HOW STRATEGIC ENVIRONMENTAL ASSESSMENT CAN INFLUENCE POWER DEVELOPMENT PLANS

Comparing Alternative Energy Scenarios for Power Planning in the Greater Mekong Subregion

ASIAN DEVELOPMENT BANK

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Executive Summary

This volume was developed from the Asian Development Bank (ADB) study ***Ensuring Sustainability of the Greater Mekong Subregion Regional Power Development*** (TA 7764-REG). This study shows how the strategic environmental assessment (SEA) process can be used for power planning. The study is the first in the world to incorporate SEA, which focuses on sustainability and policy making, into power development plans (PDPs). Specifically, the study incorporates SEA into the PDPs in the Greater Mekong Subregion (GMS) to arrive at an optimal power development trajectory for the GMS as a whole.

This volume is the third in a three-part series of knowledge products focused on particular aspects of the study. It shows how SEA may be applied to compare different energy scenarios and how, by incorporating the wider impacts considered during the SEA process, a more sustainable power plan can be developed. It also shows how sustainability may be incorporated in power planning. This study assumes that the costs of impacts resulting from power sector development are the same for all Lower Mekong Basin countries, irrespective of their national income levels.

In this SEA study, sustainability issues are defined in terms of national and regional "security"—the degree of protection against danger, damage, or loss. Eight "security aspects" that capture the essence of sustainability for power planning are identified, namely, ecological security (land, water, air); climate security; food security; social security; health and safety security; good governance and state security; energy security; and economic security. For each "security aspect," a series of indicators and sustainability statements are used to assess the contribution of the existing regional power master plan. No easily measurable indicators were identified for the good governance and state security aspect that could be used to compare the scenarios, and the analysis for this aspect was descriptive.

In this third volume, alternative scenarios, namely, (i) current PDP, (ii) renewable energy with global and regional displacement options, and (iii) energy efficiency with global and regional displacement options are used to compare different generation mixes in the power plan. These are not detailed power plans, but planning tools that reflect significant power planning policy options, such as an increased contribution from renewable energy production and energy efficiency measures.

The process of developing alternative power plan scenarios used in the SEA involves projecting the development of installed capacity and generation by fuel type across the GMS to 2025 on the basis of existing PDPs in the region (the "current PDP" scenario). The current PDP scenario is an updated version (as of 2012) of the existing GMS Power Transmission Master Plan developed under ADB's TA 6440-REG. The current PDP scenario incorporates the national PDPs of Cambodia, the Lao PDR, Thailand, and Viet Nam to 2025. The PDP for

Myanmar as well as for Yunnan Province and Guangxi Zhuang Autonomous Region in the PRC were not available for this study. The current PDP is compared to the baseline situation of all power plants and regional interconnectors operational in 2012. Using the OptGen power model, relevant data from the existing and proposed power plants are used to displace—or remove and replace—some of the existing capacity with increased power generation mixes of renewables; or to decrease the demand for power with increased energy efficiency measures. This gives a renewable energy scenario and an energy efficiency scenario. Two displacement options are considered for each of these two scenarios—a global impacts option in which some coal-fired power plants are displaced to reduce carbon emissions; and a regional and local impacts option in which some large hydropower, nuclear, and coal-fired power stations are displaced to reduce regional and local impacts. These scenarios and displacement options are described together with the required regional interconnections to service the trade in power in the region.

The projections show that there is nearly a tripling of demand for power throughout the GMS by 2025, which is somewhat reduced by about 15% if energy efficiency measures are incorporated. The global displacement cases of the renewable energy and energy efficiency scenarios show a reduction in the output (gigawatts) of coal-fired power stations by about 10% and 16%, respectively, (or 9 and 15 fewer new coal-fired plants, respectively). The regional and local impacts cases of the renewable energy scenario shows three less nuclear power plants; while for the energy efficiency scenario, there would be eight and 22 less large hydropower plants compared to the current PDP. In addition, the regional and local energy efficiency scenario shows eight less coal-fired power plants.

The current PDP and the four alternative cases (two scenarios each comprising two displacement cases) are compared both qualitatively and quantitatively. The qualitative comparison uses radar diagrams showing the relative differences between the scenarios for all 46 of the indicators used in each of the eight “security aspects” or areas of sustainability. In almost all cases, the energy efficiency scenario emerges as the most sustainable of the power development options, followed by the scenario with an increased renewable energy contribution to the power generation mix.

The quantitative comparison monetizes six of the 46 key sustainability indicators that could be consistently valued. Financial costs of electricity generation are added to these six indicators. The energy efficiency scenario incurs lower costs largely because fewer plants have to be built to meet the reduced demand. The renewable energy scenario has slightly higher financial costs (approximately 5%) because of the higher costs of these technologies and the need to provide additional backup capacity to allow for their intermittent supply. However, when the monetized sustainability impacts are taken into account, the total social costs for both global and regional cases under the renewable energy scenario are very similar to the current PDP. This indicates that the higher financial costs of renewable energy technologies can be offset by their reduced impacts, leading to unchanged or improved social welfare. Furthermore, the renewable energy scenario was found to be more energy-secure.

Monetization provides a clear comparison of the costs, benefits, and trade-offs of each scenario. It is important to note that the environmental and social benefits may be considerably higher than those monetized by this SEA. Firstly, conservative assumptions were made; secondly, the costs of some issues, such as resettlement, were only partially monetized (i.e., no attempt was made to calculate the multigenerational, community, cultural, and livelihood impacts of resettlement). Lastly, many indicators and potential impacts were not monetized at all, such as ecosystem health and biodiversity. It is recommended that further studies be carried out to monetize more indicators that can enhance the sensitivity of SEA in power development plans.

The methods for developing qualitative comparisons between all of the indicators and security aspects using a radar diagram approach illustrates how the assessment can highlight the strengths and weaknesses of the different power plan options. Application of a weighting process would increase the sensitivity of this approach.

This volume finds that incorporating significantly greater renewable energy production and greater energy efficiency measures would increase the sustainability of the power plans at a comparatively low additional financial cost. Moreover, energy efficiency measures can offset costs of additional renewable energy. From an energy planning as well as consumer perspective, the resulting power generation mix would be stable and would provide greater energy security, while remaining affordable and accessible.

Recommendations emerging from the analysis are as follows.

(i) More accurate and realistic demand forecasting is an essential part of the process of making power sector development more sustainable.

(ii) Sustainability of power sector development would be improved with greater emphasis on combining energy efficiency measures and renewable energy technologies.

(iii) There are trade-offs between financial costs and sustainability. A monetization exercise recognizes these and shows that social welfare can be increased with appropriate deployment of renewable energy technologies.

(iv) In their choice of technologies for new power generation, governments should be aware of the need to address greater regional and local impacts if they adopt a policy of reducing carbon emissions from the power sector.

Abbreviations

ADB	–	Asian Development Bank
CSG	–	China Southern Power Grid
EE-G	–	energy efficiency scenario with global displacement option
EE-R	–	energy efficiency scenario with regional displacement option
GHG	–	greenhouse gas
GMS	–	Greater Mekong Subregion
GW	–	gigawatt
Lao PDR	–	Lao People’s Democratic Republic
LMB	–	Lower Mekong Basin
MW	–	megawatt
MWh	–	megawatt-hour
PDP	–	power development plan
PRC	–	People’s Republic of China
RE-G	–	renewable energy scenario with global displacement option
RE-R	–	renewable energy scenario with regional displacement option
SEA	–	strategic environmental assessment
TA	–	technical assistance
TWh	–	terawatt-hour

Zemoshan wind farm with 61 windmills with 45.75 MW capacity, Daly, Yunnan, People's Republic of China

Introduction

The Asian Development Bank's (ADB) project on ***Ensuring Sustainability of the Greater Mekong Subregion Regional Power Development*** is a $1.35 million technical assistance project (ADB 2010a). It has the following objectives:

(i) assess the impacts of alternative directions for the development of the power sector in the Greater Mekong Subregion (GMS) through a strategic environmental assessment (SEA);[1]

(ii) develop recommendations on how to minimize and mitigate harmful impacts in the power sector; and

(iii) provide capacity building for GMS countries in the conduct of SEA, and support its integration into the power planning process.

This project commenced in March 2012 with a series of three regional consultations. National consultations were also held in four countries of the Lower Mekong to contribute toward the development of sustainability indicators for use in assessing the impacts.[2] A baseline report was produced in January 2013, including a report setting out the alternative power planning

1 The Greater Mekong Subregion includes Cambodia, the Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, Viet Nam, and Yunnan Province and Guangxi Zhuang Autonomous Region in the People's Republic of China (PRC).

2 This strategic environmental assessment (SEA) study was "sustainability-led." Sustainability issues were defined in terms of national and regional "security"—the degree of protection against danger, damage, or loss. Eight "security aspects" that capture the essence of sustainability for power planning were identified, namely: (i) ecological security (pollution, land and biodiversity, rivers); (ii) climate security; (iii) food security; (iv) social security; (v) health and safety security; (vi) good governance and state security; (vii) energy security; and (viii) economic security. Associated with each "security aspect" is a series of indicators and sustainability statements that were developed through stakeholder consultation and literature review, and against which the contribution of the existing regional power plan was assessed.

scenarios (ADB 2013a).[3] The impact assessment report and summary report, complete with recommendations were finalized in December 2013.

A three-volume series of knowledge products prepared from the study captures significant aspects of the SEA process. These volumes are as follows.

(i) Integrating Strategic Environmental Assessment into Power Planning

(ii) Identifying Sustainability Indicators of Strategic Environmental Assessment for Power Planning

(iii) How Strategic Environmental Assessment can Influence Power Development Plans—Comparing Alternative Scenarios for Power Planning in the Greater Mekong Subregion

This volume applies SEA to compare different scenarios, and shows how a more sustainable power plan can be developed by incorporating the wider impacts considered during the SEA process. It also demonstrates how sustainability may be assessed in power planning, and how incorporating wider impacts might change decisions on the optimal power plan. This volume complements the first and second volumes in this series.

The first volume shows how the SEA process can be used for power planning and how capacity for conducting SEAs and the consultation process can be strengthened. It highlights the role of SEA in assessing the sustainability of polices and plans at a regional or national level. The volume also shows how the SEA process can contribute to good governance in the power planning process, and how the capacity of national governments and stakeholders in the power planning process can be strengthened.

