CHAPTER 12

MYANMAR COUNTRY REPORT

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1. Background

1.1. Country Profile

Myanmar is the largest country in mainland Southeast Asia. It covers 676,577 square kilometres (km) and shares a border of 5,858 km with Bangladesh and India to the northwest, China to the northeast, and Thailand to the southeast. About 48% of the total land area is covered with forest, and most of the land is used for agriculture. Myanmar had a population of 52.4 million in 2015, with an average annual growth rate (AAGR) of 1% per year from 1990 to 2015.

Myanmar is located in Southeast Asia and has three distinct seasons. It enjoys 3 to 4 months of heavy monsoon and abundant sunshine all year round, which makes it ideal for accumulating water for hydropower and for agriculture. Its topographic features favour the existence of numerous rivers, mountain ranges, and sedimentary basins where mineral deposits and energy resources have abundantly accumulated. The delta regions where the two major river systems (N'mail and Mali rivers) enter the Bay of Bengal and the 2,832 km coastal strip along the southern part are also a good area for the development of marine ecosystems and an abundant source for marine products and chemicals.

Myanmar is endowed with rich natural resources for the production of commercial energy. Its current sources of energy are crude oil, natural gas, hydroelectricity, biomass, and coal. Besides these, wind, solar, geothermal, bioethanol, biodiesel, and biogas are potential energy sources found in the country.

Myanmar's proven energy reserves in 2017 comprised 105 million barrels of oil, 6.58 trillion cubic feet of gas, and 542.56 million metric tons of coal. The country is a net exporter of energy, exporting substantial amounts of natural gas and coal to neighbouring countries. However, it imports around 90% of its total oil requirements.

1.2. Socio-economic Status

The population of Myanmar grew at 1% per year between 1990 and 2015 to 52.4 million in 2015. Myanmar's gross domestic product (GDP) was US$[1] 70.5 billion (constant 2010) in 2015, and its GDP per capita grew from around US$200 in 1990 to US$1,300 in 2015. Aiming to enhance economic development, Myanmar formulated and implemented 5-year short-term plans in 1992 to 2013. The first (1992–1995), second (1996–2000), third (2001–2005), and fourth plans (2006–2010) achieved AAGRs in GDP of 7.5%, 8.5%, 12.8%, and 12.0%, respectively. The last 5-year plan (2011–2016) was formulated to achieve an AAGR of 7% in GDP.

1.3. Energy Consumption in the Base Year

Myanmar's total primary energy supply was 19.8 million tons of oil equivalent (Mtoe) in 2015. Natural gas is mainly used to generate electricity and in industry. Currently, Myanmar has 5,235 megawatts (MW) of installed generation capacity and produced almost 16 terawatt-hours (TWh) of electricity in 2015 (Table 12.1). During the same year, thermal (coal, natural gas, and oil) and hydro accounted for 41% and 59% of total electricity generation, respectively.

Table 12.1: Installed Capacity and Power Generation by Fuel Type (2015–2016)

No.	Type of Fuel	2015-2016	
		Installed (MW)	Generation (GWh)
1	Hydro	3,215	9,399
2	Gas + Steam	1,695	6,511
3	Coal	120	
4	Diesel	95	55
Total Reduction (%)		5,125	15,965

GWh = gigwatt-hour, MW = megawatt.

Source: Myanmar Ministry of Electricity and Energy (2018a).

[1] All US$ in this report are in constant 2010 values unless specified.

2. Modelling Assumptions

2.1. GDP and Population Growth

In this publication, Myanmar's GDP is assumed to grow at an average annual rate of around 6.2% from 2015 to 2040, slowing from the 9.1% growth of 1990–2015. The population is assumed to increase by about 0.71% per year from 2015 to 2040. The assumption is based on data from the Ministry of Labour, Immigration and Population.

2.2. Energy Consumption and Electricity Generation

Hydro and natural gas dominated electricity generation in Myanmar. Other fuels such as oil and coal also contributed to the country's generation mix but was only less than 13% in total in 1990. The government's plan is to increase further the share of natural gas, coal, hydro, and other renewables in the total generation mix and decrease oil share. Myanmar also has plans to export electricity to neighbouring countries, such as Thailand and China, from its hydropower plants.

Based on the yearly plan for the construction of power plants in 2018–2022 (Table 12.2), majority of the projects are gas-based power plants, including liquefied natural gas (LNG). Others are hydro and solar power plants. The yearly plan excludes coal-based power plants, currently at 120 MW installed capacity.

