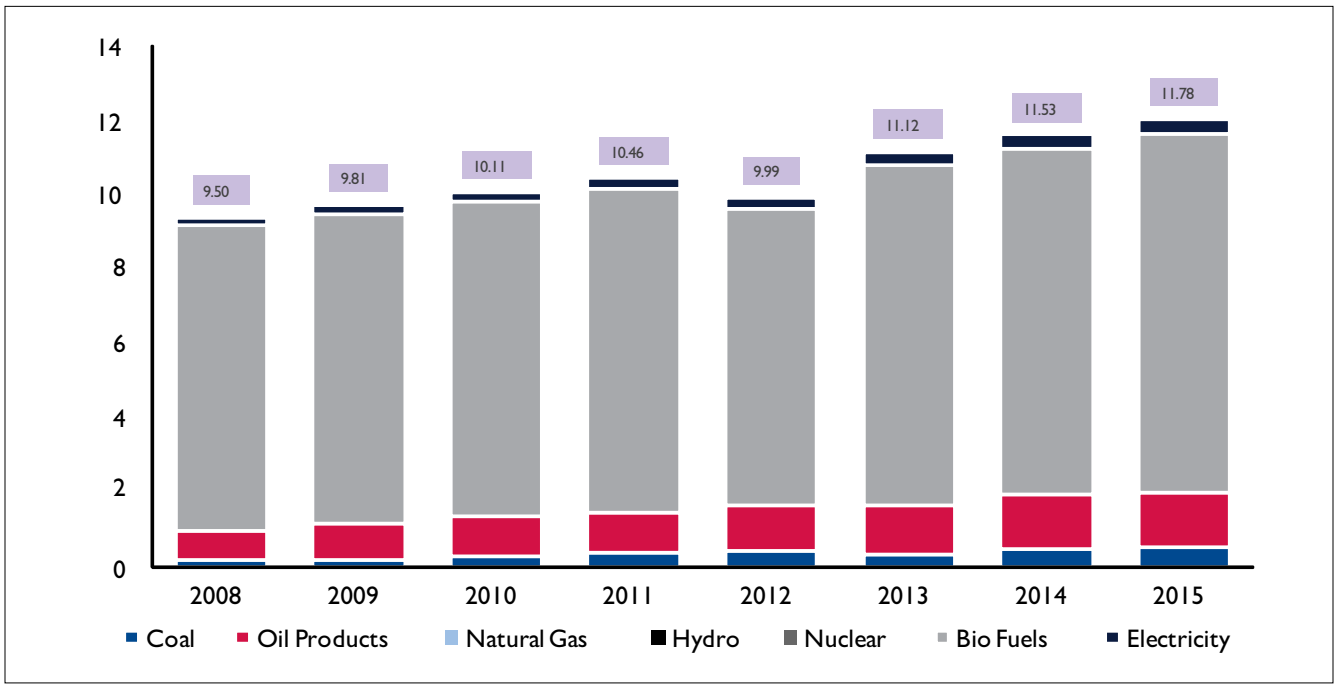
Between 2008 and 2015, the consumption of coal has increased from 0.2 Mtoe to over 0.5 Mtoe, growing at an annualised rate of 15 per cent. The industrial sector is the single largest consumer of coal and accounts for 99.6 per cent of the overall coal consumption, the remaining .4 per cent of coal is consumed by the residential sector. Similarly, the consumption of oil and petroleum products has also increased from 0.7 Mtoe in 2008 to 1.4 Mtoe in 2015, growing at an annualised rate of 9 per cent. The transport sector is the single largest consumer of oil and petroleum products and accounts for 65 per cent of the overall consumption, followed by the residential, commercial and public services and agriculture/forestry sectors that consume 13 per cent, 10 per cent and 11 per cent, respectively. The industrial sector is one of the lowest consumers of oil and petroleum products and accounts for 1 per cent of the overall consumption.

The consumption of electricity has also increased over the past few years. Between 2008 and 2015, it grew from 0.2 Mtoe to over 0.3 Mtoe, at an annualised rate of 9 per cent. The residential sector is the major consumer of electricity and accounts for 50 per cent of the overall electricity consumed in Nepal, followed by the industrial sector, which accounts for 31 per cent of the consumption. Commercial, public service and agriculture are some of the other sectors that consume electricity and account for 13 per cent and 3 per cent, respectively, of the overall electricity consumption.

The total primary energy supplied in the country has increased from 9.6 Mtoe in 2008 to 11.9 Mtoe in 2015, expanding at an annualised rate of 3 per cent during the same period.

Bio-fuels and waste comprise the main source of energy supply in Nepal as they constitute approximately 85 per cent of the overall energy supply mix, followed by oil and oil products (9 per cent). Hydropower and coal constitute 3 per cent each of the energy supply mix. Nepal is a net importer of energy and imports oil products, coal and electricity from neighbouring countries. The import of oil products has increased from 1 Mtoe in 2009 to 1.5 Mtoe in 2015, an increase of 50 per cent since 2009. Oil products are mostly imported to meet the energy demand by the transport sector as the country has limited resources for processing crude oil. Similarly, the import of coal has also increased from 0.2 Mtoe in 2009 to 0.5 Mtoe in 2015.

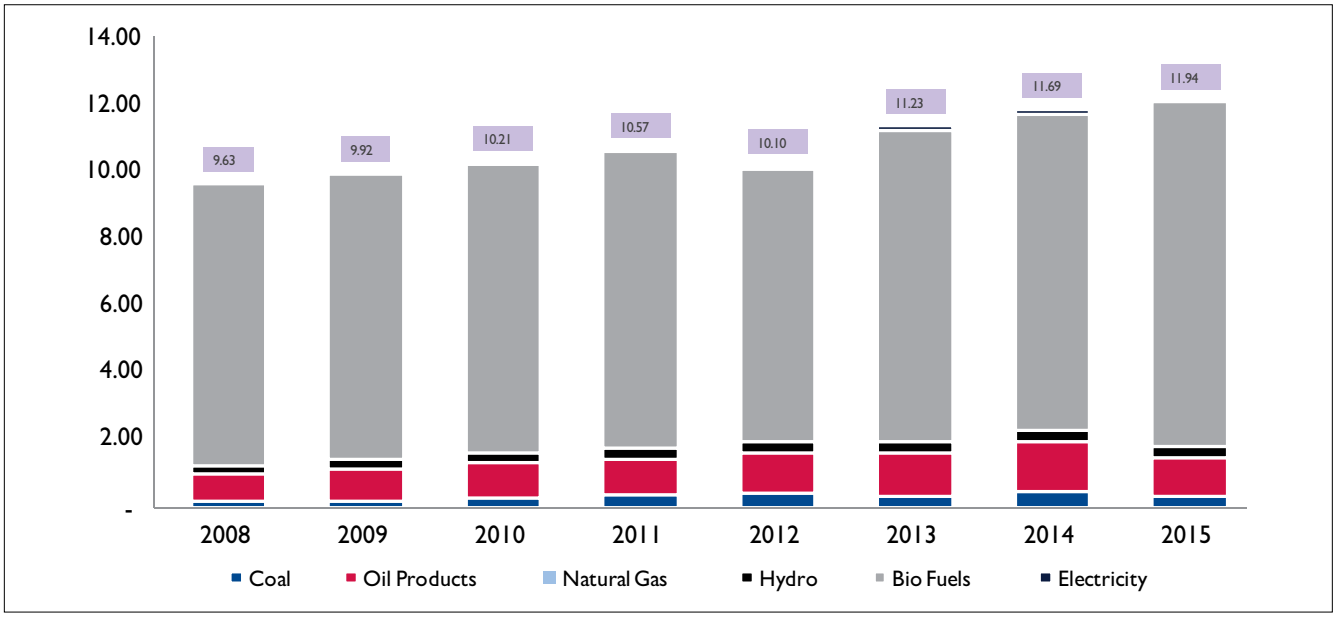
Figure 51 Primary Energy Consumption (Mtoe) in Nepal



Source: National Statistics 2015 and International Energy Agency

Nepal is endowed with large hydropower potential. Between 2008 and 2015, the primary energy supply of hydropower has increased from 0.24 Mtoe to 0.3 Mtoe, growing at an annualised rate of 3 per cent.

Figure 52 Total Primary Energy Supply (Mtoe) in Nepal



Source: International Energy Agency and National Statistics 2015

5.5.2 Resource Potential

Nepal is endowed with high potential for renewable energy resources such as hydro, solar, wind, bio-mass and so on. The country has abundant hydroelectric potential; its theoretical potential has been estimated to be as high as 83,000 MW, of which 43,000 MW are considered to be technically and economically feasible. Similarly, Nepal also has a huge potential for solar energy. The country is located at a favourable latitude that receives an ample amount of solar radiation. From solar energy alone, around 2,920 GWh of energy per year can be harnessed with the utilisation of just 0.01 per cent of the total land area of Nepal. Other renewable energy sources abundantly available in the country are bio-mass and wind. The sustainable supply of fuelwood from reachable areas of all land resources is around 12 million tonnes.

Resource	Coal	Oil	Natural Gas	Bio-mass	Hydropower
	Million Tonnes	Million Barrels	Trillion Cubic Feet	Million Tonnes	Gigawatts
Nepal	-	-	-	27.04	83.00

Source: BP Statistical Review, 2016; IRADe Presentation, September 2016

Coal

The country has negligible reserves of coal and depends on imports to meet the domestic coal requirements.

Oil and Gas

Nepal has negligible reserves of oil and gas and depends on imports to meet the domestic oil requirements. The import of oil products has been increasing gradually over the past few years.

Hydroelectricity

Nepal is endowed with a high potential for renewable energy resources such as hydro, solar, wind, bio-mass and so on. The country has abundant hydroelectric potential; its theoretical potential has been estimated to be as high as 83,000 MW, of which 42,000 MW are considered to be technically and economically feasible. However, some of the recent early new assessment shows/indicates that economically feasible potential can be much more than 43 GW due to various changes and development in technological advancements in hydropower construction and development. Similarly, Nepal also has a huge potential for solar energy.

Renewables

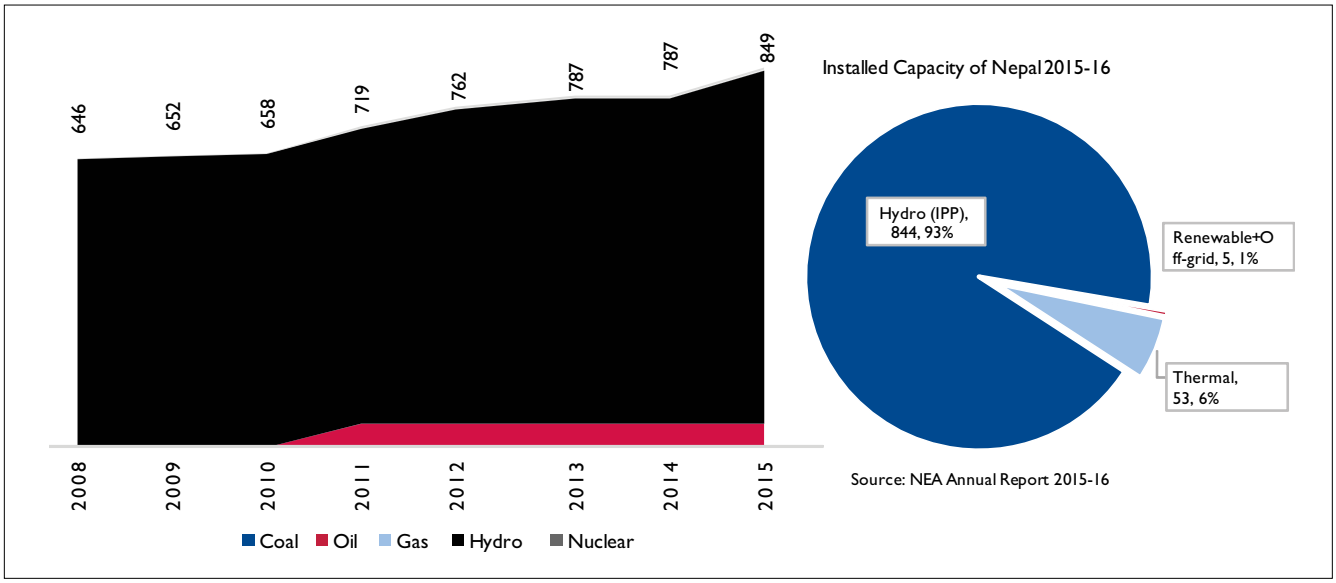
The country is located at a favourable latitude that receives an ample amount of solar radiation. From solar energy alone, around 2,920 GWh of energy per year can be harnessed with the utilisation of just 0.01 per cent of the total land area of Nepal. Other renewable energy sources abundantly available in the country are bio-mass and wind. The sustainable supply of fuelwood from the reachable areas of all land resources is around 12 million tonnes.

5.5.3 Electricity Sector

Generation

The power system in Nepal is dominated by hydropower, which contributes about 93 per cent of the system and the balance is met by multi-fuel plants. Between 2008 and 2015, the installed capacity in Nepal has increased from 646 MW to over 849 MW, growing at an annualised rate of 4 per cent. Up until 1990, hydropower development was under the Nepal Electricity Authority (NEA). However, with the enactment of the Hydropower Development Policy 1992, the sector was opened to private players and there are already a number of projects built by the private developers. Private power producers contribute 325 MW of the overall installed capacity.

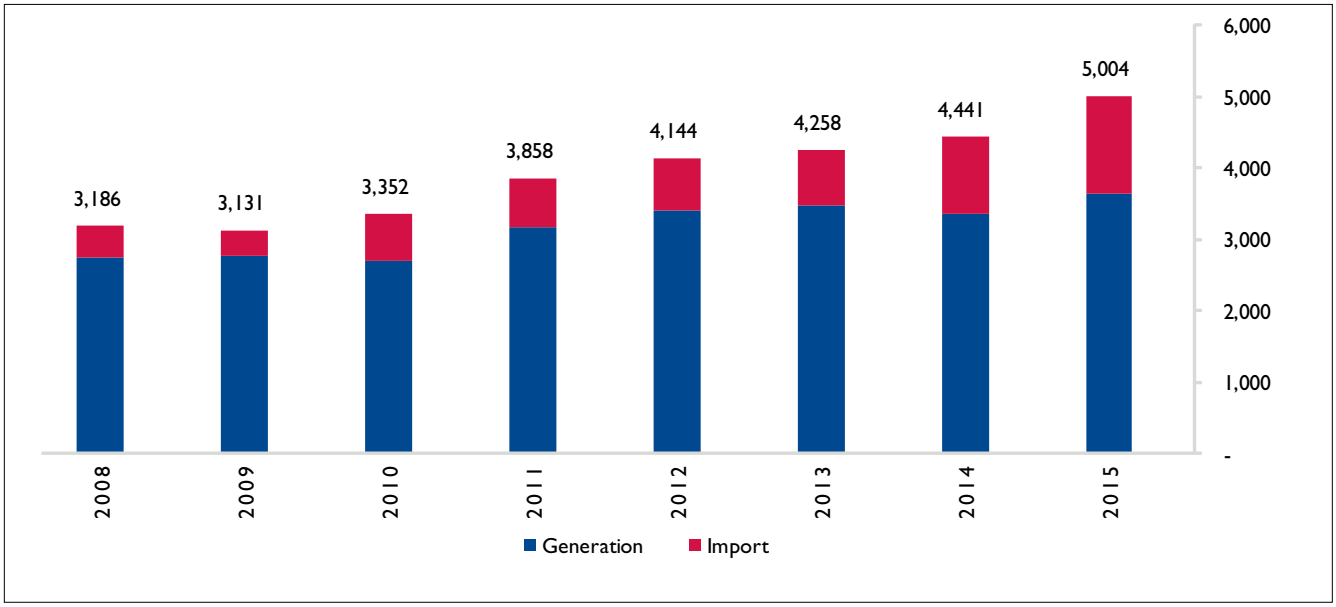
Figure 53 Installed Capacity (MW) in Nepal



Source: National Master Plan

The electricity generation and procurement of power from India has been increasing over the last two years. While the capacity additions have been delayed due to natural calamities, the purchase of power from India has witnessed an increase from 425 GWh to 1,370 GWh. Figure 54 shows the historical trends in the electricity supply in Nepal.

Figure 54 Electricity Supply (GWh) in Nepal

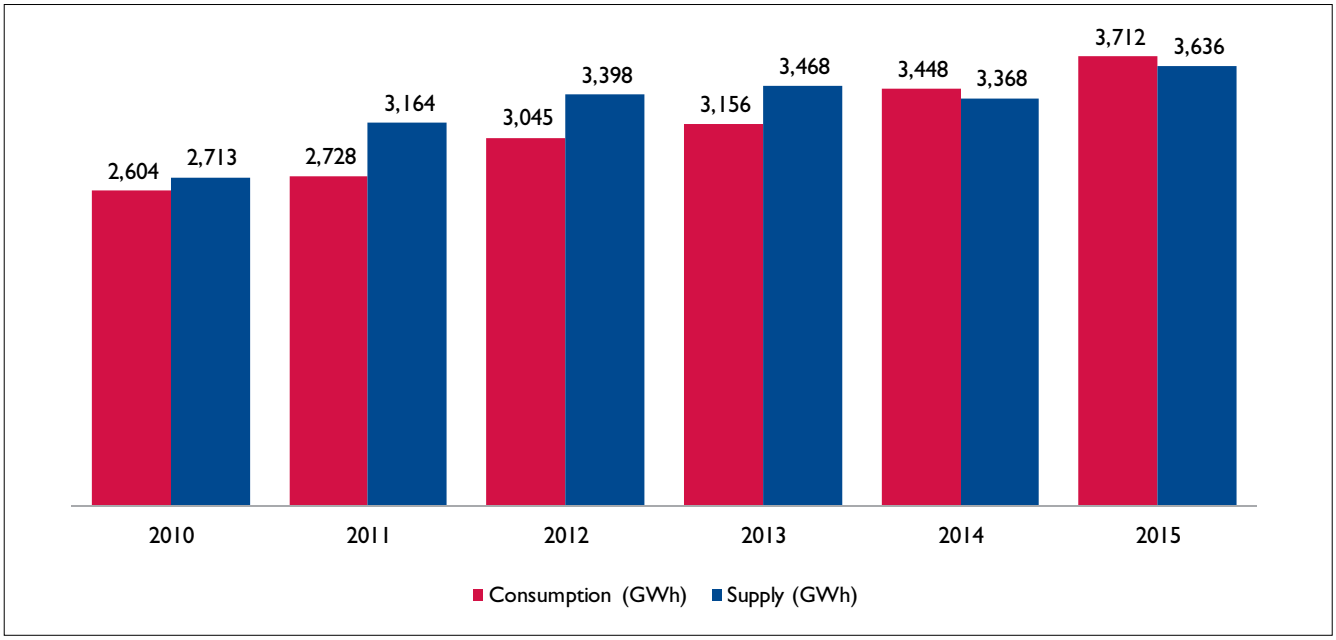


Source: National Master Plan and NEA

Demand

Overall, the electricity demand has far outgrown the supply, leading to heavy load-shedding and imports from India. The present installed generation capacity of Nepal is about 847 MW whereas the peak demand is around 1,200 MW. Nepal has a deficit of about 440 MW because of the non-availability of generation. The country's installed electricity generating capacity comprises mostly of run-of-river hydropower generation plants. The electricity demand peaks during the dry season, when generation is the lowest. On the contrary, generation is the highest in summer when demand is low. The annual energy demand of Nepal has grown at an annualised rate of 6 per cent during FY 2010 to FY 2015.

Figure 55 Electricity Demand (GWh) in Nepal



Source: NEA Annual Report 2015-16

5.5.4 Transmission and Distribution

NEA is currently responsible for the transmission system planning, infrastructure development and operations within Nepal. The country's transmission system consists of 66 KV, 132 KV transmission lines. A 220 KV East-West corridor is also under commissioning, which would connect the load centres in Nepal.

NEA is also responsible for planning the evacuation system for IPPs and the coordination with India for the transmission connectivity with the country. As the implementation agency for the transmission projects, it is in charge of the construction of transmission lines in a timely manner and of planning for future hydropower projects.

Transmission Line Length (ckM)	Existing	Under Construction	Planned and Proposed
66 KV	511.2	-	-
132 KV	2,129.7	972	1,540
220 KV	-	373	1,235.8
400 KV	-	570	1,308

Source: NEA Annual Report 2013-14

On the cross-border connections, most of the power supply is through the state of Bihar. There were 21 interconnections for power exchange through 11 KV, 33 KV and 132 KV transmission lines. Of these interconnections, some 11 KV and 33 KV lines are not being utilised and hence have been discontinued. The interconnection points still in use are listed here:

Bihar (India) – Nepal	400 KV (220 KV)	Dhalkebar (Nepal) – Muzaffarpur (India)
	132 KV	Kataiya – Duhabi Gandak East – Gandak/Surajpura (Nepal)
	33 KV	Birganj – Raxaul Kataiya – Biratnagar (Rupri) Kataiya – Rajbiraj Sitamarhi – Jaleshwar
Uttar Pradesh (India) – Nepal	33 KV	Anandnagar – Bhairwan line Nanpara – Nepalganj line
Uttarakhand (India) – Nepal	33 KV	Lohia – Mahendranagar (Nepal)
	11 KV	Pithoragarh – Baitadi Dharchula – Jajibe Dharchula – Pipli

The signing of the Power Trade Agreement (PTA) between India and Nepal on 21 October 2014 has been an important landmark in the Nepalese power sector, allowing cooperation, including developing transmission interconnections, power exchange and trading between the two countries. It also encourages and facilitates investments in the power sector; cooperation on the various aspects of policy harmonisation for the realisation of cross-border interconnections, grid connectivity and power trade; removing barriers, including tariff, levies, fees, taxes, duties or charges; allowing the authorised/ licensed electricity producers/buyers/traders of each country to engage in cross-border electricity trading, including that through power exchanges, and to seek cross-border transmission access as per the laws of the respective countries. The implementation of this agreement would require significant structural and institutional changes in the power sector in Nepal to create an enabling environment.

