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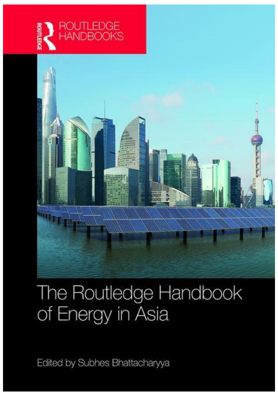

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Importance of regional climate policy instruments towards the decarbonisation of electricity system in the Great Mekong Sub-region

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IMPORTANCE OF REGIONAL CLIMATE POLICY INSTRUMENTS TOWARDS THE DECARBONISATION OF ELECTRICITY SYSTEM IN THE GREAT MEKONG SUB-REGION

Akihisa Kuriyama and Kentaro Tamura

Introduction

The decarbonisation of electricity systems is a common agenda under the climate change policies in developed countries as well as middle-income countries. The Greater Mekong Sub-region (GMS) countries, consisting of Cambodia, the Lao PDR, Myanmar, Thailand, and Vietnam, have been working on this issue as well. Though there are differences in the amount of electricity demand and renewable energy potential among the GMS countries, those potentials need to be considered in an integrated manner because the economies in this region are being integrated by enhancing regional initiatives such as the ASEAN Economic Community (AEC) and the extension of the electricity grid beyond the countries' boundaries.

Also, the least developed countries in the GMS, i.e. the Lao PDR, Cambodia, and Myanmar, enjoyed high GDP growth rates in 2014, i.e. 7.5%, 7.1%, and 8.5%, respectively (World Bank, 2016). Since their economic growth is greater than that of other GMS countries, they are catching up with other relatively developed GMS countries, which will result in increasing fossil fuel use. Therefore, it is important to develop a strategic climate policy for GMS countries as soon as possible.

In fact, all of the GMS countries have implemented climate change policies. Under the Cancun Agreements of 2011, developing countries are requested to develop mitigation actions up to 2020 with so-called nationally appropriate mitigation actions (NAMAs). Furthermore, the Paris Agreement of 2015 sought for all the countries to implement their post-2020 mitigation contributions and submit them every five years after 2015. As a consequence, all the GMS countries have already submitted their intended nationally determined contributions

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(INDCs) in response to this initiative. One common feature of their INDCs is to reduce the electricity produced by fossil fuel power plants even though there are some construction plans for coal- and gas-fired power plants in the GMS countries owing to the increase in electricity demand. Therefore, effective climate strategies and incentives to promote greenhouse gas (GHG) reduction in the electricity sector, in particular, are a key element in the decarbonisation of the society.

Therefore, this chapter summarises the key factors for achieving decarbonisation in the electricity systems. The first section estimates the renewable energy potential and electricity demand in 2035 on the basis of existing model scenarios for the GMS countries. By comparing those two potentials and highlighting the current initiatives to extend transmission lines across the GMS countries, it discusses the feasibility of decarbonising the electricity system.

The next section shows the possible institutional barriers presented by existing country-based climate policies. To highlight this, it reviews the experience of the Clean Development Mechanism (CDM), in which all the GMS countries participated actively. It also provides case studies demonstrating how the identified country-based grid emission factors created institutional barriers to the installation of a hydropower plant in the Lao PDR. The final section summarises the findings and leads to the conclusions of this chapter.

Prospective electricity market and renewable energy potential in the Greater Mekong Sub-region

The approach to identifying electricity demand forecasts and renewable energy potentials

This section reviews the renewable energy potential and electricity demand forecast for 2035 in the GMS countries as well as the current status of the grid structure. In particular, it compares the estimated electricity demand in 2035 and technical renewable energy potential in the GMS countries. Through this comparison, it highlights the feasibility of decarbonising the electricity system through the use of renewable energy sources and increased energy efficiency, which could fill the gap between electricity demand and renewable energy potential.

Electricity demand

Since electricity demand depends on assumptions about GDP growth, population, and energy efficiency improvement, it required three studies to review the electricity demand forecast. Each study has a business-as-usual (BaU) scenario and an alternative (Alt) scenario.

Energy Supply Security Planning for ASEAN (ESSPA) applied the methodology for final energy demand forecasting using econometrics. While the estimation of primary energy consumption used an engineering-based model, the energy development programmes of each member state served as the major inputs used in the models (IEEJ & ACE, 2011). The study by Kimura (2013) used the World Energy Outlook Model developed by the Institute of Energy Economics, Japan's IEEJ model and the LEAP model. It focussed on analysing the additional energy savings that might be achieved under the mitigation goals and action plans of each GMS country. The analysis also includes the scenario beyond the current policy level using the assumptions confirmed by their respective working group members. The Asian Development Bank (ADB, 2013) publishes "Energy Outlook for Asia and the Pacific", which also applies IEEJ and LEAP models. It reflects the diversity of regional economic development and population growth. The Alt scenario under the ADB study considers the potential for energy savings and

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CO_2 emissions reduction: "With the deployment of advanced technologies, electricity demand of Asia and the Pacific will increase at an annual rate of 2.5% from 2010 to 2035—a slower rate compared with the growth rate of primary energy demand in the BAU case at 2.1% per year" (ADB, 2013).

Table 23.1 summarises the macroeconomic assumptions for the three models. Each study provides two scenarios for electricity demand forecasts in 2035. The growth of the economy and electricity demand would be affected by the economic status in other countries such as China, but the analysis of macroeconomic indicators is beyond the scope of this study.

