Chapter 1

Energy Sector Development Needs and Electricity Generation Potential in Northeast India

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CHAPTER 1

Energy Sector Development Needs and Electricity Generation Potential in Northeast India

1. Introduction

Policymakers and academics alike are growing increasingly interested in strengthening economic connections between the North Eastern Region of India (NER) and major economic centres in South and Southeast Asia. The NER comprises eight contiguous states: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura. There are several critical and strategic advantages to this region participating jointly in the development of its neighbours, specifically Bangladesh, Bhutan, Myanmar, and Nepal. These adjoining countries, along with the rest of India, are amongst the most dynamic in Asia and have very impressive rates of socioeconomic development. The advantages of economic integration amongst these countries stem from politico-historical linkages, geographical proximity, socio-cultural cohesiveness, economic complementarities, and scope for further economic integration with the Association of Southeast Asian Nations (ASEAN) and China. However, the progress of trade and investment as well as industrial development in the NER has been relatively limited by various infrastructure bottlenecks, policy misalignments, and information gaps.

Energy sector development will be a major means of integrating the NER with the economic centres in neighbouring South and Southeast Asian countries. Lower tariffs and more reliable supplies are very distinct incentives for countries like

Bangladesh, India, and Myanmar to import power from Bhutan and Nepal. The NER could play a three-dimensional role in subregional energy security

2. Economic Rationale for Cross-border Energy Trade

In general, the economic benefits of energy connectivity are broadly similar to those that arise from international trade. To evaluate the economic value of energy sector interconnection, a cost–benefit network can be envisioned. The costs predominantly comprise the initial capital investment in the infrastructure, plus future operation and maintenance costs for the investment's planned lifespan, which will likely constitute only a small part of the total. The benefits, however, are far less well defined and hard to derive due to challenges in assigning monetary value to some benefits. For new energy connectivity programmes, the benefits may manifest in the following ways:

(i) savings in terms of reductions in unserved energy (typically measured in terms of value of lost load);
(ii) attainment of energy security;
(iii) climate change mitigation through the exploitation of low-carbon energy sources;
(iv) increasing competition in the energy supply and hence lower energy prices for consumers;
(v) postponing of investments in additional capacities to meet domestic demand; and
(vi) operating cost savings in terms of transmission and distribution as cheaper generation sources are substituted for costly ones.

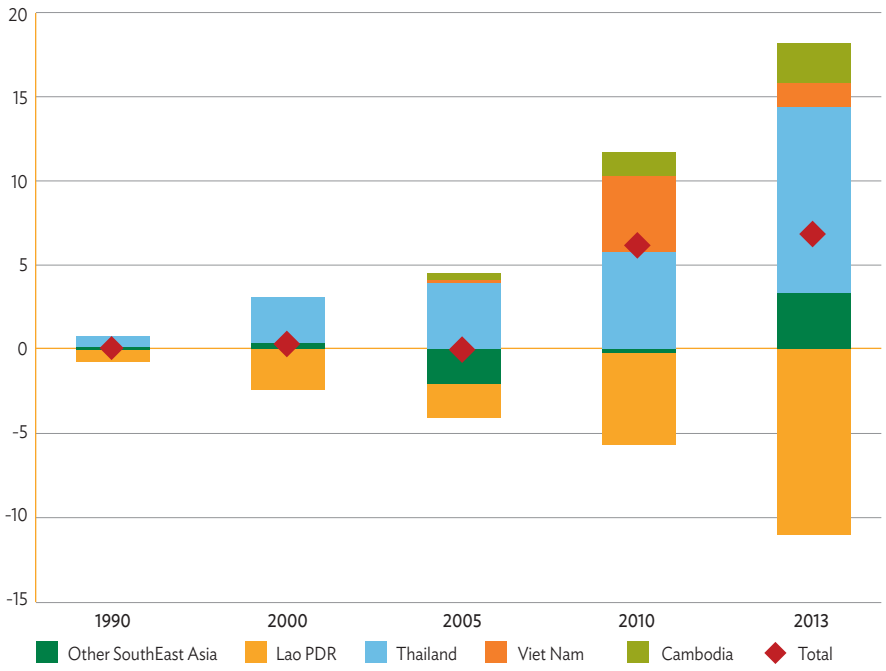
Indirect or secondary economic benefits may arise at the local level as the stability and reliability of the power system increases. Cheaper electricity may also lead to local economic and infrastructure development, improved public services, and additional effects as savings resulting from cheaper electricity translate into more disposable income. Moreover, energy connectivity enables neighbouring countries to integrate their markets, which may incentivise investment in domestic power-generation facilities and thereby contribute to lower electricity prices in the long term (Economic and Social Commission for Asia and the Pacific, 2018). The occurrence and extent of these benefits may

differ significantly depending on whether the markets being interconnected possess the necessary power-generation technologies and energy demand profiles.