5.5.5 Renewable Energy and Energy Efficiency Initiatives

The Nepalese Government has taken multiple steps towards increasing access to greener, safer and more efficient energy. The National Water Plan 2005, the 10-year Hydropower Development Plan,

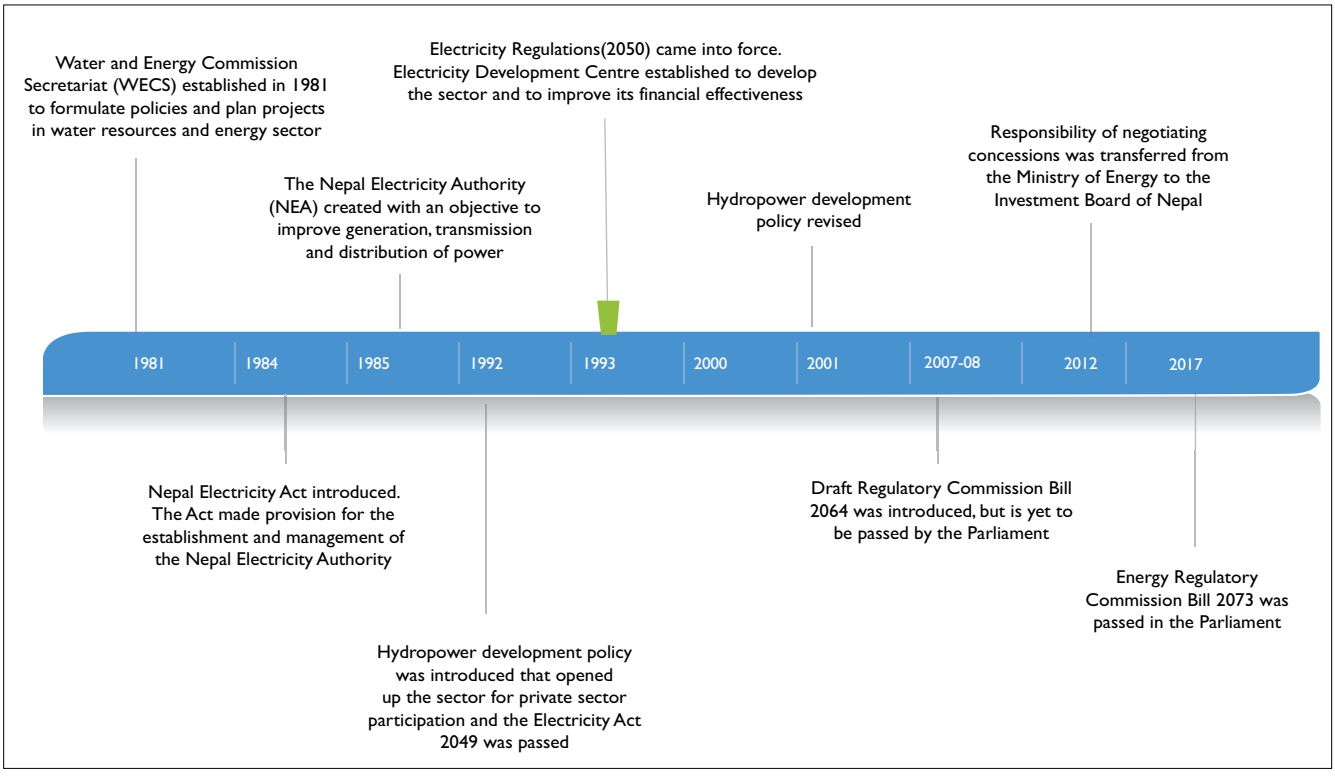
2009, the 20-year Hydropower Development Plan 2009, and the three-year Plan of 2013 are just a few examples of the initiatives undertaken by the Government to tap the country's substantial hydropower potential. In addition to hydropower, the Government is also focussing on the solar projects in order to diversify the generation portfolio. NEA is in the process of signing PPAs with 22 developers for 61 MW of solar PV projects. The Government is also encouraging the development of village solar home systems, village-scale solar PV systems and rooftop solar projects.

The Nepal Energy Efficiency Programme (NEEP) is being implemented to promote and realise energy efficiency in Nepal since 2010. After completing its first phase in June 2014, NEEP continues to support the endeavour to improve the efficiency use of energy in Nepal in its second phase from July 2014 to June 2017. The programme assists with the introduction of market-based energy efficiency services for the private and public sectors. It also backs the development of bio-mass-based improved cooking stoves for rural households. The Energy Efficiency Centre (EEC) under the Federation of the Nepalese Chamber of Commerce and Industry as well as the energy efficiency units at the District Chamber of Commerce and Industry are providing energy efficiency services to the industry and energy-intensive public infrastructure.

5.5.6 Reforms and Restructuring

Nepal's electricity sector comprises the state-owned, vertically-integrated Nepal Electricity Authority (NEA), which was established in 1984 and is responsible for the generation, transmission, distribution and load dispatch functions. It is the sole buyer of electricity in the Nepalese market and also controls around 65 per cent of the generation. NEA is responsible for the overall system planning and cross-border transactions with India. There is a plan to take out the generation, transmission and distribution functions from NEA as part of the overall reforms.

Figure 56 Evolution of the Electricity Sector in Nepal



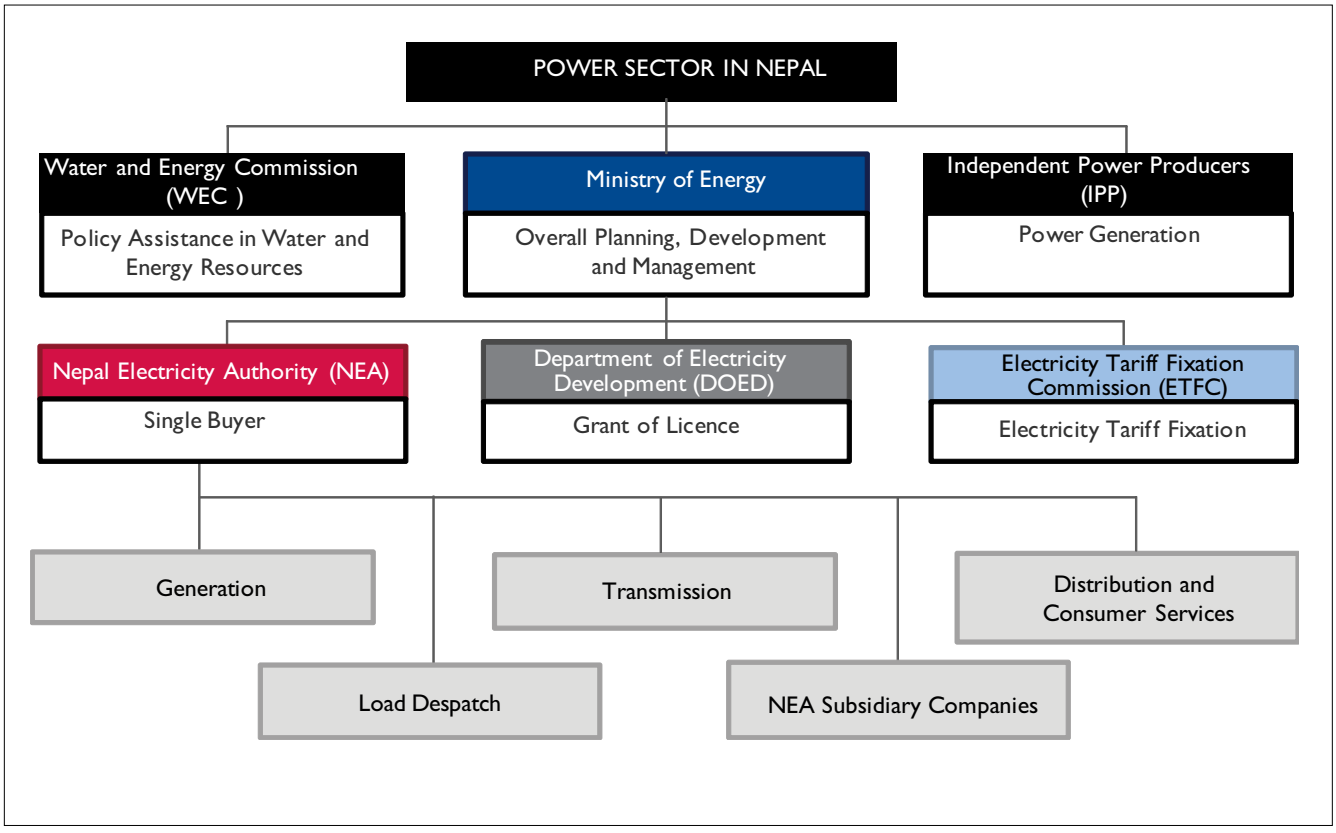
5.5.7 Institutional Framework

The power sector in Nepal is under the jurisdiction of the Ministry of Energy (the former Ministry of Water and Resources, or MOWR). The Department of Electricity Development (DoED) was formed in 1992 under the MOWR as the Electricity Development Centre. The Water and Energy Commission (WEC), established to develop water and energy resources in an integrated and accelerated manner, primarily assists the Government of Nepal, the ministry and other related agencies in the formulation of policies and the planning of projects in the water resources and energy sectors.

DoED, currently under the jurisdiction of the Ministry of Energy, is responsible for all matters related to bilateral and multilateral dialogues, agreements and understandings regarding electricity. The consumer tariffs are regulated by the Electricity Tariff Fixation Commission (ETFC), which was formed in 2011. ETFC includes the representatives from NEA, Ministry of Water Resources, Nepal Rastra Bank, consumer forums and independent experts. They fix the electricity tariffs to be charged and collected by NEA.

NEA is a government institution and is responsible for the generation, transmission and distribution of electricity in Nepal. It undertakes system planning studies, including demand forecasts and generation planning. The power trade department of NEA is responsible for the trading of electric power, both in terms of the domestic and cross-border markets. It is the single-window interface of NEA with IPPs for processing their application for PPAs. NEA is in the process of unbundling its vertically-integrated structure to improve operational efficiency. Nepal is characterised by private sector participation in electricity generation. The private generators sell power to NEA. The institutional structure of the power sector in the country is shown in Figure 57.

Figure 57 Institutional Framework in Nepal



5.6 Sri Lanka

Sri Lanka (formerly Ceylon) is an island nation south of India in the Indian Ocean. Its diverse landscapes range from rainforest and arid plains to highlands and sandy beaches. Sri Lanka spreads across 65,610 sq km and has a population of about 21.0 million.

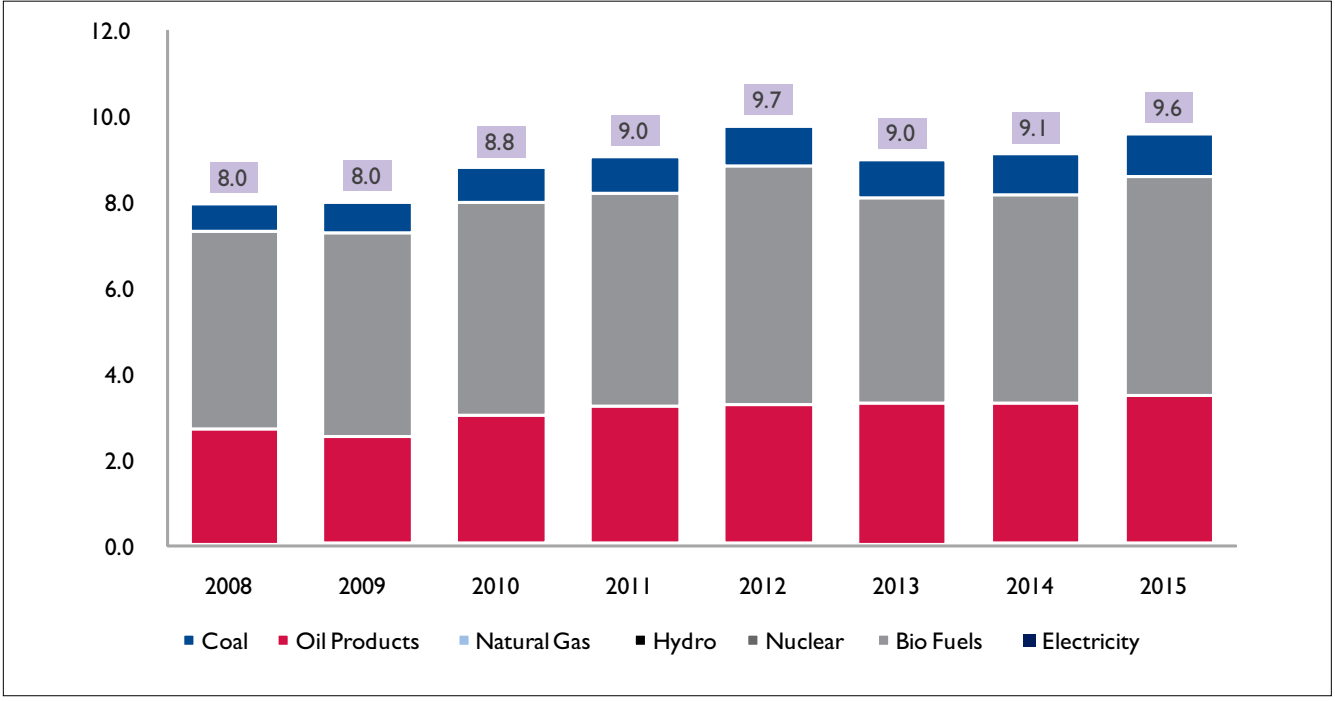
5.6.1 Primary Energy

The energy consumption in Sri Lanka has increased from 8 Mtoe in 2008 to over 9.6 Mtoe in 2015. The household, commercial and other sectors are the major consumers of energy and they use 41 per cent of the overall energy consumption in the country. Industry and transport are the second and the third largest consumers of energy in Sri Lanka (31 per cent and 29 per cent, respectively). However, since 2010, the share of the household and commercial sectors in the overall energy consumption has come down from 49 per cent in 2010 to 41 per cent in 2015. Contrary to this, the share of the industrial and transport sectors has increased from 24 per cent to 31 per cent and 27 per cent to 29 per cent, respectively, during the same period.

Bio-mass is the cheapest and most easily accessible source of energy in Sri Lanka. Between 2008 and 2015, the consumption of bio-fuels has increased from 4.6 Mtoe to over 5 Mtoe. The residential sector is the largest consumer of bio-energy and accounts for 60 per cent of the overall consumption, followed by the industrial sector (37 per cent).

The share of petroleum products in the primary consumption mix is also increasing. Between 2008 and 2015, the consumption of petroleum products grew from 2.7 Mtoe to over 3.4 Mtoe. The transport sector is the largest consumer of petroleum products and accounts for 69 per cent of the overall consumption, followed by the industrial sector (21 per cent). Residential consumers account for 5 per cent of the overall consumption.

Figure 58 Total Primary Energy Consumption (Mtoe) in Sri Lanka



Source: International Energy Agency, Long Term Generation Plan 2018-2034 and SARI/EI Analysis

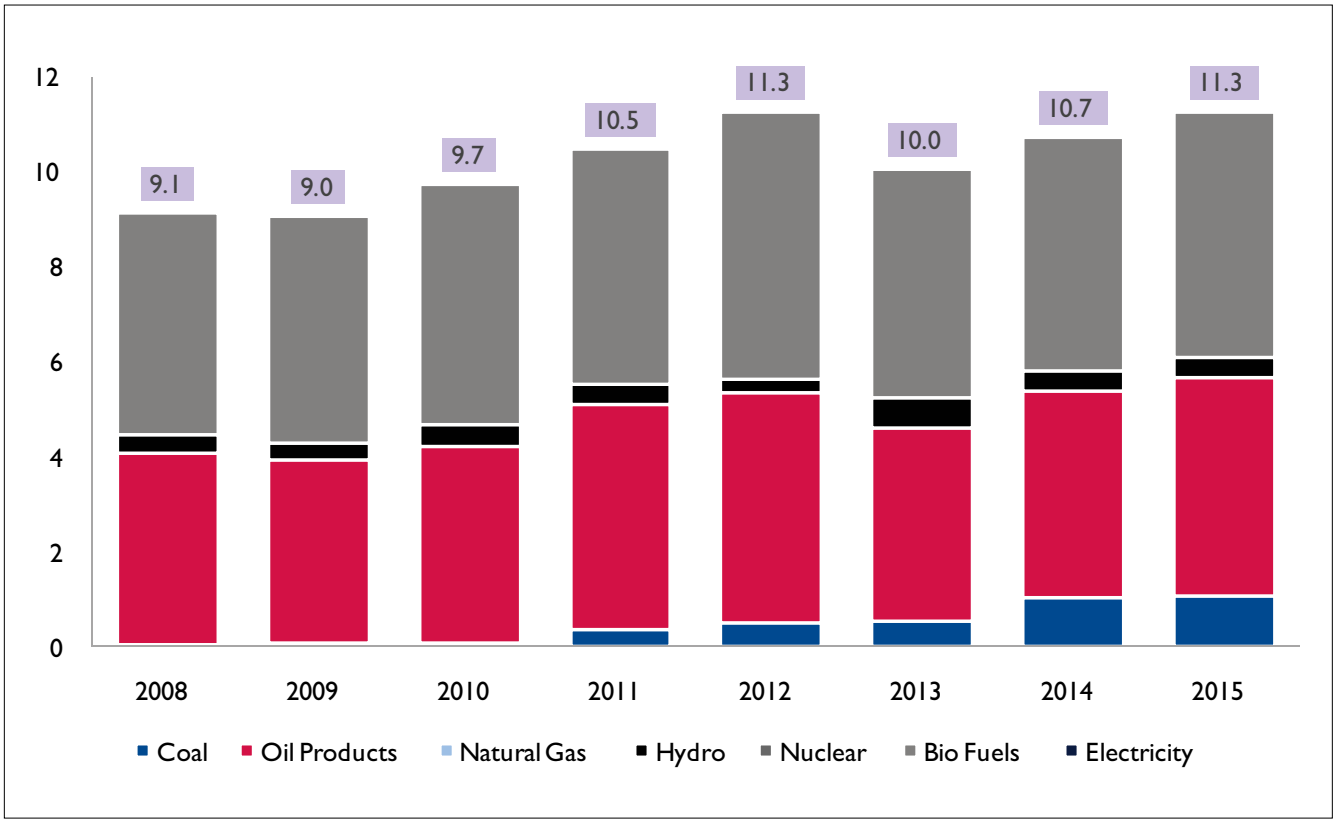
The total primary energy supplied in the country has increased from 9.1 Mtoe in 2008 to 11.3 Mtoe in 2015, expanding at an annualised rate of 3 per cent during the same period.

Bio-mass and oil products are the main sources of energy supply in Sri Lanka. Since 2000, the supply of bio-mass has increased from 4.4 Mtoe to 5.1 Mtoe in 2015. Similarly, the share of oil products has increased from 3.5 Mtoe to 4.5 Mtoe during the same period. While the supply of bio-mass and oil have increased in absolute terms, their share in the energy supply mix has decreased from 54 per cent to 46 per cent and from 43 per cent to 41 per cent, respectively. This underscores the fact that the share of alternative sources of energy, especially coal and hydrocarbons, has been increasing in the country's energy supply mix.

Coal, whose share in the early part of the century was negligible, has been gaining importance as a fuel source, as its share has increased to 10 per cent in 2015.

One of the main issues regarding the energy supply and demand in Sri Lanka is that the supply of energy has not kept pace with the increasing demand and hence the gap is being met through imports. The share of imports in meeting the energy demand of the country has increased from 40 per cent in 2009 to over 56 per cent in 2014. Crude oil and petroleum products and coal constitute 100 per cent of imports, as per 2014 figures.

Figure 59 Total Primary Energy Supply (Mtoe) in Sri Lanka



Source: International Energy Agency, Long Term Generation Plan 2018-2034 and SARI/EI Analysis

5.6.2 Resource Potential

Sri Lanka has a limited amount of oil reserves, most of which are still unexplored, with no natural gas potential. However, the country is endowed with moderate bio-mass, renewable and hydropower potential. The resource-wise potential for Sri Lanka is shown here.

Resource	Coal	Oil	Natural Gas	Bio-mass	Hydropower
	Million Tonnes	Million Barrels	Trillion Cubic Feet	Million Tonnes	Gigawatts
Sri Lanka	0	150	0.0	12	2.00

Coal

Sri Lanka has no significant reserves of fossil energy resources except for limited reserves of oil and gas, which are yet to be explored. Therefore, the country depends to a large extent on global imports to meet the domestic coal requirements.

Oil and Gas

In terms of fossil fuel potential, Sri Lanka has no proven reserves of natural gas. However, the estimated oil reserve is 150 million barrels. Most of the oil requirements of the country are met through imports. In 2014, Sri Lanka imported 3 Mtoe of oil products and 1.9 Mtoe of crude oil.

Hydroelectricity

Sri Lanka's topography provides for an excellent opportunity to harness the energy stored in river water, which flows from the central hills of the country to the Indian Ocean surrounding the island. Having an early start in hydro electricity generation, Sri Lanka has nearly exhausted 1,401 MW of the feasible hydropower potential of 2,550 MW in its river systems. This is almost 54 per cent of the overall hydropower potential in the country.

Renewables

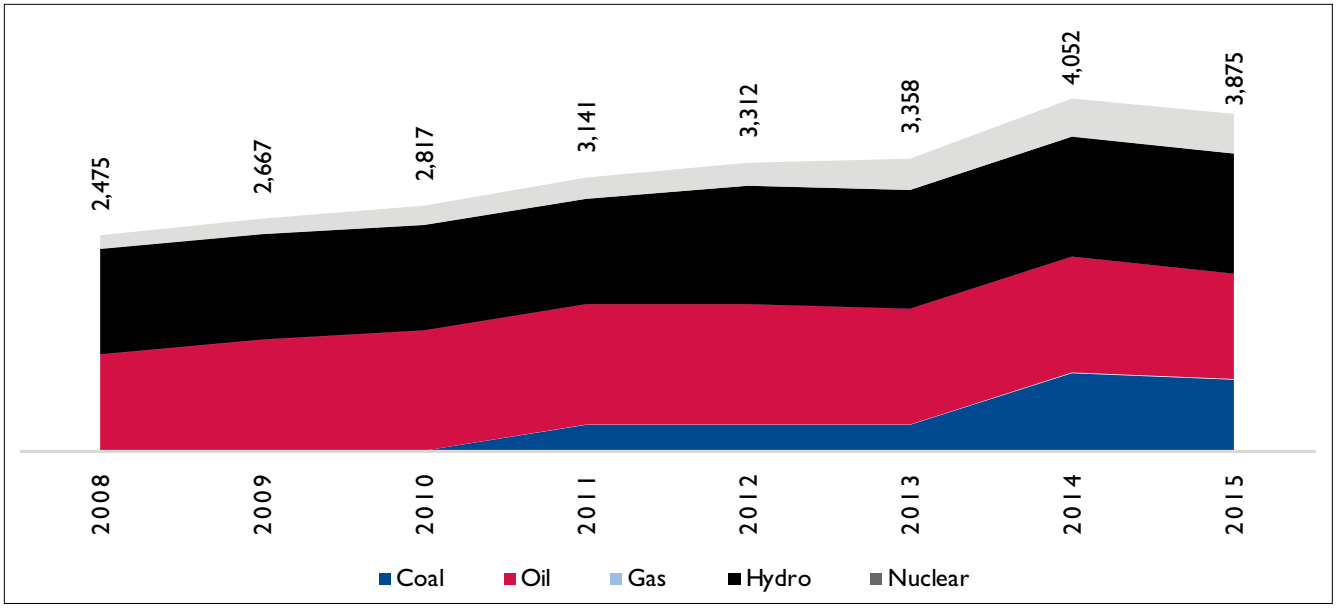
Sri Lanka is blessed with several types of renewable energy resources but has limited resources as far as fossil fuels are concerned. Some of the renewable energy resources are widely used, such as hydropower, and developed to supply the energy requirements of the country. Others have the potential for development. The total estimated potential for small hydro is 873 MW, wind power is 5,650 MW, mainly in the northwestern and central regions, solar power is 6,000 MW and bio-mass is 2,370 MW.

