ASEAN CLEAN COAL TECHNOLOGY (CCT) HANDBOOK
FOR POWER PLANT

ASEAN CENTRE FOR ENERGY
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Acknowledgement

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Foreword

According to the 3rd ASEAN Energy Outlook, under Business-as-Usual (BaU) Scenario, the current trend of the energy path will stay the same where fossil fuels will remain the dominant source of energy and will remain as the biggest share in regional’s energy mix. The region’s primary energy consumption will grow at 4.5% per annum from 2007 to 2030, resulting in a corresponding 5.7% growth in CO₂ emissions. This is due largely to the projected 7.7% annual escalation of coal consumption which is the most carbon-intensive fossil fuel, including the 4.4% annual growth rates of oil and the 3.2% of natural gas consumption. Until 2030, the composition of the region’s energy mix shows that fossil fuels are still the main energy driver to fulfil regional energy demand growth.

This increasing primary energy consumption and corresponding increase in CO₂ emissions needs to be curbed through the role of low-carbon and zero-carbon energy technologies, such as, clean coal technologies is one of the great potential for reducing CO₂ emissions in order to achieve low carbon development path in ASEAN energy sectors.

In 2011, ACE and JCOAL signed a Memorandum of Understanding, with an intention to work together in close cooperation to jointly collect, share and analyze data and information that are available in the ASEAN Member States and/or in Japan as well as to exchange views on coal policy and information, and introduction and promotion of CCT. This scope is in line with the directive of the ASEAN Energy Minister as stipulated in the Joint Ministerial Statement of 31st ASEAN Ministers of Energy Meeting, 25 September 2013, Bali, Indonesia, the importance of strengthening cooperation on coal by introducing more efforts on clean coal technology due to the increasing dependence on coal in ASEAN. Under this MOU, both parties has agreed to target at making a handbook that will support policy makers as well as utility officers and engineers in identifying optimal CCT that will be applicable to their own circumstances, in close cooperation with the AFOC Members to promote clean coal and CCT in ASEAN, and also with member companies of JCOAL.

The preparation of this report, ASEAN CCT Handbook, was one of the outcomes agreed in the AFOC Work Program 2013-2014 under the ASEAN-JCOAL Cooperation for Enhancement of Energy Sustainability in the Region and was reported to the 31st SOME in Bali, Indonesia in June 2013 by the AFOC Chairman.
The handbook was prepared with the objective to facilitate high policy level dialogues and discussions on the deployment of CCT. The document describes the situation of coal power development in ASEAN Member States, features, advantages and applicability of CCTs. Substantially, the handbook provides an in-depth overview of some of the CCT’s basic ideas for planning such as plant configuration, plant size option, site/space requirement and its associated structure. The references for deploying various CCT are clearly described and elaborated in this handbook.

ACE hopes that this handbook will bring useful insights and benefits to the energy planners and policy makers in the ASEAN Member States and their efforts to introduce and adopt clean coal technologies for power generations in achieving a sustainable energy future.

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Chapter 1

Current Energy Policy Direction in ASEAN Countries with

Global Policy Environment in Perspective
1.1 Low Carbon Development Path of Energy Sector

Energy is fundamental to human society, social development and economic growth. The broad dimension of the energy sector shows that proper management of the energy system is strongly needed to ensure sustainable energy development which is one of the key roles of governments. As the demand for energy grows, the energy sector plays a central role in supporting the country’s social and economic development by maintaining a sustainable national energy supply. Other priorities include maintaining energy security and energy independence by utilizing the domestic energy sources and preserving appropriate level of national energy reserves. The preferred long-term national energy plan must be able to answer the main challenges facing the ASEAN Member States in achieving sustainable energy development. Expansion of access to sufficient, secure and affordable energy supply by taking into account the required reliable energy infrastructures and environmental impacts associated with energy sector activities are the key elements of low carbon development path of the energy sector in maintaining economic growth and development.

Firm actions are strongly required to steer the national energy system towards a sustainable energy path while supporting national economic growth. The objectives of maintaining national energy security and reducing CO₂ emissions through appropriate mitigation actions must be met. An integrated and optimal energy mix should be implemented using environmentally friendly technology. Due to current limitations of non-renewable energy sources to fulfill the entire future energy needs, technology improvements and knowledge transfer in the energy sector become very important. The energy technology development and deployment program needs to be based on consideration of geographic location, population growth, economic growth, living standard and pattern, and environmental impact along with other important aspects such as endowment of energy resources in which as a whole should be implemented as key elements of a national long-term energy plan. In addition, social readiness will influence the willingness of energy consumers to reduce CO₂ intensive energy consumption to address climate change, and also community readiness to change their pattern of energy consumption should be considered in every step of the energy policy design.
The widespread use of existing efficient energy technologies and the development and deployment of new low-carbon and carbon-free energy technologies will be necessary in maintaining a low carbon development path of the energy sector to support stabilization of GHG atmospheric concentrations at a safe level as contributions to a global coherent mitigation efforts. A suite of policies and regulations should establish performance criteria including environmental criteria for suitable technologies while also encouraging further research and innovation. Creating a policy framework that simultaneously delivers secure, affordable, and environmentally-sustainable energy system is one of the most important challenges facing government today.

