



ADB



ASSESSMENT OF THE GREATER MEKONG SUBREGION ENERGY SECTOR DEVELOPMENT PROGRESS, PROSPECTS, AND REGIONAL INVESTMENT PRIORITIES





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Abbreviations

ADB	– Asian Development Bank
AEEMTRC	– ASEAN–EU Energy Management Training and Research Centre
AIMS	– ASEAN Interconnection Master Plan Study
APAEC	– ASEAN Programs of Action for Energy Cooperation
APEC	– Asia-Pacific Economic Cooperation
APG	– ASEAN Power Grid
ASCOPE	– ASEAN Council on Petroleum
ASEAN	– Association of Southeast Asian Nations
BAU	– business-as-usual
BOT	– build–operate–transfer
CCS	– carbon capture and storage
CDC	– Council for the Development of Cambodia
CO ₂	– carbon dioxide
CSG	– China Southern Power Grid
DSM	– demand-side management
EAC	– Electricity Authority of Cambodia
EDC	– Electricité du Cambodge
EDL	– Electricité du Laos
EEDP	– Energy Efficiency Development Plan
EGAT	– Electricity Generating Authority of Thailand
EGP	– Experts Group on Power Interconnection and Trade
ENCON Fund	– Energy Conservation Promotion Fund
EOC	– Environment Operations Center
EPD	– Energy Planning Department
EPPO	– Energy Policy and Planning Office (Thailand)
ERAV	– Electricity Regulatory Authority of Vietnam
ERC	– Energy Regulatory Commission (Thailand)
ETS	– Emissions Trading System
EU ETS	– European Emissions Trading System
EVN	– Electricity of Vietnam
FIT	– feed-in tariff
GDP	– gross domestic product
GEF	– Global Environment Facility
GHG	– greenhouse gas
HAPUA	– Heads of ASEAN Power Utilities and Authorities
HPP	– hydroelectric power plant
HVDC	– high-voltage direct current
IAG	– International Advisory Group
IEA	– International Energy Agency
IEEJ	– Institute of Energy Economics, Japan
IFI	– international financial institution
IGA	– intergovernmental agreement
IGCC	– integrated gasification combined cycle
IMF	– International Monetary Fund
IPO	– initial public offering
IPP	– independent power producer
JETRO	– Japan External Trade Organization

LMB	–	Lower Mekong Basin
LNG	–	liquefied natural gas
LPG	–	liquefied petroleum gas
MEA	–	Metropolitan Electricity Authority (Thailand)
MEM	–	Ministry of Energy and Mines (Lao People’s Democratic Republic)
MEPS	–	Minimum Energy Performance Standard
MIME	–	Ministry of Industry, Mines and Energy (Cambodia)
MOE	–	Ministry of Energy (Myanmar)
MOEP	–	Ministry of Electric Power (Myanmar)
MOGE	–	Myama Oil and Gas Enterprise
MOIT	–	Ministry of Industry and Trade (Viet Nam)
MOU	–	memorandum of understanding
MPI	–	Ministry of Planning and Investment (Viet Nam)
MRC	–	Mekong River Commission
NAMA	–	Nationally Appropriate Mitigation Action
NDRC	–	National Development and Reform Commission (People’s Republic of China)
NEA	–	National Energy Administration (People’s Republic of China)
NEC	–	National Energy Commission (People’s Republic of China)
NEPC	–	National Energy Policy Council (Thailand)
NEPO	–	National Energy Policy Office (Thailand)
NESDB	–	National Economic and Social Development Board (Thailand)
NPT	–	National Power Transmission Corporation (Viet Nam)
NTPC	–	Nam Theun 2 Power Company (Lao PDR)
PDP	–	Power Development Plan (Thailand, Viet Nam)
PEA	–	Provincial Electricity Authority (Thailand)
POE	–	Environment and Social Panel of Experts
PPA	–	power purchase agreement
PPP	–	public–private partnership
PTOA	–	power trade operating agreement
RCOBP	–	Regional Cooperation Operations Business Plan
REAP	–	Renewable Electricity Action Plan
REDP	–	Renewable Energy Development Plan
REE	–	rural electrification enterprise
REF	–	Rural Electrification Fund
RPCC	–	Regional Power Coordination Center
RPTCC	–	Regional Power Trade Coordination Committee
R&D	–	research and development
SE4A	–	Sustainable Energy for All
SEA	–	Strategic Environmental Assessment
SEF	–	Subregional Energy Forum
SERC	–	State Electricity Regulatory Commission (People’s Republic of China)
SIDA	–	Swedish International Development Cooperation Agency
SOE	–	state-owned enterprise
SPP	–	small power producer
TAGP	–	Trans-ASEAN gas pipeline
TPA	–	third-party access
TSO	–	transmission system operator
UNDP	–	United Nations Development Programme
UNFPA	–	United Nations Family Planning Agency
UNIDO	–	United Nations Industrial Development Organization
VLPC	–	Viet–Lao Power Investment and Development Joint Stock Company
VPOA	–	Vientiane Plan of Action
VSPP	–	very small power producer

Weights and Measures

bcm	–	billion cubic meter
bpd	–	barrels (of oil) per day
GW	–	gigawatt
km	–	kilometer
ktoe	–	kilo (thousand) tons of oil equivalent
kV	–	kilovolt
kWh	–	kilowatt-hour
Mtoe	–	million tons of oil equivalent
MW	–	megawatt
Tcf	–	trillion cubic feet (of gas)
TWh	–	terawatt-hour

Executive Summary

The new Greater Mekong Subregion (GMS) Strategic Framework, 2012–2022 marks a major shift in the GMS Program, reflecting changes in the regional environment and the achievements of the program to date. Adopted at the Fourth GMS Summit held at Myanmar in December 2011, the new framework calls for increased focus from conventional infrastructure to multi-sector investments, and greater emphasis on infrastructure “software” to build on physical connectivity and increased coordination across sectors. The GMS countries requested Asian Development Bank (ADB) assistance in preparing a multi-sector regional investment framework (RIF) to foster economic corridor development and in proposing an investment program aligned to the new framework. The substantive outcome of the regional planning exercise was presented at the 18th GMS Ministerial Conference in Nanning, People’s Republic of China in December 2012. This GMS energy report was made available at that meeting as a background document.

As an input to the development of the RIF, this report includes analyses of national plans at sector levels, and regional investment priorities that were preliminarily identified in the energy sector. The primary objective is to update information on regional energy resources and to analyze the prospects for regional energy sector development, taking into account the progress of projects under the GMS Vientiane Plan of Action, 2008–2012, and the various national energy projects, especially those with important regional implications. The ultimate goal is to determine how regional cooperation can contribute to national objectives, recognizing that regional cooperation is not an end in itself, but a means to further national goals.

The report assumes that Asia will continue to grow above the average global rate and that by 2050 the Asian region will be responsible for 50% of world’s gross domestic product (GDP), consistent with ADB forecasts in the Asian century. Investments in infrastructure have begun and changes in practice adopted now will still be felt in 40 years. Given this scenario, it is inconceivable for Asian countries to continue to operate as largely independent national economies, all giving priority to external trade. The only realistic vision of an Asian century is one where Asia develops, in parallel with its efforts in external trade—a *dynamic, integrated internal market*. This means integrating markets not only in manufactured goods and services but also in energy. The Asian vision for 2050 also poses huge challenges in terms of energy security and climate change. Management of these problems also can be helped by regional cooperation and solutions can be more readily found within a fully integrated energy market. The sum of nationally optimal policies will not automatically lead to an integrated, dynamic regional market. There needs to be a conscious reflection on what actions will facilitate regional cooperation and that may benefit from the limited funding available from international financial institutions.

There has been remarkable progress in the GMS energy sector over the past 2 decades. Considerable success was also achieved in rolling out rural electrification in member countries. Rapid provision of large-scale, high-volume national grid systems; successful mobilization of indigenous resources; and the beginnings of cross-country trade also took place. These successes have been achieved mainly at the national level. Despite considerable political pronouncements that recognize the imperatives of regional cooperation, progress has not matched national achievements. The high-volume trans-boundary connections that have been made to date within the GMS do not achieve a true interconnection of systems with synchronous operations, but are simply an extension of the national grids of the large- consuming countries into the territories of producers of (mainly) hydropower. On a wider canvas, the TransASEAN gas pipeline is somewhat

similar—it comprises a collection of gas pipelines that are aligned along apparent corridors, but offering little or no real connectivity.

In terms of infrastructure “software” and market liberalization, progress has been uneven. The agreement to establish a Regional Power Coordination Center is an important step forward on the route toward an integrated regional power market, but it needs to be complemented by national reform policies that will support power exchanges. Some GMS countries have clear policies for market liberalization in varying degrees, but some countries have excluded this option for the time being. Without a common, minimum degree of liberalization in national markets, it will be difficult to make the regional market work. Third-party access for single buyer is strictly necessary, but it will only be a limited solution. Third-party access for generators and users at the wholesale level would be more effective; vertically integrated utilities always have their own agendas not necessarily in the wider interest.

Regional cooperation and reform of national policies for the energy network are key activities that can contribute to national objectives for energy security, but stronger flanking policies for renewable energy and energy efficiency are also required. Here again, regional cooperation can contribute through benchmarking and upgrading policies across the GMS to match good practice. At the national level, there is some reluctance to accept the incremental costs of renewable energy and the administrative and social costs of certain measures of energy efficiency (e.g., the administrative burden of enforcing compliance with regulations and the social implications of cost-reflective pricing), but solidarity across the GMS can be helpful in bringing forward costly or unpopular policies. There is also scope for pooling efforts in research on key technologies of special significance for the subregion, such as second-generation biotechnology; a concerted effort reduces costs to individual countries and reduces risk for all.

There are strong reasons why regional cooperation should be high up in the agenda of national policy makers. Energy security, climate change, and energy access are the overriding objectives of energy policy. Broadly, these are achieved through diversity of supply (including liquefied natural gas imports, unconventional gas, renewable energy, and clean coal). These all require interconnected infrastructure, and a flexible market structure that allows rapid response to changing circumstances. Interconnection also favors access as the peripheral areas of countries are often the least well supplied.

The approach to constructing a regional market within the GMS has been consciously gradual. This is understandable as the requirements are complex and imply a novel kind of relationships among countries, but the great challenges that face the world are unfortunately not gradual—climate change and resource depletion are expected to have a significant impact on energy development efforts within the next 20 years. If action is not taken now, it may be more difficult to make the necessary and timely adjustments later.

Two major infrastructure initiatives that would contribute to the creation of a truly integrated market are (i) a backbone 500 kilovolt (kV) line in the Lao People’s Democratic Republic to move power across the country and provide high value-added services from its hydro plants to its GMS neighbors, and (ii) an interconnection line between Viet Nam and Thailand. Without a direct connection between these two large grids of the GMS, no proper regional market can be established. Connection of the isolated grid at Mawlamyine to the main grid of Myanmar would bring the country’s 500 kV system closer to Thailand’s grid for future interconnection. Transmission interconnection, as part of a concerted planned development of energy, transport, and urban infrastructure in the East–West transmission alignment (from Thailand to Mawlamyine), should also be investigated. Grid extension and off-grid projects, where necessary, should be initiated in Myanmar and continued in Cambodia.

Institutional arrangements for regional cooperation need to be extended beyond the electricity sector, where the main historic emphasis has been. The GMS Strategic Framework, 2012–2022 sets out principles to govern the next moves toward economic integration, including a greater focus on decision making on issues that are clearly regional in nature. The Subregional Energy Sector Forum (SEF) is an important innovation with strong potential for decision support. The GMS Road Map for Expanded Energy Cooperation is the new vehicle for cooperation, but the selection of projects at present is very diverse and do not all play to the competencies and authority of the SEF. Moreover, the implementation arrangements do not seem to have worked; it was envisaged that countries would be proactive in designing projects, seeking finance, and managing and monitoring implementation. This has not meaningfully happened as yet. Future technical assistance projects should be directed to support the SEF in policy analysis, and in parallel, the SEF needs to be recognized as a main platform of enhanced regional energy policy proposals to the GMS Ministerial meetings.

National Programs

Policy

Cambodia

The Electricity Law of the Kingdom of Cambodia, adopted by the National Assembly in November 2000, defines responsibilities in the energy sector and has several good aspects, which shall be explained further in this report. The Ministry of Industry, Mines and Energy (MIME) is responsible for energy policy; electric power strategies; the power development plan; and for technical, safety, and environmental standards. The law attributes to the Electricity Authority of Cambodia the duties and powers to regulate the electricity market and the power to issue regulations, issue and revoke licenses, review costs and approve tariffs, resolve disputes, and impose penalties. It was promulgated by a Royal Decree in 2001 (Government of Cambodia 2001).

The objectives of the energy policy, as formulated by the MIME, are as follows (Gnhoung 2010):

- To provide an adequate supply of energy throughout Cambodia at reasonable and affordable price.
- To ensure a reliable and secured electricity supply to encourage investments in Cambodia and support the development of the national economy.
- To encourage the exploration and an environmentally and socially acceptable development of energy resources.
- To encourage the efficient use of energy and to minimize the detrimental environmental effects resulting from energy supply and consumption.

Lao People's Democratic Republic

Several government ministries and departments are involved in the oversight of the electricity subsector. The Ministry of Energy and Mines (MEM) under the Prime Minister's Office is responsible for power sector planning, regulation, rural electrification, and management of environmental and social aspects of the sector. Commercial operations come under the state-owned Electricité du Laos (EDL). The power sector policy established by the government has the following objectives:

- To maintain and expand an affordable, reliable supply of electricity.
- To promote power exports that will earn revenues for poverty reduction programs.
- To improve the legal and regulatory framework.
- To build capacity and ensure accountability and transparency of environmental and social impacts.

The last objective reflects the National Policy on Environmental and Social Sustainability of the Hydropower Sector in the Lao People's Democratic Republic (Lao PDR) since 2005 (Government of Lao PDR 2005), but there is some evidence that the policy has not been fully applied and that there are gaps in implementation and enforcement capacity (World Bank 2011a). There is also a target to increase access to electricity to 90% by 2020 and targets for renewable energy.

Myanmar

Energy use in Myanmar mainly depends upon traditional energy such as fuelwood, charcoal, and other forms of biomass. During 2009–2010, only 28% of the total energy consumption came from commercial energy despite the very substantial resources of coal, gas, and hydropower. The policy guidelines for energy sector, according to the Ministry of Energy (MOE) are

- to maintain energy independence,
- to promote wider use of new and renewable sources of energy,
- to promote energy efficiency and conservation, and
- to promote the use of alternative fuels in households.

The MOE is responsible for the exploration and production of crude oil and natural gas, refining, manufacturing of petrochemicals, and transport and distribution of products. It performs these functions through enterprises within the ministry, namely the Energy Planning Department (EPD), Myanma Oil and Gas Enterprise (MOGE), Myanma Petrochemical Enterprise, and Myanma Petroleum Products Enterprise. MOGE, created in 1963, is responsible for oil and gas exploration and production, as well as gas transmission across the territory of Myanmar. Until 1988, MOGE had a monopoly of exploration; foreign companies were not encouraged to participate and there was no adequate, legal basis for their involvement. In 1988, a law was passed setting out conditions for foreign participation and since then, several foreign oil companies have entered the country.

The most significant oil-producing fields are the offshore Yadana and Yetagun fields; production is piped to a receiving terminal on the coast from where it is transported overland to the Ratchaburi and Wang Noi power plants in Thailand. Gas from Yadana is also landed near Yangon and is used domestically along with the products from some 20 smaller onshore fields. The large offshore Shwe project in the Gulf of Martaban is now being developed with reserves of some 100 billion cubic meters (bcm). There has been some interest from Bangladesh and India in a pipeline to South Asia, but in this instance, the eventual destination is the People's Republic of China (PRC). The gas will be piped ashore at Kyaukryu on the west coast of Myanmar and then taken overland to the border city of Ruili in Yunnan. A large offshore in the same area was found by the Petroleum Authority of Thailand and will be developed—the outputs will be for export to Thailand and for domestic use. Total production of natural gas in 2009 was 11.5 bcm, of which about 16% was used domestically; gas from Shwe and Zawtika is expected to bring production to some 25.0 bcm in 2019 with over 30% being used domestically. The production of coal is the responsibility of No. (3) Mining Enterprise within the Ministry of Mines, and electric power comes under the Ministry of Electric Power No. (1), and the Ministry of Electric Power No. (2).¹

People's Republic of China (Guangxi and Yunnan)

Yunnan has estimated coal reserves of 69 billion tons (9th among PRC provinces in terms of production) and large reserves of lignite. It is expected that production of coal in 2012 will be over 100 million tons (China Coal Resource 2012). Guangxi, in contrast, is the largest coal importer in the country and in 2011, imported 27 million tons (15% of the national total), mainly from Australia, Indonesia, and Viet Nam.

The main energy resource of Yunnan is hydropower; the province has over 600 rivers in six water systems with 222 bcm of water resources. Its theoretical hydropower reserve is estimated at more

¹ The two ministries in Myanmar responsible for the electricity sector are the (i) Ministry of Electric Power (1), which is responsible for hydro and coal power generation; and (ii) Ministry of Electric Power (2), which is responsible for power transmission and distribution, gas-fired generation, and mini-hydro.

than 100 gigawatts (GW), the exploitable capacity could be 90 GW, and the annual generating capacity is estimated at nearly 400 terawatt-hour (TWh) (People's Government of Yunnan 2012). The topography for constructing large hydropower stations is favorable and the resources are concentrated in several sites, which facilitate development and construction. There is also a substantial geothermal resource—360 million cubic meters of hot water are discharged from springs each year.

Energy policy is formulated by agencies of the central government. The National Development and Reform Commission (NDRC) is responsible for national economic and social development and planning; it is also responsible for the administration of the National Energy Administration (NEA) established in 2008. As the NEA had difficulty in coordinating multiple agencies with interests in the energy sector, the National Energy Commission (NEC) was formed in 2010 to provide strong political coordination of the overall energy policy. The NEA has members from other agencies, including the NDRC. The NEA implements the decision of the NEC, which reviews and approves investment projects of the energy sector in conformity with national plans. It is the NEC that recommends energy pricing.

The 12th Five-Year Plan for 2011–2015 has a strong focus on energy. In particular, it aims to

- upgrade the traditional energy supply base with advanced technologies;
- promote emerging industry, e.g., nuclear, wind, solar, and biomass;
- optimize regional energy resource allocation (including the main transport and transmission infrastructure and new oil and gas import options);
- enhance innovation of energy technologies and equipment;
- strengthen control of energy consumption, and environmental protection; and
- promote wider access to energy services and narrow the gap between urban and rural, and regional energy supply levels.

Among the seven strategic investment areas identified in the plan, three relate to the energy sector: clean energy, energy conservation, and clean cars. The plan sets a goal of cutting carbon intensity by 17% by 2015, compared with 2010 levels; cutting energy consumption intensity by 16%, relative to the gross domestic product; and meeting 11.4% of its primary energy requirements from nonfossil sources by 2015 (KPMG 2011).

Thailand

For many years there was no single entity in Thailand responsible for energy policy. The Metropolitan Electricity Authority and the Provincial Electricity Authority were under the Ministry of Interior, and the Electricity Generating Authority of Thailand (EGAT) depended on the Prime Minister's Office as did the National Energy Policy Office (NEPO). On 1 October 2002, the Government of Thailand established six new ministries, including the Ministry of Energy and the Ministry of Natural Resources and Environment; NEPO changed its name to Energy Policy and Planning Office (EPPO) and came under the responsibility of the ministry. An important clarification of the responsibilities in the energy sector was provided by the Energy Industry Act 2007 (Government of Thailand 2007), that among other things, establishes an Energy Regulatory Commission (ERC). The act specifies that the government should establish fundamental policy guidelines on the energy industry to ensure energy security at fair price, to promote the development of renewable energy sources and domestic resources, to limit import, and to encourage energy efficiency. It also specifies that the government should foster public participation and education to ensure transparency of management and tariff setting. The responsibility of government for the entire electricity network is reiterated in this act.

The duties of the minister include the following: (i) make proposals to the Cabinet for an energy industry structure and propose policies of the National Energy Policy Council (NEPC) on energy procurement, diversification of fuel sources, and types of electricity generation; (ii) review the power development plan, the investment plan of the electricity industry, the natural gas procurement plan, and the energy network system expansion plan for submission to the Cabinet for approval; (iii) set the policy on customer service standards and energy industry operation standards; (iv) scrutinize and approve the plans and operations of the ERC, as discussed in greater detail below.

The Electricity Act 2007 established an ERC that is partially independent; the members of the commission are appointed by the King of Thailand, but there is substantial ministerial supervision of budgets, plans, and operations. The duties and powers of the ERC are (i) to regulate energy industry operation to ensure compliance with the objectives of this act under the policy framework of the government; (ii) to license energy industry operations where necessary; (iii) to impose measures to ensure security and reliability of electricity systems; (iv) to issue Requests for Proposals for the purchase of electricity and monitor the selection procedures; (v) to provide opinions on the power development plan, the investment plan of the electricity industry, the natural gas procurement plan, and the energy network system expansion plan for submission to the minister; and (vi) to inspect the energy industry operation of the licensees.

The most recent statement of Thailand's energy policy is contained in the Policy Statement of the Government to the National Assembly in December 2008. The statement places a considerable stress on energy security that will be supported by the development of national resources, cooperation with neighbor countries, and increased reliance on renewable resources, including biofuels and biomass. The statement includes a state role to supervise and control energy prices at a level that covers production costs and emphasize the importance of public participation in managing social and environmental issues. There is a strong component of energy conservation. Some targets are set, as follows:

For short-term oil production:

- to maintain the level of proved and provable (2P) natural gas reserves,
- to maintain a reserve margin of 15%–20% on the power system,
- to maintain the share of power generation at more than 50% of the total, and
- to promote short-term use of ethanol.

For short-term (2011) targets for renewable energy:

- to increase the energy conservation target stipulated in the Energy Conservation Program to 20%;
- to set a target to reduce "energy intensity," or energy consumption per production unit, in the industrial sector by 20% compared with the base year (2006); and
- to implement the Minimum Energy Performance Standard (MEPS) for 15 electrical appliances by 2009.

Viet Nam

The Ministry of Industry and Trade (MOIT) is the principal department of government for policy development in the energy sector. It is responsible for the review and submission of laws, regulations, master plans, and major investment projects for the Prime Minister's approval. Such materials generally need review and approval from the Ministry of Planning and Investment (MPI) and the Prime Minister's office, but MOIT is the initiator. Viet Nam's energy policy objectives are set out in the National Energy Development Strategy up to 2020, with vision to 2050, and produced in 2007.

The overall goal is to ensure energy supply security for the country's rapidly growing domestic demand. The energy sector has a substantial, legal basis that include (i) the Electricity Law (2004); (ii) the Environmental Protection Law (2005) and the Energy Conservation and Energy Efficiency Law (2010); (iii) the regulation on avoided cost-based electricity tariffs for small hydropower plants, which use renewable energy published by the MOIT in 2008; and (iv) the decision on a support mechanism for development of wind power projects in Viet Nam (2010). The Electricity Regulatory Authority of Vietnam (ERAV) is a part of the MOIT but with some limited autonomy; it is responsible for the regulation of the sector including the issuing of licensing; review of the power system expansion plans and financing needs; preparation, issuance, and enforcement of regulations; and review and recommendation of tariffs.

The National Energy Development Strategy for the period up to 2020 with an outlook to 2050, was approved by the Prime Minister on 27 December 2008 (Decision No. 1855/QĐ-TTg), (Prime Minister of Viet Nam 2007). The strategy sets the following targets:

- Ensuring sufficient supply of energy to meet the demands of socioeconomic development, in which primary energy is expected to reach 47.5–47.9 million tons of oil equivalent (Mtoe) in 2010, 100–110 Mtoe in 2020, and 310–320 Mtoe in 2050.
- Developing power plants and power networks, ensuring sufficient supply of electricity for socioeconomic development, and ensuring the 99.7% reliability of electricity supply in 2010.
- Ensuring the phased development of refineries to meet domestic demand for petroleum products, and increasing the capacity of refineries to roughly 25–30 million tons (Mt) of crude oil in 2020.
- Ensuring strategic oil stockpiling adequate for 45 days in 2010, 60 days in 2020, and 90 days in 2025.
- Achieving a share of renewable energy in the total commercial primary energy supply of 3% in 2010, 5% in 2025, and 11% in 2050.
- Completing the energy program for rural and mountainous areas, and increasing the proportion of rural households using commercial energy to 50% in 2010 and 80% in 2020 (by 2010, 95% of rural households will have access to electricity).
- Transforming the electricity, coal, and oil–gas sectors to operate in competitive markets with state regulation; establishing a competitive electricity retail market after 2022; in addition to establishing a coal and petroleum product business market by 2015.
- Actively preparing the conditions for putting the first unit of a nuclear power plant into operation in 2020, and then increasing the contribution of nuclear power to the economy's energy structure (by 2050, nuclear electricity will account for about 15%–20% of total commercial energy consumption).

Summary Conclusions

Policy making and communication to the public is variable across the region. In Cambodia, the Lao PDR, and Myanmar, external communication of energy policy is limited to occasional documents that are not always available through usual disclosure channels. In Thailand and Viet Nam, there are clear policy statements, but the analytical underpinning is not presented and there is little supporting discussion so they cannot act as a basis for public debate. Public consultation is not regularly practiced, and there is very limited contact with civil society organizations. There is generally no formal manner in which they may submit information and opinion to the decision-making process. This attitude may make it difficult to enlist public support for demand-side policies and to manage social and environmental impacts. At the project level, social and environmental aspects are not given attention commensurate with the importance assigned to them in overall environmental policies dealing with biodiversity and climate change. To some extent, this is a reflection of a much

wider problem, which is, that the capacity to enforce regulation is often insufficient. There is similar weakness, for example, in the enforcement of regulations pertaining to energy efficiency. Table 1 summarizes the conclusions.

Table 1 Summary Conclusions for Energy Policy

	Clear Responsibilities	Recent Policy Document	Coverage	Consultation with Civil Society
Cambodia	Responsibility rests with the MIME	There appears to be no recent policy document.	NA	There appears to be no consultation outside of the government.
Lao People's Democratic Republic	Responsibility rests with the MEM	There appears to be no recent comprehensive policy document.	NA	There appears to be no consultation outside of the government.
Myanmar	Responsibility rests with the MOE	There appears to be no recent comprehensive policy document.	NA	There appears to be no consultation outside of the government.
People's Republic of China (Guangxi and Yunnan)	Responsibility rests with the Energy Commission	The 12th Five-Year Plan	Comprehensive	There appears to be no consultation outside of the government.
Thailand	Immediate responsibility is with the MOE, but there is substantial influence of the NESDB and the Cabinet	A policy statement was made to the National Assembly in 2008. There are several separate plans for subsectors.	Most issues are covered but only briefly; there is little analysis. No direct treatment of carbon emissions.	Government is supportive of consultation, but in practice it does not happen.
Viet Nam	Immediate responsibility is with the MOIT, but there is substantial influence of the MPI and the Office of the Prime Minister	A National Energy Development Strategy has been formulated to 2020 with outlook to 2050.	The strategy is quite detailed and extensive, but there is no indication of the underlying analysis.	There is extensive consultation within official circles, but little or no public consultation.

MEM = Ministry of Energy and Mines; MIME = Ministry of Industry, Mines and Energy; MOE = Ministry of Electric Power; MOIT = Ministry of Industry and Trade; MPI = Ministry of Planning and Investment; NA = not applicable; NESDB = National Economic and Social Development Board.

Sources: Various country energy reports and assessments.

Organization of the Power Sector

Cambodia

The organization of the electricity sector in Cambodia is fragmented and the state of physical assets is poor as a consequence of the destruction and neglect of infrastructure during the years of conflict. The Ministry of Industry, Mines and Energy is responsible for policy and for the Power Development Plan. The Electricity Authority of Cambodia acts as regulator; it is a legal public entity with powers under the Electricity Law to regulate the electric power services, and issue and revoke licenses. There are different licenses for generation, transmission, distribution, and retail, and a

consolidated license that permits the holder to engage in all or some of these businesses. The principal licensee is Electricité du Cambodge (EDC), a wholly state-owned limited liability company with licenses to generate and transmit over the territory of the country with some exceptions; it may also distribute in specified areas. There is a special purpose transmission license—for the Cambodia Power Transmission Lines Co.—to own and operate transmission facilities that run across the border into Thailand, and similar specific provisions for cross-border links with Viet Nam. There are 291 valid licenses, many of which are issued to very small organizations or individuals that operate one or two small diesel engines for local distribution (EAC 2012a). Many of the smaller licenses are engaged in rural electrification and are separately classified as rural electrification enterprises (REEs), about 200 of which are mostly off-grid. These operations tend to lack technical, managerial, and financial capacity, which contributes to distribution losses of REE-operated networks on average of 25%–30% (ADB 2011a). EDC owns rather little generation of its own, but relies on privately owned power plants in the country and on imports. In 2009, EDC supplied 13% of electricity consumed in Phnom Penh, 31% was imported, and 56% came from independent power producers (IPPs). In the provinces, EDC contributed 18%, 51% was imported from Thailand, and 19% was imported from Viet Nam; IPPs generated 12% (Gnhoung 2010). Tariffs vary geographically; they are set by the Electricity Authority of Cambodia and are changed periodically to reflect the cost of diesel; the profit margin is typically from 9% to 15%.

Lao People's Democratic Republic

The electricity sector in the Lao People's Democratic Republic (Lao PDR) is partially unbundled. Electricité du Laos (EDL) is a state-owned corporation under the Ministry of Energy and Mines (MEM) that owns and operates generation, transmission, and distribution assets in the country; manages electricity imports into its grids; and exports from its stations. EDL-Gen was created from the generating assets and associated liabilities of EDL and from an initial public offering (IPO) made on the Lao PDR stock exchange in October 2010. EDL retains a 75% interest in EDL-Gen and Ratchaburi Electricity Generating Holding Public Company Limited has a 9.3% holding. EDL-Gen's principal assets are the hydroelectric power plants (HPPs) at Nam Ngum (155 megawatts [MW]), Xe Set 2 (76 MW), Nam Leuk (60 MW), Xe Set 1 (45 MW), Nam Mang 3 (40 MW), and Xe Labam (5 MW) the outputs of which are sold to EDL under long-term power purchase agreements (PPAs); EDL retains control of the associated transmission lines. Regulation is performed by the MEM.

Myanmar

The Ministry of Electric Power (MOEP) was detached from the Ministry of Energy in 1997 and reorganized as two ministries in 2006—the Ministry of Electric Power No. (1) and the Ministry of Electric Power No. (2). There is no independent regulator. The Ministry of Electric Power No. (1) is responsible for hydropower generation. The Ministry of Electric Power No. (2) is responsible for planning, including the power system development plan; system control; and the construction of transmission and substations in compliance with the power system plan. It owns and operates thermal plants, mainly gas turbine and combined cycle plants, and purchases electricity from the Ministry of Electric Power No. (1) and from IPPs and joint ventures; it also manages the distribution of assets and sells to users through subsidiaries.

People's Republic of China (Guangxi and Yunnan)

The Electric Power Law of April 1996 creates the basic legal framework for the electricity sector. In 2002, the sector was reformed and the monopoly State Power Corporation was unbundled into separate generation, transmission, and services units. The China Southern Power Grid (CSG) is a state-owned enterprise that was established as a part of this reform; it is responsible for the

development, operation, and maintenance of the power transmission and distribution in the five southern provinces of the People's Republic of China (PRC), including Guangxi and Yunnan. There are five major generating companies directly administered by the State-Owned Assets Supervision and Administration Commission; in addition, each company has corporatized and substantially independent subsidiaries that also generate revenues. Foreign investment in the sector is modest.

The State Electricity Regulatory Commission (SERC) is empowered by the State Council to regulate the national power sector, establish a unified system for electricity regulation, and exercise direct leadership over its local branches. It can issue regulations and establish rules for electricity market operations. It regulates the electricity market, including transmission, distribution, and noncompetitive generation businesses. It proposes tariffs to the government and regulates fees and charges for ancillary services.

A main challenge facing the State Power Corporation is to move the large resources of electricity available in the West in Yunnan to the large loads in the East, especially in the rapidly growing industrial area around the Pearl River delta in Guangdong Province with its megacities Guangzhou and Shenzhen. Transport is facilitated by an 800 kilovolt (kV) high-voltage direct current (HVDC) transmission system comprising two poles—one operates at +800 kV and the other at –800 kV; this voltage difference is the largest on any transmission system in the world. The capacity of the combined poles is 5,000 megawatts (MW) and it extends over nearly 1,500 kilometers (km).

Thailand

The dominant commercial actor in the electricity sector is the Electricity Generating Authority of Thailand (EGAT). It is a state-owned enterprise under the supervision of the Ministry of Energy, and the Ministry of Finance that has a monopoly of transmission and substantial generating assets and acts as a single buyer under long-term power purchase agreements (PPAs) of generation from nine IPPs (12,152 MW) and from a variety of small power producers (SPPs) (2,182 MW). It also owns and operates 1,588 MW of high-voltage connections with the Lao PDR and Malaysia. EGAT is a shareholder in several companies that invest in IPPs in Thailand and abroad. It owns the following:

- 25% of the EGCO Group that has interests in 15 power plants in Thailand, the Nam Thuen 2 plant in the Lao PDR, and three plants in the Philippines;
- 45% of Ratchaburi Electricity Generating Holding that owns the 3,645 MW Ratchaburi's power plant and some smaller plants in Thailand, together with interests in the Nam Ngum 2 HPP, Hongsa HPP, Nam Ngum 3 HPP, and Xe Pien Xe Nam Noy HPP in the Lao PDR; and
- 99.9% of EGAT International Company Limited that was established by EGAT to invest in power projects in neighboring countries with the intention to supply energy to Thailand, but that as yet has no certain projects.

A Cabinet resolution of 5 March 1996 issued instructions to separate generation, transmission, and distribution businesses. Under this resolution, EGAT's thermal power plants would be separated into business units and then corporatized, registered, and listed on the Stock Exchange of Thailand. A subsequent Cabinet resolution of 1 September 1998 gave consent to the Master Plan for State Enterprise Sector Reform (the Master Plan), to serve as a framework in determining the scope and direction of restructuring and privatizing four main economic sectors, including the energy sector. Under this Master Plan, the electricity supply industry would evolve into a competitive model with an independent transmission system operator (TSO) that would own no generation. Implementation was foreseen in three stages with over 5 or more years to accomplish. The three stages were essentially (i) corporatization of EGAT and separation of business units, (ii) EGAT as single buyer with gradual introduction of a third-party access (TPA), and (iii) competitive wholesale market (NEPO 2001). After some delays, EGAT was corporatized on 24 June 2005 and an IPO

was scheduled in November 2005. The IPO was suspended by the Administrative Court following complaints filed by various interest groups, and in 2006 the corporatization of EGAT was revoked by a Royal Decree and EGAT reverted to the status of state enterprise (Chandler & Thong-Ek 2011). The reform process was halted and it is unclear when or if it will begin again.

Private participation in the electricity sector dates from 1994 when the first request for proposals for IPPs was announced. Seven projects were awarded, financed by domestic companies, together with the Asian Development Bank (ADB) and the Japan Bank for International Cooperation (JBIC). A second round of bids for IPPs was opened in June 2007. After the financial crisis, no further IPPs were constructed until a project finance contract was signed in November 2011 for a 1,600 MW combined cycle plant at Nong Saeng near Saraburi to be operational in 2014. The plant will be built by a local subsidiary of a Japanese company and is financed by ADB, JBIC, and Thai and Japanese commercial banks. The same developer is preparing a similar IPP project near Ayutthaya to be operational in 2014.

EGAT has a monopoly of transmission and dispatch and owns 15,000 MW of plant equal to 48.5% of the capacity of the national power system. It buys electricity under long-term PPAs from seven IPPs and two generators that were separated from EGAT, but in which it maintains an equity interest.

Viet Nam

Viet Nam has engaged upon an ambitious reform program for the power sector that will create competition and support private participation. One of the drivers for reform was the very rapid rate of growth in power demand that increased annually at an average of 14.5% from 2001 to 2010. The vertically integrated state-owned structure struggled to match this rate of growth in demand. The first private participation came through the Phu My 2.2 and 3 combined cycle power build–operate–transfer (BOT) plants that were tendered in 2002. By the end of 2010, non-Electricity of Vietnam (EVN)-owned power plants (BOTs and IPPs) contributed 6,269 MW (32% out of a total installed capacity of 21,542 MW), but it was perceived that private investors were deterred by the lack of a clear mechanism for determining pricing from private power plants. A more profound reform was introduced by the Electricity Law of 2005 that laid down the principles of reform and established a regulatory body known as the Electricity Regulatory Authority of Vietnam (ERAV), which is responsible for establishing and supervising the power market, power system planning, tariff regulation, and licensing; Decision No. 26 (2006) of the Prime Minister approved the road map for power market reform.

