Chapter 4

Cambodia Country Report

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CHAPTER 4

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1. Background

The Kingdom of Cambodia is located in the Lower Mekong region of Southeast Asia. It has an 800 km border with Thailand in the west, with 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. Of the country's area of 181,035 square kilometres, approximately 49 percent remains covered by forest. There are about 2.5 million hectares of arable land and over 0.5 million hectares of pasture land. The country's gross domestic product (GDP) in 2011 was about US$9.3 billion at constant 2005 prices, with a substantial agriculture share of 34 percent. The population in the same year was 14.5 million.

Cambodia's total primary energy supply (TPES) in 2012 stood at 5.78 Mtoe – oil represented the second largest share of Cambodia's TPES at 28.9 percent; hydro was third at 0.8 percent, followed by coal (0.2 percent), whereas others (mostly biomass) had the bulk of 67.3 percent. Imported electricity accounted for the remaining 2.8 percent.

Final energy consumption stood at 5.03 Mtoe. It is dependent on imports of petroleum products having no crude oil production or oil refining facilities. Its electricity supply is dominated by oil, at 59.8 percent, with hydro, coal, biomass, and solar energy accounting for the rest.

Cambodia has 10,000 MW of hydropower potential, of which 4,931 MW will be developed by 2020. Coal-fired power generation will have a capacity of 380 MW by 2015.

2. Modelling Assumptions

2.1. GDP and Population

In forecasting energy demand to 2035, it is assumed that the GDP of Cambodia will grow at an annual rate of 6.4 percent. With its population projected to grow at 1.7 percent per year, GDP per capita is forecast to grow by 4.6 percent per year up to 2035.

2.2. Electricity Generation

With regard to the future electricity supply, hydro is expected to dominate Cambodia's fuel mix in 2035, 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, Cambodia will have a total additional installed electricity generation capacity of 3173.2 MW, 900 MW of which will come from coal power plants to be installed from 2010 to 2018. Hydro will make up 1873.2 MW of the total.

From 2020 to 2035, the additional electricity generation capacity requirements will be met by hydro. The gross electricity generation also assumes net export of electricity to neighbouring countries of 2,600 GWh in 2020, and this is projected to gradually increase to 3,080 GWh by 2035.

2.3. Energy Efficiency and Conservation Policies

Cambodia's energy efficiency and conservation 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 for 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 importance of energy efficiency and conservation.
- Improving energy efficiency in buildings and public facilities.
- Improving energy efficiency in industries in cooperation with United Nations Industrial Development Organization (UNIDO) and the Ministry of Industry, Mines and Energy (MIME) (now changed to Ministry of Mines and Energy, MME) to be implemented in four sectors – rice mill, brick kiln, rubber refinery, and garment.

Cambodia has also embarked on preparing an action plan for energy efficiency and conservation in cooperation with the Energy Efficiency Design sub-working group. Specific actions plans are being drafted for the industrial, 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 (BAU) scenario. These initial estimates were used in forecasting energy demand under the Alternative Policy Scenario (APS).

In a close consultation process between the former MIME and European Union Energy Initiative Partnership Dialogue Facility (EUEI–PDF) that started in July 2011, it was decided to launch a project to support the Royal Government of Cambodia (RGC) 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 were 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; and
5) Efficient use of biomass resources for residential and industrial purposes.