The ASEAN Member States need to expand reliable energy infrastructures, decreasing the use of fossil fuels which are still the major source of energy and conflict with environmental priorities, promoting energy efficiency in supply side and demand side, greater role of new and renewable energy, and enhancing diffusion of low-carbon and zero-carbon energy technologies such as clean coal technologies which is one of the great potential for reducing CO₂ emissions in order to achieve low carbon development path of ASEAN energy sectors.

1.2 ASEAN Long-Term Energy Path

As described in the 3rd ASEAN Energy Outlook, under Business-as-Usual (BAU) Scenario, the current trend of the ASEAN long-term energy path will stay the same where fossil fuels will remain the dominant source of energy and will remain as the biggest share in regional’s energy mix. Until 2030, the composition of the region’s energy mix shows that fossil fuels are still the main energy driver to fulfil regional energy demand growth.

As shown by Figure 1.2.1 below, for the period of 2007 to 2030, under the Business-as-Usual (BAU) scenario, the total final energy consumption of the ASEAN is expected to grow at 4.4% per annum. The transportation sector will grow the fastest during the period with annual growth projected at 5.6% driven by the increasing per capita income. The industrial sector consumption will grow at a slightly lower rate of 5.2% while the other sectors (residential, commercial, agricultural will have an average annual growth of 2.6%. Non-energy consumption will grow at an average rate of 4.9%
Among the types of energy, electricity will grow the fastest, at 6.4% per annum in view of the projected growth in industrial GDP, as shown by Figure 1.2.2 below. Its share to the total will consequently increase from around 11.4% in 2007 to almost 17.6% by 2030. Coal will have the second highest growth rate of 5.9% per annum. Its share will increase from 9.9% in 2007 to 13.5% in 2030. Natural gas consumption will be growing at a slower average rate of 5.3% per annum over the 2007 to 2030 period. Oil will remain as the most used fuel and is projected to grow at 4.9% per annum over the forecast period. Its share to the total consumption mix will also increase from 41.7% in 2007 to 45.8% in 2030. This is driven by the rapid growth in consumption of the transport sector, which is largely fuelled by oil products. Consumption of other fuels, which are mostly biomass, will increase at an average annual rate of 1.0% resulting to a decreased share to the total consumption from 29.0% in 2007 to 13.4% in 2030.
The primary energy requirements in the ASEAN will grow at an annual rate of 4.5% from 511 MTOE in 2007 to 1,414 MTOE in 2030. Among the energy sources, coal will have the highest annual growth rate of 7.7% per annum due not only to the increasing demand of the industries but also that of the power sector. Primary coal supply will increase from around 76 MTOE in 2007 to 414 MTOE in 2030. Oil supply, in view of the fast growth rate of the transport sector will grow by 4.4% annually. Gas will have a lower annual growth rate of 3.2%. Gas for power generation will comprise 50.7% of the total gas requirements in 2030. Its share to the total primary energy mix will be reduced to 16.0% in 2030 from 21.4% in 2007.

Particularly in power sector, electricity production increased from 157 TWh in 1990 to 504 TWh in 2005 and 571 TWh in 2007, as shown by Table 1.2.1 below. This is equivalent to an average annual growth rate of 7.9% over the 1990 to 2007 period. In the future, electricity production is projected to increase to almost 2,414 TWh in the BAU scenario and lower to 2,068 TWh in the Alternative Policy Scenario (APS)¹) or at

¹) In APS scenario, it is assumed that final energy consumption will be reduced by the energy efficiency and conservation programs of each government. Effectively, it is assumed that the energy efficiency saving goals of the governments of all the member states of ASEAN is met. The scenario also includes the improvement in thermal efficiencies of fossil fuel-fired power plants and as well as use of alternative fuels and technologies such as nuclear technology, renewable energy and biofuels.
average annual growth rates of 6.5% and 5.8%, respectively. Both gas and coal will continue to form the bulk of the supply for power generation in the BAU scenario and APS. Coal share will reach 47.4% in the BAU scenario and 42.7% in the APS by 2030. Natural gas share will be 25.5% in the BAU scenario and 24.2% in the APS. Oil share will decrease significantly from 10.6% in 2007 to 1.5% by 2030 in the BAU scenario and 1.6% in the APS. This indicates that the role of oil in power generation will become minimal due to the diversification program for alternative fuels in most of the ASEAN member countries. In addition, the renewable portfolio standard implemented in some ASEAN states recently has also reduced the role of oil in power generation.

<table>
<thead>
<tr>
<th>By TYPE</th>
<th>1990</th>
<th>2005</th>
<th>2007</th>
<th>2030 (BAU)</th>
<th>2030 (APS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal</td>
<td>120</td>
<td>429</td>
<td>478</td>
<td>1796</td>
<td>1417</td>
</tr>
<tr>
<td>Nuclear</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>91</td>
<td>132</td>
</tr>
<tr>
<td>Hydro</td>
<td>29</td>
<td>57</td>
<td>71</td>
<td>351</td>
<td>338</td>
</tr>
<tr>
<td>Geothermal</td>
<td>7</td>
<td>17</td>
<td>17</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>121</td>
<td>127</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>157</strong></td>
<td><strong>504</strong></td>
<td><strong>571</strong></td>
<td><strong>2414</strong></td>
<td><strong>2068</strong></td>
</tr>
</tbody>
</table>