In June 2006, the EVN was converted into a holding company structure and in 2008, a separate legal entity—the National Power Transmission Corporation (NPT)—was formed with responsibility to operate, maintain, and develop the transmission assets at 220 kilovolts (kV) and 500 kV under a license issued by ERAV. NPT is an independent accounting unit and a wholly owned subsidiary of EVN; it has seven subsidiaries including Power Transmission Companies No. 1, 2, 3, 4 that serve different parts of the country. In 2006, the Ministry of Industry and Trade (MOIT) issued Decision 30/2006/QD-BCN to regulate the investment, construction, and operation of IPPs (MOIT 2006). Foreign investors have shown much interest, but few projects have come to fruition because of legal and regulatory obstacles, low electricity purchase prices by EVN, the lack of a transparent and competitive market, and poor coordination among related government agencies.

Distribution is at 110 kV and below through 11 subsidiary power companies (PCs) of which the largest are PC1 (northern Viet Nam), PC2 (southern Viet Nam), and PC3 (central Viet Nam); the remainder mostly serve large cities. Much of the retail distribution system in rural Viet Nam is owned by local distribution utilities that arose out of the very aggressive program of rural electrification.

Details of a competitive market model and a path to wholesale competition were gradually developed by ERAV and in July 2011, a competitive generating market was implemented in which 48 of the 73 power plants with installed capacity greater than 30 MW directly bid into the market. Big hydroelectric plants that have multi-strategic objectives (e.g., Son La, Hoa Binh, and Yali) do not participate in the market. Participating generators forward their asking prices to the Electric Power Trading Company that then prepares a schedule for dispatch. The competitive generating market should be completed by 2014 after which a competitive wholesale market will be developed, from 2014–2020, and eventually a competitive retail market, after 2020.

Summary Conclusions

The power sector is corporatized in all countries except in Myanmar and Thailand. There are distinct regulatory agencies in all countries except in the Lao PDR and Myanmar. There is some unbundling of transmission in all countries except in Myanmar and Thailand. Use-of-system charges are not practiced anywhere, but they will presumably be introduced in Viet Nam and could be possible in the Lao PDR; they are implicit in the arrangements for the 500 kV interconnection between Na Bong (Lao PDR) and Udon Thani (Thailand).

Table 2 Summary Conclusions for the Organization of the Power Sector

Country	Corporatization	Unbundling	Regulation	Use of System
Cambodia	EDC is a wholly state-owned corporation.	The sector is fragmented, but the main transmission operator is also a generator and distributor.	There is a regulator with distinct legal identity.	None
Lao People's Democratic Republic	EDL-Gen operates as a private company and its shares are privately traded. EDL is a wholly state-owned corporation.	The sector is formally unbundled although there are substantial cross-share holdings.	There is no independent regulator.	There are no published use-of-system charges, but there seems no reason why they could not be introduced.
Myanmar	Electricity supply is a part of government.	Different government departments are responsible for hydro plants and the remainder of the system.	There is no independent regulator.	None
People's Republic of China (Guangxi and Yunnan)	This is largely the preserve of SOE and their corporatized subsidiaries.	Generation and transmission was unbundled since 2002.	Regulation is done by the State Electricity Regulatory Commission.	Set by the State Electricity Regulatory Commission.
Thailand	An initial corporatization of EGAT was reversed and it reverted to an SOE.	There is no unbundling of EGAT's generation and transmission activities.	There is a partially independent Energy Regulatory Commission.	There is no published use-of-system charge. There is no separate accounting of transmission.

continued on next page

Table 2 *continued*

Country	Corporatization	Unbundling	Regulation	Use of System
Viet Nam	The Vietnam Electricity Group is a state-owned holding company.	Transmission is a separate accounting unit of the EVN holding, but will probably be separated. Many plants participate in a competitive generating market.	The Electricity Regulatory Authority of Vietnam (ERAV) is a department within the Ministry of Industry and Trade (MOIT).	None exists at present, but presumably will be developed in a competitive market.

EDC = Electricité du Cambodge, EDL = Electricité du Laos, EGAT = Electricity Generating Authority of Thailand, EVN = Electricity of Vietnam, SOE = state-owned enterprise.

Sources: Various country energy reports.

Power System Development

Cambodia

Cambodia's power sector was severely damaged by years of war and neglect and is still in a poor condition with little domestic generation from large, modern sources and a high reliance on imports. Several substantial hydro projects have been undertaken on a BOT basis by Chinese companies with funding from the People's Republic of China (PRC) and are enumerated in a later section. The generation expansion plan for the period 2008–2020 foresees a very rapid rise in demand and in installed capacity reaching 3,045 megawatts (MW) in 2024 and supplying 16.2 terawatt-hour (TWh) (MIME 2009). The source of generation will also shift radically. In 2007, 85% of power was generated from oil products, 12% was imported, and 3% was from hydropower. By 2020, the dominant source will be hydropower with a significant contribution from coal. The transmission system will be extended by a factor of 5 or 6, mainly at 230 kV.

No publicly available power system expansion plan is evident, but according to a presentation of the Ministry of Industry, Mines and Energy (MIME), there are plants envisaged up to 2020 (Table 3). Given limited documentation of the plan, it will be difficult to determine with certainty whether elements of the plan could be realized at the stipulated time frame. The same presentation also contains a list of hydro projects of around 6,000 MW in total that are envisaged to be developed by the private sector for export (MIME 2009).

The focus of technical assistance since 2005 has been to build high-voltage (230 and 115 kV) and medium-voltage (22 kV) transmission lines to connect the isolated systems that supply most provincial towns, and to create a 220 kV backbone across the country. By 2010, four high-voltage lines were operating: three at 115 kV and one at 230 kV. ADB supported the construction of a double circuit 220 kV transmission line approximately 110 kilometers (km) long from the Vietnamese border via Takeo to Phnom Penh, together with associated substations and distribution works in Phnom Penh, which were cofinanced by the World Bank and the Nordic Development Fund. Subsequently, ADB cofinanced with the Japan International Cooperation Agency (JICA) a 230 kV transmission from Kampot to Preah Sihanouk that is nearing completion; this provides power to Sihanoukville and contributes to the 230 kV backbone transmission lines in the southern part of the country. An innovative 30-year BOT project for power transmission from Thailand to meet the demand in the Siem Reap area was partially funded by ADB's private sector operations; the privately owned transmission system comprises 221 km of 115 kV lines and supplies the provinces of Banteay Meanchey, Siem Reap, and Battambang from the Aranyaprathet substation in Thailand. ADB contributed an \$8 million loan; the balance of the \$32 million project cost came from private equity and loans from the Export–Import Bank of Thailand and local Cambodian banks.

Table 3 Generation Expansion Plan for Cambodia

Project	Fuel	Capacity (MW)	COD
Kamchay Hydro Power Plant	Hydro	193	2011
200 MW Coal Power Plant (I) in Sihanoukville–Phase 1	Coal	100	2011
Kirirom III Hydro Power Plant	Hydro	18	2012
Atay Hydro Power Plant	Hydro	110	2012
200 MW Coal Power Plant (I) in Sihanoukville–Phase 2	Coal	100	2012
Tatay Hydro Power Plant	Hydro	246	2013
Lower Stung Rusey Chrum Hydro Power Plant	Hydro	338	2013
700 MW Coal Power Plant (II) in Sihanoukville–Phase 1	Coal	100	2013
700 MW Coal Power Plant (II) in Sihanoukville–Phase 2	Coal	100	2014
700 MW Coal Power Plant (II) in Sihanoukville–Phase 3	Coal	100	2015
700 MW Coal Power Plant (II) in Sihanoukville–Phase 4	Coal	100	2016
Lower Sesan II + Lower Srepok II	Hydro	420	2016
Stung Chay Areng Hydro Power Plant	Hydro	108	2017
700 MW Coal Power Plant (II) in Sihanoukville–Phase 5	Coal	100	2017
700 MW Coal Power Plant (II) in Sihanoukville–Phase 6	Coal	200	2018
Steung Treng Power Plant	Hydro	980	2018
Sambor Hydro Power Plant	Hydro	2600	2019
Coal Power Plant (III) or Gas Power Plant	Coal/NG	450	2020

COD = commercial operation date, MW = megawatt, NG = natural gas.
Source: EAC (2012b).

In 2007, the World Bank under its Greater Mekong Subregion (GMS) Power Trade Program made available a grant of \$18.5 million to the Government of Cambodia to construct cross-border transmission lines from the Lao PDR and Viet Nam with a view to bring grid-based electricity to selected provinces in Cambodia with concomitant reduction of cost through import of power from the Lao PDR and Viet Nam. The project had several components including a cross-border 115 kV line linking the Lao PDR (Ban Hat) and Cambodia (Stung Treng); a cross-border 115 kV transmission line linking Viet Nam (Tan Bien) and Cambodia (Kampong Cham) for bilateral power exchanges and eventually hydro exports from Cambodia; linking the Xeset 1 hydroelectric power plant (HPP) in the Lao PDR to the Saravan segment of the proposed 115 kV transmission that would eventually interconnect electricity grids from (western) Thailand through (southern) Lao PDR to (southern) Cambodia. Eventually, the 115 kV transmission system from Viet Nam to Kampong Cham was cancelled and it was proposed instead that the planned line from the Lao PDR border to Stung Treng be upgraded into a 230 kV, but eventually the Government of Cambodia requested full cancellation of the grant in October 2011. Table 4 summarizes existing and planned connections.

The sector assessment of ADB notes delays in the implementation of energy projects that it attributes to the limited human resource capacity of Electricité du Cambodge (EDC) and poor implementation efficiency in recruiting implementation consultants, handling procurement, and implementing environment and resettlement plans. Delays are also caused by institutional arrangements between EDC and the Ministry of Economy and Finance, such as in the evaluation of procurement (ADB 2011a). The energy sector is identified as a sector for limited engagement during the Country Partnership Strategy period with an emphasis on consolidation, advisory assistance, and policy dialogue (ADB 2011c).

Table 4 Existing and Planned Cross-Border Links^a

Type	Lao PDR	Thailand	Viet Nam	Total
22/35 kV	1	7	14 (9)	22 (9)
115 kV	–	1	–	1
230 kV	(1)	–	1	1 (1)
Total	1 (1)	8	15 (9)	24 (10)

– = no data, kV = kilovolt, Lao PDR = Lao People's Democratic Republic.

^a Planned figures are in parentheses.

Source: EAC (2012b).

Lao People's Democratic Republic

The Power Sector Policy Statement issued in March 2001 established four policy objectives for the power sector to (i) maintain and expand an affordable, reliable, and sustainable electricity supply; (ii) promote power generation for export; (iii) enhance the legal and regulatory framework; and (iv) strengthen the institutional framework. It identified the commercialization of Electricité du Laos (EDL) as a priority.

An initial Power Development Plan was prepared in 2004 with funding from the World Bank (Maunsell Limited and Lahmeyer International 2004). The most recent plan covers the period from 2010–2020 (Somvichith 2011). Detailed information on planned HPP development is available from the website of Promotion and Development under the Ministry of Energy and Mines (MEM) (EPD 2012) and from the annual report of EDL (2011). JICA is supporting a project to improve power system planning capacity in the Lao PDR and simultaneously to review the present Power Development Plan, with the intention of identifying power development projects that may be applicable for yen loan assistance (National Portal of Laos 2012).

ADB has provided consistent support to the development of the electricity subsector in the Lao PDR. Support has been given to (i) managing the hydropower resource in an effective and acceptable manner, (ii) developing a national transmission system, (iii) encouraging cross-border connections, (iv) extending access to electricity, and (v) improving the structure and capacities of the electricity industry. In the 1990s, ADB offered loans for the 210 MW Theun–Hinboun HPP and the 60 MW Nam Leuk HPP, and provided technical assistance (TA) for legal, environmental, and social issues. ADB later approved financial support for the 1,088 MW Nam Theun 2 HPP along with the World Bank and other lenders, and supported associated TA, including a study of the cumulative impacts of the expected sector developments in the Nam Ngum River Basin in preparation for Nam Ngum 3. ADB has funded several 115 kV transmission projects in Northern Lao PDR, and signed in Vientiane, Lao PDR in February 2012 a loan agreement for the Northern Power Transmission Project cofinanced by ADB to construct 400 km of 115 kV transmission lines, substations, and distribution lines in the provinces of Xaignabouli and Phongsali, and in western Vientiane and a cross-border interconnection, enabling electricity trading between the EDL and the Electricity Generating Authority of Thailand (EGAT) (ADB 2011d).

Preparatory studies have been conducted under an ADBTA of a 500kV interconnection between Na Bong (Lao PDR) and Udon Thani (Thailand). This line is planned to export about 2,000 MW from four hydropower plants in the Lao PDR—Nam Ngum 2, Nam Ngum 3, Nam Ngiep 1, and Nam Theun 1. Nam Ngum 2 is operational, Nam Ngum 3 is under final negotiations, and Nam Ngiep 1 is also being negotiated. The study proposed that EDL would create a 100% wholly owned special purpose vehicle (SPV) to act as a Transmission System Operator that would manage the

transmission assets and collect use-of-system charges from the owners of the hydro plants. This would be an important innovation, contributing to the concept of unbundling and clarity on cost-allocation that is necessary to sustain investment in transmission facilities in the future. Preparation of the loan was deferred (ADB 2009c), but has recently been added to the 2012–2014 lending program (ADB 2011e).

The Song Da Corporation of Viet Nam and the Viet–Lao Power Joint Stock Company, in which Song Da holds a 60% share, are engaged in the construction of a series of hydro plants in Sekong Province for export to Viet Nam. The plants include Xe Kaman 1 (488 MW), Upper Se Kong 3 (152 MW), Lower Se Kong 3 (96 MW), and Dak Emeule (138 MW) hydropower projects. More details are provided later in the section on private finance. The project proposed to evacuate the power by means of a single, high-capacity cross-border connection and a collector substation with links to the power plants. Under an ADB TA, a proposal has been developed to construct a new substation at Ban Sok that would connect a 500 kV line to Pleiku in Central Viet Nam. Lending for the project is included in the 2013 program.

Lending for a transmission line to connect settlements along the East–West Economic Corridor to the Lao PDR grid was included in the GMS Regional Cooperation Operations Business Plan (RCOBP) 2011–2013 pipeline, as a standby project for 2012, but has since been dropped (ADB 2011e).

The Lao PDR was a beneficiary of the GMS Power Trade Project of the World Bank. The main components were (i) the cross-border 115 kV link from the Lao PDR (Ban Hat) to Cambodia (Stung Treng), (ii) the Xset 1 to Saravan segment of the proposed 115 kV transmission link that would eventually interconnect electricity grids from (western) Thailand through (southern) Lao PDR to (southern) Cambodia, and lead to the installation of a modern Load Dispatch Center for the Lao PDR. The project's progress was significantly affected by the withdrawal of Cambodia. The connection from Xeset 1 to Saravan was completed in August 2011 to meet demand in Saravan. The interconnections of the Lao PDR with other countries of the region will not, at present, be possible because of the cancellation of the Cambodia section. Finance for the Load Dispatch Center was also cancelled because the Government of the Lao PDR had identified alternative financing.

Altogether, there are 25 existing cross-border interconnection points. Low-voltage lines are used to import power in border districts; 115 kV lines are used to exchange power and the higher voltage lines are for export from the hydro sites.

Myanmar

The country has an installed capacity of 3,435 MW on the grid in 2012 of which 2,600 MW were hydro, 715 MW were gas-fired, and 120 MW were coal-fired. There are also some 200 MW of isolated plants, mainly diesel. There appears to be no publicly available development plan; in practice, development is driven partly by foreign interest, particularly from firms in the PRC and, to a lesser extent, Thailand. There is nearly 40,000 MW potential of hydropower near the country's borders with Thailand and the PRC that could be exported, as shown in Table 6. There are also some good wind sites and coal reserves that could support export projects.

The transmission system comprises one 230 kV line running north from the four combined cycle gas turbine stations around Yangon (Hlawga, Thaketa, Ywama, and Ahlone), roughly along Route 1 up to Bago and then to Thazi. Another 230 kV line starts from the same point near Yangon and runs also north, but west of the Bago Yoma forest, up to Shwe Daung gas turbine, and then to Taungdwingyi, generally in the same corridor as Route 2. The total length of the 230 kV system is a little more than 3,000 km. Mainly to the north of the 230 kV system, there is another 2,300 km of 132 kV transmission. The small grid around Mawlamyine is isolated.

Table 5 Existing and Planned Cross-Border Links^a

Type	EDC	EVN	CSG	EGAT	PEA	Total
22/35 kV	1	6	3		5	15
115 kV			1	5	(2)	6 (2)
230 kV	(1)	(2)	(1)	2 (1)		2 (5)
500 kV		(1)		2 (1)		2 (2)
Total	1 (1)	6 (3)	4 (1)	9 (2)	5 (2)	25 (9)

CSG = China Southern Power Grid, EDC = Electricité du Cambodge, EGAT = Electricity Generating Authority of Thailand, EVN = Electricity of Vietnam, kV = kilovolts, PEA = Provincial Electricity Authority.

^a Planned figures are in parentheses.

Source: EDL (2011).

Table 6 Potential Hydropower Plants near Borders of Myanmar

Northern Borders		Other Borders	
Project	Capacity (MW)	Project	Capacity (MW)
Myitsone	6,000	Dapein-2	168
Chipwi	3,400	Kunlong (Upper Thanlwin)	1,400
Wutsok	1,800	Naopha	1,000
Kawnglanghpu	2,700	Mantong	200
Yenam	1,200	Shweli-2	520
Pisa	2,000	Keng Tong	96
Laza	1,900	Wan Ta Pin	25
Chipwinge	99	So Lue	165
Gawlan	100	Mong Wa	50
Wu Zhongze	60	Keng Yang	28
Hkankawn	140	He Kou	88
Tongxinqiao	320	Namkha	200
Lawngdin	435	Mong Ton (Upper Thanlwin)	7,110
Tamanthi	1,200	Htu Kyan	105
Nam Tamhpak (Kachin)	200	Henna	45
		Tha Kwa	150
		Palaung	105
		Bawlake	180
		Nam Tamhpak	180
		Ywathit	4,000
		Hutgyi	1,360
		Tanintharyi	600
Total	21,554	Total	17,775

MW= megawatt.

Source: RTE International (2010b).

Cross-border connections exist at present with the PRC to evacuate power from the 600 MW Shweli HPP and from the Dapein HPP. A study of future connections within the Greater Mekong Subregion (GMS) indicated that up to 100 terawatt hours (TWh) might in the future be exported from Myanmar to the PRC, which would require an order of 20–30 gigawatts (GW) of transmission

capacity, but it is not clear what routes it would take and when it might be built. The import of power by Thailand is also likely; the same study suggested about 6,000 MW of transmission capacity by 2030, but again there is no clarity as to the route (RTE International 2010b). Much needs to be done to create mechanisms to finance these very large transmission lines to ensure that they form an integral part of a transmission grid that benefits Myanmar and not simply for export; and also to minimize environmental and social damages.

People's Republic of China (Guangxi and Yunnan)

As of 2010, there were 169 GW of generating capacity in China Southern Power Grid (CSG) of which 95 GW were thermal, 68 GW were hydro, 5 GW were nuclear, and a little over 1 GW was renewable. By 2011, the total capacity had increased to 188 GW. Large energy exchanges take place within the system from West to East—Yunnan exported 32 TWh to Guangdong in 2011, Guizhou exported 35 TWh, and Guangxi exported 8 TWh. The demand forecast for 2015 is that peak demand will increase from 113 GW in 2011 to 191 GW in 2015, and consumption from 788 TWh to 1170 TWh. Capacity additions will come from thermal plant (68 GW), hydro (46 GW), nuclear (12 GW), and renewables (10 GW). Transfers inside the CSG will continue to increase and 38 GW will be imported into Guangdong by 2015 from other provinces. Large imports are anticipated from Myanmar during this period and beyond, as shown in Table 7.

There are also several projects planned with the Lao PDR, some of which are on the mainstream of the Mekong, but they appear to be mainly if not exclusively independent power producers (IPPs) intended to produce power for sale in the Lao PDR.

The CSG has several existing links with Viet Nam and an additional 500 kV line is undergoing a feasibility study. There are two existing links with the Lao PDR at 115 kV and 230 kV. The ownership and benefit-sharing of a large-scale transmission project involving a 500 kV line from the PRC to Thailand via the Lao PDR was examined in the past, funded by a World Bank Trust Fund. It is possible that the feasibility study of this project will be reexamined soon.

Table 7 Expected Capacity Imports from Myanmar

Site	Developer	Capacity (MW)	COD
Dapein (2)	Datang Co., Ltd	140	2014
Shweli (2)	Huaneng Group	520	2015
Saing Din	Datang Co., Ltd	47	2015
Nam Pawn and Nam Tamhpak	Datang Co., Ltd	765	2020
Ngaw Chan Kha	Yunnan Power Investment Co., Ltd	1200	2018
Northern Region	China Power Investment Corp.	21,500	2016–2021
Kunlong	Hanneng Holding Group	1,400	2018
Ywathi	Datang Co., Ltd	4,000	2019
Mongton	Three Gorges Corp./CSG/ Sinohydro	7,000	2023
Lemro 1 and 2	Datang Co., Ltd	690	Planning stage
Total		37,262	

COD = commercial operation date, CSG = China Southern Power Grid, MW = megawatt.
Source: Presentation by the PRC to the Regional Power Trade Coordination Committee.

Thailand

The Ministry of Energy is responsible for power system planning; this is done within a subcommittee appointed by the minister of which EGAT is a member and it is EGAT that develops the plan within policy guidelines established by the ministry. Accordingly, the latest plan or Power Development Plan (PDP) 2010 (2010–2030) was designated as a Green PDP, placing particular emphasis on energy security, carbon dioxide (CO₂) emissions cuts, energy efficiency improvement, and promotion of energy efficiency (EGAT 2010). The plan was approved by the National Energy Policy Council (NEPC) and the Cabinet in March 2010. Minor adjustments to cope with more rise in demand than was foreseen have been applied since.

The plan covers new generation capacity from EGAT and IPPs, imports from neighboring countries, and the transmission system expansion. Power purchase agreements (PPAs) have been agreed for more than 3,000 MW of generation from the Lao PDR by 2016— comprising Nam Theun 2 HPP (920 MW), Nam Ngum 2 HPP (600 MW), Theun–Hinboun expansion HPP (220 MW), and Hong Sa Lignite TPP (1,473 MW). Other imports from the Lao PDR, from coal to hydropower plant, are in negotiation, including the controversial Xayaburi dam on the main stream of the Mekong. The Xayaburi Power Company of Thailand has been granted a concession by the Government of the Lao PDR to develop a 1,280 MW HPP and is reported to have entered into a loan agreement with commercial banks and to have signed a 29-year PPA with EGAT. The dam is scheduled for completion in 2020, but construction is opposed by environment groups and some members of the Mekong River Commission (*Bangkok Post* 2012). The expansion plan also includes a 369 MW coal-fired power project at Mai-Khot in Myanmar. There is also a high expectation from the Small Power Plant and Very Small Power Plant programs. The volume of projects planned from 2020 to 2030 is also shown in Table 8. It appears not to envisage any new IPP projects.

The EGAT-owned plants to be constructed from 2020 to 2030 include (i) 11,400 MW of natural gas plant, (ii) 6,400 MW of clean coal, and (iii) 4,000 MW of nuclear capacity. The extent to which natural gas is sourced from domestic production and pipeline imports and to what extent from liquefied natural gas (LNG) is not indicated. Imports of electricity are subject to constraints; it is not permitted that imports from any single country should exceed 13%, from two countries—25%, from three countries—33%, and from four countries—38%.

EGAT has signed a memorandum of understanding (MOU) with the Government of the Lao PDR for the import of 7,000 MW of power. The cumulative capacity of the existing plants at

Table 8 Power Plant Projects from 2010–2020, and from 2020–2030

	2010–2020 (MW)	2020–2030 (MW)
EGAT-owned power plants	4,821	21,897
Independent power producers	4,400	0
Small power plants	3,539	3,800
Very small power plants	2,335	1,745
New CCGT supporting LPG production at Khanom Gas Separation Plant	800	—
Power purchase from neighboring countries	5,669	6,000
Total	13,568	31,699

— = no data, CCGT = combined cycle gas turbine, EGAT = Electricity Generating Authority of Thailand, LPG = liquefied petroleum gas, MW = megawatt.

Source: EGAT (2010).

Theun Hinboun, Houay Ho, Nam Theun 2, and Nam Ngum 2 has a total of 1,863 MW. Power is evacuated by a 500 kV transmission from Nam Theun 2 that runs to Roi Et and was completed in 2009, and a 500 kV line from Nam Ngum 2 that runs to Udon Thani and was completed in 2010. PPAs have been signed for an expansion of the site at Theun Hinboun, for three units of lignite-fired plant at Hongsa that are expected for 2015 to 2016, and for the controversial main stream dam at Xayaburi on which work has not yet begun. The transmission line for the evacuation of power from the Theun Hinboun extension was completed in 2012 and runs to Nakhon Phanom at 230 kV; transmission from Hongsa will be assured by a 500 kV line to Mae Moh that will be commissioned in 2014. The transmission from Xayaburi is planned to be accomplished through a 500 kV link to Loei and then on to Khon Kaen, to be completed in 2017.

MOUs have also been signed for imports from Nam Ngum 3 that are expected for 2017 and from Xe Pian Xe Namnoy, expected for 2018. Transmission from Nam Ngum 3 will involve the upgrading of an existing 230 kV line from the border to Udon Thani, to operate at 500 kV, together with the construction of new 500 kV lines toward Chaiyaphum and Tha Tako. Power from Xe Pian Xe Namnoy will be conveyed at 500 kV to Ubon Ratchathani. These cross-border connections are summarized in Table 9 along with some future potential projects. There is also the connection to Malaysia that is not shown because it is not a part of the GMS. The main function is to improve reliability and stability on the two systems.

The PDP of EGAT identifies two possible HPPs in Myanmar in the near term. One is the Hutgyi HPP (1,190 MW) that would connect to the EGAT system at Tha Song Yang in Tak Province; the other is the Tasang HPP (7,000 MW) that would connect at Mae Eye in Chiang Mai Province. EGAT has also signed a tariff MOU with Myanmar for the output from 3 x 123 MW units of lignite-fired plant at Mai Khot; the latter will require an extension of the high-voltage network to the border through a 230 kV transmission line linking the Chiang Rai substation to the delivery point at the Thailand–Myanmar border through the substation at Mae Chan.

Viet Nam

The Power Master Plan VII for the 2011–2020 with a vision to 2030 was approved by the Prime Minister in July 2011. The plan lays down objectives and strategies for the development of generation and transmission; cross-border interconnections; and access to electricity in remote rural, mountainous, and island areas (Government of Viet Nam 2011). Total installed power generation capacity should reach 75,000 MW by 2020 and 146,800 MW by 2030. A very large resort to coal is planned; the percentage of power from coal should rise from 19% in 2011 to 48% in 2020 and 52% in 2030; this means that the amount of electricity sourced from coal will increase about 17 times from 2011 to 2030. More natural gas plants will be built, fuelled with imported LNG. In 2020, electricity generation capacity using LNG is expected to be about 2,000 MW, rising to about 6,000 MW by 2030. Nuclear power is envisaged to enter the fuel mix in 2020 and to be 6% by 2030.

The approximate cost of the program is \$50 billion up to 2020 and \$75 billion from 2020 to 2030, roughly two-thirds in generation and one-third in transmission. Tariffs will be raised as a part of the incentives to be given to private investors and the drive to market competition will be maintained, leaving only the state monopoly of power transmission. Through tariff reform and policy on energy efficiency, the income elasticity will be reduced from 2.0 to 1.0 by 2020. The development of renewable energy sources for electricity production will be accelerated, increasing the percentage of electricity produced from these energy sources from 3.5% of total electricity production in 2010 up to 4.5% in 2020 and 6.0% in 2030. The 500 kV transmissions will be greatly expanded with more than 80,000 megavolt amperes of 500 kV substations up to 2030. To pursue the goal, the Viet Nam Electricity National Power Transmission Corporation (NPT) has recently signed an

Table 9 Existing, Expected, and Possible Cross-Border Connections from Thailand

Project	Capacity (MW)	Substation in Thailand	Date of Operation	Voltage (kV)
Lao People's Democratic Republic				
Existing				
Nam Theun 2	920	Roi Et	2009	500
Nam Ngum 2	597	Udon Thani	2010	500
Theun Hinboun expansion	220	Nakhon Phanom	2012	230
Expected				
Hongsa (lignite)	1,473	Mae Moh	2014	500
Xayaburi	1,220	Loei–Khon Kaen	2017	500
Nam Ngum 3	660	Udon Thani	2016	500
Xe Pian Xe Namnoy	390	Ubon Ratchathani	2017	500
Possible				
Nam Theun 1	510	Udon Thani		
Pak Beng	912	Nan		
Sanakham	660	Khon Kaen		
Xe Kong 4	300	Ubon Ratchathani		
Nam Kong 1	75	Ubon Ratchathani		
Xe Kong 5	330	Ubon Ratchathani		
Don Sahong	240	Ubon Ratchathani		
Myanmar				
Expected				
Mai Khot (lignite)	369	Mae Chan		
Possible				
Hutgyi	1,190	Tak		
Dawei	1,800	Ratchaburi		
Tasang	7,000	Chiang Mai		
Tanintayi	600	Prachuap Khiri Khan		
Mong Ton	3,500	Mae Moh		
Cambodia				
Possible				
Stengnam	100	Chanthaburi		
Koh Kong	1,800	Rayong		
People's Republic of China (PRC)				
South PRC	3,000	Lopburi		high-voltage direct current

kV = kilovolt, MW = megawatt.

Source: EGAT (2010).

extension to an existing loan agreement with the World Bank to include 10 new transmission line and substation subprojects—four of the projects (one transmission line and three substations) are to extend the 500 kV grid (NPT 2011).

Viet Nam is connected across its borders to the PRC through five connections at 110 kV and 220 kV as shown in Table 10, and through some lower-voltage lines that are not shown. Connectivity to power grids of other countries in the region will be considerably increased under the PDP. Connectivity to the Lao PDR grid will be enhanced by 220 kV and 500 kV lines from Northern Lao PDR toward Thanh Hoa and Nho Quan (Ninh Binh) and Son La, and by 220 kV and 500 kV transmission lines from central Lao PDR toward Thach My (Quang Nam) and Pleiku (Gia Lai). Connectivity to the Cambodian grid will be expanded at 220 kV or possibly 500 kV through future connections from the dams on the lower Sesan (220 kV) and the lower Serepok (400 MW) to Pleiku, and from Sung Treng (220 kV) to Chau Doc (400 MW). Imports from the PRC at 110 kV and 220 kV will be maintained and a future 500 kV connection between Northern Viet Nam and Yunnan with a capacity of 2,000–3,000 MW is under study between the China Southern Power Grid (CSG) and the Electricity of Vietnam (EVN). The projects are summarized in Table 10.

ADB has funded the Northern Power Transmission to expand and strengthen the transmission system of EVN in the north and to support the restructuring and commercialization of EVN, corporatizing the generation units, and merging the four previous transmission units prior to the

Table 10 Existing and Planned High-Voltage Cross-Border Connections

Route	Voltage (kV)	Capacity (MW)
Existing		
Viet Nam		
Xinqiao–Lao Cai	220	473
Malutang–Ha Giang	220	447
Maomaotiao–Ha Giang	110	116
Hekou–Lao Cai	110	91
Fangcheng (Guangxi)–Mong Cai	110	25
Cambodia		
Chao Doc–Taveo	220	156
Planned		
People’s Republic of China		
Yunnan–North Viet Nam	500	2,000–3,000
Cambodia		
Lower Sesan and Serepok–Pleiku	220	400
Stung Treng–Chau Doc	220	207
Lao People’s Democratic Republic		
Ban Hatsan–Pleiku	500, 220	
Sekaman 3–Thanh My	220	248
HPP Nam Mo–Ban Ve	220	
Luang Prabang–Nho Quan	500	

kV = kilovolt, MW = megawatt.
Source: RTE International (2010b).

unbundling of EVN. In the immediate future, ADB will cofinance the 750 MW combined cycle gas turbine power plant at O Mon—about 250 km south of Ho Chi Minh City. Future lending in the Country Operations Business Plan for 2012–2014 is shown in Table 11. Lending for Vinh Tan 3 TPP and O Mon 3 TPP, which was included in previous years, was dropped. Technical assistance in the sector is foreseen, including capacity building and technical support for the national rollout of benefit sharing and capacity building for low carbon market development (ADB 2011b).

Table 11 Lending in the Country Operations Business Plan for 2012–2014

Name	ADB Contribution (\$ million)	Total Expenditure (\$ million)	Comment
2012 Firm			
Energy Efficiency Program in the Industry Sector	10	75	Refurbish and upgrade the production lines of five cement and two steel plants
2013 Firm			
Lao PDR–Viet Nam Power Interconnection (Ban Hatsan–Pleiku)	30	90	Loan to construct 94 km of 500 kV transmission line and expand existing 220 kV/500 kV Pleiku substation. This project will transfer 3,157 GWh/year of electricity from hydropower plants in Southern Lao PDR.
2013 Standby			
Power Transmission Investment Program (MFF)	200	420	Constructing and upgrading 500 kV and 220 kV transmission lines and associated substations.

ADB = Asian Development Bank, GWh = gigawatt-hour, km = kilometer, kV = kilovolt, Lao PDR = Lao People's Democratic Republic, MFF = Multitranches Financing Facility.

Source: ADB (2011b).

The Country Strategy and Program Midterm Review identified procurement as a potential concern, in particular, the fragmenting of packages of international competitive bidding and poor bid specification in energy and transport was perceived to lead to the use of under-qualified contractors and poor value-for-money. The review confirmed the basic thrust and scope of ADB support, including the primary focus on business-led, pro-poor economic growth and the complementary themes of social equity and a balance between growth and environment. In December 2007, the Government of Viet Nam implemented a national targeted program to mitigate climate change and requested the assistance of ADB in developing renewable energy options that will supply sustainable energy to remote rural areas to promote economic activity and reduce poverty. ADB will support such efforts and assist in developing an enabling regulatory framework (ADB 2009b).

Summary Conclusions

All countries appear to have power system development plans and occasional results from those plans are made public, but in some countries they are difficult to find. The Electricity Generating Authority of Thailand (EGAT) makes the entire plan publicly available and easily accessible. Viet Nam includes a fairly detailed summary of intentions as a part of the published government decision that implements the plan. The quality of the content in countries that do not publish detailed plans is difficult to assess, but it seems probable, given the complexity of the issues, that the power capacity of Cambodia, the Lao PDR, and Myanmar would benefit from technical assistance. It is not clear from available documentation how decisions on site and scheduling of large power plants in

these countries are arrived at, and whether they result from an extensive national power planning process. It appears that foreign investment considerations carry much weight in these decisions. Investments, particularly the transmission investments associated with a particular power plant, may therefore not add much to the power system of the host country. National plans that set out the desirable expansion in time and locality and the associated transmission should determine the siting and scheduling of plant that should then be tendered by competitive bidding. For this, a supportive framework for private–public partnerships (PPPs) is needed and this is discussed in a later section. A summary is provided in Table 12.

Extending Access to Electricity

Cambodia

Utilities in Cambodia are still very underdeveloped; electricity gas and water contributed 0.6% to gross domestic product (GDP) in 2008 (ADB 2012d) and rate of electrification in Cambodia is among the lowest in Southeast Asia. Where electricity is available, the prices are some of the

Table 12 Summary Conclusions for Power System Development

	Published Current Development Plan	International Connections	Private Participation
Cambodia	There is a power development plan, but it does not seem to be publicly available.	Several cross-border interconnections are planned mainly at low voltage. A 230 kV line to Lao PDR may be constructed, but it is not clear.	This is significant both for large-scale and small-scale generation.
Lao People's Democratic Republic (Lao PDR)	No power system expansion plan appears to be publicly available.	Many cross-border connections are planned mainly for the export of power to Thailand and Viet Nam.	Very strong in generation and potentially will enter transmission.
Myanmar	No power system expansion plan appears to be publicly available.	Very large investments are likely to be needed to evacuate power to the PRC and Myanmar. These pose great challenges of sustainability.	There is considerable private finance at present and it is the only conceivable basis for expansion on the scale envisaged.
People's Republic of China (PRC) (Guangxi and Yunnan)	No power system expansion plan could be found.	Strong links will be needed if the projects with Myanmar proceed. FS is being prepared for a 500 kV link to Viet Nam; a 500 kV link to Thailand via the Lao PDR may be reexamined.	Some private participation in IPPs, mostly domestic, and in large part from corporatized subsidiaries of the SOEs.
Thailand	A detailed and regularly updated power system expansion plan is freely and publicly available.	There are strong connections with the Lao PDR and several planned cross-border connections with Cambodia, the PRC, and Myanmar.	The most recent PDP appears to eschew private finance, except for SPPs and VSPPs.
Viet Nam	A PDP is prepared, regularly updated, and a summary is published as a decree. The underlying analysis is not publicly available.	There are several lines to the PRC that may be substantially strengthened; greater connectivity to Cambodia is likely.	Private finance was successful in the early 2000s, but then dried up. Reforms have been made to the PPP regime.