Renewable electricity potential

The estimation of renewable electricity from solar, wind, and biomass power is based on "Renewable Energy Developments and Potential in the Greater Mekong Subregion" published by the Asian Development Bank (ADB, 2015b). In this report, the technical potential for solar energy is based on the degree of solar irradiation, the efficiency of conversion technologies, the suitable land area, and other factors. The authors calculated the wind energy potential based on average wind speeds over specific land areas, in metres/second (m/s), and the wind turbine generator (WTG) installation capacity (or wind power density), in megawatts per square kilometre (MW/km^2). To estimate technical potential for wind power from these figures, they (1) exclude the wind energy potential in protected forest areas, mountainous and remote areas, and urban areas, and (2) take account of the current capacity of the grid electricity systems in each country because the capacity of the transmission line is so critical to maintaining stability (ADB, 2015b). In fact, the transmission capacity of the connected grid electricity system imposes a significant restriction to limit the wind potential, especially in the least developed countries. The ADB's model excluded the electricity potential of biomass power plants based on the findings where "the technical potential of agricultural residues is much less than the theoretical potential, partly because of the difficulty of residue collection" (ADB, 2015b). For electricity potential from hydropower plants, the model used the estimations by each government. Even though some GMS countries such as Vietnam plan to start the use of nuclear power plants, the potential of nuclear power is excluded from the technical potential of electricity supply due to the uncertainty of implementing the technology in these countries.

Table 23.1 Macroeconomic assumptions of the three models for forecasting electricity demand

	IEEJ & ACE (2011)	*Kimura (2013)*	*ADB (2013)*
Model	LEAP	LEAP	LEAP
Annual GDP growth for ASEAN countries (%)	5.2	4.9	4.1
Population in GMS countries (million)	277.9	257.2	273.3
Assumption of Alt scenario	Consider the potential for energy saving	Reflect each country's goal	Use the energy saving goals set by the government
Energy demand forecast for all GMS countries (TWh)	BaU: 920 Alt: 752	BaU: 939 Alt: 802	BaU: 770 Alt: 672

Data source: Authors' compilation.

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Result of total electricity demand and renewable energy potential in GMS countries

The estimated electricity demand in all the GMS countries is from 757 TWh to 1,008 TWh under the BaU scenario. On the other hand, it ranges from 651 TWh to 757 TWh under the Alt scenarios. The technical renewable energy potential in the Mekong region was estimated to be 115 TWh for solar power, 10 TWh for wind, and 478 TWh for hydropower plants. The technical potential of wind power could be larger because the wind power potential is calculated based on the capacity of the current grid electricity system. From those figures, if we take account of the full technical renewable energy potential, the gap between the electricity demand forecast and the renewable energy potential is calculated to be 154–405 TWh under the BaU scenario. Furthermore, the Alt scenario shrinks the gap between electricity demand forecast and renewable energy potential to 48–233 TWh. Even though renewable energy potential is slightly less than the lowest electricity demand estimation under the Alt scenario, there is still the possibility that renewable energy could satisfy all the electricity demand at the 2035 level if we consider the upper range of energy efficiency potential.

First, in all the three scenarios, incremental energy efficiency potentials from the BaU scenario to the Alt scenario in Vietnam are estimated to be around 10%. However, according to ADB (2015a), the electricity saving in Vietnam can be enhanced to around 20% with proper policy implementation. The enhanced energy efficient potential is not only the case for Vietnam but also for other GMS countries. This finding means that a country's effort on energy efficiency is necessary to decarbonize its electricity system.

Second, the enhancement of transmission capacity would increase the technical wind power potential. As Figure 23.1 shows, there is huge theoretical wind power potential in the GMS countries, but it is not counted as the technical potential due to the limitation of transmission capacity according to ADB (2015b).

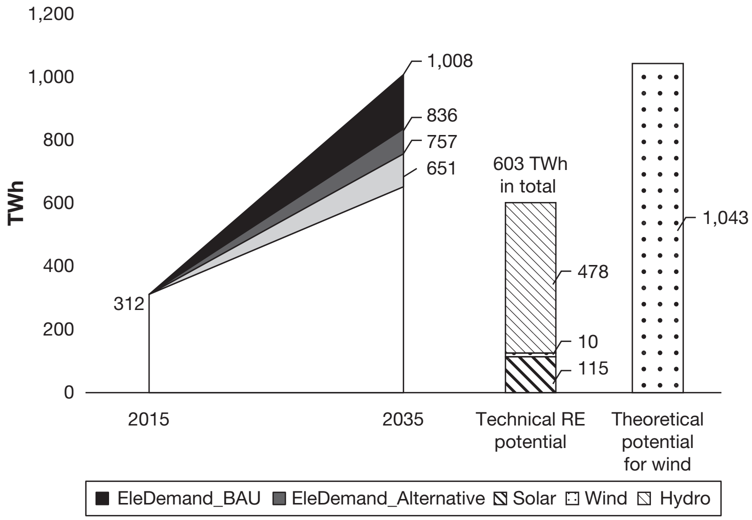

Figure 23.1 Future electricity demand and technical renewable electricity potential for all the GMS countries

Data source: Authors, based on IEEJ & ACE (2011), ADB (2013), ADB (2015a) and ADB (2015b).

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Result of electricity demand and technical renewable energy potential by country

As shown in Figure 23.1, the renewable energy potentials in the GMS countries could be enough to meet the electricity demand in 2035 if the countries fully utilised their wind energy potentials. However, the location of renewable energy potentials is separated from the place where a significant amount of electricity is needed. Figure 23.2 shows the technical renewable energy potential and electricity demand by each GMS country.