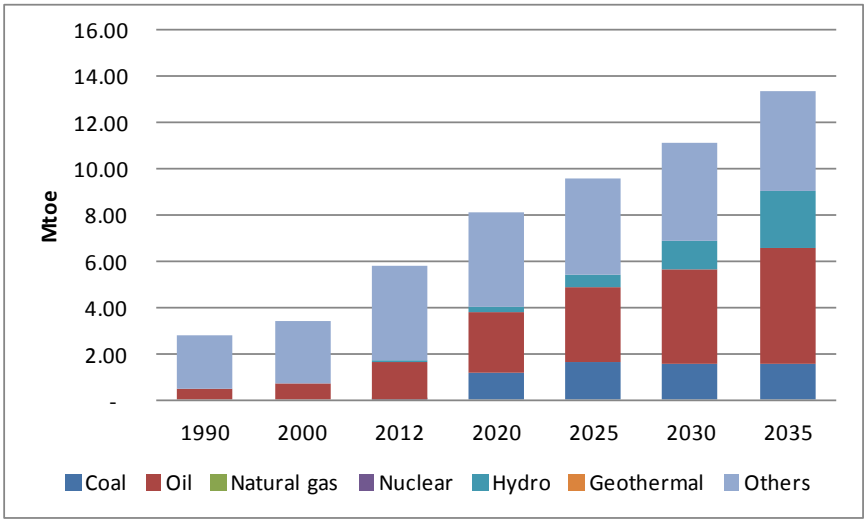
3. Outlook Results

3.1. Business-as-Usual (BAU) Scenario

3.1.1. Total Primary Energy Demand

Primary energy supply in Cambodia grew at 3.3 percent per year, which is a faster rate than final energy consumption or 2.0 times from 2.84 Mtoe in 1995 to 5.78 Mtoe in 2012. Amongst the major energy sources, the fastest growing was oil. Oil consumption grew at an average annual rate of 5.5 percent between 1995 and 2012 (Figure 4-1).

Figure 4-1. Total Primary Energy Supply in BAU



BAU = Business-as-Usual.
Source: Author's calculation.

In the Business-as-Usual (BAU) scenario, Cambodia's primary energy demand is projected to increase at an annual rate of 3.7 percent per year or 2.3 times from 5.78 Mtoe in 2012 to 13.35 Mtoe in 2035. The faster growth is expected in coal, increasing at annual average rate 24.5 percent between 2012 and 2035, followed by hydro, oil, and others (including biomass and imported electricity) at 19.0 percent, 4.9 percent, and 0.3 percent, respectively. The share of hydro is projected to increase from 0.8 percent in 2012 to 18.1 percent in 2035. This growth in the share is at the expense of biomass, the share of which is projected to decline from 67.3 percent to 32.4 percent. The share of coal is projected to increase from 0.2 percent to 11.7 percent over the same period.

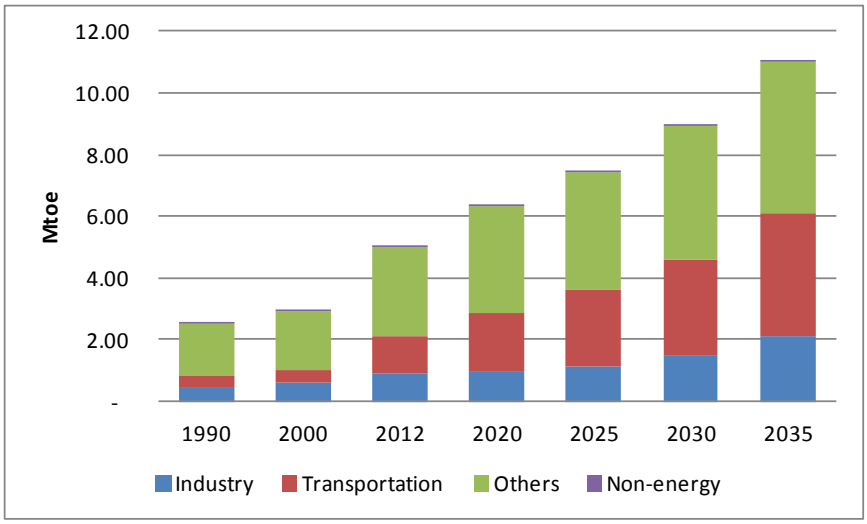
3.1.2. Total Final Energy Consumption

3.1.2.1. By Sector

Cambodia's final energy consumption grew at an average annual rate of 3.1 percent per year from 2.54 Mtoe in 1995 to 5.03 Mtoe in 2012.

In the BAU scenario, driven by assumed strong economic growth and a rising population, final energy consumption is projected to increase at an annual average rate of 3.5 percent, or more than two times from 5.03 Mtoe in 2012 to 11.04 Mtoe in 2035 (Figure 4-2).

