

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 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 km², 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 during the same year was 14.5 million.

Cambodia's conventional total primary energy supply (TPES) in 2011 stood at 5.33 Mtoe, oil represented the largest share of Cambodia's TPES at 26.1 percent; coal was third at 0.2 percent, followed by hydro (0.1 percent), and others (73.7 percent), while its final energy consumption stood at 4.51Mtoe. 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 85 percent with hydro accounting for the rest.

Cambodia has 10,000 MW of hydropower potential; and 4,931 MW by 2020. Commercial quantities of coal have capacity of 380 MW by 2015; and for efficiency 32.4%.

2. Modeling 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 7.5 percent. Its population on the other hand is projected to grow at 1.7 percent per year resulting to a growth rate of GDP per capita of 3.4 percent per year up to 2035.

2.2. Electricity Generation

With regards to the future electricity supply, coal is expected to dominate Cambodia's fuel mix in 2035 followed by hydro. This is a big change from the current oil-dominated electricity generation. According to the Electricity Supply Development Master Plan from year 2010-2020, Cambodia will have a total additional installed 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 capacity requirements will still be met by coal and hydro. The gross electricity generation also assumes net export of electricity to neighboring countries of 2600 GWh in 2020 that will gradually increase to 3080 GWh by 2035.

2.3. Energy Efficiency and Conservation Policies

Cambodia's energy efficiency and conservation programs aims to achieve an integrated and sustainable program that will facilitate energy efficiency improvements in the major energy consuming sectors and help prevent increased and wasteful fuel consumption. To achieve these aims, the country realizes 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 decentralized 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 organizations 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 energy efficiency and conservation.

- Improving energy efficiency in buildings and public facilities.
- Improving energy efficiency in industries in cooperation with UNIDO and MIME (Now change to Ministry of Mines and Energy, MME) to be implemented in the 4 sectors namely, 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 created under the WG. 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 BAU. These initial estimates were used in forecasting the energy demand in the APS.

In a close consultation process between the previous Ministry of Industry, Mines and Energy (MIME) and EUEI-PDF that started in July 2011 it was concluded to launch a project 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 will be concluded in April 2013 by a final workshop, where the recommendations and conclusion as elaborated in the document.

There are five sectors 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. Total Primary Energy Demand

Primary energy supply in Cambodia grew at a faster rate than final energy consumption 4 percent per year or 1.8 times from 2.83 Mtoe in 1995 to 5.33 Mtoe in 2011. Among the major energy sources, the fastest growing were oil. Oil consumption grew at an average annual rate of 6.4 percent between 1995 and 2011 (see table 1).

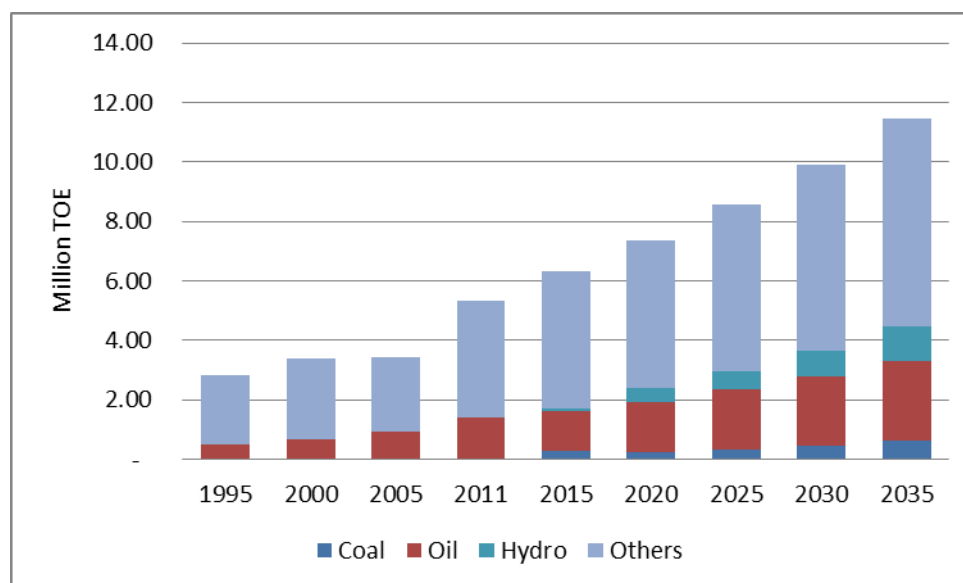
In the BAU scenario, Cambodia's primary energy demand is projected to increase at an annual rate of 3.2 percent per year or 2.1 times from 5.33 Mtoe in 2011 to 11.45 Mtoe in 2035. The faster growth is expected in hydro, increasing at annual average rate 26.6 percent between 2011 and 2035, followed by coal, oil and other (such as imported electricity) at 19.3 percent, 2.8 percent, and 2.4 percent, respectively. The share of hydro is projected to increase from 0.1 percent in 2011 to 9.9 percent in 2035. This growth is at the expense of oil and coal, whose shares are projected to decline from 26.1 percent to 23.5 percent and coal increase from 0.2 percent to 5.5 percent, respectively.