For Cambodia, electricity demand is predicted to be 8–16 TWh under the BaU scenario and 7–14 TWh under the Alt scenario that reflects the potential of energy savings in 2035. As to renewable energy, potentials of solar power, wind power, and hydropower are 12 TWh, 0.2 TWh, and 61 TWh, respectively. Cambodia has substantial solar resources that could meet a significant portion of that country's electricity demand in 2035. Wind energy, on the other hand, is limited by low wind speeds and the weakness of the grid and load system. The potential for hydropower plant is so great that Cambodia could export electricity to neighbouring countries.

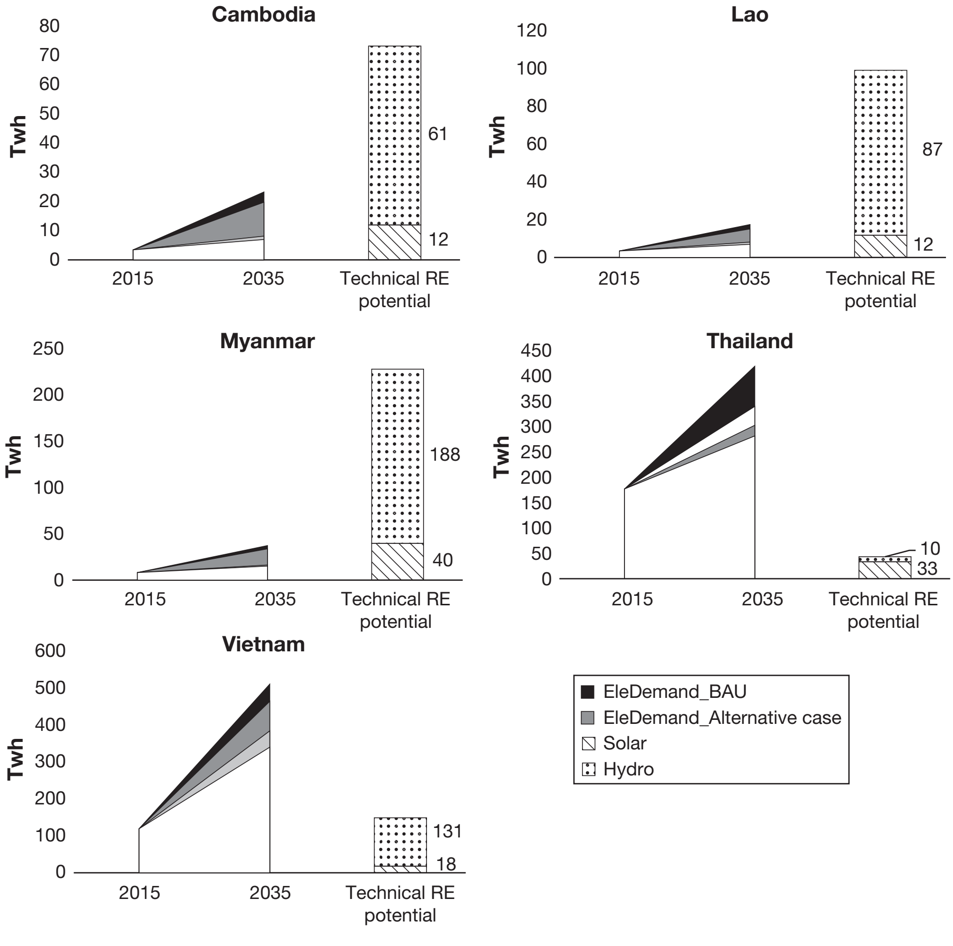

Figure 23.2 Future electricity demand and technical renewable electricity potential

Data source: Authors, based on IEEJ & ACE (2011), ADB (2013), ADB (2015a) and ADB (2015b).

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Regarding the Lao PDR, electricity demand in 2035 is predicted to be 8–17 TWh under the BaU scenario and 7–15 TWh under the Alt scenario in 2035. For renewable energy, the potential is predicted to be 12 TWh for solar power and 87 TWh for hydropower. Wind power potential is limited in the Lao PDR due to the limited capacity of the electric grid. There is, however, a considerable potential for small-scale solar and wind power electricity. Although wind power capacity is not huge, the theoretical potential for wind power in the Lao PDR is substantially higher than in the other GMS countries, which could lead to further investment in wind power, possibly beyond the capacity of the current grid electricity system. For example, a wind power project developer in Thailand, Impact Electrons Siam Co. Ltd (IES), published a press release to mark its Memorandum of Understanding (MOU) with Vestas Wind Systems to install 600 MW of wind turbines in the Dak Cheung and Sanxay districts of Sekong and Attapeu provinces. Also, the potential of hydropower is so enormous that electricity could be exported to neighbouring countries.

As to Myanmar, the electricity demand in 2035 is predicted to be 16–37 TWh under the BaU scenario and 15–34 TWh under the Alt scenario. Renewable energy potential in Myanmar is 40 TWh for solar power, 1 TWh for wind, and 188 TWh for hydropower plants. Myanmar has huge areas of high solar irradiation levels, but project developers cannot use some of the areas for solar power due to the mountainous terrain and protected areas. The potential for wind power is limited since average wind speeds in most areas are too low even if a developer applies the latest wind turbine technologies. Myanmar has the largest hydropower potential in the GMS countries, but the capacity of the grid electricity system is so small that further development of the system is required to transmit electricity to neighbouring countries.