Figure 4-2. Total Final Energy Consumption by Sector in BAU



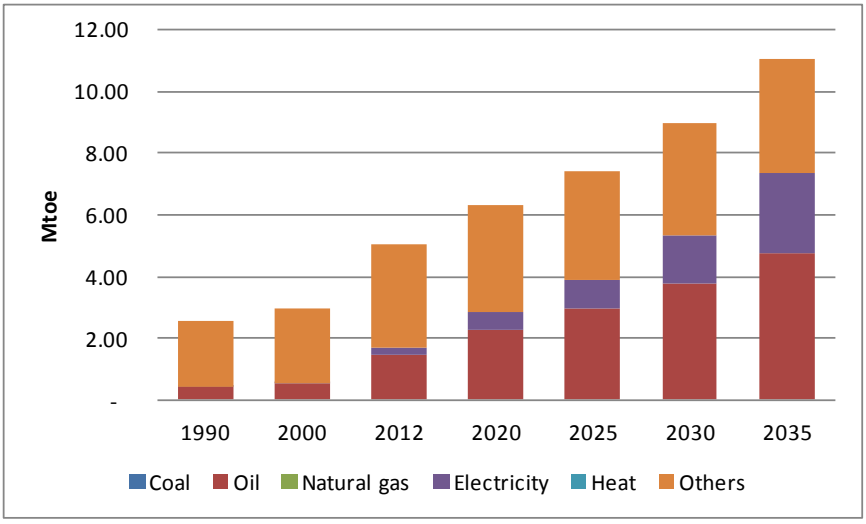
BAU = Business-as-Usual.
Source: Author's calculation.

Amongst the sectors, the strongest growth in consumption is projected to occur in the transportation sector, which increases at annual average rate of 5.3 percent between 2012 and 2035. Industry, non-energy, and others sector are projected to grow at 3.9 percent, 2.3 percent, and 4.0 percent per year, respectively.

3.1.2.2. By Fuel

Electricity is projected to exhibit the fastest growth in final energy consumption, growing at 10.6 percent per year or 10 times from 0.26 Mtoe in 2012 to 2.62 Mtoe in 2035. Oil is projected to see the second highest growth rate, of 5.3 percent per year or 3.3 times from 1.44 Mtoe in 2012 to 4.75 Mtoe in 2035. Others, which mainly include solid and liquid biofuels, will increase at 0.4 percent per year from 3.32 Mtoe in 2012 to 3.67 Mtoe in 2035 (Figure 4-3).

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



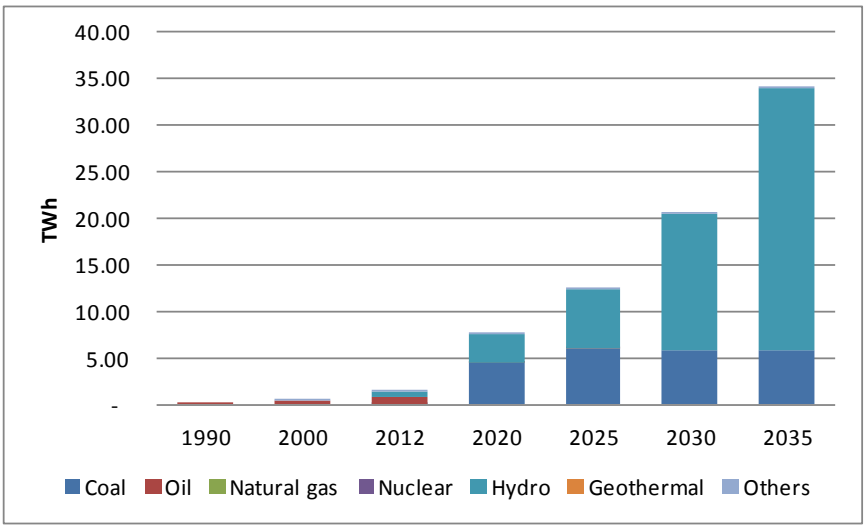
BAU = Business-as-Usual.
Source: Author's calculation.

3.1.2.3. Electricity Generation

Electricity generation increased by 9.4 percent per year from 0.2 TWh in 1995 to 1.43 TWh in 2012. From 1995 to 2001, 100 percent of electricity generated came from oil-fired power plants. In 2002, a hydropower power plant started operation in Cambodia and by 2012 its share in the power generation mix increased to 36.1 percent. Coal power generation was introduced quite late in Cambodia, in 2009. By 2012, the share of coal in the power generation mix had reached 2.6 percent.