Table 1 : Primary Energy Demand. BAU

Unit : MTOE

TPES	1995	2000	2005	2011	2015	2020	2025	2030	2035
Coal	-	-	-	0.01	0.28	0.23	0.32	0.44	0.63
Oil	0.51	0.70	0.94	1.39	1.34	1.71	2.02	2.33	2.69
Natural gas	-	-	-	-	-	-	-	-	-
Nuclear	-	-	-	-	-	-	-	-	-
Hydro	-	-	0.00	0.00	0.11	0.46	0.64	0.89	1.14
Geothermal	-	-	-	-	-	-	-	-	-
Others	2.33	2.72	2.49	3.93	4.58	4.99	5.57	6.24	7.00
Total	2.836	3.413	3.436	5.332	6.3067	7.3784	8.5566	9.896	11.452

Figure1 : Primary Energy Demand. BAU



3.1.2. Total Final Energy Consumption

3.1.2.1. By Sector

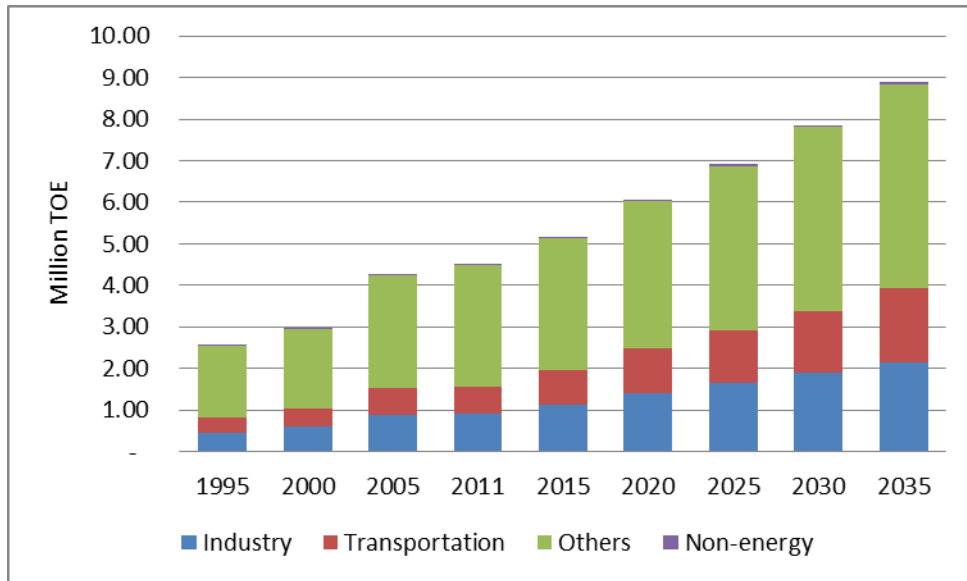
Cambodia's final energy consumption grew at an average annual rate of 3.6 percent per year or 1.77 times from 2.54 Mtoe in 1995 to 4.51 Mtoe in 2011.

In BAU scenario, driven by assumed strong economic growth and a rising population, final energy consumption is projected to increase at annual average rate of 2.9 percent or 1.96 times from 4.51 Mtoe in 2011 to 8.88 Mtoe in 2035 (Table2).

Table2: Final Energy Consumption by Sector

TFEC by Sector	1995	2000	2005	2011	2015	2020	2025	2030	2035
Industry	0.44	0.61	0.894	0.90	1.12	1.41	1.66	1.89	2.14
Transportation	0.38	0.43	0.63	0.66	0.84	1.07	1.27	1.50	1.78
Others	1.72	1.90	2.719	2.93	3.19	3.55	3.95	4.41	4.91
Non-energy	0.01	0.01	0.019	0.02	0.02	0.03	0.03	0.04	0.04
Total	2.54	2.95	4.26	4.51	5.17	6.06	6.91	7.84	8.88

Figure2: Final Energy Consumption by Sector



In the sectors, the strongest growth in consumption is projected to occur in the transportation increasing at annual average rate 4.2 percent between 2011 and 3.7 percent, 3.6 percent and 2.2 percent respectively.

3.1.2.2. By Electricity Generation

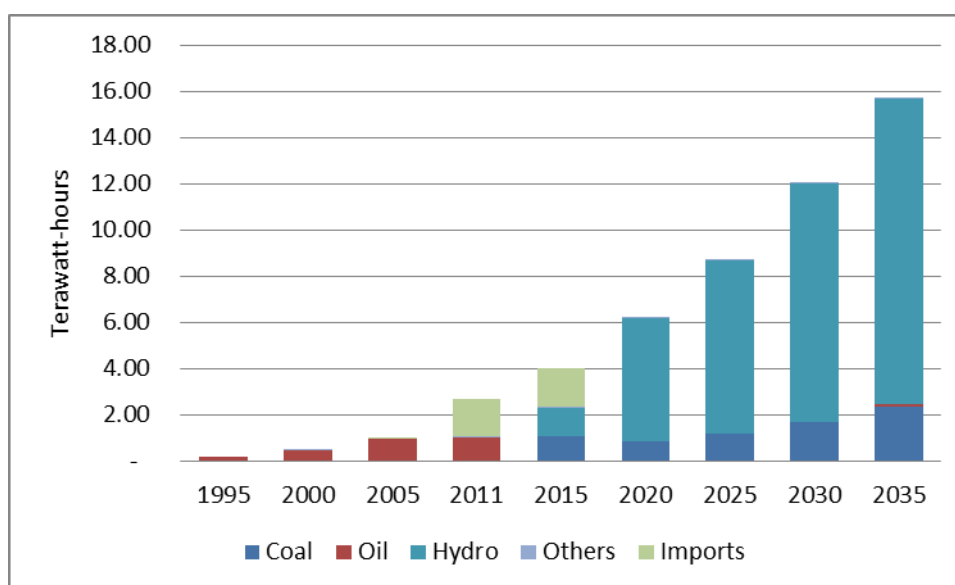
Electricity generation increased at 11 percent per year or 5 times from 0.20 TWh in 1995 to 1.05 TWh in 2011. The fastest growth occurred in the oil thermal 10.3 percent per year.