FS = feasibility study, IPPs = independent power producers, kV = kilovolt, PDP = Power Development Plan, PPP = public–private partnership, SOEs = state-owned enterprises, SPPs = small power producers, VSPPs = very small power producers.

Sources: Various country energy reports.

highest in the world. The World Bank identified the absence of electricity as a binding constraint on economic activity especially on agriculture (World Bank 2009). The Government of Cambodia, through the Ministry of Industry, Mines and Energy (MIME), has established two targets for rural electrification (MIME 2011), as follows:

- By 2020, all villages will have electricity of some type.
- By 2030, at least 70% of households will have access to grid-quality electricity.

This strategy relies on Electricité du Cambodge (EDC) to undertake the expansion of the national grid into rural areas, while private entrepreneurs invest in rural distribution and electricity supply, including supply from neighboring countries. Both components of the strategy have been supported by official development assistance (ODA). Tariffs for the sale of electricity are set for each licensee according to their costs of supply. According to the Electricity Authority of Cambodia (EAC), of the electricity generated by licensees in Cambodia, 93% use diesel and/or heavy fuel oil as fuel. So the tariff is linked to the cost of fuel and adjusted through a fuel cost adjustment mechanism. Where a licensee purchases electricity from other sources, then the EAC has fixed the tariff for sale to consumers as the cost of purchase of electricity plus a fixed charge (EAC 2012a).

A prominent feature of the off-grid component has been the Rural Electrification Fund (REF) established with loan assistance from the World Bank up until 2009, a grant from the Global Environment Facility (GEF) up until 2009, and the internal resources of the Government of Cambodia. The outputs were technical assistance, in particular a Strategic Plan for Rural Electrification (REF 2008), and the distribution of grants to subprojects (new connections, mini and micro hydro, biomass, and solar system) for rural electrification. The grants were aimed at rural electrification enterprises (REEs) that met specified lending criteria. The program aimed to achieve 50,000 new connections and by the end of December 2010 this has been done—99.5% of the target had been contracted (REF 2011). The PRC has also supported rural electrification in Cambodia through the extension of the EDC grid; distribution is being extended in four provinces including Kampong Cham, Prey Veng, Kampong Speu, and Preah Sihanouk through a concessional loan of \$53 million (*China Daily* 2012).

Lao People's Democratic Republic

The country has conducted a strong policy of rural electrification. In 1995, only 15% of households had access to electricity; by November 2010, access had increased to 71% of the population in 734,600 households and the Government of Lao PDR has an ambitious goal of providing electricity to 90% of the country's households by 2020 (80% by 2015). The effort has been supported by several international financial institutions (IFIs) and bilateral donors. In the late 1990s, technical assistance and loans supported the extension of the 115 kV transmission system and provided electricity to selected villages in northern Lao PDR. Subsequent loans continued to support further grid extension in northern provinces, but as the emphasis of implementation has moved increasingly to remote areas where grid extension is expensive, so alternative solutions based on small-scale, renewable, energy-based mini grids have been introduced, often privately owned (ADB 2010b). Four consecutive rural electrification projects have been funded by the World Bank's International Development Association (IDA) since the mid-1990s, with cofinancing from the GEF and the Norwegian Agency for Development Cooperation (World Bank 2011b). Off-grid systems contribute significantly; by 2010, 35,000 households were using off-grid systems powered by solar or mini hydro.

The rate of electrification in the Lao PDR has been one of the fastest ever seen and the factors underlying this success have been identified as

- strong and visible government leadership,
- consistent and high performance from the Electricité du Laos (EDL),
- a prudent balance between subsidies to rural consumers and a strong financial position for EDL, and
- particular and gender-sensitive provisions for the poorest consumers.

EDL and the Government of Lao PDR were successful in finding a balance between the need to maintain EDL as a financially viable entity and the need to create subsidies and cross-subsidies to ensure that supply was affordable by poor communities. Concessional funding and grants from international development organizations transmitted to EDL by the Ministry of Finance as subsidiary loans and grants were and continue to be an important part of the funding of EDL. The government also transmits part of the revenues from the hydropower development to EDL as dividends; EDL is the designated nominee shareholder of government participation in several IPPs including Theun Hinboun and Houay Ho. For a large part during the 1990s, revenues and dividends from the export of hydropower constituted more than 70% of EDL's revenue (World Bank 2012).

A review in 2005 showed significant commercial development in villages newly extended with electricity, including retail, weaving and knitting shops, and rice mills, averaging 30 new businesses per village. Electric tools and appliances have improved living standards and stimulated productive activities. Light in the evening hours extends working hours and allows study periods.

Future ADB support to the energy sector, in line with national strategy, will focus on developing (i) the national grid to integrate into the regional GMS and ASEAN grids, (ii) small and mini hydropower development, and (iii) off-grid renewable energy development in remote communities. Gender equity will be an important theme for the latter. In the hydro subsector, support will be given to regional power transfer and trading to earn foreign exchange through wheeling charges and power exports (ADB 2012b).

Myanmar

The electrification rate is low, but there is a plan for rural electrification that should increase the number of villages with access to electricity from 3,152 in 2012 to 5,419 in 2016.

People's Republic of China (Guangxi and Yunnan)

The International Energy Agency (IEA) reported that the China Southern Power Grid (CSG) aims to have completed the construction of power grids by 2010. At the end of 2008, out of a total of 63,249 administrative villages, only 37 (all located in Yunnan Province) still lacked electricity access with an access rate of 99.94%. Of the 47,614,000 rural households, 232,800 were without electricity—an access rate of 99.51% (OECD/IEA 2010).

The Township Electrification Program provided financial support to the construction of off-grid renewable energy systems (mainly hydropower, photovoltaic systems, and wind) in 11 provinces from 2002–2005. In some places, the program was entirely financed by the central government; in other cases, the costs were shared by the provincial government. Selection of the developers was made by competitive bidding in which private companies, municipalities, and state-owned enterprises could participate. The main provinces involved were in the West; Yunnan had only a modest participation (all hydro) and Guangxi did not at all participate.

Thailand

Thailand has close to universal access to electricity mainly brought about by grid extension. The first major campaign was the accelerated rural electrification program implemented from 1976 to 1996. At the end of this period, 98% of villages were connected, but not necessarily all households within the village. Subsequent campaigns were addressed more directly to the poor households not connected and by the end of 2004, 99% of villages and 96% of households had grid access. The remaining unconnected villages were located in especially remote areas, including national parks, forest reservations, islands, and mountainous areas; their needs were addressed by the solar home system project.

The key success factors were

- high degree of standardization of equipment and practice,
- local manufacture of materials as far as possible,
- concessional financial support from IFIs,
- private contractors properly supervised,
- good liaison with village leaders and prior meetings that helped avoid disputes over routing, and
- cross subsidy from the EGAT through a bulk supply tariff that gave significantly lower-priced electricity to the Provincial Electricity Authority (PEA) than to the Metropolitan Electricity Authority (MEA).

Concessional finance was obtained from ADB, the World Bank, and some bilateral donors and this was blended with commercial loans to achieve a volume of impact while maintaining financial viability.

Communities were ranked numerically for priority taking into account the level of income, the number of existing commercial enterprises, and the government's plans for other infrastructure investments in the region; this is considered to have contributed to the success of the program. An unusual aspect of the program was that local communities were encouraged to raise funds to contribute to the cost of the network and if they did so then they were able to receive electricity service before the originally targeted date although ownership of the network remained with PEA (Barnes and Foley 2004).

Viet Nam

Viet Nam has been very successful in its programs of rural electrification. An interesting facet of its rural electrification policy has been the extensive involvement of private finance in the retail stage. About two-thirds of the low-voltage retail distribution system in rural Viet Nam is owned by local distribution utilities that arose as a mechanism to share the cost of rural electrification between the central budget and users, either directly or through municipal authorities. This was the result of Decree 22-1999/CT-TTg.1999 that permitted communes to connect consumers to a low-voltage system supplied by the main grid at a concessionary tariff. The resale prices by the local distribution utilities were initially considerably higher than those paid by direct customers of the power companies, recognizing the high costs of rural electrification and the consumers' willingness to pay. This was reversed by a decision of the Prime Minister in 2009, stipulating a unified national tariff. The decision also signaled a consolidation of the structure by allowing power companies to takeover financially weak local distribution utilities.

The country's most recent Power Development Plan (PDP) up to 2030 proposes to accelerate the program of electrification in rural and mountainous areas to ensure that in 2020 most rural households will have access to electricity. This will be achieved by new investment in grid extension or local power sources (small hydro, micro; solar, wind, combined with diesel power plants) to supply electricity to rural areas; 100% of communes and 98.6% of rural households should have access to electricity by 2015 while most of the rural households should have access to electricity by 2020. The PDP is also foreseen to renovate and upgrade rural power grids to meet the technical standards and improve the quality of supply to make it more suitable for productive development. From 2011 to 2015, an additional 500,000 households in rural areas should have grid connection and about 377,000 rural households should have a supply from renewable energy sources. An additional 200,000 rural households will be grid-connected during 2016–2020 and 231,000 rural households supplied from renewable energy sources.

A detailed assessment of the impacts of rural electrification on households in Viet Nam, including self-assessment by households, showed many benefits. Electrification relieved the income constraint on households by reducing the use of expensive forms of energy (kerosene for lighting and batteries for TVs). Increased ownership of electrical goods reduced time spent on household chores (e.g., rice cookers), while school enrolment and farm productivity increased. The assessment estimated the willingness to pay of rural consumers at about \$0.70 per kWh (World Bank 2011d).

Summary Conclusions

Access rates to electricity vary widely across the subregion, as shown in Table 13. Sources are the IEA for electricity consumption (IEA 2011b) and the United Nations Population Fund (UNFPA) for population in 2009 (UNFPA 2010). The proportion of the population with electricity averaged 74.1% across the subregion. Cambodia and Myanmar have electrification rates below average. Yunnan and Guangxi are not included in this table, but as noted earlier, their rates are very high. Myanmar contributes very strongly to the total population without electricity because it has a large population and a very low rate of electrification.

The main instrument of near universal access in Thailand and Viet Nam has been grid extension. Small-scale renewables were initially seen as having a substantial role to play, but now are mainly seen as ancillary technologies for remote areas (or as distributed generation feeding into the grid). In Viet Nam, private capital has contributed effectively to retail distribution. The Lao PDR has the lowest population density among the countries by some considerable margin and its achievements recently in rural electrification are all the more remarkable for that. The Lao PDR has placed

Table 13 Electrification Rates and Per Capita Consumption, 2009

Country	Electrification Rate (%)	Population without Electricity (millions)	Consumption (kWh/person)	Population Density (people/km ²)
Cambodia	24.0	11.3	138	80
Lao People's Democratic Republic	55.0	2.6	1,508	27
Myanmar	13.0	43.5	117	90
Thailand	99.3	0.5	2,202	132
Viet Nam	97.6	2.1	987	265
Total for Greater Mekong Subregion	74.1	60.0	1,117	122

km² = square kilometer, kWh = kilowatt-hour.

Sources: IEA for electricity consumption (IEA 2011b), and the United Nations Population Fund (UNFPA) for population in 2009 (UNFPA 2010).

considerable reliance on small-scale renewables, probably because the low population density tilts the economic balance in comparison with grid extension. All three countries have made strong production subsidies to rural electrification. The hypothecation of a part of hydro revenues to rural electrification in the Lao PDR has apparently been the determinant and this could be a lesson for Myanmar and Cambodia where there are potential rents from gas and hydro. Both Cambodia and Myanmar have a long way to go yet and there is probably much to be learned from the experience of the other three countries. Reviews of successful programs show large benefits and a high willingness to pay by consumers. These and other comments are shown in Table 14.

Policy for Renewable Energy

Cambodia

Cambodia has a good renewable energy potential and many people rely upon it for their energy needs. The solar regime is typical of tropical countries, but very little exploited. Natural forests are the main source of fuelwood, but they have been severely degraded by logging and conversion to other uses. Biomass residues from forestry and agriculture are plentiful. The Wind Energy Resource Atlas Report on Southeast Asia that covers Cambodia, the Lao PDR, Thailand, and Viet Nam shows that the theoretical wind energy resource potential in the country is equivalent to

Table 14 Summary Conclusions for Rural Electrification

Country	Production Subsidies	Private Participation	Off-Grid Systems	Other Comments
Cambodia	No general scheme of subsidy; some subsidy to off-grid schemes through ODA.	A significant part of rural electrification is in private hands.	Funded by several ODA projects.	The high cost of electricity is a binding constraint on development. The capacity of EDL is weak.
Lao People's Democratic Republic	Concessional loans. Dividends for hydro export.	Off-grid networks can be privately owned.	Substantial role.	Hypothecation of hydro revenues to rural electrification has apparently been the determinant.
Myanmar	No special scheme of subsidy for rural electrification is evident.	None identified.	In experimental stage.	
People's Republic of China (Guangxi and Yunnan)	Pricing is unclear, but there has been and there is still substantial subsidy.	Private operators were permitted under the Township Program in the case of off-grid.	Off-grid was an objective of the 11th Five-Year Renewable Energy Plan.	There is considerable delegation of administrative responsibility to local levels.
Thailand	Concessional loans. Cross-subsidy through the bulk supply tariff.	Communes encouraged to contribute to costs.	Minor role.	Standardization of materials and practice. Scheduling of connection through quantitative indicators.
Viet Nam	Concessional loans. Cross-subsidy through the bulk supply tariff. Concessionary prices to cooperatives.	Important participation of municipalities and others in cooperative-style retail companies.	Minor role.	High initial prices for consumers of cooperative; indicates high willingness to pay, as confirmed by assessment results.

EDL = Electricité du Laos, ODA = official development assistance.

Sources: Various country energy reports.

1,380 megawatts (MW) (World Bank 2001). Small pilot projects have been financed by bilateral donors. The Renewable Electricity Action Plan, 2002–2012 (REAP) was largely conceived as a part of rural electrification and aims to provide framework for a decentralized system of electricity. REAP was implemented by the Ministry of Industry, Mines and Energy (MIME) in three phases: (i) market preparation, (ii) early growth, and (iii) market scale-up, but was absorbed within the Strategic Plan for Rural Electrification. There is no feed-in tariff or other support for grid-connected renewable energy.

Lao People's Democratic Republic

The Ministry of Energy and Mines (MEM), with support from the Ministry of Foreign Affairs of Finland, has prepared a National Strategy on Renewable Energy Development to 2025 that analyzes the potential for renewable energy, sets targets, and defines implementation measures. The intention is to increase renewable energy consumption to 30% of total energy use by 2025; biofuels are expected to account for 10% of total transport energy in that year. Measures that will be implemented to meet this target will focus on promoting public and private domestic and foreign investment in biofuel production, small-scale electric power plants, and other forms of renewable energy such as solar, biomass, biogas, and wind, and alternative energy for transport. Special tariffs for renewable energy are to be introduced and low-interest loans offered for investment in renewable energy production.

Myanmar

Most of the primary energy (64%) used in Myanmar is traditional energy such as fuelwood, charcoal, and biomass, but it is not used in an efficient, modern, and sustainable manner. There are substantial resources of small hydro, wind, solar, geothermal, and biomass. The main aim of energy policy in the country is not only to substitute traditional fuels with modern fuels, but also to develop where appropriate its ample resources of renewable energy. However, the technical and administrative capacity to mobilize these resources is lacking. The main focus for hydro plant has been on medium-size plants for domestic consumption, large plants for export, and less on small plants for rural electrification. Some experimental work has been done on wind energy, but there is insufficient data to judge whether there are commercially viable sites. Some small pilot-scale projects on solar energy have been installed in remote areas. There is a substantial geothermal resource that has been investigated by the Myanmar Oil and Gas Enterprise and the Myanmar Electric Power Enterprise, but its commercial volume is unclear. About one-half of the land area of the country is forested; firewood and agricultural wastes are used for household purposes leading to significant deforestation. Efforts have been made to introduce efficient cooking stoves and briquettes of carbonized residues. Since 1980, there is some promotion of biogas generation from animal residue in rural areas. Key issues in the renewable energy sector as identified by the Ministry of Energy on its website are as follows:

- To have adequate information on the renewable energy resources of the country.
- To encourage more inter-ministry and inter-department interaction and cooperation.
- To promote private participation in the development program.
- To define and specify energy policy incorporating renewable energy.

People's Republic of China (Guangxi and Yunnan)

The PRC is a leading player in renewable energy; it installed more wind power capacity during 2010 than any other country (accounting for half of the global market); it plans to install 30 gigawatts (GW) more of wind power capacity during 2011–2012; by the end of 2009 it had

the largest total renewable energy generation in the world (third place if large hydropower is excluded). The PRC is the leading global market for solar hot water systems and the third-largest producer of ethanol.

The Renewable Energy Law, promulgated in 2005, was an important step in creating dynamic renewable energy policy and industry in the PRC. The law sets out institutional responsibilities including those at the state level to survey resources and, in cooperation with the provinces, to set targets and publish development plans. The law obliges various agencies of the central state to develop and publish appropriate standards; it establishes a licensing regime, provides for a feed-in tariff for specified technologies and an obligation on the grid to purchase, and outlines rules and rights concerning grid access. It sets out principles for cost-sharing specifying how the incremental costs of renewable energy are to be shared among utility consumers. A renewable energy development fund is created for research and development (R&D), various subsidies, and surveys. The law is a framework law and has subsequently been elaborated by regulations.

The Medium- and Long-Term Renewable Energy Development Plan, published in 2007, sets a national target to meet 10% of total energy consumption by 2010 and 15% by 2020. The largest generating companies were required to source 3% of their total generation from renewable energy by 2010, and at least 8% by 2020.

The most recent 5-year plan anticipates 235 GW of new power generation from clean energy sources over the next 5 years for the whole of the PRC, which includes nuclear and natural gas. It envisages that 20% of energy will come from nonfossil fuel sources, of which 40 GW will be new nuclear, 120 GW will be new hydropower projects, 70 GW will be wind power capacity, and 5 GW will come from new solar power capacity.

Bidding for concessions for large onshore wind power and later offshore has been used since 2003. Included in the tender documents was a benchmark tariff, but initially the tariffs offered were too low and response was poor. The experiment was not entirely successful, but the received bids gave some price clarity to support the design of feed-in tariffs. Similar bidding procedures have since been extended to photovoltaic and solar power projects.

Thailand

Thailand has a long history of promoting renewable energy and has experimented with several instruments. The National Energy Administration (NEA) had a significant program of isolated micro-hydro installations in the 1970s using local labor and simple technology. The first formal instrument was the Regulation to Purchase Power from Small Power Producers (the "SPP regulation") that was approved in 1991; this permitted the sale by private producers of cogenerated electricity and power from renewable sources. The Electricity Generating Authority of Thailand (EGAT) was obliged to purchase the output at its own avoided cost. The initial limit on the size of qualifying producers was 60 MW, but this was raised to 90 MW later. This endeavor marked the first entry of private finance into the electricity sector and preceded the large independent power producer (IPP) program. The main uptake was from cogeneration plant on industrial sites and from the use of agricultural wastes as fuel, particularly bagasse, rice husk, and wood wastes.

The economic crisis in 1997 reduced the demand for electricity and led to overcapacity of generation. Consequently, the SPP program was rescinded and only reintroduced some years later. The requirements of the SPP for connection were deemed too demanding to encourage small renewable plants other than those fuelled by biomass. The Very Small Power Producer Program (VSPP) introduced in 2001 permitted sale to the grid by plant of less than 1 MW under the less

restrictive sales regime of net metering. VSPPs can sell at low voltage to the Ministry of Economic Affairs and PEA. The Ministry of Energy created in 2002 moved away from the SPP concept and introduced a Renewable Portfolio Standard in 2004 that required EGAT to source 160 MW of new capacity from renewable energy. The administrative procedures to implement this policy were never completed and it failed (Piyasvasti 2008).

A premium FIT, known in Thailand as the “adder” was introduced in 2006. Under this scheme, an additional payment is made to renewable energy generators on top of the normal prices that power producers would receive. The “adder” was initially determined through a competitive bidding system, which resulted in approval of projects with rather low adders agricultural and forestry wastes as fuels. There was no submission of projects using other forms of renewable energy. In 2007, the renewable program was revised and changes were made to the SPP regime to encourage more participants; the upper limit on VSPPs was raised to 10 MW. The scheme of adders was made more complex and differentiated according to source; targets were set by source and special incentives were introduced for the three southernmost provinces where there was a local power shortage and political risk. In June 2010, as a consequence of the falling cost of photovoltaic systems, the Cabinet passed a resolution to stop accepting applications for solar installations and to severely reduce the adder for solar plants for those projects that had not signed power purchase agreements (PPAs). The resolution changed the FIT from a premium tariff to a fixed feed-in tariff—which means that payments to generators are no longer affected by electricity prices.

In 2008, the Renewable Energy Development Plan, 2008–2022 (REDP) was published with the goal that renewables should provide 20% of final energy demand by 2020. Intermediate targets were set, to reach 15.6% by 2011 and 19.1% by 2016. This was updated to the Alternative Energy Development Program, 2012–2021 at the end of 2011 with more ambitious targets. Biofuels were a key component because of the strong dependence of the country on imported oil. By 2022, the plan envisaged 5,608 MW of renewable electricity generation, (mainly from biomass); 800 MW of wind (half the technical potential identified), and 500 MW of solar power. As of January 2010, the contract capacity of 35 potential SPPs using renewable energy was 903 MW and as of December 2009, there were 159 VSPPs using renewable energy with a total capacity of 350.3 MW connected to distribution utilities. Of these were 51 solar energy projects (7.8 MW), 41 biogas projects (43.0 MW), 53 biomass projects (287.8 MW), 8 municipal solid waste projects (10.8 MW), 3 small hydro projects (0.5 MW) and 3 wind energy projects (0.4 MW) (EGAT 2010).

The most recent power development plan of EGAT sets out expectations from its own investments and for the SPP and VSPP programs. It proposes to invest itself not only in power generation from renewable energy where the production cost is not higher than the sum of average bulk tariff plus the Government’s Adder Subsidy, but also to conduct some semi-research prototype projects that promote clean energy. The tentative targets in EGAT’s plan are shown in Table 15.

In addition, EGAT expects 1,045 MW of extra renewable generation from the SPP program by 2015 and additions of nearly 4,000 MW from the VSPP program by 2030. These expectations are not entirely consistent with the targets of the REDP and the Alternative Energy Development Program; the latter envisages that renewables would represent 19.3% of installed capacity by 2021, whereas the EGAT PDP indicates only 6% (Tongsopit and Greacen 2012). The same source draws attention to the lack of a clear legal basis for the renewable energy policy and the confusion caused by chronic alterations of policy, often with little warning.

Thailand experimented with ethanol as an additive to reduce pollution from vehicles in the 1980s, but it was only when oil prices began to rise sharply in 1984 that significant programs for bulk use of biofuels were introduced. The current 15-year ethanol and biodiesel targets are derived from the REDP according to which, production of ethanol production should have reached 3.0 million liters/

Table 15 Tentative Renewable Additions under the Power Development Plan to 2022

	MW Additions			
	2008–2011	2012–2016	2017–2022	Total
Small hydro	48.7	86.0	59.0	193.7
Wind energy	20.5	19.0	89.0	128.5
Solar energy	1.0	0.5	0.5	2.0
Municipal solid waste	–	7.5	7.5	15.0
Total	70.2	113.0	156.0	339.2

– = no data, MW = megawatt.

Source: EGAT (2010).

day by 2011, 6.2 million liters/day by 2016, and 9.0 million liters/day in the long term during 2017–2022. The targets for biodiesel are 3.02 million liters/day in 2011, 3.64 million liters/day in 2016, and 4.50 million liters/day in 2022. The targets have proved challenging as consumers have not found the price differential between gasoline and gasohol sufficient incentive to change with the result that ethanol production (from sugar molasses and cassava) has exceeded the target and only been accommodated through exports at distressed prices. In the case of biodiesel, the supply of biodiesel has been erratic and insufficient (GAIN 2011) with the consequence that production of biodiesel in 2011 was probably no more than 2.22 million liters/day. Compulsory blending to B5² has therefore been withdrawn and B2, B3, and B4 were permitted instead.

The instruments intended to meet the targets set out in the REDP 2008–2022 include production mandates for biodiesel, tax privileges from the Board of Investment, tax and retail price incentives, R&D support, and public awareness programs. Ethanol producers receive an excise tax exemption on ethanol of B7.0 per liter when selling ethanol for gasohol production in the domestic market, which is higher than for other uses, and gasohol refineries receive a subsidy of B13.5 per liter for E85 gasohol production. Automobile manufacturers who produce vehicles compatible with E85 are able to import parts and components duty free from 2011 to 2013. In 2011, there were 19 ethanol plants in operation with a combined capacity of 1.8 million liters/day with five more in construction. In February 2008, the government adopted a 15-year Biodiesel Development Plan up to 2022 that required the compulsory use of B2 biodiesel, with the intention that B5 would be compulsory from 2011, and B10 would also be available for use on a voluntary basis, in the event, as noted, the feedstock was not available to meet this goal. Attempts to extend the land used for palm oil planting have been only partly successful.

Viet Nam

The first Renewable Energy Action Plan of Viet Nam was prepared in 2001 by the Ministry of Industry and Trade (MOIT) and Electricity of Vietnam (EVN) with financial support from the World Bank. It was designed mainly as an ancillary approach to rural electrification for remote and mountainous areas. It identified a potential of between 1,100 and 1,600 MW (mainly mini hydro wind and biomass) that could be developed by 2020 and that could generate between 3.6 and 5.0 terawatt-hour (TWh) of electricity; by 2030, the potential was estimated at 3,300 MW and 9.5 TWh. A small part of the System Efficiency Improvement, Equitization, and Renewables Project financed by the World Bank was devoted to improving the policy and regulatory framework and, in particular, to support the implementation of a simplified PPA. A standardized “no negotiations”

² B1 to B5 refers to mandated blending of biodiesel in percentage terms (e.g., B1 at 1%, B5 at 5%).

PPA (SPPA) for power plant less than 30 MW and a standard tariff for small generators based on the avoided costs of EVN were implemented through Regulation No. 18/2008/QĐ-BCT of MOIT in 2008 (MOIT 2008).

In the National Energy Development Strategy of Vietnam for the period up to 2020 with outlook to 2050, the government encourages the development and use of new and renewable energy sources and provides financial support for R&D and pilot demonstration (Prime Minister of Viet Nam 2007a). The strategy specifies the objective to increase the share of renewable energy in total commercial primary energy from 3% in 2010 to 5% in 2020 and 11% in 2050. The National Master Plan for Power Development for the 2011–2020 period with a vision to 2030 requires that the percentage of electricity produced from renewable energy should increase from 3.5% of total electricity production in 2010 to 4.5% in 2020 and to 6.0% in 2030. In particular, the total wind power capacity should rise from the current negligible levels to around 1,000 MW by 2020 and 6,200 MW by 2030. The proportions of electricity production from wind power would then be 0.7% in 2020 and 2.4% in 2030. Biomass power, and power generation in sugar mills, should be 500 MW by 2020 and 2,000 MW by 2030; the proportion of electricity production will increase from 0.6% in 2020 to 1.1% in 2030.

The World Bank is supporting a new Renewable Energy Development Project for Viet Nam with the aim to increase the supply of electricity to the national grid from renewable energy sources on a commercially, environmentally, and socially sustainable basis. The project appraisal document notes the obstacles to more effective development of renewable energy in Viet Nam that it is proposed to address, namely:

- **High transaction costs.** The approvals and contracting procedures for projects are similar regardless of the size. Approvals, including obtaining the necessary investment, construction, environment, and other licenses are also the same. These create a significant burden for relatively small projects and also, given the limited capacity of the project developers.
- **Site allocation.** There is no procedure for allocation (and reallocation) of small-scale renewable energy project sites, which means that the best sites are often allocated to those not best able to develop them and then tied up for years.
- **Weak developers.** Few developers have the capacity to prepare and implement small-scale renewable energy projects according to technical, economic, financial, environmental, or social best practices.
- **Lack of access to long-term financing.** Viet Nam's commercial banks do not provide long-term financing suited to the cash flow profiles of small-scale renewable energy projects, which are capital-intensive and receive returns over long periods.
- **Poor capacity to address risks.** The limited number of projects that are proposed for financing, and the limited financing available means that few sponsors or financiers have experience in appraising renewable energy projects. Coming from an environment of directed credit and reliance on sponsor size and financial strength, banks are particularly weak at assessing credit risks.

The beginning of a policy for biofuels was marked by the Prime Minister's Decision No. 177/ 2007/ QĐ-TTg published in 2007 that gave approval to a scheme for the development of biofuels up to 2015, with a vision to 2025 (Prime Minister of Viet Nam 2007b). The decision is very general; it sets targets of an annual output of 100,000 tons of E5³ and 50,000 tons of B5 by 2010, which is equivalent to 0.4% of the projected total demand for oil and gasoline. The combined output

³ E5 refers to the blending of ethanol with gasoline in percentage terms.

of ethanol and vegetable oil by 2025 is envisaged to be 1.8 million tons equivalent to 5% of oil and gasoline demand. The decision also specifies government responsibilities in the area and provides financial support for research and capacity building. PetroVietnam, in conformity with this policy, invested heavily in ethanol production but delays in implementing a blending mandate, now expected for 2013, have meant that it must export the majority of its product. PetroVietnam has three ethanol projects in various stages of construction, each of 100 million liter/year capacity. There is an operating plant at Dong Xanh in central Quang Nam's Dai Loc District, which started production in 2009; another is located in the southern province of Binh Phuoc and the third in the northern Phu Tho Province. Of the 300 million liter/year production, 85% will be exported until the blending mandate is introduced when exports are expected to fall to 20%–25%.

Summary Conclusions

In most countries, the commitment to renewable energy is modest. Thailand is something of an exception; there is a long history of promoting renewable energy, a substantial planning effort with stretch targets, and a series of interventions that partially support the intent. The effectiveness of the policy has been limited by several alterations of policy and withdrawal of incentives with little warning. This problem would be alleviated by a law on renewable energy that would be more difficult to reverse than administrative decrees. Table 16 summarizes the situation.

Table 16 Summary Conclusions for Renewable Energy

Country	Renewable Energy Law and Policy	“Stretch” Targets	Feed-in Tariff or Other Incentives	Blending Mandates
Cambodia	No law. The REAP was conceived as a supplement to electrification.	No.	No.	No.
Lao People's Democratic Republic	No law. There is a national strategy to 2025.	Yes. 30% by 2025.	Discussed but not in place.	No.
Myanmar	No law or policy.	No.	No.	No.
People's Republic of China (Guangxi and Yunnan)	Well-designed law and subsequent regulation.	Yes.	Yes. For wind and solar.	Aim is 10% biofuels mandate by 2020. Nine provinces require 10% ethanol blends (but not Guangxi or Yunnan)
Thailand	No law. Detailed strategy.	Yes. 20% by 2020.	Yes. A well-designed feed-in tariff differentiated by technology and scale. Plus other support.	Voluntary for ethanol—market resistance. Mandatory for biodiesel, but shortages of feedstock. Problems in implementation.
Viet Nam	No law. The most recent strategy is for 2020 with outlook to 2050.	Partially. 5% in 2020. Very low considering the potential.	Yes, but tariffs are too low to be effective.	There are production targets, but blending mandates have been delayed.

REAP = Renewable Electricity Action Plan.

Sources: Various country energy reports.

Policy for Energy Efficiency

Cambodia

Given the low availability of energy, a main priority is to improve access rather than enhance efficiency, but clearly, the two objectives are linked and new access should be created in a manner that ensures efficiency. In 1994, the Government of Cambodia developed a policy and plan on energy conservation and efficient use of renewable energy sources and created the Energy Efficiency Office that has since been involved in a series of projects with the World Bank, Environment and Energy Management Agency (ADEME), Association of Southeast Asian Nations (ASEAN), United Nations–Energy Sector Management Assistance Program (UN–ESMAP), Japan External Trade Organization (JETRO), and United Nations Industrial Development Organization (UNIDO). The ESMAP funding from 1997 to 1999 was aimed at capacity building and some audits of garment factories; the JETRO support also focused on audits in industry, but the cumulative impact seems to have been limited. A new Global Environment Facility (GEF) project was agreed in 2012 to reduce greenhouse gas (GHG) emissions through improved energy efficiency in the industrial sector (GEF 2012). Industry in Cambodia uses more energy per unit of output than do other countries in the region and more than double that of the developed countries. UNIDO has estimated a potential for 50% savings of wood in brick kilns and there are similar savings in the processing of rice and rubber. The obstacles to energy efficiency identified by GEF are as follows:

- The inadequacy of existing policies, institutions, and regulatory framework to effectively promote and support energy efficiency improvements in the industry.
- The lack of information and/or knowledge and technical capacity for efficiency, best practices, and benchmarking among industry decision makers.
- The lack of management’s commitment to implement and promote efficiency, which means that efficiency is not a part of process internalization but is considered an optional area.
- The scale of operation of the majority of enterprises, which for the most part are small-scale, family-run units.
- The continued use of obsolete equipment and technology.
- The lack of competent local suppliers of energy-efficient technologies and after-sales services.
- Financing and credit constraints faced by private enterprises.

The GEF project will address the technical issues through pilot projects and other means and will offer capacity building to government agencies with responsibilities in the area, not only to the Ministry of Industry, Mines and Energy (MIME), but also to other departments such as the Ministry of Agriculture that covers rice and rubber processing, and to local banks.

Lao People’s Democratic Republic

The climate change strategy of the Lao PDR includes the intention to improve energy efficiency in industry during the production process. However, no evidence has been found as to the presence of implementation instruments such as (i) a published strategy on energy efficiency, (ii) an energy conservation law, and (iii) fiscal incentives or public information campaigns. Electricité du Laos (EDL) did implement a Demand-Side Management and Energy Efficiency Project as a part of the Rural Electrification Phase I Project of the World Bank. The project aimed to determine reasonable energy consumption levels for the major energy-consuming ministries and agencies and to address the issue of inefficient practices in public sector electricity consumption. It also involved the creation of a demand-side management (DSM) cell within EDL with the capacity to audit public sector buildings, obtain load profiles, and suggest options for improving efficiency (LaoDSM 2012). Based

on the implementation status and results report for the overall project, over 50 energy audits had been conducted by the end of 2011 and four pilot energy efficiency programs implemented on selected sites. There is, however, no mention of the DSM program in the annual report of EDL (EDL 2011).

Myanmar

There seems to be no systematic policy for energy efficiency in Myanmar. Energy prices are low; there is no energy efficiency law or any specialized agency nor any concessionary funding or other instrument. There have been occasional programs to substitute for fuelwood, through the use of briquetted materials, solar cookers, and promotion of liquefied petroleum gas (LPG) as a household fuel.

People's Republic of China (Guangxi and Yunnan)

The principal legislation is the law on Energy Conservation of the People's Republic of China in 1997, which was amended in 2004 and again in 2008. This law includes provisions for energy conservation management, rational energy utilization, technological innovation, legal liabilities, and some supplementary rules. The law also requires that the State Council and people's governments in provinces, autonomous regions, and municipalities should set up energy conservation funds (China.org 1997). The law is essentially a framework law that needs elaboration through subsequent secondary legislation to be effective.

The impact of the original law was perceived as insufficient and a stronger and more prescriptive law was promulgated in 2008 stating that the government "will implement a system of accountability for energy conservation targets and a system for energy evaluation whereby the fulfillment of energy conservation targets is taken as one part of the evaluation of local people's governments and their responsible persons." The document further states that "Energy Conservation is a basic policy of the PRC. The State implements an energy strategy of promoting conservation and development concurrently while giving top priority to conservation" (China.org 1997).