In the BAU scenario, to meet the demand for electricity, power generation is projected to increase at an average rate of 14.7 percent per year between 2012 and 2035. The fastest growth in electricity generation will be in coal (24.5 percent per year), followed by hydro (19.0 percent per year), and others (0.2 percent per year) (Figure 4-4). Generation from oil-fired power plants will decrease considerably, due to high fuel cost.

Figure 4-4. Electricity Supply in Cambodia, 1995 to 2035 in BAU



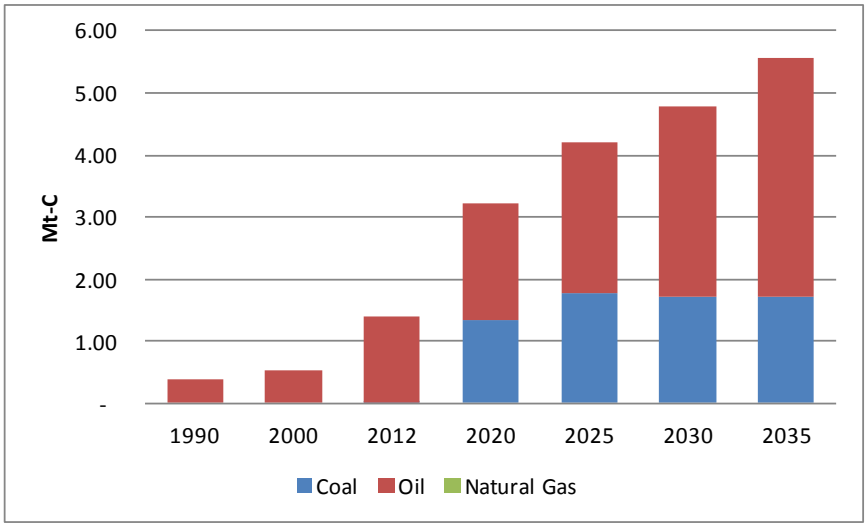
BAU = Business-as-Usual.
Source: Author's calculation.

3.1.2.4. CO_2 Emissions

CO_2 emissions from energy consumption are projected to increase by 6.2 percent per year, from 1.4 Mt-C in 2012 to 5.6 Mt-C in 2035 under the BAU scenario.

Oil is the largest source of carbon emissions, which will increase from 1.4 Mt-C in 2012 to 3.5 Mt-C in 2035. Emission from coal is expected to see the fastest growth rate, at 24.5 percent per year from 0.01 Mt-C in 2012 to 1.7 Mt-C in 2035 (Figure 4-5).

Figure 4-5. CO_2 Emissions from Energy Combustion in Cambodia, BAU



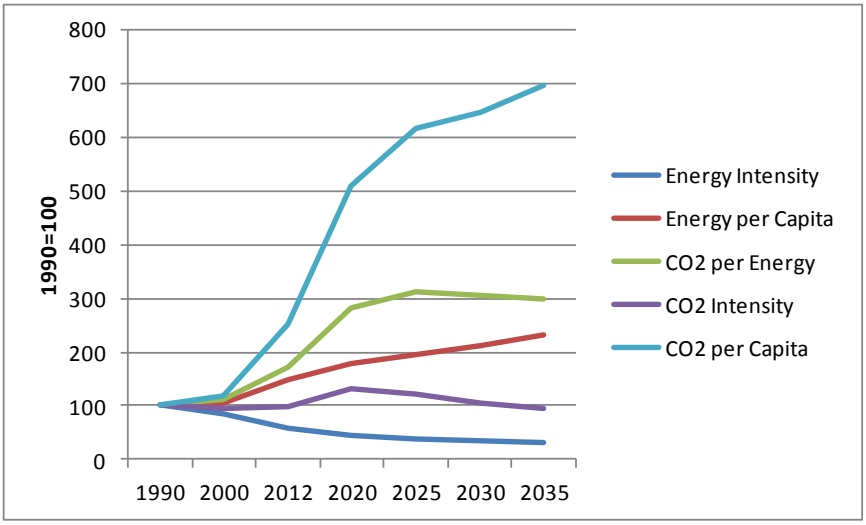
BAU = Business-as-Usual.
Source: Author's calculation.