As depicted by Figure 1.2.3, CO₂ emissions from energy sector in 2007 was 283 Mt-CO₂e. The Outlook projected the 4.5% annual growth in primary energy consumption under the BAU scenario will result in a corresponding 5.7% growth in CO₂ emissions. This is due largely to the projected 7.7% annual escalation of coal consumption which is the most carbon-intensive fossil fuel, including the 4.4% annual growth rates of oil and the 3.2% of natural gas consumption. This increasing primary energy consumption and corresponding increase in CO₂ emissions needs to be curbed through the role of low-carbon and zero-carbon energy technologies, such as, clean coal technologies is one of the great potential for reducing CO₂ emissions in order to achieve low carbon development path in ASEAN energy sectors.
The implementation of Alternative Policy Scenario (APS) for reduction of associated GHG emissions will slow the CO\textsubscript{2} emissions annual growth rate to 4.4%. This is the result of imposing the Energy Efficiency and Conservation (EE&C) action plans and saving targets of the member countries which reduces the fuel consumptions in the end-users and power generation as well as the installation of more carbon free or carbon neutral energy such as nuclear, biomass, wind and solar power facilities. Total CO\textsubscript{2} emission in the APS will be about 679 million tons of Carbon equivalent (Mt-CO\textsubscript{2e}), 24% lower than the BAU scenario (895 Mt-CO\textsubscript{2e}).

![Figure 1.2.3: CO\textsubscript{2} Emissions in the Reference and Alternative Policy Scenarios, in Mt-CO\textsubscript{2e}](image)

1.3 ASEAN Energy Situation in Global Context

The growth of fossil-energy demand needs to be curbed intensively which strongly requires the increasing role of low-carbon and zero-carbon energy technologies in the long-term national energy program in order to achieve low carbon development path in the ASEAN energy sectors. Clean coal technologies as key mitigation technologies to use coal as primary energy source that is low in carbon dioxide emissions and other pollutant emissions.

Global energy demand is continuously on the rise and forecasted to remain the same in the coming years. The IEEJ’s Asia/World Energy Outlook 2012 indicates that share by
Non-OECD countries of the world primary energy demand exceeded OECD countries in 2010 and will continue up to 2035 as resulted from the long-term projection. As shown in Figure 1.3.1, the share of the growth in World Primary Energy Demand in 2010 Non-OECD countries was 53%, and OECD countries was 47%, but in 2035 Non-OECD Countries will be 66% and OECD countries will be 34%. The increased volume of demand by non-OECD countries during the period is supposed to be immense considering that entire global primary energy demand is forecasted to increase about 1.5-fold from 11,743 MTOE in 2010 to 17,517 MTOE in 2035.

As described in Figure 1.3.2, energy demand in Asia will exhibit a rapid growth, with the share of Asia in the world energy demand is expanding from 37% in 2010 to 45% in 2035. Among those regions, the share of China in the world energy demand will increase to 24% by 2035, and India to 8% (a total of 32%). The share of Japan will decline from 4% in 2010 to 3% of world energy demand in 2035.
Energy demand growth in Asia, like many other regions, is dominated by fossil fuel. As described in Figure 1.3.3, in the long term only Asia will expand its share of coal demand, from 64% share of the growth in world coal demand in 2010 into 73% in 2035.
According to the long-term projection of primary energy demand by type in Asia (IEEJ's Asia/World Energy Outlook 2012), 54% was coming from coal only in 2010. It is natural that coal has come up as a favored and high-priority choice of fuel in view of its availability and affordability. As described in Figure 1.3.4, coal will remain significant for growing economies in Asia in the long term. Even on the Advanced Technology Scenario, Asia will keep coal as most favored fuel. Coal power has come to constitute a crucial part of power generation ASEAN countries as in many other emerging economies. IEEJ's Asia/World Energy Outlook 2012 forecasted its share will decrease into 46% under Reference Scenario or only 37% under Advance Technology Scenario in 2035.

![Figure 1.3.4: World and Asia Primary Energy Mix on Two Scenarios](Source: IEEJ's Asia/World Energy Outlook 2012)

### 1.4 ASEAN's Regional Response to Climate Change

Southeast Asia is highly vulnerable to climate change as a large proportion of the population and economic activity is concentrated along coastlines; the region is heavily reliant on agriculture for livelihoods; there is a high dependence on natural resources and forestry; and the level of extreme poverty remains high.
With projected dominance of fossil fuels, the increasing primary energy consumption and corresponding increase in CO\textsubscript{2} emissions needs to be curbed in order to achieve low carbon development path in ASEAN energy sectors in reducing contribution to global warming as coherent actions. ASEAN is also at a risk on the impact of climate change that will be confronted with additional costs associated with climate change mitigation and adaptation in the future.

Through the ASEAN Plan of Action for Energy Cooperation (APAEC) 2010-2015, which was adopted at the 27\textsuperscript{th} AMEM in Mandalay, Myanmar on 29 July 2009, ASEAN recognized global and regional issues and challenges on energy and climate change. Furthermore, energy and climate change become the theme of the 28\textsuperscript{th} AMEM in Da Lat, Viet Nam on 22 July 2010. The Ministers noted the Leaders’ vision for an ASEAN Community resilient to climate change as set out in the 2009 ASEAN Leaders’ Statement on Joint Response to Climate Change. In this respect, the Ministers re-affirmed their commitment towards strengthening efforts to address climate change and enhancing ASEAN energy cooperation towards low-carbon and green economy.

