Chapter 4

Cambodia Country Report

September 2016

This chapter should be cited as

Sarasy, C. (2016), 'Cambodia Country Report' in Kimura, S. and P. Han (eds.) in *Energy Outlook and Energy Saving Potential in East Asia 2016.* ERIA Research Project Report 2015-5, Jakarta: ERIA, pp.91-107.

Chapter 4

Cambodia Country Report

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1. Background

The Kingdom of Cambodia is located in the Lower Mekong region of Southeast Asia. It has an area of 181,035 km^2, an 800 km border with Thailand in the west, Lao PDR in the north, and Viet Nam in the east. The physical landscape is dominated by lowland plains around the Mekong River and the Tonle Sap Lake. There are about 2.5 million hectares of arable land and over 0.5 million hectares of pastureland.

Real gross domestic product (GDP) in 2013 was US$10.7 million, comprising agriculture (24.2 percent); manufacturing (22.4 percent); electricity, gas, and water (0.6 percent); commerce including hotels and restaurants (14.2 percent); transport and telecommunications (6.4 percent); construction industry (5.8 percent); financial operations (8.1 percent); and 'others' (18.3 percent). The Cambodian economy maintained high economic growth exceeding an annual average 10 percent from 2004 to 2007. Although the economic growth rate in 2009 fell to 0.1 percent due to the impact of the global economic crisis, it recovered to 6.0 percent in 2010. The economic growth rates in 2011, 2012, and 2013 were 7.1 percent, 7.3 percent, and 7.2 percent, respectively. In short, steady GDP growth rates were maintained except in 2009. Growth is forecast by the Ministry of Economy and Finance to be maintained at around 7 percent per year.

Based on the 2008 Population Census of Cambodia, the population was 13,388,910 in 2008, 56 percent of which was under 24 years old. Cambodia's population in 2013 was 15.1 million. The continuing inflow of population into urban areas could make up more than 15 percent of the national population in future. Population density is about 75 people per square kilometre and 85–90 percent still lives in rural areas. Phnom Penh Capital City has a population of about 2 million, and Siem Reap Province has about 100,000 people.

Cambodia's power generation facility by fuels is shown in Table 4.1. Installed capacity of hydropower accounted for about 60 percent of the total. Energy generated from hydropower in 2013 was around two times as much as in 2012. Cambodia's hydropower energy potential was estimated at 10,000 MW, 50 percent of which is in the Mekong mainstream, 40 percent in its tributaries, and 10 percent in the south-western coastal area outside the Mekong River Basin. Hydropower capacity of up to 4,931 MW will be developed by 2020. Coal-fired power generation will have a capacity of 380 MW by 2015.

Table 4.1. Power Generation Facility, by Fuel

No.	Type of Generation	Installed Capacity [MW]		Proportion in Percent for 2013
		2012	2013	
1	Hydro	225	683	59.06
2	Diesel/Heavy Fuel Oil	321	325	28.17
3	Biomass	22.5	14.5	1.26
4	Coal	13.0	133	11.52
Total		581.5	1,155.5	100

MW = megawatt.
Source: EAC report 2013.

Cambodia's total primary energy supply (TPES) in 2013 stood at 6.82 million tons of oil equivalent (Mtoe), with renewable energy (mostly biomass) accounting for the largest share at approximately 60 percent, followed by oil at 36.6 percent, and coal at 0.7 percent.

Final energy consumption had increased to 6 Mtoe by 2013. It is dependent on imports of petroleum products as Cambodia has no crude oil production or oil refining facilities. Its electricity supply is dominated by hydro at 57.4 percent, with oil, coal, and biomass accounting for the rest.

2. Modelling Assumptions

2.1. GDP and Population

In forecasting energy demand to 2040, the GDP of Cambodia is assumed to grow at an annual average rate of 6.1 percent. With its population projected to grow by 1.6 percent per year, the forecast is for GDP per capita growth of 4.4 percent per year up to 2040.

2.2. Electricity Generation

With regard to future electricity supply, hydro is expected to dominate Cambodia's fuel mix in 2040, followed by coal. This is a big change from the current oil-dominated electricity generation. According to the Electricity Supply Development Master Plan for 2010–2020, the country will have a total additional installed electricity generation capacity of 3,536 MW, 1,050 MW of which will come from coal power plants to be installed from 2010 to 2018. Hydro will make up 2,606 MW of the total and, from 2020 to 2040, will meet the additional electricity generation capacity requirements.

2.3. Energy Efficiency and Conservation Policies

Cambodia's energy efficiency and conservation (EEC) programmes aim to achieve an integrated and sustainable programme that will facilitate energy efficiency improvements in the major energy consuming sectors and help prevent wasteful fuel consumption. To achieve these aims, the country realises the need for market transformation towards more efficient energy use, increased access to energy

efficiency project financing, and the establishment of energy efficiency regulatory frameworks.