3.1.2.5. Energy Indicators

Energy intensity had a decreasing trend from 1,002 toe/million US$ in 1995 to 579 toe/million US$ in 2012. In the BAU scenario, energy intensity will further decrease, to 324 toe/million US$ in 2035. This indicates that energy will be used more efficiently in economic development. This will be mainly the result of 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 0.26 toe/person in 1995 to 0.39 toe/person in 2012. In the BAU scenario, energy per capita will further increase, to 0.61 toe/person in 2035. This indicates that people's living standards of people are improving, resulting in increasing energy demand per capita. Figure 4-6 shows various indicators for energy consumption.

Figure 4-6. Energy and CO_2 Indicators



Source: Author's calculation.

On the one hand, CO_2 per energy in the BAU case is projected to increase from 0.24 metric tons of Carbon per toe (t-C/toe) in 2012 to 0.42 t-C/toe in 2035, implying faster growth of fossil fuels than total energy consumption.

However, CO_2 intensity had been decreasing from 140 t-C/million US$ in 1995 decreasing to 139 t-C/million US$ in 2012. It will drop further, to 135 t-C/million US$ in 2035.

4. Scenario Analysis

4.1. Alternative Policy Scenario (APS)

The Alternative Policy Scenario (APS) consists of scenarios such as 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 in each scenario:

- APS1: focus on EEC on the demand side, such as:
  - All sectors' demand to be reduced by 10 percent in 2015 and 15 percent by 2035 relative to BAU.
  - Using efficient motorbikes in road transport.
  - Replacing inefficient devices with efficient ones in commercial and residential sectors like 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 until 2035 under BAU. In the APS, new coal power plants are assumed to have thermal efficiencies of 35 percent.

- APS3: Additional 50MW of biomass gasified power plants by 2030 and solar PV with capacity gradually increasing to 50MW by 2035 are assumed in this scenario.
- APS5 or APS: Combination of APS1 to APS3

4.2. Energy Saving Potential and CO_2 Emissions Reduction

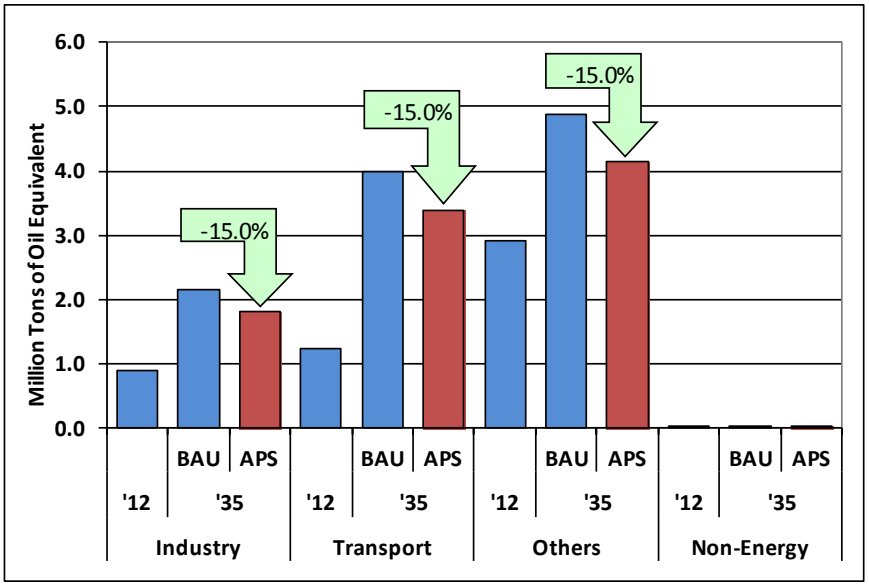
4.2.1. Final Energy Consumption

In the APS, final energy consumption is projected to increase at a slower rate of 2.8 percent (compared with 3.5 percent in BAU) from 5.03 Mtoe in 2012 to 9.39 Mtoe in 2035 because of EEC measures APS1 in industrial, transportation, residential, and commercial (others) sectors.

Savings in final energy consumption amount to 1.7 Mtoe. The bulk of the savings are expected to occur in the others sector (0.7 Mtoe), followed by the transportation sector (0.6 Mtoe), and the industry sector (0.3 Mtoe).