In the BAU scenario, to meet the demand of electricity, power generation is projected to increase at an average rate of 11.9 percent per year or 14.98 times between 2011 and 2035. The fastest growth in the hydro electricity generation (26.7 percent per year) followed by the coal thermal electricity generation (19.3 percent per year) and others (1.3 percent per year). And electricity import from 0.02 TWh in 2005 to 1.64 TWh in 2015 (Table3).

Table3: FEC by Electricity Generation

Electricity Generation	1995	2000	2005	2011	2015	2020	2025	2030	2035
Coal	-	-	0.031	0.03	1.07	0.85	1.20	1.66	2.36
Oil	0.20	0.45	0.914	0.95	-	-	-	-	0.09
Natural gas	-	-		-	-	-	-	-	-
Nuclear	-	-		-	-	-	-	-	-
Hydro	-	-	0.026	0.05	1.25	5.31	7.47	10.34	13.24
Geothermal	-	-		-	-	-	-	-	-
Others	-	0.00	0.003	0.02	0.03	0.03	0.03	0.03	0.03
Total	0.20	0.45	0.97	1.05	2.34	6.19	8.69	12.03	15.73
Imports	-	-	0.02	1.64	1.64	-	-	-	-

Figure3: FEC by Electricity Generation



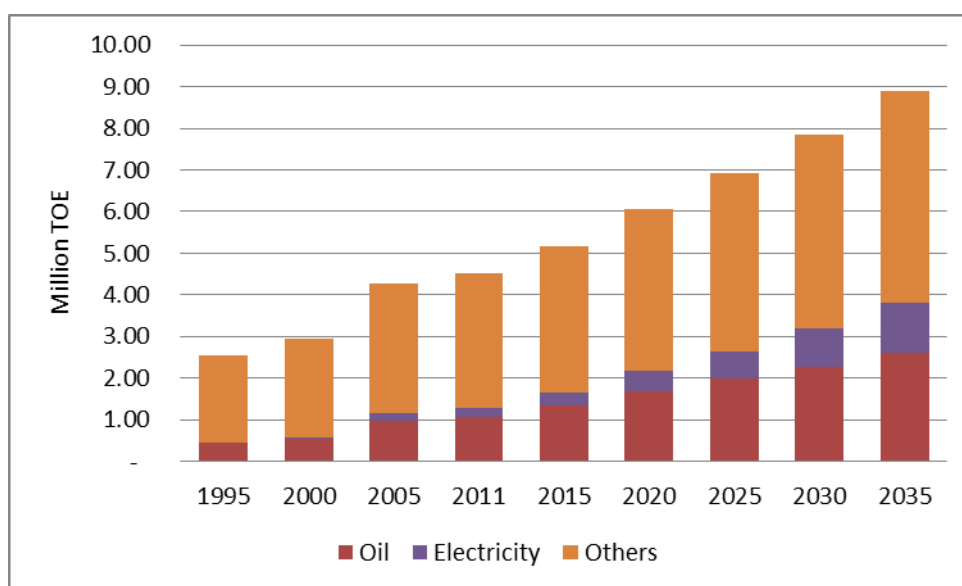
3.1.2.3. By Fuel

Others is projected to exhibit the fastest growth in final energy consumption, increase at 1.9 percent per year or 1.5 times from 3.23 Mtoe in 2011 to 5.08 Mtoe in 2035. Oil is projected to have the second highest growth rate of 3.8 percent per year or 2.4 times from 1.07 Mtoe in 2011 to 2.62 Mtoe in 2035 and followed by electricity growth rate of 7.6 percent per year or 5.9 times from 0.20 Mtoe in 2011 to 1.19 Mtoe in 2035 respectively.

Table4: FEC by Fuel

TFEC by Fuel	1995	2000	2005	2011	2015	2020	2025	2030	2035
Coal	-	-		-	-	-	-	-	-
Oil	0.44	0.54	0.984	1.07	1.34	1.69	1.99	2.28	2.62
Natural gas	-	-		-	-	-	-	-	-
Electricity	0.01	0.03	0.175	0.20	0.30	0.47	0.66	0.91	1.19
Heat	-	-		-	-	-	-	-	-
Others	2.09	2.39	3.103	3.23	3.53	3.90	4.26	4.65	5.08
Total	2.54	2.96	4.26	4.51	5.17	6.06	6.91	7.84	8.88