ASEAN also set a collective action for to strengthen cooperative partnerships in the promotion and utilization of coal and clean coal technologies among the Member States as stipulated in the APAEC 2010-2015 with strategic goal to promote and increase cleaner coal use and trade for regional energy security, to strongly encourage the use of clean coal technologies through regional cooperation, and to build coal image to the public in concrete manner.

ASEAN Member States, though not the source of significant emission of greenhouse gases, have taken actions to address climate change through various environmental, economic and social activities over the years. Several ASEAN Member States have announced national emission reduction targets: Indonesia (26% emission reduction from business-as-usual (BAU) by 2020, and with international support, it can be reduced further to 41%), Malaysia (reduction of 40% in terms of energy intensity of GDP by 2020 compared to 2005 levels), Philippines (deviate by 20% from BAU of their emission growth path), and Singapore (emission reduction of 16% below BAU by
1.5 Why ASEAN Needs Coal and CCT

There is no doubt that ASEAN Member States are trying to make strenuous efforts in facilitating new and renewable energy development in view of the environment and climate change issues; Indonesia in its new energy policy is committed to increase share of new and renewable energy in generation mix from the current 5.6% in 2012 to 23% in 2025. Malaysia established the Sustainable Energy Development Authority of Malaysia (SEDA Malaysia) and targets to achieve 985MW or 5.5% in generation mix by 2015. The Philippines has set out a long term energy plan with a reference scenario and two low carbon scenarios under the latter of which renewables will be doubled in terms of capacity. Thailand plans to increase production of electricity from renewable sources to 25 percent of total output over the next 10 years. Vietnam is planning to increase renewable energy share of power generation to 5.6% in 2020 and 9.4% in 2030. Cambodia, Laos and Myanmar follow the same policy direction.

In the meantime, each one of the above member countries has been in a steady growth path and needs to further grow to bring about benefits to its people in a fairer and more equitable manner. It is clear that the current development phase of renewable energy in general may not fully address surging demand especially in terms of scale and cost-efficiency as well as applicability as base load.

It is not a matter of “fossil fuels or renewables”. These ASEAN Member States respectively need an optimal energy mix and an optimal generation mix in which coal, other fossil fuels and renewables coexist.

We have to be aware while coal is appreciated especially as power generation source since it is widely and abundantly available for much longer term than other fossil fuels, and is normally free from cost fluctuation, it has serious downside; it may cause local pollution if utilized without environmental equipment and devices, and also it is the most carbon-intensive fossil fuel. Apart from highly expected near-future development of CCS (Carbon Capture and Storage) technology, Clean Coal Technology (CCT) is the answer to the current situation where those ASEAN member states wish to balance between environmental consideration, emission reduction and power development.
Chapter 2

Present Situation of Coal Power Development in ASEAN Countries
2.1 Cambodia

While Cambodia is still at lower levels of electrification rate, 34% as of 2013, the country actually saw considerable improvement during the last couple of years; its electrification rate increased by 10% from 2011.

Cambodia’s power generation is rather dependent on oil fuel. The country has great potential for hydropower, which is also reflected in the power generation mix below. In view of the world energy situation, the country’s energy mix portfolio is supposed to shift as the overall energy consumption volume increases according to its economic growth.

![Figure 2.1.1 Cambodia's power generation mix in million kWh](image)

Source: Report on power sector of the Kingdom of Cambodia 2013 Edition, Electricity Authority of Cambodia

Electricity Authority of Cambodia (EAC) was established as a legal public entity to act as the Regulator and the arbitrator of power sector business activities. Cambodian strategy for the development of electricity supply is in place to construct transmission lines between major cities in southern and western regions in order to construct large-scale power generating plants and to import electric power from neighboring
countries during the construction period of such power plants.

According to the Power Development Plan of the Kingdom of Cambodia in 2007, electricity demand is expected to show a rapid increase until 2020. The future power demand is summarized in below table.

<table>
<thead>
<tr>
<th>Table 2.1.1 Power Demand Forecast (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>1,062</td>
</tr>
</tbody>
</table>

Source: MIME, Cambodia²

In order to meet the increasing demand, the RGC has developed the power source expansion plan under the Power Development Plan for a period of 2008-2021. In line with the power source expansion, transmission lines are under construction and electric power has been imported from neighboring countries. Currently, 22.47% of Cambodian households have access to the electricity (54% of urban households and 13% of rural households). EDC aims to provide electricity service to 100% of all the villages by 2020 and 70% of all the rural households by 2030.

Regarding the expansion of power source, the Department of Energy Development of MIME formulated electricity supply development plan up to 2020. According to this plan, as below table indicates, the construction of eight hydro power plants and three coal power plants will be completed by 2020³. In total, including imported electricity, approximately 3,576 MW at the maximum will be generated in 2020.