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

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



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

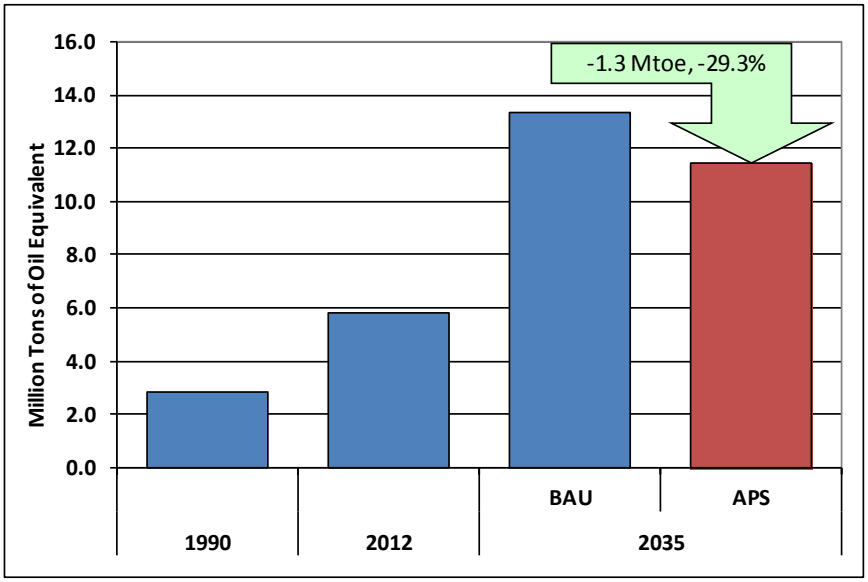
4.2.2. Total Primary Energy Demand

In the APS, total primary energy demand is projected to increase at a slower rate of 3.0 percent per year from 5.78 Mtoe in 2012 to 11.44 Mtoe in 2035. The savings 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 24.0 percent compared with 24.5 percent in the BAU, followed by oil with 4.2 percent compared with 4.9 percent in the BAU, respectively, over the same period.

The total saving amounts to 1.9 Mtoe, which is equivalent to 14.3 percent of Cambodia's total primary energy consumption in 2035 (Figure 4-8).

Figure 4-8. Total Primary Energy Demand by Fuel in BAU and APS



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

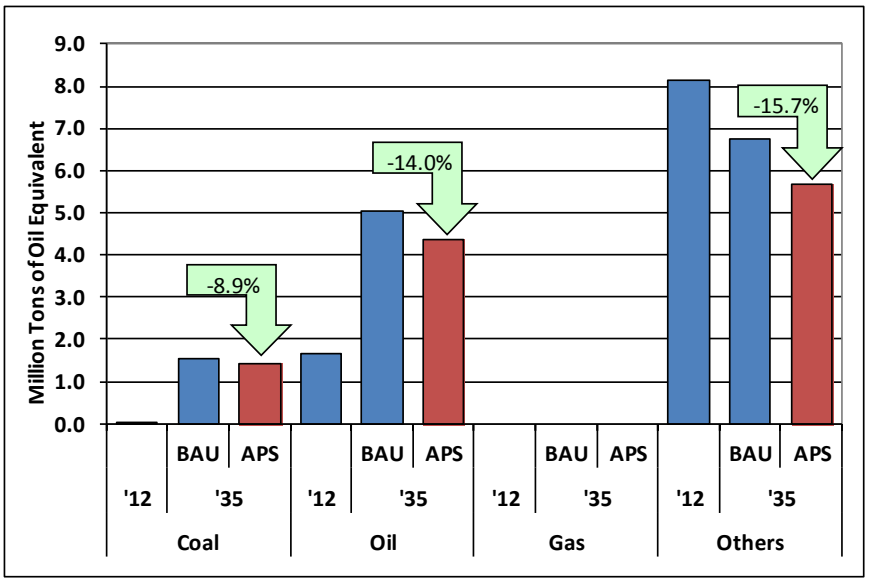
The slower growth in consumption, relative to the BAU scenario, comes from EEC measures on the demand side (APS1), more aggressive uptake of energy efficiency in thermal power plants (APS2), and adoption of renewable energy (APS3) on the supply side. Accordingly, the coal saving potential would be 8.9 percent, followed by oil at 14.0 percent, and others at 15.7 percent (Figure 4-9).