5.6.3 Electricity Sector

Generation

The installed generation capacity in Sri Lanka has grown significantly during 2008–15, when its generation capacity went up from 2,475 MW to 3,875 MW at an annualised rate of 6.6 per cent. Hydropower is the main source of electricity generation in the country and constitutes almost 36 per cent of the overall current installed capacity, followed by oil (31 per cent). The current share of the coal-based capacity electricity mix is 21 per cent, as against nil in 2010. The share of renewables in the electricity mix is also increasing. Since 2000, the share of renewables has increased from just under a per cent to over 12 per cent by FY 2015.

Figure 60 Installed Capacity (MW) in Sri Lanka

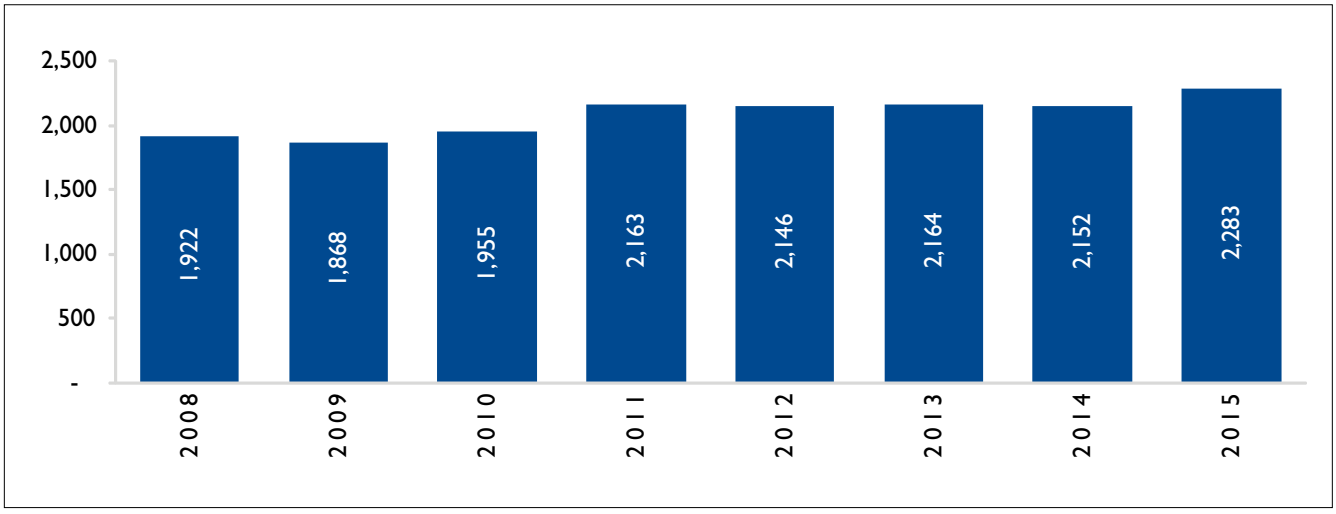


Source: CEB's Long Term Generation Plan 2018-2037, draft

Demand

The peak electricity demand in Sri Lanka has grown at a steady rate of over 3.2 per cent during 2008-2015, when the demand for electricity increased from 1,992 MW to 2,283 MW. The domestic sector is the biggest consumer of electricity and uses 40 per cent of the overall electricity generated, followed by the industrial (33 per cent) and commercial (27 per cent) sectors.

Figure 61 Peak Demand (MW) in Sri Lanka



Source: CEB's Long Term Generation Plan 2018-2037, draft

5.6.4 Transmission and Distribution

The electricity transmission network in Sri Lanka is solely owned by the Ceylon Electricity Board (CEB) and is operated at 220 KV and 132 KV to transport electricity from the point of generation to distribution bulk supply points. By 2013, the country had added 502 km of 220 KV lines and 1,846 km of 132 KV lines. Going forward, Sri Lanka is likely to expand the current network of 220 KV lines toward the northern, eastern and southern parts of the country and build 400 KV lines on the eastern and the southern legs.

On trans-border electricity exchange, for Sri Lanka to get access to a South Asian regional electricity grid, the only feasible connection is with India through a HVDC marine cable. Towards this end, a HVDC line, operating at ±400 KV, is being planned connecting Madurai (at 400 KV) in India and Anuradhapura (at 220 KV) in Sri Lanka. The total interconnection capacity will be 1,000 MW.

5.6.5 Renewable Energy and Energy Efficiency Initiatives

Sri Lanka is also using off-grid solutions to provide electricity in remote areas. The off-grid for the rural programme is aiming to electrify households using off-grid solar and off-grid mini grid solutions.

The country is targeting for the development of solar, wind and hybrid renewable energy projects in various parts. The Sri Lanka Sustainable Energy Authority (SLSEA) has identified the northern and western regions of the country to build wind and solar power plants. Sri Lanka also has an active rooftop solar power programme. In addition, CEB has set a target to increase electricity produced by renewables to 17 per cent of the total generation by the end of 2019.

A mandatory energy labelling programme is being implemented with the goal of covering the most commonly used appliances. The Code of Practice on Energy Efficient Buildings has been compiled to ensure that energy efficiency features are included in the design and construction of large-scale buildings.

5.6.6 Reforms and Restructuring

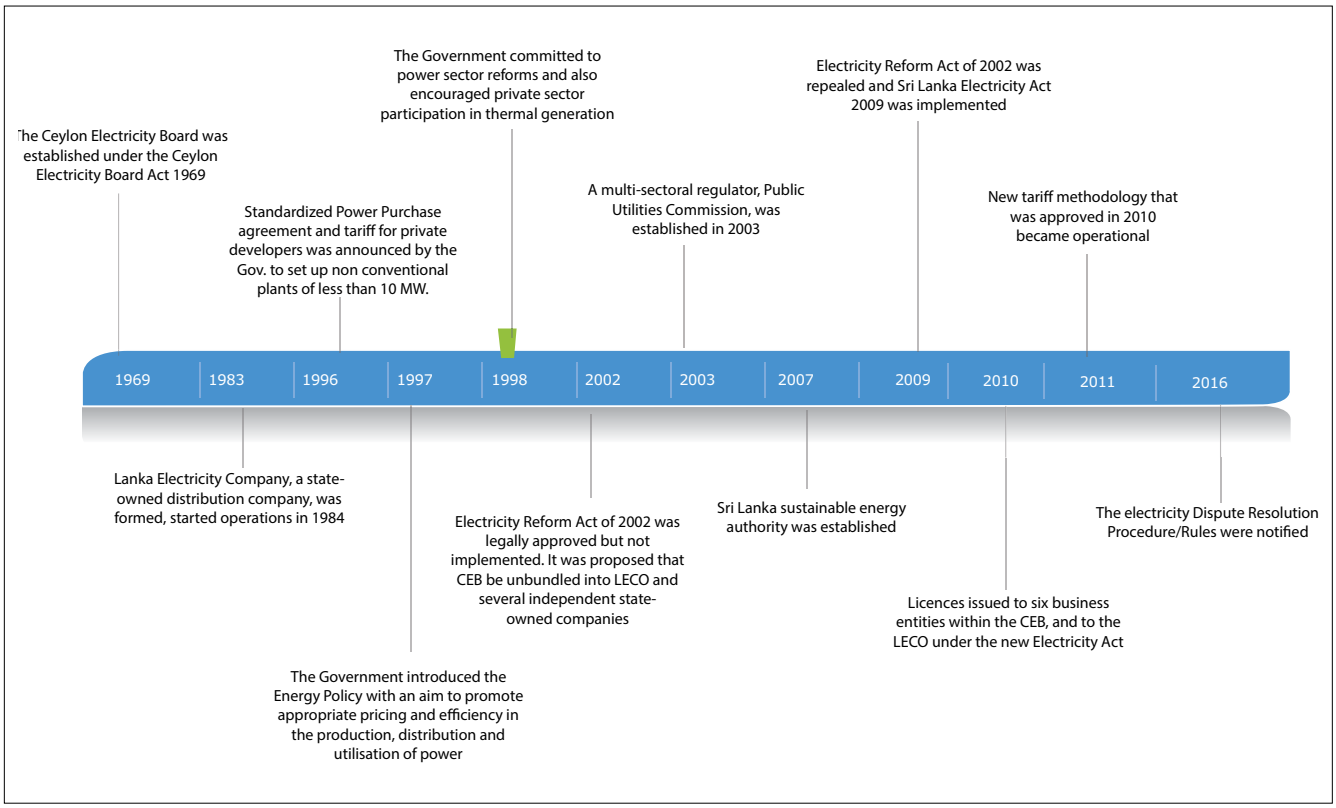
Before independence, the power sector in Sri Lanka was owned and operated by a government department. However, in 1969, the management and operation of the sector was formally transferred to CEB, a public sector undertaking, constituted by the Government of Sri Lanka that operated as a vertically-integrated monopoly regulated by the Ministry of Power and Energy. CEB, a bundled utility, carried out all three functions of electricity generation, transmission and distribution, along with retail supply, with no competition at any level. While the creation of a separate utility to manage the day-to-day functioning of the sector was some improvement over the previous model, the fault line of this model became visible in the form of pricing inefficiencies, high transmission and distribution losses, perceived structural and managerial weaknesses and operational inefficiencies within the monolithic power utilities. These inefficiencies were some of the key drivers of the power sector reforms in Sri Lanka.

The reforms have been carried out in two distinct phases. The first phase of power sector reforms was carried out during 1982-2008. This period witnessed the establishment of a state-owned distribution company, Lanka Electricity Company; the introduction of some administrative changes in the management of CEB and, finally, structural reforms, with the enactment of the Electricity Reform Act, No. 28 and the Public Utilities Commission Act, No. 35, to regulate the sector.

The second phase of power sector reforms was carried out from 2009 onwards with the implementation, that is, the operationalisation of the Electricity Reform Act, No. 20. The revised Act allowed the Power Sector Utilities Commission to finally operate as the power sector regulator, but it authorised less restructuring of CEB than had been originally proposed in the 2002 Electricity Reform Act. Under the

revised structure, the three separate functions (generation, transmission and distribution) of CEB were not spun off as separate entities with an independent ownership structure and management. Instead, a single-buyer model was introduced, with the CEB transmission entity as the single buyer. As a result, CEB now holds a total of six power sector licences—a generation licence for about 66 per cent of all generating capacity in the grid; a transmission licence for 100 per cent of transmission and for 100 per cent of bulk supply in accordance with the single-buyer model; and four distribution licences that cover approximately 90 per cent of power consumers.

Figure 62 Evolution of the Electricity Sector in Sri Lanka

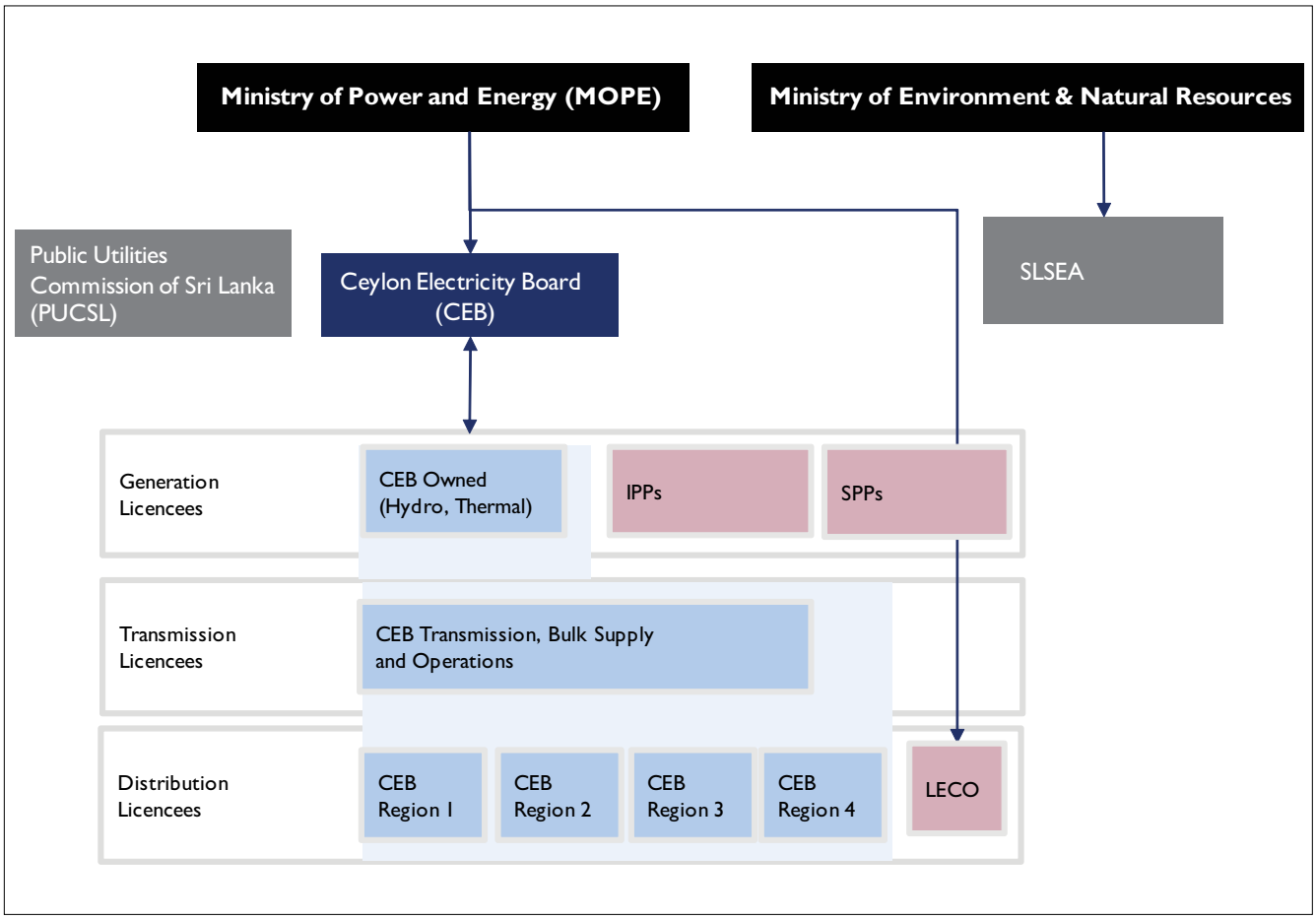


5.6.7 Institutional Framework

The power sector in Sri Lanka is composed of a mix of large, small, public and private entities. The Ministry of Power and Energy (MOPE) oversees the publicly-owned CEB, which is involved in power generation, transmission, distribution and revenue collection. MOPE is responsible for the formulation of the energy policy, project implementation and monitoring and the supervision of state-owned electricity utilities. The Ministry of Petroleum and Petroleum Resource Development (MOPPRD) looks after petroleum industry project implementation and monitoring, the supervision of the state-owned petroleum corporation, petroleum resource development and exploration and the supply of fuel for the thermal power projects.

The Public Utilities Commission of Sri Lanka (PUCSL) is the infrastructure regulatory commission empowered to regulate the electricity, bunker and lubricating oil industries. The Sri Lanka Electricity Act, No. 20, of 2009 (subsequent amendment in 2013) mandates the Commission to promote competition and determine transmission pricing in a way that it provides an efficient service to the consumers. Currently Sri Lanka does not have CBET with any country.

Figure 63 Institutional Framework in Sri Lanka



5.7 Thailand

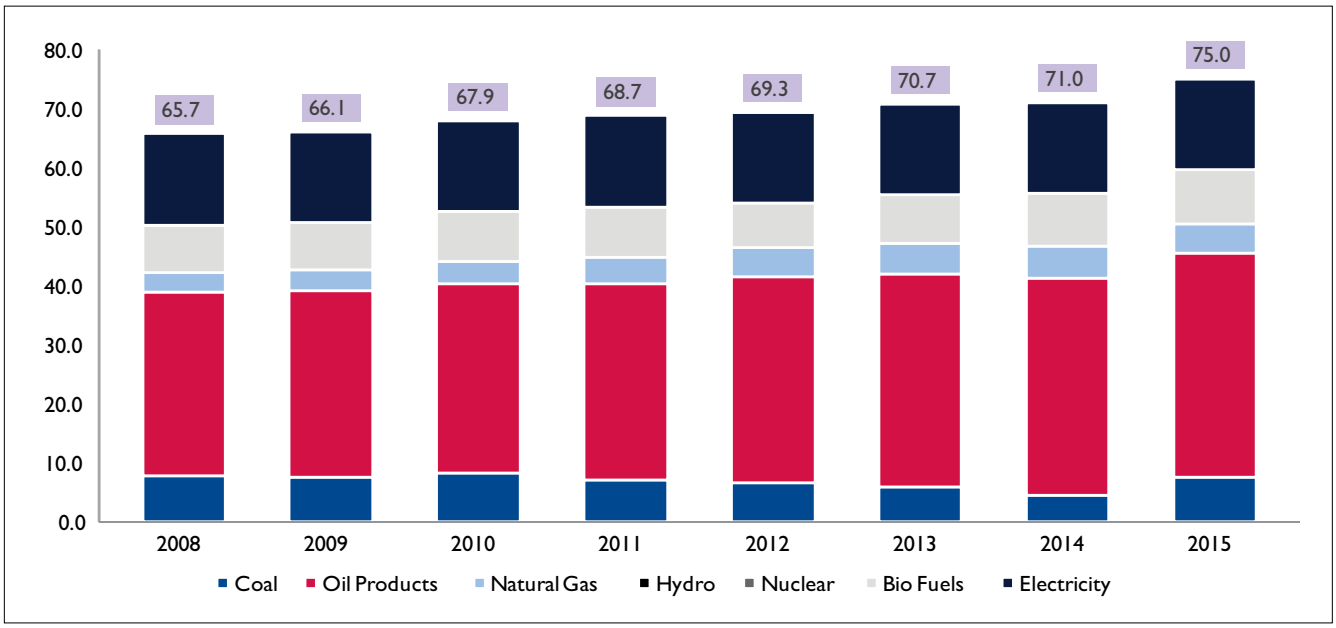
Thailand is located in the heart of the Southeast Asian region. The country is spread across 513,120 sq km, comparable to the size of France and has a land area bigger than that of Japan. Thailand is divided into five regions and has 75 provinces.

5.7.1 Primary Energy Consumption and Supply Trends

The primary energy consumption in Thailand has increased from 65.7 Mtoe in 2008 to 75 Mtoe in 2015, an annualised growth of 1.9 percent during the period. The growth has been highest for natural gas during the period, at 6.7 per cent, while growth in coal has been stagnant. The contribution of petroleum products to the primary energy consumption has increased during the period and had 50 per cent share of the total primary energy consumption in 2015. It was followed by electricity with 20 per cent and bio energy at 12 per cent of the total primary energy consumption.

Industry and transport are the major energy consuming sectors in the country (31 per cent and 23 per cent, respectively). The residential sector consumes 12 per cent and the commercial sector 5 per cent of the overall energy. Other sectors such as agriculture, including those with non-energy use, consume 29 per cent of the overall energy in the country.

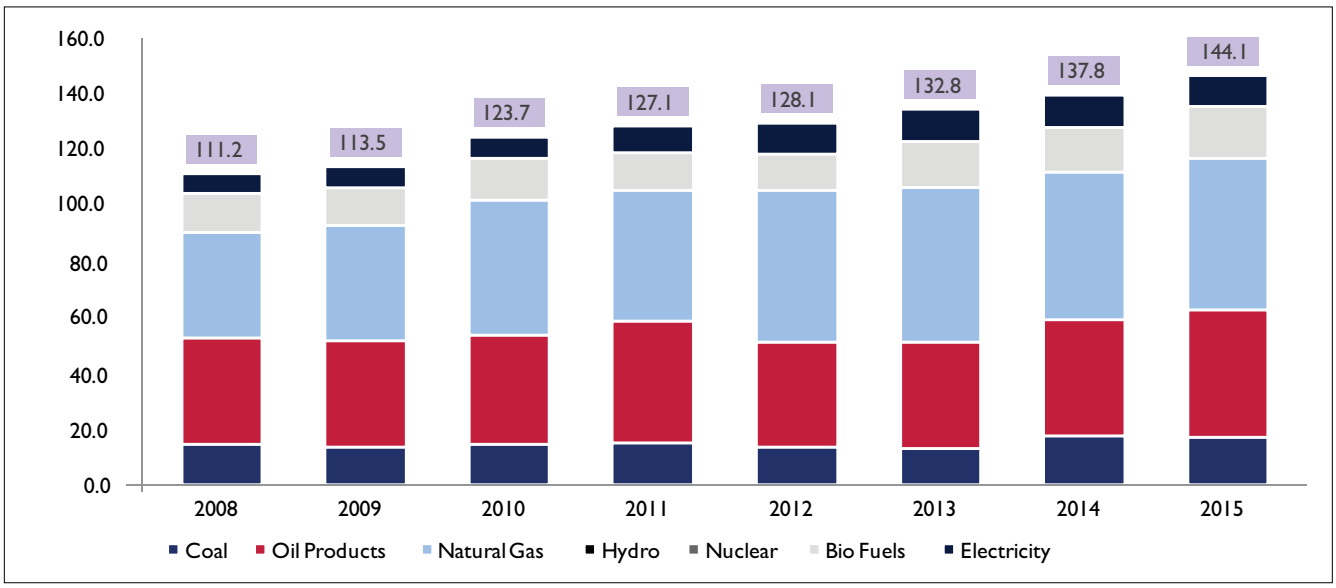
Figure 64 Primary Energy Consumption (Mtoe) in Thailand



Source: Thailand Energy Pocketbook, 2011, 2013, 2015, 2016 (Department of Alternate Energy Development, Ministry of Energy)

The primary energy supply in Thailand grew at an annualised rate of 3.8 per cent, from 111 Mtoe in 2008 to 144 Mtoe in 2015. Natural gas has the highest share of TPES, contributing 38 per cent in 2015. It is followed by oil products with about 31 per cent of the TPES share. The share of bio-energy and coal was 12 per cent each. The country is dependent on energy exports, primarily oil prpducts, natural gas and electricity, for meeting its requirements.