The second volume describes the application of the SEA methodology to the GMS regional PDP. It shows how a set of indicators may be defined and used to capture the wider impacts of power planning, and to analyze PDPs in the GMS to achieve greater sustainability.[4] The volume explains why the particular indicators were selected for the study, why they are important, how they can be measured, and what the indicators reveal. Using the indicators established by the study, the volume shows how SEA may be applied to qualitatively and quantitatively compare different scenarios. The second volume also presents monetization

3 The study had three power planning scenarios: (i) current power development plan (PDP), (ii) renewable energy, and (iii) energy efficiency. The current PDP scenario is an updated version (as of 2012) of the existing GMS Power Transmission Master Plan developed under the Asian Development Bank's (ADB) TA 6440-REG. The current PDP scenario incorporates the national PDPs of Cambodia, the Lao PDR, Thailand, and Viet Nam to 2025. The PDP for Myanmar as well as for Yunnan Province and Guangxi Zhuang Autonomous Region in the PRC were not available for this study. The current PDP is compared to the baseline situation of all power plants and regional interconnectors operational in 2012. Two displacement options are considered for the renewable energy and energy efficiency scenarios—a global impacts option in which some coal-fired power plants are displaced to reduce carbon emissions; and a regional and local impacts option in which some large hydropower, nuclear, and coal-fired power stations are displaced to reduce regional and local impacts. In the context of this SEA, the term "displacement" is used to indicate the option of removing a planned thermal, large hydropower, or nuclear plant from the PDP scenario and replacing it with greater contributions from renewable energy and energy efficiency.

4 The World Commission on Environment and Development (the Bruntland Commission) in 1987 defined sustainability as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

as a means of comparison across scenarios, and explains how selected indicators were monetized.

In addition, a series of SEA briefing papers produced earlier present the different stages of the SEA process in the format of case studies. An updated database of power plants in the GMS developed from a database provided by an earlier ADB project (TA 6440-REG) titled *Facilitating Regional Power Trading and Environmentally Sustainable Development of Electricity Infrastructure in the Greater Mekong Subregion. Component 2: Analysis of SEA in GMS Countries, and Identification of Gaps, Needs and Areas for Capacity Development* (ADB 2010b) is also available, together with an explanatory manual (ADB 2014).

The SEA process is usually conducted at a relatively high level and complements the more detailed environmental impact assessments (EIAs) necessary for specific developments. The SEA process has its own limitations and assumptions because of the scale at which it is conducted. Such assumptions must be made clear and transparent.

The development of more sustainable power plans must be underpinned by good governance.[5] Poor governance throughout the power planning process and operation of power plants in the GMS, along with the associated environmental and social impact assessment and monitoring, were major concerns of stakeholders consulted throughout this study.

This study constitutes an attempt to introduce and incorporate a methodology for SEA in PDPs. The findings and recommendations are by no means exhaustive and final, but are meant to serve as a springboard for more in-depth SEA on individual national PDPs. The monetization of more indicators, in particular, is an area for future research.

[5] In this study, good governance covers policy making including laws and regulations, enforcement of environmental conditions and social safeguards, as well as issues of corruption and capacity of institutions to manage the process. It refers to oversight of policy making, planning, operations and management by government, state-owned enterprises, and private entities, and involves consultation with public, private, and civil society organizations. Good governance and capacity development is one of the five drivers of change that ADB, in its long-term strategic framework Strategy 2020 (ADB 2008), focuses on to better mobilize and maximize resources, the others being (i) private sector development and private sector operations, (ii) gender equity, (iii) knowledge solutions, and (iv) partnerships.

Construction is nearly complete in this 40 MW Phyu hydropower dam in Myanmar

Development of the Alternative Scenarios

In this study, ADB drew up alternative scenarios in the SEA process to compare and contrast the sustainability of different variations on the regional power plan. From this analysis, conclusions are drawn for power planning policy such as the choice of technology to include in the power generation mix, the proportion of renewable energy, and the emphasis required on energy efficiency. The alternative scenarios are not intended to be fully developed power plans but to serve as an important planning tool. They reflect significant differences in policy, so that the SEA comparisons can highlight important differences and trends.

Process of Development

The process of developing alternative power plan scenarios used in the SEA involves projecting the development of installed capacity and generation by fuel type across the GMS to 2025 on the basis of existing PDPs in the region (the "current PDP" scenario). The current PDP scenario is an updated version (as of 2012) of the existing GMS Power Transmission Master Plan developed under ADB's TA 6440-REG. The current PDP scenario incorporates the national PDPs of Cambodia, the Lao PDR, Thailand, and Viet Nam to 2025. The PDP for Myanmar as well as for Yunnan Province and Guangxi Zhuang Autonomous Region in the PRC were not available for this study. The current PDP is compared to the baseline situation of all power plants and regional interconnectors operational in 2012. The scenarios are (i) current PDP, (ii) renewable energy with global and regional displacement options, and (iii) energy efficiency with global and regional displacement options.[6] The study looked

[6] In the context of this SEA, the term "displacement" is used to indicate the option for removing a planned thermal, large hydropower, or nuclear plant from the PDP scenario and its replacement by greater contributions from renewable energy sources and energy efficiency measures. The global displacement scenario involves the displacement of some coal-fired thermal plants to address issues of carbon emissions. The regional displacement scenario involves the displacement of some planned large hydropower plants, nuclear plants in Viet Nam, and a few coal-fired plants.

at how capacity and generation would change when (i) additional renewable energy is developed, displacing conventional capacity; and (ii) where additional energy efficiency measures are undertaken, also displacing conventional capacity.[7] The renewable energy scenario represents a plausible additional level of penetration of renewable energy capacity in addition to that included in existing PDPs, while the energy efficiency scenario represents the achievable levels of efficiency based on benchmarking against performance elsewhere.

For each of these scenarios, two displacement cases or sub-scenarios were defined. Under the first, the "global impacts" case, conventional capacity with the highest impacts on greenhouse gas (GHG) emissions is displaced by additional renewable energy capacity or energy efficiency measures comprising lignite and coal-fired generation. Under the second, the "regional impacts" case, conventional capacity with the highest impacts on the GMS environment and population is displaced. This comprises large hydropower, nuclear, lignite, and coal capacity, in that order.

In displacing conventional capacity, it was assumed that many new power projects are already committed and, therefore, cannot be displaced. Significantly, this includes the Xayaburi mainstream dam and the Hong Sa lignite power plant, both located in the Lao People's Democratic Republic (Lao PDR). The expansion of the Mae Moh lignite power plant, located in Thailand, is assumed to be displaced in all cases.

While the projected capacity and generation is available for the whole of the GMS under the current PDP scenario, data limitations restrict the projections of the alternative scenarios to the four Lower Mekong Basin (LMB) countries comprising Cambodia, the Lao PDR, Thailand, and Viet Nam. Comparisons of the current PDP scenario and the alternative scenarios are for the LMB countries only.

In developing the scenarios for this study, the threshold for medium- and large-sized hydropower was taken as 30 megawatts (MW), the standard for Viet Nam. Existing small hydropower plants (less than 30 MW) are considered as aggregate installed capacity. In developing the scenarios, the standard of 10 MW was used and applied to an estimated potential for small hydropower in each country, based upon the optimum regions for small-scale hydropower in the country (ADB 2010a). It was not based on the numbers of plants currently in the planning and design stages.

Assumptions and Limitations

The project's focus on the LMB under the alternative scenarios was required as detailed power development plans are not available for the power sector in Yunnan Province and Guangxi Zhuang Autonomous Region in the People's Republic of China, and in other GMS members.

7 Separating these scenarios into renewable energy and energy efficiency scenarios was specified in the terms of reference for the project and reconfirmed at the first regional consultation. Consequently, renewable energy sources and energy efficiency measures are treated as alternatives to each other for the purposes of the SEA analysis although in practice, a sustainable energy development path would combine elements of both.

Communications with China Southern Power Grid Company (CSG) have, however, allowed significant power plants and expected developments over the study period to be identified.

Other assumptions and limitations associated with the analysis are presented below.

(i) Demand projections under the PDPs are retained to reflect current power planning assumptions in GMS countries. While consultations under the project revealed a wide perception that such demand projections may prove to be overestimated, the PDPs remain as the figures most widely accepted by power planners and used as basis for the analysis.

(ii) Potential renewable energy plants are modelled as "blocks" of capacity using a standard plant size and their geographic distribution is assumed to be uniform across areas of identified renewable resource potential. Due to the "broad brush" nature of the analysis, it was not possible to identify specific locations, which would depend on many site-specific variables.

(iii) Displacement of plants under the alternative scenarios removes conventional capacity and replaces it with renewable capacity or energy efficiency, based on the electricity output they produce. It assumes that power trade between countries will redistribute electricity output in a perfect interlinked grid and as such simplifies the potential grid management issues that may arise from increased power trade.

(iv) Modelling uses a monthly time-step, hence, daily and hourly variations in power output particularly for renewables are not reflected. Such variation has been addressed by incorporating sufficient reserve capacity in the form of open cycle gas plants that can be readily switched on and off to compensate for fluctuations in the grid.

(v) Reliable water inflow data was available only for existing plants in Viet Nam due to the availability of the database supplied by the Load Dispatch Centre of Electricity Vietnam National. The data made available included many years of historical inflows, from which a reliable synthetic inflow model could be derived. Data from an earlier ADB study (TA 6440-REG) was used for the remainder of the region, outside Viet Nam.

(vi) No new flexible thermal capacity is planned for the region. Modelling of this aspect may have significant impacts on the needs for interconnection and on emissions. The limited flexibility of the thermal projects planned throughout the region is likely to result in higher emissions, as they will be forced to run at minimum output during low load periods. Larger interconnection capacity may be required to allow load following to be supplied by means of hydropower plants located in other areas.

(vii) Data on the earliest commissioning dates for interconnectors and their capacity and load profiles was taken from the preceding study and could not be updated within the constraints of this project.

(viii) The costs of energy efficiency measures to be implemented in the energy efficiency scenario required the creation of appropriate cost curves by assuming rising payback periods for greater volumes of energy efficiency. The assumptions upon which this was based are outlined in the energy efficiency scenario discussion in section 3.

Using the OptGen Power Planning Model

The OptGen database used for this study was prepared for the earlier TA 6440-REG project.[8] OptGen is a proprietary hydrothermal power system expansion planning system developed by Power Systems Research of Rio de Janeiro.

The database was updated using current power plans for each country, and improved using new data. New sources of data include the Mekong River Commission database, and the database used by Electricity Vietnam National in their dispatch planning model, stochastic dual dynamic programming.

Because of the need to work within the framework of a general purpose hydrothermal power system planning software, a number of "work-arounds" are present in the OptGen database. Consequently, various dummy power plants are included, so the database does not correspond exactly to the physical system.

In this SEA, OptGen was used to determine optimal commissioning dates for new interconnections, in addition to those already committed. OptGen was not used to calculate optimal generation plant commissioning, as this data was taken from the PDPs of each country in the region. These plans were considered to be fixed, except for the Lao PDR. Export projects were included in the plan only if they were also included in the plans of the receiving country. The remaining generation in the Lao PDR would have created a large surplus for export. New projects have been removed or delayed to reduce Thai imports to approximately 15%.

Five separate databases were prepared, each corresponding to one scenario. Differences consisted of commissioning dates for new plant and interconnections; quantities of alternative energy sources; and for the energy efficiency scenario, different load growth profiles.

Data assumptions and limitations include the following:

(i) a time horizon of 1 January 2012 to 31 December 2027 in monthly time-steps with five load categories;

(ii) three inflow scenarios: dry, average, and wet;

(iii) a discount rate of 12%, with costs in US dollars in 2010 terms;

(iv) a deficit cost (economic penalty for blackouts) of $3,500 per megawatt-hour (MWh); and

(v) for thermal plant fuel costs, the key input was the International Energy Agency's costs for their "New Policies" scenario.