² From http://www.cambodiainvestment.gov.kh/investors-information/infrastructure/electricity.html
³ It is reported that Ratchaburi Electricity Generating Holding will cancel its joint-venture agreement with local KK Power to build a 1.8-gigawatt coal-fired power plant, the largest scale of the kind if constructed, in Koh Kong province of southwestern Cambodia, due to the situation where power purchase by Thailand may not be made as initially planned.
<table>
<thead>
<tr>
<th>No</th>
<th>Project</th>
<th>Country of Supplier</th>
<th>Type</th>
<th>Power (MW)</th>
<th>Year of Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kamchay Hydro Power Plant</td>
<td>China</td>
<td>Hydro</td>
<td>193</td>
<td>2011</td>
</tr>
<tr>
<td>2</td>
<td>Kirirom III Hydro Power Plant</td>
<td>China</td>
<td>Hydro</td>
<td>18</td>
<td>2012</td>
</tr>
<tr>
<td>3</td>
<td>200MW Coal Power Plant in Sihanoukville (I) (Phase 1)</td>
<td>Malaysia+ Cambodia</td>
<td>Coal</td>
<td>100</td>
<td>2013</td>
</tr>
<tr>
<td>4</td>
<td>Stung Atay Hydro Power Plant</td>
<td>China</td>
<td>Hydro</td>
<td>120</td>
<td>2013</td>
</tr>
<tr>
<td>5</td>
<td>Stung Tatay Hydro Power Plant</td>
<td>China</td>
<td>Hydro</td>
<td>246</td>
<td>2013-2014</td>
</tr>
<tr>
<td>6</td>
<td>Lower Stung Russey Chhrum Hydro Power Plant</td>
<td>China</td>
<td>Hydro</td>
<td>338</td>
<td>2013</td>
</tr>
<tr>
<td>7</td>
<td>700MW Coal Power Plant in Sihanoukville (II) (Phase 1)</td>
<td>-</td>
<td>Coal</td>
<td>100</td>
<td>2014</td>
</tr>
<tr>
<td>8</td>
<td>700MW Coal Power Plant in Sihanoukville (II) (Phase 2)</td>
<td>-</td>
<td>Coal</td>
<td>100</td>
<td>2015</td>
</tr>
<tr>
<td>9</td>
<td>700MW Coal Power Plant in Sihanoukville (II) (Phase 3)</td>
<td>-</td>
<td>Coal</td>
<td>100</td>
<td>2016</td>
</tr>
<tr>
<td>10</td>
<td>200MW Coal Power Plant in Sihanoukville (I) (Phase 2)</td>
<td>Malaysia+ Cambodia</td>
<td>Coal</td>
<td>135</td>
<td>2017</td>
</tr>
<tr>
<td>11</td>
<td>Lower Se San II &amp; Lower Sre Pok II</td>
<td>Vietnam</td>
<td>Hydro</td>
<td>400</td>
<td>2017</td>
</tr>
<tr>
<td></td>
<td>Project Description</td>
<td>Source Type</td>
<td>Capacity (MW)</td>
<td>Year</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------------------------------------------------</td>
<td>-------------</td>
<td>---------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>700MW Coal Power Plant in Sihanoukville(II) (Phase 4)</td>
<td>Coal</td>
<td>100</td>
<td>2017</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Stung Chhay Areng Hydro Poer Plant</td>
<td>China Hydro</td>
<td>108</td>
<td>2017</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>700MW Coal Power Plant in Sihanoukville(II) (Phase 5)</td>
<td>Coal</td>
<td>100</td>
<td>2018</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Lower Sre Pok III + IV Hydro Power Plant</td>
<td>Hydro</td>
<td>368</td>
<td>2018</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Add 700MW Coal Power Plant at Offshore</td>
<td>Coal</td>
<td>200</td>
<td>2019</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Sambor Hydro Power Plant</td>
<td>China Hydro</td>
<td>450</td>
<td>2019</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Coal Power Plant (III) or Gas Power Plant</td>
<td>Coal/Natural gas</td>
<td>400</td>
<td>2020</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>3,576</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: MIME, Cambodia

While coal currently does not have strong presence in Cambodia’s energy mix unlike some other coal users among ASEAN member states, it is probable that coal comes to be of further significance as the country’s growth speed may push up electricity demand to the scale that may not be addressed solely by hydroelectric and renewable sources with oil fuel becomes more and more economically viable.

### 2.2 Indonesia

Once used to be a powerful resources exporter, Indonesia has been shifting its energy policy toward oil dependency reduction and efficient resources utilization with focus on

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long term domestic energy supply security that will bolster sustainable economic growth.

![Energy mix trend in 2012, 2025, 2030 and 2050](image)


On January 28, 2014 Parliament approved Presidential Regulation No. 1/2014 about guidelines for the National Energy Plan (RUEN) that is to be formulated.

Thrusts of the national policy that are emphasized among others in this new law are as follows:

(1) Energy resources are defined as national assets for development.

(2) Constantly improving the contribution of renewable energy in the national energy mix.

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6 It is said that as of April 2014 the law is yet to be signed by the President.
(3) Improving independence in national energy management, accelerate the creation of new job opportunities, accelerate the role and participation of domestic industry in the energy sector, and encouraging research and development in the energy sector.

(4) Optimizing the use of natural energy resources for economic development of the people according to Economic Added Value Process by creating job opportunities and industrial development.

(5) Securing energy supply, especially electricity, oil and gas.

As observed in the energy mix in the above Figure 2.2.1, coal will remain as one of the pillars even while Indonesia goes through the sustainable growth path increasing the share of renewable energy.

As a G20 member and one of the leaders among emerging economies that have set voluntary emission reduction targets, Indonesia values and tries to promote introduction of CCTs in the power sector and rest of relevant industrial sectors in order to achieve both steady economic development and emission reduction at the same time, which is reflected on the “Low Scenario [BAU]” in the Table 2.2.1 of the projected electricity supply and consumption trend.