Even so, the results have been variable; enforcement across the country has been variable, generally stronger in large cities, and weaker in the periphery. Contradictory broader policies of consumer price subsidies have unintended effects of discouraging energy efficiency. The basis of the policy has been prescriptive regulation and there are few market-based instruments such as fiscal and financial incentives; this is a logical approach if prices are not cost-reflective. Several projects on innovative finance for energy efficiency have been implemented, but although there have been some successes they do not seem to have been replicated (UNEP-SEFI 2008). Sustained government support is needed to make highly prescriptive policies work effectively and that makes training, monitoring, reporting, and supervision essential.

A particular challenge in the PRC has been the control of energy use in buildings because of the enormous climatic variation across the country. To manage this problem, the country has been divided into six different climate zones and building codes developed for each zone, starting with the heating zones in the north (Zhou, McNeil, and Levine 2010). The Ministry of Housing and Urban-Rural Development creates the codes, but they are enforced by local officials, who often contract out the task to independent agencies. In the past, because of a lack of supervision, this has not worked well and enforcement has been weak, but recently, it has been much improved as penalties have been imposed, including revoking the licenses of inspectors, obliging developers to correct faults, and blacklisting developers who infringe regulations. Enforcement is still apparently uneven, being more stringent in the large cities, although random inspections are now made across the country (Evans et al. 2010).

The PRC has made a significant effort to develop and enforce standards for appliances. Energy-efficiency standards were originally required by the Energy Conservation Law of 1998; a major driver for their introduction was the dramatic growth in appliance ownership experienced as the country developed. A second influence was the emergence of the PRC as a large global producer of appliances and consumer electronics—it is obliged to meet high standards in export markets. The PRC has implemented minimum energy performance standards (MEPS) for over 30 appliances, voluntary energy efficiency labels for 40 products, and a mandatory energy information label that covers 19 products to date. There is apparently still room for improvement as many of the standards are below international best practice (Zhou 2011).

The 11th Five-Year Plan of the PRC (2006–2010), required government divisions to reduce energy intensity by 20% over the period; it seems that this was broadly achieved and most of the Ten Key Projects, the Top1,000 Programs, and the Small Plant Closure Program met their targets. The 12th Five-Year Plan (2011–2015) aims (i) to cut carbon intensity by 17% by 2015, compared with 2010 levels; (ii) to reduce energy consumption intensity by 16%, relative to gross domestic product (GDP); and (iii) to meet 11.4% of its primary energy requirements from nonfossil sources by 2015.

Japan and the PRC have recently signed an MOU creating a fund to promote energy saving and environment conservation through the collaboration of a group of Japanese and Chinese banks led by the Japan Bank for International Cooperation (JBIC). The group will provide equity funding to venture companies for projects related to energy saving and environment conservation in the PRC by leveraging collaboration among leading financial institutions in the PRC and Japan (JBIC 2011).

Thailand

Thailand introduced an energy efficiency law at an early stage, in 1992. This law has some aspects of a framework law, but includes also some detailed regulation. It establishes the Energy Conservation Promotion Fund (ENCON Fund) financed from a tax on fuels and lays down detailed rules for the operation of this fund. It also introduces the concept of designated facilities and defines somewhat onerous obligations and reporting requirements. The effects have been generally positive. The provisions for the promotion of energy-efficient equipment have underpinned the innovative labeling program led by the utility and the energy conservation fund, which has been broadly successful (Government of Thailand 1992). The ENCON Fund was allocated an initial capital of \$60 million and annual revenues of comparable magnitude from a supplementary tax on all petroleum products sold in the country. The fund was initially used in compulsory, voluntary, and complementary programs. The compulsory program addressed private factories and buildings and government buildings consuming more than 1 MW or a total consumption of more than 20 terajoule (TJ) per year of energy use. The owners and/or occupants of these buildings are required to keep regular records of their energy consumption, set targets and plans for conservation, audit their operations, and report to the Department of Energy Development and Promotion. The voluntary program provided finance to approved groups to invest in energy-conserving equipment, or to disseminate information. The complementary program created awareness and promoted energy conservation to the general public. About 60% of the expenditure went to the compulsory program and about 20% each to the voluntary and complementary programs.

An Energy Efficiency Revolving Fund was introduced after the 1997 financial crisis with initial capital from the ENCON Fund; money was lent to approved banks at a zero interest rate and then on-lent to customers for investment in energy-efficiency projects at a rate capped by government. The allocation from the ENCON Fund to the Energy Efficiency Revolving Fund must be repaid in 10 years. The administration of the Energy Efficiency Revolving Fund was outsourced to the banks and this is perceived to have expedited disbursement. The energy efficiency law was revised in 2007

without major implication for the funding process (Government of Thailand 2007). An independent evaluation of the ENCON Fund prepared for the Asia-Pacific Economic Cooperation (APEC) was broadly positive (APERC 2010); it found that the financing model was simple and straightforward and was attractive to the government because the main risk is the possibility of project proponents defaulting on loans and this risk is borne by the bank and the developer and is not covered by the government. It found that the loans had leveraged significant additional investment in the project from nongovernment sources.

The Energy Conservation Program was revised in 2008 with the aim to reduce energy use by 10.8% by 2011; it also included a component to promote renewable energy. An Energy Service Company (ESCO) Fund was launched in October 2008 as a source of venture capital for ESCOs with an initial capital of about \$15 million that came from the ENCON Fund. The ESCO Fund provides up to 50% of total equity; the identification and appraisal of projects have been outsourced to two-third parties organizations.

There has also been a strong activity in labeling and in the implementation of the MEPS deriving from the original Energy Conservation Law. The Electricity Generating Authority of Thailand (EGAT) has been running a voluntary energy labeling program for refrigerators and air-conditioners since 1994, but this is now to be supplemented by voluntary and mandatory MEPS and voluntary High Energy Performance Standard. Several institutions are involved, as follows:

- Energy Policy and Planning Office (EPPO)—responsible for promoting energy efficiency programs for appliances and equipment,
- Department of Alternative Energy Development and Efficiency—responsible for setting high-efficiency levels for energy-using equipment and for establishing MEPS,
- Thailand Industrial Standards Institute—responsible for energy performance test protocols and for publishing the MEPS, and
- EGAT—responsible for labeling and promotion of electrical appliances.

The Department of Alternative Energy Development and Efficiency has signed an MOU with the Thailand Industrial Standards Institute in 2007 for six MEPS for refrigerators, air conditioners, fluorescent lamps, compact fluorescent lamps, 3-phase motors, and LPG stoves; while eight High Energy Performance Standard have been introduced (Vongsoasup 2011; APERC 2010).

In 2007, APEC leaders agreed to a common strategy to reduce energy intensity by 25% by 2030 compared with the 2005 base year. Accordingly, Thailand has developed a 20-Year Energy Efficiency Development Plan (EEDP) for 2011–2030, which is intended to achieve that goal and to overcome the perception that progress had been limited until now by the absence of a long-term national plan, with clear targets and long-term work plans. The main sectors where the EEDP expects gains are industry and transport. The measures envisaged are similar to those in place, but with more rigorous enforcement and extended scope, including the promotion of energy-efficient vehicles through energy labeling, MEPS, and tax measures. Emphasis is placed on partnership with the private sector and a greater role for municipalities. Detailed work plans are included within the EEDP (MOE 2010).

Viet Nam

Energy efficiency was first addressed by various technical and financial assistance programs in the 1990s, mainly the European Union (EU), Swedish International Development Cooperation Agency (SIDA), and United Nations Development Programme (UNDP). The World Bank has maintained since 1997 a long-standing program of assistance focused particularly on demand-side management

in the electricity industry. The Vietnam Demand-Side Management and Energy Efficiency Project (DSM-EE Project) during 2003–2010 covered a variety of aspects including (i) the creation of a DSM Cell within the Electricity of Vietnam (EVN) to conduct load profiling and DSM programs, (ii) development and implementation of a pilot commercial energy-efficiency program and pilot market transformation programs with solar water heaters and air conditioners, and (iii) capacity building of the Ministry of Industry and Trade's (MOIT) Energy Efficiency and Conservation Office. Preliminary results include the following (World Bank 2010):

- Successful transformation of the compact fluorescent lamp market from less than 1 million lamps in 2004 to more than 10 million lamps by 2007.
- Savings from EVN programs of 500 GWh per year and 91 MW of peak demand.
- Implementation of 100 commercial projects with expected savings of 34 GWh per year and training of 100 service providers.

During this period, the government also issued a Decree on Efficient Utilization of Energy and Energy Conservation (2003) and in 2006, the Prime Minister issued Decision 79/2006/QD-TTg ratifying the Vietnam National Energy Efficiency Program for the period 2005–2015, which was prepared by MOIT. The program was the first comprehensive plan to improve energy efficiency across the economy of Viet Nam; its objective was to save between 3% and 5% energy consumption by 2010 and 5%–8% by 2015. It covered the legislative framework, education and dissemination of information, standards and labels, audits in industry, building management, and more efficient transport. A Law on Energy Efficiency and Conservation was approved by the National Assembly in 2010; ADB provided technical assistance in the formulation of this law.

The Prime Ministerial Decision authorizes the MOIT to issue guidelines for suppliers to label high-efficiency electric appliances including electric motors, fans, air conditioners, fluorescent-tube lamps, and ballasts. Technical standards for equipment energy are to be developed by the Ministry of Science and Technology. Little seems to have been done in this respect. Mandatory standards and labeling programs are foreseen in the Law on Energy Conservation, but enforcement seems to be an obstacle. The APEC Peer Review was critical of this weakness and recommended a better integration of planning and implementation of the MEPS and labeling programs with clearer roles and responsibilities of involved agencies and deliverable targets (APEREC 2009).

A GEF project approved in 2010 is intended to further promote industrial energy efficiency by strengthening the capacity of corporate entities, officials, and service providers (GEF 2010). It has three objectives, as follows:

- to help formulate Energy Efficiency Action Plans for key industrial sectors and implement pilot programs;
- to provide technical assistance to energy service providers to improve auditing skills, evaluate possible funding mechanisms, and develop guidelines for energy performance contracting;
- to support the capacity building of the Energy Efficiency and Conservation Office under the General Directorate of Energy of the MOIT through implementation, and monitoring and evaluation of energy efficiency projects, programs, and policies (World Bank 2011d).

Summary Conclusions

Performance across the subregion is variable, in terms of existence of energy conservation laws, strategies and/or targets, ENCON Fund, and standards and labels. Thailand has engaged in energy efficiency since 1992 with a law, a fund, and voluntary standards. Although the program has met with some administrative problems, much has been accomplished and the new 20-year development

plan is helpful. Viet Nam is now initiating a comprehensive approach with a new law, reasonably demanding targets and some appropriate instruments. More could be done in both countries through more sharply defined responsibilities and in the case of Viet Nam, by more substantial funding. Enforcement appears to be a difficulty in both cases; regulations on audits, reporting, and standards require enforcement and this is administratively demanding. In Cambodia, the Lao PDR, and Myanmar, there is only minimal effort devoted to energy efficiency through isolated projects and time-limited programs. Table 17 presents the discussion.

Table 17 Summary Conclusions for Energy Efficiency Policy

	Energy Conservation Law	Strategy and Targets	ENCON Fund	Standards and Labels
Cambodia	No.	No, but GEF project now agreed will partially remedy this	No.	No.
Lao People's Democratic Republic	No.	No.	No.	No.
Myanmar	No.	No.	No.	No.
People's Republic of China (Guangxi and Yunnan)	Yes, from 1997. Comprehensive and prescriptive.	Yes. Set out in 5-year plans.	Included in the original law.	Yes—many MEPS and labels.
Thailand	Since 1992.	Yes. Detailed strategy and 25% saving target.	ENCON Fund financed from a tax on fuels.	Voluntary labels since 1994. Mandatory standards being implemented.
Viet Nam	Law agreed in 2010.	Yes. Objective is to save 8% by 2015.	No. Present in early drafts of the law, but removed.	Law provides for standards, but little has been done.

ENCON Fund = Energy Conservation Promotion Fund, GEF = Global Environment Facility, MEPS = Minimum Energy Performance Standard. Sources: Various country energy reports.

Private Finance

Cambodia

A 1994 Law on Investment governs private sector investment and business activities in Cambodia; it provides for common conditions for foreign and local investors, except on the issue of land ownership (Government of Cambodia 1994). The law and its various sub-decrees set out incentives applicable to investors and establish a Council for the Development of Cambodia (CDC) chaired by the Prime Minister, to oversee policy and strategy concerning foreign investments (CDC 2012).

Several large hydro projects have been undertaken on a build–operate–transfer (BOT) basis by Chinese companies with funding from the PRC. In 1999, a Chinese state-owned enterprise, China Electric Power Technology Import and Export Corporation, was contracted to rebuild the Kirirom I HPP that had fallen into disuse during the armed conflict under a 30-year BOT agreement with Electricité du Cambodge (EDC). The 193 MW Kamchay HPP on the Kamchay River in Bokor national park was completed by Sinohydro in 2011, with funding from the China Exim Bank; it has a 40-year build–transfer (BT) concession, the power being sold to EDC. Kirirom III is an 18 MW project

operated by the China Electric Power Technology Import and Export Corporation. The Lower Stung Russei Chrum HPP that comprises the Upper Stung Russei Chrum and the Lower Stung Russei Chrum with total rated installed capacity of 338 MW is being constructed by the China Huadian Corporation; work began in 2011 and is expected to be finished in 2013. The Stung Tatay 246 MW HPP is being built by the China National Heavy Machinery Co. with a 42-year BOT and is expected to be finished in 2015; power will be sold to EDC at \$0.0745 per kWh. Stung Atay HPP is 120 MW and is being built by Datang Corporation along with Cambodia Hydropower Development Company and Cambodia Power Grid Co. BOT finance has also been used to develop the coal resources of Cambodia. In December 2011, the Cambodia International Investment Group was awarded a 33-year BOT contract for a 270 MW coal-fired plant near Preah Sihanouk. Many other hydro plants are under consideration, mainly by project developers for the PRC and Viet Nam.

Although private participation may be seen as successful in terms of the volume of forthcoming investments, some aspects of the process could be clarified. Criteria for identifying projects and selecting bidders are unclear, competitive bidding does not seem to be employed, and details of the contractual agreements between the Government of Cambodia and the project developers are not disclosed to the public. The basis for monitoring and evaluation is not evident; there are no published reports and there are allegations of negative environmental and social impacts (International Rivers 2008).

Private finance has been a vital part of the post-conflict provision of electricity distribution infrastructure in Cambodia. Small-scale providers were active even before the initial peace agreement and continued to establish new ventures even after the resumption of armed conflict in 1997. Entrepreneurs were willing to enter the market and mobilize resources rapidly to take advantage of suppressed demand and the lack of regulations and licensing requirements (PPIAF 2004). These small power providers are envisaged to consolidate into local distribution companies as transmission is extended across the country.

Interestingly, Cambodia has also managed to involve the private sector in transmission system development, often a national monopoly. A 30-year BOT project for power transmission from Thailand to meet the demand in the Siem Reap area was partially funded by ADB's private sector operations along with private equity and loans from the Export-Import Bank of Thailand and from the local banks of Cambodia.

Lao People's Democratic Republic

There is significant participation of the private sector in rural electrification where grid access is not viable. In these remote areas, the government has promoted decentralized or off-grid delivery models through small, local private sector providers.

The Nam Theun 2 HPP is a build–own–operate–transfer (BOOT) project, financed by, among others, ADB and the World Bank, with a power purchase agreement (PPA) between the Nam Theun 2 Power Company (NTPC) and EGAT. Equity in NTPC is owned by Electricité de France (35%), Italian–Thai Development Public Company Limited of Thailand (15%), Electricity Generating Public Company Limited of Thailand (25%), and the Lao Holding State Enterprise (LHSE) (25%) (PPIAF 2011). Since then, several independent power producers (IPPs) have proposed to export to Thailand including hydro plants at Nam Ngum 3, Nam Theun 1, and Nam Ngiep 1, and the Hongsa lignite thermal power plant. The Government of Cambodia gave the approval to a Cambodian and Thai joint venture firm to make a feasibility study for a 1,800 MW coal-fired power plant in Koh Kong Province in the southwest of Cambodia. The capacity of the LHSE to manage these arrangements has been strengthened by grants from the Public–Private Infrastructure Advisory Facility (PPIAF) of the World Bank. Nam Ngum 2 Hydroelectric Power Project was constructed under a 25-year BOT

given to South East Asia Energy Limited that owns 75% of the Nam Ngum 2 Power Company, the remainder being held by EDL.

Private finance from Viet Nam has been active in the Lao PDR, particularly the Song Da Corporation, which is the leading constructor of hydro plants in Viet Nam, and Viet–Lao Power Investment and Development Joint Stock Company in which Song Da Corporation holds a controlling stake. In 1998, the governments of Viet Nam and the Lao PDR signed a cooperation agreement on electric power development to support the implementation of the agreement. Subsequently, with the encouragement of the Government of Viet Nam, the Viet–Lao Power Investment and Development Joint Stock Company (VLPC) was established, initially to construct Xekaman 3 HPP in the Sekong Province of the Lao PDR for export to Viet Nam. Shareholders were EVN (10%), Song Da Corporation (60%), and other Vietnamese construction companies. Work on the Xekaman 3 HPP began in April 2006 as a 30-year BOT. VLPC contributed 100% of the capital and the Government of the Lao PDR will buy back 15% upon completion. The plant has a capacity of 250 MW and is located on the main branch of Xekaman River—the main tributary of the Sekong River. The project should be completed in 2012.

VLPC is also building Xekaman 1 HPP; this plant is located downstream of the Xekaman River on two levels and has a total installed capacity of 322 MW. It is being built under a 30-year BOT in which VLPC contributes 75% and the government contributes 25%. Based on the project schedule, both Xekaman 1 and the lower Xekaman Sanxay HPP will be completed in 2013. Most of the outputs will be exported to Viet Nam, but 10% will be available for domestic consumption in the Lao PDR.

The third hydroelectric power plant (HPP) in which VLPC is currently engaged is the Dak E Meule 112 MW plant on the Nam Emun River. It is implemented through a 30-year BOT in which VLPC has a 75% interest and the government with 25%. Construction has begun and should be completed in 2014.

The Song Da Corporation has signed on its own account an MOU in 2008 for the Upper and Lower Se Sekong 3 with a combined output of 205 MW that is now under construction and is planned to be commissioned in 2015. Song Da Corporation has also signed MOUs for HPPs at Xebanghieng 1 and 2.

Although there has been success in developing public–private partnerships (PPPs) in specific cases, this has been essentially ad hoc. There is no clear and comprehensive framework of law and policy for a PPP that sets out responsibilities, protocols for project preparation, bidding and awards, or dispute resolution.

Myanmar

The foreign investment law in Myanmar dates back from 1988. A new law has been prepared and was approved in November 2012. A draft has been circulated in the press that suggests foreigners will be allowed either to own companies (100% ownership) or set up a joint venture with the citizens or government departments. Foreign investors can also lease land from the state or from private citizens who have permission to use land, the law says. The initial lease would be for up to 30 years, depending on the type and size of foreign investment, and could be extended twice, for up to 15 years on each occasion. The new law also rescinds a requirement that products manufactured by foreign firms must be exclusively for export. Various forms of tax relief is made available and there is a somewhat opaque discussion of nationalization (*Reuters* 2012). There have also been press reports that the government is considering privatizing some state-owned enterprises (SOEs), although with conditions on foreign investment in some strategic sectors, such as power and energy (*Wall Street Journal* 2012).

Despite the absence of a robust legal and regulatory framework, there has been a very strong presence of private sector Chinese companies, backed by Chinese state funds to develop infrastructure in Myanmar, especially hydropower. The government already supplies power to the China Southern Power Grid Company (CSG) from the 600 MW Shweli HPP commissioned in November 2009, and from the Dapein HPP to Dehong in Yunnan. Companies from Thailand have also shown interest.

It is estimated that some 45 companies from the PRC have been or are involved in approximately 63 hydropower projects in Myanmar, including several related substation and transmission line projects (ERI 2008). The plants' sizes range from small plants in the MW range that are intended for local use to very large plants intended for export to the PRC. The latter group includes the 7,100 MW Tasang Dam on the Salween River proposed by Sinohydro Corporation and the Thai MDX group for the export of electricity to Thailand. A groundbreaking ceremony was held but the project has not apparently progressed further. Another very large plant is the Myitsone dam at a site in Kachin State at the head of the Irrawaddy River; this dam is part of the huge Confluence Region Hydropower Project, which includes seven dams with a total installed capacity of 16,500 MW (Burma Rivers Network 2012a). The suspension by the President of Myanmar of the Myitsone dam in September 2011 indicated some intention to reconsider the balance between the benefits of power sales and the economic and social costs, but there is also some contrary indication that the project may still proceed (DVB 2012). Greater transparency on the financing and sharing of benefits for these plants would be helpful to international financial institutions when positioning their assistance and support.

The cost of a new power plant in the PRC is somewhat higher than in Myanmar and there is a difference in the hydro regime that provides useful diversity of power generation. This is based on the results of a power system planning undertaken within the ADB TA-6440, and these factors may justify exports of up to 18,900 MW from Myanmar to the PRC by 2025, although specific sites were not identified (RTE International 2010a). The same study suggests that the export of 2,100 MW to Thailand in the same year is likely.

People's Republic of China (Guangxi and Yunnan)

There is a significant history of PPPs in the People's Republic of China (PRC), and many generating plants are nominally IPPs, but mainly the agents are corporatized subsidiaries of SOEs, rather than private investors. The legal and regulatory framework is rather unclear and there is a considerable bureaucratic burden. For example, under the Township Electrification Program, although contracts were awarded by competitive bidding, the main actors were government-affiliated institutions or semi-private entities such as spin-off companies from former government institutions. The private sector was poorly represented and there was no significant participation from foreign investors (IEA 2010a).

In principle, there is strong support to the PPP concept in the PRC because of the contribution that it can make to the massive infrastructure need, but there is no specific national-level PPP agency. Projects are treated in a similar manner as traditional state infrastructure projects—the State Council and its ministries approve PPP projects, and then oversee their management. This is likely to work better in large cities than in rural areas (EIU 2011).

Power companies in the PRC have been active as private developers outside the country. In part, this may be because the strict tariff controls on electricity pricing make it hard for companies to balance their accounts. Acting as IPPs outside of the regulatory framework of the PRC allows them non-regulated revenues with higher profitability.

Thailand

Although there is some considerable presence of private capital in infrastructure in Thailand, there is no specific legislation to govern project finance or PPPs; projects have typically been structured as long-term concessions between the relevant government authority and the investor supported by conventional project finance. Activities are governed under the Private Participation in State Undertaking (PPSU) Act B.E. 2535 of 1992. The act was mainly intended to prevent corruption in granting rights to private investors; consequently, there are missing aspects that are normally included in PPP legislation. Specifically, there is no mention of how projects are evaluated, what methods of procurement are acceptable, and how risks are shared between public and private actors. The institutional setup is fragmented, with regulatory power, initiative, and authority resting with several agencies (Jaggs and Lui 2010). A new PPP law is being prepared and, in the meantime, PPP guidelines were issued in November 2009. ADB assisted in the development of the new law and guidelines through a technical assistance that aimed not only to prepare an effective PPP policy and a legal and regulatory framework but also to come up with a Project Development Facility for designing bankable infrastructure projects and for supporting pilot PPP projects.

Within the energy sector, private participation is confined to generation. It comprises the IPP plants that sell under long-term PPAs to EGAT and the small power producer (SPP) plants that sell under standardized PPAs to EGAT and the very small power producer (VSPP) plants that sell to the Provincial Electricity Authority (PEA) and Metropolitan Electricity Authority (MEA). The estimated cost of these projects in 2010 was B363 billion (Jaggs and Lui 2010).

Viet Nam

A Law on Investment No. 59-2005-QH11, which combines previous laws on foreign investment in Viet Nam and laws pertaining to domestic investment, was adopted by Viet Nam's National Assembly on November 2005 and came into effect in July 2006. The intention is to create a level playing field among investors, in line with international commitments and to improve the capacity of state management on investment (Government of Viet Nam 2005). A later Decree No. 108/2006/ND-CP of 2006 deals specifically with BOT-type contracts, but was superseded by a PPP decree of the Prime Minister that became effective on 15 January 2011 and will continue to be implemented over the next 3–5 years. After this time, it is intended that they will be replaced by a Government Decree on PPP Investment in Viet Nam. Under the regulations, the Ministry of Planning and Investment (MPI) is tasked to coordinate and implement activities and has, thus, established a PPP Task Force to assist in this. The regulations stress competitiveness, fairness, transparency, and economic efficiency, as well as conformity with Viet Nam's law and international practices, but do not contain implementing regulations for guidance (Pinsent Masons 2011).

Despite the apparently supportive legal framework, there has been relatively little activity, except in the energy sector, and no recent development. The Mekong Energy Company Ltd owns and operates the Phu My 2.2 715 MW combined-cycle power plant in the Ba Ria Vung Tau Province, 80 kilometers (km) southeast of Ho Chi Minh City. The equity is distributed among EDF International (56%), Sumitomo (28%), and TEPCO (16%). The BOT contract is with MOIT, the PPA is with the Electricity of Vietnam (EVN), and gas is supplied by Petroleum Viet Nam under a gas supply agreement. The project was Viet Nam's first private power project awarded on the basis of an international competitive bidding process; it was funded 25% through equity and 75% through loans from ADB, JBIC, the World Bank, and commercial banks. A similar arrangement was made for the Phu My 3 BOT Power Co. Ltd., which owns and operates the 716.8 MW gas-fired combined-cycle power plant at Phu My 3 under a 20-year, take-or-pay basis PPA. The company is jointly held by BP Holdings B.V., SembCorp Utilities Pte. Ltd., and the consortium of Kyuden International Corporation and Nissho Iwai Corporation. The plant became operational in 2004.

Following the plants at Phu My, there was no further IPP project in Viet Nam until AES Corporation achieved financial closure on the Mong Duong 2 coal-fired plant in Quang Ninh Province toward the end of 2011. AES Corporation owns 51% of the equity in the BOT contract; PSC Energy Global Co Ltd, a wholly owned subsidiary of POSCO Power Corp, has a 30% stake; and Stable Investment Corporation, a wholly owned subsidiary of China Investment Corporation, has the remaining 19%. The PPA is for 25 years and is back-to-back with a 25-year coal purchase agreement from Vinacomin. Finance from the project came from a broad syndicate of commercial banks and from the Government of the Republic of Korea's export credit agencies.

The relative lack of activity since the first plants at Phu My may be due to low tariffs and unattractive PPAs or to a lack of provision for risk-allocation, weak mechanisms for arbitrating disputes, and an underdeveloped capital market. The most recent power development plan recognizes the huge capital requirements (estimated to be a total of \$123.8 billion) for the power sector in the next 2 decades, and sets out various policies to attract foreign investment, including increasing tariffs to a level that will ensure reasonable returns for the investors. The ADB Country Operations Business Plan for Viet Nam, 2012–2014 notes the need to accelerate efforts to help mobilize private sector financing for infrastructure projects, including guarantee operations and PPPs, and a technical assistance for a PPP Support Facility.

Summary Conclusions

There is a considerable participation of private finance, but often, it is administered in an ad hoc manner and in some countries, with little transparency. In all countries, the legal, regulatory, and institutional framework for PPP needs strengthening; in several countries, it would need to be developed substantially, taking a cue from lessons of best practices in other parts of the world.

Stronger incentives and policies for renewable energy would help support private participation in grid-connected renewables. The successful involvement of private finance in the distribution and retail of electricity in the early stages of rural electrification is relevant to Myanmar. There is little private financing for transmission; this can only come when there are clear, transparent, and no discriminatory user-system-charges. Table 18 summarizes the private participation found within the Greater Mekong Subregion (GMS).

Regional Supply–Demand Prospective

No recent forecast of the energy supply–demand balance for the GMS countries as a group is available. The long-term outlook for the supply and demand for energy in the Association of Southeast Asian Nations (ASEAN) to 2030 has been studied by the ASEAN Center for Energy with the assistance of the Institute of Energy Economics, Japan (IEEJ) and expert teams from each of the member countries (IEEJ 2011). Unfortunately, it does not include comparable forecasts for Yunnan and Guangxi. The outlook considered two scenarios: the reference scenario took the gross domestic product (GDP) growth targets of the 10 member states as an exogenous input; the alternative policy scenario is intended to analyze the impact of the energy-saving goals and action plans. The demand projections were made using an econometric model fitted to historic data from each country; the supply estimates were made using an engineering model, namely the LEAP model, developed by the Stockholm Environment Institute. Energy prices were derived from the oil price assumption in the International Energy Outlook 2010 of the US Department of Energy.

The predicted energy supply profiles for the GMS countries are shown in Table 19; expectations are extremely variable across the region. Myanmar indicates an intention to depend significantly

Table 18 Summary Conclusions for Private Finance

	Large-Scale Generation	Small-Scale Generation	Transmission	Distribution and Retail
Cambodia	Several plants have long-term PPAs until now, for national use. Interest in export projects from Vietnamese developers.	Only within context of local private sector providers.	Innovative ADB-financed BOT for a transmission line to Thailand.	Many small-scale operations in towns and countryside. Important contributor to post-conflict reconstruction.
Lao People's Democratic Republic	Several IPPs often with IFI support, mainly for export markets.	Only within context of local private sector providers.	None.	Off-grid delivery models through small, local private sector providers.
People's Republic of China (Guangxi and Yunnan)	Nominally, but generally as private arms of SOEs.	The possibility has existed for off-grid, but was not much taken up.	None.	None.
Myanmar	Many plants for local use and export to the PRC.	None known.	Only possibly as a part of export projects.	None known.
Thailand	Several IPPs have been built and are operating.	Many SPPs and VSPPs within well-defined legal context.	None.	Minor involvement through cost contribution to rural electrification.
Viet Nam	Early interest in IPPs built under BOT contracts, little recent activity. Strong political motivation; regulatory and commercial context is weak.	Little activity. No adequate incentives.	None.	Important part of rural electrification. Local communes selling often at high prices; now regulated.

ADB = Asian Development Bank, BOT = build–operate–transfer, PRC = People's Republic of China, IFI = international financing institution, IPP = independent power producers, PPA = power purchase agreements, SOEs = state-owned enterprises, SPP = small power producers, VSPP = very small power producers.

Sources: Various country energy reports.

Table 19 Primary Energy Consumption in 2030 by Country (base case)

	Coal	Oil and Oil Products	Natural Gas	Nuclear	Hydro	Others	Total
Cambodia	2.6	4.4	–	–	2.0	4.2	13.2
Lao People's Democratic Republic	3.3	2.5	–	–	1.9	1.0	8.7
Myanmar	0.7	9.7	9.4	–	13.4	2.0	35.2
Thailand	41.8	96.7	36.3	11.4	0.3	61.3	247.7
Viet Nam	103.2	66.6	16.1	12.4	6.4	21.1	225.8
Total	151.6	179.9	61.8	23.8	24.0	89.6	530.6

– = no data.

Source: IEEJ (2011).

on hydro; it is not clear if this is practical and a more effective use of the resource than to spread it more widely, but this will require an appropriate infrastructure for connectivity. Coal is expected to be an important source of supply for Thailand and Viet Nam and it will be used mainly in power generation.

Greater Mekong Subregion Regional Energy Connectivity

The Greater Mekong Subregion Regional Power Trade

The Regional Power Trade Coordination Committee

Several early studies of power systems interconnection in the Greater Mekong Subregion (GMS) were made by ADB in 1995, which led to the formation of the subregional Electric Power Forum, the Mekong River Commission in 1996, and the World Bank Power Trade Strategy Study in 1999 that established the Experts Group on Power Interconnection and Trade (EGP). ADB funded an Indicative Master Plan on Power Interconnection in the GMS countries that demonstrated considerable benefits from integration and considered, among other options, a 500 kilovolt (kV) supergrid linking the power systems of the Lao People's Democratic Republic (Lao PDR), Thailand, and Viet Nam (Norconsult 2002).

The recommendations in the master plan included a

- i. 230 kilovolt (kV) line between Phnom Penh in Cambodia and Chau Doc in Viet Nam in 2004,
- ii. 115 kV line between Thailand and western Cambodia in 2004,
- iii. 500 kV line between Roi Et in Thailand and Ha Tinh in Viet Nam via the Lao PDR in 2009,
- iv. 500 kV line between Savannakhet in the Lao PDR and Pleiku in Viet Nam in 2010,
- v. 230 kV line between Nam Mo in the Lao PDR and Ban Mai in Viet Nam in 2009;
- vi. 230 or 500 kV line between Na Bong in the Lao PDR and Udon Thai in Thailand in 2008,
- vii. 500 kV line between Tasang in Myanmar and Mae Moh in Thailand in 2012,
- viii. 500 kV line between Jinghong of Yunnan Province of the People's Republic of China (PRC) and Tha Wung in Thailand in 2013,
- ix. 230 or 500 kV line between Malutang in Yunnan Province in the PRC and Soc Son in Viet Nam in 2019, and
- x. 230 kV line between Sambor in Cambodia and Tan Dinh in Viet Nam in 2019.

The recommendations of this study were endorsed by the EGP in 2002.

An important institutional step forward was taken in November 2002 when an intergovernmental agreement (IGA) on Regional Power Trade in the GMS was signed on the occasion of the First GMS Summit. The IGA confirmed the commitment of the GMS countries to advance power trade and harmonize their power systems' development based on the principles of cooperation, gradualism, and environmental sustainability. The IGA established a Regional Power Trade Coordination Committee (RPTCC) with the responsibility to specify the rules that should govern regional power trade. At the request of the GMS countries, ADB provided technical assistance (RETA 6100) to prepare a regional power trade operating agreement (PTOA) in the GMS; the work was monitored by the RPTCC. A final report on the design of the PTOA was submitted in October 2004 and based on this proposal, a memorandum of understanding (MOU) on the guidelines for the implementation of the first stage of the regional PTOA was signed on 5 July 2005 by the Ministers of Energy of the six GMS countries. The RPTCC has since met from one to two times a year and most recently in

March 2012. Responsibility for organizing venues and meetings rotates among the member states and ADB provides the secretariat.

The Regional Power Trade Operating Agreement

The proposal to develop power trade in the GMS is anchored on the principle that integration should proceed in four well-defined stages, as follows:

- Stage 1: Bilateral cross-border connections through power purchase agreements (PPAs);
- Stage 2: Grid-to-grid power trading between any pair of GMS countries, eventually using transmission facilities of a third regional country;
- Stage 3: Development of transmission links dedicated to cross-border trading; and
- Stage 4: Most of the GMS countries have moved to multiple sellers–buyers regulatory frameworks, so a wholly competitive regional market can be implemented.

The MOU sets out guidelines for the implementation of the first stage of the Regional Power Trade Operating Agreement, i.e., when only country-to-country power transactions are possible and before a regional transmission network is established, to enable power trading between any pair of member countries. During this period, the existing cross-border transmission lines are mostly associated with PPAs by which a power plant located in any one country (normally an independent power producer [IPP], but not necessarily) sells power to a utility in a neighboring country. However, this is a very limited concept of power trade because it is exclusively in one direction. A broader concept of trade is envisaged in Stage 1, where exchanges of power between utilities are achieved using the excess capacity of existing cross-border transmission lines over and above the transmission capacity required for power transfers associated with PPAs. MOU–1 also established two new institutions to support the work of the RPTCC—the Focal Group, which will coordinate implementation activities in each GMS country; and the Planning Working Group, which will undertake operational and system planning to prepare a regional interconnection plan, participate in developing regional performance standards, and create a regional database.

Preparing the Greater Mekong Subregion Power Interconnection Project, Phase I

Following a request from the EGP, ADB provided technical assistance through RETA 6147 for a study of 500 kV transmission line from the Lao PDR to Viet Nam that, together with the Nam Theun 2 transmission line between Thailand and the Lao PDR, would interconnect the grids of Thailand and Viet Nam. The study, which was completed in 2005, showed that by interconnecting both systems with a capacity of 1,000 megawatts (MW), savings of \$190 million per year in investments and fuel could be achieved by taking advantage of the different seasonal availability of hydropower. The original concept envisaged that excess capacity in the double-circuit 500 kV line from Nam Theun 2 to Roi Et could be used to create the Lao PDR–Thai section of the connection and that a new line would be built from Ha Tinh in Viet Nam to join the Thai–Lao PDR section. The Nam Theun 2 Power Company (NTPC) that owned the section of the transmission line in the Lao PDR from the dam to the Mekong crossing point refused to allow the line to be used in this manner. The project was, therefore, reconsidered and a more southerly line was investigated toward Ban Soc and Pleiku, picking up power also from hydro plants to be built in southern Lao PDR. The completion report found that the study was coherent with the development strategy of the Lao PDR and Viet Nam, but not with Thailand. It appears that, at least, part of the unease of Thailand was that the Vietnamese system was not sufficiently stable and would impose costs on the Electricity Generating Authority of Thailand (EGAT) system. ADB expressed concern that the line would not be financially viable until there was a clearer schedule of construction for the hydropower plants. The section of line from Ban Soc to Pleiku is still in the ADB pipeline.