8 Detailed instructions on how the OptGen software and power plant database were operated can be found in the associated report, *GMS Strategic Environmental Assessment Power System Modelling: Processes and OptGen Database* (ADB 2013b).

West Phnom Penh
230 kV substation,
Cambodia

Description of the Scenarios

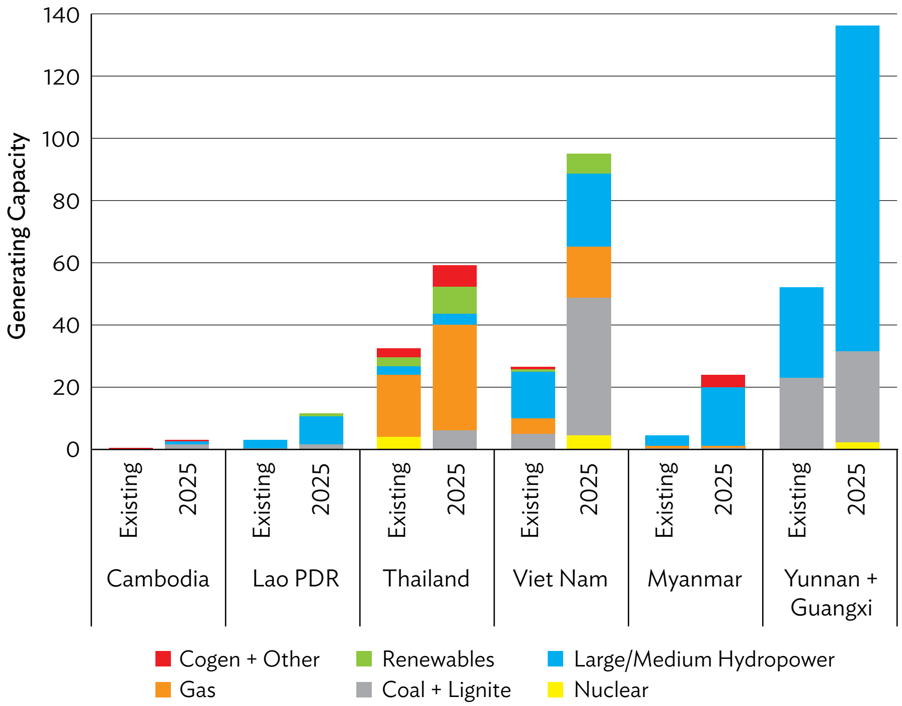
Current Power Development Plan Scenario

The current PDP scenario projects a very rapid expansion of installed generating capacity within the GMS, almost tripling from 2012 to 2025 (Figure 1). This expansion is driven by the projected increase in Yunnan Province and Guangxi Zhuang Autonomous Region in the PRC, which are expected to more than double in installed capacity from 53 gigawatts (GW) in 2012 to 136 GW by 2025, representing 40% of the total increase across the GMS. However, the dominance of Yunnan and Guangxi may still be understated. This is because SEA figures are based only on *identified* new plants, while new CSG information shows that total additional thermal and nuclear alone are greater than these figures.

Among the LMB countries, Thailand and Viet Nam represent 88% of installed capacity in 2025. Viet Nam is projected to become the largest market among the four LMB countries by 2016, overtaking Thailand, with a demand 60% greater than that of Thailand by 2025. Viet Nam's installed capacity is projected to grow more than threefold from 27 GW to 94 GW in 2025, 30 GW of which will come from coal-fired capacity and a further 5 GW from nuclear capacity. Cross-border trade within the LMB countries will increase significantly, with the major flow being from hydropower export projects located in the Lao PDR to Thailand.

The new coal-fired generating plants are clustered in southern Viet Nam, and in northern Viet Nam around Hai Phong; as well as in Guangxi and Yunnan. Nuclear generation is located in southeastern Viet Nam and in the coastal region of Guangxi. Large hydropower projects are developed across the region.

Figure 1. **Projected Installed Capacity by Country in the Greater Mekong Subregion, Current Power Development Plan Scenario**
(gigawatt-hours)

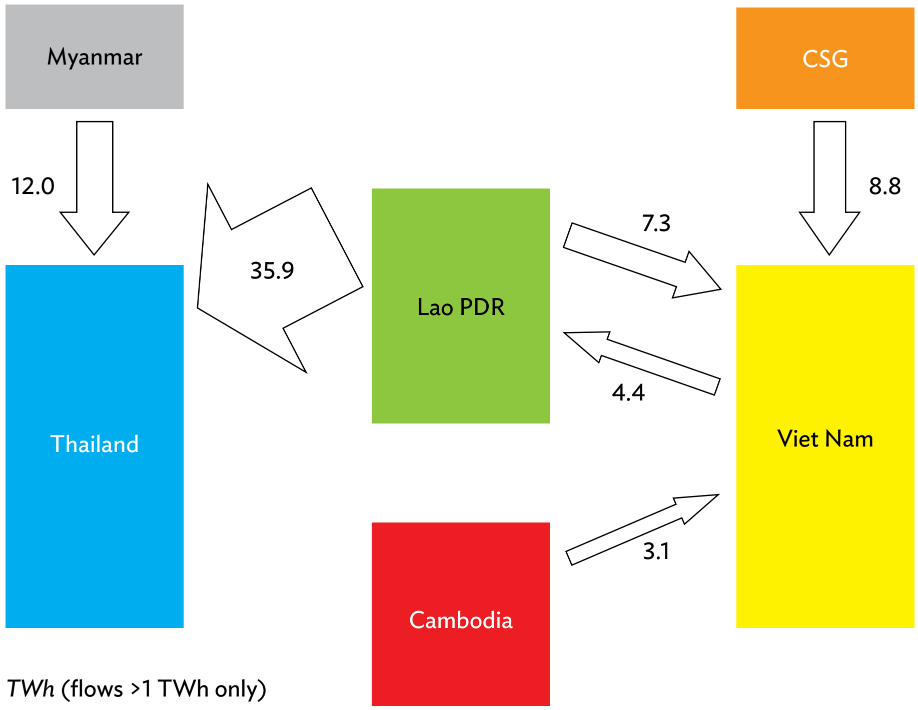


Cogen = cogeneration, Lao PDR = Lao People's Democratic Republic.
Source: ADB. 2013c.

The projected cross-border flows in 2025 under the current PDP scenario are shown below. As can be clearly seen, the major flow is that from hydropower export projects located in the Lao PDR to Thailand, with smaller imports from hydropower export projects located in Myanmar. Viet Nam has limited imports from hydropower export projects in Cambodia, the Lao PDR, and CSG. Exports from Viet Nam to the Lao PDR represent flows into the southern part of the Lao PDR; at the same time, Viet Nam is importing from the northern part of the Lao PDR to its northern region (Figure 2 and Map).

Under the current PDP scenario, this increased trade means the existing 1,037 kilometers (km) of interconnectors will increase by a further 2,743 km by 2025. The approximate routes for identified interconnectors are shown in the map.

Figure 2. **Projected Cross-Border Flows in the Lower Mekong Basin, Current Power Development Plan Scenario, 2025**
(terawatt-hour)

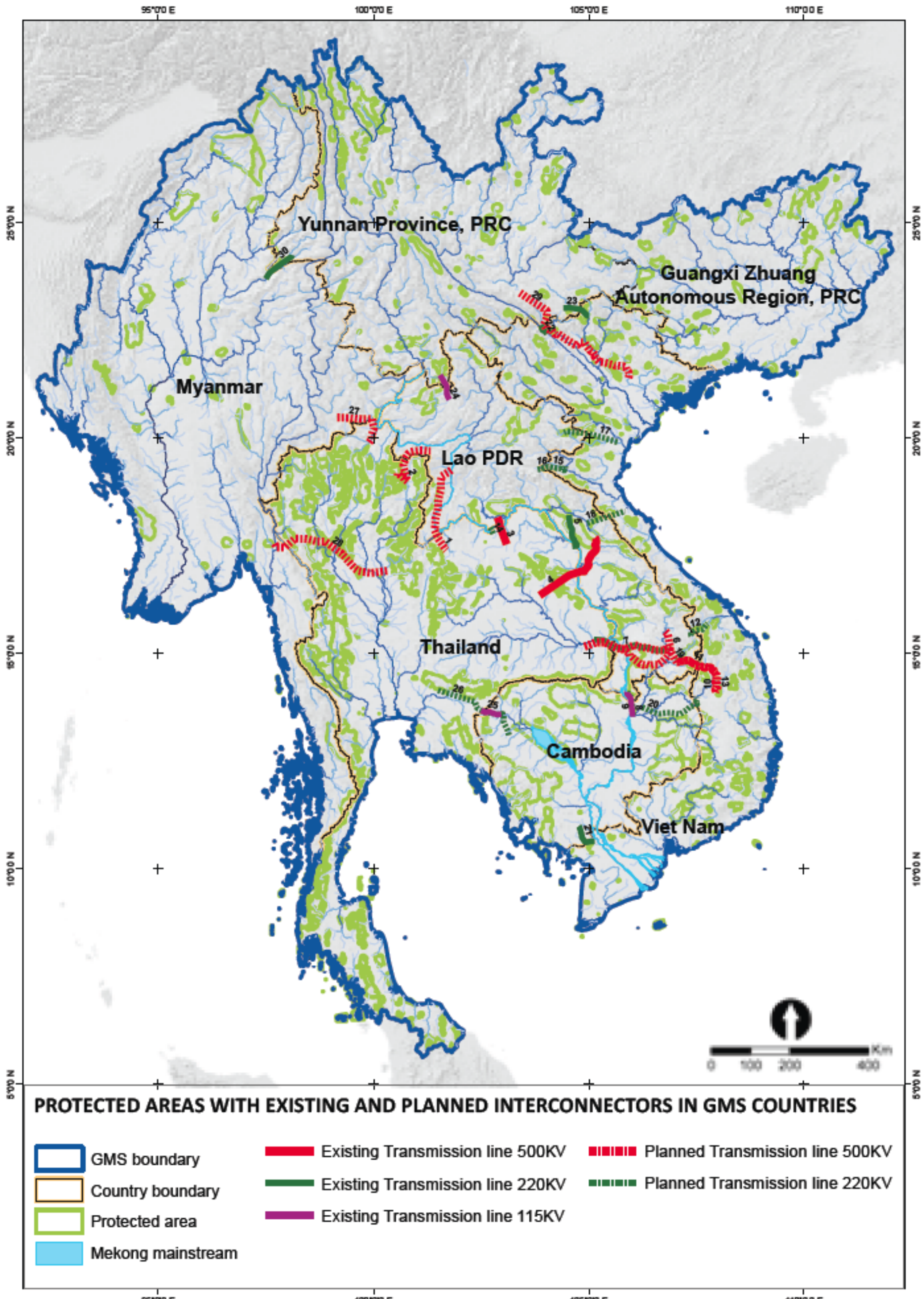


CSG = China Southern Power Grid, Lao PDR = Lao People's Democratic Republic, TWh = terawatt-hour.
Note: Only flows greater than 1 TWh are presented.
Source: ADB. 2013c.