Figure 65 Primary Energy Supply (Mtoe) in Thailand



Source: Thailand Energy Pocketbook, 2011, 2013, 2015, 2016 (Dept. of Alternate Energy Development, Ministry of Energy)

5.7.2 Resource Potential

Thailand has a moderate amount of fossil and non-fossil fuel natural resource potential. The resource-wise potential for the country is shown here.

Table 8 Resource Potential in Thailand

Resource	Coal	Oil	Natural Gas	Bio-mass	Hydropower
	Million Tonnes	Million Barrels	Trillion Cubic Feet	Million Tonnes	Gigawatts
Thailand	1,239	405	8	-	17

Source: BP Statistical Review, 2016; IRADe Presentation, September 2016

Coal

Thailand possesses decent coal reserves, estimated at 1,239 MT. In 2014, the demand for coal amounted to 25.6 MT of coal-equivalent (Mtoe), and was evenly split between industrial and power generation uses. The demand for coal is expected to increase at an average annual rate of 1.8 per cent per year, reaching 36.1 Mtoe by 2036. While increasing industrial demand accounts for some of this growth, the majority is due to an increase in coal used for power generation.

Oil and Gas

Thailand's indigenous natural reserves are relatively limited when compared with that of the region. As per recent estimates, Thailand has 405 million barrels of probable reserves of crude oil and 8 TCF of natural gas reserves.

Hydroelectricity

Thailand's existing hydropower potential is estimated to be 17,000 MW of which only one-fourth has been exploited. However, the Government plans to increase the share of hydropower in the electricity mix by 2030 to 20 per cent from the current level.

Renewables

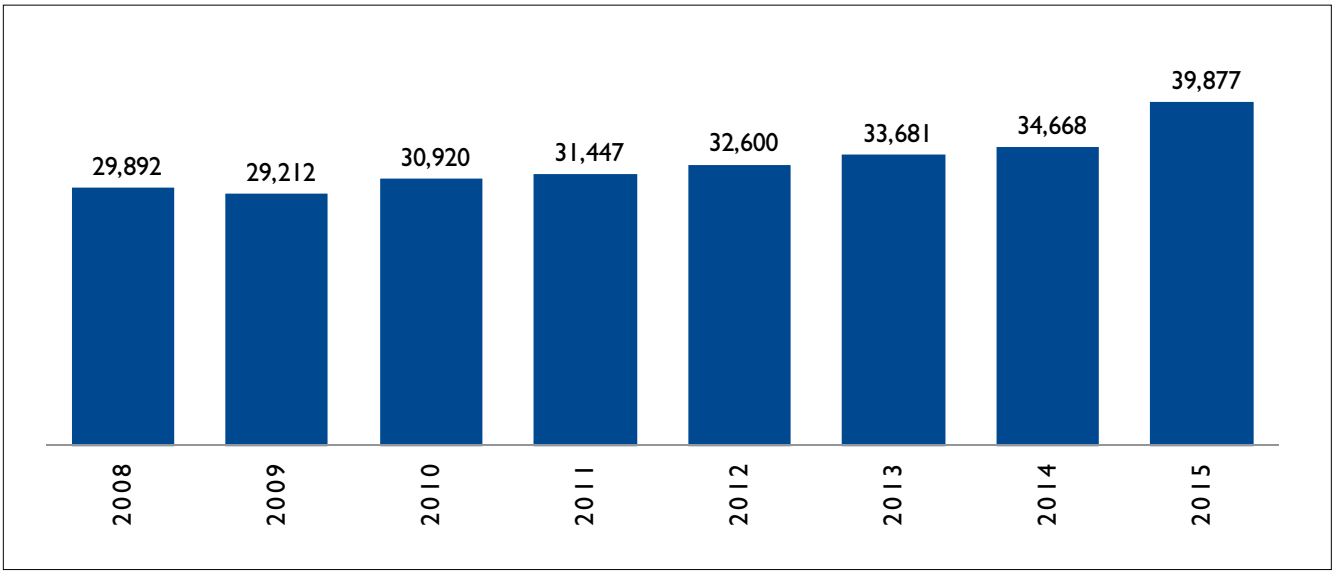
Thailand is also blessed with a huge amount of renewable energy potential. As per preliminary estimates, the total RE potential was expected to be 71 GW. Its overall solar potential is more than 50 per cent, followed by wind and bio-mass.

5.7.3 Electricity Sector

Generation

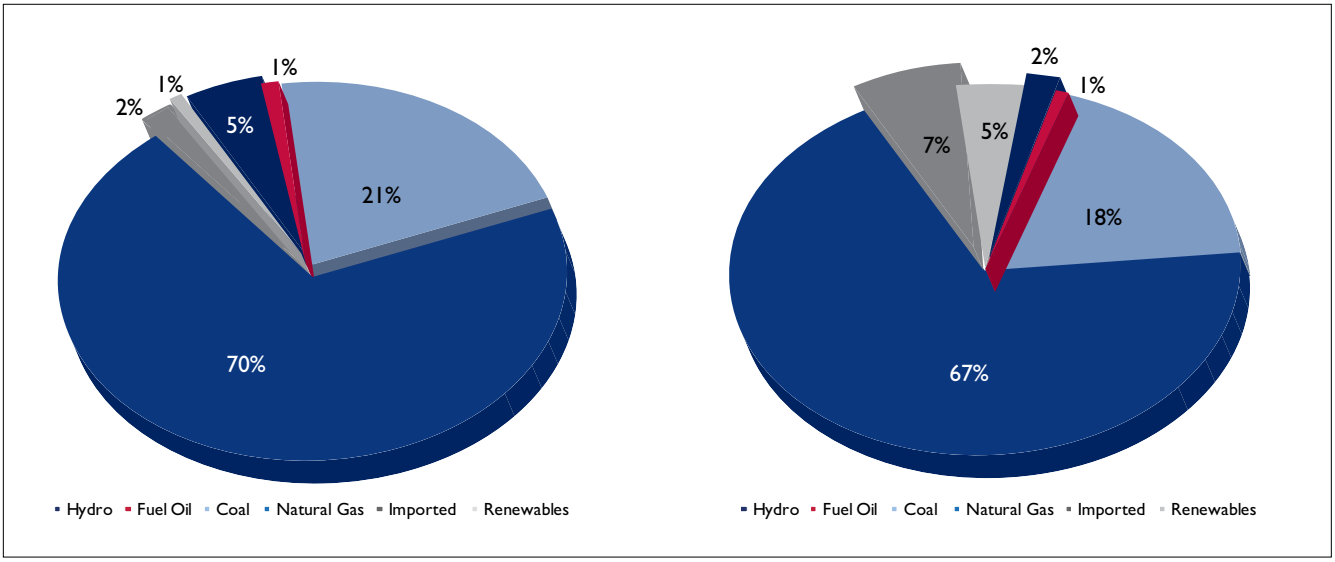
The generation supply mix in Thailand has undergone significant changes in the last decade-and-a-half. The overall installed capacity, including both public and private, in the country has increased from 29 GW in FY 2008 to over 38 GW in FY 2015. During this period, 9 GW of additional capacity has been installed in the system, at an annual growth rate of 3.8 per cent. The most notable change in the electricity sector has been the role played by the private sector in meeting the country's power needs. The share of the private sector in the overall installed capacity has increased from 30 per cent in FY 2000 to 51 per cent in FY 2015. During the same period, the share of the Electricity Generating Authority of Thailand in the overall installed capacity has decreased from 68 per cent in FY 2001 to 40 per cent in FY 2015. The import of electricity has also increased over the past few years and its share has gone up from 2 per cent in FY 2001 to 9 per cent in FY 2015.

Figure 66 Installed Capacity (MW) in Thailand



Source: Energy Policy and Planning Office, Ministry of Energy (Thailand), Power Development Plan 2036

Figure 67 Power Generation by Fuel Type in Thailand



Source: Energy Policy and Planning Office, Ministry of Energy, Thailand

Gas continues to be the mainstay of the country's electricity mix, followed by coal. The share of gas in the generation mix has decreased from 70 per cent in FY 2008 to 67 per cent in FY 2015. During the same period, the contribution of coal in meeting the country's electricity requirements has also tapered, from 21 per cent in FY 2008 to 18 per cent in FY 2015. While gas and coal will continue to remain the foundation of the country's energy portfolio, renewable energy is also gaining importance. In the past few years, the share of renewables has increased from 1 per cent in FY 2008 to 5 per cent in FY 2015, and is likely to be one of the most important sources of electricity generation in the country

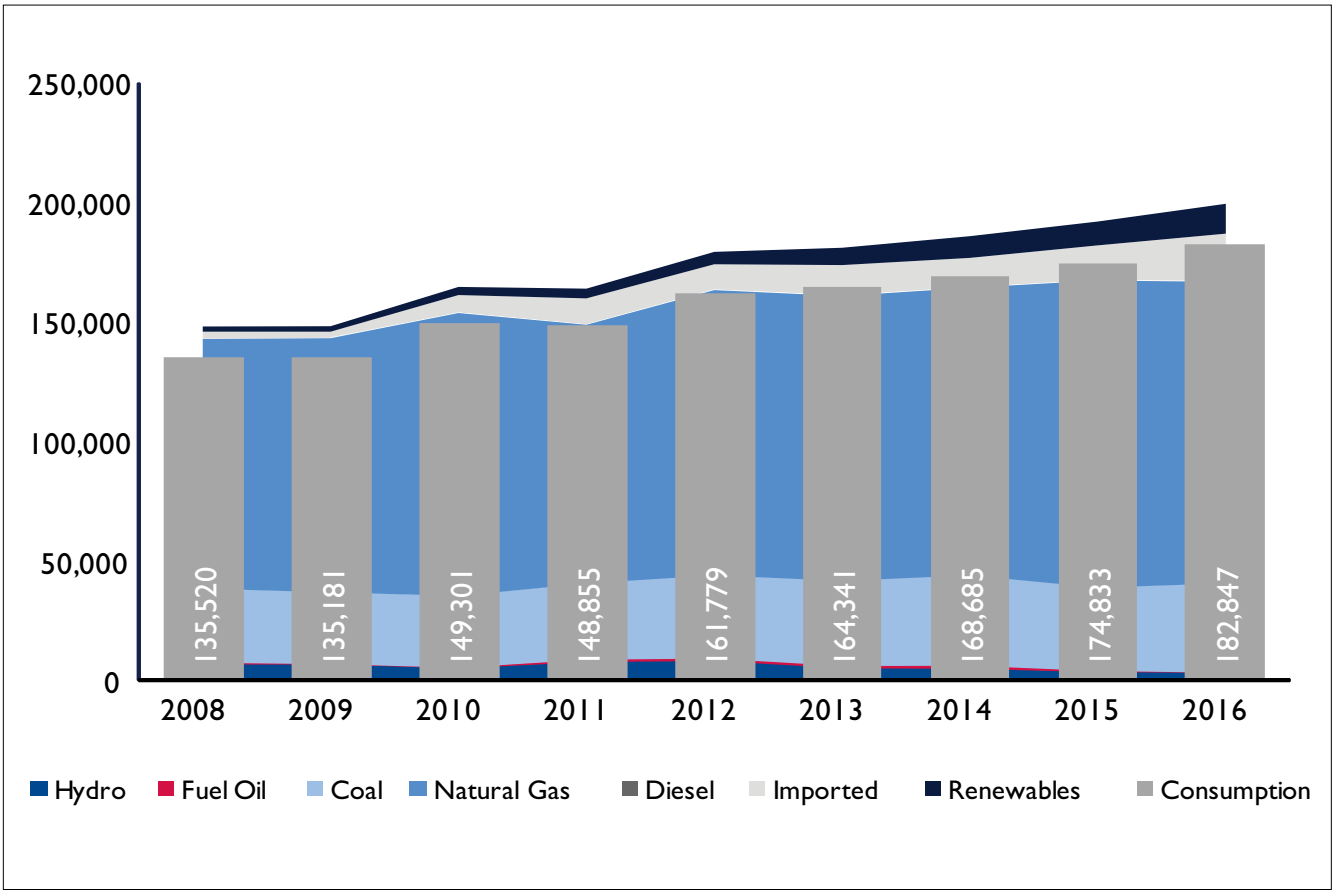
going forward. Despite the increase in capacity addition, Thailand depends on imports to meet its electricity requirements. The share of imports in meeting the energy needs of the country has increased from 2 per cent in FY 2008 to 7.5 per cent in FY 2015.

Demand

The consumption of electricity in Thailand has increased at an annualised rate of 4 per cent between 2008 and 2016, giving it a total increase of 35 per cent since 2008. The electricity consumption was highest at 182 TWh in 2016, an increase of 5 per cent over the previous year. The consumption of electricity is highest in the industrial sector, which consumes 48 per cent of the overall electricity generated, followed by the residential and commercial sectors, which consume 24 per cent each. The consumption of electricity by the agriculture sector is below 1 per cent.

In order to meet the electricity demand, domestic generation in Thailand has also increased at an annualised rate of 2.7 per cent between 2008 and 2016, giving it a total increase of 24 per cent since 2008. The gap between the demand and supply of electricity is met through imports that have increased at an annualised rate of 28 per cent between 2008 and 2016. The import of electricity was highest at 19 TWh in 2016 and has increased 612 per cent since 2008.

Figure 68 Electricity Consumption and Supply (GWh) in Thailand

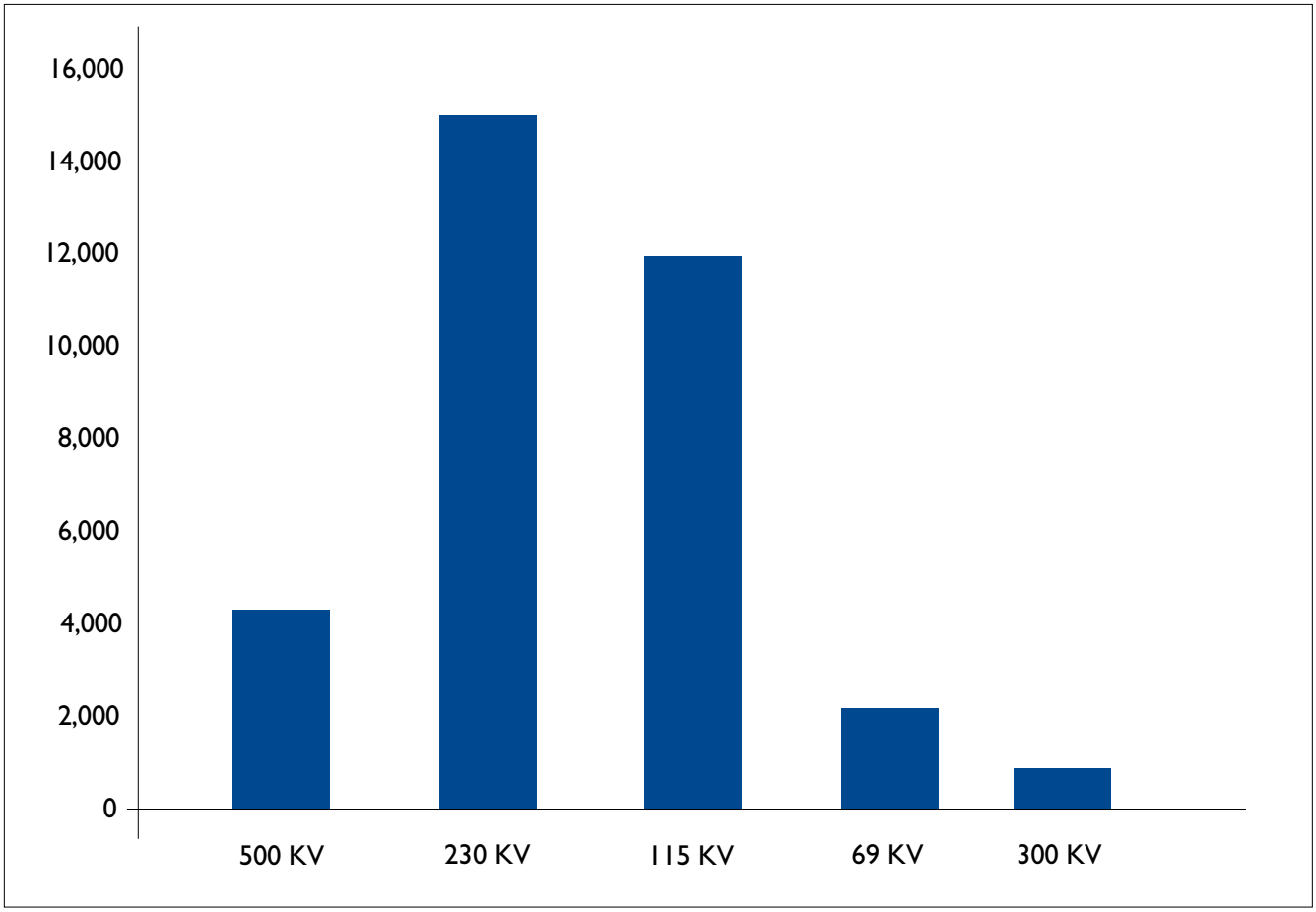


Source: Energy Policy and Planning Office, Ministry of Energy, Thailand

5.7.4 Transmission and Distribution

The transmission system is owned and operated by the Electricity Generating Authority of Thailand through a national control centre and five regional control centres. It also owns and operates the national transmission network, which includes transmission lines and substations of various high voltage levels that cover all parts of the country. The power network in Thailand operates at a voltage level of 500 KV, 230 KV, 115 KV and 69 KV. As of 2015, the total line length of the transmission system was 35,256 CKM with a transformer capacity of 88,461 MVA. In addition to this voltage level, there is a 300 KV HVDC line that is 23 CKM in length and has a transformation capacity of 388 MVA.

Figure 69 Transmission System Profile (cKM) in Thailand, 2015



Source: Energy Policy and Planning Office, Ministry of Energy, Thailand

Cross-border interconnection points exist between Thailand and the neighbouring countries in the region. As of 2014, Thailand had existing interconnection with Malaysia, Lao PDR, Vietnam and Cambodia. Some of the transmission interconnections between Thailand and its neighbouring countries in the region are shown in the table.

Table 9 **Existing Cross-Border Interconnections in Thailand**

Existing Project	System	Commissioning Year	Capacity (MW)
Thailand – Malaysia			
■ Sadao-Chuping	HVAC 132/115 KV	1980	80
■ Khlong Ngae – Gurun	HVAC 300 KV	2002	300
■ Su – Ngai Kolok – Rantau Panjang	HVAC 132/115 KV	2015	100
Thailand – Lao PDR			
■ Nakhon Phanom – Thakhek – Theun Hinboun	HVAC 230 KV	1998	220
■ Ubon Ratchathani 2 – Houay Ho	HVAC 230 KV	1999	126
■ Roi Et 2 – Nam Theun 2	HVAC 230 KV	2010	948
■ Udon Thani 3 – Na Bong – Nam Ngum 2	HVAC 500 KV	2011	597
■ Expansion – Nakhon Phanom – Thakhek – Theun Hinboun	HVAC 230 KV	2012	220
Thailand – Cambodia			
■ Aranyaprathet – Banteay Meanchey	HVAC 115 KV	2007	100

Source: Development of Cross-Border Trade between Thailand and Neighbouring Countries presentation, 12 February 2014, Bangkok

5.7.5 Renewable and Energy Efficiency Initiatives

The Government of Thailand has developed the Alternative Energy Development Plan (AEDP), which targets 25 per cent of the total energy consumption from renewable energy by 2021. The AEDP's overall objectives are developing renewable energy to replace imported fossil fuels and strengthening Thailand's energy security. The energy efficiency initiatives are led by the Department of Alternative Energy Development and Efficiency (DEDE) under the Ministry of Energy.

Thailand has a well-established regulatory framework for energy efficiency under the Energy Conservation and Promotion Act (1992). The Act also provides for establishing a fund for the promotion of energy efficiency that covers designated buildings and industries. Some of the key initiatives undertaken include:

- Standardising and labelling of equipment and materials.
- Building energy codes for new and retrofitted buildings.
- Demand Side Management (DSM) programmes by the Electricity Generating Authority of Thailand (EGAT).

Thailand's Energy Efficiency Development Plan 2011-2030 has set the short-term and long-term energy efficiency and conservation targets as well as strategies for achieving these.

5.7.6 Reforms and Restructuring

The electricity sector in Thailand has undergone significant changes since the early 1990s, with the liberalisation of the sector to private sector investments, followed by market-oriented reforms in the mid-1990s. However, before reforms were introduced, the sector was operating under the EGAT Act of 1968. This Act was introduced by the Office of the Prime Minister. It endorsed a vertically-integrated structure by merging several regional state-owned units into a single generating company responsible for the generation and transmission of electricity to the entire nation. The distribution and the retail supply of electricity were the responsibility of the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA).