Figure 23.2 shows that technical renewable potential, especially hydropower plants, in the Lao PDR, Cambodia, and Myanmar is much higher than the predicted electricity demand. At the same time, those three countries have less electricity saving potential. On the contrary, Thailand and Vietnam have a growing electricity demand, and it is expected to increase rapidly. The models predicted electricity demand in Thailand to be 340–419 TWh under the BaU scenario and 281–302 TWh for the Alt scenario. Renewable energy potential in Thailand is predicted to be 33 TWh for solar power, 5 TWh for wind power, and 9.8 TWh for hydropower plants. Thailand has plenty of solar power potential, and the government also has an ambitious target of nearly 2,000 MW of solar PV installations by 2021. On the other hand, weak wind speeds result in Thailand's modest wind power potential. There is less hydropower potential in Thailand because it has few mountainous areas. For Vietnam, electricity demand is forecasted to be 385–512 TWh under the BaU scenario and 341–465 TWh under the Alt scenario. Renewable energy potential in Vietnam is predicted to be 18 TWh for solar power, 7 TWh for wind power, and 131 TWh for hydropower. Obviously, there is a large gap between electricity demand and renewable energy supply in Thailand and Vietnam. Solar power potential in Vietnam is located in the southern half of the country owing to the relatively high solar irradiation levels. A large part of its wind power potentials exists in the southern coastal areas and offshore.

From those figures, it can be observed that Cambodia, the Lao PDR, and Myanmar have a huge potential to export renewable energy electricity to Thailand and Vietnam where the amount of renewable energy is not enough to meet their large electricity demands.

Expanding the grid system in GMS countries to fill the electricity demand and renewable energy supply gap

The grid electricity systems in the GMS countries except for Myanmar are interconnected with one another as shown in Figure 23.3. One-fifth of the electricity supply for Lao's grid system consists of imported electricity from Thailand. Also, as discussed below, the operation of the grid

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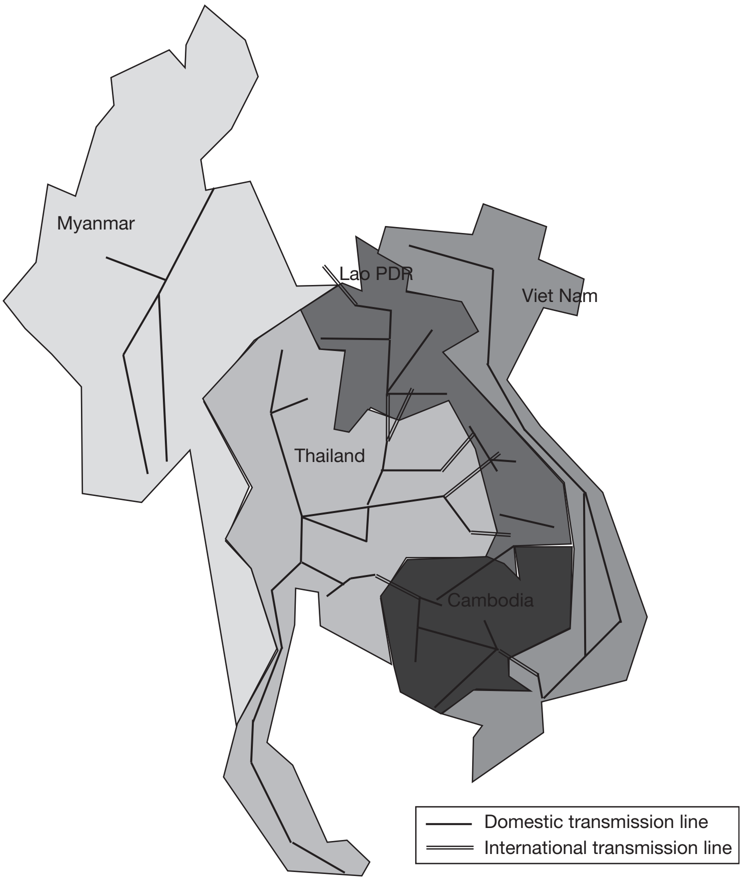

Figure 23.3 Grid map of the Mekong region

Data source: Authors.

electricity system in the Lao PDR highly depends on the grid electricity system in Thailand. For Cambodia, Vietnam supplies one-quarter of the electricityand Thailand supplies one-tenth. Also, there is an initiative of an ASEAN Power Grid (APG) that interconnects the electricity grids in all of the ASEAN countries, enabling cross-border electricity exchange, and could potentially increase the export capacity of electricity by renewable energies from the Lao PDR, Cambodia, and Myanmar to other countries. As has been discussed above, the Lao PDR and Cambodia have an enormous potential for renewable energy; the integration of the grid electricity systems would enable those countries to export more electricity to neighbouring countries.