Renewable Energy Scenario

Under the renewable energy scenario, an additional 27 GW of renewable energy capacity is installed in LMB countries displacing big hydropower and thermal power plants. By 2025, the projected share of renewable energy in installed capacity across these countries rises from 9% under the current PDP scenario to 23%, and the share of generation from 7% to 16%. Solar installations in Thailand account for 9.4 GW of the additional renewable energy capacity, followed by small hydropower in Viet Nam of 4.8 GW, and 4 GW of solar also in Viet Nam. The contributions of wind and biomass or biogas are relatively small, reflecting limited high-quality resources in the region that are not already targeted for development. The additional renewable energy generation output in the renewable energy scenario is shown in Figure 3.

Map. **Cross-Border Interconnector Routes, 2025**

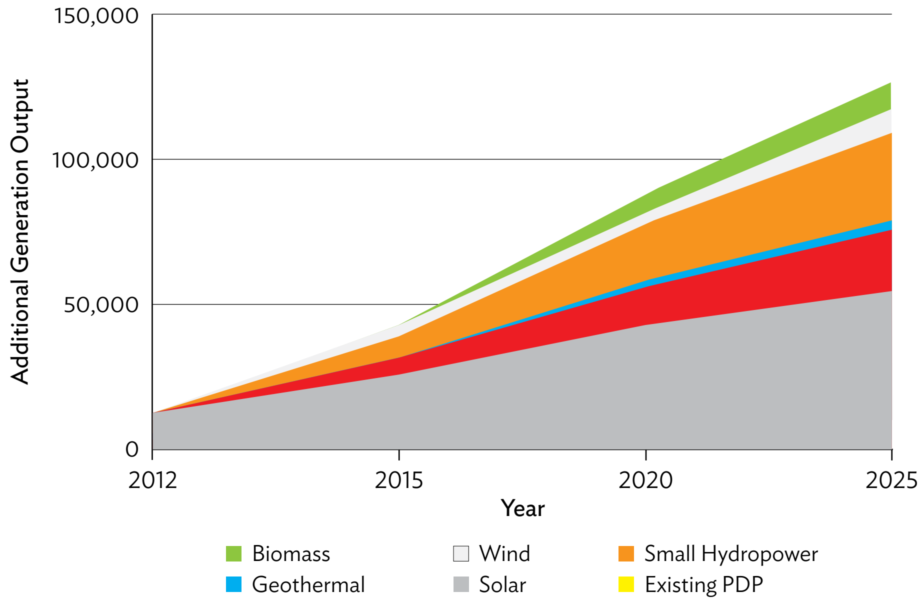


GMS = Greater Mekong Subregion, KV = kilovolt, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.

Note: At the time this study was written (April 2014), the base map was still under revision. The map was generated using ArcGIS, a platform for designing and managing solutions through the application of geographic knowledge (http://www.esri.com/software/arcgis).

Source: ADB. 2013c.

Figure 3. **Renewable Energy Generation Output in the Renewable Energy Scenario, All Lower Mekong Basin Countries**
(gigawatt-hour per annum)



PDP = power development plan.
Source: ADB. 2013c.

The resulting share of renewable energy technologies in total capacity and generation under the current PDP scenario and the renewable energy scenario is compared in Table 1 below.

Table 1. **Renewable Energy Shares by Scenario in Lower Mekong Basin Countries, 2025**
(%)

	Current PDP Scenario		Renewable Energy Scenario	
Security Aspect	Capacity	Output	Capacity	Output
Cambodia	1	1	25	20
Lao PDR	2	2	17	15
Thailand	15	12	27	20
Viet Nam	7	5	19	13
LMB	**9**	**7**	**22**	**16**

Lao PDR = Lao People's Democratic Republic, LMB = Lower Mekong Basin, PDP = power development plan.
Source: ADB. 2013c.

The additional renewable energy capacity is assumed to be located in areas of high resource potential, as follows:[9]

(i) solar potential is concentrated in central and northeast Thailand and along Viet Nam's coastline;

(ii) biomass potential is concentrated in the major rice-growing areas of the Chao Phraya basin, northeast Thailand, and the Mekong Delta;

(iii) onshore wind potential is concentrated along Viet Nam's southeast coastline; and

(iv) small hydropower is concentrated in the highland areas of the Lao PDR and Viet Nam.

Energy efficiency measures will have a cost to implement, and that cost will rise with the volumes of measures implemented. To assume that energy efficiency measures are "costless" is equivalent to saying energy efficiency should be pursued without limit, which is clearly meaningless.

However, while costs of a limited number of energy efficiency policies are publicly available, these are not readily transferable to estimating the costs of achieving a given volume of demand reduction through a mix of unspecified measures, which is what is required. Hence, an assumed cost curve for energy efficiency measures was created. An investment cost was estimated using an assumed payback period in years and the estimated short-run marginal cost of supply for each country was obtained from the power sector modeling. For example, if additional energy efficiency measures are expected to deliver electricity savings of 1 TWh annually and the estimated short-run marginal cost is $100/MWh, then the value of these savings is $100 million annually. With an assumed required payback period of 5 years, then the present value of these savings is $360 million (applying a discount rate of 12%). This represents the maximum amount at which it is economical to invest in energy efficiency measures to deliver these savings. To convert this into a levelized cost, energy efficiency investments were assumed to operate over 20 years, with the levelized cost being the present value of the monetary savings divided by the present value of the energy savings, or $48/MWh in this example.

In the calculations, it was recognized that the costs of energy efficiency measures will increase as the volumes of savings increase. A cost curve was created by assuming rising payback periods for greater volumes (which implies a higher initial investment under this approach). The payback periods for the first 25% of additional savings in Thailand and Viet Nam were obtained from a recent study by ReEx Capital (2010). Each additional 25% block of savings was assumed to have a payback period 2 years longer. The payback periods for Cambodia and the Lao PDR are weighted averages of those for Thailand and Viet Nam.

The additional renewable energy capacity in the renewable energy scenario allows the displacement of 9 GW of lignite and coal capacity relative to the current PDP scenario, mostly located in Viet Nam, under the global impacts case. Under the regional impacts case, 2 GW of large hydropower capacity, 5 GW of nuclear capacity, and 2 GW of lignite and coal

[9] Maps showing the parts of the GMS with the greatest potential for different renewable technologies can be found in ADB (2013c).

capacity are displaced. The relatively small quantity of large hydropower capacity displaced reflects the study's assumption that many of these projects are already committed (only eight projects are displaced in total).

Energy Efficiency Scenario

The energy efficiency scenario projects demand across the LMB to decrease by 15% by 2025 relative to the current PDP scenario. Energy efficiency potential in the industrial, commercial, and residential sectors was estimated in Thailand and Viet Nam using published sources, government plans, and international energy consumption benchmarks. These two countries comprise 96% of projected electricity demand to 2025 in the LMB countries. Cambodia and the Lao PDR are yet to develop national energy efficiency plans, and their national demand is a much smaller share of regional demand.

Table 2 shows the resulting implied reductions in projected demand by 2025, relative to the current PDP scenario. Over the LMB as a whole, the additional energy efficiency potential identified is equivalent to a reduction in demand of approximately 15% relative to that in the current PDP scenario.[10]

The reduction in demand under the energy efficiency scenario allows a reduction of 16 GW of lignite and coal capacity under the global impacts case and of 4 GW of large hydropower capacity (22 plants), 5 GW of nuclear capacity, and 8 GW of lignite and coal capacity under the regional impacts case. The much greater quantities of capacity that energy efficiency displaces relative to additional renewable energy capacity is evident.

Table 2. **Projected Demand by Scenario, 2025**

Security Aspect	Current PDP Scenario and Renewable Energy Scenario (terawatt-hour)	Energy Efficiency Scenario (terawatt-hour)	Percent Change
Cambodia	12.3	11.1	(10.0)
Lao PDR	18.2	16.4	(10.0)
Thailand	294.5	247.2	(16.1)
Viet Nam	489.6	413.6	(15.5)
LMB	**814.7**	**688.3**	**(15.5)**

( ) = negative, Lao PDR = Lao People's Democratic Republic, LMB = Lower Mekong Basin, PDP = power development plan.
Source: ADB. 2013c.

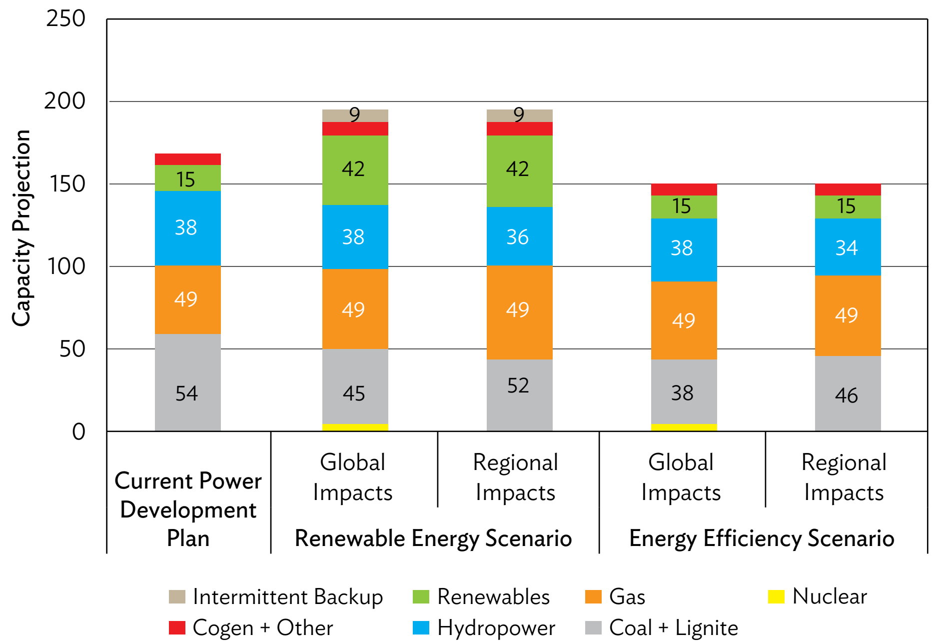
[10] For simplicity and in the absence of information on how this reduction may be distributed, it is assumed to be applied equally in each hour (i.e., peak demand reduces proportionally by the same amount as off-peak demand).

Comparison of Scenarios

Figure 4 shows the projected installed capacity for the LMB countries under the different scenarios and displacement cases.[11]

The large increase in installed capacity under the renewable energy scenario is readily apparent. Across the LMB, displacing conventional capacity with additional renewable energy capacity leads to total installed capacity rising from 168 GW to 195 GW. This is a reflection of the lower capacity factors of most renewable energy technologies relative to conventional technologies, meaning more capacity is needed to deliver the same amount of output, including the need for backup capacity to compensate for the impacts of intermitted renewable energy generation.[12]

Figure 4. **Projected Installed Capacity in the Lower Mekong Basin, Alternative Scenarios, 2025**
(gigawatt)



Cogen = cogeneration, GWh = gigawatt-hour, LMB = Lower Mekong Basin, PDP = power development plan.
Source: ADB. 2013c.