Road Map for Implementing a Greater Mekong Subregion Cross-Border Power Trading

Recognizing that the MOU-1 does not specify a schedule of dates with which activities should comply and against which progress toward achieving objectives of the IGA could be monitored, ADB provided technical assistance through RETA 6304, funded by the Agence Française de Développement. The assistance comprised four components addressing (i) an Action Plan, (ii) institutional development, (iii) capacity building, and (iv) a database for information exchange and communication. The action plan developed within the project formed the basis for an MOU on the Road Map for Implementing the GMS Cross-Border Trading, which was prepared and signed in March 2008 by the GMS Ministers of Energy. The road map, which is attached to the MOU, covers the period (2008–2012) required to implement Stage 1 of the regional power trading and to prepare for Stage 2. In Stage 2, trading is possible between any pair of GMS countries, using transmission facilities of a third regional country. The available cross-border transmission capacity is still envisaged to be based on surplus capacity of lines linked to PPAs. The shift from Stage 1 to Stage 2 depends on enough cross-border transmission capacity to allow power transactions among all (or most) of the GMS countries. Trade at this stage is confined to national utilities (presumably envisaged as single buyers). The MOU strengthened the high-level commitment from the GMS governments and prescribed timelines for establishing the regional power trade. How the actual performance compares to the requirements of the road map is discussed in a later section.

The Updated Master Plan

One component of the road map was to update the regional indicative master plan every 2 or 3 years. Under RETA 6440, with funding from the Swedish International Development Cooperation Agency (SIDA), ADB arranged a consulting study to provide an indicative master plan for the GMS region for the period 2009–2025, focusing particularly on the cross-border connections that are needed (RTE International 2010b). The schedule of generating plants is taken from national plans, which to some extent prejudices the outcome of the analysis as transmission lines are inevitably built largely to serve these exogenous construction schedules. In the base case, the analysis concludes that new interconnections should be developed between or among the following:

- the PRC and Myanmar, and Thailand and Myanmar;
- Thailand, Lao PDR North, and Viet Nam North;
- Lao PDR South and Viet Nam Center; and
- to a lesser extent, Cambodia and Viet Nam South.

The Viet Nam Center to South transmission line is to be upgraded in 2015 from 2,000 MW to 5,000 MW.

The resulting trade in electricity in 2020 and 2025 is summarized in Table 20. The overall totals are 98,800 gigawatt-hour (GWh) and 163,700 GWh, respectively, which may be compared to the 8,475 GWh recorded in 2009. The economic resilience of the different interconnections varies rather widely depending on the difference in cost between the importing and exporting countries. Exports to the PRC are the most vulnerable because the study calculates only a \$13 per megawatt-hour (MWh) differential between Myanmar and the PRC, and a \$5/MWh differential with the Lao PDR. Myanmar to Thailand has the highest differential at around \$74/MWh and the other connections are from \$20–\$60 per MWh.

Table 20 Possible Electricity Trade in 2020 and 2025 (GWh)

2020	Exporter			Total
	Cambodia	Lao People's Democratic Republic	Myanmar	
PRC	NA	NA	45,600	45,600
Thailand	NA	24,900	9,800	34,700
Viet Nam	1,800	16,700	NA	18,500
TOTAL	1,800	41,600	55,400	98,800
2025	Exporter			Total
PRC	NA	NA	100,000	100,000
Thailand	NA	30,200	13,500	43,700
Viet Nam	1,800	18,200	NA	20,000
TOTAL	1,800	48,400	113,500	163,700

PRC = People's Republic of China, GWh = gigawatt-hour, NA = not applicable.

Source: RTE International (2010b).

Regional Power Coordination Center

A problem in sustaining progress has been the absence of a permanent secretariat to follow up and monitor activities. To address this issue, RETA 6440 included a component to develop the concept of a Regional Power Coordination Center (RPCC). This has been very actively debated during the successive meetings of the RPTCC. The RPCC will take over the work of the RPTCC; the executive director will be appointed on rotation basis for a 3-year term. An intergovernmental MOU to establish the center is needed. The draft of the MOU discussed at the RPTCC-12 meeting in Vientiane on 17–18 May 2012 is ambitious. It affirms a conviction that there is a need to synchronize power system operation and to harmonize the regulatory framework governing the electricity sector within the GMS. It establishes the RPCC with the principal objective to promote the synchronized operation of the national power system operations toward a unified, fair, and transparent regional electricity market with the ultimate goal of providing the GMS member states with stable and reliable electricity supply at the most economic costs. The RPCC's functions would include the duty to monitor national transmission system operators (TSOs), utilities, and other relevant national authorities to ensure adherence to common rules across the technical and commercial spectrums, and to harmonize planning and operation of the interconnected GMS power systems. RPCC would be financed by contributions from member states and from donors where appropriate. The MOU was signed by four countries (Cambodia, PRC, Lao, and Viet Nam) at the 18th GMS Ministerial Meeting in the PRC in December 2012.

In parallel with the elaboration of the draft intergovernmental MOU, two working groups of the RPTCC will be established to start work on regulatory and normative issues. The working group on regulatory issues will ensure compatibility in the technical operations of national power systems and the functioning of new financial mechanisms at the regional level. The working group on normative issues will establish performance standards and grid codes and implement common standards for operational security, reliability, and quality of supply of the GMS interconnected system; encourage an integrated planning of power system expansion; and ensure nondiscriminatory access to the interconnected system for users. The creation of the two working groups is an interim measure prior to the establishment of the RPCC. The terms of reference for these groups have not yet been fully agreed.

Ensuring Sustainability of the Greater Mekong Subregion Regional Power Development

Integration of the power grids of the GMS countries must be done in a way that is consistent with wider strategic issues including (i) environmental, climate change, and social impacts; (ii) energy security and diversification of supply; and (iii) energy efficiency and demand-side management (DSM). RETA 7764 will address these issues as it contains a strong component of strategic environmental assessment (SEA) that continues the work of the GMS Environment Operations Center (EOC) in Bangkok and the Mekong River Commission (MRC). In particular, it builds upon the Initiative on Sustainable Hydropower of the MRC, including the SEA that was prepared in conjunction with the proposals for mainstream dams in the Lower Mekong Basin.

Assessment

The path to a regional power market is marked by retreat from ambition, partial success through gradualism, and significant structural obstacles that still need to be dealt with. The original concept of a fully synchronized and integrated power market as set out in the original master plan failed to advance through the planned interconnection among Thailand, the Lao PDR, and Viet Nam. Since then the perseverance of ADB has gradually moved the political process forward to the point that the new draft intergovernmental MOU could be signed in order to begin to put the wider concept back on track.

Severe structural problems still exist at regional and national levels. The IPPs that have been created or are in the process of creation on some of the most favorable hydro sites will lock up generation in long-term PPAs for many years to come. The transmission lines that have been built or are under construction are predicated on an export-oriented concept of trade and may not be the optimal configuration for a less constrained market. There are also obstacles caused by market structures that are little adapted to international trade. It is hard to see how the intergovernmental MOU can be implemented without a degree of reform in national markets. Thailand is a key market as it is large, central, and an important buyer, now and in the future, of power from the Lao PDR; it came very close to reforming the power sector, but chose eventually not to continue. It may be helpful to explore, within the PRC, the underlying reasons why unbundling has not proceeded and to identify the minimum requirements for national markets to operate the MOU. Greater transparency in some countries regarding national plans and tendering procedures is also needed. The Lao PDR is important in this context because of its “battery” role; the capacity in the Lao PDR to manage the process for awarding concessions appears to be limited and may benefit from technical assistance under the new GMS framework.

The ASEAN Power Grid

Although it extends beyond the GMS and does not include the provinces of the PRC, the reflections of the Association of Southeast Asian Nations (ASEAN) on the most desirable configuration of the ASEAN Power Grid (APG) are interesting and relevant. The development of the APG is the responsibility of the Heads of ASEAN Power Utilities and Authorities (HAPUA). The APG was endorsed by heads of state in their declaration on an ASEAN Vision 2020 published in 1997 and has been a prominent aspect of subsequent ASEAN Programs of Action for Energy Cooperation (APAEC 2003, 2009). HAPUA completed a first ASEAN Interconnection Master Plan Study (AIMS) in 2003 (HAPUA 2003). The master plan was updated in 2010 (ASEAN 2011); the analysis found that many interconnection projects would be required, some of which would be for import and some

Table 21 Selected Interconnection Projects, AIMS II

Systems	Capacity (MW)	Year	Comment
Cambodia–Thailand	300	2015	GMS, EE ^a
Lao PDR–Thailand	600	2015	GMS, EE ^a
Myanmar–Thailand	3,829	2016–2025	GMS
Cambodia–Thailand	100	2017	GMS
Cambodia–Viet Nam	222	2017	GMS
Lao PDR–Thailand	3,521	2017–2023	GMS

^a EE indicates that the line is for exchange of energy.

AIMS II = ASEAN Interconnection Master Plan Study II, GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, MW = megawatt.

Source: ASEAN (2011).

for energy exchange. The necessary interconnections within the GMS over and above those already existing are shown in Table 21.

Trans-ASEAN Gas Pipeline

The natural gas business has not been directly addressed by the GMS as historically, regional cooperation in this area has been through ASEAN—through the ASEAN Council on Petroleum (ASCOPE). There are good reasons for this as the largest gas reserves are in the non-GMS countries of South East Asia. A brief account of cooperation is given here, because there may be aspects in the future that apply particularly to the GMS.

The vision of the Trans-ASEAN gas pipeline (TAGP) was proposed by the ASEAN–EU Energy Management Training and Research Centre (AEEMTRC) in the late 1980s and an outline master plan was developed under European Union (EU) funding. The basic idea was to link major load centers and sources of natural gas through a gas pipeline from Thailand along Peninsular Malaysia, Sumatra, and Java, with a branch to the large fields in Sarawak, Brunei Darussalam, Sabah, and East Kalimantan. The concept was adopted by the 17th ASEAN Ministers of Energy Meeting in Bangkok in 1999 and entrusted to ASCOPE for further elaboration and development. A task force was formed, led by Petronas, to develop and maintain the master plan. An MOU on the project was signed by the ASEAN Ministers of Energy in 2002 (ASEAN 2002).

Eleven bilateral connections have since been established with a total of 3,020 kilometers (km) of pipeline connections, and bilateral agreements have been signed between Petronas and Pertamina, between Singapore and Malaysia, between Thailand and Malaysia, and between Singapore and Indonesia. ASCOPE has also been active in preparing a regulatory framework to manage the TAGP. The ASEAN Gas Consultative Council was formed in July 2003 with representatives from government and national oil companies to address cross-border issues in gas market integration and to facilitate the implementation of the TAGP project. The ASCOPE Gas Center was created in Malaysia as a resource for technical and commercial information and capacity building. Model agreements for gas sale and purchase and for gas transport have been formulated. Future plans include the following:

- Form model ASEAN Joint Venture (JV) Gas Pipeline Company (2013).
- Adopt common technical standards for construction, operation, and maintenance of ASEAN gas pipeline projects (2013).
- Adopt a business model for ASEAN gas pipeline ownership and operation (2014).

- Develop and implement a regional safety and security plan for TAGP pipelines and facilities (2014).
- Optimize Trans-ASEAN gas pipelines (2015).

The business of gas transport will take on a new importance for the GMS as power systems move toward natural gas for generation. Given that the huge reserves of gas around the island of Borneo are largely preempted and that national reserves within the GMS countries will not support large-scale expansion, there is quite likely to be a substantial increase in imports of liquefied natural gas (LNG). The price of LNG will probably remain at a premium to that of coal, adjusted for efficiency because of its good environmental properties. If the power business in the GMS does turn in a substantial way to LNG then the TAGP will take on a new significance. By means of the TAGP, it may be possible to exploit economies of scale in regasification by sharing output through the pipeline. The TAGP will enhance security of supply because in the event of a supply interruption at one regasification terminal, supplies may be moved through the pipeline to another; it will also allow consuming countries to share storage in depleted gas reservoirs. These new functions will have implications for the physical design and control of the pipeline as it will need to provide bidirectional transmission. A joint reflection on the optimization of power generation and gas importation and the future role of the TAGP might be justified.

Assessment of Connectivity

Regional Power Trade

Most of the cross-border connections, especially those at 500 kV, do not provide true connectivity. They simply connect power stations on a foreign territory to the importing grid. Essentially, the grid of the importing country is extended onto foreign soil and this is true even if the power line is owned by the host country of the power station. The EGAT power system expansion plan actually shows the hydropower plants and transmission lines in the Lao PDR as a part of the EGAT system (EGAT 2010). The power lines concerned do not even allow trade in the very restricted sense allowed in Stage 1 of the GMS regional market, which is to allow exchanges of power between utilities using the excess capacity of existing cross-border transmission lines over and above the transmission capacity required for power transfers associated with PPAs. In the study of an interconnection between Thailand and Viet Nam, the Nam Theun 2 Power Company (NTPC) refused access to their line from the dam to the Mekong crossing point. It would be possible, in principle, to remove this obstacle by legislative reform in the Lao PDR, which obliged third-party access.

The only true cross-border connectivity in the region is where the importing grids are synchronized to the exporting grid and exchanges are possible if that is appropriate. This includes the PRC and Northern Viet Nam, Cambodia and Viet Nam, Cambodia and Thailand, Thailand to the Lao PDR, and the interconnector from Thailand to Malaysia.

The TransASEAN Gas Pipeline

The TAGP as originally conceived by AEEMTRC in the late 1980s was intended as an alternative to the export of natural gas out of the region as LNG. The original logic was that the pipeline would shift gas from the production areas, particularly around the island of Borneo, to the potential loads in the large cities and industrial areas of ASEAN in the event the commercial logic of LNG was irresistible and the great majority of gas that is exported now goes outside the region. The TAGP became a more modest venture—essentially a collection of independent pipeline and unconnected projects that are roughly aligned geographically. ASCOPE has done good work in establishing

construction and operating norms for pipelines across the region, but it is difficult to say that the TAGP provides true connectivity. Gas cannot be moved freely around the system and is doubtful whether any of the constituent pipelines have the capacity for bidirectional flow.

The concept of the TAGP may become more important and its nature could be changed as imported natural gas becomes a main feature of regional energy supply. Single-source dependency of individual countries incurs risks that may be partially alleviated by a pipeline system that enables gas to be moved around the region as needed. It may also be that the TAGP would permit LNG regasification terminals to be shared among two countries with the division of gas being achieved through the pipeline. The possible exploitation of coal-bed methane and similar tight sources of natural gas could be facilitated by the pipeline infrastructure with appropriate modifications. This will most obviously be an option for the coal-bed methane in Sumatra, but parts of Kalimantan may also be relevant. The willingness of countries outside the region to pay high prices for gas and the financial strength of the counterparties were factors in preferring LNG trade to pipeline transport and these may no longer be determinant, although the sunk costs of the liquefaction plants will clearly be influential. Lastly, in a region that is dependent on imports, gas storage will become necessary. This might be achieved in depleted or semi-depleted fields in proximity to the TAGP infrastructure. The TAGP then can serve to make this storage available over a wide area. On a longer timescale, the route, if not the infrastructure of the TAGP, could be a basis for a carbon dioxide pipeline system—taking carbon dioxide from coal-fired power stations for final disposal in depleted gas reservoirs that originally supplied the TAGP.

Regional Programs

The Vientiane Plan of Action for Greater Mekong Subregion Development, 2008–2012

Background

The third summit of the Greater Mekong Subregion (GMS) leaders held in Vientiane on 30–31 March 2008 addressed the need to enhance competitiveness through greater connectivity, noting that

Enhancing economic competitiveness and accelerating our economic and social development process through the greater use of improved and expanded connectivity will be the key focus of our cooperation in the coming years. Our central location in East Asia and the contiguity of our borders position our subregion to not only benefit substantially from regional economic integration, but also to spearhead the process. Enhancing our competitiveness is essential to fulfilling our subregion's potential to be a hub of development in this part of the world.

The summit affirmed the intent to translate achievements in physical connectivity into full and sustainable connectivity to increase trade, investment, and tourism. To this end, it endorsed the Vientiane Plan of Action for GMS Development for 2008–2012, covering important areas of cooperation including energy. The main goal of the plan in energy was to help establish a sustainable and efficient GMS energy supply market. The plan comprised 73 activities in energy and was constructed around four main strategic thrusts, as follows:

- Broadening GMS energy cooperation—Enhanced efficiency and security, and sustainable development of energy resources.
- Regional power trade development—Building capacity for power trade operation, coordination, and grid interconnection.
- Regional power trade development—Implementing key GMS interconnection projects for Stage 1 power trading.
- Regional power trade development—Developing generation projects for power exports under Stage 1.

The Vientiane Plan of Action (VPOA) expires at the end of 2012 and will be replaced by a new Regional Investment Framework (RIF) and pipeline under the new GMS Strategic Framework. This note attempts to assess the performance of the plan as a guide to future work.

Broadening the Greater Mekong Subregion Energy Cooperation

Table 22 lists the activities that were included within the VPOA, along with a note of the status and remarks concerning implementation and follow up. It appears from Table 22 that only two activities can be said to have been completed. Developing the GMS Energy Strategy was successfully delivered under a technical assistance from ADB and was published as *Building a Sustainable Energy Future*

(ADB 2009a). The study identified seven priority actions for the GMS that were taken into account in the Energy Road Map that was endorsed at the 15th GMS Ministerial Conference in June 2009. The study also generated estimates of investment need and the savings that could accrue from integration and trade. The subregional Strategy for Cooperation in Renewable Energy was not strictly completed, but was incorporated into the Energy Road Map.

Table 22 Enhanced Efficiency and Security and Sustainable Development of Resources

Project Code ^a	Project	Status and/or Outputs	Remarks
Group 1: Projects that are ongoing or for immediate implementation			
1	Developing the GMS Energy Strategy (All GMS countries)	Completed. Published as <i>Building a Sustainable Energy Future</i> . Identifies seven priority actions for the GMS. Estimates investment need of \$585 billion by 2025; integration and trade can save \$200 billion in investment and operating costs during that period.	Made under RETA 6301. High degree of consultation. Proposals were incorporated in the Energy Road Map.
2	Subregional Strategy for Cooperation in Renewable Energy (RE) (All GMS countries)	Completed. Included within the GMS Energy Road Map (endorsed at the 15th GMS Ministerial Conference in June 2009).	Focus is on enhancing the policy and institutional framework, promoting biofuels and biomass, and strengthening of information networking. See Activities 4 and 6 below.
3	Promoting Greater Interaction between the Subregional Energy Forum (SEF)/ Regional Power Trade Coordination Committee (RPTCC), and the Working Group on Environment (WGE)/ Environment Operations Center (EOC) (All GMS countries)	Ongoing. The main activities of EOC have been bilateral: two SEAs have been completed for power development in Viet Nam with support from the EOC, including an SEA of Master Plan VII; training has been conducted in the Lao PDR.	RETA 7764 is relevant. See Activity 10 on next page.
4	Improving Energy Efficiency (EE) through Demand-Side Management (DSM) and Energy Conservation (EC) in the GMS (All GMS countries)	Ongoing. Combined with Activity 6 under the RETA 7679 “GMS: Promoting RE, Clean Fuels (CF) and EE in the GMS.” The inception report was presented at the 5th SEF meeting in Ho Chi Minh, Viet Nam on 11 November 2011.	The intended impact is to increase the share of RE and CF in the total energy supply of GMS to about 10% by 2015, and to double the amount of energy saved through DSM and EC measures from 2010 to 2015 by technology transfer and sharing of best practice. Complements several national projects.
5	Study on Promoting Carbon-Neutral GMS Economic Corridors (included in the EOC work program) (All GMS countries)	Pending. It is to be covered under the project on “Promoting Low-Carbon/ Climate-Resilient Economies in the GMS”; this has been merged with “Climate-Friendly Bioenergy” and will now be implemented in 2014. Includes technical assistance and loans. The project preparatory TA for the combined project is in the pipeline for 2013.	Note that an “Environment-Friendly and Climate-Resilient GMS Economic Cooperation Program” is the expected outcome of TA 7987 covering the Core Environment Program and Biodiversity Conservation Corridors Initiative in the Greater Mekong Subregion, Phase 2.

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Table 22 continued

Project Code ^a	Project	Status and/or Outputs	Remarks
6	Promoting the Development of Renewable Energy (RE) and Clean Fuels (CF) in the GMS <i>(All GMS countries)</i>	Ongoing. Combined with Activity 4 under the RETA “GMS: Promoting RE, Clean Fuels (CF) and EE in the GMS.” The inception report was presented at the 5th SEF meeting in Ho Chi Minh, Viet Nam on 11 November 2011.	See Activity 4.
6A	GMS Renewable Energy (RE) Development II <i>(All GMS countries)</i>	Pending. This is a firm project in the pipeline for 2014.	
7	Coordination Between SEF and the Working Group on Agriculture (WGA) on the Rural Renewable Energy (RRE) Project (renamed GMS Climate-Friendly Bioenergy Project) <i>(All GMS countries)</i>	Ongoing. The Climate-Friendly Bioenergy Project has been merged with Project 5 and is to be implemented in 2014. The role of SEF is unclear—it should be clarified by a preparatory technical assistance in the pipeline for 2013.	The “Climate-Friendly Bioenergy Project” aims in part at upgrading the production technology of biofuels and is important. A part of TA 6521 on “Accelerating the Implementation of the Core Agriculture Support Program” is relevant.
8	Sharing of Methodology and Analysis for Developing Each GMS Country’s Economy and Energy Development Plan <i>(All GMS countries)</i>	Ongoing within both the RPTCC and SEF.	A more systematic basis for sharing would be useful.
9	Coordination between the RPTCC and EOC, e.g., Conduct of Strategic Environmental Assessments (SEAs) for the Power Sector, and Environmental Impact Assessments (EIAs) for Energy Projects (Cambodia and the Lao PDR)	Ongoing in the Lao PDR. There seems to be no activity in Cambodia.	Training on SEA for the energy sector has been conducted in the Lao PDR and is continuing. Inclusion of Cambodia is important given the future intentions for hydropower.
10	Promoting Environmentally Sustainable Power Trade Planning, Coordination, and Development in the GMS (renamed “Ensuring Sustainability of GMS Regional Power Development”) <i>(All GMS countries)</i>	Ongoing under RETA 7764. The consultant presented the inception report at the RPTCC 12 meeting on 18 May 2012 in Vientiane.	RETA 7764 integrates in the process the GMS Power Master Plan—an SEA to address environmental, climate change, and social externalities; energy security and energy efficiency measures; and economic pricing of indigenous fossil fuels.
11	Sharing of Best Practices in Development/Propagation of the Use of Natural Gas in Transport <i>(All GMS countries)</i>	Ongoing within the RPTCC and the SEF.	Thailand’s experience in tax incentives and a revolving fund for natural gas in vehicles was discussed in the knowledge-sharing session of the RPTCC-8 meeting in Luang Prabang, Lao PDR in November 2009.
Group 2: Projects for later implementation			
12	Study on the Development of the GMS Energy Efficiency (EE) Network <i>(All GMS countries)</i>	Ongoing. Included in the RETA 7679 “GMS: Promoting RE, Clean Fuels (CF) and EE in the GMS.” See Activity 4.	See Activity 4.
13	Implementing Public Awareness Campaign for Energy Conservation (EC) Particularly in the Residential Sector <i>(All GMS countries)</i>	Proposed. No information available.	

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Table 22 continued

Project Code ^a	Project	Status and /or Outputs	Remarks
14	Energy-Efficient Transport Modal Mix (All GMS countries)	Proposed. No information available.	
15	Improvement of Transport System Efficiency (All GMS countries)	Proposed. No information available.	
16	Study for Promoting the Use of Electric Cars in GMS Countries (All GMS countries)	Proposed. No information available.	
17	Regional Energy Efficiency Program (All GMS countries)	Ongoing. Included in the RETA 7679, “GMS: Promoting RE, Clean Fuels (CF) and EE in the GMS.” See Activity 4.	See Activity 4.
18	Regional Framework for RE Development (All GMS countries)	Ongoing. Included in the RETA 7679 “GMS: Promoting RE, Clean Fuels (CF) and EE in the GMS.” See Activity 4.	See Activity 4.
19	Small-Scale Clean Generation Fund (All GMS countries)	Proposed.	Further refinement of project concept needed; to be done under the SEF.
20	Renewable Energy (RE) Resource Assessment Studies (All GMS countries)	Ongoing. Included in the RETA 7679 “GMS: Promoting RE, Clean Fuels (CF) and EE in the GMS.” See Activity 4.	See Activity 4.
21	Sharing Best Practices in Biofuels (All GMS countries)	Pending. To be covered under the project on “Promoting Low-Carbon/Climate-Resilient Economies in the GMS” now merged with “Climate-Friendly Bioenergy” for 2014.	
22	Biomass Generation Project (PRC, Lao PDR, and Viet Nam)	Ongoing. Will be covered under RETA 7833 for “Capacity Building for the Efficient Utilization of Biomass for Bioenergy and Food Security in the GMS,” and also included in “Climate-Friendly Bioenergy” for 2014.	
23	Training on Biodiesel at the Community Level	Pending. Will be included in “Climate-Friendly Bioenergy” for 2014.	
24	Study on Networking for Propagating GMS-Appropriate RE Technology (All GMS countries)	Ongoing. Included in the RETA 7679 “GMS: Promoting RE, Clean Fuels (CF) and EE in the GMS.” See Activity 4.	See Activity 4. Includes website for sharing of best practice.
25	Renewable Energy Advocacy Program for the GMS (All GMS countries)	Ongoing. Included in the RETA 7679 “GMS: Promoting RE, Clean Fuels (CF) and EE in the GMS.” See Activity 4.	See Activity 4.
26	GMS Energy Database Development, Publications, and Networking (All GMS countries)	Ongoing. Included in the RETA 7679 “GMS: Promoting RE, Clean Fuels (CF) and EE in the GMS.” See Activity 4.	See Activity 4.
27	Training Needs Analysis and Capacity Building Program for Energy Initiatives in the Road Map (All GMS countries)	Proposed.	Awaiting consideration of SEF.
28	Study on Accreditation Schemes for Energy Managers/Technical Personnel in the GMS (All GMS countries)	Proposed.	Awaiting consideration of SEF.

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Table 22 continued

Project Code ^a	Project	Status and/or Outputs	Remarks
29	Study on Initiative for Energy Stockpiling and Strategic Reserves for Enhanced Energy Security (All GMS countries)	Proposed.	Awaiting consideration of SEF.
30	Sharing of Knowledge and Experience in Nuclear Energy Development (All GMS countries)	Proposed.	Awaiting consideration of SEF.
31	Regional Project Preparation Technical Assistance Facility (PPTAF) (All GMS countries)	Proposed.	Awaiting consideration of SEF.
32	Development of Decentralized (Off-Grid) Energy Systems for Integration of Isolated Areas (All GMS countries)	Ongoing under national projects.	National efforts to promote off-grid electrification are ongoing in all GMS countries and supported by ongoing technical assistance in the Lao PDR and Cambodia.
33	Piloting of Smart Subsidies for the Use of RE Technologies in Off-Grid/ Grid Systems (All GMS countries)	Ongoing. Included in the RETA 7679 “GMS: Promoting RE, Clean Fuels (CF) and EE in the GMS.” See Activity 4.	See Activity 4.
34	Review of Prospects for Promoting Identified GMS Segments of the Trans-ASEAN Gas Pipeline (TAGP); Other Possible Segments (Cambodia, Lao PDR, Myanmar, Thailand, Viet Nam)	Proposed. No progress; there is no activity on oil and gas in the Regional Cooperation Operations Business Plan (RCOBP) for 2012–2014.	Project is overseen by ASCOPE at ASEAN level. Rationale for particular consideration of GMS segments needs discussion with ASEAN institutions.
35	Sharing of Experience and Best Practices on Regulatory Issues and Legal Framework (Oil and Gas)	Proposed. No progress; there is no activity on oil and gas in the RCOBP for 2012–2014.	
36	Coordination of Efforts to Enhance Energy Market Integration in ASEAN (Oil and Gas)	Proposed. No progress; there is no activity on oil and gas in the RCOBP for 2012–2014.	Essentially an ASEAN-level project.
37	Studies on Safety and Security of Oil/ Gas Pipelines and Their Environmental Risk Mitigation (All GMS countries)	Proposed. No progress; there is no activity on oil and gas in the RCOBP for 2012–2014.	
38	Abated Clean Coal Generation (Viet Nam)	Proposed. No progress; there is no activity on coal in the RCOBP for 2012–2014.	Further refinement of project concept needed; to be done under the SEF.
39	Coal Liquefaction and Carbon Neutrality Technical Assistance (PRC and Viet Nam)	Proposed. No progress; there is no activity on coal in the RCOBP for 2012–2014.	Further refinement of project concept needed; to be done under the SEF.
40	Monitoring Carbon Capture and Storage (CCS) Technologies for Coal Power Plants in the GMS (All GMS countries)	Proposed. No progress; there is no activity on coal in the RCOBP for 2012–2014.	Further refinement of project concept needed; to be done under the SEF.

ASCOPE = ASEAN Council on Petroleum, ASEAN = Association of Southeast Asian Nations, PRC = People’s Republic of China, GMS = Greater Mekong Subregion, Lao PDR = Lao People’s Democratic Republic, RETA = regional technical assistance, SEA = Strategic Environmental Assessment, TA = technical assistance.

^a Reflects project codes in the Vientiane Plan of Action (VPOA).

Source: ADB (2008c).

Several of the projects identified as “ongoing” have slipped from their original schedule. Work on energy efficiency, clean fuels, and renewable energy only began in November 2011. Work on the promotion of environmentally sustainable power trade has also only just begun; the inception report was presented to the RPTCC in May 2012.

Of the projects listed in Group 2 of the Vientiane Plan of Action (VPOA), many related to biomass, renewable energy, and energy efficiency have been incorporated either into RETA 7679 “GMS: Promoting RE, Clean Fuels (CF) and EE in the GMS” that has recently begun, or into the proposed project created by merging the two earlier projects: “Promoting Low-Carbon/Climate-Resilient Economies in the GMS” with “Climate-Friendly Bioenergy” for 2014. The merged project is now rescheduled to begin in 2014.

There are many other activities in this group where little or no progress has been made, including projects on (i) energy-efficient transport, (ii) electric cars, (iii) public awareness, (iv) training needs analysis, (v) accreditation of energy managers, (vi) stockpiling and strategic reserves, (vii) nuclear energy, (viii) promoting the TAGP, (ix) sharing of experience in the regulation of oil and gas, (x) safety of oil pipelines (xi) clean coal generation, (xii) coal liquefaction, (xiii) and carbon capture and storage (CCS). The list is consistent with the motivation behind the creation of the GMS Subregional Energy Forum (SEF), which was to oversee the expansion of cooperation to other energy subsectors as requested by the GMS countries. Despite this apparent coherence with the rationale of the SEF, many of the activities proposed beyond the power sector have not been followed up. In part this is because the limited resources of time and money do not permit coverage of the entire range of issues across the energy sector. In part it may also be that the SEF, at its first meeting in Bangkok in December 2004, began the construction of an expanded Energy Sector Road Map that to some extent took precedence over the VPOA in the wider field.

Regional Power Trade Development: Building Capacity

Table 23 lists the activities of the VPOA in the strategic thrust 2, with a note of outcomes and comments on implementation and follow up. All activities within the VPOA that were scheduled for ongoing or for immediate implementation have been completed within the period of the plan. The activity of the Regional Power Trade Coordination and Development was undertaken within RETA 6304 and was in most part successful. The completion report notes that implementation of the initial Regional Power Trade Agreement was not fully achieved, partly because of a lack of firm government agreement, and partly because of the impact of the financial crisis in 2007–2009 on investments in generation and transmission. The sustainability of the capacity building of the institutions created to coordinate and develop the Regional Power Trade Agreement was limited by the transitional character of these groups and lack of a permanent institution dedicated to work with the regional power trade.

The activities in the Facilitating Regional Power Trading and Environmentally Sustainable Development of Electricity Infrastructure in the Greater Mekong Subregion was implemented under RETA 6440. The project met its objectives: (i) the road map for regional power integration was updated, (ii) a methodology for evaluating benefits from cross-border trading was prepared but is not yet in use, (iii) a proposal to establish a regional coordination center (RCC) to manage regional power trade was agreed, and (iv) a regional power system database was established.

Although the activities of the VPOA have been successfully achieved within this strategic thrust, it is questionable how far they have taken the GMS countries along the road to a competitive, modern power system fully integrated and serving to support the competitiveness of the economy at large; enhanced access to energy among poorer communities; and improved the quality, reliability, and security of the energy supply in the GMS. An assessment of progress by a consulting team engaged

Table 23 Building Capacity for Operation, Coordination, and Grid Interconnection

Project Code ^a	Project	Status/Outputs	Remarks
Group 1: Projects that are ongoing or for immediate implementation			
41	GMS: Regional Power Trade Coordination and Development (All GMS countries)	Completed under RETA 6304. Final report presented to RPTCC-7 in Ho Chi Minh City on 20 November 2008. Many of the issues were elaborated in the subsequent RETA 6440.	Outputs: Action Plan on Regional Power Trade Development; Concepts for Institutions to Coordinate and Develop Regional Power Trade; Capacity Building; Platform or Database for Information Exchange and Communication. Funded by the Agence Française de Développement (AFD).
42	Establishment of Regional Power Database and Website (All GMS countries)	Completed. This was first accomplished under RETA 6304 and the PRC accepted to host the database, but as acknowledged in the completion report of ADB, it never became operational. A second database was constructed under RETA 6440 (see below).	
43	Facilitating Regional Power Trading and Environmentally Sustainable Development of Electricity Infrastructure in the GMS (All GMS countries)	Completed under RETA 6440. A regional power master plan was updated in July 2010 and discussed at the PWG/FG/RPTCC-9 meeting in Shenzhen in October 2010. The road map for regional power integration was updated, a methodology for evaluating benefits from cross-border trading was prepared but is not yet in use, proposal to establish a regional coordination center (RCC) to manage regional power trade was agreed, and regional power system database established.	Funded by the Swedish International Development Cooperation Agency (SIDA), details of the location, structure, governance, powers, and duties of the RPTCC are still under discussion. In addition to the intended outputs, terms of reference (TORs) for two working groups on (i) regulation and (ii) performance standards and grid codes were prepared.
Group 2: Projects for later implementation			
44	Facilitating Regional Power Trading and Environmentally Sustainable Development of Electricity Infrastructure in the GMS, Phase 2	Pending. This is a standby project for 2014 in the RCOBP for the GMS, 2012–2014.	

PRC = People's Republic of China, FG = focal group, GMS = Greater Mekong Subregion, PWG = Planning Working Group, RCOBP = Regional Cooperation Operations Business Plan, RETA = regional technical assistance, RPTCC = Regional Power Trade Coordination Committee.

^a Reflects project codes in the Vientiane Plan of Action (VPOA).

Source: ADB (2008c).

on behalf of Swedish International Development Cooperation Agency (SIDA), concluded that so far, the activities undertaken within the Regional Power Trade Coordination Committee (RPTCC) have not adequately laid out the concrete tasks that need to take place, both domestically and regionally, in order for a regional power market to be developed (SIDA 2011). This issue is discussed elsewhere in this paper in more detail.