In this masterplan, the shares between scenarios differ. The lowest is the Power Resource Balance scenario (Scenario 3), under which total installed capacity will reach 23,594 MW by 2030 with hydro share amounting to 38%; coal, 33%; gas, 20%; and the remaining which are renewables (solar, wind, etc.), 8%. Both installed capacity in the yearly plan and the power supply scenario 3 are included in the current outlook model under the Reference scenario.

Table 12.2: Yearly Plan for the Construction of Power Plant Projects (MW)

No	Project Name	2018	2019	2020	2021	2022	Total
1	Thahtone CCGT (World Bank)	118					
2	MyinGyan CCGT (Sembcorp)	225					
3	Minbu Solar (Green Earth)		40	40	40	50	
4	Baelin Gas Engine (Rental)		135				
5	MyinGyan Gas Engine		90				
6	Myanaung Gas Engine (Japan Grant)			20			
7	Pahtoelon CCGT (JICA)			12			
8	Ahlon LNG to Power (Toyo Thai)			356			
9	KyaukPhyu CCGT (Sinohydro)			135			
10	MelaungGyaing (LNG) LNG to Power (Zhefu)				1390		
11	Kanbauk LNG to Power (Total & Siemens)				820	410	
12	Ywama (W.B.) (Gas)				150	75	
13	Upper KyaingTaung (Hydro)				51		
14	Upper Yeywa (Hydro)				280		
15	Middle PaungLaung (Energize)					152	
16	Dee Dote (Andritz)					60	
	Total	343	265	563	2731	747	4649

MW = megawatt.

Source: Department of Electric Power Planning, Myanmar Ministry of Electricity and Energy (2018b).

The Energy Masterplan of Myanmar considers three scenarios (Table 12.3).

Table 12.3: Installed Capacity and Power Supply in Scenarios for 2030

No		Scenario 1		Scenario 2		Scenario 3	
		(Domestic Energy Consumption)		(Least Cost)		(Power Resources Balance)	
	Energy Resources	Installed Capacity		Installed Capacity		Installed Capacity	
		(MW)	%	(MW)	%	(MW)	%
1	Hydro (large)	12,147	42	12147	43	1412	6
2	Hydro (small and medium)	6,891	24	6,891	24	7,484	32
3	Gas	4,986	17	2,484	9	4,758	20
4	Coal	2,760	10	5,030	18	7,940	34
5	Renewable	2,000	7	2,000	7	2,000	8
	Total	28,784		28,552		23,594	

MW = megawatt.

Source: Myanmar Energy Master Plan (2015).

2.3. Energy and Climate Change/Environmental Policies

Myanmar's energy policy in general strives to maintain energy independence by increasing indigenous production of available primary energy resources through intensive exploration and development activities. It also addresses electric power as the main driving power source for economic development and the need to generate and distribute in terms of volume, density, and reliability. It also advocates the use of water resources, a renewable energy resource for generating electricity to save non-renewable sources of energy such as fossil fuels for alternative and future use. It also emphasises energy efficiency and conservation (EEC) to save energy through effective energy management and to reduce energy consumption to minimise harmful environmental impacts. It further encourages the use of new and renewable energy (NRE) sources, especially solar and wind which are abundant under Myanmar's climatic condition. It also recognises that traditional energy sources, such as fuelwood and charcoal, still need to be used. Regulations and anticipatory actions are necessary for the sustained harvesting of this primary energy source.

Savings in Myanmar's energy consumption can be attained through the implementation of energy efficiency programmes in all energy-consuming sectors. In the industry sector, energy savings of at least 14% from Business-As-Usual (BAU) scenario levels are expected by 2020 from improved manufacturing technologies. In the residential and commercial ('others') sectors, efficient end-use technologies and energy management systems are also projected to induce significant savings. In the transport sector, efficiency improvements will be achieved by improved vehicle fuel economy and more effective traffic management.

Myanmar still lacks a national strategy and action plan for mitigating and adapting to climate change, but several ministries have been implementing sector-specific initiatives relevant to climate change. The government is encouraging the use of biofuel in the transport and agriculture sectors to reduce oil dependency and curb carbon dioxide (CO_2) emissions. These efforts are already in place, although the amount of biofuel used in the country is still small for the time being. The government, through the Ministry of Electricity and Energy, has initiated the Clean Fuel Programme to reduce CO_2 emissions by increasing the use of natural gas in the industry sector for power generation. This includes converting gasoline, diesel, and liquefied petroleum gas (LPG) vehicles to compressed natural gas vehicles.