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11 Alternative scenarios were not prepared for the PRC and Myanmar due to data limitations.

12 Backup capacity is the additional capacity required to ensure continued electricity supply when some forms of renewable energy sources are not working, e.g., when the sun is not shining for solar power, and when the wind is not blowing for wind power.

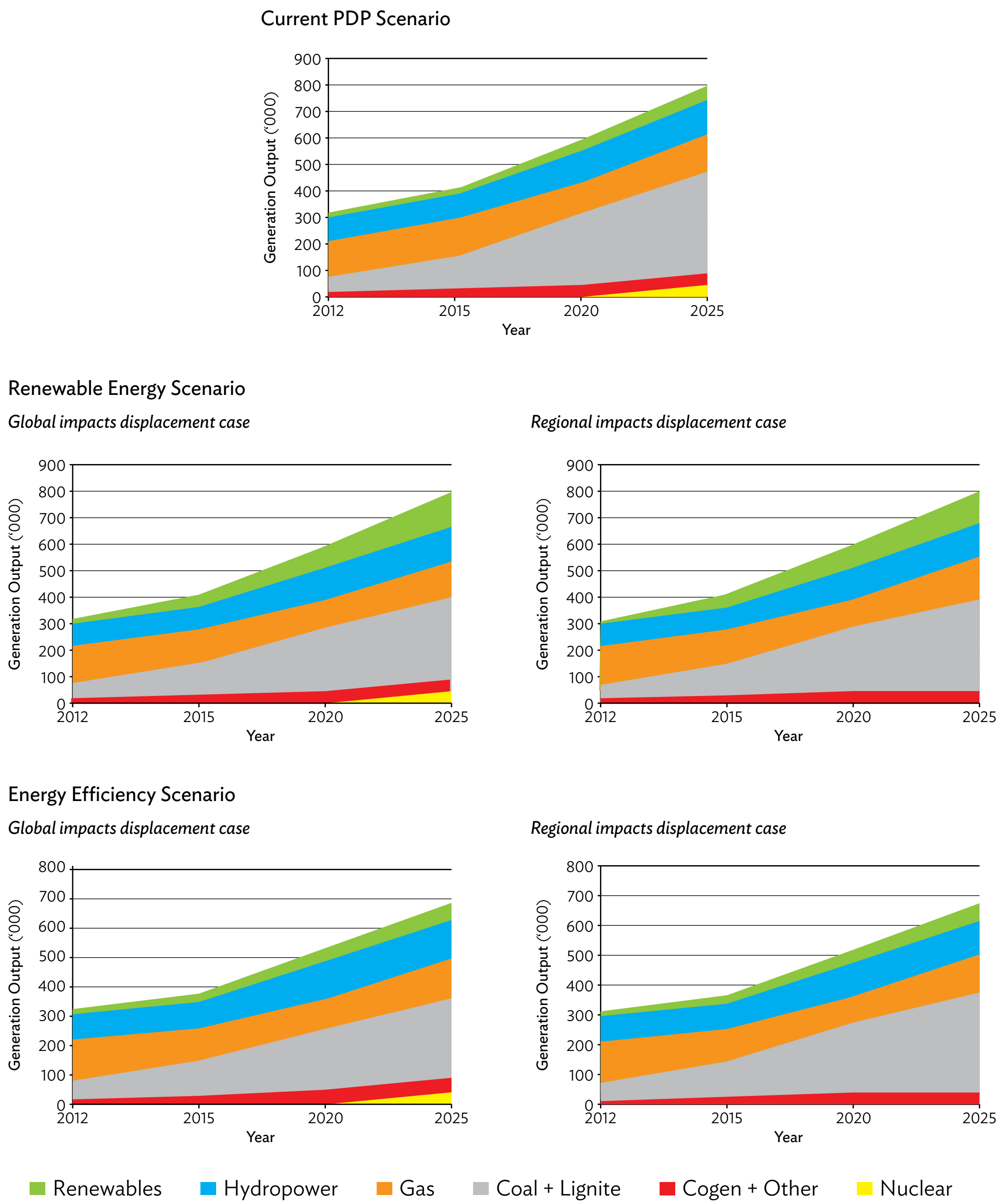
Unsurprisingly, under the energy efficiency scenario, installed capacity falls relative to the current PDPs scenario reflecting the lower demand to be met. Installed capacity requirements are reduced by around 17 GW or 10% in 2025.

The change in generation output over the assessment period for LMB countries under each scenario is presented in Figure 5. The changes in installed capacity and numbers of plants by technology and country by 2025, which give rise to these scenarios, are presented in Figures 6 and 7.

Cross-border trade as a whole across the LMB rises in the renewable energy scenario under the global impacts case but falls under the regional impacts case and the energy efficiency scenario. The increase is driven by the need for Thailand to replace the lost output of the Mae Moh lignite plant with increased imports from the Lao PDR. Under the regional impacts case, this lost output is instead compensated for by increased gas output in Thailand as the Lao PDR's opportunities to export fall due to the displacement of large hydropower projects. Under the energy efficiency scenario, demand falls across the region, meaning less need for imports.

Under the renewable energy scenario, in the global impacts case, increased trade results from the increase in length of cross-border transmission lines by approximately 250 km relative to the current PDP scenario. Required line lengths fall under other cases relative to the current PDP scenario.

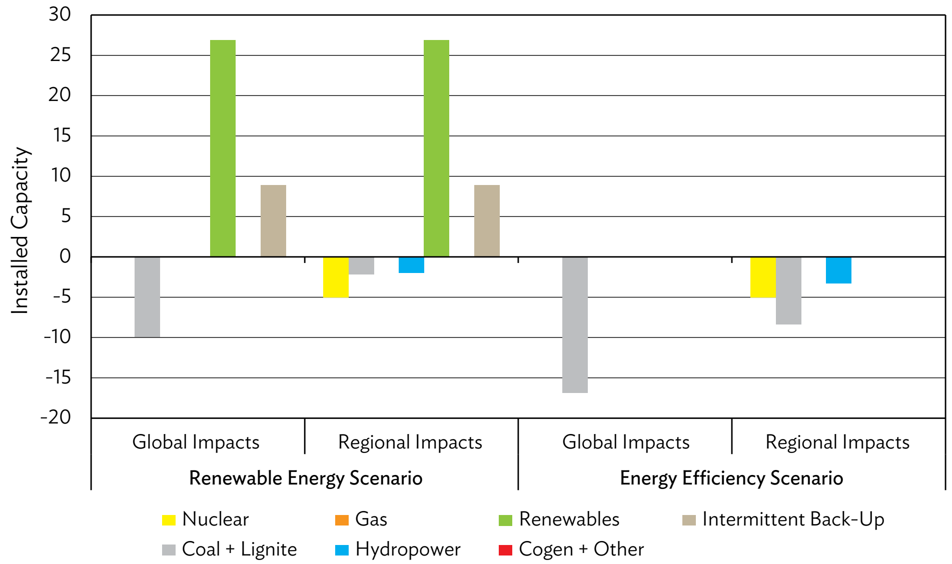
Figure 5. **Projected Generation Output in the Lower Mekong Basin, Alternative Scenarios, 2012–2025**
(gigawatt-hour per annum)



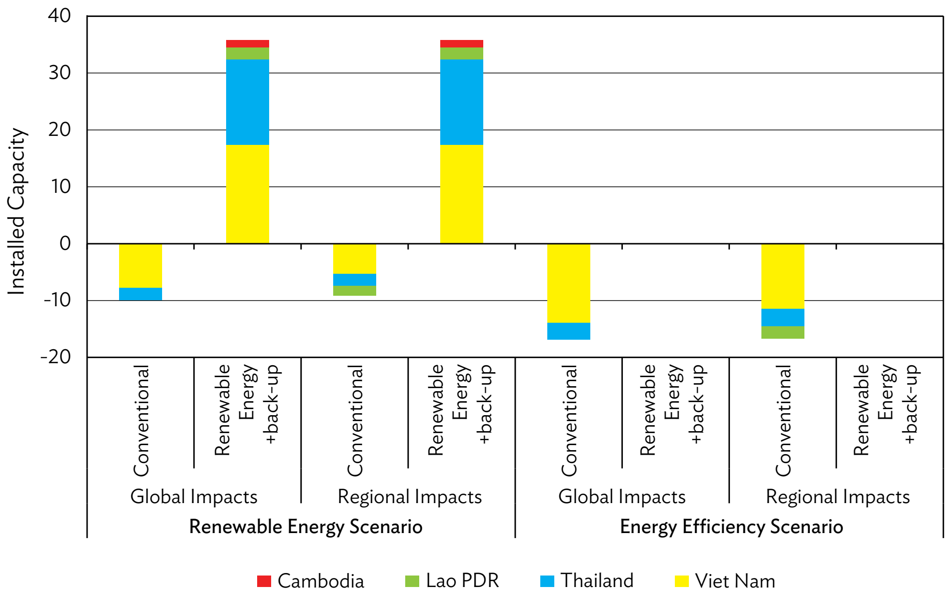
Cogen = Cogeneration, PDP = power development plan.
Source: ADB. 2013c.