Implementing Key Interconnection Projects

Table 24 lists the activities specified in the VPOA. Implementation of key interconnection projects has not been met as originally planned. Only two projects have been completed, although the 220 kV link between Kampot and Sihanoukville is nearly finished and should be completed by the end of the plan period. Projects have been constantly rescheduled. A loan for the Nabong 500 kV

Table 24 Implementing Key Interconnection Projects for Stage 1 Power Trading

Project Code ^a	Project	Status/Outputs	Remarks
Group 1: Projects that are ongoing or for immediate implementation			
46	GMS Nabong–Udon Thani Power Transmission and Interconnection <i>(Lao PDR and Thailand)</i>	Pending. A loan for the Nabong 500 kV Substation and Transmission Facility Project was originally scheduled for 2008, but deferred in 2009 to 2012 as a consequence of delays in the associated generation projects. It was dropped in the RCOBP for 2011–2013, but reintroduced in the RCOBP for 2012–2014 as a firm project for 2012. Board approval for the loan is expected in February 2013.	This is a first step to establishing a national EHV transmission network. The line is for exporting about 2,000 megawatts (MW) from four HPPs in the Lao PDR: Nam Ngum 2, Nam Ngum 3, Nam Ngiep 1, and Nam Theun 1. Nam Ngum 2 is operational, Nam Ngum 3 is under final negotiations, and Nam Ngiep 1 is also being negotiated. A preparatory study under an ADB technical assistance proposed a 100% EDL-owned special purpose vehicle (SPV) to act as a TSO and collect use-of-system charges from the owners of the hydro plants. This would be an important innovation.
47	GMS 500 kV Lao PDR–Viet Nam Interconnection (Ban Sok–Pleiku) <i>(Lao PDR and Viet Nam)</i>	Pending. The Lao PDR–Viet Nam Power Interconnection Project was originally in the pipeline as a firm project for 2010, then rescheduled to 2012, then moved to 2013 in the RCOBP for 2012–2014. Board approval for the loan is expected by March 2013.	Project preparation was undertaken under RETA 6481: Preparing the Ban Sok–Pleiku Power Transmission Project in the GMS; it included recommendations for cost recovery through payment of wheeling charges to EDL.
48	GMS Northern Power Transmission <i>(Lao PDR)</i>	Ongoing. Originally programmed for 2009 then rescheduled to 2010. Recently implemented; bid documents for engineering, procurement, and construction are expected by mid-2012.	The PPTA was approved in July 2006 and completed in July 2008. It covers rural electrification and a 115 kV transmission line from Paklay to the Lao PDR–Thailand border near Kenthao for interconnection with EGAT. It is intended to stimulate trade based on seasonal availability of hydropower.
49	GMS Northern Power Transmission II (replaced by GMS East–West Corridor Power Transmission) <i>(Lao PDR)</i>	Proposed. Loan was first scheduled for 2012; in the lending program for 2011–2013, it was replaced by the GMS East–West Corridor Power Transmission for 2012, and that project was dropped from the pipeline in the RCOBP for 2012–2014.	Originally intended to extend the 115 kV transmission across the northern provinces and to contribute to rural electrification and promote trade with Thailand.
50	Viet Nam–PRC (Yunnan) 500 kV Power Interconnection <i>(PRC and Viet Nam)</i>	Proposed. This interconnection is under discussion between SCP and EVN and has been on that status for some time. No intended loan or technical assistance has ever appeared in the ADB pipeline.	
51	Cambodia: GMS Power Trade Project <i>(Cambodia)</i>	Dropped. Funded by the World Bank. The project was intended to construct 115 kV transmissions from Viet Nam–Border to Kampong Cham and from the Lao PDR–Border to Stung Treng. The Government of Cambodia requested full cancellation of the grant on 4 October 2011.	The objective of the GMS Power Trade Projects of the World Bank is to enhance power trade and bring affordable grid-based electricity to selected provinces in Cambodia through import of power from the Lao PDR and Viet Nam. It operates over the three countries.
52	Transmission Line–220 kV Link between Takeo and Kampot <i>(Cambodia)</i>	Completed. The line appears to have been completed in 2011.	EDC received financing from the KfW, Germany via on-lending through the Ministry of Economy and Finance of the Government of Cambodia.

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Table 24 continued

Project Code ^a	Project	Status/Outputs	Remarks
53	Transmission Line—220 kV Link between Kampot and Sihanoukville (Cambodia)	Ongoing. Funded by ADB under the Second Power Transmission and Distribution Project. The 230 kV transmission line and substations will be completed by the end of 2012.	The link will allow EDC to import lower-cost electricity from Viet Nam to meet demand in Phnom Penh, Takeo, Kampot, and Sihanoukville. Medium- and low-voltage distribution systems are established along the 230 kV transmission corridor.
54	Lao PDR: GMS Power Trade Project (Lao PDR)	Partially completed. The cross-border transmission component was truncated by Cambodia's withdrawal (see Activity 51). The dispatch center was cancelled as the Government of Lao PDR found alternative funding.	See note under Activity 51.
55	Study on the Lao PDR—Cambodia—Viet Nam Power Interconnection and Transmission Improvement (Cambodia, Lao PDR, and Viet Nam)	Partially satisfied by RETA 6440. An updated master plan was developed with a conceptual design for a GMS transmission system, including broad specifications of links between countries.	
56	Shweli 1—Yunnan Interconnection (PRC and Myanmar)	Completed. In April 2009, the Yunnan Power Grid (a subsidiary of CSG) commissioned the link from Yunnan to Shweli.	85% of electricity from Shweli 1 is exported to the PRC.
Group 2: Projects with no definite timeline			
57	PRC—Thailand Power Transmission through the Lao PDR (PRC, Lao PDR, and Thailand)	Pending. A 500 kV HVDC transmission line with 3,000 MW capacity that would link the Jinghong and Nuozhadu hydro projects in the Yunnan Province, PRC to Thailand has been discussed; there is some indication that a feasibility study may restart soon.	
58	Nam Mo—Ban Mai Interconnection Project (including possible extension) (Lao PDR and Viet Nam)	Pending. The project is still under negotiation between the Lao PDR and Viet Nam. It involves a 230 kV line to transfer power from Nam Mo hydropower in the Lao PDR to Northern Viet Nam. The project was included in the original GMS Indicative Master Plan for 2004–2007.	

ADB = Asian Development Bank, PRC = People's Republic of China, CSG = China Southern Power Grid, EDC = Electricite du Cambodge, EDL = Electricite du Laos, EGAT = Electricity Generating Authority of Thailand, EHV = extra high voltage, EVN = Electricity of Vietnam, GMS = Greater Mekong Subregion, HPP = hydropower plant, HVDC = high-voltage direct current, KfW = Kreditanstalt für Wiederaufbau, kV = kilovolt, Lao PDR = Lao People's Democratic Republic, PPTA = preparatory technical assistance, RCOBP = Regional Cooperation Operations Business Plan, RETA = regional technical assistance, TSO = transmission system operator.

^a Reflects project codes in the Vientiane Plan of Action (VPOA).

Source: ADB (2008c).

Substation and Transmission Facility Project was originally scheduled for 2008, deferred twice, dropped, and now is expected to be approved in 2013. It is a somewhat similar story for the 500 kV Lao PDR–Viet Nam Interconnection (Ban Sok–Pleiku). The impact of the World Bank GMS Power Trade Project has been restricted by the withdrawal of Cambodia. The rescheduling of transmission projects appear to be occasioned by the unpredictable nature of the generation projects that have been delayed by the withdrawal of developers and sometimes by local opposition—as discussed in the next section.

This relatively unsatisfactory outcome does not give a full picture of the buildup of transmission across the region. Other cross-border transmission lines that were not included in the plan have been built. ADB brought to fruition an innovative build–operate–transfer (BOT) project for power transmission from Thailand to Cambodia to meet demand in the Siem Reap area. Cross-border power lines associated with specific export projects have also been constructed including the 500 kV transmission from Nam Theun 2 to Roi Et, completed in 2009; the 500 kV line from Nam Ngum 2 to Udon Thani, completed in 2010; and the 230 kV line from the Theun Hinboun extension to Nakhon Phanom, completed in 2012.

A limitation on the impact of these lines associated with specific export projects was noted by the SIDA review team. Transmission lines that go across borders to a single plant do not improve regional connectivity; it is simply a means by which the importing country moves its grid into the territory of the exporter. Another difficulty posed by the construction of dedicated export projects is that the generation is tied up in power purchase agreements (PPAs) for 20–30 years and, therefore, actually impedes the transition to a competitive and liberalized market.

Some of the transmission projects within the VPOA are designed simultaneously not only to support trade but also to enhance axis to energy along the transmission corridor. This is important because the benefits to the people living in the vicinity of high-voltage transmission lines are limited if associated local electrification projects are not implemented in parallel. It is disappointing that the GMS Northern Power Transmission project, which was of this type, was implemented some 2–3 years late and the GMS East–West Corridor Power Transmission project that replaced the GMS Northern Power Transmission II appears to have been dropped entirely from the plan.

Developing Generation Projects for Power Exports under Stage 1

Table 25 lists the activities that were included within the VPOA along with a note of the status and remarks concerning implementation and follow up. The performance is similar to that noted for transmission projects, not surprisingly because the two aspects are closely related. Only two projects have been completed during the period. Nam Ngum 2 (Lao PDR) 615 MW HPP has been operating since the autumn of 2010 and Jinghong HPP on the mainstream of the Mekong was completed in 2009. Some other projects have had complex histories. Xe Kaman 1 was originally negotiated by the Government of Tasmania’s Hydro Electric Commission in 1997, but then passed on at privatization to a company called Anstran, based in Malaysia. It was cancelled in 2005 and a new memorandum of understanding (MOU) was signed with South East Asia Energy Limited; completion is now expected by 2013. The site at Nam Ngiep was first identified in the 1990s; an MOU was signed with a US company, but cancelled in 1996. A feasibility study was then financed by the Japan International Cooperation Agency (JICA). The consultant that performed the feasibility study then took on the project proper, but later withdrew from the consortium that was changed again subsequently; the plant is now expected by 2018.

Projects are negotiated each in a unique way, without any adherence to a long-term plan or direction from fundamental principles in published guidelines. The main ordering principle seems to derive from the planning of the importing countries, which through their subsidiaries or national companies, place certain plants within their long-term planning and then work to see that they are duly constructed in time. Even this is not entirely a guarantee, as demonstrated in the case of Nam Theun 1, where Electricity Generating Public Co. Ltd. of Thailand (EGCO) led the consortium and signed a PPA with the Electricity Generating Authority of Thailand (EGAT), but the project still fell through. This unstructured approach may be manageable for the importers, but it is unlikely to deliver an economically, socially, and environmentally optimal solution for the host country. These issues are discussed in more detail elsewhere within this paper.

Table 25 Developing Generation Projects for Power Exports under Stage 1

Project Code ^a	Project	Status/Outputs	Remarks
Group 1: Projects that are ongoing or for immediate implementation			
59	Xe Kaman 1 (Lao PDR) 290 MW Hydropower Project <i>(Lao PDR and Viet Nam)</i>	Ongoing. Comprises two power plants—the 290 MW Xekaman 1 and the 32 MW Xekaman Xanxay. Of the power, 80% will be exported to Viet Nam; 20% will go to Lao PDR. MOU for FS signed in 2006; a 30-year project concession agreement signed in February 2011; completion is expected in 2015.	Xekaman 1 Power Company is wholly owned by Viet–Lao Power Investment and Development Joint Stock Company. (VLPC). Shareholders of VLPC are all Vietnamese entities including EVN (10%), Song Da Corporation (60%), and other Vietnamese construction companies. A concession agreement was originally signed in November 1997 with Anscan International, Ltd. based in Malaysia and cancelled in 2005.
60	Nam Ngum 2 (Lao PDR) 615 MW Hydropower Project <i>(Lao PDR and Thailand)</i>	Completed. The project reached financial closure in 2006 and initial operation began in 2010. Commercial operation is expected in March 2013.	Nam Ngum 2 Power Company is owned 75% by South East Asia Energy Limited and 25% by EDL.
61	Nam Ngum 3 (Lao PDR) 440 MW Hydropower Project <i>(Lao PDR and Thailand)</i>	Ongoing. The plant will be developed under a 27-year concession agreement with the Government of the Lao PDR and will sell exclusively to EGAT. It is expected to be completed in 2017.	Nam Ngum 3 Power Company is owned by: GMS Lao Company Limited (27%), Ratchaburi Electricity Generating Holding Public Limited Company (25%), Axia Power Holdings B.V. (25%), and Lao Holding State Enterprise (23%).
62	Xe Kaman 3 (Lao PDR) 250 MW Hydropower Project <i>(Lao PDR and Viet Nam)</i>	Ongoing. The VLPC began work on the project in 2006. It is structured as a 30-year BOT. VLPC contributed 100% of the capital and the Government of the Lao PDR will buy back 15% on completion, expected in 2012.	Shareholders of VLPC are all Vietnamese entities including EVN (10%), Song Da Corporation (60%), and other Vietnamese construction companies.
63	Jinghong (PRC) Hydropower Project <i>(PRC, Thailand, and Viet Nam)</i>	Completed. The Jinghong Hydropower on the mainstream of the Mekong (Lancang) began construction in July 2003 and was completed in 2009. It has a capacity of 1,750 MW.	Originally conceived in part for export to Thailand, but the rapid growth in demand from Guangdong preempted the output. Any future sale of power to Thailand will not be from a power plant, but from the Southern Power Grid Company.
64	Nam Ngiep 1 (Lao PDR) 261 MW Hydropower Project <i>(Lao PDR and Thailand)</i>	Pending. The developers and EGAT have agreed on a tariff MOU. PPA, construction contract, and loan agreement are being negotiated. Construction may begin in 2012; COD is expected in 2018. EGAT will take 370 MW; EDL will take 40 MW.	The site was identified in the 1990s; an MOU was signed with a US company, but cancelled in 1996. A feasibility study was then financed by JICA. Shareholders are KANSAI (45%), EGATi (30%), and LHSE (25%).
65	Theun Hinboun Expansion (Lao PDR) 280 MW (220 MW downstream + 60 MW upstream) Hydropower Project <i>(Lao PDR and Thailand)</i>	Ongoing. The project includes an upstream 60 MW HPP on the Nam Gnouang River; 230 MW expansion of the existing HPP downstream. Output from the downstream power plant will be sold to EGAT and from the upstream powerhouse to EDL. Completion is expected by 2012.	Shareholders of the Theun Hinboun Power Company include Electricite du Laos (EDL) at 60%, Statkraft SF at 20%, and GMS Lao Company Limited at 20%.

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Table 25 continued

Project Code ^a	Project	Status/Outputs	Remarks
Group 2: Projects for later implementation			
66	Xe Pian–Xenamnoy (Lao PDR) 390 MW Hydropower Project (Lao PDR and Thailand)	Pending. A tariff MOU was signed in August 2009; the BOT concession is for 27 years. EGAT will take 370 MW and EDL, 40 MW. Financial closure is expected at the end of 2012 and completion is expected in 2018.	The joint operating company is owned by Ratchaburi Electricity Generating Holding Plc (25%), the Republic of Korea-based SK Engineering and Construction (26%), Korea Western Power (25%), and Lao Holding State Enterprise (24%).
67	Lower Se San 1 (Cambodia) 90 MW Hydropower Project (Cambodia and Viet Nam)	Pending. In 2007, EVN signed an MOU for a feasibility study and EIA of Lower Sesan 1 and Lower Sesan 2 dams. In January 2011, the MPI in Viet Nam licensed EVN to invest. The Lower Se San 2 project appears to have priority for the developer, but has met considerable opposition.	The project is implemented by the Cambodia–Vietnam Hydropower Company, a joint company of EVN International—a subsidiary of Electricity of Vietnam—which holds 51% and the Royal Group of Cambodia, with 49%.
68	Nam Theun 1 (Lao PDR) 523 MW Hydropower Project (Lao PDR and Thailand)	Pending. A tariff MOU with EGAT was signed in December 2006 by a consortium led by EGCO and Gamuda; a 27-year PPA was signed and the EPC contract awarded, but the arrangements failed. In March 2012, a new MOU was signed by Phonesack Group for a feasibility study.	The participants in the original consortium were Lao Holding State Enterprise (LHSE) with 20%, Gamuda (Malaysia) with 40%, and EGCO (Thailand) with 40%. Phonesack is a wholly Lao PDR-owned group.
Group 3: Projects with no definite timeline			
69	Xe Kong 4 (Lao PDR) 300 MW Hydropower Project (Lao PDR and Thailand)	Pending. A project development agreement was signed in June 2008. A tariff agreement was signed with EDL in 2010 for 10% of the output; an agreement with EGAT for the rest is under negotiation. A draft concession agreement has been prepared.	The main developer is Region Oil (a Russian Federation company) through a wholly owned subsidiary Region Hydro Power Stations Lao Co Ltd. (80%); LHSE has 20%. Korea Western Power Co., Ltd. has also reportedly expressed interest in joining the consortium.
70	Lower Se San 2 (Cambodia) 420 MW Hydropower Project (Cambodia and Viet Nam)	Pending. In 2007, EVN signed an MOU for a feasibility study and an EIA of Lower Sesan 1 and Lower Sesan 2 dams. In January 2011, the MPI in Viet Nam licensed EVN to invest. The Lower Se San 2 project appears to have priority for the developer, but has met considerable opposition.	The project is implemented by the Cambodia–Vietnam Hydropower Company, a joint company of EVN International—a subsidiary of Electricity of Vietnam—which holds 51% and the Royal Group of Cambodia, with 49%.
71	Nam Kong 1 (Lao PDR) 75 MW Hydropower Project (Lao PDR and Thailand)	Pending. A project development agreement was signed in June 2008. A tariff agreement was signed with EDL in 2010 for 10% of the output; an agreement with EGAT for the rest is under negotiation. A draft concession agreement has been prepared.	The main developer is Region Oil (a Russian Federation company) through a wholly owned subsidiary Region Hydro Power Stations Lao Co Ltd. (80%); LHSE has 20%; Korea Western Power Co. has reportedly shown interest to join the consortium.

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Table 25 continued

Project Code ^a	Project	Status/Outputs	Remarks
72	Xe Kong 5 (Lao PDR) 330 MW Hydropower Project (Lao PDR and Thailand)	Pending. A project development agreement was signed on June 2009. A tariff agreement was signed with EDL in 2010 for 10% of the output; an agreement with EGAT for the rest is under negotiation. A draft concession agreement has been prepared.	The main developer is Region Oil (a Russian Federation company) through a wholly owned subsidiary Region Hydro Power Stations Lao Co Ltd (80%); LHSE has 20%; Korea Western Power Co. has reportedly shown interest to join the consortium.
73	Nam Mo (Lao PDR) 105 MW Hydropower Project (Lao PDR and Viet Nam)	Pending. Electricity International Joint Stock Company signed an MOU for a feasibility study in March 2010 that should be completed by the end of 2012.	The Government of the Lao PDR reportedly has selected the Vietnam–Laos Economic Cooperation Corporation as the main investor in the Nam Mo hydroelectric power projects.

BOT = build–operate–transfer, PRC = People's Republic of China, COD = commercial operation date, EDL = Electricite du Laos, EGAT = Electricity Generating Authority of Thailand, EGCO = Electricity Generating Public Co. Ltd., EIA = Energy Information Administration, EPC = engineering procurement and construction, EVN = Electricity of Vietnam, FS = feasibility study, GMS = Greater Mekong Subregion, JICA = Japan International Cooperation Agency, Lao PDR = Lao People's Democratic Republic, LHSE = Lao Holding State Enterprise, MOU = memorandum of understanding, MPI = Ministry of Planning and Investment, MW = megawatt, PPA = power purchase agreement, VLPC = Viet–Lao Power Investment and Development Joint Stock Company.

^a Reflects project codes in the Vientiane Plan of Action (VPOA).

Source: ADB (2008c).

Overall Assessment of the Vientiane Plan of Action

A wide range of activities were initially proposed that were not followed up. There is a natural tendency to seek to solve all problems, but there has to be selection of issues where the GMS institutions can make an impact and there have to be clear criteria for making that choice. This stringency does not seem to have been applied and, to some extent, the same diffuse approach is visible in the Road Map for Expanded Energy Cooperation discussed in the next section.

The activities of the Vientiane Plan of Action (VPOA) concerned with building the capacity for regional power trade have been formally completed, but there is some doubt over the effectiveness as a consequence of the changing representation within the RPTCC; this difficulty will be relieved by the creation of the RPCC that should have a more stable staffing.

The implementation of the key infrastructure projects has been repeatedly delayed because of delays and cancellation of the supporting generating plant. The origin of the delays varies from case to case, but can include (i) the failure of the developer to find finance, (ii) a decision by the importing country that the project was not needed or should be delayed, and (iii) opposition from local people affected by the development.

It may be that concessional finance from ADB is better employed at strengthening national networks than in funding connections to specific investments that are likely fundable by the developer and whose timing is beyond the control of ADB and the government. Technical assistance from ADB to support activities that would help implement more rational guidelines for developing cross-border power projects is also a priority.

The Road Map for Expanded Energy Cooperation

Achievements

Following a request from the Greater Mekong Subregion (GMS) countries to seek to extend the scope of cooperation in the energy sector, the Subregional Energy Forum (SEF) was created to prepare and oversee such a program; it met for the first time in Bangkok in December 2004. With some technical assistance from ADB, a Road Map for Expanded Energy Cooperation was prepared and presented to the SEF-2 in Ho Chi Minh City in November 2008, then on the basis of comments received from countries, it was finalized at a special SEF meeting in Bangkok in March 2009 and subsequently endorsed at the 15th GMS Ministerial Meeting held in Thailand in June 2009.

The road map identifies four main strategic objectives that were later subsumed into the GMS Strategic Framework as the objectives of the expanded cooperation in the energy sector up to 2022, as follows:

- Enhance access to energy for all sectors and communities, particularly the poor in the GMS, through promotion of best energy practices in the subregion;
- Develop and utilize more efficiently indigenous, low carbon, and renewable resources, while reducing the subregion's dependence on imported fossil fuels;
- Improve energy supply security through cross-border trade while optimizing the use of subregional energy resources; and
- Promote public-private partnership (PPP) and private sector participation, particularly through small and medium enterprises (SMEs) for subregional energy development.

The work plan for 2009–2015 contained within the road map is ambitious and wide-ranging. It has the following components:

New and Renewable Energy Sources

- Enhancing the policy and institutional framework for the development, financing, and private investment in new and renewable energy (NRE).
- Promoting the utilization of biofuels and biomass.
- Strengthening of information networking, particularly in GMS-appropriate NRE technology.

Energy Efficiency and Conservation

- Promoting information sharing and/or dissemination and networking of best practices in the GMS context.
- Expanding private sector involvement through enhanced energy management in industrial and commercial sectors.
- Promoting energy efficiency (EE) in the transport sector.
- Expanding financing for EE initiatives.

Regional Energy Planning, Policy, and Program Coordination

- Strengthening the energy policy and planning; and program management, coordination, and networking in the GMS (including oil stockpiling and nuclear energy).
- Ensuring sustainable financing and support for initiatives under the road map for expanded GMS energy cooperation.

Power

- Establishing the policy and regulatory framework for power trade in the GMS (including building capacity for power trade operation, coordination, and grid interconnections).
- Developing the grid interconnection infrastructure and power generation projects for export (long list of priority interconnections).
- Expanding power coverage to all (rural electrification).
- Promoting environmentally sustainable development of electricity infrastructure.

Oil and Gas

- Supporting the realization of GMS segments of the Trans-ASEAN Gas Pipeline (TAGP).
- Promoting the development of oil and natural gas logistics and network in the GMS.
- Mitigation of environmental risks in construction and/or operation of pipelines.

Coal

- Promotion of energy efficiency, clean coal technologies, and reducing carbon emissions from coal plants.
- Strengthening of policy and institutional framework to enhance GMS trade and private investments in the coal subsector.

Arrangements for implementing the road map are specified. A GMS member country will assume the “lead” role in the development of specific projects included in the road map and will be responsible for formulating the assigned project, and coordinating with development partners for financing and technical support and project management. The Subregional Energy Forum (SEF) meeting at least once a year, will monitor the progress of the road map and serve as the vehicle for information sharing in GMS energy cooperation.

At the SEF-4 meeting in Shenzhen in October 2010, ADB presented the RETA 7679: Promoting Renewable Energy, Clean Fuels and Energy Efficiency in the GMS, cofinanced by the Asian Clean Energy Fund and Multi-Donor Clean Energy Fund under the Clean Energy Financing Partnership Facility, which constituted the first substantial step in the accomplishment of the road map. The technical assistance is to be implemented under the auspices of the SEF, and the SEF will be the vehicle for disseminating knowledge and experiences that are accumulated through the project.

The aims of the technical assistance are as follows:

- To strengthen the SEF as a forum for networking among partners and with the private sector on renewable energy, clean fuels, and energy efficiency.
- To establish a regional database of best practices and technologies on renewable energy, clean fuels, and energy efficiency.
- To create subregional performance targets for the use of renewable energy and clean fuels, and energy efficiency savings.
- To create renewable energy and clean fuels resources, and energy efficiency potential map for all GMS countries, with a technology- and cost-based ranking of various options.
- To construct business models for the deployment of selected energy efficiency, renewable energy, and clean fuels technologies based on local conditions, and at least five pilot project proposals identified for financing by ADB and other financing agencies.

The Inception Report of RETA 7679 was presented to SEF-5 in Ho Chi Minh City in November 2011. The Inception Report of RETA 7764 on Ensuring Sustainability of Greater Mekong Subregion

Table 26 Examples of a Greater Mekong Subregion-Level Value Added

Topic	Justification of a Subregional Approach
Creation of a subregional power market by developing all of its requisite aspects.	Common vision, rules, protocols, and subregional institutions are indispensable for a subregional market. This should include also a shared vision of infrastructure development.
Benchmarking and upgrading of national capacity for power system planning and procurement	A regional market can only be developed and sustained if it is widely recognized to bring national benefit. A prerequisite for this is that all countries have adequate capacity to plan and control national development.
Energy efficiency	There is considerable scope for benchmarking, a good degree of cultural homogeneity, and practice.
Renewable energy	Same as above.
Biofuels	Same as above. There is also a strong case for pilot plant development of second-generation technologies, and costs and risks can be pooled.
Clean coal (maybe)	Normally this might be better done at the ASEAN level, but the presence of the People's Republic of China in the Greater Mekong Subregion may create added value.
Energy policy capacity building	It is necessary for regional planners to have a regional strategy based on good evidence; this is not at present produced on a regular basis.
Social and environmental analysis	The benchmarking and cultural arguments apply, but there is also a need for common environmental rules to avoid unfair competition on the market and many important assets are held in common (river basins) and need common treatment.

Source: Author.

Regional Power Development was also discussed during this meeting, but within the framework of the Regional Power Trade Coordination Committee (RPTCC).

Assessment

The idea of extending cooperation among GMS countries to a wider spectrum of energy activities has merit; any regional project needs a representative regional steering group and the SEF can provide that function along with potentially a degree of institutional stability and memory. In each case, it is necessary to be clear about what is the particular added value of conducting the activity at the level of the GMS rather than at national level or at the Association of Southeast Asian Nations (ASEAN) level. This condition is required by the GMS Strategic Framework, as discussed below.

It is not apparent that the Extended Road Map conforms to this condition. There is no evident added value in addressing oil-related issues in the GMS. Oil is an international business; there is a quite satisfactory working arrangement within ASEAN around the ASEAN Council on Petroleum (ASCOPE) and it is difficult to see what the GMS countries can do better. It is also not clear what value the SEF can add in terms of promoting unrealized sections of the TAGP; the construction of pipeline segments will be determined by gas discoveries and commercial negotiations among national oil companies. There may be some aspects of the TAGP that do bear on energy policy within the GMS—the possibilities are analyzed later—but even then, it may be more appropriate for the GMS countries that are also a part of ASEAN to promote such projects within the ASEAN framework. Other areas where the added value from GMS level projects needs to be better justified are energy efficiency in transport (that seems more appropriate at the ASEAN level and in all economic corridors), and nuclear safety.

The principal areas that seem suitable for GMS-level analysis are given in Table 26, with reasons as to why they merit the subregional approach.

The practicality of the arrangements to implement the program may also need to be reviewed. The financing arrangements are unconvincing. They are consistent with the recommendation of

the mid-term review of the previous strategic framework of the GMS that member states take on more responsibilities (ADB 2007), but they seem unlikely to work. It seems unlikely that any country will be able to find funding for any of these projects as they are too vague. Also, it seems unlikely that a country in dialogue with a potential donor will promote a regional project before national projects.

It is also doubtful that the program can be satisfactorily managed under the arrangements foreseen. Project management is a complex business and needs continuity that the proposed arrangements are unlikely to provide; it will always be a low priority in the agenda of the national host institution and likely to be passed from one project officer to the next with no continuity and little commitment. Furthermore, by outsourcing to the countries, all the synergies of managing the projects will be lost—accounting, monitoring, and reporting.

Lastly, the actions listed in the work plan cannot be monitored in their present form because there are no objectively verifiable indicators of success.

These doubts over the implementation of the work plan receive some support from the observation that the only perceptible success of the road map at this half-way stage is the conduct of the largely standard regional technical assistance (RETA) on energy efficiency, renewable energy, and biofuels, in which there is only the minor institutional novelty that the SEF serves essentially as a steering group.

There are strong arguments in favor of focused cooperation in energy under the auspices of the SEF, but it does not seem to be working at the moment and there are persuasive structural reasons why this is so. The issue is discussed in more detail in the concluding sections of this report with some suggestions for change.

Road Map for Implementing the Greater Mekong Subregion Cross-Border Power Trading

The memorandum of understanding (MOU) on the Road Map for Implementing the GMS Cross-Border Power Trading was prepared and signed in March 2008 by the GMS Ministers of Energy; it covers the period from 2008 to 2012—the time required to implement Stage 1 of regional power trading and to prepare for Stage 2. Seven milestones are identified and a set of activities are specified along with dates by which they should be completed. After discussion within the 7th RPTCC meeting, the TOR of RETA 6440, that had been developed prior to the signing of MOU-2, were slightly modified to match the requirements of the road map. Table 27 reproduces the road map, along with a commentary on the extent to which the expectations were met, largely by RETA 6440.

Based on the achievement of RETA 6440, the consultants proposed an amended road map wherein the completed studies would be adopted and the remaining issues treated through new work. Outstanding topics include the following:

- Complete the Performance Standards with coordinated in-depth network studies (transient stability studies).
- Complete the study on power trade rules, including resolution mechanisms for disputes.
- Complete the study on a GMS Grid Code.
- Implementation of Prerequisites for the GMS Market (price reform, synchronous operation where feasible, and transformation of PPAs to contracts for differences (CFDs)).

Table 27 Assessment of the Cross-Border Power Trade Road Map

Activities	Schedule	Comment
Timelines to fully achieve Stage 1		
Milestone 1: Complete the Indicative Power Interconnection Master Plan and select priority new interconnection projects for undertaking feasibility studies		
Complete the GMS Indicative Master Plan for power development	2008	An Indicative Master Plan was delivered by RETA 6304 in 2008. Update of the GMS Indicative Master Plan was completed in RETA 6440. (September 2010)
Select priority interconnection projects identified in the master plan	2009–2010	The updated master plan contains a list of priority projects: <ul style="list-style-type: none"> • Myanmar–PRC • Myanmar–Thailand • Lao PDR North–Thailand • Lao PDR South – Viet Nam South (through Viet Nam C) • Lao PDR North–Viet Nam North • Cambodia–Viet Nam South (September 2010)
Develop feasibility studies of selected priority projects.	2009 onward	None appears to be available.
Update the regional indicative master plan	Every 2 to 3 years	Schedule is on track. A new update will be delivered from RETA 7764 incorporating a strategic environmental assessment to address environmental, climate change, and social externalities.
Milestone 2: Complete the study on performance standards		
Complete the study on GMS Performance Standards and consider for adoption the suggested GMS Performance Standards on new regional interconnections and for the synchronized operation of interconnected grids	2010	Partially completed under RETA 6440 (September 2010)
Consider for adoption the proposed transitional arrangements to achieve GMS Performance Standards	2010	Partially completed under RETA 6440 (September 2010)
Milestone 3: Complete the study on transmission regulations		
Complete the study on transmission regulations	2010	Deliverables of RETA 6440 include: <ul style="list-style-type: none"> • Completion of the GMS transmission • Regulations • Assessment of potential for synchronous operation • HVDC vs. DC interconnection
Consider for adoption the findings of the study to coordinate the operation and power flow control in grid-to-grid interconnections synchronization and operation	2010	Awaiting decision of RPTCC
Milestone 4: Complete the study on standard regional metering arrangements and power trade rules		
Complete the study on standard regional metering arrangements and communications system in grid-to-grid interconnection for implementation during Stage 1; consider for adoption the findings of the study	2010	Deliverables of RETA 6440 included a report on metering (September 2010) The findings do not appear to have been adopted by the RPTCC
Complete the study on power trade rules, including resolution mechanisms for disputes outside existing PPAs for implementation during Stage 1; consider for adoption the findings of the study	2010	Not available.

continued on next page

Table 27 continued

Activities	Schedule	Comment
Timelines to prepare for Stage 2		
Milestone 5: Undertake the study to identify the regulatory barriers to the development of power trade and implementation of next stage		
Complete the study to identify the regulatory barriers to development of power trade	2012	Completed within RETA 6440. Deliverables include: <ul style="list-style-type: none"> • Review of GMS Regulatory Framework • Review of international experiences • Conceptual design of the GMS market • Proposed implementation of the conceptual design for the GMS market (September 2010)
Consider for adoption the measures and institutional arrangements to address regulatory barriers	2012	Awaiting decision of RPTCC
Milestone 6: Complete the study on a GMS Grid Code (Operational Procedures)		
Complete the study on a GMS Grid Code and consider for adoption the findings of the study, which include: <ul style="list-style-type: none"> • GMS Performance Standards; • Coordination procedures between System Operators to schedule and control cross-border flows, management of deviations; • Metering and communications; • Sharing of power reserves and support during emergencies 	2010–2012	Not yet available
Milestone 7: Complete the study on Stage 2 Transmission Regulations to allow third-party access, including Stage 2 power trade rules, and dispute resolution mechanisms		
Complete the study on Stage 2 Transmission Regulations	After 2012	Not yet available
Consider for adoption the findings of the study to include development of payment agreements and/or tariffs for third-party use, to compensate countries that host flows linked to third parties' trading	After 2012	Not yet available
Develop and consider for adoption of power trade rules for short-term cross-border trading	After 2012	Not yet available
Develop and consider for adoption power trade rules for settlement of deviations to scheduled power trade in grid-to-grid interconnections	After 2012	Not yet available

PRC = People's Republic of China, DC = direct current, GMS = Greater Mekong Subregion, HVDC = high-voltage direct current, Lao PDR = Lao People's Democratic Republic, PPA = power purchase agreement, RETA = regional technical assistance, RPTCC = Regional Power Trade Coordination Committee.

Source: RTE International (2010a).

The practices and standards proposed by the consultants do not appear to have been adopted by the RPTCC; the SIDA review team expressed the view that this may have been because of a low sense of ownership of the results and that this should be improved by the establishment of the RPCC to which the countries will contribute financially.

Energy Sector Strategy Study

In 2009, ADB published the results of a 3-year study of the energy future of the GMS. The study was supported by a technical assistance grant and was conducted in a very inclusive fashion that

involved close consultation with the GMS countries. The strategy was supported by modeling using the MESSAGE model, in which the energy industries are represented as a reference energy system and investment and operation is optimized using mixed-integer programming (ADB 2009a).

Results of the exercise showed very strong financial and strategic benefits from integration of the energy sectors. Regional cooperation reduces the stream of discounted costs by 19%, or \$200 billion over 2 decades as compared to a non-integrated scenario and will reduce import dependence by 5.5%. Moreover, greenhouse gas (GHG) emissions would grow more slowly. The analysis demonstrates that \$585 billion of investment will be needed during the period if infrastructure availability is not to be a constraint on economic growth. The integration of environmental and social costs into the model indicates that some 11 gigawatts (GW) of off-grid solutions would be cost-effective, out of the 238 GW of new capacity that will be required. The study comes to several more strategic conclusions among which the following are especially relevant to the work of the SEF:

- Improvements in policy regimes and sector reforms are often easier to effect in a regional context and need to be pursued in a time-bound fashion.
- GMS has a high and increasing dependency on oil imports; actions have to be taken to reduce oil use and to find substitutes, such as biofuels.
- Collective action is needed to promote private–public participation and innovative solutions.
- Convergence to a sustainable path will require strategic planning at the level of institutions and energy systems; creating institutional and human capital is perhaps the biggest challenge.

Seven specific priority actions were proposed to strengthen cooperation and to progress toward a better energy future for the GMS. They are as follows:

- Mobilize political will for cooperation in all energy sectors.
- Improve energy efficiency.
- Pursue a time-bound program of sector reform on a GMS-wide basis.
- Reduce oil dependency.
- Review transport modal mix.
- Promote regional private sector participation.
- Create institutional capital and human capability.

These are all important, but the first is of special relevance to the SEF. The measure of success of the SEF will be if it manages to change policy. This will only happen if it can effectively and persuasively lobby at the political level. It is a real challenge and is addressed in the closing sections of this report.

The model used in the study was offered to the GMS countries for maintenance and future use, but no partner was willing to adopt it, which is unfortunate as the human capacity and the extensive database are then lost.

Pertinent International Programs

Post-Kyoto Mechanisms

The Clean Development Mechanism (CDM) was introduced to provide a mechanism by which developing countries could participate in mitigation and also by which the great potential for mitigation in developing countries could be harnessed. The scheme will end in 2012 although projects registered before the end of that year will continue to receive credits. Although the CDM represented an enormous step forward in the attempt to find an equitable procedure for distributing the costs of mitigation, practical problems, especially in the interpretation of baseline conditions and additionality, have limited its effectiveness.