4.2.3. CO_2 Emission Reduction Potential

CO_2 emissions from energy consumption under the BAU scenario are projected to increase by 6.2 percent per year from 1.4 million metric tons of carbon (Mt-C) in 2012 to 5.6 Mt-C in 2035 Under the APS, the annual increase in CO_2 emissions between 2012 and 2035 is projected to be 4.9 percent per year, which is 1.3 percent lower than the BAU.

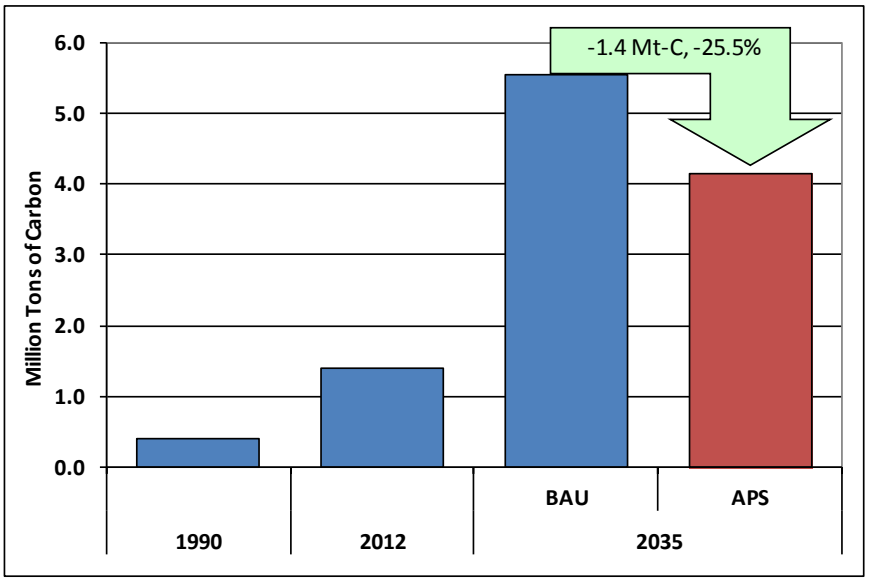
The CO_2 emission reduction would be mostly derived from EEC measures on the demand side (APS1). Improvement of energy efficiency in thermal power plants (APS2) and development of renewable energy technologies (APS3) can also contribute significantly to CO_2 reduction (Figure 4-10).

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



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

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



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

5. Key Findings and Policy Implications

From the above analysis on energy saving potential, the following are the 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 scenario are estimated to have significant potential to help meet future demand in a sustainable manner.

- Cambodia's energy intensity will be further reduced, reflecting efficient use of energy.
- The annual growth of energy demand in the transportation sector is projected to be 5.3 percent, the highest in BAU, and its share is projected to continuously increase, from 24.3 percent in 2012 to 36.0 percent in 2035. This shows that the transportation sector has a large potential for saving on energy.
- Electricity demand is increasing with the highest annual growth rate of 10.6 percent in BAU and is projected to be lower at 9.8 percent under the APS.
- Hydro power plants will be the major source of power generation in Cambodia in the coming years. Its share in total power generation output is projected to increase continuously, from 36.1 percent in 2012 to a dominating share of 83.0 percent in 2035.
- Coal thermal power plants will be the second major power generation source in Cambodia in the coming years. Its share in total power generation output is expected to increase continuously, from 2.6 percent in 2012 to 17.0 percent in 2035. This is also the area with the largest energy saving as well as the highest greenhouse gas (GHG) mitigation potential in Cambodia.

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

- Promotion for establishment of targets and roadmap for EEC implementation: The targets for EEC in Cambodia should be set up for the short-, medium-, and long-term periods and focused on the buildings and industries sectors. The long-term should be set up based on an assessment of energy saving potential for all energy sectors, including residential and commercial sectors, which have large potential on energy saving up to 2035.
- Compulsory energy labelling for electrical appliances: Annual growth of electricity demand in residential and commercial (other) sectors is projected to be substantial compared to other sectors. Compulsory energy labelling for electrical appliances could be an effective management measure for generation of energy savings.
- Priority for development of advanced hydro and coal thermal power technology: Hydro and coal thermal power plants will be the major power generation in Cambodia up to 2035. 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. This is necessary to build up the strategy and mechanisms to support renewable energy development.

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