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>2010</th>
<th>2025</th>
<th>2030</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Scenario [BAU]</td>
<td>TWh</td>
<td>148</td>
<td>628</td>
<td>933</td>
<td>2710</td>
</tr>
<tr>
<td>Low Scenario [Efficient]</td>
<td>TWh</td>
<td>148</td>
<td>511</td>
<td>733</td>
<td>2100</td>
</tr>
<tr>
<td>High Per Capita Scenario [BAU]</td>
<td>kWh</td>
<td>620</td>
<td>2316</td>
<td>3332</td>
<td>8827</td>
</tr>
<tr>
<td>Low Per Capita Scenario [Efficient]</td>
<td>kWh</td>
<td>620</td>
<td>1886</td>
<td>2618</td>
<td>6840</td>
</tr>
<tr>
<td>Average Growth [Efficient]</td>
<td>%</td>
<td>7</td>
<td>8.4</td>
<td>7.5</td>
<td>4.7</td>
</tr>
<tr>
<td>Elasticity</td>
<td></td>
<td>1.06</td>
<td>1.05</td>
<td>1.00</td>
<td>0.70</td>
</tr>
<tr>
<td>High Scenario [BAU]</td>
<td>GW</td>
<td>35</td>
<td>145</td>
<td>203</td>
<td>550</td>
</tr>
<tr>
<td>Low Scenario [Efficient]</td>
<td>GW</td>
<td>35</td>
<td>115</td>
<td>159</td>
<td>430</td>
</tr>
<tr>
<td>Annual Average Utilization</td>
<td>Hours</td>
<td>4722</td>
<td>4805</td>
<td>5065</td>
<td>5420</td>
</tr>
<tr>
<td>High Scenario [BAU]</td>
<td>Hours</td>
<td>4722</td>
<td>4977</td>
<td>5157</td>
<td>5470</td>
</tr>
<tr>
<td>Low Scenario [Efficient]</td>
<td>Hours</td>
<td>4722</td>
<td>4977</td>
<td>5157</td>
<td>5470</td>
</tr>
</tbody>
</table>

Toward “Visi 75-100”\(^7\), the national target of 100% electrification in 2020, PT.PLN has been engaging in mid-term national power capacity enhancement by defining coal as its mainstay while it is also committed to enhancement of renewable power development toward the future optimal generation mix based on such new policy direction.

Two-phased Fast-Track Programs (FTP I and II) were launched as the national flagship program to address surging power demand; however, the overall plan is lagging far behind the schedule supposedly due to some on-site troubles or construction delay. In the meantime, prolonged process of land acquisition or environmental assessment is causing delay of some IPP projects highlighted as a strong force in FTP II.

2.3 Lao PDR

In 2009, the average fuel use in Lao PDR was 0.935 tons of TOE. Fuel consumption in Lao PDR remains very low compared with most of ASEAN member states.

In the meantime, the Government is very keen in facilitating renewable energy development. A strategy, “Renewable Energy Development Strategy in Lao PDR”, is already in place.

While majority of ASEAN member states rely on coal, Laos is different: hydropower dominance-over 90%- features its generation mix.

As shown in the following Figure 2.3.1 of energy demand trend, coal is not as dominant in the energy mix of Laos as in some of ASEAN countries and it may not be much different for the coming years.

\(^7\) The slogan indicates that Indonesia will achieve 100% national electrification by August 17, 2020 when the country celebrates its 75 years of Independence.
In the meantime, hydro-based electricity purchased by Thailand has been one of the foreign exchange earners for Laos. While hydropower is better than fossil fuel in terms of emission reduction, it has also disadvantage; that is, production may not be the same during drought or other type of extreme weather.

Now Hongsa Mine Mouth Power Project with 3 units of 626MW each is under construction and are expected to boost foreign exchange earnings for Laos. The project comprises a lignite power plant, a lignite mine, a limestone mine, and supporting infrastructures such as 67 km of 500kv transmission line to the border.

<table>
<thead>
<tr>
<th>Table 2.3.1 General Information of Hongsa Power Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concession Area</td>
</tr>
<tr>
<td>Concession Period</td>
</tr>
<tr>
<td>Construction Phase</td>
</tr>
<tr>
<td>Power Plant Output</td>
</tr>
<tr>
<td>Lignite Consumption</td>
</tr>
</tbody>
</table>

8 Based on a presentation file available on the website of Department of Mineral Resources, Thailand.
Total finance package worth US$3,710 million in capital commitments to Hongsa Power Company (HPC) was proportionately contributed by 9 Thai commercial banks.

Total loan facilities for the project is US$2,783 million.

Once the power plant comes to be in operation, it is expected to sell power as large as 1,473 MW to EGAT of Thailand and 100MW to Electricité du Laos (EDL).

### 2.4 Malaysia

Malaysia is one of ASEAN’s most prosperous economies and the third-largest energy consumer in ASEAN with relatively high per-capita consumption.

As significant oil and LNG producer and exporter, Malaysia has no specific policy on coal. However, since its introduction to the national energy mix in 1988 as the Four Fuel Policy came into force, coal has been regarded as part of Malaysia’s fuel mix strategy and forms part of the long-term development of a sustainable energy supply for the country, which is indicated in the following energy mix trend as of 2010, 2015, 2020 and 2050.