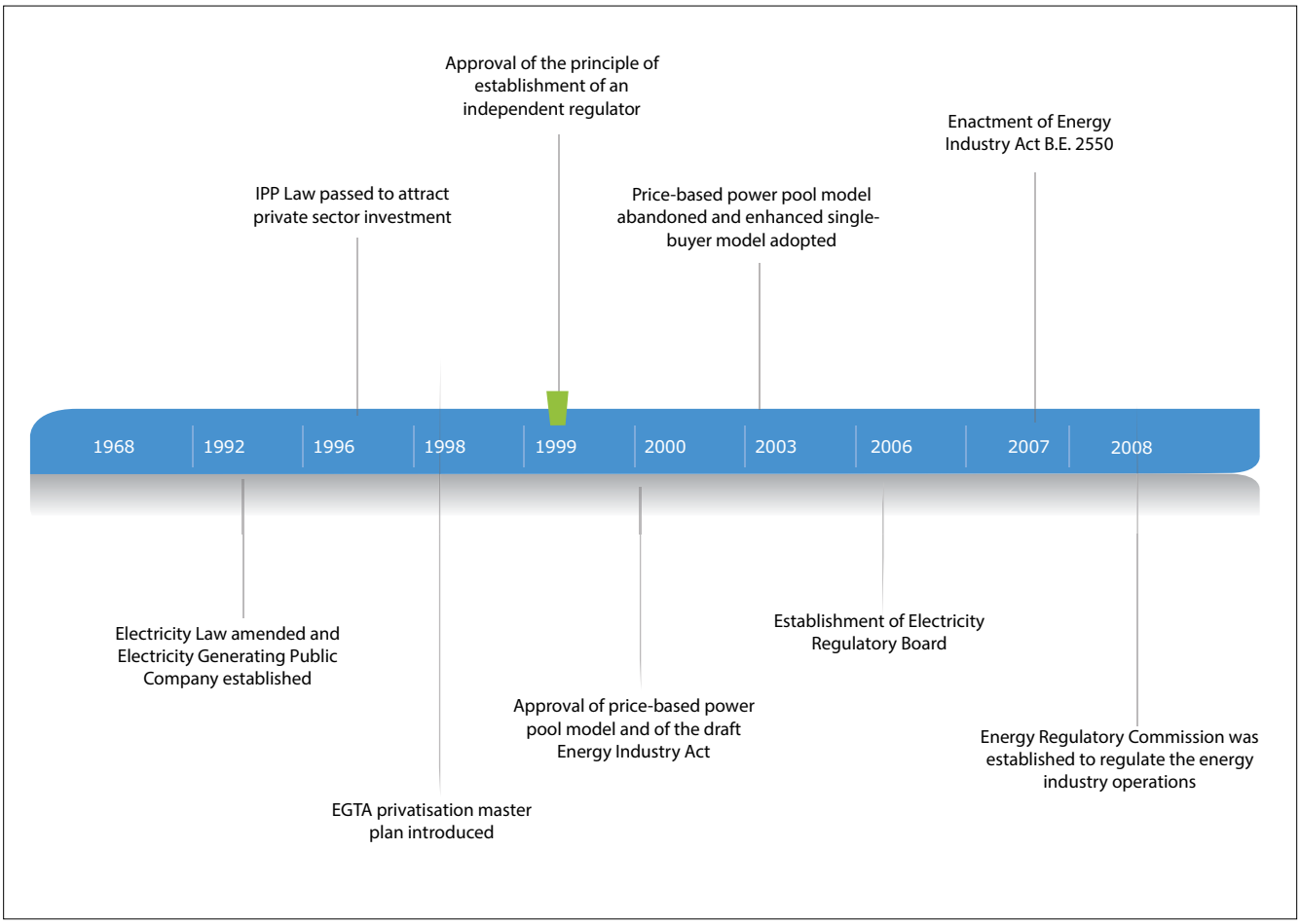
By the early 1990s, several internal and external factors, such as mounting public sector debt in the electricity industry, oil price shocks of the 1970s and shrinking funds for the electricity sector, led to the introduction of the Independent Power Producers and Small Power Producers (SPPs) programme and the formation of the National Energy Policy Office (NEPO). The constitution of NEPO was viewed as the first effort, after the establishment of EGAT, MEA and PEA, to reorganise the institutions involved in the electricity sector. Starting in the early 1990s, NEPO embarked on an ambitious electricity restructuring effort, the first stage of which was the introduction of IPPs.

The opening up of the sector to private sector investment was followed by, in the mid- to the late-1990s, a proposal to introduce market-oriented reform. The Asian financial crisis of 1997-98 was the main catalyst for this phase of reform. The priorities under this phase of the reform programme were to introduce market orientation to the electricity sector by unbundling the generation from transmission and distribution functions and building competition in electricity supply by providing a choice to the consumers to select their own service provider.

The electricity industry reforms were not only limited to the restructuring initiatives or allowing for private sector participation by the last 1990s, but also included some significant institutional arrangements. The establishment of the Ministry of Energy in 2002 marked an important change in the electricity industry. This transition meant that institutes such as EGAT, MEA and PEA, which were once reporting to the Ministry of Interior and NEPO, were now brought under the umbrella of the Ministry of Energy.

Early 2005 witnessed the revival of the privatisation programme and the temporary establishment of the interim regulator, the Electricity Regulatory Board. EGAT was the first public enterprise to be corporatised in April 2005, and it was scheduled to be listed on the Stock Exchange in October 2005. The Energy Regulatory Board was finally established as part of the law on 1 February 2008. This regulatory board is responsible for the regulation of the energy sector, including electricity and gas. It is expected to bring in transparency, creditability and public participation to the energy sector decision-making process.

Figure 70 Evolution of the Electricity Sector in Thailand

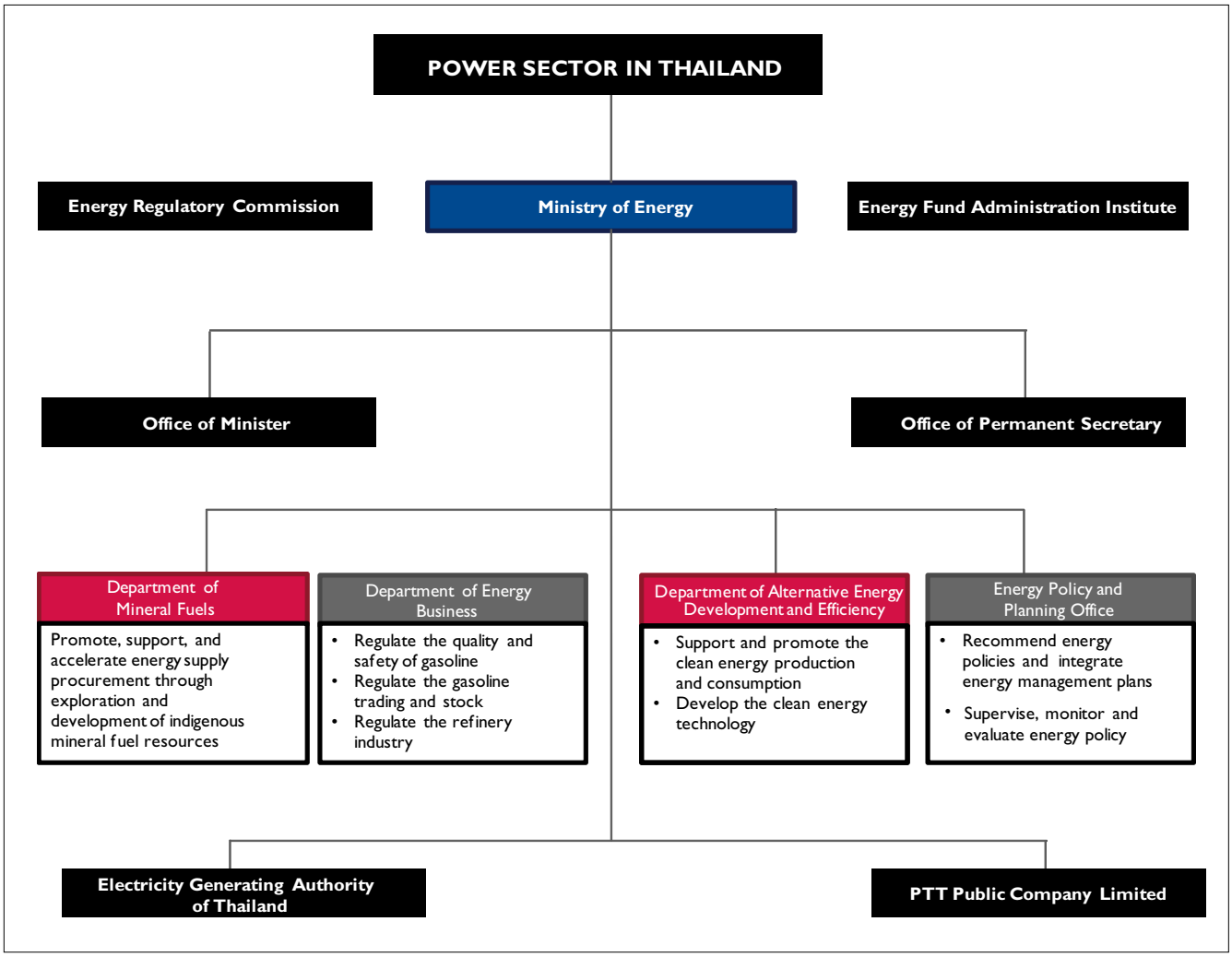


5.7.7 Institutional Framework

Thailand follows a single-buyer model, with EGAT as the single vertically-integrated utility, holding and running part of the generation, the entire transmission system and a part of the retail market. Apart from its own generation, EGAT purchases power from IPPs and SPPs and it imports power from other countries as well in order to serve domestic electricity requirements.

While bulk supply consumers buy power directly from EGAT, smaller commercial and residential consumers purchase power from MEA and PEA, the two distribution companies of Thailand. Very Small Power Producers (VSPPs) sell electricity directly to MEA and PEA. Real-time coordination between EGAT, MEA and PEA is managed through various regional dispatch control centres, as well as a single national control centre.

Figure 71 Institutional Framework in Thailand



6. BIMSTEC Energy Outlook 2030

6.1 Energy Supply Forecast

6.1.1 Primary Energy Supply

The total primary energy supply in the BIMSTEC region is projected to grow at an annualised rate of 3.36 per cent during the period 2015-30, to increase from 1,070 Mtoe to 1,758 Mtoe. The primary energy supply mix would undergo a significant change till 2030. The region will continue to depend on fossil fuels (coal, petroleum products, gas and so on) to meet its domestic energy requirements. Between 2015 and 2030, the supply of fossil fuels in the region is expected to increase from 783 Mtoe to 1,339 Mtoe, an increase of 556 Mtoe. The share of fossil fuels is likely to increase from 73 per cent in 2015 to 77 per cent in 2030. During the same period, the share of other sources of supply except bio-energy will also increase. In case of bio-energy, the share is likely to reduce from 23 per cent in 2015 to 17 per cent in 2030.

The BIMSTEC region is endowed with huge hydropower potential. It has been estimated that the overall potential in the region is about 350 GW. Currently, countries in the South Asia region have been able to harness only 15 per cent of the overall hydropower potential. Bhutan and Nepal have developed 5 per cent and 1 per cent, respectively, of their hydro resource potential, while India has been able to develop 29 per cent. With an increasing focus on CBET and the growing importance of the non-energy benefits of hydro for grid balancing and RE integration, the share of hydro in the energy mix is likely to increase. Between 2015 and 2030, the supply of hydropower in the region's primary energy supply is likely to increase from 12 Mtoe to 38 Mtoe, growing at an annualised rate of 8.1 per cent.

Bio-energy has played an important and a dominant role in the primary energy supply of the BIMSTEC region, as this has been the most accessible and affordable fuel for rural consumers. However, during the outlook period, the share of bio-energy in the region's energy supply is likely to decrease from 23 per cent in 2015 to 17 per cent in 2030. One of the main reasons for this is the increasing availability of conventional sources of energy, including electricity, in both rural and urban areas.

Table 10 **Total Primary Energy Supply by Fuel (Mtoe) in the BIMSTEC Region**

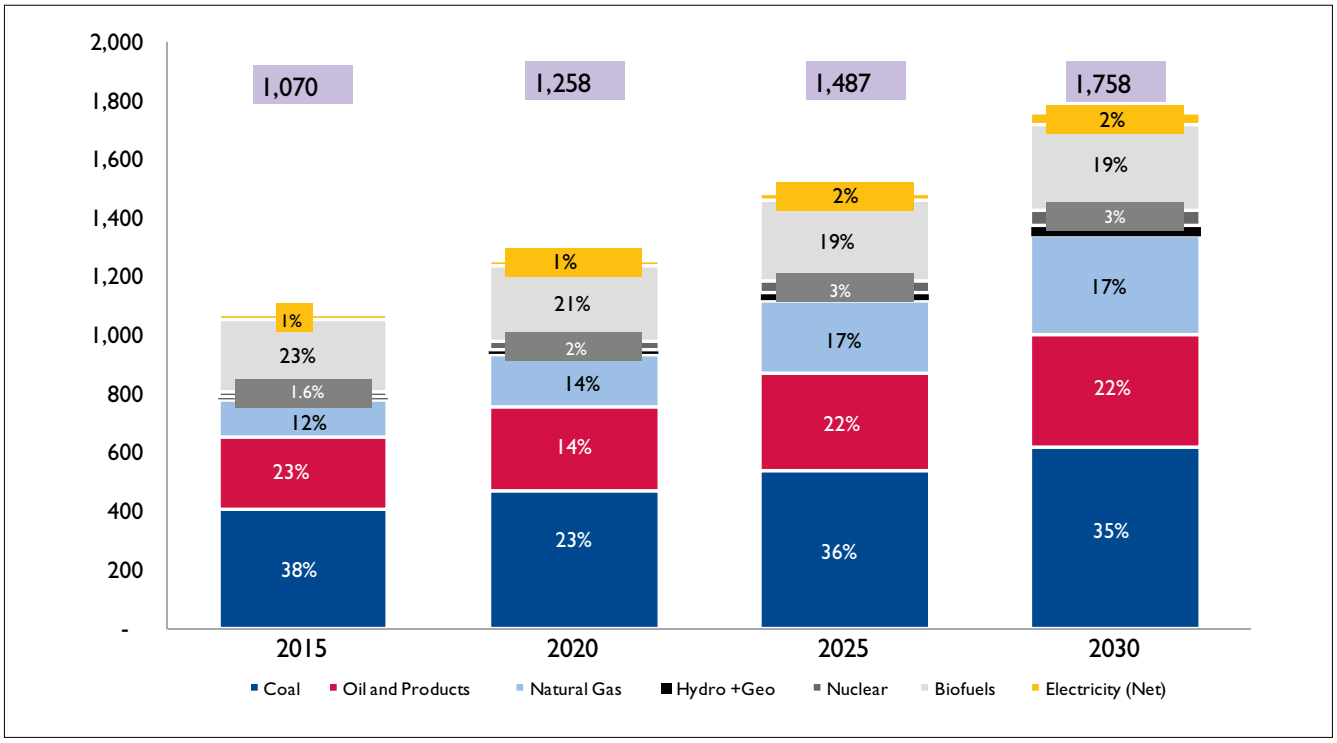
	2008	2015	2020	2030	Share (%)		Annualised Rate
					2015	2030	2016-30
Fossil Fuels	533	783	936	1,339	73%	76%	3.65%
Coal	247	409	473	619	38%	35%	2.79%
Oil	197	247	284	383	23%	22%	2.98%
Gas	89	127	180	337	12%	19%	6.74%
Hydro	12	12	17	38	1%	2%	8.13%
Nuclear	4	17	26	52	2%	3%	7.72%
Bio-energy	216	247	260	291	23%	17%	1.11%
Electricity (Net)	7	12	18	37	1%	2.10%	7.85%
Total	772	1,070	1,258	1,758	100%	100%	3.36%

Coal production in the region is expected to increase at an average rate of 2.8 per cent as the countries expand their energy consumption to realise their economic potential. India will be the largest contributor of coal production in the region, given that it has one of the largest coal reserves in the world, followed by Bangladesh and Thailand. The production of coal will also get enhanced on account of an increase in coal-based capacities in the BIMSTEC region by 2030, as the countries plan to reduce their dependence on gas-based plants. However, the share of coal in the supply mix declines from 38 per cent in 2015 to 35 per cent in 2030. One of the contributing factors to the declining share of coal is the improvement in technology, due to which the consumption per unit of coal will reduce and there will be a rise of renewables in the capacity mix.

The total supply of oil in the region is likely to increase at an annualised rate of 3 per cent till 2030, given the increase in energy demand. However, the share of crude oil in the energy supply mix is likely to decline from 23 per cent in 2015 to 22 per cent in 2030. Depleting reserves and a strategic focus to move towards cheaper sources of energy are the key reasons for the reducing share of crude oil in the energy mix.

The supply of natural gas is projected to increase by threefold, from 127 Mtoe in 2015 to 337 Mtoe in 2030. Almost two-third of the projected total primary supply of natural gas is likely to come from India, as the Government has indicated that the share of natural gas in the energy mix will increase to 15 per cent by 2030. The share of natural gas in the BIMSTEC region's total energy supply would increase from 12 per cent in 2015 to 19 per cent in 2030, growing at an annualised rate of 6.7 per cent. The share of nuclear in the primary energy supply is projected to increase from 1.6 per cent in 2015 to 3 per cent in 2030, with maximum increase likely to come from India. Figure 72 shows the future trends in the primary energy supply in the BIMSTEC region.

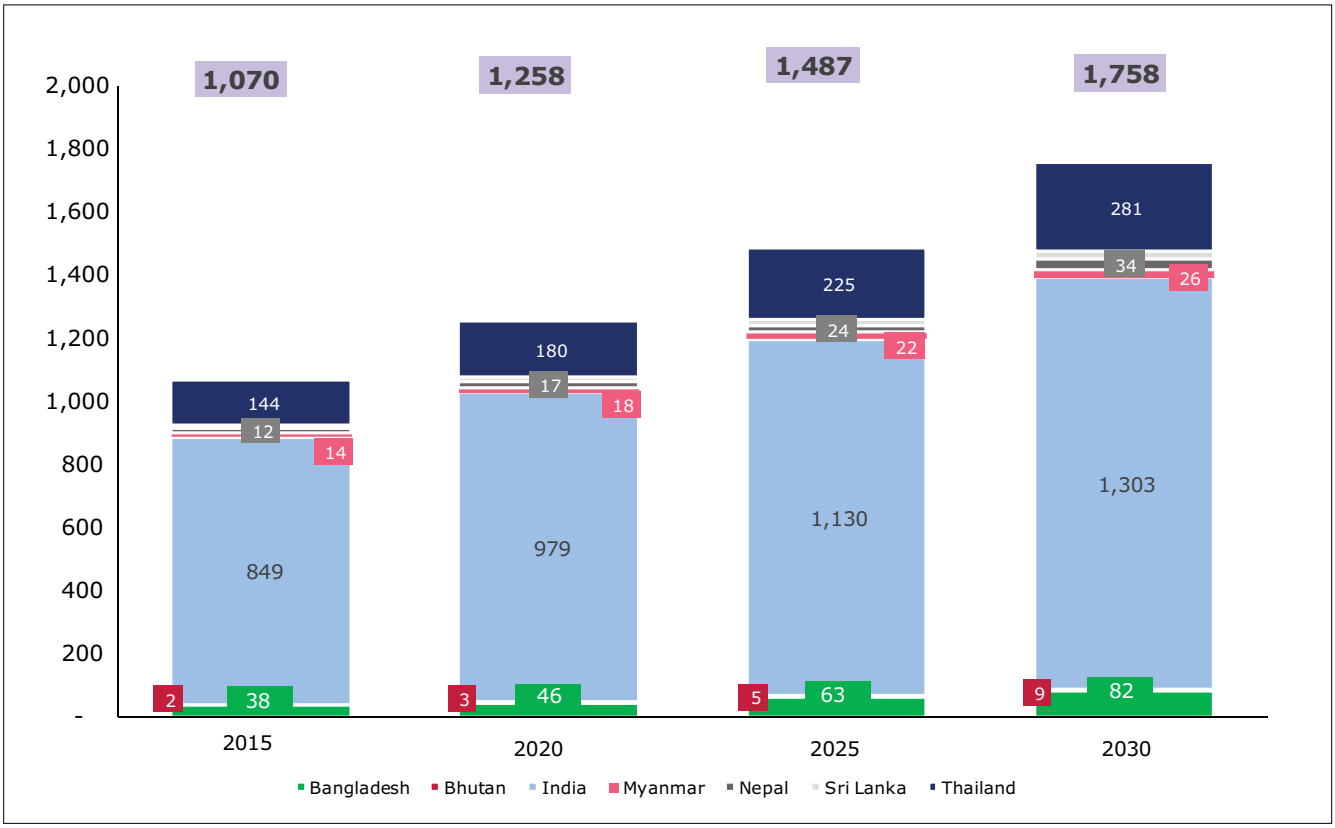
Figure 72 Total Primary Energy Supply (Mtoe) in the BIMSTEC Region



Source: IEA Database, Country Reports

India, Thailand and Bangladesh contributed to more than 95 per cent of the region's primary energy supply in 2015 and the situation will continue to be same till 2030. India will have 74 per cent of the total primary energy supply in 2030, a decline of 5 per cent from 2015.

Figure 73 Country-wise Primary Energy Supply (Mtoe) in the BIMSTEC Region



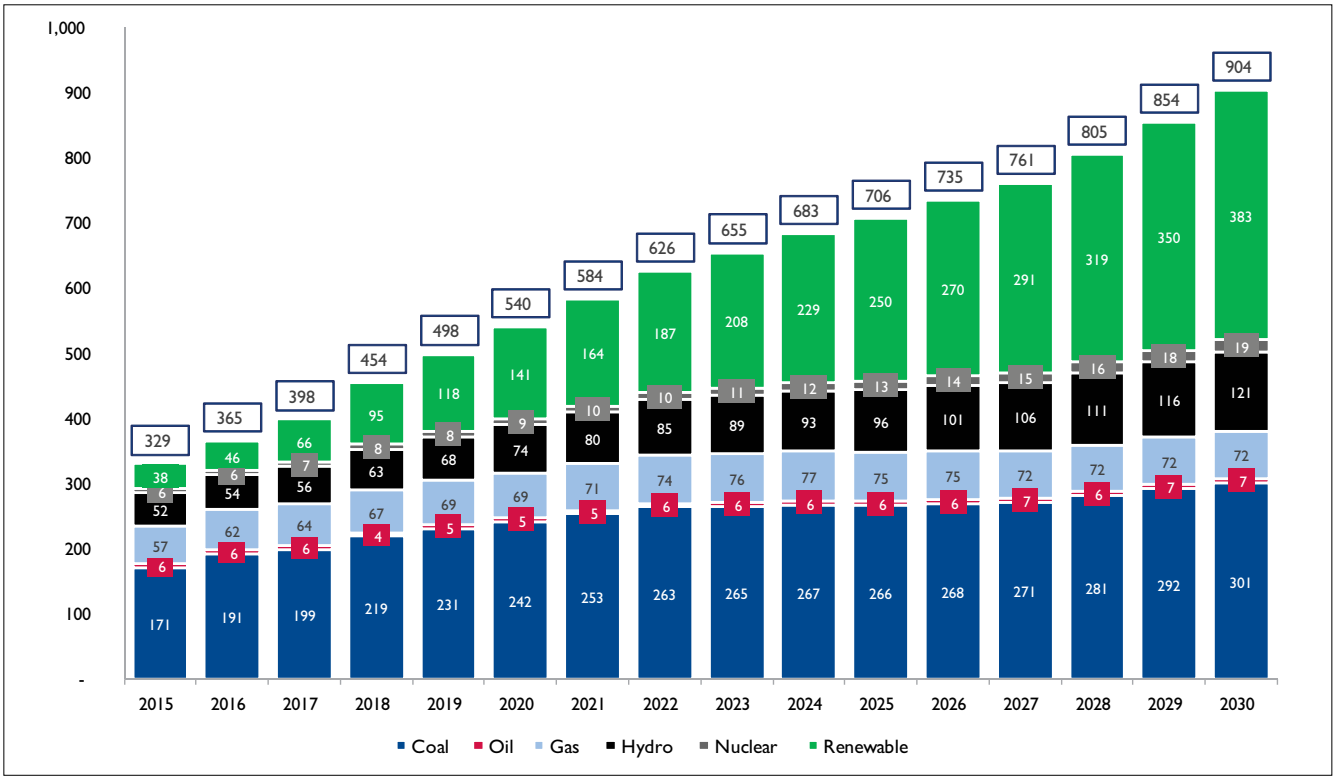
Source: IEA Database, Country Reports

6.1.2 Generation Capacity

During the outlook period, BIMSTEC's generation capacity is projected to increase threefold, from 293 GW in 2014 to almost 904 GW in 2030. The generation mix in the region would see a shift from predominantly thermal-based capacity to cleaner sources as more renewables get added in the system.