3. Impacts of Improved Energy Connectivity

An overview of the energy trade and evolution of interconnection in international markets can illustrate the intended impacts of improved cross-border connectivity. Cases relevant to NER–ASEAN connectivity include (i) the Greater Mekong Subregion (GMS), the first significant project in Asia to involve several countries sharing power and facilitating trade in clean energy; (ii) Nord Pool, which operates as part of the European electricity market; and (iii) the South African Power Pool (SAPP), which facilitates multilateral energy trade amongst 12 African countries.

Figure 1.1 Electricity Trade in the Greater Mekong Subregion



Lao PDR = Lao People's Democratic Republic. Note: Negative values indicate net exports while positive values indicate net imports. The diamond represents the total electricity traded in the region.

Source: Association of Southeast Asian Nations Studies Centre (2013), ASEAN Energy Market Integration (AEMI): From Coordination to Integration. Bangkok: ASEAN Energy Market Integration Group, Chulalongkorn University.

3.1. Energy Cooperation in the Greater Mekong Subregion

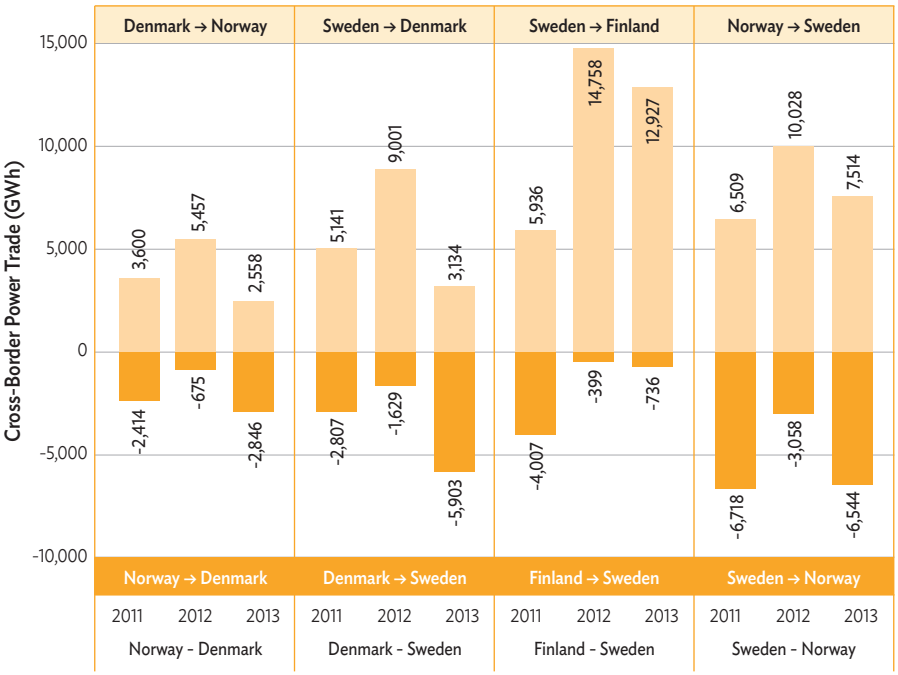
Figure 1.1 shows an overall increasing trend in the historical volume of traded electricity in Southeast Asia since 1990. Most of the electricity is exchanged amongst GMS members. The Lao People's Democratic Republic (PDR) has grown into a major net exporter of hydropower, and its electricity exports quadrupled from 2.8 terawatt-hours in 2000 to 12.5 terawatt-hours in 2013. This has been largely facilitated by the operation of the Nam Theun 2 Dam. Thailand receives 80% of the country's energy exports, and other neighbouring countries receive the rest. Thailand's steady economic growth and increasing energy demand are the main reasons for this increase in electricity imports.