Coal reserves are concentrated in Sarawak, while the demand center, the mainland Peninsular substantially has no coal resources and is fully dependent on overseas coal imported from Indonesia, South Africa and Australia.

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Figure 2.4.1 Energy mix trend in 2010, 2015, 2020 and 2030
Source: Based on “Initiatives to Enhance Malaysia’s Electricity Supply Security”

Table 2.4.1 Electric power situation in Malaysia

<table>
<thead>
<tr>
<th>As of Dec 2012</th>
<th>INSTALLED CAPACITY (MW)</th>
<th>PEAK DEMAND (MW)</th>
<th>RESERVE MARGIN (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pen. Malaysia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TNB</td>
<td>7,096</td>
<td>15,476</td>
<td>40%</td>
</tr>
<tr>
<td>IPPs</td>
<td>14,777</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21,689</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sabah</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SESB</td>
<td>410</td>
<td>773</td>
<td>33%</td>
</tr>
<tr>
<td>IPPs</td>
<td>625</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,035</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sarawak</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEB</td>
<td>1,349</td>
<td>1,067</td>
<td>26%</td>
</tr>
<tr>
<td>Total</td>
<td>1,349</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Country Report at 12th AFOC Council Meeting, 2013

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Malaysia’s total installed capacity is 24,073MW. Total installed capacity produced by coal fired plant in Malaysia are 9680MW both in Peninsular and Sarawak region.

*Table 2.4.2 List of coal-fired power plants in Malaysia*

<table>
<thead>
<tr>
<th>Name of power plant</th>
<th>Technology</th>
<th>Capacity (MW)</th>
<th>Location</th>
<th>COD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanjung Bin SC</td>
<td>3 x 700</td>
<td>Johor</td>
<td>2006/2007</td>
<td></td>
</tr>
<tr>
<td>Jimah Subcritical</td>
<td>2 x 700</td>
<td>Negeri Sembilan</td>
<td>1st Unit in 2009</td>
<td></td>
</tr>
<tr>
<td>Manjung (TNB Janamanjung)</td>
<td>3x 700</td>
<td>Perak</td>
<td>2004</td>
<td></td>
</tr>
<tr>
<td>Sejingkat</td>
<td>100</td>
<td>Sarawak</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
After controversy over and suspension of planned construction of a coal-fired power plant in Lahad Datu between 2008 and up to around 2012, Malaysia has not seen any particular coal power development plan until Manjung Unit 4 came to be under the light.

Manjung Unit 4, once coming into operation, will be the first coal power unit with USC and the largest capacity in the country.

Malaysia has pledged to Copenhagen Commitment on carbon emission intensity reduction of 40% by 2020 in comparison to the 2005 level.

Also stringent environmental codes and regulations are to be well followed and right information is to be appropriately provided in developing such new power plants in view of people’s concern that was expressed in the past case of protest against coal power.

Applicable CCTs will address such concerns especially under the situation where subcritical units are still common and the country as one of most matured ASEAN member states may need to intend for gradual transition to USC or any other available CCT.

2.5 Myanmar

Myanmar’s primary energy supply includes coal, oil, gas, hydropower and biomass. Myanmar is one of the major energy exporters in the region, particularly of natural gas.

\[11\text{ Total capacity of the plant including oil/gas fired units is } 2,420\text{MW.}\]
While coal and hydropower accounts for only small part of the country’s primary energy mix, coal production has increased at a fast pace during recent years.

In FY2011, a total of 693 thousand tons of coal was used domestically, out of which 290 thousand tons (42%) was for electric power generation.

The large coal-fired power plant in Tigyit, Southern Shan State, operated by the Ministry of Electric Power (MOEP), has a capacity of 120MW. Japan has provided new technology to the plant, enabling it to use lignite coal more efficiently. To help meet the growing demand for electricity, Myanmar is planning to construct and operate the following coal-fired power plants; (i) a 270MW plant in Yangon; (ii) a 600MW plant in Kalewa; and (iii) a 6MW plant in Tanintharyi Division.

Though electricity consumption in Myanmar has doubled during the first decade of this century, its per capita electricity consumption in 2011 was only 100 kWh per year, which was the lowest among ASEAN 10 member states.
Total installed capacity in 2011 was 3,361MW and coal power accounted for 4% (120MW) only. The Government is intending to explore possibility of clean coal utilization in the power sector as it may compensate for disadvantage of currently dominating hydropower; i.e. lack of water during the dry season often prevents operation at full capacity.

However, it should be noted that the transmission system should be appropriately enhanced; currently transmission and distribution losses are one of major issues to be addressed in promoting electrification in the country.

2.6 Philippines

The Philippines is a net energy importer in spite of low consumption levels relative to its Southeast Asian neighbors. The country produces small volumes of oil, natural gas, and coal. Domestically produced geothermal, hydropower, and other renewable sources constitute a significant share of electricity generation.

Dry natural gas production was 102 billion cubic feet (Bcf) in 2011, all of which was domestically consumed. The Malampaya field is one of the largest foreign energy
projects in the country and is operated by Shell with joint venture partners Chevron and the PNOC Exploration Corporation, a subsidiary of the state-owned Philippine National Oil Company.