Towards an effective institutional framework for mitigation actions to promote renewable and energy efficiency potential

As shown above, there are enough renewable energy potentials to meet the electricity demand increase in the GMS countries. It is important to implement an effective institutional framework to promote mitigation actions that enable them to mobilise renewable and energy efficiency potentials in these countries. Mitigation actions could be mobilised by not only project-based

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mechanisms such as baseline and credit mechanisms but also national climate and energy policies under national emission reduction targets such as INDCs under the Paris Agreement. In any case, MRV (measurement, reporting and verification) for mitigation actions at the project level, sector level, or national level is becoming critical for enhancing the transparency of those mitigation actions including renewable energy projects. Therefore, this section highlights the lessons learned from the operation of MRV under the Clean Development Mechanism (CDM) to provide insights into developing an efficient institutional framework that harnesses mitigation actions, because CDM is the first international mitigation mechanism for developing countries under the United Nations Framework Convention on Climate Change (UNFCCC) as a project-based baseline and credit mechanism under the Kyoto Protocol. In fact, CDM has suffered from identifying the baseline of mitigation project activity by renewable energies because CDM project developers had to determine the amount of emission reduction within host countries as a principle. In this case, it creates a complicated process for the calculation of grid emission factors in countries where the grid electricity systems are interconnected with those of other countries. Therefore this section highlights this issue because a similar concern arises as long as the mitigation initiatives are conducted in a single country rather than in multiple countries.

Calculation and accounting for emission reduction by mitigation actions

While mitigation policies or schemes provide an adequate incentive to implement renewable energies, this section highlights two technical issues which should be considered under a framework to mobilise mitigation actions: identification and accounting method of emission reduction by policy instruments.

First, Table 23.2 summarises the importance of identifying emission reductions. At the first stage of implementing mitigation policy instruments, a government often selects a baseline and crediting schemes such as CDM and the joint crediting mechanisms which Japan and the partner countries are jointly implementing. For those mechanisms, an emission factor is an essential number that quantifies the emission reduction by project activities of energy efficiency and renewable energy under this scheme.

A cap and trade scheme is another major instrument used to put a price on carbon by setting an emission cap for target entities. The basic design of the scheme covers direct emissions from target entities, but some cap and trade schemes cover indirect emissions such as the Tokyo Cap and Trade Programme. During the first commitment period of the Tokyo Cap and Trade Programme (FY 2010–2014), the average emission factor of 2005–2007 was applied (TMG, 2014). In this case, an emission factor is also needed to identify the achievement of emission reduction by through the scheme.

Mitigation efforts by all the countries are requested to be reported to the UNFCCC secretariat as biannual update reports. Therefore, the current climate regime requests each country to quantify its emission reduction amount by energy efficiency and renewable projects to communicate its efforts. While the mitigation outcome is reported by emission reductions which are calculated with direct emission data, countries that claim emission reduction efforts by mitigation action not by emission reduction targets, such as a goal of installing renewable energy or improving energy intensity per capita, may be recommended to quantify their emission reduction impacts to enhance transparency of their mitigation efforts.

Second, the accounting rule is also important to secure the environmental integrity of international mitigation policy instruments. In fact, accounting issues among developing countries have not been fully addressed under the CDM because no developing countries had mitigation commitments during the first commitment period of the Kyoto Protocol. However,

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Table 23.2 The role of grid emission factors for identifying impacts of mitigation policies and projects

Mitigation policy instruments	*Importance of identifying the grid emission factor*
Baseline and crediting scheme	Calculation of emission reduction by energy efficiency project and renewable energies project applies an emission factor of grid electricity system.
Cap and trade scheme	Some schemes cover indirect emissions and use the emission factor for calculating CO_2 emissions.
National mitigation actions/target such as NAMA and NDC	Some NDCs describe renewable energy implementation or energy efficiency targets as mitigation actions. It is preferable to identify emission intensity to quantify policy impacts.

Data source: Authors.

when the developing countries have emission reduction targets such as NAMAs and INDCs, accounting issues need to be addressed. IGES (2016b) points out four categories of accounting issues: double registration, double issuance, double usage, and double claiming. All of the issues are relevant to the identification of any mitigation mechanisms.

Lessons learned for identifying and accounting for mitigation effects: a case in the Lao PDR

One feature of the electric power sector in the GMS countries is grid electricity connection across national borders. This connected grid system provides both challenges and opportunities for international collaborative actions for promoting electricity savings and renewable energy under the international climate change policy regime, as the experience of the CDM shows. Though the price of CDM credits has declined sharply due to the recent economic recession, the CDM has provided major incentives to promote energy savings in this region. A total of 303 CDM projects had been registered in the GMS countries up to the end of 2015 (IGES, 2016a).

At the initial stage of the CDM, a grid electricity system was defined along the national borders, when emission factors were determined. This approach, however, hindered the development of CDM projects, in particular in the Lao PDR and Cambodia. First, since those two countries import a significant amount of electricity, they cannot identify the real emission factor of the electricity system by using only domestic electricity generation data. In this case, the two countries had to use an overly conservative emission factor for imported electricity, which resulted in lower Certified Emission Reduction issuance and did not provide an incentive to develop projects. Second, a project that reduces the importing of electricity has to be approved by both countries, that in which the project is located and the one from which the electricity is imported, to communicate how much the CDM project will make an impact on the electricity system of the neighbouring countries and contribute to emission reduction in both countries. Since this process was difficult for CDM project developers, it was only after taking a new approach, having the option of an international grid system, that CDM projects increased in the Lao PDR. The following goes into more detail on how identification of the baseline was improved through the case of the Lao PDR.

Identification of emission factors of the electricity system

The Lao PDR has plenty of hydropower sources owing to the abundance of water in the Mekong River Basin, which covers the entire area of the Lao PDR. As electricity demand in the Lao PDR

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and neighbouring countries such as Thailand and Vietnam has increased in proportion to economic development, especially for Thailand, the Lao PDR exported 200–700 TWh of electricity between 2009 and 2012, depending on the availability of water in rivers (EDL, 2009; 2010; 2011; 2012). Thus, the Lao PDR has attracted developers' attention as the "Battery of Mekong". However, the Lao PDR needs to import electricity from neighbouring countries such as Thailand despite having plenty of hydropower potential. This is because the capacity of hydropower plants with water reservoirs is not sufficient during the dry season.

