Chapter 2

Methodology

May 2020

This chapter should be cited as
ERIA (2020), 'Methodology', in ERIA and Myanmar Ministry of Electricity and Energy, *Myanmar Energy Outlook 2020.* ERIA Research Project Report FY2020 no.01, Jakarta: ERIA, pp.3-7.

Chapter 2

Methodology

1. Model Framework

Energy modelling involves the forecast of final energy consumption and the corresponding primary energy requirements or supply. Final energy consumption forecasts cover industry and transport, as well as 'others', which comprise agriculture, residential, commercial, and other sectors.

The energy outlook model was developed using the Long-range Energy Alternatives Planning System (LEAP)[1] software, an accounting system used to develop projections of energy balance tables based on final energy consumption and energy input and/or output in the transformation sector. Final energy consumption was forecasted using energy demand equations by the energy sector and future macroeconomic assumptions.

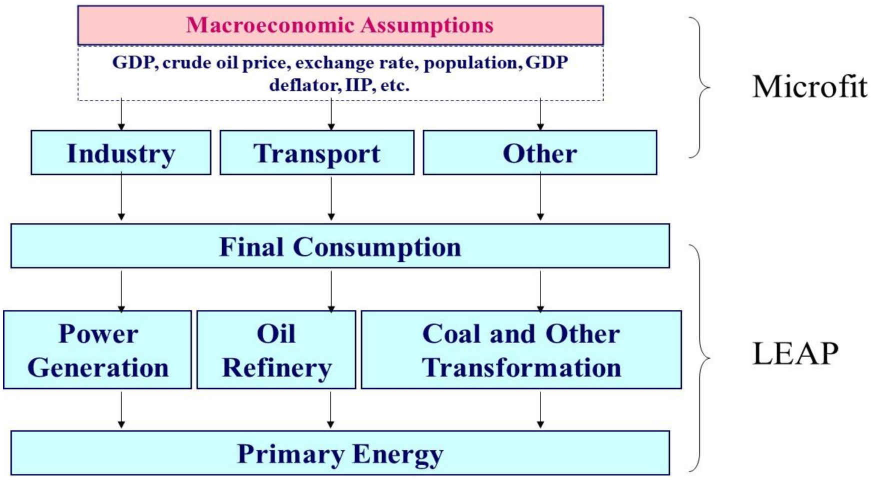
The energy demand equations are econometrically estimated using historical data, whilst future values are projected using the estimated energy demand equations under given explanatory variables. An econometric approach means that future demand will be heavily influenced by historical relations between socio-economic activities and energy demand. However, the supply of energy and new technologies is treated exogenously.

The ordinary least square (OLS) method is used to estimate energy demand functions. OLS is part of regression analysis and needs two types of historical data. One is energy data, which are national energy balance tables in 2000–2016 produced in 2018–2019 with ERIA's support, and the other is macroeconomic data such as population and gross domestic product (GDP) from the World Bank's World Development Indicators.

[1] An energy policy analysis and climate change mitigation assessment software developed at the Stockholm Environment Institute. For more information see LEAP, http://www.energycommunity.org/default.asp?action=47.

Figure 2.1 shows the model structure from final energy demand projection and forecast of transformation inputs and/or outputs to arrive at the primary energy requirements.

Figure 2.1. Structure of the Myanmar Energy Outlook Model

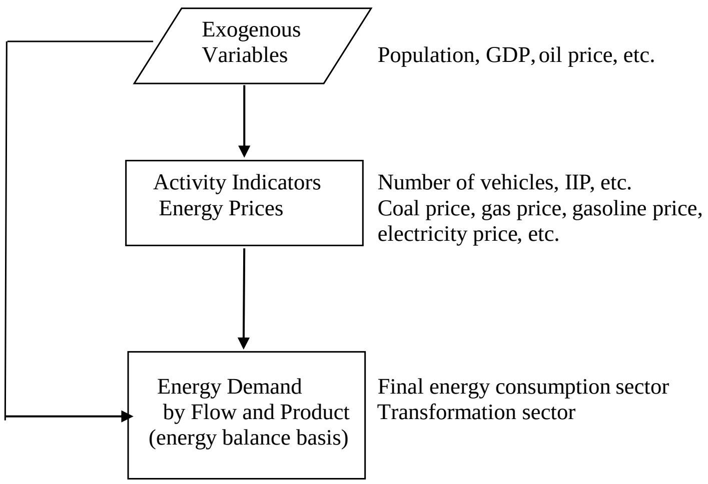


GDP = gross domestic product, IIP = index of industrial production, LEAP = Long-range Energy Alternatives Planning System.
Source: Author.

