Chapter 5

Model Assumptions

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Chapter 5

Model Assumptions

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This chapter focuses on model assumptions for projecting future energy demand and greenhouse gas emissions in the Business-As-Usual (BAU) scenario and other scenarios in the case studies. These assumptions used were based on the future values of macroeconomic, energy price, and other activity indicators such as electricity generation technologies, as well as energy development policies.

5.1 Macroeconomic Assumptions

Population: In 2015, the total population in the Lao People's Democratic Republic (Lao PDR) was 6.49 million. The population is projected to increase at an average annual rate of about 1.5%, reaching about 9.42 million in 2040. It is assumed that there is no difference in population between the BAU scenario and other scenarios in the case studies.

GDP: The Lao PDR's gross domestic product (GDP) grew at an average annual rate of 8.0% during 2005–2010, and was slightly down to 7.8% during 2010–2015. The GDP is assumed to grow at an average annual rate of 7.1% during 2016–2020, followed by 6.4% and 5.7% for the periods of 2020–2030 and 2030–2040, respectively. These projections are used for the development of the BAU scenario and also used as a base for the scenario of changes in the GDP in the case studies.

The assumptions on the growth of the GDP and population are shown in Table 5.1.

Table 5.1 Assumption on Annual Average Growth of GDP and Population

Period	GDP Growth (%)	Population Growth (%)
2015–2020	7.1	1.5
2020–2030	6.4	1.5
2030–2040	5.7	1.5

GDP = gross domestic product.
Source: Author's assumptions based on consultation with relevant ministries.

5.2 Crude Oil Price

Future changes in crude oil prices remain highly uncertain. In this study, the crude oil price, as referred to Japan's average import price (nominal dollars per barrel), is assumed to increase from US$49 a barrel in 2015 to US$80 a barrel in 2020, US$150 a barrel in 2030, and US$200 a barrel in 2040. These assumptions are used for the development of the BAU scenario and also used as a base for the scenario of high oil prices in the case studies.

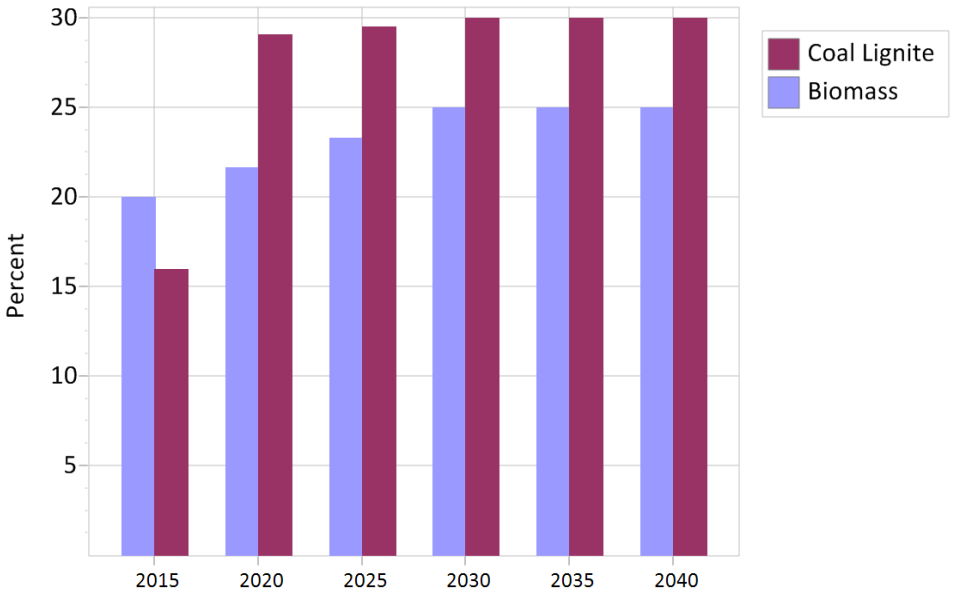
5.3 Electricity Generation Technologies

Electricity generation thermal efficiency

The thermal efficiency of electricity generation reflects the amount of fuel required to generate a unit of electricity. Thermal efficiency was set exogenously based on the historical data in electricity generation and development trends in the future.