Figure4: FEC by Fuel



3.1.2.4. By CO2 Emission

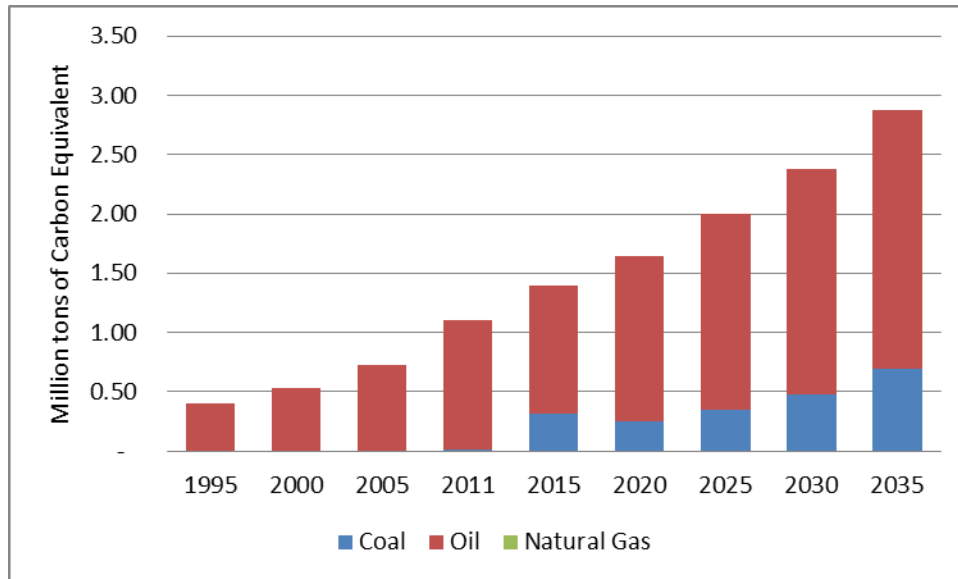
CO2 emissions from energy consumption are projected to increase by 4.1 percent per year from 1.10 Mt-c in 2011 to 2.88 Mtoe-c in 2035 under the BAU scenario.

Oil is largest of 2 times from 1.09 Mt-c in 2011 to 2.19 Mt-c in 2035, followed by coal with 19.3 percent per year from 0.01 Mt-c in 2011 to 0.69 Mt-c in 2035 increase (Table 5).

Table5: FEC by CO2 Emission

CO2 Emission	1995	2000	2005	2011	2015	2020	2025	2030	2035
Coal	-	-		0.01	0.31	0.25	0.35	0.48	0.69
Oil	0.40	0.53	0.721 08	1.09	1.09	1.39	1.65	1.90	2.19
Natural Gas	-	-		-	-	-	-	-	-
Total	0.40	0.53	0.72	1.10	1.40	1.64	2.00	2.38	2.88

Figure5: FEC by CO2 Emission



3.1.2.5. By Energy Indicators

Energy intensity had trend of increasing with 100 toe/million US Dollars in 1995, decreasing to 57.15 toe/million US Dollars in 2011. The major reason is that the industrial sector of Cambodia with sub-sector such as textile, cement and food of medium energy intensities is developed in the recent years.

In the BAU, the energy intensity will have trend of reduction. That is good trend an approving that the energy will be used efficiently in the economic development.

Energy per capita had trend of increasing from 1 toe/person in 1995 to 1.41 toe/person in 2011. In the BAU, energy per capita will have trend of increasing 1.41 toe/person in 2011 to 2.03 toe/person in 2035. This approves that the living standards and incomes of people are increasing and resulting in increasing energy demand per capita.

CO2 per energy in the BAU case are projected to increase from 1.47 million tones of carbon (Mt-c) in 2011 to 1.79 Mt-c in 2035, implying an average annual growth rate of 4.1 percent. This is slightly higher than the growth in total primary energy consumption of 3.2 percent per year.

CO2 intensity had trend of increasing with 100 t-c/million US Dollars in 1995, decreasing to 84.37 t-c/million US Dollars in 2011.

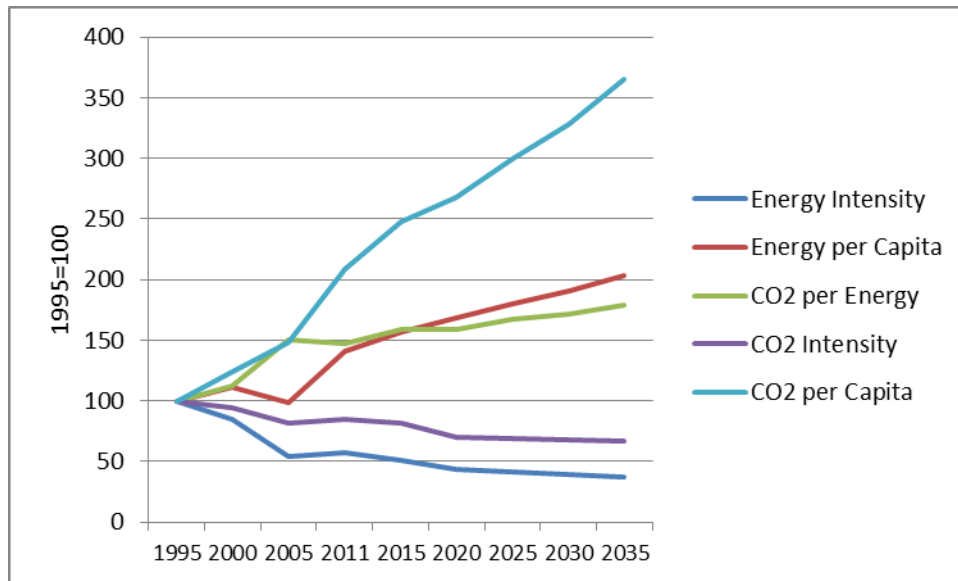
In the BAU, the CO2 intensity will have trend of reduction. That is good trend as approving that the energy will be used efficiently in the economic development.

CO2 per capita had trend of increasing from 1 t-c/toe in 1995 to 2.08 t-c/toe in 2011 to 3.65 t-c/toe in 2035 (Table 6).