Figure 23.4 shows the structure of the grid system in the Lao PDR. According to the grid map of Electricité du Laos (EDL), the Lao national grid electricity system is divided into four quadrants: the Northern Grid, Central Grid 1, Central Grid 2, and the Southern Grid. The Northern Grid covers five provinces and includes a population of 1.6 million people. The Northern Grid covers Sayaburi and Luang Prabang provinces. Central Grid 1 covers four provinces and has a population of 2 million people. This area includes the capital city, Vientiane, and it has the greatest electricity consumption among the four quadrants. The Central Grid 2 covers three provinces and has a population of 1.6 million people. Both Asian Highway 15, which passes Thakhek, and Asian Highway 16, which passes through Avannakhet, are located in this area. As a result, this area has clusters of industrial factories, which consume a fair amount of electricity. The Southern Grid covers four provinces and has a population of 1.3 million people.

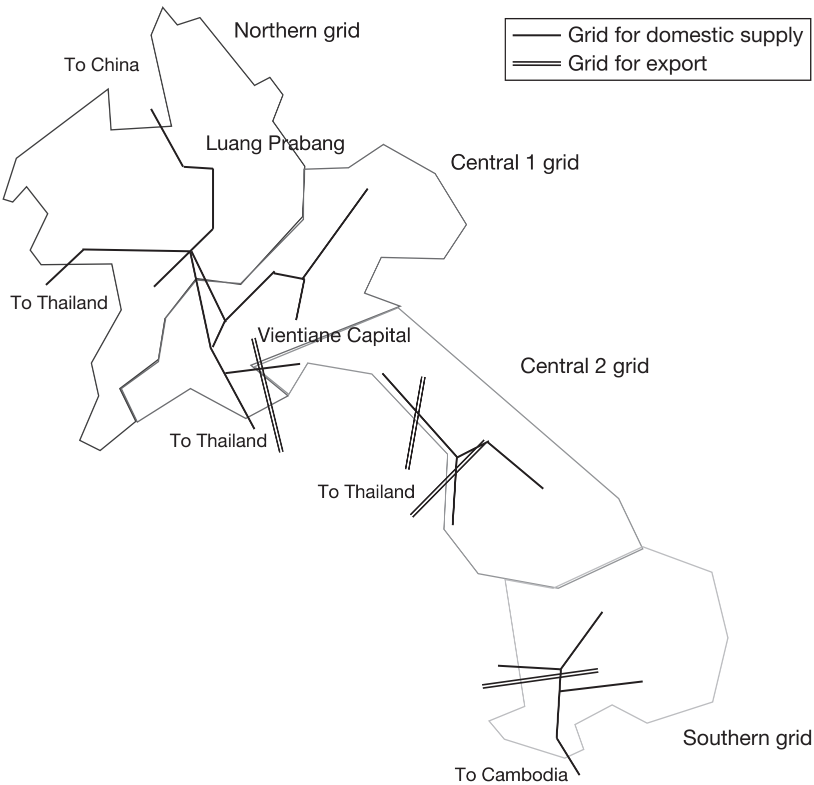

Figure 23.4 Four separate grids in the Lao PDR

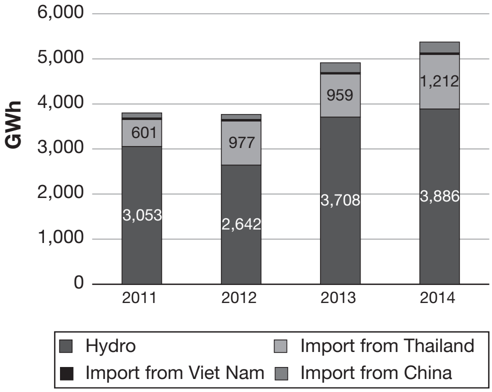

Figure 23.5 Electricity mix in the Lao PDR

Data source: Authors, based on the data provided by EDL.

Figure 23.5 shows the electricity mix of the Lao PDR from 2011 to 2014. As noted above, all the domestic power plants in the Lao PDR are hydro, but the electricity supplies were not stable. In 2011, the amount of electricity generated by hydropower plants was 3,053 MWh, but this decreased to 2,642 MWh owing to insufficient water resources. To supply the difference between the electricity demand and electricity supply capacity, imported electricity from Thailand increased even after the new hydropower plant started operating during 2012 and 2013. In 2014, electricity imported from Thailand increased to 1,212 GWh.

To calculate emission reduction by electricity saving or renewable energies, which displaces the electricity supplied by a fossil fuel fired power plant, a project participant had to identify the emission intensity (i.e. tCO_2/MWh) of the grid electricity system to which the proposed project connects. To calculate this number, the CDM Executive Board (CDM EB) provided guidelines for a "tool to calculate the emission factor for electricity" at the 35th CDM Executive Board meeting in 2007. This guideline requireed the defined boundary of the grid electricity system to be a national boundary. However, in practice, this request made it difficult for project developers to promote any CDM project activities in the Lao PDR since all the domestic power sources are hydropower. For example, even though the Lao PDR imports electricity from Thailand and Vietnam where many fossil fuel power plants supply electricity, the guidelines also denote "the emission factor is 0 tonnes CO_2 per MWh for imports from connected grid electricity systems located in another host country(s)" (UNFCCC, 2007). In the end, the grid emission factor is calculated to be 0 tCO_2/MWh, which results in no emission reduction by any energy efficiency and renewable energy project.