The benefits of creating a GMS- or ASEAN-wide grid connectivity system include cost and fuel savings, enhanced energy security for countries like Thailand, and environmental benefits for the region. Increased geographical coverage and the integration of common grids allow other countries like Viet Nam and Cambodia to take advantage of all available resources. Displacing the use of hydrocarbons with cheaper hydropower is benefitting growing economies through reduced electricity costs and lower carbon emissions.

3.2. Nord Pool

The Nord Pool market was first opened between Norway and Sweden, which were soon joined by Finland, Denmark, and the Baltic states. The geographical power flows amongst Nord Pool countries are shown in Figure 1.2. In 2013, the highest recorded trade volume was between Norway and Sweden, followed by that between Sweden and Finland. The energy trade follows daily and seasonal patterns that depend heavily on the availability of renewable power sources in the region. Nord Pool has multiple interconnections with other European countries, with a total capacity of more than 6,000 megawatts. Over 50% of all electricity supplied in Nord Pool comes from hydropower, given the region's ample water resources. However, annual hydropower generation can vary by +/- 20% based on weather conditions. Another 20% of the electricity supply is supplied by nuclear power, 14% by combined heat and power, 7% by fossil-fuel generators, and another 7% by wind power.

Figure 1.2 Cross-Border Energy Trade between Norway, Sweden, Denmark, and Finland



GWh = gigawatt-hour.

Source: Nord Pool Consulting (2014), South East Europe Wholesale Market Opening: Final Report. Lysaker: Nord Pool AS.

The success of the Nord Pool energy trade is largely due to high levels of transparency, as equal access to information for all participants improves trust and efficiency. Because of this, Nord Pool is becoming increasingly connected with European electricity markets. Although Nord Pool is exposed to weather-related uncertainties in the output of renewable energy, energy prices have remained steady, indicating the benefits of energy interconnection. Interconnection has also resulted in falling carbon dioxide emissions in the Baltic region. An interesting fact about Nord Pool is that the scheme permitted multilateral cross-border trading before establishing the Nord Pool spot market. Thus, reforming the power sector by separating the generation and transmission sectors is not a requirement for the multilateral market. Nevertheless, this unbundling played a crucial role in the later success of the scheme in terms of competition and efficiency.

3.3. South African Power Pool

The SAPP was launched as a cooperative pool scheme that encouraged members to share information about generation and transmission costs for price-setting purposes. There are currently 16 SAPP members comprising 12 national power utilities, two independent power producers, and two independent members. Most of the members are national utilities of countries operating under the single-buyer model. The statistics of electricity trading amongst the 12 members are in Table 1.1.

The energy trade of the SAPP can generally be divided into two networks that rely on different electricity supply sources. The southern region mainly uses coal-powered plants, while the northern region mainly uses hydropower. Connectivity allows the southern region to take advantage of cheap hydropower generated in the north during the rainy season; conversely, during the dry season the net flow is reversed and the thermal south exports energy to its northern neighbours.

A cost–benefit study of the SAPP concluded that both immediate and long-term befits can be reaped from the cross-border energy trade (CBET) and coordination of electricity investments. An estimated $100 million per year can be gained through the short-term optimisation of regional opportunities, and a total of $1.5 billion in net present value of investments could be saved in the long term. Coordinating regional capacity development plans under a single umbrella could yield $48 billion in savings by 2025, compared to a scenario in which the capacity plans made by each country remain uncoordinated (Energy Coordination Agency, 2010).

The cases of the GMS, Nord Pool, and the SAPP show that cross-border connectivity has multiple benefits. They also illustrate that, while a single system operator is not a prerequisite for trading energy, a harmonised set of rules and grid codes can evolve over time.