The period marked between 2008 and 2014 was dominated by coal and gas-based capacity. During this time, a total of 137 GW of capacity was added in the region, of which 51 per cent was coal-based and 22 per cent, gas-based. However, this trend is likely to change. Over the projected period, a total of 609 GW of capacity gets added in the region, renewables account for about 57 per cent of gross capacity additions, followed by coal at 25 per cent, gas at 4 per cent and hydro at 11 per cent. In this gross capacity addition of renewable, solar will dominate with an addition of 207 GW, followed by wind (130 GW) and bio-mass (33 GW).

Figure 74 Resource-wise Generation Capacity (GW) in the BIMSTEC Region



Source: SARI/EI Analysis

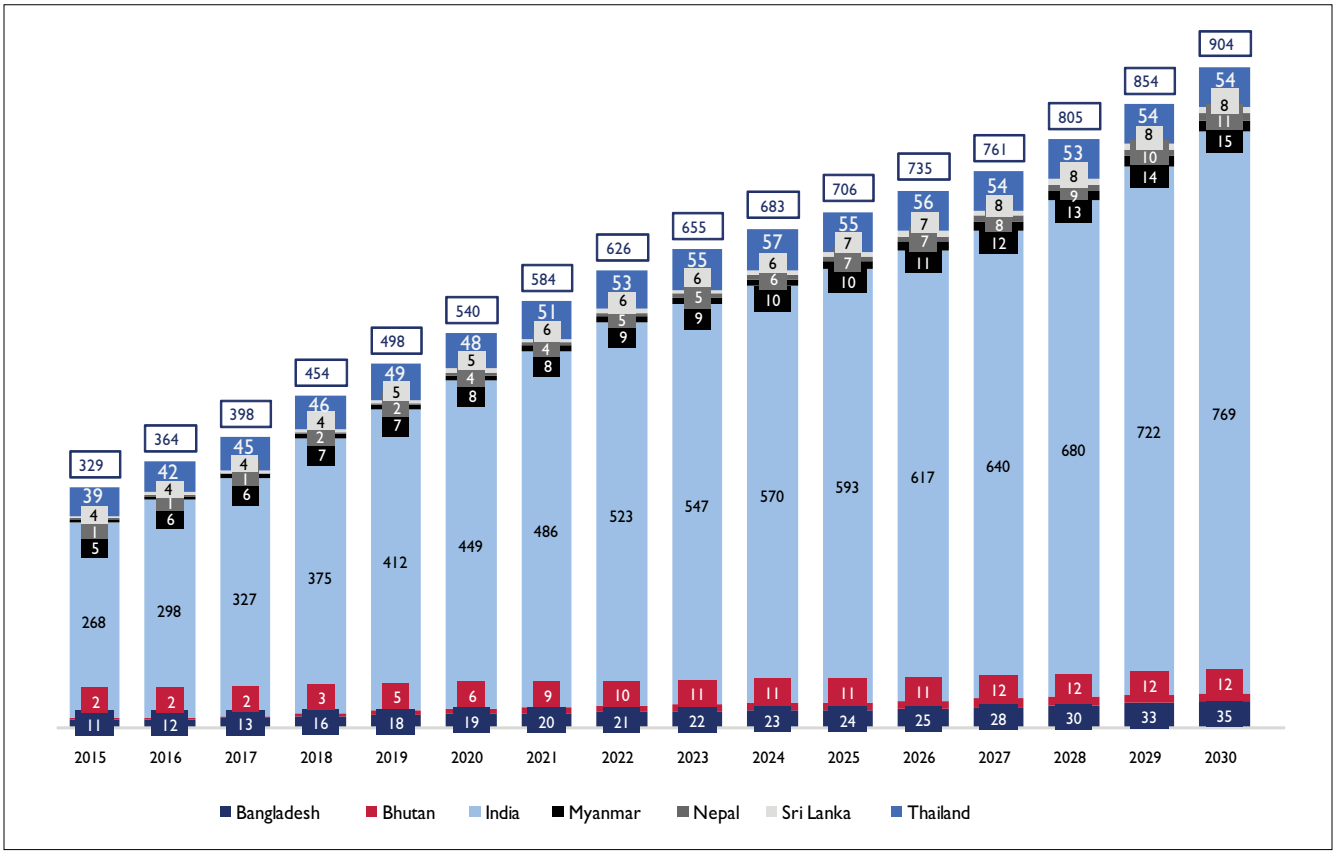
The BIMSTEC region's coal-fired power plants are likely to grow at an annualised rate of 3.9 per cent till 2030. The share of coal in the region's electricity mix would decline from 52 per cent in 2015 to 33 per cent in 2030 to become the second largest source of electricity supply after renewables. Bangladesh and India are expected to lead the expansion of coal-based capacity. The share of gas is likely to decline from 17 per cent in 2015 to 8 per cent in 2030. The sector gas-based capacity is likely to grow at an annualised rate of 1.6 per cent during the outlook period. The hydro sector's contribution is likely to be constant, declining slightly from 15.8 per cent in 2015 to 13.8 per cent in 2030. The generation capacity that is likely to gain the most is the renewable sector, whose contribution to the overall generation portfolio is likely to increase from 11.6 per cent in 2015 to 42.2 per cent in 2030.

Table 11 Installed Capacity (GW) in the BIMSTEC Region

	2008	2015	2020	2030	Share (%)		Annualised Rate
					2015	2030	2016-30
Thermal	98	234	316	380	71%	42%	3.3%
Coal	77	171	242	301	52%	33%	3.9%
Oil	1	6	5	7	2%	1%	0.9%
Gas	19	57	69	72	17%	8%	1.6%
Hydro	44	52	74	121	16%	13%	5.8%
Nuclear	4	6	9	19	2%	2%	8.4%
Renewables	11	38	141	383	12%	42%	16.6%
Total	157	329	540	904	100%	100%	7.0%

India will continue to be the dominating partner in the region with its share of the total installed generation capacity likely to grow from 81 per cent in 2015 to 85 per cent in 2030. Bhutan and Nepal are expected to experience the highest growth rate in the region (14 per cent and 19 per cent, respectively) as a result of the development of hydropower potential in these countries for cross-border trade. Figure 75 shows the country-wise break-up of the capacity additions in the BIMSTEC region.

Figure 75 Country-wise Generation Capacity (GW) in the BIMSTEC Region



Source: SARI/EI Analysis

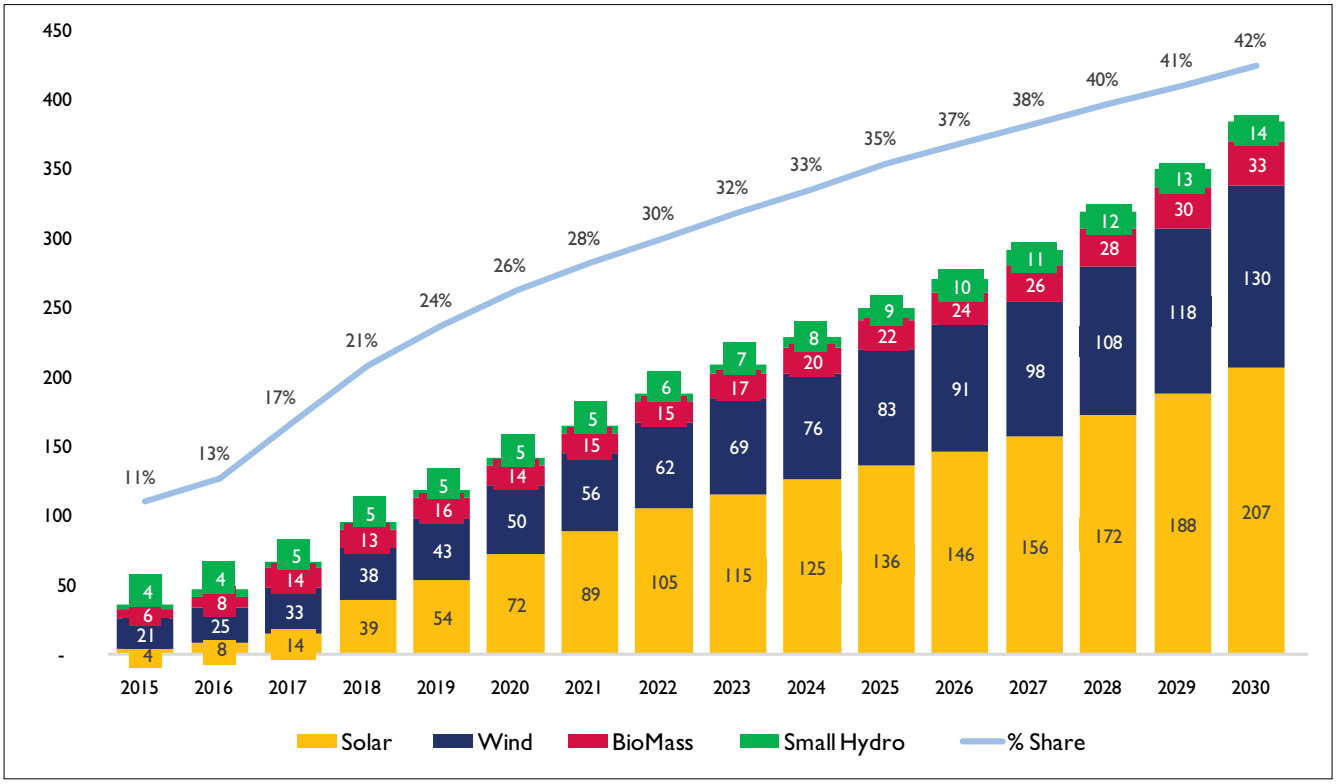
6.1.3 Renewable Energy

Renewable-based capacity addition is expected to grow at an annualised rate of 16.6 per cent, the highest recorded rate during the outlook period, expanding from 38 GW in 2015 to 383 GW in 2030. The share of renewables in the electricity mix will be the highest, at 42 per cent, up from 12 per cent in 2015, as shown in Figure 76. Although all the countries in the region are planning to increase the share of renewables in the power sector, the expansion of renewables in the BIMSTEC region will be driven by India. As per the projected planned capacity, the overall installed capacity of renewables in India will increase to 175 GW in 2022 and over 250 GW by 2027 and beyond. The current installed renewables' capacity in India is 57 GW. Almost 71 per cent of the overall renewables' capacity in the country is from wind energy, 21 per cent is from solar energy, with the remaining from bio-mass and small hydro. To achieve its target capacity addition, India will have to add approximately 120 GW of renewables in the next five years. The increasing proportion of renewables in the electricity grid will also increase the intermittency in the grid and, therefore, investments will be required to strengthen the support infrastructure.

Thailand would be the second largest contributor to the renewables' capacity addition in the region. The share of renewables in the country's electricity mix will increase threefold in the next decade-and-a-half and will be over 12 GW by 2030. Between 2020 and 2030, the overall installed capacity of renewables in Thailand is expected to increase from 8.8 GW to 12 GW, growing at an annualised rate of 3.1 per cent.

Recognising the depletion of its fossil fuel reserve, price volatility of fossil fuel, emission reduction for mitigating climate change and energy security, the Government of Bangladesh introduced the Renewable Energy Policy of Bangladesh in 2008. The objective of this policy is to promote the development of renewable energy. The policy foresees that 10 per cent of the total electricity demand should be met from renewable energy by 2021. While the growth of renewables in Bangladesh has been moderately slow, the capacity addition programme is likely to gather momentum. During the outlook period, it is expected that the overall renewables' capacity will grow from 1.7 GW in 2025 to over 2.4 GW in 2030.

Figure 76 Renewable Capacity Addition Outlook (GW) in the BIMSTEC Region



6.2 Energy Consumption Forecast

6.2.1 Primary Energy Consumption

The total energy consumption in the BIMSTEC region is likely to increase from 713 Mtoe to 1,210 Mtoe between 2015 and 2030, a growth of 70 per cent. The annualised increase in the total primary energy consumption will be 3.6 per cent. The energy mix of the region will also undergo some changes during this period. The region's energy consumption continues to remain heavily reliant on fossil fuels with their share increasing from 54 per cent in 2015 to 57 per cent in 2030. In comparison, the share of bio-energy is projected to decline from 31 per cent in 2015 to 22 per cent in 2030.

The consumption of coal rises steadily in absolute terms, from 126 Mtoe in 2015 to 198 Mtoe in 2030. Despite the increase in consumption of coal, the share of coal decreases from 18 per cent to 16 per cent during the same period. One of the contributing factors to the decreasing share of coal is the fact that the countries in the region are increasingly considering to diversify their electricity mix by adding more renewable energy sources to their generation portfolio.

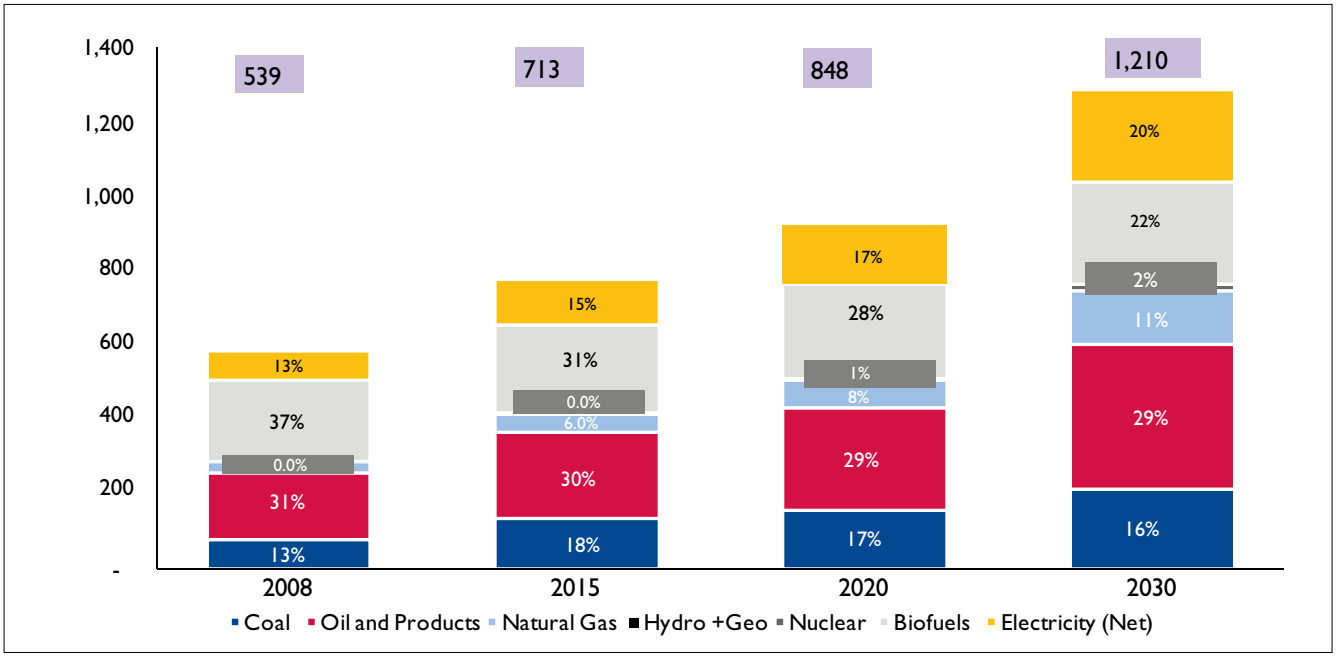
The consumption of oil and oil products is likely to grow at an annualised rate of 3.54 per cent between 2015 and 2030. During this period, the absolute consumption of oil would by 145 Mtoe, its share in the primary energy consumption would marginally reduce from 30 per cent in 2015 to 29 per cent in 2030. BIMSTEC is one of the regions in the world which is largely import dependent as far as the consumption of oil is concerned. Therefore, the countries in the region are undertaking efforts to reduce their dependence on oil, by switching towards indigenous fuels or less expensive alternatives. During this period, the share of natural gas in the primary energy consumption for the region is projected to increase from 6 per cent to 11 per cent, growing at an annualised rate of 7.2 per cent. India, Bangladesh and Myanmar will contribute to the increasing consumption of natural gas in the region. The share of electricity in the primary energy consumption share in the region would increase from 15 per cent to 20 per cent during the period. The following table shows the change in the primary energy consumption mix in the region.

Table 12 Total Primary Energy Consumption (Mtoe) in the BIMSTEC Region

	2008	2015	2020	2030	Share (%)		Annualised Rate
					2015	2030	2016-30
Fossil Fuels	267	383	465	686	54%	57%	3.96%
Coal	72	126	147	198	18%	16%	3.06%
Oil	165	211	250	356	30%	29%	3.54%
Gas	30	46	68	132	6%	11%	7.24%
Nuclear	0	1	5	19	0%	2%	19.74%
Bio-energy	200	219	234	264	31%	22%	1.24%
Electricity	72	109	144	241	15%	20%	5.43%
Total	539	713	848	1,210	100%	100%	3.59%

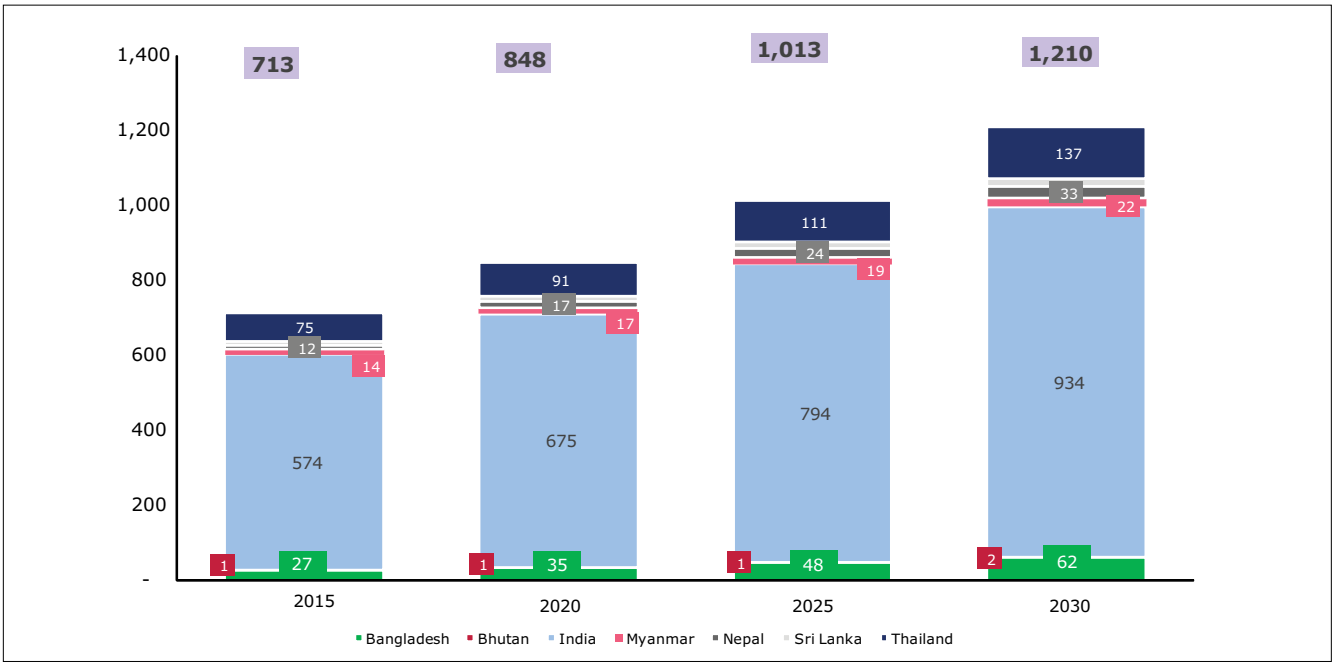
The most notable change in the energy consumption pattern of the region is the growth in the share of electricity. The overall consumption of electricity is likely to grow at an annualised rate of 5.43 per cent. In comparison, the share of bio-energy is likely to grow at annualised rate of 1.2 per cent. As a result, the share of bio-energy in the overall primary energy consumption is likely to reduce from 31 per cent in 2015 to 22 per cent in 2030. One of the major contributing factors related to the decline in bio-energy consumption is rapid urbanisation and rising living standards that encourage the adoption of modern fuels, particularly electricity.

Figure 77 Fuel-wise Primary Energy Consumption (Mtoe) in the BIMSTEC Region



The bulk of the increase in the primary energy consumption will come from India and Thailand. About 72 per cent of the addition to the primary energy consumption will be contributed by India and 12 per cent by Thailand. Bangladesh is the third largest consumer of energy in the region and will contribute 7 per cent to the overall increase in primary energy consumption of the region. The following figure provides the country-wise primary energy consumption trends in BIMSTEC.