The base year 2015 thermal efficiency by fuel type (coal and biomass) was derived from the 2010–2017 energy balance tables. Thermal efficiency is expected to improve considerably over time in the BAU scenario as more advanced generation technologies become available.

Figure 5.1 Thermal Efficiency of Coal and Biomass Power Plants up to 2040



Source: Author's assumptions based on consultation with experts from the Ministry of Energy and Mines.

Electricity generation fuel mix

The fuel mix used in electricity generation is an important input for the energy outlook, because it is a key driver for primary energy demand and greenhouse gas emissions. It was also an exogenous input to the model.

The main sources of electricity generation in the Lao PDR are hydropower plants and one coal-fired power plant. According to the Mekong River Commission study in 1995, the Lao PDR has a large potential hydropower source of 26,000 megawatts (MW) (ERIA, 2019). By 2015, the total installed capacity of hydropower reached 3,737 MW accounting for 16.2% of total potential hydropower. It is assumed that around 15,000 MW and 20,000 MW capacity of hydropower would be installed by 2030 and 2040, respectively. Hydropower plants provide electricity to both domestic customers (through the grid) and foreign markets (Thailand and Viet Nam).

The Lao PDR also has a considerable potential coal source, mostly as lignite in Hongsa in Xayabouly province. By 2015, the total installed capacity of the Hongsa coal-fired thermal plant was 1,878 MW. This capacity assumed would reach to around 3,000 MW and 3,500 MW by 2030 and 2040, respectively.

By 2015, a total power capacity of 5,641 MW had been developed and produced around 17,099 gigawatt hours (GWh) of electricity for both domestic consumption and export. Electricity generation is mainly from hydropower, accounting for nearly 85.1% (equivalent to 14,543 GWh), the remaining shares are the coal-fired thermal power plant (14.9%) and negligible renewable energy (RE).

The share of electricity generated at the coal-fired thermal power plant is projected to increase considerably, from 14.9% in 2015 to 22.5% in 2040, while hydropower will slightly decrease from 85.1% in 2015 to 77.1% in 2040. The remaining share of 0.4% by 2040 is coming from RE sources.

5.4 Other Energy Development Policies

The Lao PDR does not have a comprehensive national energy policy setting out a systematic approach to energy planning, policy formulation, and sector development. However, the government has issued a Law on Electricity, as well as policies, strategies, and plans for large hydropower and RE resources. The present strategic and planning approach is essentially concentrated on the development of the country's potential hydropower resources to meet domestic as well as export demands. RE use and technology development, on the other hand, are explicitly covered in the national RE development strategies.

The existing laws, regulations, policies, strategies, and development plans are summarised as follows:

Law on Electricity: The Law on Electricity was amended in 2011 and enacted on 20 December 2011 by replacing the earlier Law on Electricity notified on 8 December 2008. The Law on Electricity specifies the principles, rules, and measures on the organisation, operation, management, and inspection of electrical activities for the high effectiveness of electricity generation and business operation.

Renewable Energy Development Strategy: The strategy issued in October 2011 is the main policy framework for the development of RE in the country. The strategy sets a target of increasing the share of RE in total energy consumption to 30% by 2025. The government also aims to increase the share of biofuels to meet 10% of the demand for transport fuels by 2025.

Policy on Sustainable Hydropower Development in the Lao PDR: The policy applies to all hydropower projects larger than 15 MW throughout the project development process (planning, construction, operation, and transfer/closure stages) and incorporates technical, engineering, economic and finance, and environment and social impacts aspects. At present, the policy is under the revision process conducted by the Ministry of Energy and Mines.