Although the CDM is likely to continue, it may be a less effective source of finance than in the past as the European Union (EU) will revoke the Bridging Directive that was an important support for the carbon price. There is some support for the provision credit for Nationally Appropriate Mitigation Actions (NAMAs), such as specific policies (e.g., energy efficiency standards), investments, or the implementation of new domestic emission trading systems in developing countries. The Cancun Agreements reached under the 16th Session of the Conference of the Parties (COP 16), recognize two types of NAMAs—"unilateral" and "supported." Unilateral NAMAs are voluntary undertakings by developing countries that are cost-effective in their own right and do not require financial support from developed countries—these would be not be subject to rigorous monitoring and reporting, indeed, maybe none at all. Supported NAMAs will require technical cooperation with developed countries and/or financial transfers and would normally be appropriate when the costs of the actions exceed the financial benefits. It is not yet clear whether financial support could be offered through carbon markets or whether it would be confined to conventional financial instruments.

The policy of the EU in this respect is influential as it is the largest buyer by far of Certificates of Emission Reduction. The revised European Emissions Trading System (EU ETS) Directive (Article 11a) will exclude all except least-developed countries from selling CERs on the ETS. For the GMS, only projects in Cambodia, Myanmar, and the Lao PDR will be able to use CDM credits after 2012 on the EU ETS. The ETS may be open to other developing countries through the sectoral crediting mechanism that is intended to reward greenhouse gas (GHG) emission reductions from a specified sector measured against a target level below business-as-usual (BAU) level. The crediting baseline may be expressed as a volume of emissions or as a specific intensity of emissions; if emissions fall below the crediting threshold then CERs would be recorded; no penalties for exceeding the target. Revenues would probably go to the government. The eventual development of these ideas is unclear, but it is important that the GMS be aware of the options and organizes its activities accordingly.

Sustainable Energy for All

In December 2010, the United Nations General Assembly declared 2012 as the International Year of Sustainable Energy for All, recognizing that "... access to modern affordable energy services in developing countries is essential for the achievement of ... the Millennium Development Goals and sustainable development" (UN 2011).

In response, the UN Secretary-General, with support from the UN-Energy and the United Nations Foundation, created a new global initiative—Sustainable Energy for All (SE4A)—to engage governments, the private sector, and civil society partners globally (UN Secretariat 2011). The vision proposes three linked objectives to underpin the goal of achieving sustainable energy for all by 2030, as follows:

- Ensuring universal access to modern energy services.
- Doubling the rate of improvement in energy efficiency.
- Doubling the share of renewable energy in the global energy mix.

Sources of financing—including multilateral institutions, bilateral assistance, national development banks, the private sector, and carbon markets—are insufficient and not well coordinated and small-scale renewable energy and energy efficiency projects can be particularly difficult to finance because of their high transaction costs relative to their size. New business models are needed that are commercially viable and innovative financing mechanisms will be necessary to support them.

At the opening of the Rio+20 UN Conference on Sustainable Development, the UN Secretary-General reported that more private investors have pledged to invest more than \$50 billion to reach the program's goal of doubling renewable energy production and energy efficiency gains while providing all people access to modern electricity services by 2030. Viet Nam was one of the first countries to partner with the initiative and is developing a national energy action plan to support capacity development and innovative financing mechanisms (SE4A 2012).

Environmental and Social Assessment

Mekong River Commission

The Mekong River Commission (MRC) was formed in 1995 from an earlier institution, the Mekong Secretariat, to help the governments of the Lower Mekong Basin (Cambodia, the Lao People's Democratic Republic [Lao PDR], Thailand, and Viet Nam) manage the water and related resources of the basin. One of its functions is to ensure that decision makers have timely and accurate information and as a part of that objective, it publishes occasional State-of-the-Basin Reports. The 2010 report notes the declining catches and smaller average size of fish caught; the reasons for this cannot be conclusively demonstrated but it is possible that the construction of dams, weirs, and other infrastructure; abstraction of water for other uses; clearing of flooded forest; deforestation of catchments; and local pollution all play a role (MRC 2011).

According to the MRC, in 2009, there was 2,612 megawatts (MW) of hydropower capacity installed on lower Mekong tributaries and a further 3,574 MW was under construction. The dams are all located on tributary systems from the mainstream reach in northern Lao PDR to the mainstream reach above Kratie in Cambodia. Some plants are in cascade on the same tributary systems. Viet Nam has developed most of its available tributary hydropower potential in its Mekong subbasins; Thailand has additional development potential on Mekong tributaries, but does not propose at present to pursue it. The main activity is in Cambodia and the Lao PDR, especially the latter. The MRC notes that this rapid pace of development will create cumulative impacts, including impacts on stream-flow, fish passage, water quality, and sediment flow. The cumulative impact need to be assessed and recognized in decision making. Some strategic environment assessments (SEAs) and cumulative impact assessments (CIAs) have been made. A CIA for the basin was prepared for the Government of the Lao PDR as part of the decision-making procedure for Nam Theun 2 in 2005. A pilot SEA is being prepared for the Sesan, Sre Pok, and Sekong (3-S) tributary system shared by Viet Nam, the Lao PDR, and Cambodia to consider the cumulative impacts of the 41 potential dam developments in the 3-S basin.

On the mainstream, there are several dams in the Upper Basin in the People's Republic of China (PRC) and the effects downstream are now discernible in the dry season between Chang Saen in Thailand and Luang Prabang in the Lao PDR. MRC models suggest that the primary impacts on the Lower Mekong Basin (LMB) will be flood flows in the wet season, a shift in the timing of the peak flood, and higher river flows in the dry season. Eleven of the proposed dams in the LMB would span at least part of the mainstream channel. Some of the dams in the Lao PDR would form reservoirs up to 100 kilometers (km) in length within the existing channel and some would also inundate outside the mainstream channel, especially around the tributaries that intersect the reservoirs. The two proposed projects in Cambodia (Stung Treng and Sambor) would inundate land extensively outside the channel.

Strategic Environmental Assessment of Hydropower on the Mekong Mainstream

Responding to the concerns expressed in the State-of-the-Basin Report, the MRC commissioned an SEA of hydropower development on the mainstream of the Mekong. The objective was to identify potential opportunities and risks and to assess alternative mainstream Mekong hydropower development strategies, including the regional distribution of development costs and benefits. The SEA began in 2009 and the final report was submitted in September 2010.

The report concluded that the Lao PDR was likely to be the main recipient of export revenues with many implications for economic growth and the ability to fund development; Viet Nam and Thailand would be the main importers and would benefit from a lower cost supply of electricity. Mainstream projects would have significant net negative impacts on fisheries and agriculture and would widen development gaps as the benefits would be felt mainly by wealthier people connected to electricity grids, and the costs would fall upon poor riparian communities. At the country level, Thailand and the Lao PDR will experience the main benefits while Cambodia and Viet Nam will experience the heaviest costs. For the environment, the projects are likely to result in serious and irreversible damage through losses in long-term health and productivity of natural systems, and losses in biological diversity and ecological integrity.

The SEA team recommended that decisions on mainstream dams should be deferred for a period of 10 years with review every 3 years to ensure that other activities specified in the recommendations were being pursued diligently, including a comprehensive assessment and fast-tracking of tributary projects that the SEA team considered feasible and ecologically sustainable (ICEM 2010).

Expert Monitoring of Nam Thuen 2

From its inception, the Nam Theun 2 (NT2) hydroelectric power project was perceived to carry a range of social and environmental impacts and to trigger the safeguard policies of the World Bank and ADB that are designed to prevent and mitigate undue harm to people and their environment in the development process. Consequently, at the insistence of the international financial institutions (IFIs), the Concession Agreement for Nam Thuen 2 requires expert monitoring. The World Bank is advised by an International Advisory Group (IAG) and the Government of the Lao PDR has engaged an Environment and Social Panel of Experts (POE). Their reports and assessments are shared between the government and the World Bank, and with the public.

The POE is a standing body established for the period of the concession; it is required to assess the extent to which NT2 meets the requirements of the safeguard policies concerning environment, indigenous peoples, and resettlement. The most recent report is that of July 2011 (McDowell, Scudder, and L 2011). The report shows some indications of concern, indicating for example that the original NT2 Social Development Plan envisaged that

...by this time the income and sustenance of the Nakai resettlers would be largely derived from well-established agricultural crops on new and partially irrigated (for dry season cultivation) plots plus livestock raising, from dividends earned by the processing and sale of Village Forestry Association timber and—though with less confidence—from the harvesting of reservoir fish. In reality the main sources of income at the moment appear to be from illegal and unsustainable collection of rosewood from the reservoir and the watershed, with reservoir fishing a second source. Some serious rethinking on income sources is called for.

The implication is that even in this model project, very visible and closely monitored, some aspects of resettlement are not proceeding satisfactorily. This finding lends credence to the allegations of nongovernment organizations (NGOs) active elsewhere, claiming wide-scale social damage from similar, less visible projects that are not properly monitored at official level. Some of the claims are illustrated in the next section.

The mandate of the IAG is to provide guidance to the World Bank on how it can improve its handling of environmental and social issues, among others, in the NT2 project and to make specific recommendations on addressing these issues. The most recent report of the IAG from April 2010, has a slightly different emphasis from that of the POE, concluding that life is better for villagers but the benefits have been unevenly spread and their sustainability is still unclear.

Land has suddenly gone from being an infinite resource, bounded only by spirits and cultural rights, to a scarce commodity to be husbanded, fenced, managed and fed with nutrients and water. The margin for error in subsistence livelihoods is now of a different and unfamiliar quality. The adaptation to new livelihoods will take a generation. The change will continue, for better or for worse, long after Nam Thuen Power Company has met its obligations (IAG 2010).

It is not possible here to fully convey the detail and minutiae of the reports from the two groups, but it is very clear from their perusal that they constitute an important vehicle by which concerns of affected people can be conveyed to officials, documented, and remedies monitored thereafter, as they contribute positively to the chronic problem of poor enforcement. They also permit experienced people to contribute to solving problems as they arise and, given that the problems of such ventures can never be fully anticipated, this is a very important contribution.

It might be useful for the Regional Power Trade Coordination Committee (RPTCC) to propose that similar arrangements of similar authority and independence be included as an obligation within all future concession agreements across the GMS.

Reports by Academia and Civil Society

The socioeconomic impacts of energy developments have been monitored by a wide range of organizations. Normally, the reports that are produced are extremely critical, but there is some theoretical basis for believing that private sector developers will attempt to meet their resettlement obligations in the cheapest possible way and that this could be damaging to those resettled; there is also evidence from the monitoring of NT2 that even very visible and closely monitored projects experience difficulties that need constant attention, and there is much evidence from all over the world that unless such processes are closely monitored, there will be abuses. It is difficult, therefore, to dismiss these criticisms entirely. A few examples are given in Table 28.

The activities of these groups reveal a commitment and interest in the prevention of social and environmental damage from development that should be engaged rather than rejected. The attitude of these NGOs is in general combative, but also there is evidence that their inputs are consistently ignored by decision makers. Experience over the last few decades has shown that the contrary positions of NGOs sometimes can be important indicators of the direction of social change. It is better to engage than to reject such actors; they can usefully serve as interlocutors with affected people if there is a genuine commitment on both sides.

Table 28 Nongovernment Organizations Active in Social and Environmental Impacts of Energy

Project	Issues and/or Content	Reference
Xayaburi HPP	Low-quality resettlement, poorly built housing. No jobs. No new land. No mechanism for redress.	(International Rivers 2012)
Irrawaddy Myitsone Dam	No environmental protection law in place. Threats to historical and cultural sites. Poor quality of EIA.	(International Rivers 2012)
Shwe gas pipeline to the PRC dams on the Shweli river	Corruption. Forced resettlement. Loss of livelihoods.	(Palaungland 2012)
Sesan, Srepok, and Sekong (3S) rivers	Community network, aiming to strengthen capacity to engage in advocacy, dialogue, information collection, research, monitoring, information awareness activities, and capacity building.	(3SPN 2012)
Dams in Myanmar	Displacement, lack of compensation, loss of culture, disease, and human trafficking.	(Burma Rivers Network 2012)
Salween River	Potential damage to fish stocks, biodiversity, traditional culture and settlements.	(LivingRiverSiam 2005)

PRC = People's Republic of China, EIA = Energy Information Administration, HPP = hydropower plant.
Sources: References are shown on the 3rd column of the table.

Means should also be found to absorb and assess basic scientific research. For example, recent study by scientists from the Princeton University suggests that dams on the tributaries are in some ways more damaging than dams on the main stream (Ziv 2012). The Princeton University study alleges that the most damaging dam is that on the Lower Sesan 2 that might reduce fish biomass by 8% in the flood plains of Cambodia and Viet Nam. The study presents a Pareto frontier between loss of yield from fisheries and electrical generation. Whether the calculations of the study are correct is one thing, but certainly the presentation of results in this form represents a step forward. There will be a trade-off and it is important to determine where it lies and who, at that point, loses and who gains. The Princeton University study suggests that beyond 30 terawatt-hour (TWh) per year of electrical output, there is a very rapid fall off in fish yields; the form of this argument is theoretically persuasive; there is certainly a trade-off between fish yields and electricity and it is likely that at some point the marginal utility of further increments of electricity falls rapidly. It is not appropriate to take a view in this paper on the technical detail of the debate, but it is important to be confident that the scientific basis for decisions is sound. This is a significant challenge because the scientific basis may be complex and is constantly evolving, but if the resources of the Mekong are to be deployed optimally among the various important social services that it provides, then it must be done.

The GMS Environment Operations Center

The GMS Environment Operations Center (EOC) was established to mainstream sound environmental management across all GMS Economic Cooperation Program sectors and corridors. The GMS Core Environment Program and Biodiversity Conservation Corridors Initiative (CEP-BCI) was launched in 2006 and has been funded by ADB (\$1.6 million) and cofinanced by the following: The Netherlands (\$14 million), Sweden (\$10 million), United Kingdom (\$0.55 million), Finland (\$4.9 million), the PRC (\$0.5 million), and in-kind contributions from GMS countries (\$1.2 million). The program consists of three components: Strategic Environmental Assessments (SEAs), the Biodiversity Conservation Corridors Initiative (BCI), and Environmental Performance Assessments.

The main activities of EOC in the energy sector have been bilateral: two SEAs have been completed for power development in Viet Nam with support from the EOC, including an SEA of Master Plan VII; training has been conducted in the Lao PDR. The EOC has built partnerships with national universities, institutes, and other organizations to strengthen science and policy linkages for climate change initiatives and has prepared a concept for an innovative low-carbon sector intervention—Carbon Neutral Transport Corridors—that is now ready for piloting. The work under the Biodiversity Conservation Corridors Initiative is relevant to energy connectivity because large areas of low population are attractive corridors to use for power transmission and this will conflict with their value in conservation. The EOC should help countries identify and resist these threats.

Strategic Guidelines for Greater Mekong Subregion Regional Cooperation

Greater Mekong Subregion Strategic Framework, 2012–2022

GMS Strategic Framework, 2012–2022 establishes the broad guidelines for the development of the GMS over the next decade and was endorsed by the GMS Summit of Leaders in December 2011 (ADB 2011g). The principles that should govern the next moves toward economic integration are set out in this framework and are important discriminators among options for taking forward energy cooperation. They are set out in full below:

- First, there needs to be a more effective focus on the software aspects of the program to complement the continued focus on hardware. This will require not only greater progress on the policy and institutional dimensions of infrastructure development (e.g., transport and trade facilitation or power market integration), but also an increased emphasis on knowledge generation and management related to program initiatives and cross-country coordination.
- Second, there should be more selectivity and prioritization of focus areas within sectors, including less emphasis on information sharing and a greater focus on decision making on issues that are clearly regional in nature. This should lead to more tangible results and greater impact.
- Third, the program should be more closely linked to the broader regional integration agenda, leading to more clarity on which regional issues should be covered by the GMS program and which ones are better left to other regional organizations.
- Fourth, it is important that the program focuses more attention on the linkages across different sectors (e.g., among energy, agriculture, food security, and the environment) and recognizes climate change as a broader development issue as well as an environment issue.
- Fifth, there is scope for some rebalancing of attention and resources without changing the broad sector focus of the program and bearing in mind organizational capacities and the potential for achieving real results across the sectors.
- Finally, the GMS program will focus more strongly and effectively on monitoring results and on other improvements in program implementation that will help enhance its overall effectiveness and impact.

Based on principles, the framework endorses the strategic objectives of the energy sector set out in the Road Map for Expanded Energy Cooperation. In terms of program content, the framework is somewhat more focused than the road map itself and identified the following as software priorities:

- Promoting environmentally sustainable regional power trade planning, coordination, and development.
- Improving energy efficiency through demand-side management and energy conservation.

- Promoting the development of renewable energy resources and clean fuels, such as compressed natural gas.
- Promoting a policy framework for facilitating renewable energy development and energy efficiency.

In terms of infrastructure, the master plan reiterates the need to develop the grid, to connect power systems, and to support the realization of GMS segments of the Trans-ASEAN gas pipeline (TAGP) and clean coal technologies, noting the need for GMS countries to rely substantially upon coal for future power generation. It confirms that the Subregional Energy Forum (SEF) will be responsible for overseeing the program and specifically confers on it the duties to

- ensure that social and environmental factors are integrated into energy planning,
- ensure that high levels of private financing are mobilized for major energy projects,
- identify a lead country for specific projects,
- coordinate with development partners for funding and technical support,
- monitor regularly the progress of the Road Map for Expanded Energy Cooperation, and
- serve as the vehicle for information sharing on GMS energy cooperation.

ASEAN Economic Community Blueprint

Guidelines for regional cooperation in energy are given within the ASEAN Economic Community Blueprint (ASEAN 2008). The blueprint notes the importance of energy security and recognizes the role of biofuels. Regional collaboration in the Trans-ASEAN Gas Pipeline (TAGP) and the ASEAN Power Grid (APG) will allow the optimization of the energy resources of the region for greater security and quality of supply. Policies must be sustainable and should contribute to the abatement of global climate change. Efforts in renewable energy are essential to help manage declining resources of fossil fuels; open trade and cooperation in renewable energy are important as well as investment in the necessary infrastructure. The third ASEAN Programs of Action for Energy Cooperation (APAEC) is designed to support the energy component of the ASEAN Economic Community (AEC) Blueprint, 2015 and repeats the same themes (APAEC 2009).

Master Plan for ASEAN Connectivity

The Master Plan for ASEAN Connectivity elaborates on some potential investments that match the ambitions of the blueprint; in particular it lists 16 possible electrical cross-border connections identified by the Heads of ASEAN Power Utilities and Authorities (HAPUA) as technically possible; among the set are the links from Pekan Baru to Melaka and from Sarawak to West Kalimantan. The master plan recognizes the need to adapt the TAGP to the advent of liquefied natural gas (LNG) and acknowledges that there will be financial and legal obstacles to overcome, along with complications in synchronizing national technical and security regulation requirements, and differences in the supply, distribution, and management procedure of natural gas across the countries (ASEAN 2011).

The master plan addresses the need to ensure a good alignment of the GMS initiative in the subregional trade of electricity with ASEAN connectivity and the AEC Blueprint; it recognizes that ensuring coherence may not be easy since the APG and the GMS subregional trading initiative have been pursuing parallel efforts that may not be completely compatible and such incompatibility may be difficult to eliminate. Evidently, ASEAN is the superior legal entity as it is established by a treaty, which takes priority over the intergovernmental agreement establishing the GMS subregional

power trade. On the other hand, the GMS is much further advanced in the movement toward a subregional market, for the simple reason that it is easier to connect across the long land borders than in the archipelagic territories of the non-GMS countries, and it is scarcely desirable or practical that progress toward common rules and practices in the GMS should be impeded by a need to consult in detail with other partners. It is understandable that utilities not directly involved should feel some concern, but it is also not uncommon in the development of regional power markets that they are built out from a nucleus. The master plan correctly proposes a continuous, detailed, and careful analysis of the specific protocols of both initiatives to ensure alignment.

The Long-Term Strategic Framework of ADB

ADB priorities for the period 2008–2020 are set out in its Long-Term Strategic Framework (ADB 2008a); they are encompassed in three strategic agendas: inclusive growth, environmentally sustainable growth, and regional integration and these are based upon five drivers of change, as follows:

- Private sector development and private sector operations,
- Good governance and capacity development,
- Gender equity,
- Knowledge solutions, and
- Partnerships.

Private capital has been an important driver of hydro expansion in Southeast Asia because of the considerable rents associated with hydro sites. In an all-thermal power system, there are few rents; there are some particularly good sites and sometimes rents can be created by changes in relative fuel prices, but on the whole, only a risk-adjusted return on capital can be achieved. This is not true of hydro developments the costs of which may be much lower than the marginal thermal plants. This has led to a very great interest from private developers in sites in Cambodia, the Lao People's Democratic Republic (Lao PDR), Myanmar, and Sarawak. In the case of Myanmar and Sarawak, much of the interest is from Chinese contractors and power companies; in the Lao PDR, Thai developers including companies with a strong presence of the Electricity Generating Authority of Thailand (EGAT) have been very successful, but many other foreign interests are present; in Cambodia, Vietnamese companies are active. The regulation of these developments is often poor in several respects and need strengthening, in particular, to assure transparent, nondiscriminatory awards of concessions; to improve assessment and management of environmental and social impacts; and to guarantee revenue transparency.

The mechanism by which private capital is mobilized through independent power producers (IPPs) is well-established and has been widely used throughout the region. The main active constraint is the legal, regulatory, and institutional framework that needs strengthening and, in several countries, must be built from scratch. The most difficult area for private finance is transmission. Where the transmission line simply brings power from a remote source, it is clearly linked to a reliable revenue stream and is treated as an intrinsic part of the generation project that has to be funded if the project is to be built. Where a transmission line interconnects two networks, the problems are more complex. ADB has funded one private sector project in Cambodia as a build—operate—transfer (BOT) project. It would be helpful to launch a debate on the merits and possibilities of private finance of interconnectors in the region.

Good governance and capacity development is very relevant to the energy sector; performance varies across the subregion. Some countries still need support in basic sector planning; there is

much scope in improving regulatory practice in design and enforcement. Policy analysis could be strengthened in most countries. Furthermore, there is no mechanism to create a convincing vision of an energy future across the subregion that simultaneously takes care of the environmental and social dimensions while observing the constraints imposed by the international energy markets and global climate change. There is also a need to upgrade the process of awarding concessions and managing whole river basins, both at national and regional levels.

Gender equity has much relevance to energy policy, particularly with respect to extended access. Enhancing modern energy access reduces the use of fuel wood for cooking, which has been found hazardous to women's health. Electrical machines can relieve women's manual labor and create more time that they can use in more profitable occupations. Equal access of women and girls to education becomes important, not only for ethical reasons, but to enhance the value creation from the extra time available.

The fourth driver of the strategy is knowledge solutions. This could be applied to many aspects of energy policy, but one that appears exceedingly suitable is the adoption of new technologies for the use of biomass. The subregion is favorably endowed with biomass as a consequence of good rainfall and high levels of insulation. Biotechnology is rightly seen as a possibly contributor to sustainable energy supply, but the first generation technologies practiced in the region today conflict with food security. This conflict might be avoided by a shift toward second-generation technologies using agricultural, forest, and municipal wastes. In this case, it will be necessary also to establish new biomass value chains that can increase rural employment and incomes and help to close development gaps. ADB can support pilot projects in specific circumstances of the GMS and disseminate the experience acquired on local feedstocks, value chains, and suitable technology.

The importance given in the ADB strategy to partnerships is especially resonant in the creation of stable, inclusive energy policy within the subregion. Several countries recognize in principle the need to involve actors from the civil society and to consult widely in the preparation of policy, but in practice, it is never done. Indeed, nongovernment organizations (NGOs) are regarded almost with hostility. Partnerships with NGOs and community-based organizations are useful mechanisms to gauge the social value of impacts that have no market value. There are many international organizations concerned with different environmental and social aspects of energy development that are very forceful in their approach and many policy makers find them difficult to engage with, but who nevertheless have information and experience to bring. A stronger engagement with these actors is desirable.

Regional Cooperation Operations Business Plan

The proposed lending program for 2012–2014 involves \$2.2 billion of ADB financing, spread over 28 investment projects. The energy projects are summarized in Table 29; they account for 12% of the total funding.

The Nabong–Udon Thani Power Transmission and Interconnection project has a long history; it was included as a firm project for 2008 in the 2008–2010 Regional Cooperation Operations Business Plan, then postponed several times and finally dropped in 2011–2013. It was reinstated in 2012–2014 as firm for 2012. The Ban Sok–Pleiku 500 kV line is intended to evacuate power from a set of hydropower plants in Cambodia to market in Viet Nam; the project was originally prepared in 2008, but delays in the construction of the power plants have deferred the need for the transmission line and final agreement on tariffs took some time to reach. The technical assistance projects are not on the ADB databases, so there is no easily available information on the likely content.

Table 29 Summary of Energy Activities in the 2012–2014 Regional Cooperation Operations Business Plan

Project	Country	Status	Total Cost	ADB	Government	Cofinance
Nabong 500 kV Substation Transmission Facility Project	Lao PDR	2012 Firm	95.0	89.0	6.0	–
Ban Sok–Pleiku 500 kV Line	Lao PDR, Viet Nam	2013 Firm	38.0 40.0	30.0 30.0	8.0 10.0	150.0 ^a 50.0 ^a
Green, Low-Carbon GMS Value Chains Project	Cambodia, Lao PDR, Viet Nam	2014 Firm	55.0 5.0 115.0	55.0 5.0 105.0	10.0	55.0 ^b
Preparing the Green, Low-Carbon GMS Value Chains (PPTA)	Cambodia, Lao PDR, Thailand, Viet Nam	2013 Firm	1.5	–	–	1.5 ^c
Developing of GMS Coordination Centre for Regional Power Trade (CDTA)	Greater Mekong Subregion	2013 Firm	3.0	–	–	3.0 ^d
GMS: Renewable Energy Development (Phase 2) (PATA)	Greater Mekong Subregion	2014 Firm	2.0	–	–	2.0 ^e
Facilitating Regional Power Trading and Environmentally Sustainable Development of Electricity Infrastructure in the GMS (Phase 2) (PATA)	Lao PDR	2014 Standby	1.0	–	–	1.0 ^f

– = no data, ADB = Asian Development Bank, CDTA = capacity development technical assistance, kV = kilovolt, Lao PDR = Lao People's Democratic Republic, PATA = policy and advisory technical assistance, PPTA = project preparatory technical assistance.

^a To be determined.

^b Nordic Development Fund.

^c Asian Clean Energy Fund.

^d Swedish International Development Cooperation Agency (SIDA).

^e Unspecified trust fund.

^f Agence Française de Développement (AFD).

Source: ADB (2009c).

Gap Analysis

Energy Networks

Power

The review of the regional power trade commissioned by the Swedish International Development Cooperation Agency (SIDA) concluded that although some progress has been achieved, the regional power market is no closer than when the intergovernmental agreement (IGA) was signed in 2002. The review team attributed this to the lack of transmission infrastructure in the smaller countries, and the absence of a legal and regulatory framework in some member states. All the countries, it surmised, are not necessarily ready to proceed in the direction of a free electricity market (SIDA 2011). One might go further and note that independent power producers (IPPs) create obstacles in that they forbid third-party access (TPA) to their dedicated transmission lines. Thus, the associated power purchase agreements (PPAs) will need somehow to be renegotiated if the public-private partnerships (PPPs) are to participate in a regional market.

Market Concepts and Rules

Although RETA 6440 has delivered some proposals for basic rules and standards, these do not appear to have been agreed yet by the Regional Power Trade Coordination Committee (RPTCC) and there are important aspects of the market that have not yet been defined; a Grid Code also is still lacking. Part of the difficulty is that progress with a regional market is difficult unless there has been a minimum level of unbundling and liberalization in national markets. This is not the case in some member states; in such cases, the countries concerned are unlikely to be interested in a liberalized market at regional level.

Experience from around the world suggests that utilities rarely, if ever, seek market liberalization; they are normally obliged to conform under political instruction and they frequently resist. The political level in the Greater Mekong Subregion (GMS) (as also in the Association of Southeast Asian Nations [ASEAN]) has always been in favor of the regional market, but the political affirmation of the importance of a regional market has always been in such general terms that it is unclear as to what precisely is required. Progress is likely to be slow until there is a more specific and detailed political intervention.

The link between the political process and the technical work of the RPTCC is weak. Normally in an administration, a permanent secretariat attached to the executive branch of government will develop detailed legislative proposals based on political instruction that are then refined and developed according to a defined political process and then agreed by the legislature. The regional power market of the GMS has no such mechanism behind it.

The decision to create the Regional Power Coordination Center (RPCC) is certainly a step forward. The work necessary to take the concept forward was defined under RETA 6440 and presented as an amended road map; this can serve as the basis for a work program for the RPCC once it is established. Priorities for the work of the RPTCC include the elaboration of a grid code, a transmission expansion plan designed on a regional basis, and rules for charging for the use of the transmission systems. Technical studies are, however, unlikely to be sufficient; there will come a point where difficult political decisions must be made. A closer and more effective oversight by

political decision makers will be needed if the inability of the RPTCC to resolve technical disputes becomes an obstacle to implementation.

Electrical Connectivity

As has been noted earlier, there is in reality very little connectivity in the power systems of the GMS; there are simply power lines that run from power stations in host countries to substations in importing countries. The grid of the importing country is effectively expanded on to foreign soil. The intervening transmission line cannot be used for TPA because it is connected to nothing else and according to the SIDA review, the PPAs anyway forbid the use of TPA.

A consequence of this form of development is that it makes relatively little contribution to the national grid of the host country. The Lao People's Democratic Republic (Lao PDR) is a very good example; the hydropower sites in its territory are essentially being divided among geographically linked (monopoly purchasers) monopsonies in Thailand, Viet Nam, and the People's Republic of China (PRC). Consequently, the exporting country could not obtain better prices it could have otherwise obtained in a competitive market. The rent thus flows to the developer and not to the exporter. A similar situation is developing in Cambodia, where the connection of hydro sites to Pleiku will create a monopsony for Viet Nam.

The transmission investments that could actually change the dynamics of the regional power markets are, for different reasons, the creation of a 500 kV backbone in the Lao PDR and an interconnection of the systems of Thailand and Viet Nam. The creation of the 500 kV backbone in the Lao PDR would enable the country to offer power from a favorable hydro site to a wider variety of prospective buyers and obtain a better price. In the long run, in the context of a liberalized market, the strongly interconnected system in the Lao PDR would be an important element; the Lao PDR is, as is often said, the "battery" of the system. In an interconnected market, it can offer valuable services in terms of peaking power, voltage, and frequency regulation to the countries around, provided that the system is strong enough. The idea should be pursued in parallel with the mooted PRC–Lao PDR–Thai 500 kV link, but should not be dependent upon the success of that initiative.

The connection between Viet Nam and Thailand would be a step change in the regional market in a different way. These are the two largest systems (setting aside the PRC that, not being within ASEAN, has a slightly different status). Connection of the two systems would enable practical experience of the benefits to be acquired and assessed. Ideally, the two systems should be synchronized and connections built across central Lao PDR and southern Lao PDR, more or less on the alignments studied under TA 6147 and described earlier. This may not yet be acceptable, in which case, a high-voltage direct current (HVDC) connection on the southern alignment would be a modest substitute. This would then give the Electricity of Vietnam (EVN) and the Electricity Generating Authority of Thailand (EGAT) the practical experience of operating an interconnection and permit an assessment of the benefits that would lend reality to the as yet somewhat theoretical activities of the RPCC.

If the power systems of Viet Nam, the Lao PDR, and Thailand were optimized as a single unit, it would be easy to justify investment in both the 500 kV backbone and the East–West connectors between Thailand and Viet Nam.

Gas Connectivity

The Trans-ASEAN gas pipeline (TAGP), as originally conceived by the ASEAN–EU Energy Management Training and Research Centre (AEMTRC) in the late 1980s, was intended as an alternative to the export of natural gas out of the region as liquefied natural gas (LNG). The commercial logic of LNG

was irresistible and the great majority of gas that is exported now goes outside the region. The TAGP became essentially a collection of independent pipeline and unconnected projects that are roughly aligned geographically. The concept of TAGP may become more important and change its nature as imported natural gas becomes a main feature of regional energy supply. Single-source dependency of individual countries incurs risks that may be partially alleviated by a pipeline system that enables gas to be moved around the region as needed. It may also be that the TAGP will allow LNG regasification terminals to be shared between two countries with the division of gas being achieved through the pipeline. The possible exploitation of coal bed methane and similar sources of natural gas could be facilitated by the pipeline infrastructure with appropriate modifications. Lastly, in a region that is dependent on imports, gas storage will become necessary. This might be achieved in depleted or semi-depleted fields in proximity to the TAGP infrastructure. The TAGP then can serve to make this storage available over a wide area. On a longer timescale, the route, if not the infrastructure, of the TAGP could be a basis for a carbon dioxide (CO₂) pipeline system taking CO₂ from coal-fired power stations for final disposal in depleted gas reservoirs that originally supplied the TAGP.

A broad scoping study of the future of the TAGP in this new gas world is desirable and it should take into account the changing relationship with the electrical supply system. Gas is an important fuel for electricity supply, not only because gas turbines can provide the rapid response that will be needed on power systems with substantial renewable inputs. It is doubtful whether the GMS is the correct level on which to conduct such work; it is essentially a problem to be analyzed at the ASEAN level because much of the infrastructure lies outside the GMS as does the coal bed methane, and much of the potential reservoir storage. The GMS, through the Subregional Energy Forum (SEF), might lobby for this to be done by ASEAN and might wish to participate as a GMS grouping that would enable differences of opinion within GMS countries to be resolved more easily.

Development Gaps Remain Very Large

Table 30 shows the percentage of the population below the national poverty line for four of the GMS members; no data could be found for Yunnan and Guangxi provinces or for Myanmar. There is a marked contrast between Thailand and Viet Nam, which have managed to reduce poverty levels rapidly over the period, and Cambodia and the Lao PDR where progress has been less. Reduction of poverty seems not necessarily to be correlated with income; the Lao PDR has a per capita income not much less than Viet Nam, but higher poverty levels.

Table 30 Population Below the National Poverty Line and Per Capita Income, 2010

	1998	2000	2002	2003	2004	2006	2007	2008	Per Capita Income (\$)	
	%								Nominal	PPP
Cambodia	30.1	—	—	—	34.7	—	30.1	—	760	2,040
Lao PDR	38.6	—	—	27.6	—	—	—	27.6	1,010	2,300
Thailand	17.5	21.0	14.9	—	11.2	9.6	8.5	9.0	4,210	8,240
Viet Nam	37.4	—	28.9	—	19.5	16.0	—	14.5	1,100	2,910

— = no data, Lao PDR = Lao People's Democratic Republic, PPP = purchasing power parity.
Sources: Millennium Indicators Data Base, United Nations, and the World Bank.

Clearly, the effort to bridge the development gap needs to be sustained fully and in the case of the energy sector, this means principally extending access to modern energy and also to modern efficient uses. It means assuring also that access to energy is associated with economic development by verifying that flanking policies of urban infrastructure, credit, training, health, and telecommunications are in place. The SEF might review where extending access has been successful in the GMS and what made it successful and develop guidelines for new projects.

Electrification rates in Myanmar are very low and much effort will be needed to remedy the deficiency; the experience of the GMS countries that have successfully extended access in a manner conducive to economic development will be of great value.

There Is Much to Be Done for Energy Efficiency

RETA 7679 addresses this issue, but it does so at a preponderantly technical level, aiming at feasibility studies for thermal generation efficiency improvements in existing power plants and/or power transmission system upgrades for reduced system losses, and efficient lighting, heating, or cooling programs in households. As important as the identification of technical options, if not more so, is the implementation of effective policy that will motivate actors across the economy to behave more efficiently. There is considerable acquired experience of the available instruments and of their efficiency and effectiveness.

A political commitment that might be proposed by the SEF is that countries should adopt specific, measurable targets for energy efficiency improvements over a precise period that can be monitored against a well-defined baseline. The Asia–Pacific Economic Cooperation (APEC) member countries have already made such a commitment and it would be a good start if the non-APEC member countries adopted the same target. The countries might then agree to prepare National Energy Efficiency Action Plans on a common basis. These plans should

- establish business-as-usual (BAU) trends for energy consumption on a sectoral level;
- establish targets for energy efficiency on a sectoral level below BAU, based on measurable indicators; and
- define clearly the measures that will be implemented and the impact of the individual measures, realistically assessed through plausible modeling.