The Ministry of Natural Resources and Environmental Conservation (MONREC), the designated national authority for clean development mechanism, has submitted one hydropower project to the United Nations Framework Convention on Climate Change for consideration. The National Environmental Conservation Committee was formed in 2004 and re-formed in April 2011, replacing the National Commission for Environmental Affairs, and now serves as the focal organisation for environmental matters. It is chaired by MONREC, formerly the Ministry of Forestry, and its members come from 19 ministries.
The Environmental Conservation Law was enacted in March 2012. The law provides the legal basis for implementing a range of enhanced environmental management measures. Simultaneously, the draft Environmental Conservation Rule, which embodies regulations and technical guidelines and creates the enabling conditions for their effective implementation, is being drawn up and submitted to the authorised body.

2.4. The National Efficiency Policy

The National Energy Efficiency and Conservation Policy, Strategy and Roadmap for Myanmar (ADB, 2015) mandates the following:

> *The National Energy Efficiency and Conservation Policy, Strategy and Roadmap for Myanmar 2015 was supported by the Asian Development Bank and the Japan Fund for Poverty Reduction. Based on the calculated potential energy savings, the National Energy Efficiency Policy targets the following objectives by 2020, using 2012 as a baseline: (i) to reduce national electricity demand by 12%, (ii) to reduce biomass consumption by 2.3%, and (iii) to reduce national carbon dioxide emissions by 78,690 tonnes. To reach the overall energy efficiency objective, it is necessary to develop a strategy to save energy for all important energy-intensive sectors such as the industry, transport, commercial, and residential sectors.*

Specifically, the following strategies could achieve the goals:

For the residential sector: (i) introduction of energy efficiency performance standards and labelling for appliances, (ii) establishment of testing and certification facilities for appliances, (iii) introduction of incentives for energy-efficient equipment, (iv) phasing out of inefficient appliances from the market, (v) promotion of efficient biomass cook stoves, (vi) increasing consumer awareness on the benefits of LPG for cooking, (vii) introduction of energy efficiency labelling scheme for LPG cook stoves, and (viii) conduct of regular energy efficiency awareness campaigns in national media.

For the commercial sector: (i) conduct of energy audits; (ii) formulation of energy performance standards (for appliances); (iii) incorporation of energy efficiency in new building design, energy building code, and refurbishments; and (iv) preparation of energy efficiency guidelines for commercial buildings.

Action Plan 2018–2021 provides for a step-by-step implementation of activities to harmonise energy efficiency performance standards for air conditioning and lighting.

In addition, the following measures are considered important in achieving the goals:

- Residential: high efficiency lighting and refrigeration, LPG cooking
- Industry: cogeneration, energy efficiency (boiler, kilns, motor), waste heat recovery
- Commercial: high efficiency lighting and air conditioning, LPG cooking, solar water heating, standard labelling equipment of appliances, LED

2.5. Intended Nationally Determined Contributions/Nationally Determined Contributions (INDC/NDC)

Mitigation actions and policies in the energy sector:

- Energy – 30% renewable in rural electrification (mini hydropower; biomass; solar, wind, and solar mini-grid technologies)
- Clean cooking and heating – distribute approximately 260,000 energy-efficient cooking stoves between 2016 and 2031
- Renewable energy (hydropower) – 9.4 GW hydroelectric generation by 2030
- Energy efficiency – 20% electricity-saving potential of the total forecast electricity consumption by 2030.

Government plans to achieve by 2030 a 27% share of renewable energy to the national energy mix. To fulfil this goal, the share of these four types of renewable energy sources should be allocated as follows: hydropower (1.3%), solar (on-grid, 17.8%) (off-gird, 3.7%), biomass (1%), bio-gasification (0.02%), and biofuel (5%).This higher share of renewable targets in the energy mix could be achieved if the government has clear policy support to scale up renewables such as feed-in-tariff or any other policy to attract investment in renewable power generation.

2.6. Alternative Policy Scenarios

In previous studies, two scenarios were formulated to analyse the impact of policy interventions to the energy sector. The BAU scenario serves as the reference case to project energy demand and CO_2 emissions, and the Alternative Policy Scenario (APS), to evaluate the impacts of policy interventions in the development and utilisation of energy resources in the country. The APS as such can include policies to increase EEC targets, expedite penetration of NRE and introduction of cleaner technology, including options for a nuclear power plant. To understand further the impact of individual policy interventions, this year's study formulated five APSs as follows:

- APS1 – Improved energy efficiency of final energy demand
- APS2 – Higher efficiency of thermal electricity generation
- APS3 – Higher contribution of NRE (here, NRE for electricity generation and biofuels in the transport sector are assumed)
- APS4 – Introduction or higher contribution of nuclear energy
- APS5 – Combined impact of scenarios APS1 to APS4

Myanmar does not have an existing plan to introduce nuclear energy for power generation. As such, APS4 has not been considered in the analysis. Thus, APS5 would consist only of APS1, APS2, and APS3.