Table6: FEC by Indices

Indices (1995=100)	1995	2000	2005	2011	2015	2020	2025	2030	2035
Energy Intensity	100	84.56	54.47	57.15	51.44	43.93	41.62	39.34	37.20
Energy per Capita	100	111.16	98.87	141.33	156.39	168.34	179.62	191.15	203.51
CO2 per Energy	100	112.01	149.98	147.62	158.52	158.89	166.96	171.96	179.50
CO2 Intensity	100	94.72	81.70	84.37	81.56	69.80	69.50	67.66	66.78
CO2 per Capita	100	124.52	148.29	208.64	247.92	267.48	299.89	328.71	365.33

Figure6: FEC by Indices



4. Scenario Analysis

4.1. Alternative Policy Scenario (APS)

In APS proposed consisting of scenarios such as Energy Efficiency and Conservation (EE&C) scenarios (APS1), improvement of Energy Efficiency in power generation (APS2), development of renewable energy (APS3), development of nuclear power plants (APS4) but in this case Cambodia do not mention on that issue, combination of (APS1) to (APS3).

- APS1: focus on EE&C in demand side ,such as:
 - The initial estimates of all sectors demand to be reduced by 10% in 2015 and 15% by 2035 that relative to BAU.
 - Switching from DO to CNG in transportation and using efficient motorbikes, case in road transport.
 - Replacing inefficient devices to efficient devices in commercial and residential Sectors likes cook stoves, CFL or LED, Refrigerators and Air conditioners, etc
- APS2: Improvement of Energy Efficiency in thermal power plants. It assumes that Energy Efficiency of coal , fuel oil thermal power plants still constants 32 percent , and 32 percent by 2035 compared with 32 percent, and 32 percent in BAU, while Cambodia do not have natural gas with CCGT technology.
- APS3: Development of renewable energy technologies installed electricity generating capacity from renewable energy to additional 50MW of biomass gasified power plants by 2030 and solar PV has capacity to gradually increase to 50MW by 2035.
- APS4: In this case Cambodia do not have plan to introduce of nuclear power plants.
- APS5: Combination with APSA to APS3

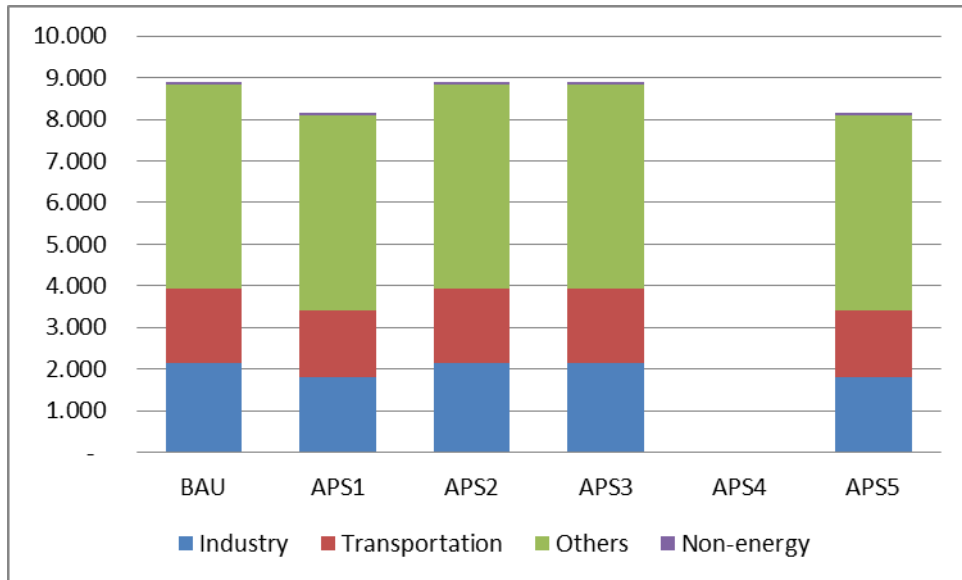
4.2. Energy Saving Potential and CO2 Emissions Reduction

4.2.1. Final Energy Consumption

In the Alternative Policy Scenarios 5 (APS5), final energy consumption is projected to increase at a slower rate of 2.5 percent (Compared with 2.9 percent in BAU) from 4.51Mtoe in 2011 to 8.14Mtoe in 2030 because of EE&C

measures APS1 in industrial, transportation residential and commercial (others) sectors.

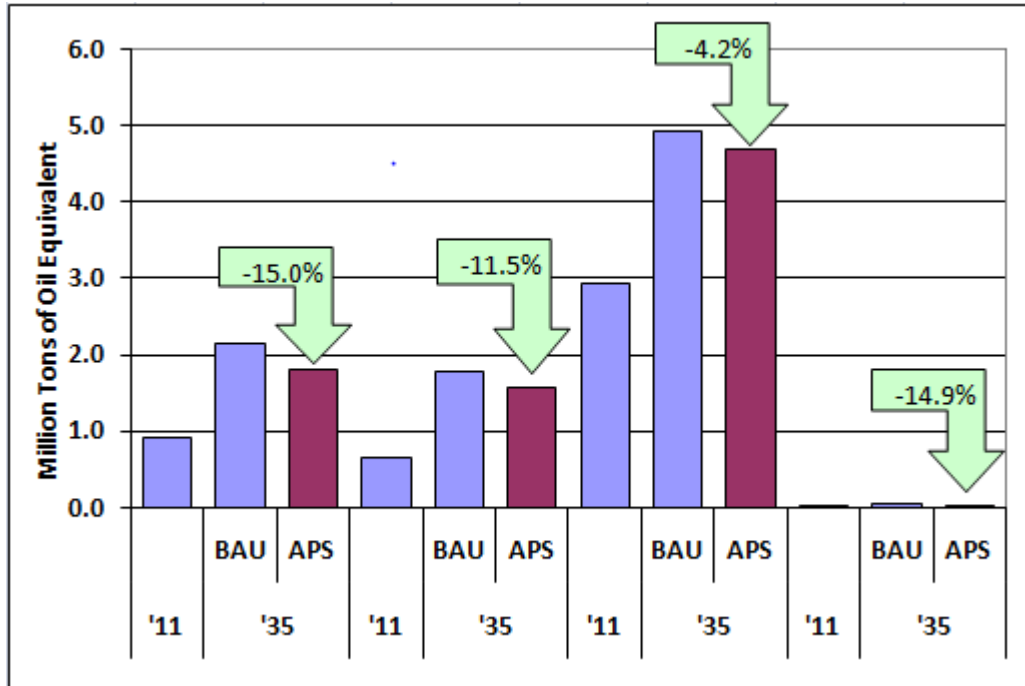
Figure7: Final Energy Consumption by sector in BAU and APS