Figure 6. **Change in Installed Capacity from Current Power Development Plan Scenario, 2025**
(gigawatt)

By Technology



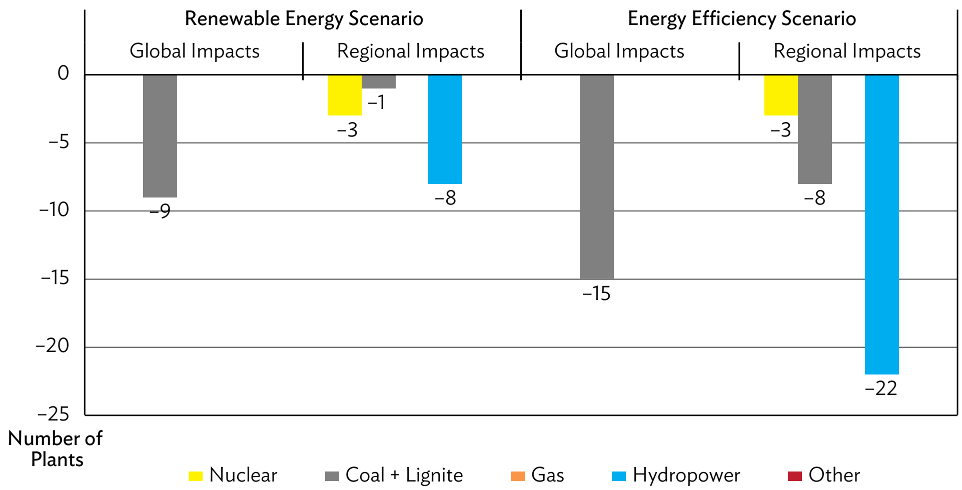
By Country



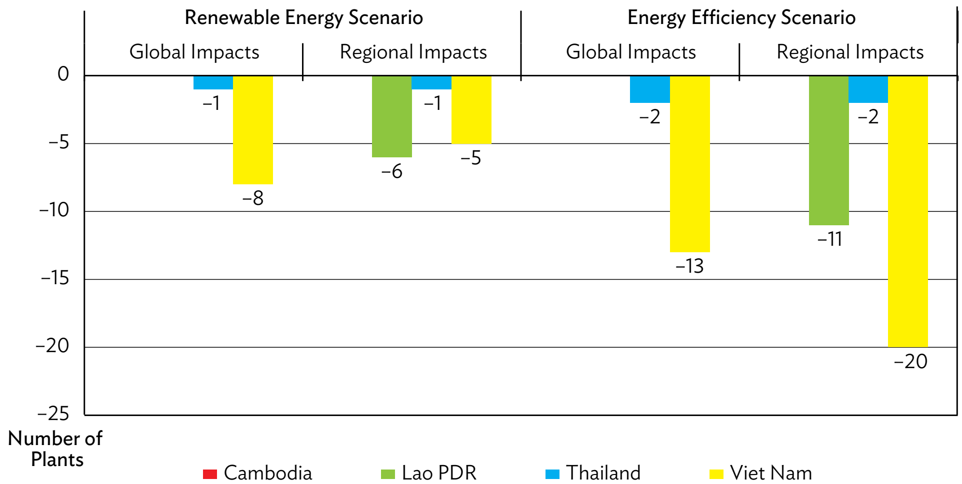
Cogen = cogeneration, Lao PDR = Lao People's Democratic Republic.
Source: ADB. 2013c.

Figure 7. Change in Number of Major Power Plants from Current Power Development Plan Scenario, 2025

By Technology



By Country



Lao PDR = Lao People's Democratic Republic.
Source: ADB. 2013c.

The Na Bong 500 MW regional interconnector substation in the Lao People's Democratic Republic takes power from Nm Ngum 2 and Nam Ngiep 1 hydropower

Comparing the Sustainability of Alternative Scenarios with Current Power Development Plan

In this section, the sustainability indicators for the current PDP for 2025 are compared with the alternative scenarios. They are first compared qualitatively using the radar diagram approach combining all 46 indicators grouped into their relevant "security aspects."[13] The radar diagrams highlight the strengths and weaknesses of the different power options. Some indicators are obviously more important than others and these can be emphasized in the radar diagrams through a weighting process. The values that can be ascribed to indicators that are most readily monetized are then compared quantitatively.

All of the scenarios are designed to meet the same demand throughout the region, and all will have significant impacts on all "security aspects" because all plans reflect the very rapid growth in demand, which almost triples between 2012 and 2025. These impacts cannot be avoided, so the comparisons among all scenarios are described relative to each other to illustrate the strengths, weaknesses, and trade-offs implicit in the choice of scenario.

Qualitative Comparisons

Comparison between Current Power Development Plan and Global Displacement Options

Compared to the current PDP, the renewable energy scenario with global displacement option (RE-G) and the energy efficiency scenario with global displacement option (EE-G) perform better from the pollution, climate, food, and health and safety perspectives

[13] The second volume in this series presents the eight "security aspects" covered in this study and describes their chosen indicators, outlining the methods for measuring them.

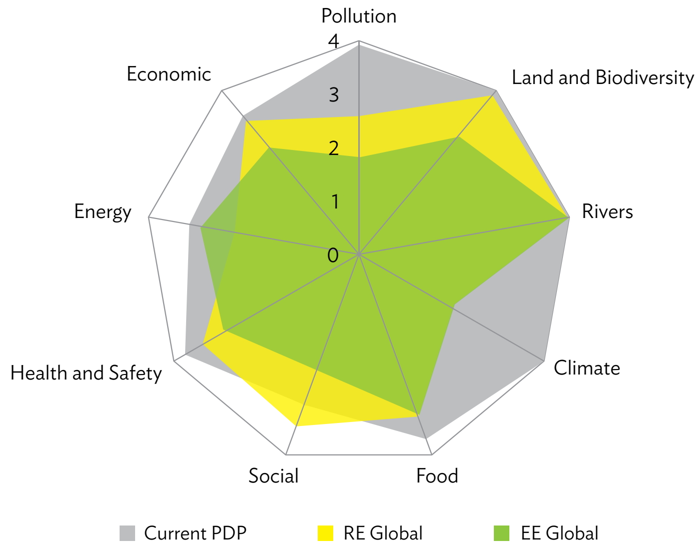
(Figure 8). All of these are to be expected because the two alternatives reduce the number of coal-fired plants, which all have poor performance in terms of air and water pollution, GHG emissions, agricultural land take, and possible health on people within the vicinity of coal-fired plants.

For impacts upon land and terrestrial biodiversity, the EE-G scenario performs better than the current PDP and RE-G. This is because of the reduced land take for both conventional and renewable power plants in the EE-G scenario. There is no difference between the scenarios in the rivers and aquatic biodiversity. All three plants have the same number of hydropower plants.

In terms of social security, RE-G has the poorest performance, largely because of the increased numbers of people to be relocated for small hydropower plants under the renewable energy scenario. The EE-G scenario performs better than the other two because of the fewer numbers of new thermal plants that would require relocation.

For health and safety security, EE-G performs best, because there are fewer people affected by coal-fired power plants, followed by RE-G and then the current PDP. Under the energy security aspect, RE-G performs best largely because of the greater diversity of power

Figure 8. **Radar Diagram Comparing Security Aspect Scores of Global Renewable Energy Displacement and Global Energy Efficiency Displacement with Current Power Development Plan**



EE = energy efficiency, RE = renewable energy, PDP = power development plan.

Note: Pollution, land and biodiversity, and rivers are components under the ecological "security aspect." The aspect of good governance and state security is not included in the diagram, because no measurable indicators were found to compare the scenarios.

Source: ADB. 2013c.

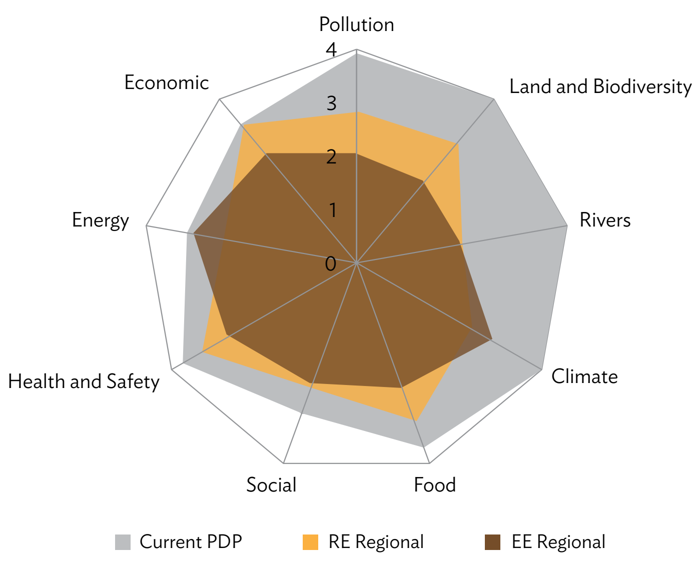
generation types introduced under the renewable energy scenario. The EE-G scenario is slightly better than the current PDP because of the reduced dependence upon coal-fired plants.

Under economic security, EE-G performs best because of the lower costs of supply, lower electricity intensity, and lower per capita expenditure. The RE-G and current PDP have more or less the same score.

Comparison between Current Power Development Plan and Regional Displacement Options

Compared to the current PDP, the renewable energy scenario with regional displacement option (RE-R) and the energy efficiency scenario with regional displacement option (EE-R) show that the current PDP does not perform so well in almost all of the "security aspects," with substantial differences in pollution, land and biodiversity, rivers, and climate (see Figure 9). This can be explained in part by the reduction in the pollution contributions from the displaced large hydropower and nuclear plants, the reduced land take of the displaced hydropower plants, and the reduced impacts upon rivers and fish by the regional displacement options. The differences in climate security reflect both

Figure 9. **Radar Diagram Comparing Security Aspect Scores of Regional Renewable Energy and Regional Energy Efficiency with Current Power Development Plan**



EE = energy efficiency, RE = renewable energy, PDP = power development plan.

Note: Pollution, land and biodiversity, and rivers are components under the ecological "security aspect." The aspect of good governance and state security is not included in the diagram, because no measurable indicators were found to compare the scenarios.

Source: ADB. 2013c.

reductions in GHG emissions and the decreased risks of extreme events, especially for RE-R.

In terms of food security, the main difference is the lower loss of agricultural land in the two regional scenarios, counterbalanced by the slightly lower production in reservoir fisheries due to fewer reservoirs in the two regional scenarios. In the social security aspect, the two regional displacement scenarios have fewer people to be resettled than the current PDP. In health and safety aspects, the main difference is the displacement of the nuclear plants in Viet Nam in the two regional scenarios.

In energy security, there is greater diversity in power generation types with the RE-R because of the greater proportion of renewables. The EE-R is more similar to the current PDP. In the economic aspects, the position is reversed, EE-R performs better because of lower investment costs in power plants, while RE-R is almost the same as the current PDP because of costs associated with renewables displacing the costs associated with conventional plants.

Comparing the two regional scenarios, EE-R performs better than the EE-R on pollution, land and biodiversity, food, health and safety, and economic aspects. It has similar performance for rivers and social aspects. The RE-R scenario fares lower in climate and energy security aspects.

Comparison between Current Power Development Plan and Renewable Energy Scenario

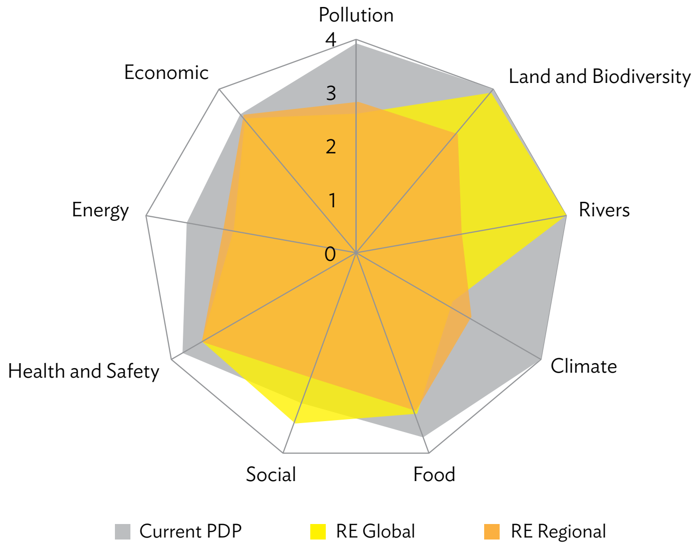
Figure 10 compares the current PDP with the two renewable energy scenarios. Both scenarios perform better under the pollution, climate, food, health and safety, and energy security aspects compared to the current PDP. This can be explained by fewer coal-fired thermal plants in the RE-G scenario, and the fewer hydropower and nuclear plants displaced under the RE-R scenario. In terms of energy security, the greater proportion of renewable technologies used in both RE-G and RE-R gives them better performance.