As a start, Cambodia is implementing the following pilot projects:

- Improving the efficiency of the overall supply chain for home lighting in rural areas by the provision of decentralised rural energy services through a new generation of rural energy entrepreneurs.
- Assisting in market transformation for home and office electrical appliances through bulk purchase and dissemination of high-performance lamps, showcasing of energy-efficient products, support to competent organisations for testing and certification of energy-efficient products, and establishment of 'Green Learning Rooms' in selected schools to impart life-long education on the relevance of EEC.
- Improving energy efficiency in buildings and public facilities.
- Improving energy efficiency in industries in cooperation with the United Nations Industrial Development Organisation (UNIDO) and the Ministry of Industry, Mines and Energy (MIME) (now changed to Ministry of Mines and Energy, MME) to be implemented in the four sectors of rice milling, brick kilns, rubber refinery, and garment.

Cambodia is also preparing an action plan for EEC in cooperation with the Energy Efficiency Design sub-working group. Specific actions plans are being drafted for the industry, transportation, and 'other' sectors. The initial estimates of sector-demand reduction of existing consumers from these actions plans are 10 percent by 2015 and 15 percent by 2035 relative to the Business-as-Usual scenario (BAU). These initial estimates were used in forecasting the energy demand in the Alternative Policy Scenario (APS).

In a close consultation process between the previous MIME and EUEI–PDF that started in July 2011, it was decided to launch a project to support the Royal Government of Cambodia in the elaboration of a National Energy Efficiency Policy, Strategy and Action Plan. The project started with an inception phase in August 2012 and was concluded in April 2013 with a final workshop, which elaborated the recommendations and conclusions of the plan.

Five sectors have been identified as priority areas for the National Energy Efficiency Policy, Strategy and Action Plan:

1. Energy efficiency in industry
2. Energy efficiency of end-user products
3. Energy efficiency in buildings
4. Energy efficiency of rural electricity generation and distribution
5. Efficient use of biomass resources for residential and industrial purposes

3. Outlook Results

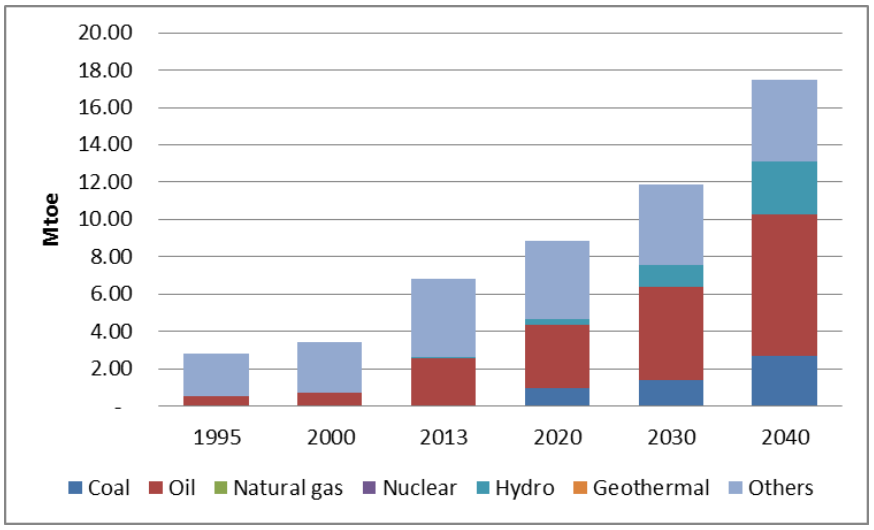
3.1. Business-as-Usual (BAU) Scenario

3.1.1. Primary energy supply

Primary energy supply in Cambodia grew at 5 percent per year, which is a slightly faster rate than final energy consumption from 2.84 Mtoe in 1995 to 6.82 Mtoe in 2013. Among the major energy sources, the fastest growing was oil. Oil consumption grew at an average annual rate of 9.2 percent between 1995 and 2013 (see Figure 4-1).

In the BAU, Cambodia's primary energy supply/consumption is projected to increase at an annual average rate of 3.5 percent or by 2.56 times from 6.82 Mtoe in 2013 to 17.46 Mtoe in 2040. The fastest growth is expected in coal, increasing at an annual average rate 16.3 percent between 2013 and 2040, followed by hydro, oil, and others (including biomass) at 13.8 percent, 4.2 percent, and 0.2 percent, respectively. The share of hydro is projected to increase from 1.3 percent in 2013 to 16.3 percent in 2040. This growth in its share is due to the huge potential for water reservoirs in Cambodia. The share of oil is projected to increase from 36.6 percent in 2013 to 43.4 percent in 2040 due to the projected growth in the numbers of cars and motorbikes in the transportation sector.