Saving in final energy consumption amount to 0.72 Mtoe. The bulk of the saving are expected to occur in the industry sector followed by transportation sector and the residential and commercial (others) sector 0.2 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 others (residential and commercial) sector, industry and transportations.

Figure8: Final Energy Consumption, BAU vs APS



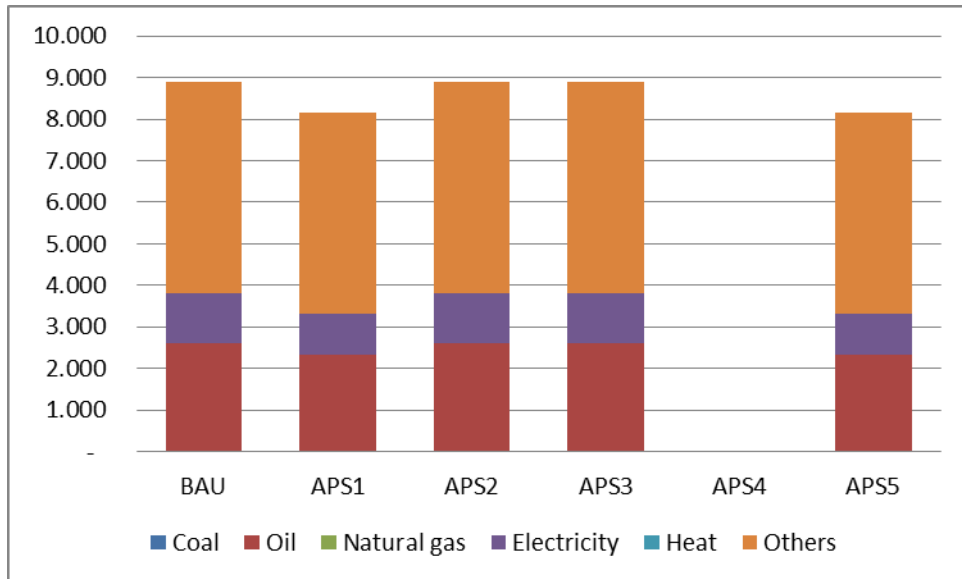
4.2.2. Total Primary Energy Demad

In the APS5, primary Energy demand is projected to increase at slower rate of 2.6 percent per year from 5.33 Mtoe in 2011 to 9.78 Mtoe in 2035.

The saving that could be derived from EE&C Scenarios on demand side development of renewable energy technology (APS3).

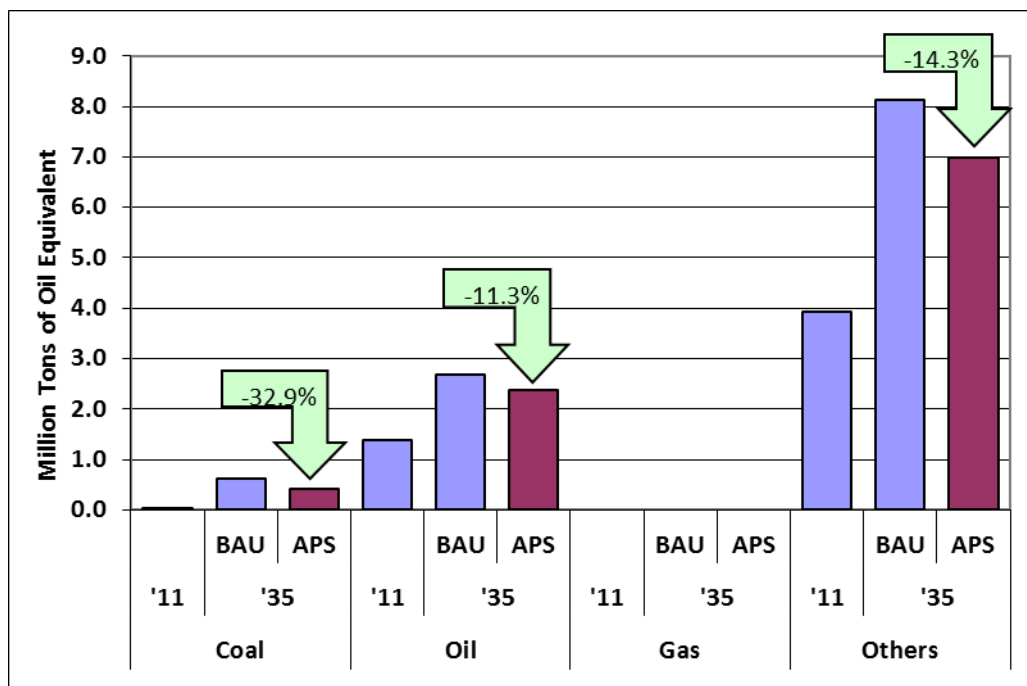
In the APS5, coal is projected to grow at an average annual rate 17.4 percent compared with 19.3 percent in BAU, followed by oil with 2.3 percent (Compared with 2.8 percent in BAU), respectively over the same period.