Several countries have such plans that would be adaptable to the possibly stricter format proposed. Implementation should be carefully monitored by the SEF. ADB can supply assistance to those countries that may require it.

These plans will be of immediate value to countries, not only as an instrument of policy, but also because they can form the basis of negotiation with industrialized countries concerning post-Kyoto instruments such as the Nationally Appropriate Mitigation Actions (NAMAs) and sectoral trading and crediting.

An agreement within the GMS to develop such plans according to agreed norms would foster a spirit of common engagement and provide an incentive for the timely production of high-quality strategies. The norms might be as follows:

- A common timescale—to 2025
- Common delivery date—mid-2013 should be feasible
- Common format and coverage

To do this would require a political commitment that the SEF would not be able to undertake. In this as, in other aspects, it is necessary to develop stronger links to the political process if the technical studies undertaken within the SEF are really to have fruitful policy results.

Renewable Policy Needs to Be Strengthened

RETA 7679 addresses this issue, but the limitations are the same as for energy efficiency. The scope is preponderantly technical, aiming at feasibility studies for small-scale, community-based, isolated renewable energy/clean fuels (RE/CF) energy systems (mini-, micro-hydro, biomass, solar, and wind). Much work has been done on this topic (IPCC 2011; IEA 2010b) and such systems have been a prominent factor in the electrification programs in rural areas in the Lao PDR (World Bank 2012); it is unlikely that the outputs of such work will lead to the adoption of stronger renewable energy policies. Moreover, the regional added value is not obvious. A process for energy efficiency, such as the one described above, may also be more appropriate. The countries might agree to prepare National Renewable Energy Action Plans on a common basis. These plans should

- establish BAU trends for renewable energy;
- establish targets for renewable energy, based on measurable indicators; and
- define clearly the measures that will be implemented and the impact of the individual measures, realistically assessed through plausible modeling.

The commentary given for energy efficiency applies here also. Several countries have plans that could be adapted; implementation should be monitored by the SEF; ADB can supply assistance to those countries that need it; the plans can form the basis of negotiation with industrialized countries concerning post-Kyoto instruments, such as NAMAs; and sectoral trading and crediting.

The difficulty is mainly in linking the technical level, represented by the SEF, with the political level. This is a difficult undertaking even with the implementation of national projects, where it is often hard to get good political direction and feedback, but in a subregional project where the political direction can only come from an occasional Ministerial meeting, it is especially hard. Until some way is found to create a more flexible relationship between the technical work and political decision making, the work of the SEF on wider cooperation in energy policy is likely to be limited in its impact.

Biofuels Need Second Generation Technologies

First generation biofuels are produced from cereal crops (e.g., cassava), oil crops (e.g., rapeseed, palm oil) and sugar crops (e.g., sugar cane) using established technology. Bioethanol can be made from fermentation of sugar from sugar cane or from starch; the starch is usually hydrolyzed enzymatically to sugar, followed by fermentation to bioethanol. The manufacture of biodiesel from the esterification of fatty acids obtained by hydrolysis of vegetable and animal fats is a purely chemical procedure. Second-generation biofuels are those biofuels produced from cellulose, hemicellulose, or lignin. These three materials are more difficult to convert than starch. A variety of methods has been explored to treat these feedstocks; they divide into two main categories: biochemical and thermo-chemical. Biochemical conversion routes begin by hydrolysis of the lingo-cellulosic material through a variety of enzymes that break the cellulosic material into sugars that are fermented and distilled. In thermo-chemical conversion, the feedstock is gasified at high temperature and the synthesis gas is transformed into liquid or gaseous fuel by chemical processes that are very well known from fossil fuel conversion.

First-generation technologies inevitably engender some conflicts with food production as the land and sometimes the crops could be used for food. Second-generation technologies do not create such an acute conflict, moreover, they offer the opportunity to create new value chains for farmers through the operations of collecting, transporting, and preprocessing agricultural waste materials. GMS countries should explore the possibilities as they apply to subregional agricultural practice, through one or more pilot plants evaluating technologies and value chains. This would fit well with the strategic priority of ADB to adopt “knowledge solutions.” The possibility should be explored by implementing this project as a PPP with a biotechnology company.

Arrangements for Private Sector Financing Still Need Attention

Investment in infrastructure provides essential support for the manufacturing and services sectors that drive productivity and maintain long-term economic growth. This is clearly articulated by the GMS countries in all the strategy documents concerning the development of the subregion. Such investments are expensive, may offer relatively low returns, and require continuous expenditure to maintain it. The public sector has been the traditional provider, but there are severe constraints on public finance and it is generally accepted that a greater resort to private capital is necessary to avoid limits to growth imposed by restrictive infrastructure.

The private sector has been very active in hydropower investment in the GMS, attracted by the large rents and high returns. It has also contributed, to a varying extent, to the delivery of conventional power plant through the build–operate–transfer (BOT) mechanism and its derivatives. The private sector has an important role to play in renewable energy. Given the correct incentives through feed-in tariffs, or other means, the private sector has demonstrated in many countries its willingness to invest (IPCC 2011). The constraint in the GMS has been the nonexistence or low level of incentives.

Transmission lines linking hydropower plants to a substation are often privately owned, but in general there has been little attempt in the GMS to attract private finance to invest in networks more broadly. The BOT project to construct a local transmission and distribution network in Cambodia, financed by ADB, is a notable (and apparently successful) exception. There has been some effort in India where guidelines for private sector participation in the transmission sector were issued in January 2000; they envisaged two possibilities—either a joint venture or an independent private transmission company. The International Finance Corporation was active with the Maharashtra State Electricity Transmission Company in developing a risk-sharing contractual framework that successfully attracted reputable transmission developers to take up contracts worth around \$1.5 billion (ESMAP 2012). Despite this, the initiative has been difficult to replicate elsewhere in India (Government of India 2010).

An ADB-commissioned report into the capacity of countries in the Asia–Pacific region to carry out sustainable public–private infrastructure partnerships found that experience had been mixed and that fiscal limitations, poor feasibility assessments, and regulatory barriers had delayed the execution of projects, and that concerns about financial viability, oversight, and poor service delivery have arisen once contracts had been signed. The report concluded that to ensure success, public sector project planning and selection, as well as implementation capacity, should be improved (EIU 2011).

A detailed review of the legislative and regulatory frameworks in use through the subregion, experience of implementation, benchmarking, and proposals for best practice in different parts of the energy sector might be prepared by the SEF. Given its importance and complexity, a separate review of the options for incorporating private capital into transmission system expansion might also be prepared.

Socioenvironmental Management and Enforcement

The impacts of power plants and transmission lines on natural resources and on communities dependent upon those resources can be severe. There is evidence that even when developments are closely monitored, the resettlement of people is problematic, not always given priority, and beset with unexpected consequences that need a degree of attention that may not be forthcoming. Many developments are scarcely monitored at all. ADB has demonstrated good practice at the Nam Theun 2 site through the imposition of independent monitoring. This should be a requisite for all developments. The SEF may like to propose this as an obligation to be included in all concession agreements and to develop guidelines on how it should be done.

The Strategic Environmental Assessment (SEA) has proved to be a useful tool in the Mekong. RETA 7764 will follow up the initiative to integrate an SEA into the GMS Power Master Plan along with issues of energy security and energy efficiency measures (ADB 2012a). This will be a useful exercise. It is now important to extend the technique to address other river systems, particularly in Myanmar. Very large hydro developments are foreseen in this country and there seems to have been little or no environmental assessment. Detailed studies of a similar nature to that performed for the Mekong should be a priority.

The scientific appraisal and evidence base is also evolving. Some studies suggest that dams on tributaries have a greater impact on fish yields and biodiversity than do dams on the main stream (Ziv 2012); these are very complex and important issues and the scientific debate needs to be properly absorbed into investment decisions and policy. The Mekong River Commission is the appropriate body to channel science into decision making and a close cooperation with the SEF is desirable.

Clean Coal

As noted earlier, the countries of the GMS envisage a large shift to coal in the future, especially for power generation. Coal-fired power plants produce large volumes of CO₂ and therefore this shift will have implications for greenhouse gas (GHG) emissions. There is a variety of technical approaches to this problem that involve either improving the efficiency of generating plants to reduce the emissions of CO₂ per kilowatt-hour (kWh), or capturing and sequestering the emissions, normally in deep geological structures—this is known as carbon capture and storage (CCS). It is quite possible to combine the approaches. The improved generating technologies are super-critical steam plant and integrated gasification combined-cycle plant (IGCC). Neither IGCC nor CCS is a proven technology and neither seems likely to be adopted by GMS countries in the near future.

All the elements of CCS have been separately proven and deployed, although not always at the necessary scale. Carbon capture in amine solutions is used commercially to remove acid gas impurities from process gas streams, but up-scaling to the large volumes of gas flow from a power plant is a challenge. Injection of CO₂ into underground reservoirs is widely used in the oil industry to enhance oil recovery from mature oil fields and geological disposal has been demonstrated. Around 1 million tons of CO₂ has been stored each year at the Sleipner project since it started operating in 1996. Transport of CO₂ by pipeline has also been proven.

There is now a substantial effort in several countries to demonstrate fully integrated, large-scale CCS systems fitted to commercial-scale power stations. Preferred formations are coal seams, deep saline aquifers, and depleted oil and gas reservoirs. The formations may be offshore or onshore. The storage of CO₂ in coal seams may be associated with the recovery of coal bed methane and

the CO₂ is absorbed preferentially on the surface of the coal and displaces methane; it may not be widely applicable in the GMS, but could be of value elsewhere in Southeast Asia where there are substantial resources of coal bed methane, often in proximity to coal mining and mine-mouth power stations. There are also many oil and gas reservoirs in the region that may eventually be candidates.

The largest potential for storage on a global scale is in saline aquifers, but it is the least well-characterized option. The project at Otway in south-western Victoria in Australia has demonstrated storage of CO₂ in a depleted gas reservoir. A second stage of the project to investigate storage in deep porous rocks containing formation water has begun and data acquired (CO₂CRC 2012). The technology is at a very early stage, but eventually it will be of interest in the GMS because such formations are very widely distributed and do not impose a constraint on siting power plants.

There are several options to improve combustion efficiency. Integrated gasification combined cycle (IGCC) plants convert coal to synthesis gas or syngas in a gasifier and then use the gas to drive a gas turbine combined cycle. Carbon can be removed pre-combustion with the advantage that smaller volumes of gas are involved. Using pure oxygen for combustion reduces the volume further. An IGCC demonstration has found it hard to achieve acceptable levels of reliability and availability and such plants are significantly more expensive than standard plants. The European Union (EU) is making €1.5 billion available for demonstration plants covering, among others, IGCC with pre-combustion capture, post-combustion capture on existing plant, integrated supercritical coal-fired power plant with an oxy-fuel CO₂ capture solution, and CO₂ geological storage (EU 2012). IGCC cannot be said to be a proven technology that the GMS countries could adopt in the medium term.

The alternative higher-efficiency coal plant is super-critical plant and this is an established technology that should be the basis for future generation from coal in the GMS. There is considerable experience and the generating efficiencies are substantially higher than for conventional plant; the 400 MW plant at Nordjyllandsværket in Denmark, for example, achieves 47% efficiency on a lower heating value basis, albeit with cooling from the cold waters of the North Sea (IEA 2007). There is a case to be made for a project dealing with the experience of super-critical plant in the GMS and its future prospects, but it may well be that such a study should be at the ASEAN level because other Southeast Asian countries will also make large use of coal and Indonesia is an important producer.

Capacity for Regional Prospective Studies Is Needed

It is difficult for the SEF to make informed judgments about the future of cooperation without a clear quantitative framework to indicate how the subregional energy system will develop with and without intervention, especially cooperative interventions. The prospective study carried out for the GMS and published in 2009 used data from 2005. Much has changed since then in our understanding of climate change, in international fuel prices, in expectations of domestic resource potential, and in technology. The time horizon for the original study was set at 2025 and that is now close. A large-scale prospective study needs to be conducted every 5 years. If the human capacity and computing software were available to make such studies and if the necessary data were compiled then even more frequent use of such a facility would develop to investigate specific issues. Modern evidence-based policy making normally requires quantitative evidence of impacts of all interventions; if the GMS is to develop as a real focus of cooperative policy then policy makers will have recurrent resort to modeling of subregional scope.

Consideration needs to be given to whether such work should be done at the ASEAN level or at the GMS level; there are arguments in favor of both. It is probably desirable that for different

purposes and at different times, modeling will be needed for the GMS, Brunei-Indonesia-Malaysia-Philippines East Asian Growth Area (BIMP-EAGA), Indonesia-Malaysia-Thailand Growth Triangle (IMT-GT), ASEAN, and maybe at the national level. The closing argument is probably that the GMS has an immediate need for this kind of analysis to guide its work and has perhaps a better institutional framework through the SEF to manage it.

The SEF may wish to consider creating a PPP to deliver this work. A basic contract could be established with a competent institution, through competitive tender, to deliver specified outputs, for example, the GMS. The costs of providing the human capacity and software would be shared, the institution accepting to contribute resources on the understanding that it would also be able to deliver services to other clients at market prices. The alternative would be to establish a permanent competence in a regional quasi-governmental institution, but that appears to be, in all respects, a less attractive option.

Implications of the Opening Up of Myanmar

There are several important implications of the opening of Myanmar. The country has very good chances of revenues from the energy sector through the sale of gas and hydropower to the PRC and Thailand, maybe later across Thailand to Viet Nam. It is clearly important that the revenues be used effectively to promote development. Support from ADB to introduce a transparent process of accounting for energy sector revenues and possible creation of a sovereign wealth fund is desirable.

It is also important that the developments do not destroy the natural environment and that hardship to indigenous peoples is avoided. The planning system in the country is not strong and it is probable that avoidable social and economic damage will be incurred from the infrastructure investments that are being considered. Support from ADB (and the experience of other countries of the GMS) is necessary to strengthen the planning system in legal and regulatory terms and to transfer the tools of effective environmental management. The Environment Operations Center (EOC) should be strongly involved in this process.

The national grid is relatively weak, the area around Mawlamyine is isolated from the main grid and has a poor and unreliable electricity supply. From a national perspective, the connection of that part of the country to the main grid through a 500 kV link might be considered. The improved power supply would be beneficial to the economy of Mawlamyine and could support improved access to electricity in the surrounding areas.

The need to extend access to modern energy in Myanmar is acute. One model that may be helpful is to undertake rural electrification in the country from nodes on the Chinese and Thai borders, in the same fashion as Thailand and Viet Nam have contributed to the electrification of Cambodia. Thailand and the PRC have helped to supply power to border areas of the Lao PDR, and the PRC supplies power to Northern Viet Nam. The practical possibilities appear to be from Mae Sot and Mae Chan where there are already 115 kV lines from the main Thai network.

The second model would be to extend the Thai electrical network to some reasonably close center of economic activity in Myanmar as part of a bigger exercise to create an economic corridor. Mae Sot might be a possible starting point with the intention to connect to the isolated grid around Mawlamyine, where the power supply is at present unreliable and inadequate. The transmission expansion plan of the Electricity Generating Authority of Thailand (EGAT) (EGAT 2010) shows that a second 115 kV circuit is already planned between Tak and Mae Sot so if that were brought forward it could provide initial power. No great deal of economic activity is apparent along that

alignment, so such a proposal would need to be carefully analyzed and should be seen as part of a combined infrastructure project covering power, roads, and urban infrastructure with the intention of extending the East–West economic corridor to Mawlamyine. It is unclear whether this is compatible with the 500 kV extension within Myanmar to link the national grid to Mawlamyine, identified earlier as an option. It would be difficult to connect the two lines because of the implications for the stability of the EGAT system. A high-voltage direct current (HVDC) back-to-back converter would be needed and the financial viability is not obvious. If the economic corridor were considered worthwhile, then another option would be to ensure electrical supply from both ends without connection.

A third model is to combine extended access with the export projects to the PRC and Thailand. In this model, between 10% and 20% of the power output from an export project would be reserved to extend access around the exporting plant; some of the benefits from the sale of generation could be incorporated into a favorable supply tariff and, with concessional finance, it may be possible to create a local network. Whether this is feasible would depend on there being some prospective load around the exporting plant. None of the plants foreseen by EGAT seems to fulfill this condition; Hutgyi and Tasang are mainstream dams on the Salween. The lignite prospect at Mai Khot is also remote, but it is planned to bring the power to Mae Chan, which could serve as a node for building out the network into Myanmar, if there is sufficient demand to justify the investment.

ADB may wish to consider a feasibility study of extending the East–West energy corridor to Mawlamyine as part of a concerted and planned extension of the East–West economic corridor, with and without the connection of Mawlamyine to the main grid.

Implementation of the Program through the Subregional Energy Forum

As noted earlier, the management arrangements envisaged in the Road Map for Extended Cooperation do not seem to have worked. It was proposed that countries would take the lead in certain areas and be proactive in designing projects, seeking finance, managing, and monitoring implementation. No examples of this seem to be happening; instead, the SEF is serving as a steering committee for conventional ADB technical assistance projects. This is a sensible function for the SEF, but there may be more that could be done. As a steering committee, it may improve the quality of deliverables, but it is not going to change subregional policy.

The top action proposed in the conclusions of the Energy for a Sustainable Future was that it was necessary to “mobilize political will for cooperation in all energy sectors.” This is easy to say and highly desirable, but difficult to achieve, especially at subregional level where access to the political institutions is complex. The SEF potentially provides this opportunity, in that acting as a community, it can create consensus within its members and lobby for effective regional policies within its national governments and at the energy ministers’ meetings. If it takes up this challenge, then it will need more resources. Funding for regional institutions is not an activity in which most donors wish to participate, although the EOC in Bangkok appears to be an exception. Donors are normally more interested to fund program activities undertaken by the institution once established.

If such an institution were put in place, then it could function as a subregional think tank preparing proposals for subregional policy initiatives. One of the weaknesses of the GMS is that it has no permanent secretariat preparing proposals on a regular basis for consideration by people with

legislative powers and without this there can only be limited progress. ADB does a good job of sustaining GMS activities, but it does this over and above its normal functions and, in any case, there would be more ownership if the activities were performed by the member states. It is tempting to suggest that the Regional Power Coordination Center (RPCC) assumes this role, but it would be outside of its terms of reference and it would not be technically equipped to handle such responsibility. The first step in developing this institutional capacity would be a feasibility study to scope the activities and to sound out donor and country interest.

Potential Activities and Results Framework

Table 31 summarizes the potential activities indicated by this paper. It lists the areas needing further support and assesses them against a set of criteria describing whether they (i) match the ADB strategy, (ii) are consistent with regional objectives, (iii) have regional added value, (iv) contribute to the strengthening of the economic corridors, and (v) contribute to closing development gaps. Table 32 provides a simplified results framework.

Table 31 Potential Activities and Selection Criteria

Activities	Matches ADB Strategy	Consistent with Subregional Objectives	GMS Added Value	Contributes to Strengthening Economic Corridors	Contributes to Closing Development Gaps
1. Support to RPTCC in the completion of performance standards, grid codes, market rules, and subregional transmission expansion plan	If done correctly, consistent with all three strategic agenda: inclusive growth, sustainable growth, and regional integration.	Described in the Connectivity Master Plan as “well in line with the ASEAN Connectivity and AEC Blueprint.” Also in GMS Framework Strategy, MOUs, and IAGs for GMS.	Yes. Stimulates regional trade. Cannot be done bilaterally. Needs common market principles.	Indirectly by strengthening the capacity of national systems to supply corridors.	Not directly, but can underpin associated policies of extending access.
2. Design and funding of backbone grid for the Lao People’s Democratic Republic (Lao PDR)	Can support inclusive and sustainable growth in the Lao PDR by facilitating the creation of access. Stimulates regional integration in the medium term.	Complex. Consistent with the spirit of ASEAN Connectivity and AEC Blueprint. Also with GMS Framework Strategy, MOUs, and IAGs for GMS. Not explicit in these texts.	Yes. In the medium term, will enable the Lao PDR to make high value-added services from its hydro plants available to all states.	Indirectly, by strengthening the capacity of national systems to supply corridors.	Positive. Should support energy access and rural development within the Lao PDR.
3. Reinvestigation of the Thailand –Viet Nam interconnection	Consistent with, sustainable growth and regional integration.	Consistent with texts cited in 1 and 2 above. Selected in original GMS Master Plan, but not in Update nor in the AIMS II.	Yes. Would represent a step change in the creation of the regional power market.	Would fall within existing corridors, but unclear what direct contribution it would make.	No.
4. Scoping study of the future of the TAGP	Coherent with good governance, capacity development, and regional integration in the ADB strategy.	Specified in the Master Plan on Connectivity. A major contribution to energy security.	Yes. Fundamentally a regional project. Cannot be done in any other way. Maybe should be at ASEAN-level. Needs big input from ASCOPE.	No direct link. High-capacity gas transmission does not stimulate economic development along the route.	Indirectly, as it contributes to energy security that impacts poor communities also.

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Table 31 *continued*

Activities	Matches ADB Strategy	Consistent with Subregional Objectives	GMS Added Value	Contributes to Strengthening Economic Corridors	Contributes to Closing Development Gaps
5. Development of guidelines for successful extension of access (on- and off-grid) with economic development	Consistent with inclusive growth, sustainable growth, good governance, and capacity development.	GMS SF explicitly requires enhanced access to energy particularly by the poor, through promotion of best practices in the subregion.	Benchmarking has clear value added.	Yes. Corridors only stimulate growth if there is energy access, and energy access needs other inputs.	Very strong and direct support.
6. Continued projects in rural electrification on- and off-grid	Consistent with inclusive growth, sustainable growth, good governance, and capacity development.	GMS SF explicitly requires enhanced access to energy particularly by the poor, through promotion of best practices in the subregion.	Not strongly. Most projects will be bilateral. More added value for cross-border projects.	Yes. Corridors only stimulate growth if there is energy access, and energy access needs other inputs.	Very strong and direct support.
7. Design of and lobbying for coherent EE action plans across the subregion	Coherent with good governance and capacity development.	Strongly coherent with the second principle of GMS SF; move from information sharing to decision making.	Yes. The common practices and culture permit effective sharing, benchmarking, and peer review.	No direct link.	Increases energy availability, reduces costs. Access to energy should also include access to energy efficiency.
8. Design of and lobbying for coherent RE action plans across the subregion	Coherent with good governance and capacity development.	Strongly coherent with the second principle of GMS SF; move from information sharing to decision making.	Yes. The common practices and culture permit effective sharing, benchmarking, and peer review.	No direct link.	Increases energy availability, reduces costs. Access to energy should also include access to energy efficiency.
9. Project to demonstrate second-generation biofuel technologies and associated biomass value chains	Coherent with search for knowledge solutions. (ADB strategy and GMS SF)	Directive from the 26th ASEAN MEM to foster cooperation in promoting biofuels produced in a sustainable manner.	Yes. Cost-sharing; risk-sharing in pilot plant development. Similar crops and farming practices.	Biomass value chains will need energy and transport connectivity.	Positive. Biomass value chains will boost rural employment and incomes.
10. Review of legislative and regulatory frameworks for PPP in the subregion, experience of implementation, benchmarking, and proposals for best practice	Coherent with good governance and capacity development. Private sector development is the first guiding principle of ADB strategy.	Need for better articulation with private finance is a constant theme of the GMS SF. Also coherent with incitement to move from knowledge sharing to decision making.	Yes. The common practices and culture permit effective sharing, benchmarking, and peer review.	Relevant to all infrastructure investment.	Widely used as a tool in rural electrification.

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Table 31 *continued*

Activities	Matches ADB Strategy	Consistent with Subregional Objectives	GMS Added Value	Contributes to Strengthening Economic Corridors	Contributes to Closing Development Gaps
11. Strengthening of the use of environmental management tools and rollout to Myanmar	Environment and climate change identified as ADB's comparative advantage in Strategy 2020. Also underpins inclusive and sustainable growth.	Fifth thrust of GMS SF is ensuring that environmental concerns are addressed and integrated into development.	Not very obvious. Could be bilateral, but major developers are from Thailand and the PRC—maybe useful to include them.	Relevant to all infrastructure investment.	Yes. Poor people invariably pick up the costs of social and environmental damage, often severely.
12. Proposal for mandatory independent monitoring of dam projects	Inclusive and sustainable growth is often threatened by dam projects. ADB has helped establish good practice. Should be better disseminated.	GMS SF requires that equitable and sustainable environment and social interests be fully respected in the GMS program.	Regional because it avoids distorted competition and creates solidarity.	Not directly.	Yes. Poor people invariably pick up the costs of social and environmental damage, often severely.
13. Improved and timely access to scientific evidence	Coherent with the search for knowledge solutions.	GMS SF asks for high-quality analytic work, discussion, and consensus building around the complex links among energy, food security, and the environment.	Yes, because science does not stop at borders and many issues detected will cross frontiers. The MRC or EOC is probably the better host.	Not directly.	Yes. Poor people invariably pick up the costs of social and environmental damage, often severely.
14. Guidelines for the selection and design of supercritical coal plant	Coherent with the search for knowledge solutions.	Promoting clean coal technologies is a priority regional initiative of both the GMS SF and the Road Map.	Not so obvious. Some advantages to a regional approach, but ASEAN is the more logical level.	No.	No direct impact.
15. Strengthening of capacity for prospective studies (maybe through PPP)	Knowledge solutions and better governance. Strongly coherent with Energy Sector Strategy: Mobilize political will for cooperation in all energy sectors.	Coherent with incitement to move from knowledge sharing to decision making.	Yes. Can only be done at regional level; ASEAN level is a possibility, but greater coherence of GMS suggests it would be more effective at that level.	Possibly indirect.	Possibly indirect.
16. Conventional rural electrification programs in Myanmar	Consistent with inclusive growth, sustainable growth, good governance, and capacity development.	GMS SF explicitly requires enhanced access to energy particularly by the poor, through the promotion of best practices in the subregion.	Largely bilateral, but see next project in the next page.	Yes. Corridors only stimulate growth if there is energy access, and energy access needs other inputs.	Very strong and direct support.

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Table 31 continued

Activities	Matches ADB Strategy	Consistent with Subregional Objectives	GMS Added Value	Contributes to Strengthening Economic Corridors	Contributes to Closing Development Gaps
17. 500 kV link from Mawlamyine to the main grid	Consistent with sustainable growth.	In the long term, can be consistent with regional integration.	Little regional implication in the short term although it brings the 500 kV system closer to the Thai frontier.	No direct link.	Indirectly, can support improved access in and around Mawlamyine.
18. Extension of access in Myanmar from nodes in Thailand (and the PRC)	Consistent with inclusive growth, sustainable growth, good governance, and capacity development.	GMS SF explicitly requires enhanced access to energy particularly by the poor, through the promotion of best practices in the subregion.	Genuine regional initiative, building on previous experience elsewhere in the GMS.	Yes. Corridors only stimulate growth if there is energy access, and energy access needs other inputs.	Very strong and direct support.
19. Feasibility study of extending the E–W energy corridor to Mawlamyine as part of a concerted and planned extension of the E–W economic corridor.	Consistent with inclusive growth, sustainable growth, good governance, and capacity development.	GMS SF explicitly requires enhanced access to energy particularly by the poor, through the promotion of best practices in the subregion.	Genuine regional initiative, building on previous experience elsewhere in the GMS.	Yes, very strong. Would essentially create new economic corridor.	Very strong and direct support.
20. Permanent institutional support for the SEF	Consistent with good governance and capacity development.	Strongly coherent with the second principle of GMS SF; move from information sharing to decision making.	Yes—informal intergovernment agreements are no threat to ASEAN and can spur action in the wider arena.	Not directly.	Not directly, but better decision making could contribute.
21. Strengthening of links of the SEF to the political level	Consistent with good governance and capacity development.	Strongly coherent with the second principle of GMS SF; move from information sharing to decision making.	Yes—informal intergovernment agreements are no threat to ASEAN and can spur action in the wider arena.	Not directly.	Not directly, but better decision making could contribute.

ADB = Asian Development Bank, AEC = ASEAN Economic Community, AIMS = ASEAN Interconnection Master Plan Study, ASCOPE = ASEAN Council on Petroleum, ASEAN = Association of Southeast Asian Nations, PRC = People's Republic of China, EE = energy efficiency, EOC = Environment Operations Center, GMS SF = Greater Mekong Subregion strategic framework, IAG = international advisory group, IGA = intergovernment agreement, kV = kilovolt, MEM = Ministry of Energy and Mines, MOU = memorandum of understanding, MRC = Mekong River Commission, NOC = national oil company, PPP = public–private partnership, RE = renewable energy, RPTCC = Regional Power Trade Coordination Committee, SEF = Subregional Energy Forum, TAGP = Trans-ASEAN gas pipeline, TPA = third-party access. Source: Author.

Table 32 Simplified Results Framework for the Tentative Proposals

Intervention	Outcome	Output	Risks and Assumptions
1. Support to RPTCC in the completion of performance standards, grid codes, market rules, and subregional transmission expansion plan	Functional regional market with genuine exchanges of electricity. Improved reliability and quality, lower costs.	Clear basis for regional market comprising agreed rules and agreed indicative planning of interconnections.	There is genuine commitment to a regional market. Political will is sustained. Infrastructure is built.
2. Design and funding of backbone grid for the Lao People's Democratic Republic (Lao PDR)	National grid in the Lao PDR can move power across the country and provide high value-added services across the GMS.	North–South 500 kV line completed.	Cost allocation rules can be designed to permit finance of the lines. The Government of Lao PDR agrees.
3. Reinvestigation of the Thailand–Viet Nam interconnection	Step change in the development of the regional market. Reduced reserve, lower costs, and enhanced confidence in the regional market.	Interconnectors through the Lao PDR. One or both of Nam Thuen 2 and Ban Sok as candidates.	All three governments agree. Cost allocation can be agreed. NTPC agrees or the Government of Lao PDR introduces mandatory TPA.
4. Scoping study of the future of the TAGP	TAGP becomes a major asset for the future.	Concept agreed for the deployment of TAGP in the future. Critical investments identified.	NOCs are amenable to the study. Commercial confidentiality is not insuperable. Probably best done by ASCOPE at ASEAN level.
5. Development of guidelines for the successful extension of access (on- and off-grid) with economic development	Practice in rural electrification improved, especially in Cambodia, the Lao PDR, and Myanmar. Economic impacts of rural electrification increased.	Lessons from past practice quantified and factors improving or diminishing impact clearly identified. Principles of good planning and monitoring demonstrated. Subsidies clearly identified. Role of private sector clarified.	Baseline data and proper survey evidence from past practice exists. Utilities make available staff for the review of ex ante and ex post survey data.
6. Continued projects in rural electrification, on- and off-grid	Improved welfare and stimulus to economic development in deprived areas.	Grid extension according to sound selection principles. Off-grid projects implemented where grid extension is not feasible.	No high risks. Probably best seen as bilateral projects.
7. Design of and lobbying for coherent EE action plans across the subregion	Stronger and better-targeted actions in energy efficiency. Energy efficiency increases relative to baseline. NAMAs successfully established.	National Energy Efficiency Action Plans prepared using a common format. Proposals for the negotiation of NAMAs agreed at political level and monitored by SEF.	Agreement to the action at ministerial level. Ministerial meeting confirms agreement to content.
8. Design of and lobbying for coherent RE action plans across the subregion	Stronger and better-targeted actions in renewable energy. Deployment of RE increases relative to baseline. NAMAs successfully established.	National Renewable Energy Action Plans prepared using a common format. Proposals for the negotiation of NAMAs agreed at political level and monitored by SEF.	Agreement to the action at ministerial level. Ministerial meeting confirms agreement to content.
9. Project to demonstrate second-generation biofuel technologies and associated biomass value chains	Upgrading of biofuel technology; reduced conflicts with food security. Increased rural incomes from novel biomass value chains.	Pilot plant(s) built under a PPP framework. Financial targets met. Successful demonstration. Value chains created.	Second-generation technologies are sufficiently mature. Private partners can be found.

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Table 32 continued

Intervention	Outcome	Output	Risks and Assumptions
10. Review of legislative and regulatory frameworks for PPP in the subregion, experience of implementation, benchmarking, and proposals for best practice	Legal and regulatory frameworks for PPP brought up to best-practice levels across the region.	Best practice for PPP in the power sector identified. Compared to practice in the GMS. Guidelines prepared for improvement.	No obstacles to implementation. Ministerial approval is a risk.
11. Strengthening of the use of environmental management tools and rollout to Myanmar	Improved environmental management of river basins in Myanmar. Strengthened planning and concession framework.	Conduct of SEA in Myanmar; transfer of tools; capacity building. Review of planning process; recommendations for improvement.	Data collection is challenging. Needs cooperation of many actors throughout the country. Approval of the Government of Myanmar.
12. Proposal for mandatory independent monitoring of dam projects	Monitoring of social and environmental impacts of dam construction and operation brought up to best-practice levels across the region.	Best practice identified. Compared to practice in the GMS. Guidelines prepared for improvement.	No obstacles to implementation. Ministerial approval is a risk.
13. Systematic assessment of evolving scientific evidence base	Better environmental management.	Procedures to ensure timely, comprehensive, and accurate incorporation of new scientific evidence into decision making.	Countries are committed to evidence-based policy.
14. Guidelines for the selection and design of supercritical coal plant	Adoption of the best available technology for coal firing consistent with GMS context.	Regularly updated database of best practice in coal-fired power generation, especially supercritical steam plant.	None.
15. Strengthening of capacity for prospective studies (maybe through PPP)	Better regional policy making in all facets of the energy sector.	Sustainable capacity for high-grade energy modeling and analysis created under a PPP, and regular analyses delivered.	Competent private partner can be found. Private partner is convinced of potential commercial prospects.
16. Conventional rural electrification programs in Myanmar	Improved welfare and stimulus to economic development in deprived areas.	Grid extension according to sound selection principles. Off-grid projects implemented where grid extension is not feasible.	No high risks. Probably best seen as bilateral projects.
17. 500 kV link from Mawlamyine to the main grid	Lower costs and improved reliability of power supply especially around Mawlamyine.	Connection of isolated grid at Mawlamyine to main grid.	Financial return is acceptable. Essentially a bilateral project.
18. Extension of access in Myanmar from nodes in Thailand (and the PRC)	Improved welfare and stimulus to economic development in deprived areas.	Grid extension from the Thai (and the PRC) border using generation plant in Thailand and the PRC. Building on the experience in Cambodia, the Lao PDR, and Viet Nam.	That there are suitable sites. That the concerned governments agree.
19. Feasibility study of extending the East–West energy corridor to Mawlamyine as part of a concerted and planned extension of the East–West economic corridor.	Improved welfare; significant stimulus to economic development along western extremity of East–West corridor.	Concerted planned extension of corridor including energy, transport, and urban infrastructure.	Financial (economic) calculations are favorable. Governments agree. Coordinated planning is possible.

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Table 32 *continued*

Intervention	Outcome	Output	Risks and Assumptions
20. Permanent institutional support for the SEF	Improved design, finance, and management of the SEF energy sector program.	Creation of secretariat that would support SEF through position papers, analysis, proposals for communication to political institutions, dialogue with donors, and monitoring.	Financing for the secretariat may be problematic. Staffing either through secondment recruitment may be difficult.
21. Strengthening of links of the SEF at the political level	Improved and accelerated decision making in regional energy policy.	Principle agreed that SEF should design and submit regional policy initiatives to the political institutions where appropriate.	Political institutions are in agreement. SEF can muster the secretariat support to make plausible proposals.

ASEAN = Association of Southeast Asian Nations, ASCOPE = ASEAN Council on Petroleum, PRC = People's Republic of China, GMS = Greater Mekong Subregion, EE = energy efficiency, kV = kilovolt, NAMA = nationally appropriate mitigation action, NOC = national oil company, NTPC = Nam Theun 2 Power Company, PPP = public-private partnership, RE = renewable energy, RPTCC = Regional Power Trade Coordination Committee, SEA = Strategic Environmental Appraisal, SEF = Subregional Energy Forum, TAGP = Trans-ASEAN gas pipeline, TPA = third-party access.

Source: Author.

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Assessment of the Greater Mekong Subregion Energy Sector Development Progress, Prospects, and Regional Investment Priorities

This report analyzes the Greater Mekong Subregion's current energy situation and the challenges and opportunities it faces, given its resource endowments and development efforts. The creation of a Regional Power Coordination Center is a critical step forward, but should be matched by supportive infrastructure, national electricity market reform, and workable rules for cross-country trade. It endorses the 500 kilovolt backbone grid for the Lao People's Democratic Republic, interconnecting Thailand and Viet Nam, to form the nucleus of the regional market. The report proposes support for the Subregional Energy Forum to drive regional policy creation through stronger capacity for policy analysis.

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