Figure 4-1. Primary Energy Supply by Source, BAU



BAU = Business-as-Usual scenario; Mtoe = million tons of oil equivalent.
Source: Author's calculation.

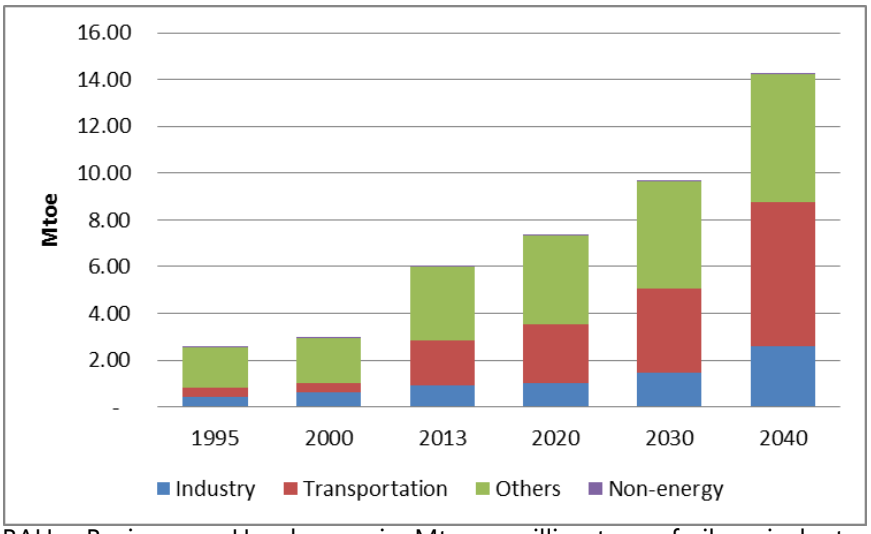
3.1.2. Final energy consumption

By sector

Cambodia's final energy consumption grew at an average annual rate of 4.9 percent, from 2.54 Mtoe in 1995 to 6.00 Mtoe in 2013.

In the BAU, driven by assumed strong economic growth and an increasing population, final energy consumption is projected to increase at an annual average rate of 3.3 percent or by almost 2.4 times, from 6.00 Mtoe in 2013 to 14.29 Mtoe in 2040 (Figure 4-2). The strongest growth in consumption is projected to occur in the transportation sector, which will increase at an annual average rate of 4.3 percent or by 3.15 times, from 1.95 Mtoe in 2013 to 6.15 Mtoe in 2040. The industry sector is projected to grow at an annual rate of 4.0 percent or by 2.87 times, from 0.9 Mtoe in 2013 to 2.59 Mtoe in 2040, followed by the non-energy sector and the 'others' sector at 3.3 percent (from 0.02 Mtoe in 2013 to 0.05 Mtoe in 2040) and 2.1 percent (from 3.13 Mtoe in 2013 to 5.51 Mtoe in 2040), respectively.

Figure 4-2. Final Energy Consumption by Sector, BAU

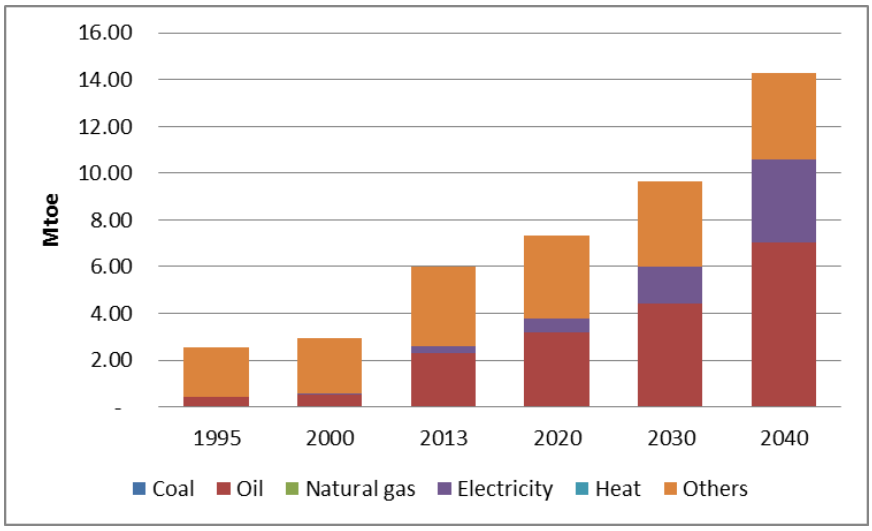


BAU = Business-as-Usual scenario; Mtoe = million tons of oil equivalent.
Source: Author's calculation.