In the social security aspect, the RE-G scenario performs the worst, largely because of the greater numbers of people to be resettled as a result of small-scale hydropower, which is not countered by the saving in resettlement requirements of the large hydropower displaced under the RE-R scenario.

In terms of economic security, the performance of both scenarios is similar to the current PDP, largely because the savings from the displaced conventional technologies recover the additional costs from the renewable technologies.

When the RE-G and RE-R scenarios are compared, the main differences are in the land and biodiversity and rivers components of ecological security, where RE-R outperforms both RE-G and the current PDP. This can be explained by the reduced impacts in these aspects as a result of displaced large hydropower. In other aspects, they are both very similar, except for the poor performance of RE-G in social security as mentioned above.

Figure 10. **Radar Diagram Comparing Security Aspect Scores of Global Renewable Energy and Regional Renewable Energy with Current Power Development Plan**



RE = renewable energy, PDP = power development plan.

Note: Pollution, land and biodiversity, and rivers are components under the ecological "security aspect." The aspect of good governance and state security is not included in the diagram, because no measurable indicators were found to compare the scenarios.

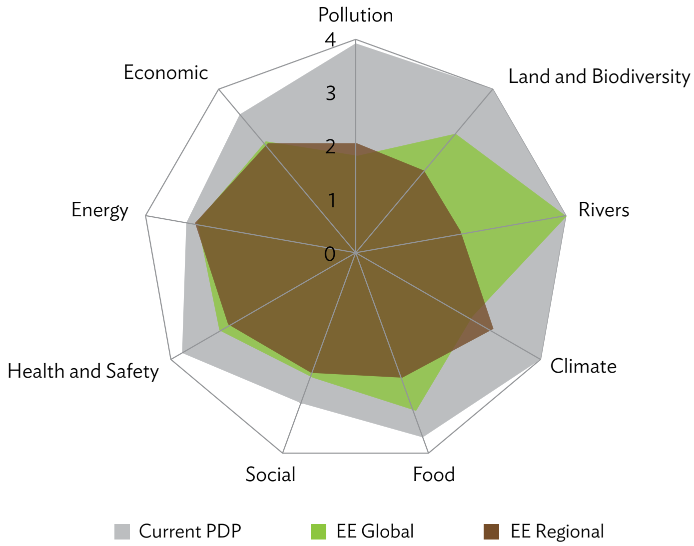
Source: ADB. 2013c.

Comparison between Current Power Development Plan and Energy Efficiency Scenario

Figure 11 compares the current PDP with the two displacement options for the energy efficiency scenario, EE-G and EE-R. The energy efficiency scenario outperforms the current PDP in almost all aspects, which can be explained by the fact that under the energy efficiency scenario, there is a reduced overall demand and need for power plants of all sorts—coal-fired, hydropower, and nuclear—therefore there is less overall impact in the different "security aspects."

In the energy security aspect, they show only slightly better performance, which can be explained by the fact that there is similar diversity of power generation types as in the current PDP, but with a slightly reduced dependence upon conventional energy and fuel sources.

Figure 11. **Radar Diagram Comparing Security Aspect Scores of Global Energy Efficiency and Regional Energy Efficiency with Current Power Development Plan**



EE = energy efficiency, PDP = power development plan.

Note: Pollution, land and biodiversity, and rivers are components under the ecological "security aspect." The aspect of good governance and state security is not included in the diagram, because no measurable indicators were found to compare the scenarios.

Source: ADB. 2013c.

Although largely similar in many aspects, the performance of the EE-G scenario is not as good as the EE-R scenario in the rivers component of ecological security. The EE-G and current PDP are virtually the same in this security aspect. This can be explained by the fact that EE-G and the current PDP have exactly the same number of large hydropower plants. Hydropower, which has the main impact upon rivers, is only displaced under the RE-R scenario. Similarly, RE-R posts better performance in the land and biodiversity component of ecological security and food security, compared to the RE-G.

In contrast, the EE-R scenario performs more poorly than the EE-G scenario under the climate security aspect, but still better than the current PDP. This is largely because under the EE-G scenario, the displaced coal-fired plants reduce overall GHG emissions.

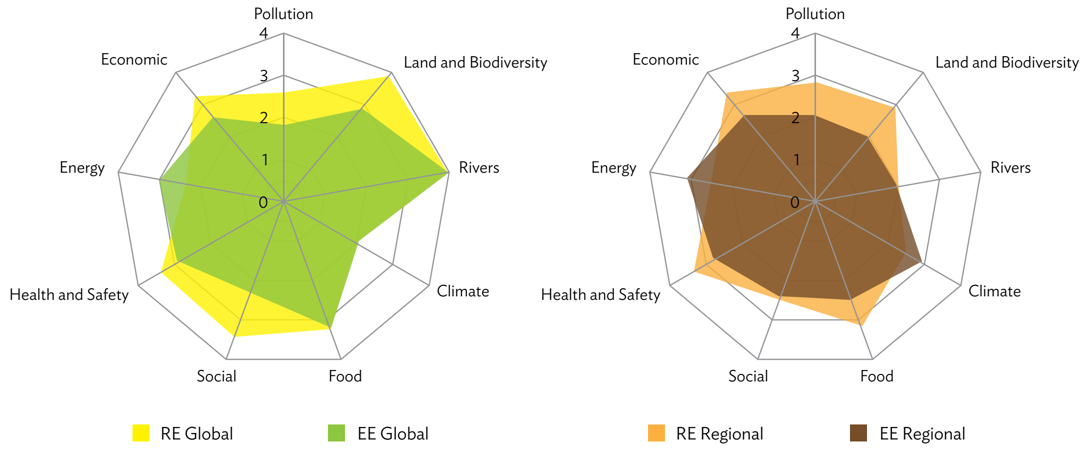
Comparison between the Renewable Energy and Energy Efficiency Scenarios

Figure 12 compares the two alternative scenarios and their global and regional displacement options. It can be seen that when RE-G and EE-G are compared, EE-G outperforms RE-G in terms of pollution, land and biodiversity, social, health and safety, and economic security aspects. The RE-G scenario outperforms EE-G in terms of climate and energy security aspects, which can be explained by the greater proportion of renewables in the power generation portfolio. They have similar performance for rivers and food security because they do not displace any large hydropower.

It should be remembered that both global scenarios displace the same number of coal-fired thermal plants. The main difference between them is the increased use of renewable energies under the RE-G scenario. These renewables have implications for pollution and increased land take, social impacts, and health and safety, which diminish the performance of RE-G.

Between RE-R and EE-R, EE-R outperforms the renewable scenario in every aspect except energy security and climate security. With the energy efficiency scenario, lesser generation capacity installations mean lesser impacts in all "security aspects." Both have the same displacement of hydropower, and thus post similar performance with respect to rivers and social aspects.

Figure 12. **Radar Diagram Comparing Security Aspect Scores of Global Renewable Energy Displacement and Global Energy Efficiency Displacement with Current Power Development Plan**



EE = energy efficiency, RE = renewable energy, PDP = power development plan.

Note: Pollution, land and biodiversity, and rivers are components under the ecological "security aspect." The aspect of good governance and state security is not included in the diagram, because no measurable indicators were found to compare the scenarios.

Source: ADB. 2013c.

Again, RE-R has a higher proportion of renewables, increasing diversity of generation and achieving better performance than the EE-R.

Quantitative Comparisons

Of the 46 indicators used to assess impacts, six are monetized for quantitative comparisons.[14] The set of indicators does not include the benefits of increased electricity supply. This is not because they are unimportant—they are—but because demand, including for rural electrification, is assumed to be met in full under all scenarios. Therefore, there is no difference in these benefits across scenarios and do not serve as a guide to determining an optimal trajectory.

This study assumes that the costs of impacts resulting from power sector development are the same for all LMB countries, irrespective of their national income levels. This is appropriate for this regional study that looks at the optimal power development trajectory for the GMS as a whole. An implication of this is that comparative advantage cannot be assumed in building hydropower projects in the Lao PDR, for example, relative to Thailand as regards the costs of the resulting environmental and social impacts. These would be valued the same irrespective of the country in which they are incurred.

Inevitably, the valuations applied will be contentious. These valuations are not necessarily the best theoretically possible, but they represent the best estimate given the limitations of data, time, and budget.

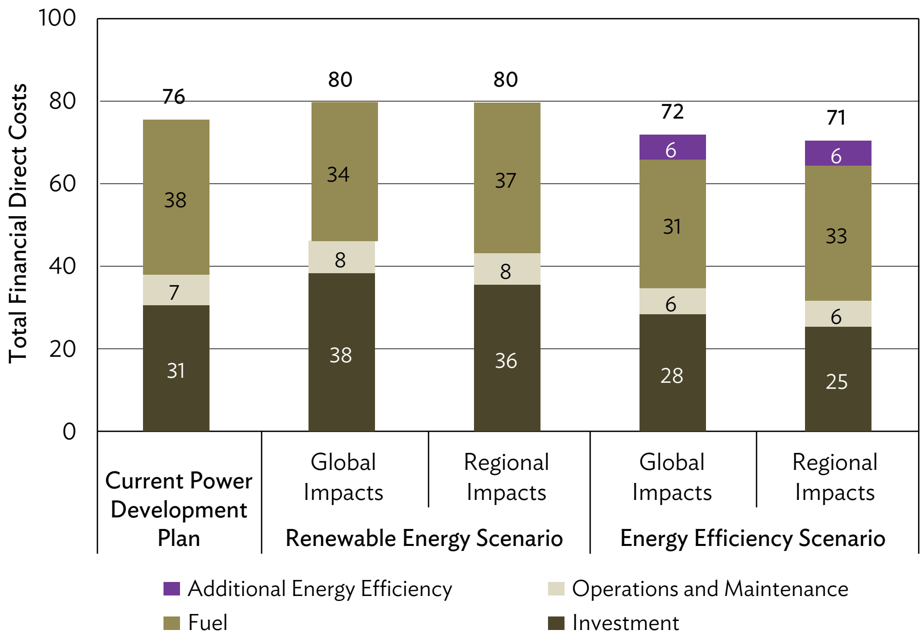
Financial Direct Costs

The total financial direct costs under the different scenarios are shown in Figure 13. These represent the annual costs of electricity generation including capital, fuel, and operating and maintenance costs, all valued on a consistent basis across countries. The economic or opportunity cost of fuel is used, represented by the import price or world market price.

Total annual financial costs under the current PDP scenario are estimated at $76 billion in 2025. In the renewable energy scenario, these costs rise to around $80 billion, an increase of 5.5%. Of this increase, $1 billion represents the costs of the additional thermal capacity required to provide backup for increased intermittent renewable energy capacity. Under the energy efficiency scenario, total costs including investments in additional energy efficiency measures fall to around $72 billion or by 5%–7%.