Table 1.1 Electricity Trade amongst the South African Power Pool Members

Country	Utility	Installed Capacity	Net Capacity	Maximum Demand (MD)	MD Growth	Sales	Sales Growth	Generation Sent Out	Net Imports	Net Exports	Transmission System Losses
		MW	MW	MW	%	GWh	%	GWh	GWh	GWh	%
Angola	ENE	2,210	1,805	1,599	0.49	3,427	-0.051	5,613	0	0	0.1
Botswana	BPC	892	460	610	0.06	3,118	0.003	371	1207	0	0.037
DRC	SNEL	2,442	1,485	1381	0.18	7,584	0.1181	8,185.2	95	0	0.1
Lesotho	LEC	71	72	150	0.16	488	0.062	487	175	27	0.11
Malawi	ESCOM	351	361	326	317	1,476	0.02	1,809	0	0	0.09
Mozambique	EDMHCB	2,308	2,279	830	0.18	2,380	0.13	390	1004	233	0.064
Namibia	NamPower	501	392	629	0.03	3,648	0.012	1,305	1337	37	0.032
South Africa	ESKOM	46,963	41,071	36,170	0.01	224,446	0.027	237,430	542	4,909	0.0327
Swaziland	SEC	70.6	70	221	0.08	1,018.6	0.037	288.1	889	0	0.06
Tanzania	TANESCO	1,380	1,143	935	0.05	3,370	0.209	3,034	0	0	0.0612
Zambia	ZESCO	2,128	2,029	1,987	0.12	10,688	0.072	11,381	165	3,441	0.046
Zimbabwe	ZESA	2,045	1,600	1,671	0.08	7.367	0.045	6,951	979	1,231	0.04

BPC = Botswana Power Corporation, DRC = Democratic Republic of the Congo, EDM = Electricidade de Moçambique,
ENE = Empresa Nacional de Electricidade de Angola, ESCOM = Electricity Supply Corporation of Malawi, GWh = gigawatt-hour,
LEC = Lesotho Electricity Company, MW = megawatt, SEC = Swaziland Electricity Company, SNEL = Société Nationale d'Électricité,
TANESCO = Tanzania Electric Supply Company, ZESA = Zimbabwe Electricity Supply Authority, ZESCO = Zambia Electric Supply Company.

Source: South African Power Pool (2014), SAPP Annual Review Report 2013. Harare: South African Power Pool Secretary General.

4. Integration and Cooperation in the India–Association of Southeast Asian Nations Energy Market

India is already engaged in energy infrastructure development in the ASEAN region, particularly in Cambodia, Lao PDR, Myanmar, and Viet Nam. India is building hydropower projects, power transmission lines and substations, and oil and gas pipelines in these countries. India's trade in electricity and energy commodities is largely limited to coal imports from Indonesia and exports of Indian petroleum products. Singapore, Thailand, the Philippines, and Cambodia depend more heavily on imports than India does; however, the resource positions of India and ASEAN indicate that India can import much more, particularly natural gas and electricity (Table 1.2).

Table 1.2 Energy Balances in India and the Association of Southeast Asian Nations Countries

Country	Production (MToe)	Imports (Mtoe)	Exports (Mtoe)	TPES (Mtoe)	Net imports	Import dependency
India	540.94	277.98	64.52	749.45	213.46	0.28
Brunei Darussalam	18.69	0.24	14.85	3.83	-14.61	-3.81
Cambodia	3.79	1.57	0.00	5.33	1.57	0.29
Indonesia	394.57	47.30	232.11	209.01	-184.8	-0.88
Malaysia	84.27	43.0	47.04	75.91	-4.05	-0.05
Myanmar	22.39	0.24	8.63	14.06	-8.39	-0.60
Philippines	23.89	21.36	3.32	40.45	18.04	-0.45
Singapore	0.93	135.98	56.98	33.45	79.00	0.99
Thailand	68.74	66.06	11.84	119.15	54.22	0.46
Viet Nam	66.6	15.08	21.85	61.21	-6.77	-0.11

Mtoe = million tonnes of oil equivalent, TPES = total primary energy supply.

Source: International Energy Agency (2016), World Energy Outlook 2016. Paris: International Energy Agency.

ASEAN is in the process of developing two region-wide grids: the ASEAN Power Grid and the Trans-ASEAN Gas Pipeline. India's NER can connect to these two grids via transmission lines and gas pipeline connections through Myanmar. India's electricity grid is already connected to Bangladesh's grid, and Bangladesh is planning to link its grid with Myanmar's. As countries recognise the multiple benefits of interconnectivity, significant discussions have arisen over a potential

Myanmar–Bangladesh–India natural gas pipeline. India and Myanmar have also revived a discussion concerning a proposed gas pipeline connecting India and Myanmar through Bangladesh. Various design options are being considered, including a land route via the NER states of Tripura and Mizoram, an offshore route through the coastal areas of Bangladesh, and a deep-sea route. In the future, India will be able to access not only electricity and gas from Myanmar but also gas from faraway fields in Indonesia, Malaysia, and Brunei, as well as electricity from the Lao PDR.