By fuel

Electricity is projected to see the fastest growth in final energy consumption, increasing by 9.8 percent per year or by 12.61 times from 0.28 Mtoe in 2013 to 3.58 Mtoe in 2040. Oil is projected to show the second highest growth rate of 4.2 percent per year or by 3.06 times, from 2.29 Mtoe in 2013 to 7.02 Mtoe in 2040. Others, mainly solid and liquid biofuels, will increase at 0.3 percent per year from 3.42 Mtoe in 2013 to 3.69 Mtoe in 2040 (Figure 4-3).

Figure 4-3. Final Energy Consumption by Fuel, BAU



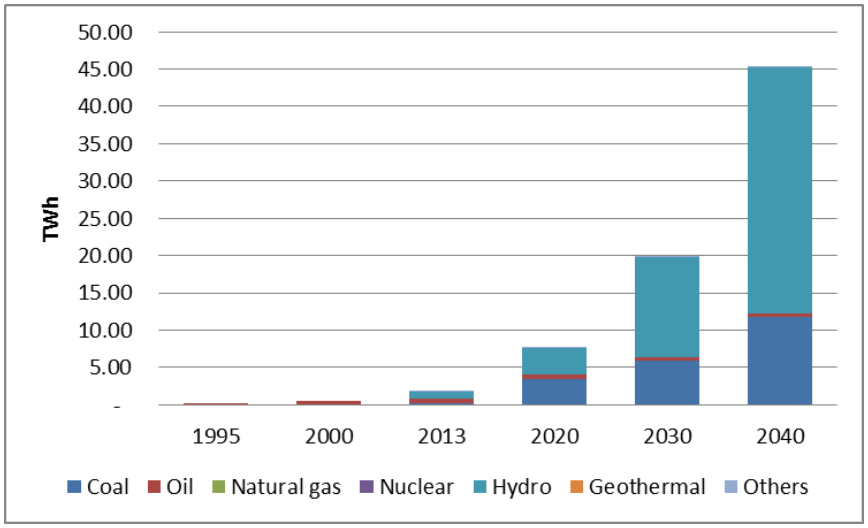
BAU = Business-as-Usual scenario; Mtoe = million tons of oil equivalent.
Source: Author's calculation.

3.1.3. Electricity generation

Electricity generation increased at 12.9 percent per year from 0.20 TWh in 1995 to 1.77 TWh in 2013. From 1995 to 2001, 100 percent of electricity generated came from oil-fired power plants. In 2002, a hydro power plant started operation in Cambodia and by 2013 its share in the power generation mix had increased to 57.4 percent. Coal power generation was also introduced to Cambodia rather late in 2009. By 2013, the share of coal in the power generation mix had risen to 9.5 percent.

In the BAU, to meet the demand for electricity, power generation is projected to increase at an average annual rate of 12.8 percent between 2013 and 2040. The fastest growth in electricity generation will be in coal (17.0 percent per year), followed by hydro (13.8 percent per year), and 'others' (8.3 percent per year) (Figure 4-4). Generation from oil-fired power plants will decrease considerably due to high fuel cost.

Figure 4-4. Power Generation by Fuel, BAU



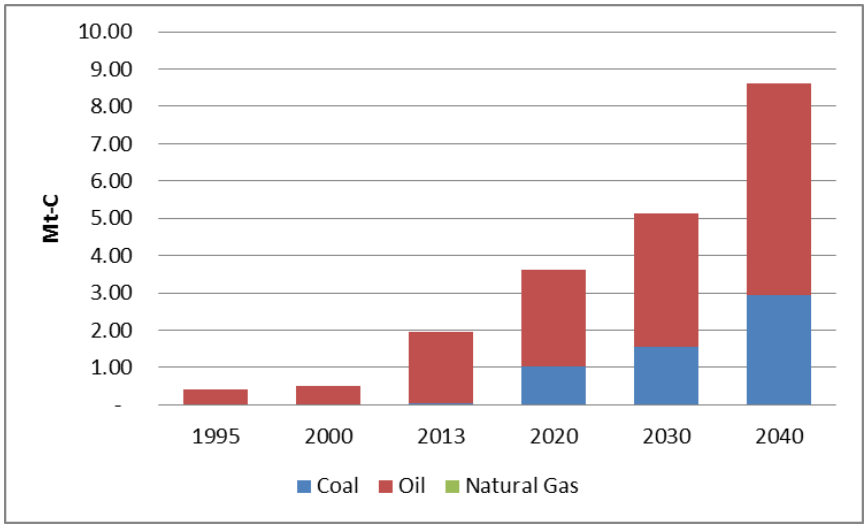
BAU = Business-as-Usual scenario; TWh = terawatt-hour.
Source: Author's calculation.