[14] The second volume in this series presents monetization as a means of comparison across scenarios, and explains how the selected indicators were monetized. The volume also describes the application of the SEA methodology to the GMS regional power development plan.

Figure 13. **Financial Costs of Electricity Supply by Scenario, 2025**
($ billion/year)



Source: ADB. 2013c.

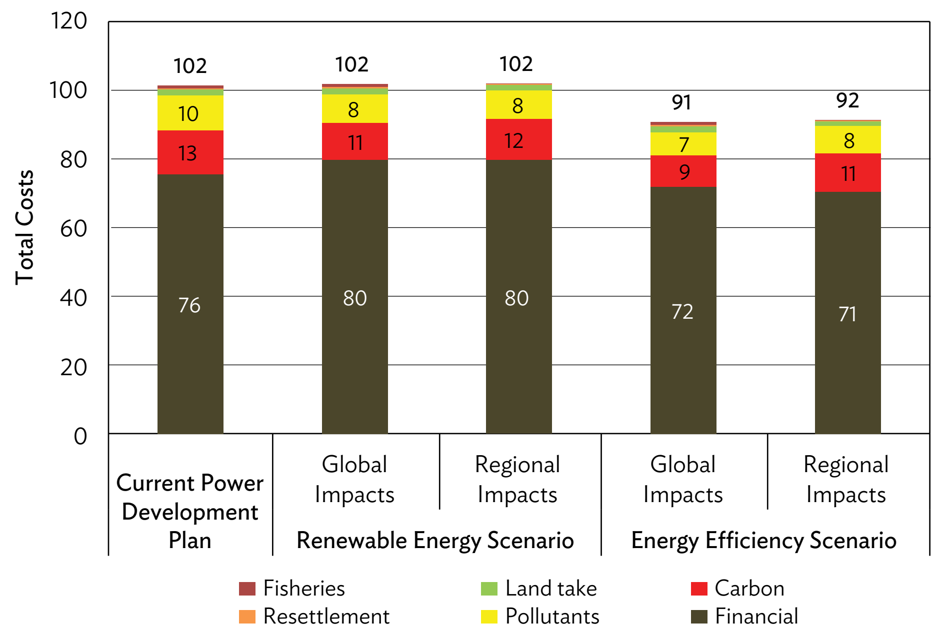
Total Cost Comparisons

The costs of major impacts of power generation within the LMB are added to the direct costs of electricity generation to obtain estimates of the total costs of alternative PDPs.[15] These costs represent the costs of health impacts of pollutants, the loss of productive land and of fisheries, the need to resettle households located in hydropower project sites, and the costs of carbon emissions (valued using a social cost of carbon of $0.30/ton carbon dioxide equivalent). The total costs comparison is shown in Figure 14.

The costs of impacts are dominated by GHG emissions and pollutants. Together, these represent from 17% to 23% of total costs, depending on the scenario. The costs of resettlement, land take, and fisheries are relatively insignificant at only 1%–3% of total costs. This reflects the regional nature of the analysis, i.e., while these impacts are very important for the individuals directly affected, they are less so when considered in the context of the

[15] These costs are not strictly comparable. Financial costs and the costs of emissions of greenhouse gases and pollutants are calculated for all power plants, existing and new. The costs of land take, resettlement, and impacts on fisheries are calculated as the change from the 2012 baseline rather than being the total cost. However, this does not impact on the differences between the scenarios, as the baseline is the same for all scenarios analyzed.

Figure 14. **Total Costs of Electricity Supply in the Lower Mekong Basin by Scenario, 2025**
($ billion/year)



Note: For clarity, interconnector costs are not separately shown given their small size relative to total costs.
Source: ADB. 2013c.

numbers of those affected compared to a total population across the four LMB countries of 180 million people.

What is readily apparent is that there is little difference between the current PDP scenario and the renewable energy scenario under both displacement cases. The higher financial costs of the renewable energy scenario due to the use of more costly technologies and increased capacity requirements are offset by reductions in the costs of impacts, particularly GHG and pollutant emissions and, in the regional impacts case, reduced impacts on fisheries yields. However, this comparison does not take into account the impacts on biodiversity, particularly of different power generation technologies, as these impacts were not monetized. Large hydropower projects would be expected to perform particularly poorly in this regard, given the land areas required for their reservoirs; their location in many cases in areas of ecological importance; and for mainstream dams, their disruption of ecological connectivity. Where estimates of the value of other costs and benefits streams are broadly equal, as is the case for the current PDP and renewable energy scenario shown above, this additional qualitative assessment would lead to a bias away from those development paths that make the greatest use of large hydropower projects.

Table 3. **Total Costs of Electricity Supply in the Lower Mekong Basin by Scenario, 2025** ($ billion)

Security Aspect	Current PDP Scenario	Renewable Energy Scenario		Energy Efficiency Scenario	
		Global Impacts	Regional Impacts	Global Impacts	Regional Impacts
Greenhouse gas emissions	12.8	10.8	12.0	9.3	11.2
Pollutants	10.2	8.3	8.3	6.8	7.9
Land take	1.6	1.6	1.5	1.6	1.4
Resettlement	0.4	0.5	0.4	0.4	0.3
Fisheries	0.8	0.8	0.1	0.8	0.1
Total	**101.6**	**102.0**	**102.2**	**90.8**	**91.5**
Change from current PDP	–	0.4	0.6	(10.7)	(10.0)
	–	0.4%	0.6%	(10.6%)	(9.9%)

– = data not available, ( ) = negative, PDP = power development plan.
Source: ADB. 2013c.

The energy efficiency scenario appears to offer an unambiguous saving over the current PDP scenario. This is not surprising—this scenario assumes that demand and, therefore, requirements for investment in new power generating capacity, can be reduced at lower cost compared to building new power plants. Whether this is achievable in practice is, of course, debatable. Experience has been that energy efficiency targets are rarely achieved despite their apparent economic attractiveness.

The methods for developing qualitative comparisons between all of the indicators and security aspects using a "radar diagram" approach illustrates how the assessment can highlight the strengths and weaknesses of the different power plan options. Application of a weighting process would increase the sensitivity of this approach.

The Salween river at
Tata Fang above the proposed
dam site at Hutgyi between
Myanmar and Thailand

Conclusions and Recommendations

Current power planning in the GMS does not adequately take into account wider environmental and social impacts. From the SEA analysis, it is clear that the current PDP does not perform as well as PDPs with greater contributions of renewable and energy efficiency in most, if not all, of the "security aspects" and their sustainability statements.

The increasing demand for power over the next 15 years to 2025 and the need to meet this demand within the GMS will inevitably exert greater pressure upon the receiving environment and entail further social costs. With a tripling of demand, these pressures will intensify, and it will be critical that power development matches the demand with much greater attention to sustainability.

Despite this projected tripling of demand in the GMS, there is a perception that the demand forecasts within each country in the GMS are overestimated and are often incompatible with those of other countries within the region. This leads to PDPs that are overambitious and difficult to achieve, with unnecessary plants being built. A much greater attention to accuracy of demand forecasting and integration within the region is required.

Increased energy efficiency obviously leads to lower demand and reduces the need to build more power plants of all types. Although still substantial, the financial costs and the environmental and social impacts that have to be managed will be lower. Energy efficiency measures are often more difficult to design and effectively implement compared to building another power plant, which is relatively straightforward. Energy efficiency measures have to be implemented throughout all sectors—domestic, commercial, and industrial—and require strong and focused policies and programs to promote them. Incentives for energy efficiency will be required to contribute to the implementation costs as incorporated in the SEA analysis.

Increasing the contribution from renewable energy also results in fewer environmental and social impacts and tends to increase sustainability of PDPs. Contributions from renewable energy tend to have higher financial costs—approximately 5% in the scenarios used in this SEA—because of the need to build extra capacity to cope with intermittent power generation. The introduction of some monetized environmental and social impacts results in very similar total costs as current PDPs. However, as this study did not monetize, or only partially monetized many externalities, further research may find that introducing more renewable energy would in fact be more economical. This is likely, considering that the SEA's estimates of the cost of externalities were conservative, and many biodiversity impacts were not calculated.

Renewable energy tends to lead to increased energy security because of the increased diversity of supply and reduced reliance upon fossil fuels and their steadily rising costs. Increasing renewable energy in the power generation mix of current PDP can lead to significantly greater sustainability. The analysis of the renewable energies conducted under this SEA shows that there is still considerable potential throughout the region. Portfolio-based planning, as illustrated in this SEA for the first time in the GMS, can be a useful tool for increasing energy security in PDPs.

The combination of increased energy efficiency and increased renewable energy in the power generation mix would make the PDP even more sustainable. The analysis done in this SEA separates the energy efficiency and renewable energy contributions, but they are not incompatible and together, the differences with the current PDP would be greater.

There is considerable global pressure to reduce GHGs and carbon emissions from the power sector to address global climate change. The analysis of this SEA shows that there are significant regional and local impacts that may be incurred if such a policy is implemented fully. The SEA highlights the trade-offs between global and regional or local impacts, especially in the promotion of large hydropower and nuclear plants if the number of new coal-fired power stations is to be reduced. The study suggests that a balance must be found between addressing global climate change but not at the expense of regional and local issues.

In addressing these regional and local impacts, site selection should be improved to find the optimum locations for power plants to minimize many environmental and social impacts. Cumulative impact assessment is a useful tool either conducted separately or as part of environmental impact assessment.

The following are recommendations for increasing sustainability in power planning.

(i) Agencies responsible for demand forecasting should focus attention on making accurate and realistic forecasts.

(ii) Governments should strengthen policies, programs, and targets for increasing energy efficiency throughout all sectors.

(iii) Governments should strengthen the contributions of renewable energy in the power generation mix of future PDPs, over and above the current levels of renewable energy envisaged.

(iv) Sustainability analysis of power development plans would be improved by considering scenarios with both increased energy efficiency and renewable energy contributions.

(v) In the choice of technologies for new power generation, governments should be aware of the need to address greater regional and local impacts if they adopt a policy of reducing carbon emissions from the power sector.

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How Strategic Environmental Assessment Can Influence Power Development Plans

Comparing Alternative Energy Scenarios for Power Planning in the Greater Mekong Subregion

This book is the third in a three-volume series of studies arising from the project Ensuring Sustainability of the Greater Mekong Subregion Regional Power Development. The project aimed to assess the impacts of alternative directions for development of the power sector in the Greater Mekong Subregion (GMS) through a strategic environmental assessment (SEA); develop recommendations on how to minimize and mitigate harmful impacts in the power sector; and provide capacity building for GMS countries in the conduct of SEAs, and support their integration into the power planning process. This volume finds that incorporating significantly greater renewable energy production and greater energy efficiency measures would increase the sustainability of power plans at a comparatively low additional financial cost. Moreover, energy efficiency measures can offset costs of additional renewable energy. The resulting power generation mix would be stable and would provide greater energy security, while remaining affordable and accessible.

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