Figure 78 Country-wise Primary Energy Consumption (Mtoe) in the BIMSTEC Region

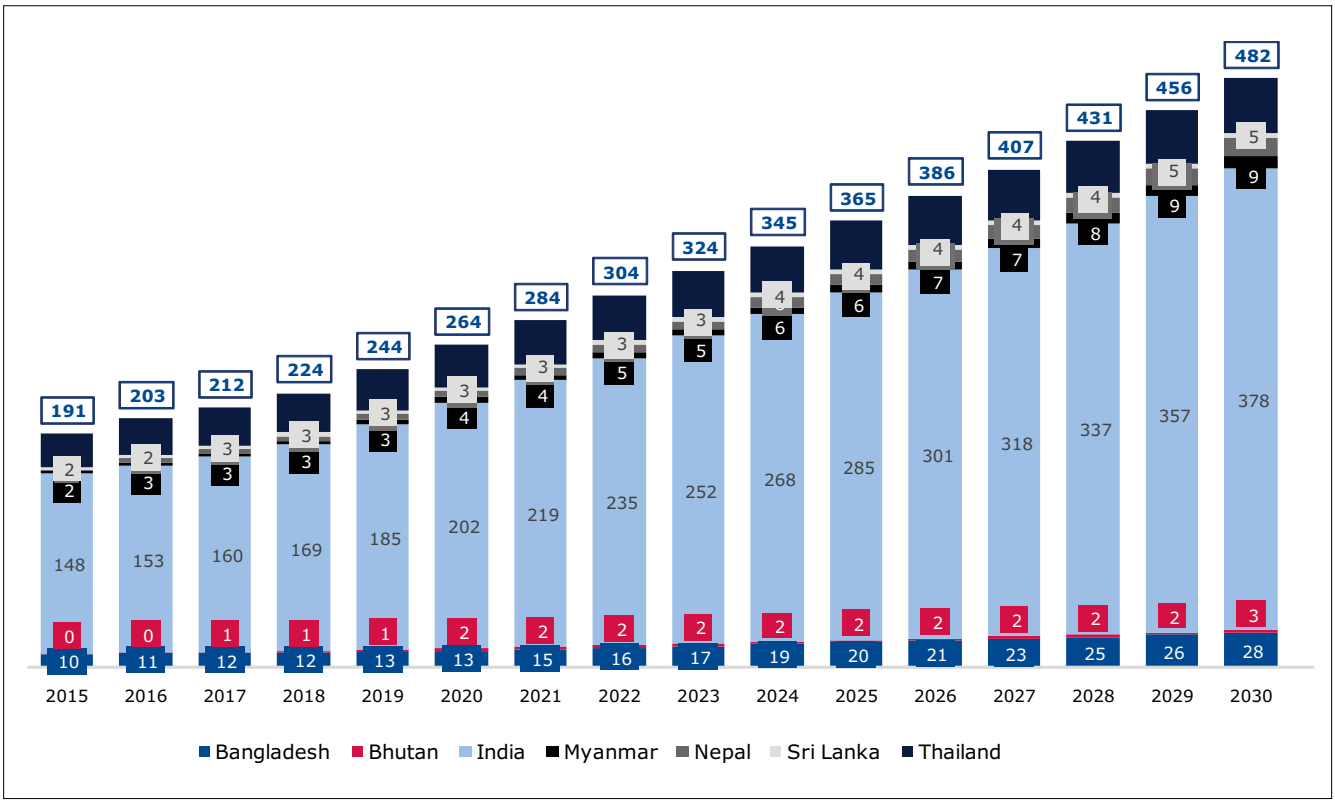


6.2.2 Electricity Demand

The peak electricity demand in the BIMSTEC region grows at an annualised rate of 6.5 per cent during the outlook period, an increase from 175 GW in 2014 to 482 GW in 2030. Almost three-fourth of this demand will come from India and the remaining from the other countries in the region. Some of the contributing factors to the increasing demand of electricity are the high economic growth rate projected during the outlook period, rapid urbanisation and the electrification of households.

Thailand, Bangladesh and Nepal are the countries which imports electricity. These three countries are projected to have an annualised peak electricity demand growth rate of 3.29 per cent, 6.83 per cent and 11.30 per cent, respectively, for the outlook period. India, which is exporting as well as importing electricity with its neighbouring countries, will have a peak electricity demand growth rate of 6.45 per cent for the period 2015-30. Such a significant increase in the demand of electricity requires more energy infrastructure to be established at the same rate. This requires a comprehensive approach for the development of energy infrastructure in a sustainable manner by sharing energy resources at the regional level.

Figure 79 Peak Demand (GW) in the BIMSTEC Region



6.3 CBET in the BIMSTEC Region

CBET in the region has evolved through bilateral arrangements, with India being the central figure because of its geographical location and large economy. While several initiatives have been taken up under the SAARC framework, CBET's focus has mostly been on the BBIN sub-group, which consists of Bhutan, Bangladesh, India and Nepal. The bilateral arrangements between India-Bhutan, India-Bangladesh and India-Nepal are well established now and are being further strengthened. A brief profile of the CBET interconnections in the BIMSTEC region that are proposed to be developed is provided here.

India – Bhutan

- Punatsangchu HEP – Alipurduar 400 KV D/c (quad moose): 170 km.
- Jigmeling – Alipurduar 400 KV D/c (quad moose): 198 km.
- Strengthening of the Indian grid from Alipurduar (ER):
  Alipurduar – Siliguri. 400 KV D/c line (quad)
  and Kishanganj – Darbhanga 400 KV D/c line (quad).

India – Nepal

- Commissioning of 132 KV Raxaul-Parwanipur and Kataiya-Kushaha line.
- Upgradation of 400 KV D/c Dhalkebar-Muzzafarpur line to 400 KV
  (presently it is charged at 132 KV).

India – Sri Lanka

- 2 x 500 MW HVDC bi-pole line from India (Madurai)
  to Sri Lanka (Anuradhapura [New]): 370 km.
  - Overhead line (India): Madurai to near Dhanushkodi.
  - Submarine cable: Dhanushkodi (India) to Talaimannar (Sri Lanka).
  - Overhead line (Sri Lanka): Talaimannar to Anuradhapura (New): 150 km.
  - 2 x 500 MW HVDC terminal stations each at India (Madurai)
    to Sri Lanka (Anuradhapura [New]).

Thailand – Myanmar

- Mai Khot – Mae Chan – Chiang Rai (369 MW).
- Hutgyi – Phitsanulok 3 (1,190 MW).
- Ta Sang – Mae Moh 3 (7,000 MW).
- Mong Ton – Sai Noi 2 (3,150 MW).

Bangladesh – Nepal

- Purnea – Barapukuria (1,000 MW by 2025).
- Additional 1,000 MW by 2030.

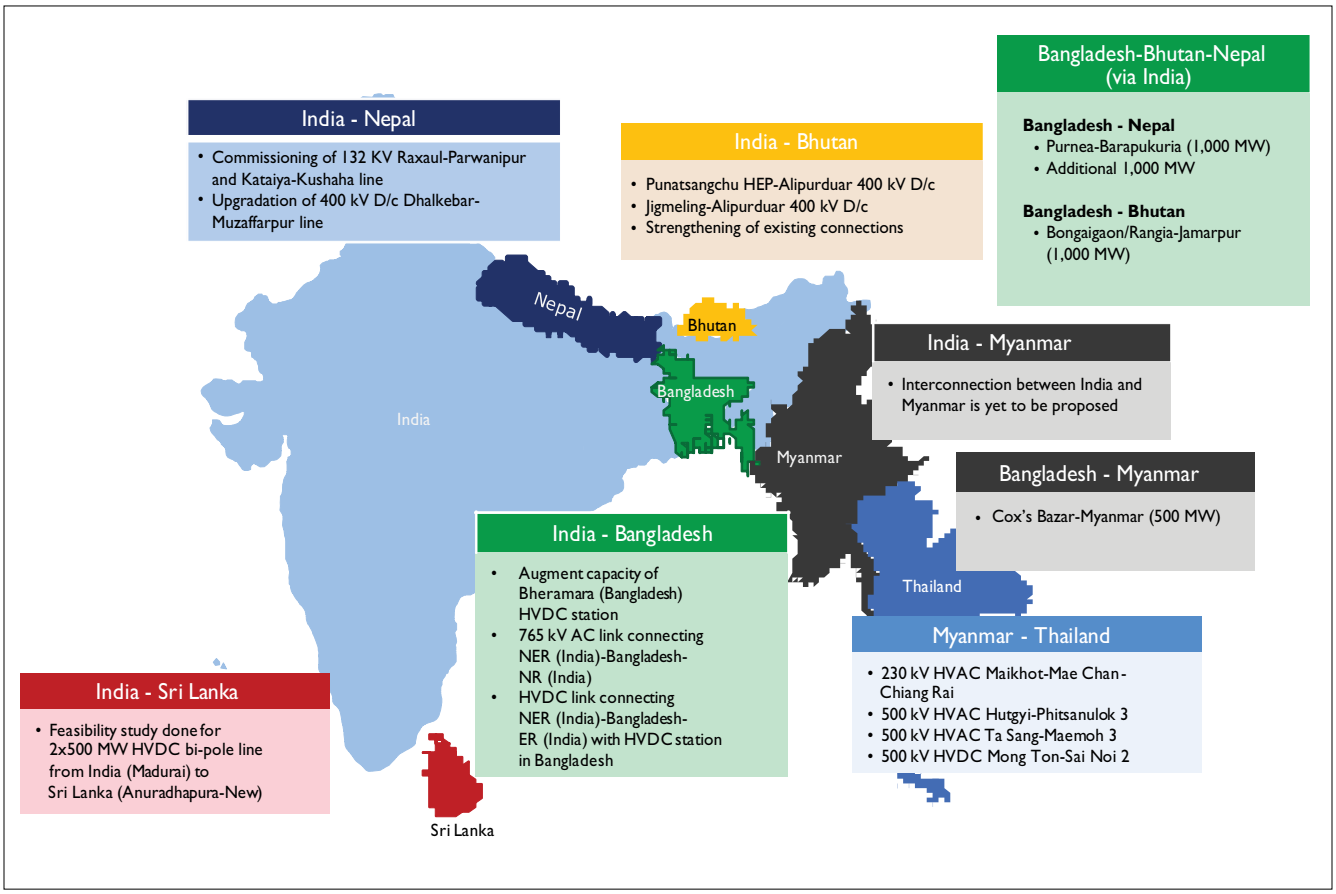
Bangladesh – Bhutan

- Bongaigaon/Rangia – Jamarpur (1,000 MW by 2030).

Bangladesh – Myanmar (Proposed Interconnections)

- Cox's Bazar – Myanmar (500 MW by 2040).

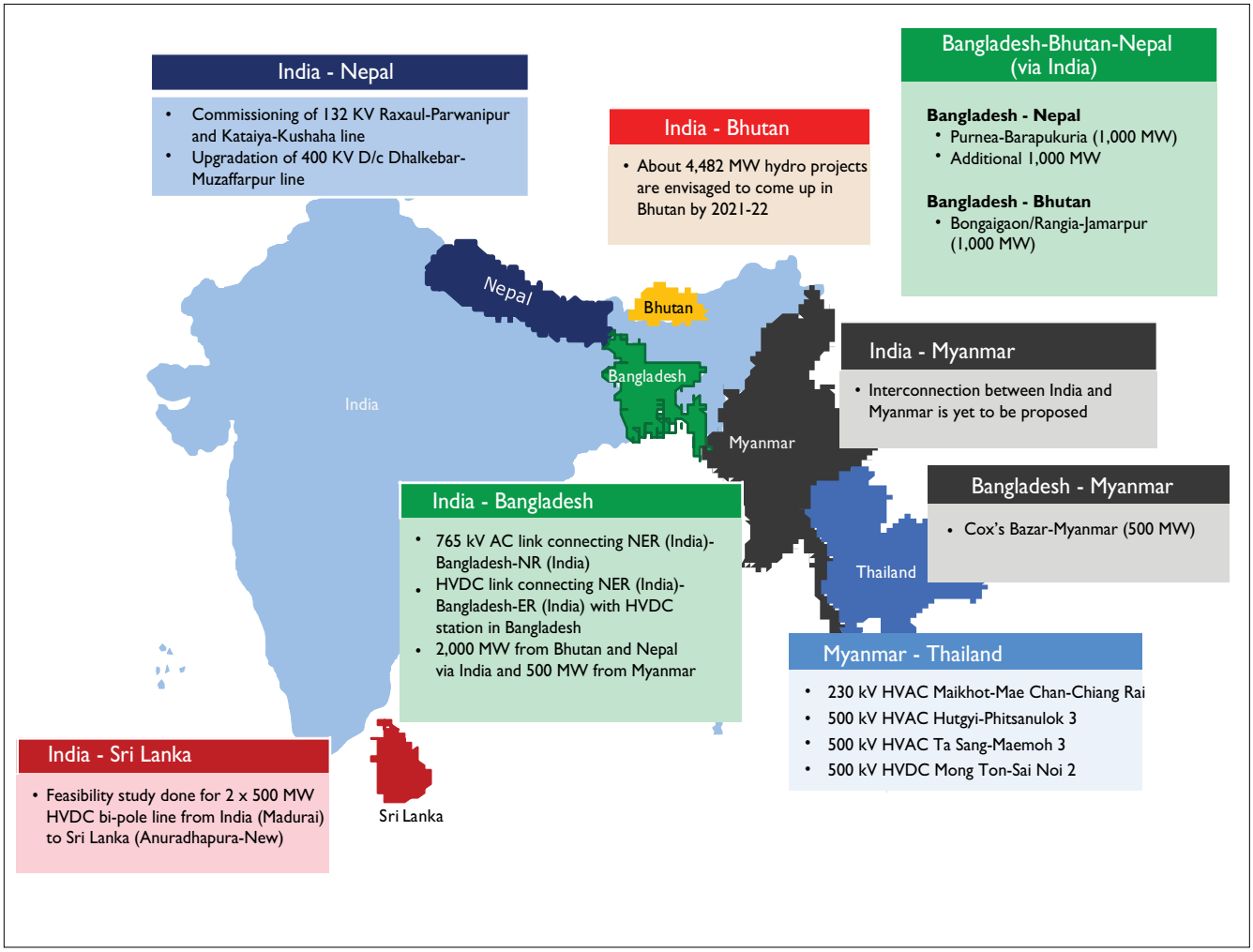
Figure 80 Proposed Cross-Border Interconnection Capacities by 2026-27



Source: National Electricity Plan for Transmission, India and Power System Master Plan 2016, Bangladesh

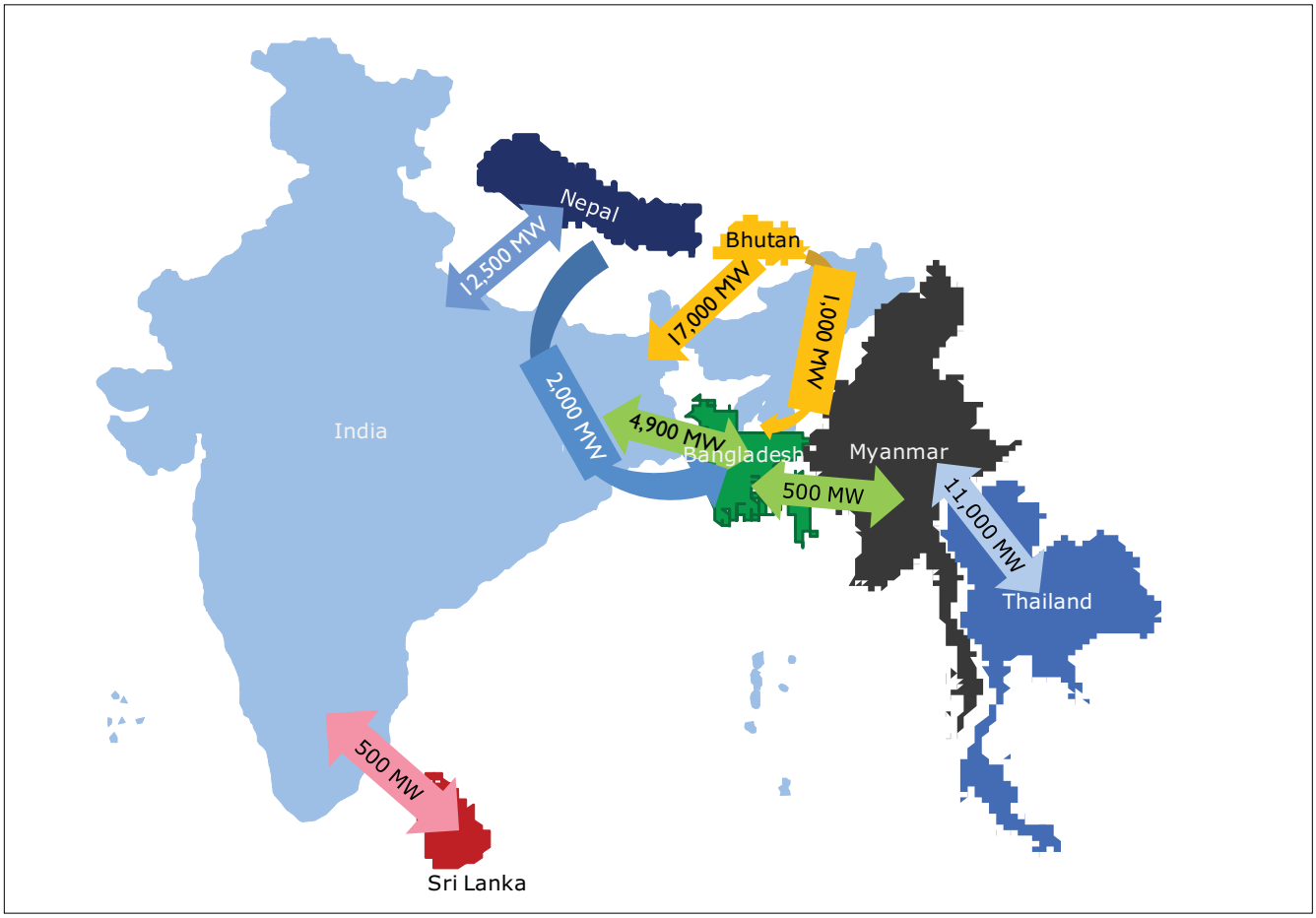
By 2030, cross-border interconnections between India and its neighbouring countries (Bangladesh, Bhutan and Nepal) are proposed to be further strengthened. The import of electricity from Bhutan and Nepal to India and also Bangladesh will be the key drivers for developing the transmission infrastructure. 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. 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. Figure 82 shows the likely capacities that would be developed by 2030.

Figure 81 Proposed Cross-Border Interconnection Capacities by 2031-32



Source: National Electricity Plan for Transmission, India and Power System Master Plan 2016, Bangladesh

Figure 82 BIMSTEC: Required Cross Border Power Transmission Interconnection Capacity (in 49.4 GW) by 2031-32 for Cross Border Electricity Trade



Source: Perspective Transmission Plan, CEA, National Electricity Plan for Transmission, India and Power System Master Plan 2016, Bangladesh, Other Sources

6.4 Future Energy Cooperation in the BIMSTEC Region

The countries in the region face multiple challenges for energy access and energy security and require a transition in the way energy is generated, transmitted and consumed. The respective countries will have to focus on an improved energy access, an increased renewable energy share, energy efficiency initiatives and more interconnected systems across the region. Some of the key drivers for the energy sector include:

- The countries in the region are striving for better electricity access. An increase in the per capita consumption of electricity will fuel the overall demand. The growth in the electricity demand is expected to be around 72 per cent during this period.

- The demand associated with the fast-growing economies in the region. There is a need to increase the energy supply in the region by 63 per cent by 2030 in order to meet this demand.
- A shift towards low carbon energy sources to reduce the environmental impact and meet the global commitments would be a key driver in realigning the generation portfolios. The countries would have to diversify their energy portfolio to improve the energy security.
- A transformation in the energy sector through reforms and restructuring. While most countries have taken initiatives in this regard, the pace of change needs to be accelerated. The countries in the region can leverage their collective experience to chart their own course.

There have been key initiatives on developing cross-border connectivity in the region. These include:

- NTPC Vidyut Vyapar Nigam Ltd, India, entered a preliminary pact with the BPDB for supply of power from Nepal.
- Bangladesh plans to invest in a large hydropower project in Bhutan in a joint venture to supply power to Bangladesh using Indian transmission infrastructure.
- Securing power transmission capacity in India: Bhutan and Nepal are positively in favour of electric power exports to Bangladesh. However, when Bangladesh imports electric power from the two countries, it must pass through the Indian system. It is especially important to match the system development plan in India and to advance the plan, if necessary, in order to secure the power transmission capacity in India. In the case of power transmission from hydropower stations located in Bhutan or Nepal through India, HVDC interconnections with a capacity of around 500–2,000 MW will be required in the northwestern part of Bangladesh.

Similar cross-border cooperation initiatives are also seen 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:

- **India – Bangladesh**
  - Three preliminary agreements related to cooperation in the field of LNG signed between Indian and Bangladeshi companies in 2017. Petrobangla (Bangladesh) signed preliminary agreements with Petronet LNG (India) for LNG terminal use, with Reliance Power (India) for setting up an LNG terminal at Kutubdia Island, and with Indian Oil Corporation for LNG cooperation.
  - India's Oil and Natural Gas Company (ONGC) and Bangladesh Petroleum Corporation (BPC) are in negotiation to build the 6,900 km gas pipeline that will link Bangladesh, Myanmar and the northeastern states. The pipeline project has been conceived under the Hydrocarbon Vision 2030 for the northeastern region and is planned to connect Chittagong (in Bangladesh), Sitwe (in Myanmar) with the northeastern states. A lot of gas is burned in the northeast as it cannot be supplied due to a lack of infrastructure. Now a joint LPG plant is planned at Chittagong from where the gas will be piped to the northeastern region.
- **India – Nepal**
  - India has been supplying fuel to Nepal since 1974 under contracts that were periodically renewed. There is a proposal to build the Raxaul-Amlekhganj petroleum product pipeline, for which work is expected to start in 2017-18. India exports about US$ 1.1 billion worth of petroleum products per annum to Nepal and the bulk of this volume will be transported through the proposed pipeline.
  - 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;

the construction of a natural gas pipeline from Gorakhpur to Sunwal and Indian Oil Corporation Limited (IOCL) assistance for preparing a detailed project report (DPR) for the extension of the petroleum products pipeline from Amlekhgunj to Chitwan in Nepal.

- **India – Bhutan**
  - Bhutan imports most of its petroleum requirements from India under the bilateral agreement on trade, commerce and transit.
  - MoU between India and Bhutan on technical cooperation in the field of capacity building, benchmarking and bilateral exchange in infrastructure engineering.
- **India – Sri Lanka**
  - Trade in petroleum between India and Sri Lanka takes place through the Lanka Indian Oil Corporation (IOC), Indian Oil's subsidiary in Sri Lanka. It provides bulk supply to industrial users, carries out retail marketing of petroleum products and establishes petroleum storage facilities in Sri Lanka.
- **India – Myanmar**
  - India is considering building an oil pipeline to connect refineries in its northeastern provinces to consumer centres in Myanmar. Indian oil marketers have already started selling petroleum products in neighbouring Myanmar, with the construction of a pipeline seen as the logical extension of India deepening its economic cooperation with the countries in the region.
  - India, Bangladesh and Myanmar are now reconsidering the pipeline plan connecting the three nations. 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 northeastern states on the eastern side. Some 7,000 km of pipeline would be required for the gas grid, which could be used by the three countries.
  - An agreement has been reached between India and Myanmar to supply diesel to Myanmar across the land border. This will give the people of North Myanmar cheaper and more reliable access to petroleum products.
- **Myanmar – Thailand**
  - Proposed interconnection arrangement for Myanmar-Yunnan-Thailand and the adaption of the MOEP-NEMP 500 KV-HVDC.

The regional cooperation is also being explored in the area of energy efficiency and smart grids. A MoU has been signed between Energy Efficiency Services Ltd (EESL) of India and Sustainable and Renewable Energy Development Authority (SREDA) of Bangladesh.

India has offered to conduct a solar radiation resource assessment in Myanmar. In addition, technology demonstration projects are being undertaken through EESL to introduce LED-based energy efficient lighting in key townships and buildings identified by Myanmar in Nay Pyi Taw, the Bago region and Rakhine state.