3.1.4. Carbon Dioxide (CO_2) emissions

CO_2 emissions from energy consumption are projected to increase by 5.6 percent per year from 1.96 Mt-C in 2013 to 8.62 Mt-C in 2040 under the BAU.

Oil is the largest source of carbon emissions; it will increase from 1.91 Mt-C in 2013 to 5.69 Mt-C in 2040. Emission from coal is expected to have the fastest growth rate at 16.3 percent per year from 0.05 Mt-C in 2013 to 2.93 Mt-C in 2040 (Figure 4-5).

Figure 4-5. CO_2 Emission from Energy Consumption, BAU



CO_2 = carbon dioxide; BAU = Business-as-Usual scenario; Mt-C = metric tons of carbon.
Source: Author's calculation.

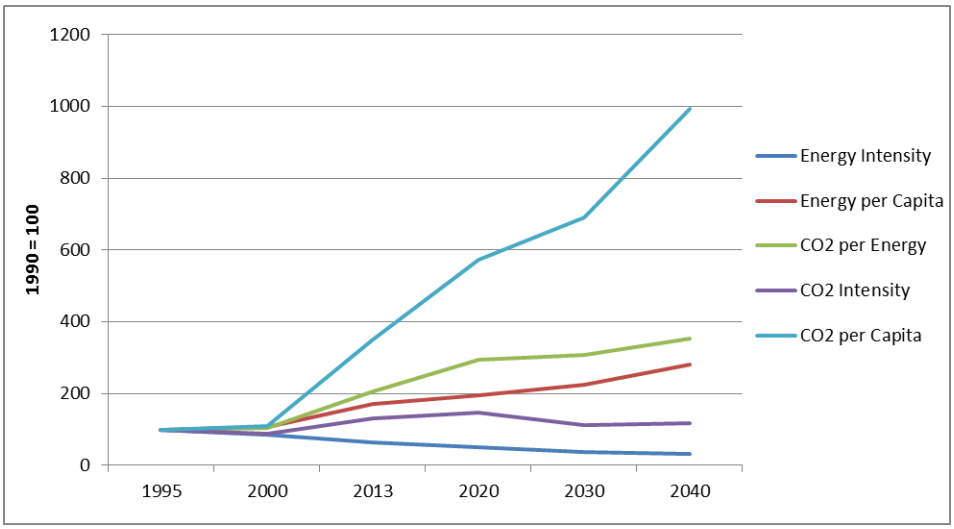
3.1.5. Energy indicators

Energy intensity had a decreasing trend from 1,002 toe/million US$ in 1995 to 636 toe/million US$ in 2013. In the BAU, energy intensity will further decrease to 331 toe/million US$ in 2040. This indicates that energy will be used more efficiently in economic development. This is mainly due to the dominance of conventional biomass use in the rural areas of the country and the future growth of it will be slower than GDP growth.

Energy per capita had been increasing from 0.27 toe/person in 1995 to 0.45 toe/person in 2013. In the BAU, energy per capita will further increase to 0.75

toe/person in 2040. This indicates that living standards of people are improving, resulting in increasing energy demand per capita. Figure 4-6 shows various indicators of energy consumption.

Figure 4-6. Energy and CO_2 Indicators



CO_2 = carbon dioxide.
Source: Author's calculation.

CO_2 per energy in the BAU case is projected to increase from 0.29 metric tons of carbon per toe (t-C/toe) in 2013 to 0.49 t-C/toe in 2040, implying faster growth of fossil fuels in total energy consumption.

But CO_2 intensity had been increasing from 140 t-C/million US$ in 1995 to 183 t-C/million US$ in 2013. It will drop further to 164 t-C/million US$ in 2040.

4. Scenario Analysis

4.1. Alternative Policy Scenario (APS)

The APS consists of scenarios such as the Energy Efficiency and Conservation (EEC) scenario (APS1), improvement of energy efficiency in power generation (APS2), and development of renewable energy (APS3). The scenarios were individually modelled to determine the impact of each scenario on reduction of energy consumption and CO_2 emissions. Below are the assumptions of each scenario:

- APS1: focus on EEC on the demand side, such as:
  - Energy demand in all sectors to be reduced by 10 percent in 2015 and 20 percent by 2040 relative to the BAU.
  - Using efficient motorbikes and hybrid cars in road transport.
  - Replacing inefficient devices with efficient ones in commercial and residential sectors, for example for cooking, lighting, refrigeration, and air conditioning.
- APS2: Improvement of energy efficiency in thermal power plants. It is assumed that energy efficiency of coal and fuel oil thermal power plants will stay constant at 32 percent until 2040, in the BAU. In the APS, it is assumed that new coal power plants will have thermal efficiencies of 38.8 percent.
- APS3: Additional 5,000 MW of hydro power plants by 2040 is assumed in this scenario.
- APS5 or APS: Combination of APS1 to APS3.