Figure9: Primary Energy Demand by Fuel in BAU and APSs



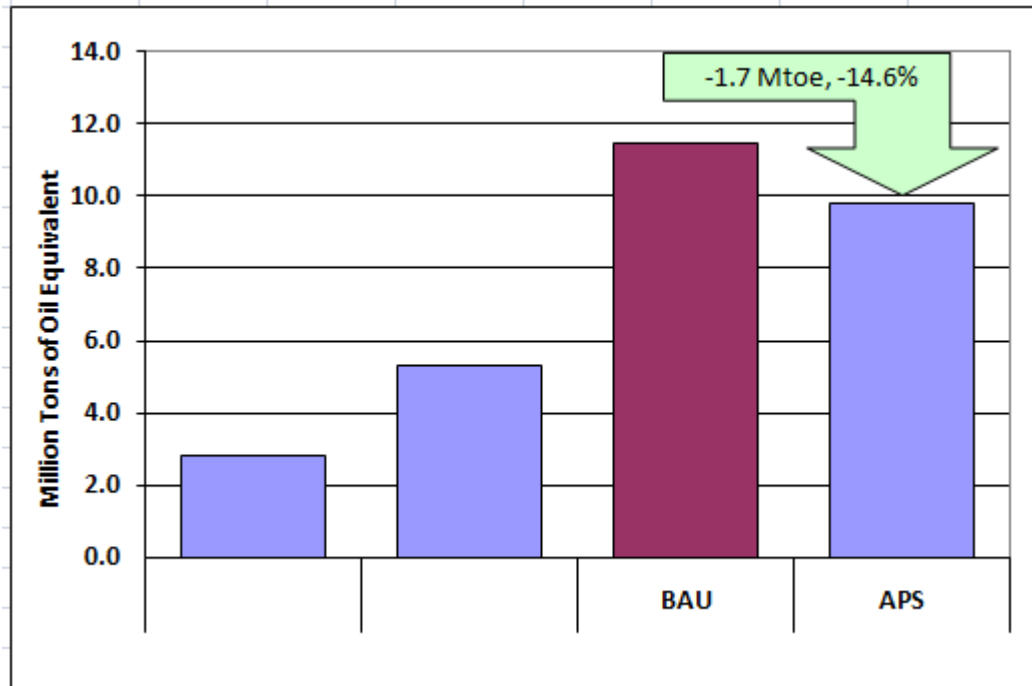
The slower growth in consumption, relative to the BAU scenario, come from EE&C measures on the demand side (APS1), and the more aggressive uptake of energy Efficiency in thermal power plants (APS2), Renewable energy (APS3) on the supply side coal has highest energy saving potential with 32.9 percent followed by others 14.3 percent and oil 11.3 percent.

Figure10: Primary Energy Saving Potential by Fuel, BAU vs APS



The total saving are equal to amount to 1.7Mtoe of equivalent to 14.6% of total Cambodia's primary energy consumption in 2035 (Figure 11)

Figure11: Evolution of Total Primary Energy Consumption, BAU and APS

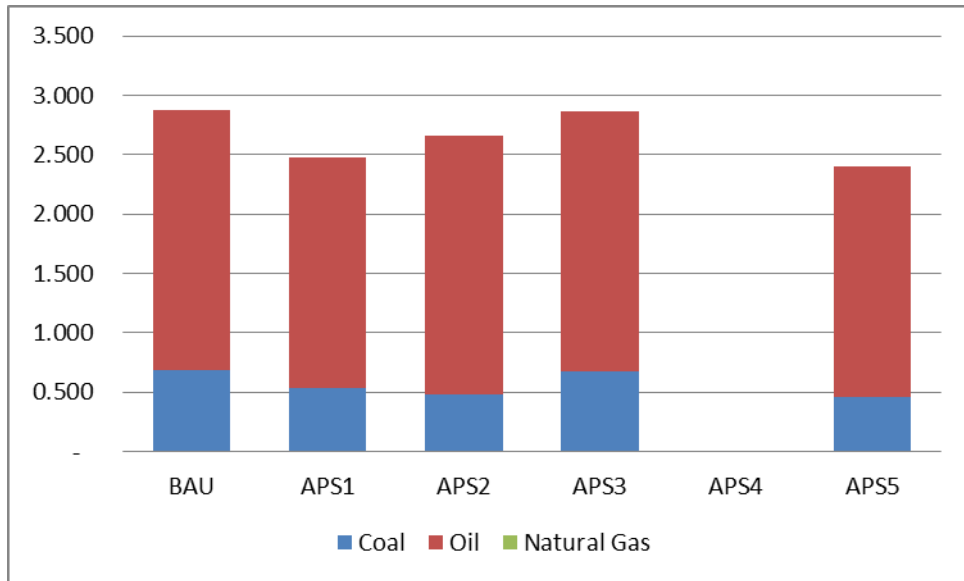


4.2.3. CO2 Reduction Potential

CO2 emissions from energy consumption under the BAU scenario are projected to increase by 4.1 percent per year from 1.10 million metric ton of carbon (MT-C) in 2011. Meanwhile, under APS5, the annual increase in CO2 emissions between 2011 and 2035 is projected to be 3.3 percent per year which is 0.8 percent points lower than the BAU.