6.5 Investment Potential and Business Opportunities in the BIMSTEC Region

BIMSTEC as a region offers significant business opportunities in the electricity sector. The region will require US$ 1,056 billion[26] investments in the generation sector till 2030 in order to achieve the projected electricity capacity requirement. Renewables, coal and hydropower will attract approximately 93 per cent of the overall investment potential. The investments in renewables will be the highest at US$ 724 billion, which is approximately 68.6 per cent of the overall investment requirement, followed by coal that will require US$ 168 billion or 16 per cent of the investment potential. Hydropower will require US$ 93.3 billion or 9 per cent of the overall investments in the region.

Within the group, India is projected to have the largest grid connected capacity and, therefore, will need US$ 947 billion or 90 per cent of the overall investment potential to achieve its target. Bangladesh and Bhutan will be the other big investment destinations, together requiring approximately US$ 59 billion or 5.6 per cent of the overall investments in the region.

The investment potential of the region has been arrived at by using technology-specific capital cost estimates for each country and the projected capacity installation. The total investment requirement is the summation of investment needed in each country to achieve its target capacity. In addition, it has also been assumed that the capital cost of each technology will remain constant and any change in technology will be available at similar costs. The investment potential estimates using this methodology is an indicative figure to highlight the quantum of investment required, however, the actual investment requirement to achieve the target capacity addition can be very different.

Table 13 **Investment Potential (US$ billion) in the BIMSTEC Region**

Investment (US$ Billion)	Bangladesh	Bhutan	India	Myanmar	Nepal	Sri Lanka	Thailand	Total
Coal	27.38	-	134.02	3.95	-	-	2.43	167.78
Oil	0.17	-	-	2.67	-	-	-	2.84
Natural Gas	1.15	-	4.04	0.00	-	0.05	0.82	6.06
Hydro	-	24.70	46.02	7.50	11.72	0.96	2.42	93.32
Nuclear	-	-	62.00	-	-	-	-	62.00
RE: Solar	2.90	-	428.50	0.59	0.08	1.87	2.32	436.26
RE: Wind	1.48	-	192.58	-	-	1.46	3.75	199.27
RE: Small Hydro	0.62	-	55.81	-	0.01	0.21	6.16	62.79
RE: Bio-mass	0.69	-	24.51	-	-	0.45	-	25.65
Total Investment	**34**	**25**	**947**	**15**	**12**	**5**	**18**	**1,055.98**

[26]Estimated at current cost of investments in various technologies

7. Way Forward

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

The total primary energy consumption in the BIMSTEC region is likely to increase from 706 Mtoe in 2014 to 1,210 Mtoe by 2030. The peak electricity demand in the BIMSTEC region grows at an annualised growth rate of 6.5 per cent during the outlook period, an increase from 175 GW in 2014 to 482 GW in 2030.

The BIMSTEC region is endowed with an abundant amount of natural energy resources; together the region holds 92,615 million tonnes of coal, 5,880 million tonnes of crude oil, 295 TCF of natural gas and 392 GW of hydropower potential. However, due to a lack of adequate development of energy resources, both domestically as well as on a regional level, it depends on imports of energy (crude oil, gas, coal, petroleum products) outside the region to meet its energy needs. Therefore, the countries in the region as a whole can mutually benefit one another by promoting energy trade among themselves.

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 and so on. These will have to be achieved through creating platforms at the regional level. The existing success stories in CBET, energy efficiency measures and renewable capacity additions need to be replicated across the region. The BIMSTEC region will require US$ 1,056 billion till 2030 in order to achieve the projected electricity capacity addition. Renewables, coal and hydropower will attract approximately 93 per cent of the overall investment requirement. The investment in renewables will be the highest, at US$ 724 billion, which is approximately 68.6 per cent of the overall investment requirement, followed by coal that will require US$ 168 billion or 16 per cent of the investment potential. Hydropower will require US$ 93.3 billion or 9 per cent of the overall investments in the region. To materialise these investments, a conducive and cooperative political, economic and investment-friendly environment is required in the BIMSTEC region.

There are certain initiatives that need to be taken up for developing energy connectivity, particularly the interconnections of electricity grids and gas pipelines. These can offer multiple energy/electricity sector benefits to the BIMSTEC countries and its people.

7.1 Promoting Regional Energy Cooperation through Regional Energy Treaty/Agreement/MoU and Enhancing Political Consensus in the BIMSTEC Region

Political commitment at the highest level is important for promoting energy cooperation and energy trade in the BIMSTEC region. As the regional electricity/energy cooperation takes a formidable shape, there is a need to formalise the whole process through a BIMSTEC Regional Energy Treaty/ Agreement, which will help in minimising the risks associated with regional investments in electricity/ energy and cross-border electricity/energy trade. BIMSTEC has finalised a MoU on the BIMSTEC grid interconnection, which provides a broad framework for the BIMSTEC countries to cooperate towards the implementation of grid interconnections for trade in electricity. There is a need to expedite the signing of the MoU on this interconnection. While the MoU on will promote electricity integration in the region, there is also a need to have a Regional Energy Treaty/Agreement/MoU for promoting the

oil and gas and gas grid interconnection, There is also a need to develop a BIMSTEC-Comprehensive Plan for Energy Cooperation (BIMSTEC-CPEC) to augment interconnectivity and promote regional energy trade.

7.2 Coordination/Harmonisation of Energy/Electricity Policy, Regulatory and Legal Framework

Policy/regulatory provisions and legal frameworks required for promoting/facilitating CBET exist in some BIMSTEC countries but are not exhaustive in nature. Currently, these countries are at different stages of power/energy sector reforms and have different energy/electricity policies and regulatory environments. To enhance CBET among BIMSTEC countries, there is a need to have a common/ coordinated set of regulations, policies and legal frameworks. These should facilitate/address the mechanism of cross-border interconnection, recognise CBET, have open access to transmission networks, licencing, imbalance settlement mechanism, coordinated procedures for integrated system operation, dispute resolution, and so on.

Without a consistent and coherent regional regulatory framework in place, investment opportunities and consequently large-scale CBET that could benefit both importing and exporting nations may not happen. In the BIMSTEC countries' regional context, the risks associated with forging an intra-regional, CBET project would be greatly minimised if each participating country adopts complementary regulatory frameworks to facilitate cross-border interconnection and electricity trade.

7.3 Integrated Regional Energy/Electricity Sector Planning

The countries in the BIMSTEC region need to build Integrated regional energy/electricity sector master plans to optimise resources and the costs of the various energy sub-sectors. Integrated regional energy/ power sector planning would ensure optimal resource utilisation levels. The following initiatives can be undertaken under BIMSTEC:

- Mapping of the energy demand and consumption on a geographical as well as a sector level for the purpose of forecasting.
- Designing and implementing interventions based on newer technologies, pricing and so on to reduce or substitute energy.
- Identifying cross-border regional assets to be developed for energy exchanges for the power, oil and gas sectors.
- Prioritising the energy resources to be developed, based on optimisation at the regional level.
- Developing a regional transmission interconnection master plan for promoting CBET.

7.4 Establishment of Regional Institutions for Promoting Energy/Electricity Trade

Cross-border energy trade requires enabling the institutional structure to manage the complexities involved and provide continuity. Cross-border electricity trade can be facilitated through supporting institutes such as the BIMSTEC Energy Centre, BIMSTEC regulatory forums/bodies/associations, the BIMSTEC forum of transmission utilities, BIMSTEC forum/association of system operators, and so on. There is a need to expedite the operationalisation of the BIMSTEC Energy Centre.[27] Given the high potential of energy sources in the region, particularly renewable and clean energy sources, BIMSTEC

[27]BIMSTEC Leaders' Retreat 2016 Outcome Document, 16 October 2016, Goa, India

leaders also agreed to accelerate efforts to develop a comprehensive plan for energy cooperation with a view to augment interconnectivity and promote regional energy trade. Leveraging relevant experience from other regional groupings on the institutional requirements and contextualising for BIMSTEC would be an important step in the long-term plan for developing the energy markets.

7.5 Promoting Development of the Regional Energy Markets' Framework

The establishment of a regional energy market will provide necessary enablers to expand and sustain energy trade. It will also allow the countries in the region to minimise energy trade risks in the medium to long-term period.

BIMSTEC member states can collectively develop a regional energy/electricity market framework (treaty or charter) to promote and safeguard the investments in the energy sector. The framework can strengthen the governing laws to minimise the risks associated with regional investments and trade, while focussing on inter-governmental cooperation. A vibrant regional power/energy market will make the BIMSTEC power/energy sector competitive and streamline investments, making it lucrative for investors who seek fair, steady and risk-mitigated short and long-term returns on their capital.

7.6. Energy Cooperation in the New Emerging Areas and Promoting Technology Transfer

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. They can also learn from each other the various best practices in the area of sustainable hydropower development and the business models associated with them.

The countries in the region can also cooperate with each other for the introduction and advancement of energy efficiency measures, industrial efficiency improvement, LED replacement, promotion of smart grid initiatives, integration of distributed generation, fuel cell, clean coal technologies, energy storage, electric vehicles and large-scale integration of renewable energy to the grid. Member countries can develop and update the energy efficiency and renewable energy potentials of all sectors of the economy; develop a 'BIMSTEC Energy Database'; work on knowledge sharing, training and transfer of know-how across BIMSTEC member countries in the energy and electricity sectors; and work on the large-scale integration of renewable energy to the grid.

On the energy technology front, various new technologies in the area of renewable energy, long range and high voltage power transmission, power generation, hydrogen energy, fuel cell, clean coal, energy storage and electric vehicles and so on are on the verge of a breakthrough. There is a need for energy technology cooperation and the transfer of energy technologies among the BIMSTEC countries to help each other in modernising the energy system and building a futuristic climate-friendly energy system in the region. Cooperation on energy technologies for the collective development and transfer of energy technologies among the BIMSTEC countries will help in addressing the energy needs of the countries and their people.

7.7. Promoting/Mobilising Investments in the Region

Power and energy projects are highly capital-intensive in nature. Mobilising finances for capital-intensive cross-border power generation and associated transmission infrastructure projects, oil and gas pipeline/grid interconnections and so on is crucial for the success of CBET in BIMSTEC. Most of the BIMSTEC countries have initiated reforms in their power sector, which has resulted in significant private sector

investment. Private entities are perceived to be politically neutral, commercially motivated agencies focussed on project delivery within specified timelines, which often endows them with greater credibility. However, enticing the private sector participation, establishment of clear and conducive policy regimes, lucrative incentives, reasonable rate of returns, conducive taxation, royalty regimes and so on are important. Further, investments must be secured via investor protection agreements. BIMSTEC countries should prepare regional investment-friendly policies for promoting public and private sector investment. Although the bulk of financing comes from national governments who usually hold majority stakes in the projects, various financial institutions, multilateral development banks such as the World Bank and the Asian Development Bank and New Development Bank, are willing to invest more, if the right policies, circumstances and incentives are in place.

8 Annexures

A 1 Transmission Interconnections

1 India – Nepal and India – Bhutan

Interconnection Projects	Type Capacity	Commissioning	Capacity (MW)
India – Nepal (existing)			
■ Dhalkebar (Nepal) – Muzaffarpur (Bihar, India)	HVAC 400 KV		200
■ Kusaha/Duhabi (Nepal) – Kataiya (Bihar, India)	HVAC 132 KV		130
■ Gandak/Surajpura (Nepal) – Ramnagar (Bihar, India)	HVAC 132 KV		50
■ Mahendranagar (Nepal) – Tanakpur (Uttarakhand, India)	HVAC 132 KV		50
■ Birganj (Nepal) – Raxaul (Bihar, India)	HVAC 33 KV		
■ Jaleshwar (Nepal) – Sitamarhi (Bihar, India)			
■ Siraha (Nepal) – Jainnagar (Bihar, India)			
■ Rajbiraj (Nepal) – Kataiya (Bihar, India)			
■ Biratnagar/Rupri (Nepa) – Kataiya (Bihar, India)			
■ Nepalganj (Nepal)– Nanpara (UP, India)			
■ Mahendranagar (Nepal) – Lohia (Uttarakhand, India)	HVAC 11 KV		
■ Baitadi (Nepal) – Pithoragarh (Uttarakhand, India)			
■ Jaljibe (Nepal) – Dharchula (Uttarakhand, India)			
■ Pipli (Nepal) – Dharchula (Uttarakhand, India)			
India – Nepal (ongoing)			
■ Raxaul – Parwanipur	HVAC 132 KV		
■ Kataiya – Kushaha	HVAC 132 KV		
India – Bhutan (existing)			
■ Chukha (Bhutan) – Birpara (India)	HVAC 220 KV		2,500
■ Kuruchu: Geylegphug (Bhutan) – Salakati (NER – India)	HVAC 132 KV		2,500
■ Tala (Bhutan) – Siliguri (India)	HVDC 400 KV		2,500
India – Bhutan (ongoing)			
■ Punatsangchu – Lhamoizingkha – Alipurduar	HVAC 400 KV		
■ Jigmeling – Alipurduar	HVDC 400 KV		

2 India – Bangladesh and India – Myanmar

Interconnection Project	Type Capacity	Commissioning (Year)	Capacity (MW)
India – Bangladesh (existing)			
■ Baharampur – Bheramara ■ Surjyamaninagar – North Comilla – South Comilla	HVDC 500 KV HVAC 400 KV	2013 2016	540
India – Bangladesh (ongoing)			
■ Katihar – Parbotipur/Barapukuria – Bornagar	765 KV		
India – Bangladesh (proposed)			
■ Rangia/Rowta – Bangladesh – Muzaffarnagar ■ Bongaigaon (Assam) – Purnia (India) via Jamalpur or Barapukuria, dropping 500-1,000 MW to Bangladesh	800 KV 765 KV		7,000
India – Myanmar (existing)			
■ Moreh (Manipur) – Tamu (Myanmar)	HVAC 220 KV		

3 Thailand – Malaysia, Lao PDR, Cambodia and Myanmar

Interconnection Project	Type Capacity	Commissioning (Year)	Capacity (MW)
Thailand – Malaysia (existing)			
■ Sadao – Chuping ■ Khlong Ngae – Gurun ■ Su – Ngai Kolok – Rantau Panjang	HVAC 132 KV HVAC 300 KV HVAC132 KV	1980 2002 2015	80 300 100
Thailand – Malaysia (proposed)			
■ Khlong Ngae – Gurun (addition)	HVDC 300 KV		300
Thailand – Lao PDR (existing)			
■ Nakhon Phanom – Thakhek – Theun Hinboun ■ Ubon Ratchathani 2 – Houay Ho ■ Roi Et 2 – Nam Theun 2 ■ Udon Thani 3 – Na Bong – Nam Ngum 2 ■ Expansion – Nakhon Phanom – Thakhek – Theun Hinboun	HVAC 230 KV HVAC 230 KV HVAC 230 KV HVAC 500 KV HVAC 230 KV	1998 1999 2010 2011 2012	220 126 948 597 220

Interconnection Project	Type Capacity	Commissioning (Year)	Capacity (MW)
Thailand – Lao PDR (ongoing)			
■ Mae Moh 3 – Nan 2 – Hong Sa	HVAC 500 KV	2015	1,473
■ Udon Thani 3 – Na Bong – Nam Ngiep 1	HVAC 500 KV	2019	269
■ Ubon Ratchathani 3 – Pakse – Xe Pien Xe Namnoi	HVAC 500 KV	2018	390
■ Khon Kaen 4 – Loei 2 – Xayaburi	HVAC 500 KV	2019	1,220
Thailand – Lao PDR (proposed)			
■ Nong Khai – Khoksa-At	HVAC 230 KV	-	600
■ Nakhon Phanom – Thakhek	HVAC 230 KV	-	600
■ Thoeng – Bo Keo	HVAC 500 KV	-	600
■ Udon Thani 3 – Na Bong	HVAC 500 KV	2018	510
■ Ubon Ratchathani 3 – Pakse	HVAC 500 KV	2019	315
■ Nan 2 – Tha Wang Pha – Nam Ou	HVAC 500 KV	2023	1,040
Thailand – Cambodia (existing)			
■ Aranyaprathet – Banteay Meanchey	HVAC 115 KV	2007	100
Thailand – Cambodia (future)			
■ Battambang – Prachin Buri 2	HVAC 230 KV	-	300
■ Stung Meteuk – Trat 2	HVAC 230 KV	2017 and beyond	100
■ Koh Kong – Chantaburi 2 – Pluak Daeng	HVAC 500 KV	2020	1,800
Thailand – Myanmar (proposed)			
■ Mai Khot – Mae Chan – Chiang Rai	HVAC 230 KV	-	369
■ Hutgyi – Phitsanulok 3	HVAC 500 KV	2022	1,190
■ Ta Sang – Mae Moh 3	HVAC 500 KV	2024-2025	7,000
■ Mong Ton – Sai Noi 2	HVDC 500 KV	2025	3,150

A2 Key Programmes – Energy Efficiency and Smart Grid

	Bangladesh	Bhutan	India	
Energy Efficiency	Energy Efficiency and Conservation Programme (Energy Management Programme, EE Labelling Programme, EE Building Programme) Energy Efficient Lighting Programme	Energy Efficiency and Conservation Policy, under formulation	Schemes related to promote energy conservation and energy efficiency (Standards and Labelling, ECBC, PAT and so on) Market Transformation for Energy Efficiency (Bachat Lamp Yojana, Super-Efficient Equipment Programme and so on) Energy Efficiency Financing Platform Framework for Energy Efficient Economic Development (Partial Risk Guarantee for EE, Venture Capital Fund for EE and so on)	
Smart Grids	–	–	National Smart Grid Mission	
Renewable Energy	Renewable Energy Programme	–	Jawaharlal Nehru National Solar Mission	
Efficiency and Financial Turnaround of Discoms	–	–	Ujwal DISCOM Assurance Yojana	
Rural Electrification	100% rural electrification programme	–	24 x 7 Power for All Pradhan Mantri Sahaj Bijli Har Ghar Yojana or Saubhagya Deen Dayal Upadhyaya Gram Jyoti Yojana	

	Myanmar	Nepal	Sri Lanka	Thailand
	–	Nepal Energy Efficiency Programme	Energy Efficiency Labelling Scheme	Minimum Performance Standards and Labelling Energy Efficiency Resource Standards Building Energy Code Compulsory Energy Management Programme for Designated Buildings and Factories
	–	–	–	–
	–	National Rural and Renewable Energy Programme	–	–
	–	–	–	–
	Myanmar's National Electrification Programme to electrify 100% households by 2030	Kailali Kanchanpur Rural Electrification Project	–	Accelerated Rural Electrification Programme of Thailand

A 3 Institutional Structure in the BIMSTEC Region

	Bangladesh	Bhutan	India	
Policy (electricity)	Ministry of Power Energy and Mineral Resources	Ministry of Economic Affairs	Central: Ministry of Power State: Power/Energy Department under the state department	
Policy (hydrocarbons)	Ministry of Power Energy and Mineral Resources	–	Ministry of Petroleum and Natural Gas	
Regulatory (electricity)	Bangladesh Energy Regulatory Commission	Bhutan Electricity Authority	National: CERC State: SERC/JERC	
Regulatory (hydrocarbons)	Bangladesh Energy Regulatory Commission	–	Directorate General of Hydrocarbons	
Generation	BPDP, EGCB, APSCL, NWPGC, IPPs, SIPPs, Rental Plants	Druk Green Power Corporation (DGPC)	Central: NTPC, NHPC, NPCIL, UMPPs, IPPs and MPPs State: State-owned GenCos, IPPs, CPPs	
Exploration and Production	Petrobangla	–	ONGC, RIL, BG, NICO and so on	

A 4 Country Statistics

(2015)	Bangladesh	Bhutan	
Total Land Area (sq km)	147,630	38,394	
Total Population (million)	161	1	
GDP (US$ billion)	195	2	
GDP Per Capita (US$)	1,212	2,656	
FDI Inflows (US$ million)	3,380	34	
Installed Capacity (GW)	11	1.61	
Generation (TWh)	45.83	7.75	
Consumption (TWh)	39.62	2.06	
Total Primary Energy Supply (per capita)	233	1,998	
Total Primary Energy Consumption (per capita)	169	1,950	

	Myanmar	Nepal	Sri Lanka	Thailand
	Ministry of Electricity and Energy	Ministry of Energy	Ministry of Power & Renewable Energy	Ministry of Energy, but the Energy Policy and Planning office is the pivotal agency for the formulation and administration of energy policies
	Ministry of Energy	Ministry of Supply	Ministry of Petroleum Resources Development	Ministry of Energy (Department of Mineral Fuel)
	Energy Regulatory Commission	Electricity Tariff Fixation Commission; Electricity Regulatory Commission to be instituted soon	Power Utilities Commission of Sri Lanka	Energy Regulatory Commission
	–	–	Power Utilities Commission of Sri Lanka	Energy Regulatory Commission
	Electricity Power Generation Enterprise and IPPs	Nepal Electricity Authority, IPPs	Ceylon Electricity Board, IPPs and SPPs	Electricity Generating Authority of Thailand, IPPs and SPPs
	Myanmar Oil and Gas Enterprise	–	–	PTT Public Company Limited and private players

	India	Myanmar	Nepal	Sri Lanka	Thailand
	3,287,259	676,590	147,180	65,610	513,120
	1,311	54	29	21	68
	2,095	63	21	82	395
	1,598	743	1,161	3,926	5,815
	44,009	2,824	52	681	9,004
	267	5.27	.85	3.88	38.81
	1,048	15.97	3.63	14.25	192.19
	696.28	11.25	3.71	11.74	174.83
	647	365	418	536	2,070
	438	320	413	456	1,320

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Bhutan

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About SARI/EI

Over the past decade, USAID's South Asia Regional Initiative/Energy (SARI/E) has been advocating energy cooperation in South Asia via regional energy integration and cross-border electricity trade in eight South Asian countries (Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka). This fourth and the final phase, titled South Asia Regional Initiative for Energy Integration (SARI/EI), was launched in 2012 and is implemented in partnership with Integrated Research and Action for Development (IRADe) through a cooperative agreement with USAID. SARI/EI addresses policy, legal, and regulatory issues related to cross-border electricity trade in the region, promotes transmission interconnections, and works toward establishing a regional market exchange for electricity.

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The United States Agency for International Development (USAID) is an independent government agency that provides economic, 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 economic 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 most profound results to a greatest number of people.

About IRADe

IRADe is a fully autonomous advanced research institute, which aims to conduct research and policy analysis and connect various stakeholders including government, non-governmental organizations (NGOs), corporations, and academic and financial institutions. Its research covers many areas such as energy and power systems, urban development, climate change and environment, poverty alleviation and gender, food security and agriculture, as well as the policies that affect these areas.

For more information on the South Asia Regional Initiative for Energy Integration (SARI/EI) program, please visit the project website:

www.sari-energy.org