4.2. Energy Saving Potential and CO_2 Emissions Reduction

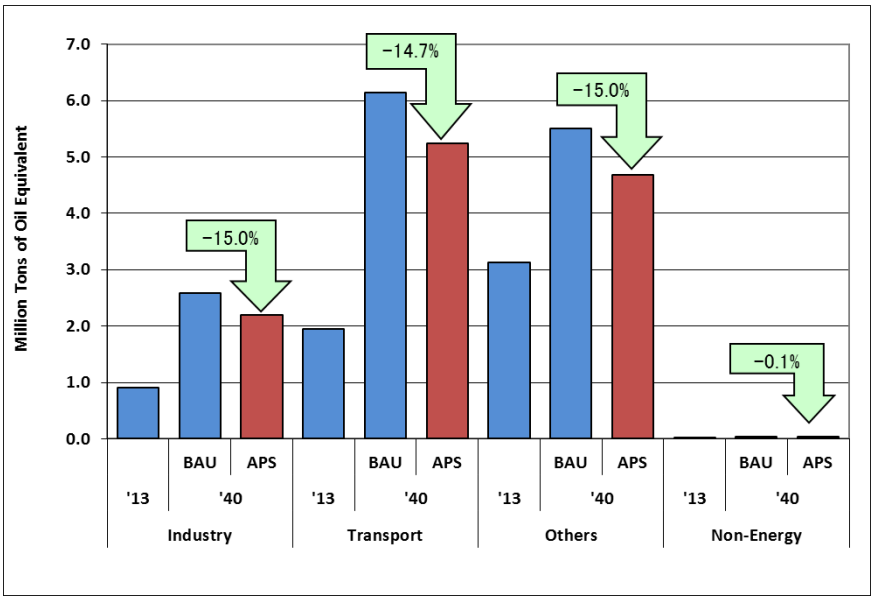
4.2.1. Final energy consumption

In the APS, final energy consumption is projected to increase at a slower rate of 2.7 percent (compared with 3.3 percent in the BAU), from 6.00 Mtoe in 2013 to 12.18 Mtoe in 2040 because of EEC measures (APS1) in industrial, transportation, residential, and commercial ('others') sectors.

Final energy consumption is expected to make savings amounting to 2.1 Mtoe. The bulk of the savings are expected to occur in the transportation sector (0.9 Mtoe), followed by the 'others' sector (0.8 Mtoe), and the industry sector (0.4 Mtoe).

An improvement in end-user technologies and the introduction of energy management systems is expected to contribute to a slower rate of consumption growth, particularly in the 'others' (residential and commercial) sector, and the industry and transportation sectors (Figure 4-7).

Figure 4-7. Final Energy Consumption by Sector, BAU and APS



BAU = Business-as-Usual scenario; APS = Alternative Policy Scenario.
Source: Author's calculation.

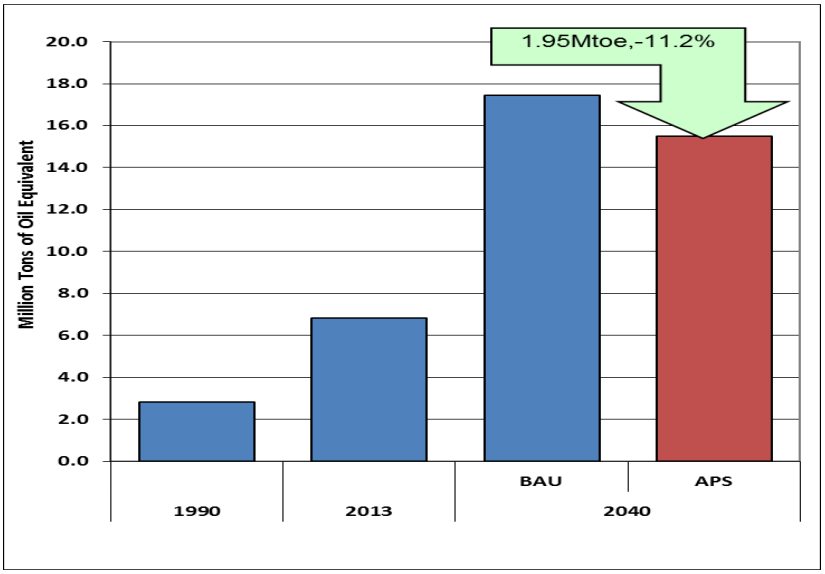
4.2.2. Primary energy supply

In the APS, primary energy supply/consumption is projected to increase at a slower rate of 3.1 percent per year from 6.82 Mtoe in 2013 to 15.51 Mtoe in 2040. The saving could mostly be derived from EEC Scenarios on the demand side and development of renewable energy technology (APS3).