However, setting the grid boundary by the national boundary does not reflect on the actual operation of the grid electricity system for the countries where electricity import and export are frequently transacted through the international transmission line. Figure 23.6 shows the electricity supply from domestic hydropower resources and the electricity imported to each local grid in the Lao PDR.

Northern Grid does not have a large hydropower plant; it largely depends on imported electricity from China to meet electricity demands. For Central Grid 1, electricity supply has continuously increased. Even though the EDL power generation marked the largest amount of electricity supply, imported electricity has a major role in supplementing it, especially when demand exceeds supply during the dry season. Electricity supply from the Independent Power

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Producer (IPP) had been kept around 40 GWh in 2011 and 2012 owing to the long-term contract on electricity supply to Central Grid1 between the EDL and IPP owners.

For Central Grid 2, the amount of electricity supply for this region has also increased since 2010. Because this area harnesses some large IPP power plants, the main power source is electricity from IPP power generators. It should also be noted that, from the beginning of 2012, the imported electricity supplements the electricity supply when the electricity demand exceeds the supplying capacity of the IPP power plant for Central Grid 2. Even though it is not captured by Figure 23.6, there is also electricity export to Thailand by IPP plants through their original transmission line.

In Southern Grid, there are several large hydropower plants owned by the EDL, but those hydropower plants do not have a water reservoir; therefore, during the rainy season, the power stations can produce a lot of electricity and export it to Thailand and Cambodia. On the other hand, during the dry season, Central Grid 2 needs to import electricity from Thailand to meet the demand.

Owing to efforts to improve the guideline tool, some mitigation projects including energy saving projects in the Lao PDR come to the CDM project pipeline. Figure 23.7 shows the pathways to developing CDM projects in Mekong countries, reflecting the resulting share of the registered project of each year in the total registered project at 2015. The CDM project proponents extensively developed CDM projects in Cambodia, the Lao PDR, and Thailand around 2011. In contrast, around 60% of CDM projects in the Lao PDR were registered during 2013–2015. For this reason, until 2012, there had been a low incentive to develop CDM projects due to the low grid emission factors. However, after the government of the Lao PDR published the official grid emission factor at the beginning of 2014, the number of CDM projects in these countries significantly increased. It demonstrates good planning that the integration of the grid electricity system in this region will, by its very nature, contribute to promoting mitigation projects, including energy efficiency in the electricity sector and the implementation of renewable projects.

Reporting mitigation projects to countries exporting electricity

In addition to identifying emission factors, project approval by both the host country and the country exporting electricity was an additional burden on project developers. According to the clarification of CDM EB in its 28th meeting (Paragraph 14, meeting report), the transnational electricity systems are eligible under ACM0002 methodology (i.e. the CDM methodology for grid connected renewables), and the designated national authority (DNA) of countries in the region which the electric system spans shall be considered as host parties and shall provide a letter of approval stating that the project activity assists them in achieving sustainable development. Even though nothing is specified, there are at least two reasons for this. First, because the displacement of imported electricity could affect the operation of power plants (the stability of the grid electricity system in the exporting country, for example), the project developers in importing countries are encouraged to communicate with companies exporting electricity. Second, the displacement of imported electricity could also reduce GHG emissions from power plants in the exporting countries, owing to reduced electricity generation. When exporting countries implement domestic mitigation policies for the power sector, those policies would also help reduce CO_2 emissions by improving heat efficiency, lowering the amount of generation, etc. Therefore, when policy makers in exporting countries evaluate mitigation policies, they should consider the accounting issues involved in mitigation actions. So far, accounting issues have been less important because there has been no emission reduction

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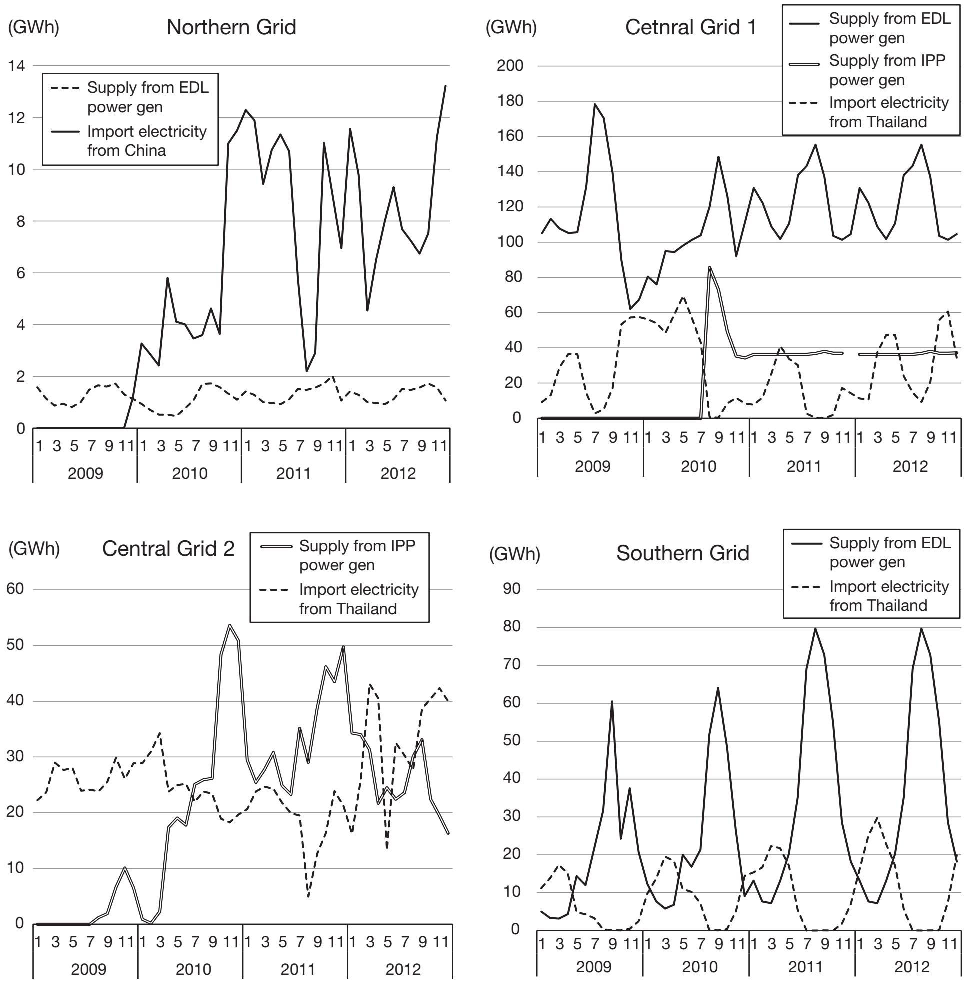