2. Estimating Demand Equation

Future energy demand for various energy sources is forecast using assumed future values of macroeconomic and activity indicators. The future values of these indicators were derived using historical data when they were enough for such analysis. The concept of estimating final energy demand equation is shown in Figure 2.2.

Figure 0.2. Process Flowchart of Myanmar Energy Outlook Model



GDP = gross domestic product, IIP = index of industrial production.
Source: Author.

In this process flowchart, energy demand is modelled as a function of activity such as income, industrial production, number of vehicles, number of households, number of appliances, and floor area of buildings. In the residential sector, for example, demand for electricity could be a function of number of households, disposable income, and penetration rate of electrical appliances. In the commercial sector, energy consumption could be driven by building floor area and GDP of service sector.

Such relationships amongst variables were derived using linear regression. The basic formulation is the following:

$$Energy\ demand\ (De) = f(Y, Pe/PGDP, De_{-1})$$

where,

Y: Income (GDP, etc.)

Pe: Energy price (oil price, etc.)

$PGDP$: GDP` deflator (overall price, consumer price index, etc.)

$Pe/PGDP$: Relative variable

De: Energy demand (coal, oil, gas, and electricity)

De_{-1}: Lag variable (show habit)

The regression analysis for the energy outlook was derived using OLS. The derived econometric equations were used in the LEAP model to estimate future energy demand based on growth assumptions of the activity (independent) variables such as GDP.

In cases where regression analysis is not applicable because of insufficient data or a failure to derive a statistically meaningful equation, appropriate growth assumptions were used to forecast future demand.

3. Forecasting Primary Energy Requirements

After future final energy demand is forecasted, the corresponding primary energy requirements need to be projected. Some of these primary energy requirements are the inputs to transformation to produce secondary fuels. Energy transformation involves electricity generation, oil refining, gas processing, charcoal making, and any other process that converts fuels from primary energy to secondary products.

Only the primary requirements for electricity generation were considered in the transformation sector. An oil refinery is being planned. Since no firm capacity was provided, the oil refinery was not included in this energy outlook.

Electricity in Myanmar is mainly produced by hydropower and gas power plants.

Myanmar also has coal, solar/PV, and biomass power plants. The electricity generation process in the model calculated the fuel requirement to produce electricity. The calculation of the primary energy requirements for electricity generation involves the following steps:

(1) Forecasting total electricity generation requirements. The total electricity generation requirement is greater than final electricity demand to cover the electricity consumption in the power stations and the expected losses in the transmission and distribution systems.

(2) Forecasting electricity generation capacity requirements, which involves two processes:

(a) Forecasting total capacity requirement, which is the capacity needed to meet peak demand. Total capacity requirement is peak demand plus assumed reserve margin, which is a percentage of peak demand. Reserve margin is the preferred amount of available capacity above peak demand to ensure that supply is not disrupted.

(b) Determining the power plants that should be added when total capacity of existing power plants cannot meet peak demand.

(3) Forecasting generation by each type of power plant. Generation by individual type of power plant in the energy model used the dispatch rule, which will meet annual demand for electricity as well as instantaneous demand for power in time slices of the year. Each power plant will be run (if necessary) up to the limit of its maximum capacity factor in each dispatch period.

4. Estimating Fuel Inputs

Finally, information on electricity generation together with conversion efficiency variables or the thermal efficiencies is used to calculate the input fuels required by power plants. This can be derived from the simple formula below:

$$Fuel\_Input_i = \frac{Electricity\_Generation_i}{Efficiency_i}$$

The unit of *Fuel_Input* and *Generation* is ktoe whilst that of *Efficiency* is a decimal number.

5. Case Studies and Scenarios

The outlook examined the business-as-usual (BAU) scenario, reflecting the country's current goals and action plans. BAU uses historical correlations of final energy consumption and economic activity from 2000 to 2016. The GDP growth rate is appropriate. It is used to estimate other drivers of energy demand such as GDP of the industrial sector, GDP per capita, and number of vehicles, amongst others. In view of the use of the regression analysis, future consumption trends will be similar to historical trends. Energy supply will be based on current government targets, as well.

The outlook examined the impact of changes in GDP, oil price, energy efficiency promotion, and renewable development. The details of these cases will be discussed in Chapter 5, on modelling assumptions.