In the APS, coal is projected to grow at an average annual rate of 17.0 percent compared with 16.3 percent in the BAU, followed by hydro with 12.4 percent, compared with 13.8 percent in the BAU, respectively, over the same period.

The total saving will be equal to 1.95 Mtoe, which is equivalent to 11.2 percent of Cambodia's primary energy supply in 2040 (Figure 4-8).

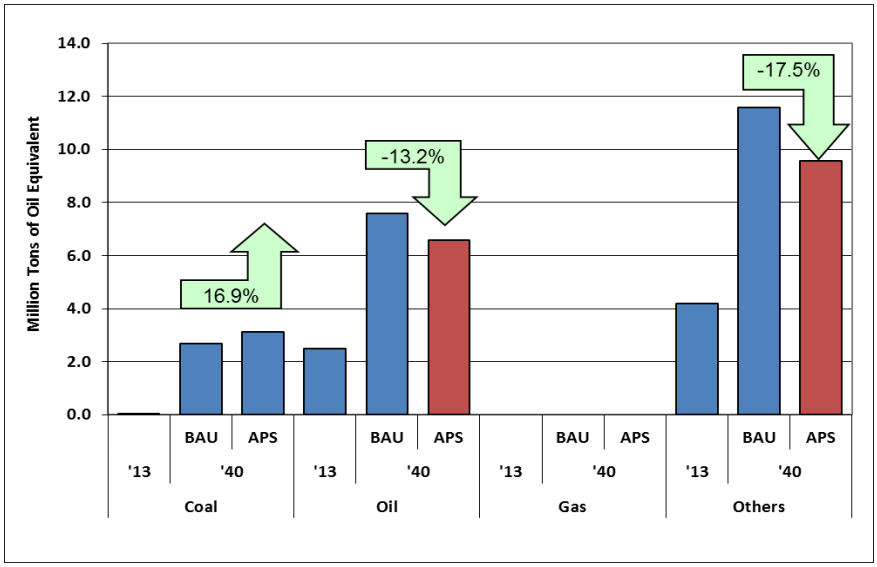
Figure 4-8. Primary Energy Supply by Fuel, BAU and APS



BAU = Business-as-Usual scenario; APS = Alternative Policy Scenario; Mtoe = million tons of oil equivalent.
Source: Author's calculation.

The reduction in consumption, relative to the BAU, comes from EEC measures on the demand side (APS1), more aggressive uptake of energy efficiency in thermal power plants (APS2), and adoption of renewable energy (APS3) on the supply side. Accordingly, the energy saving potential from other energy sources would be 17.5 percent, followed by oil at 13.2 percent. Coal is projected to increase by 16.9 percent (Figure 4-9).

Figure 4-9. Primary Energy Supply Saving Potential by Fuel, BAU vs APS



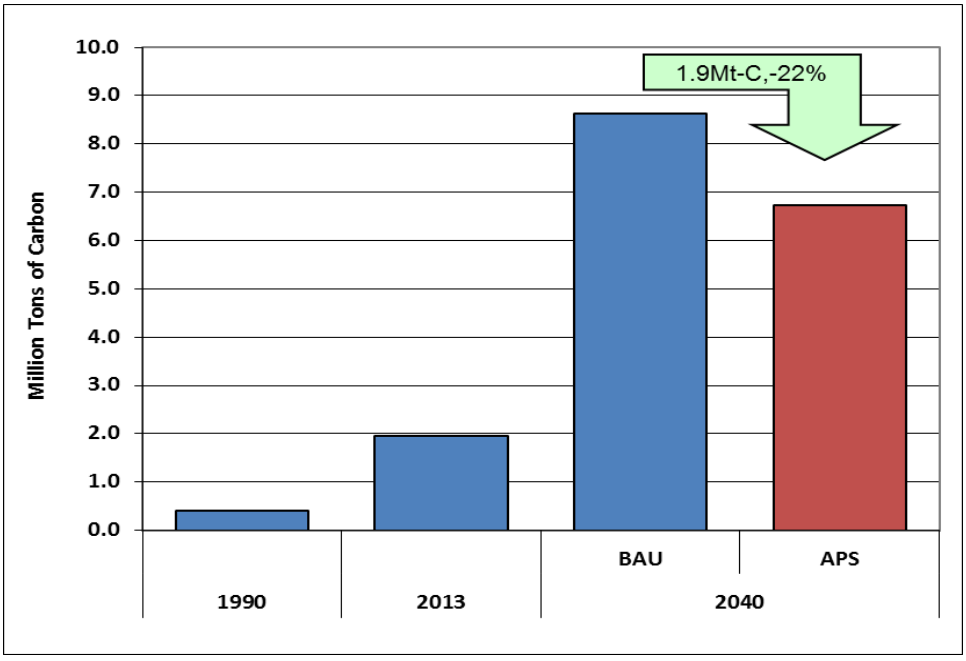
BAU = Business-as-Usual scenario; APS = Alternative Policy Scenario.
Source: Author's calculation.