Figure 23.6 Electricity generation and import of each grid system in the Lao PDR

Data source: Authors, based on the data provided by EDL.

commitment for non-Annex I countries during the first commitment period of the Kyoto Protocol, and the CDM has been the only international mitigation mechanism. However, it will be more important during the second commitment period of the Kyoto Protocol and even after 2020, when all countries including the GMS countries need to take mitigation actions and implement several international mitigation schemes.

Examples of regional mitigation policy being consistent with integrated grid electricity systems in other regions

While grid electricity systems in the GMS countries are becoming integrated, it is reasonable to implement mitigation measures to reduce GHG emissions by achieving energy efficiency or increasing renewable energy production at the regional level. For example, the EU emission trading system (EU-ETS) covers all the grid electricity systems that are connected to one another. If some

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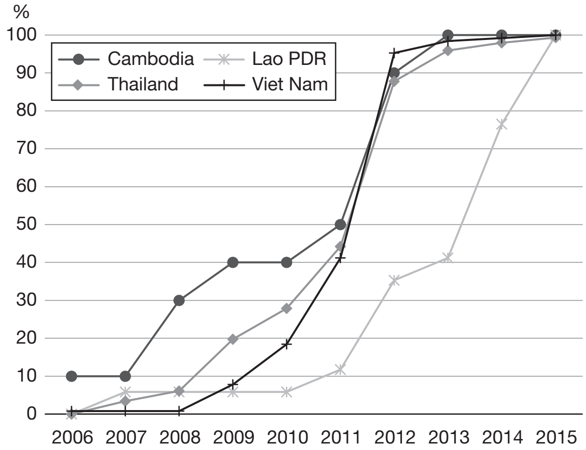

Figure 23.7 CDM project development pathways in GMS countries

Data source: Authors, based on IGES (2016a).

countries were not covered by the emission trading system, and fossil fuel power stations in these countries supplied electricity to the transnational electricity grids, power companies would have incentives to construct fossil fuel power plants in these countries. This disincentive to reduce GHG emissions is called "carbon leakage". For example, RGGI is the first mandatory emission trading system in the United States among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont to reduce CO_2 emissions from power plants. Banks et al. (2015) report the carbon leakage by transmitting electricity from the non-RGGI states, while RGGI achieved significant CO_2 emissions reductions.

On the other hand, if an ETS covers all the fossil fuel power plants that supply electricity to the transnational grid, zero emission power sources including renewable energy can be invested without carbon leakage. In the case of the US Clean Power Plan (CCP), which aims to reduce CO_2 emissions from power plants, each state develops its rules based on EPA guidelines. However, the CCP provides options for joint proposals by multi-states because grid electricity systems in some states are interconnected, and it is more efficient to develop an implementation plan by the states where power plants connect to the same grid electricity system (US EPA, 2015). Such cases imply that an integrated grid system is essential for robust market-based mitigation measures including a baseline and crediting system and a cap and trade system.

Therefore, once the regional emission reduction measures are also taken in the GMS countries, it is not necessary to address the identification and accounting issues as discussed above for the Lao PDR case because the area of emission sources corresponds to the area of emissions targets. The benefit of this integrated grid system approach is not only to promote mitigation projects but also to harness both domestic policies and the emerging international mitigation policies, including green finance and changing individual behaviour, by putting a price on carbon pollution (OECD, 2013).

Conclusion

The GMS countries have the potential to decarbonise their electricity systems by promoting energy efficiencies and renewable energies. While the mitigation policy instrument would have

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a major role to play in maximising the renewable energy and energy efficiency potentials towards decarbonisation, the identification and accounting method for emission reduction in a country-specific manner would impose significant barriers in the GMS countries based on the experience of the CDM.

To tackle those barriers, the proposed integrated electricity system, known as the ASEAN Power Grid, would have a positive impact in two respects. First, it physically bridges the linkage between the large renewable energy potential area and the demand area. Second, it presents the opportunity to bring in regional mitigation initiatives that would eliminate the complexity of identifying and accounting for mitigation impacts.

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