Power Development Plan: Article 9 of the Electricity Law states that the electricity enterprise shall prepare the electricity development plan. Électricité du Laos (EDL) prepares the Power Development Plan (PDP) every 3to 5years. EDL formulated the PDP 2010–2020 in August 2010, revising the former PDP 2007–2017. In August 2011, EDL updated PDP 2010–2020 by reflecting the latest electricity demand forecast and prospective project developments in the generation and transmission sector.

Energy Efficiency and Conservation (EEC): The National Socio-Economic Development Plan (2006–2010), published in October 2006, stated a policy to promote environment management and, moreover, clean and highly-energy efficient technologies and industrial development in the industry and construction sectors. The Lao PDR is a developing country with relatively small energy consumption, and accordingly, there is no specific national strategy for energy saving. But the country is considering the development of an energy-saving strategy and policy with the support provided by the Asian Development Bank. An energy-saving act has not been developed, but there is a plan to develop one within several years.

The Law on Electricity (enacted in 2011) stipulates that the responsible ministries and agencies establish, approve, and test the quality of domestically produced or imported electrical equipment in order to secure the safety and energy-saving capability of electric machinery and equipment.

Currently, EEC in the Lao PDR is at an early stage. There are several EEC activities in the commercial and residential sectors focusing on energy saving of lighting equipment. A plan to reduce the energy consumption by government institutions by 10% between 2006 and 2007 was implemented. Moreover, the current energy saving target is also set by the government aiming to reduce energy intensity by 10% by 2025.

5.5 Case Studies

The BAU scenario was developed based on the above assumptions, accordingly, energy demand and supply are projected based on the relation between energy consumption and the macroeconomic indicators such as GDP, oil price, population, as well as policies on energy development, assuming that there would be a lack of additional policies to promote EEC and RE development.

The above indicators and energy policies may be variable: that is the reason why we need to evaluate the impacts of these variables on energy demand, supply, and CO2 emissions.

In this study, some case studies are implemented including changes in the GDP, high oil price, additional EE promotion, and RE development with assumptions as follows:

1) Changes in GDP: It is assumed that the GDP annual growth rate could increase or decrease with an additional ±1% (compared to the BAU scenario) as shown in Table 5.2.

Table 5.2 Changes in GDP Annual Growth Rate

Unit: KN trillion

Scenario	2015	2020	2025	2030	2035	2040	AAGR 2015–2040
BAU	101.8	142.5	194.3	263.2	347.2	458.2	6.2%
GDP increasing 1%	101.8	149.3	213.3	302.8	418.7	579.1	7.2%
GDP decreasing 1%	101.8	135.9	176.8	228.5	287.4	361.7	5.2%

AAGR = annual growth rate, BAU = Business-As-Usual, GDP = gross domestic product, KN= kip.
Source: Prepared by author.

2) Higher oil price: It is assumed that the crude oil price could increase from US$150 by 2030 and US$200 by 2040 in the BAU scenario to US$200 by 2030 and US$250 by 2040, respectively.
3) EEC promotion: It is assumed that the total final energy consumption (TFEC) would reduce by 10% (case 1 of EEC10) and 20% (case 2 of EEC20) compared to the BAU scenario through EEC activities in 2040.
4) RE development: It is assumed that the share of power generation outputs from RE sources (solar and wind) could reach 10% (case 1 of RE10) and 20% (case 2 of RE20) of the total power generation (compared to a negligible share under the BAU scenario) by 2040. These additional increases are assumed for replacing the coal-fired power plant.

   The maximum capacity factor of wind and solar power plants are 20% and 15%, respectively, while the coal-fired power plant's maximum factor capacity is 75% (or around 6,600 hours operation per year). It means that 5 MW of solar could be replaced only for around 1 MW of the coal-fired power plant at the same amount of power generation outputs.

References

Economic Research Institute for ASEAN and East Asia (ERIA), (2019), Energy Outlook and Energy Saving Potential in East Asia 2019. Jakarta: ERIA.