4.2.3. CO_2 Emissions

CO_2 emissions from energy consumption under the BAU are projected to increase by 5.6 percent per year from 1.96 million metric tons of carbon (Mt-C) in 2013 to 8.62 Mt-C in 2040. Under the APS, the annual increase in CO_2 emissions is projected to be 4.7 percent per year between 2013 and 2040, which represents a 22 percent reduction from the BAU.

The CO_2 emission reduction would be mostly derived from EEC measures on the demand side (APS1). Improvement of energy efficiency in thermal power plants (APS2) and development of renewable energy technologies (APS3) can also contribute significantly to CO_2 reduction (Figure 4-10).

Figure 4-10. CO_2 Emission by Fuel, BAU and APS



CO_2 = carbon dioxide; BAU = Business-as-Usual scenario; APS = Alternative Policy Scenario; Mt-C = metric tons of carbon.
Source: Author's calculation.

5. Key Findings and Policy Implications

The above analysis on energy saving potential produces the following key findings:

- Energy demand in Cambodia is expected to continue to grow at a significant rate, driven by robust economic growth, industrialisation, urbanisation, and population growth. Energy efficiency and conservation is the 'new source' of energy and measures reflected in the APS are estimated to have significant potential to help meet future demand in a sustainable manner.
- Cambodia's energy intensity will be further reduced due to efficient use of energy.
- The annual growth of energy demand in the transportation sector is projected to be the highest at 4.3 percent in the BAU and its share will increase continuously from 32.5 percent in 2013 to 43.0 percent in 2040. This shows that the transportation sector has large energy saving potential.
- Electricity demand is increasing at the highest annual growth rate of 9.3 percent in the BAU and growth is projected to be slightly lower at 9.2 percent in the APS.
- Coal thermal power plants will be the major power generation source in Cambodia in the coming years. Its share in total power generation output is projected to increase continuously from 9.5 percent in 2013 to 26.0 percent in 2040. This is also the area with the largest expected energy savings and greenhouse gas (GhG) mitigation potential in Cambodia.
- Hydropower plants will be the second major source of power generation in Cambodia in the coming years. Its share in total power generation output is projected to increase continuously from 57.4 percent in 2013 to 72.9 percent in 2040.

Based on the above findings and to be able to effectively implement EEC activities in Cambodia, the following actions are recommended:

- Promotion of the establishment of targets and a road map for EEC implementation: The targets for EEC in Cambodia should be set for the short-, medium-, and long-term periods and focus on the buildings and industrial sectors. The long-term plan should be based on an assessment of

the energy saving potential for all energy sectors, including the residential and commercial sectors, which have large energy saving potential up to 2040. Moreover, some activities could promote EEC in Cambodia, such as (i) support for the development of professionals in the energy conservation field to be responsible persons for energy management and operation, verification and monitoring, consultancy and engineering services provision, and the planning, supervision, and promotion of the implementation of energy conservation measures; (ii) support for the development of institutional capability of agencies/organisations in both the public and private sectors, responsible for the planning, supervision, and promotion of the implementation of energy conservation measures; (iii) support for the operation of energy savings companies to alleviate technical and financial risks of entrepreneurs wishing to implement energy conservation measures; and (iv) public relations and provision of knowledge about energy conservation to the general public, via the teaching/learning process in educational institutions, fostering youth awareness.

- Compulsory energy labelling for electrical appliances: Annual growth of electricity demand in residential and commercial ('other') sectors is projected to be substantial compared with other sectors. Compulsory energy labelling for electrical appliances could be an effective management measure to generate energy savings.
  - Priority for development of advanced hydro and coal thermal power technology: Hydro and coal thermal power plants will be the major power generators in Cambodia up to 2040. Therefore, advanced technologies for both types of resources should be prioritised for development from the stage of project design.
- Priority for renewable energy development: Renewable energy is an important resource for energy independence, energy security, and GhG emissions abatement. It is necessary to draw up a strategy and construct mechanisms to support renewable energy development.

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