Figure 2.6.1 Primary Energy Supply Outlook of the Philippines, 2008-2030
Source: Department of Energy (DOE), the Philippines

The Philippines consumed almost 19 million short tons of coal in 2012, almost half of which was produced domestically and the remainder imported. Coal consumption in the Philippines is projected to continue increasing due to a rise in domestic supply and increased demand from domestic coal-fired power plants.

As of 2012, coal accounted for one-third of the country’s national generation mix (Figure 2.6.2) and will remain a base load power source for the coming years either in BAU or low carbon scenario (Figure 2.6.3 and 2.6.4).
Figure 2.6.2 Philippines National Generation Mix in 2012\textsuperscript{12}

Source: DOE website\textsuperscript{13}

Figure 2.6.3 Philippines power generation reference scenario, 2009-2030

Source: Philippine Energy Outlook 2009\textsuperscript{14}

\textsuperscript{12} The figure does not include off-grid capacity.

\textsuperscript{13} https://www.doe.gov.ph/

2.7 Thailand

Thailand has limited domestic oil production and reserves, and imports make up a significant portion of the country's oil consumption. Thailand holds large proven reserves of natural gas, and natural gas production has increased substantially over the last few years. However, the country still remains dependent on imports of natural gas to meet growing domestic demand for the fuel.

The government forecasts its economy to grow by 5.5 percent in 2012 in anticipation of
post-flood reconstruction and higher domestic demand. In turn, oil and gas production and consumption are expected to increase slightly in 2012 and 2013, and industry sources estimate that the first half of 2012 shows a recovery in both oil and gas supply and demand from 2011 levels.

Natural gas will account for a significant portion even in the long term, while coal is expected to continue playing an important role in Thailand energy mix—it is to account for 18% which exceeds the portion by renewables as of 2030.

Figure 2.7.2 Thailand energy balance forecast
Source: Country Report at 12th AFOC Council Meeting, 2014

Solid biomass and waste have played a strong role as an energy source in Thailand and comprise roughly 16 percent of energy consumption. Most biomass feedstock is from sugarcane, rice husk, bagasse, wood waste, and oil palm residue and is used in residential and manufacturing sectors. Thailand, in aiming at energy diversification, has been promoting biomass for heat and electricity, though growth has been very gradual.
due to industry inefficiencies and environmental concerns. Thailand's new Alternative Energy Development Plan calls for renewable energy to increase its share to 25 percent of total energy consumption by 2022 in efforts to reduce dependence on fossil fuels, which in light of the current situation seems to be a rather hard target to achieve.

![Figure 2.7.3 Thailand electricity generation by source](source)

Source: Country Report at 12th AFOC Council Meeting, 2014

The other option which the government has been taking to enhance its electricity supply security is purchasing power (Figure 2.7.4).

![Figure 2.7.4 Thailand electricity generation by producer](source)

Source: Country Report at 12th AFOC Council Meeting, 2014

In its latest revision of the 20-Year Power Development Plan (PDP) released in June
2012, Thailand projects that electricity generation will double in size, reaching 346 TWh by 2030.

Thailand plans to reduce dependence on natural gas for generation in favor of renewable sources and nuclear power, the first plan of which has been delayed and scaled back upon Japan’s Fukushima incident following large scale earthquake and tsunami in 2011.

While Thai Government is trying to boost up renewables basically to reduce its dependency on natural gas, it seems that coal may also play an important role in keeping energy and generation mix well-balanced.

2.8 Vietnam

As of 2013, the country’s total installed capacity is 28,000MW and the demand is growing by 11%. Vietnam’s “National Master Plan for Power Development in the 2011 - 2020 PERIOD with the Vision to 2030”\(^\text{15}\) tells that the domestic demand, electricity production and import will be steadily going up and will be 3.6-4.0 times in 2030 compared to 2015.

<table>
<thead>
<tr>
<th>Scenario/Year</th>
<th>2015</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>210</td>
<td>362</td>
<td>834</td>
</tr>
<tr>
<td>Low</td>
<td>194</td>
<td>330</td>
<td>695</td>
</tr>
</tbody>
</table>

Source: Based on the National Master Plan for Power Development

The Master Plan emphasizes that the development of renewable energy sources will be of high priority and will increase its share in the national generation mix from 3.5% in 2010 up to 4.5% in 2020 and 6.0% in 2030. Vietnam accelerates coal power development in parallel with aforementioned endeavors about renewable energy development in view of the surging electricity demand for the coming years, trend of which is clear in Figure 2.8.1.

\(^{15}\) No. 1208/QD-TTg legislated as of July 21, 2011
Coal that accounted for 22% in the national generation mix is forecasted to be in 36% in 2015. Having abundant anthracite resources and used to be a coal exporter, Vietnam has started importing coal; during the period of 2015-2020 when domestic coal production is to increase by 62%, amount of imported coal is forecasted to increase by 32 times reaching 32% of the entire consumption volume in 2020.

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16 Presentation at ERIA Working Group meeting for CCT, 2013
Looking into the long term trend of coal consumption as indicated below, it is evident that the power sector among others boosts the demand and coal import accordingly.

With import coal increasing, the Government is more concerned about issues around coal blending and tries to identify an optimal method to blend different domestic coals as well as to blend its domestic coal and imported coal mainly from Indonesia. The Government is keen to introduce CCT in the power sector as like the rest of its members; for a large scale plant SC will be applied, while the Government is considering for introduction of USC in the not-too-distant future.