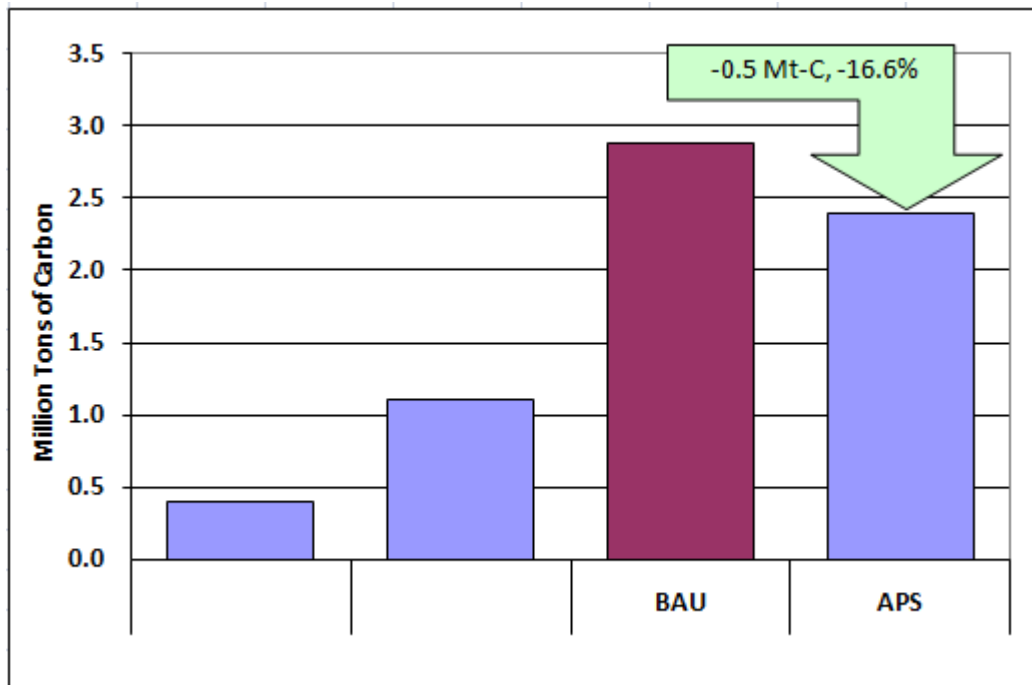
The CO2 emission reduction mostly derived from EE&C measures on demand side (APS1). And improvement of energy efficiency in thermal power plants (APS2), development of renewable energy technologies (APS3) can contributed significantly to CO2 reduction (Figure 12)

Figure12: CO2 Emission by Fuel, BAU and APSs



Improvement on CO2 emission under the APSs will be around 0.48 MT-C lower equal to 16.7 percent reduction in 2035, indicating that the energy saving goals and action plans of Cambodia are very effective in reducing CO2 emission.

Figure13: CO2 Emission, BAU and APS



5. Key Findings and Policy implication

From the above analysis on energy saving potential, some keys findings could be recognized as follows:

- Energy demand in Cambodia is expected to continue to grow at a significant rate, driven by robust economic growth, industrialization, urbanization and population growth. Energy Efficiency and conservation is the new sources of energy that measures have the potential to contribute to meet higher demand in sustainable manner.
- Cambodia energy intensity will be reduced, that is good case for energy will be used efficiently in the economic development.
- Annual growth of energy of energy demand in transportation sector is projected at highest rate of 4.2 percent in BAU and it's share is increasing continuously from 14.6 percent in 2011 to 20.1 percent in 2035. This shows that the transportation sector has large potential on energy saving.
- Electricity demand is increasing with highest annual growth rate of 7.6 percent in BAU and is projected to decline to 6.9 percent in APS. This decline proved the EE&C measures are effective in electricity demand. And electricity saving potential is still large, particularly in residential and commercial sectors.
- Hydro power plants will be the major power generation in Cambodia in coming years. Its share in the total of power generation output is increasing continuously from 4.3 percent in 2011 to dominated share of 84.2 percent in 2035. And for coal thermal power plants will be the second major power generation in Cambodia also in coming years. Its share in the total of power generation output is increasing continuously from 3.2 percent in 2011 to dominated share of 15 percent in 2035.this is the area with the largest energy saving as well as the GHG mitigation potential in Cambodia.

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

- Promotion for establishment of target and roadmap for EE&C implementation:
The target for EE&C in Cambodia should be set up for a short, medium, and long term period and focused on the buildings, industries sectors are priority. 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 labeling for electrical appliances: Annual growth of energy demand in residential and commercial (other) sectors is projected at the third rate of 1.9 percent in BAU, and it is a priority demand on electricity (Annual growth of electricity demand is projected at the first highest rate of 7.6 percent in BAU) in Cambodia. The compulsory energy labeling for electrical appliances is an affective management measure for energy saving.
- 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 both energy technologies should be prioritized for development power plants at stage of project design.
- Priority for renewable energy development: Renewable energy is the supply side technology based power generation is and important factor for energy independent, energy security and GHG abatement. This is necessary to build up the strategy and mechanisms to support renewable energy development.

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