5. Objectives and Scope of the Study

India's energy connectivity, particularly that of the NER with ASEAN, is one of the foundations of the Act East Asia policy, which envisages accelerated and wide-ranging engagement between ASEAN and India. While working to establish a comprehensive free-trade area through the proposed Regional Comprehensive Economic Partnership, India's cooperation with ASEAN will be key to promoting economic stability, competitiveness, growth, and integration in the region. From this perspective, the NER is in a good position to meet the common requirements of economic growth through energy connectivity.
The aim of this study is to (i) determine the energy sector development needs and potential for electricity generation in the NER; (ii) analyse the opportunities for CBET between the NER and its neighbours such as Bangladesh, Myanmar, and Nepal; (iii) estimate the cost of such arrangements and investment possibilities; and (iv) draw policy implications for prioritised investment needs, including regulatory reforms, financial flows, and institutional cooperation at national and international levels.

This study is an effort to improve existing knowledge on infrastructure connectivity and other relevant issues related to the energy sector. This book is the outcome of a study that addressed the prospects and challenges of NER–ASEAN connectivity, and it provides a policy framework for strengthening energy market integration.

To meet these objectives, this book addresses the following topics:

5.1. Energy Sector Development Needs and Electricity Generation Potential in the North Eastern Region of India

Economic growth in India has been uneven as the states are developing at different speeds. Growth acceleration in the NER must be supported by parallel development of the energy sector to create rebound effects. This region possesses 23% of India's estimated reserves of crude oil as well as the nation's largest supply of potential hydropower, which remains unexploited. Securing an adequate physical energy supply and extending the benefits of modern electricity to the region's estimated 3 million people who still live without it also presents a challenge. Looking further ahead, this region must harness all potential sources of energy, secure sufficient energy for itself, and sell the surplus. The NER's energy demand and supply will be estimated at state levels, with appropriate assumptions based on business as usual and alternate economic development scenarios.

5.2. Advancing Energy Infrastructure Development for Cross-Border Energy Trading

The development of energy infrastructure (as well as transport and industrial infrastructure) and cross-border trading will be driven by several factors, including energy resource endowments relative to demand, timing of the peak load, locational factors that favour cross-border connectivity, and economies of scale and operation from linking the NER's electric power grids with those of neighbouring countries. CBET can provide substantial benefits, including the efficient use of the NER's energy resources, improved energy security and reliability at the subregional level via diversification of supply, and an optimised transmission network to meet varying peak load demands in the NER and neighbouring countries. This should lead to lower energy costs and will provide direct economic and social benefits to the NER in terms of higher growth, increased productivity, and access to energy. The costs and benefits of new energy infrastructure development and cross-border trade will be estimated and opportunities analysed. There are numerous potential barriers to CBET, including technical, environmental, and political issues (these range from grid synchronisation to purchase agreements). Other international working CBET

models include ASEAN, Lao PDR–Thailand, Nord Pool, the SAPP, and the latest initiatives like the Central American Electrical Interconnection System.

5.3. Realising Priority Infrastructure Investments for the North Eastern Region of India

Investment in gross fixed-capital formation is crucial for the development of new energy infrastructure. However, compared to current and future investment needs, the level of capital formation in the NER states is not as high as it should be. Several attempts to raise this in line with India's approach to prioritise critical energy infrastructure needs have been made by the North Eastern Council, the acting agency for development; the North Eastern Development Finance Corporation; and the Ministry of Development of North Eastern Region. Realising domestic and cross-border energy infrastructure projects requires funding across the entire project cycle from initial concepts to eventual maintenance of the commissioned infrastructure such as dams, transmission lines, and utilities. Generally, several sources of finance should be tapped, including public financing, private investors, and international financial institutions; and extensive consultations should be held with international financiers of energy infrastructure projects in the NER and across borders, to identify obstacles and barriers. Economically viable, environmentally sound, and socially acceptable projects should be prioritised. After discussing the challenges faced by the financing community in advancing investments in the NER, implications for policy reform or choice will be drawn from the perspective of (i) the specific nature and type of the energy project, (ii) current policies and the investment climate of the NER states and neighbouring countries, and (iii) the feasibility of using different forms of national and international financing.

References

International Energy Agency (2016), World Energy Outlook 2016. Paris: International Energy Agency.

Economic and Social Commission for Asia Pacific (2018), Integrating South Asia's Power Grid for a Sustainable and Low-Carbon Future. Bangkok: Economic and Social Commission for Asia Pacific.