APS3 includes more renewables in the power generation mix of Myanmar. As such, for APS3, the additional installed capacity for coal-based and gas-based power plant for 2030 is replaced by renewable energy capacity, including hydro plants.

Beside the APS, this 2018 study also considers the emissions plan and target of East Asia Summit member countries under the INDC/NDC of the energy sector.

3. Outlook Results

3.1. Business-As-Usual Scenario

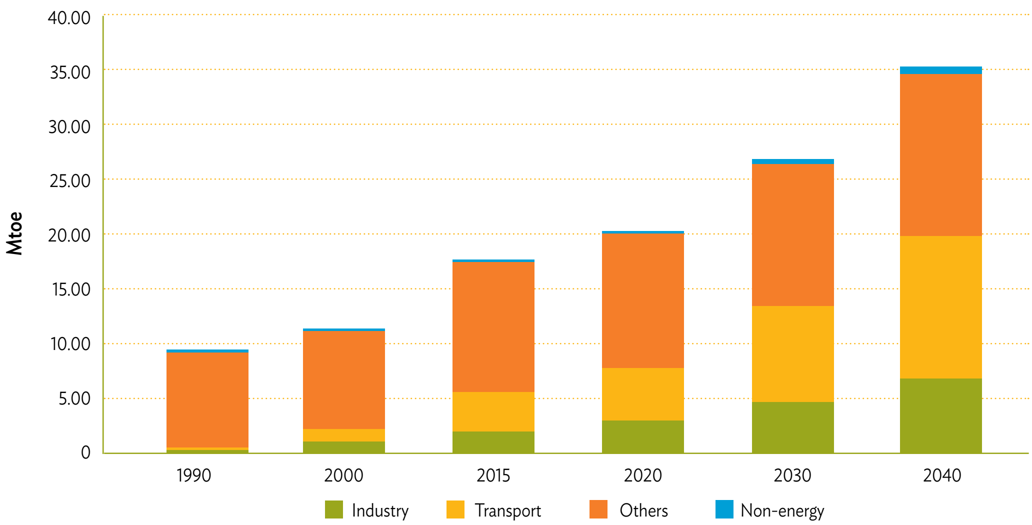
Final Energy Consumption

The total final energy consumption in Myanmar increased by about 2.6% per year, from 9.4 Mtoe in 1990 to 17.73 Mtoe in 2015.The transport sector was the fastest-growing sector with an average annual growth of 8.6% in 1990–2015. Consequently, the share of this sector in the total final energy demand increased from around 4.7% in 1990 to almost 19.9% in 2015. The industry sector was the second-fastest growing sector with an AAGR of 7.1% over the same period; the share of this sector in the total final energy demand increased from 4.2% in 1990 to 12.3% in 2015.

The 'others' sector, which comprises the commercial, residential, and agriculture sectors, was the major contributor to total final energy consumption. The shares of this sector, however, has been declining from 90.1% in 1990 to 66.3% in 2015. This indicates that the annual growth of demand for this sector was slower than that of the industry and transport sectors. The AAGR of the demand of the 'others' sector was 1.3% in 1990–2015. Non-energy consumption grew gradually at an average annual rate of 4.2% over the same period, from almost 0.09 Mtoe in 1990 to 0.27 Mtoe in 2015. Although the share of this sector demand was only 1.0% in 1990, it increased slightly to 1.5% in 2015.

Using the socio-economic assumptions stated above, final energy demand in Myanmar is projected to grow at an annual rate of 2.8% under the BAU scenario, reaching 35.29 Mtoe in 2040. The transport sector will still experience the fastest growth in final energy demand in 2015–2040. Its growth rate, however, is lower than that of 1990–2015. Final energy demand of the transport sector will increase at an average rate of 5.3% per year while that of the industry sector will grow at 4.8% per year. Final energy demand of the 'others' sector (mainly the residential and commercial sectors) is projected to grow at an annual average rate of 0.9%, slower than in the past. This is mainly because of the reduction in biomass demand, which represents majority of the fuel consumed by the sector. Figure 12.1 shows the final energy demand by sector to 2040 under the BAU scenario.

Figure 12.1: Final Energy Demand by Sector, BAU (1990-2040)



BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

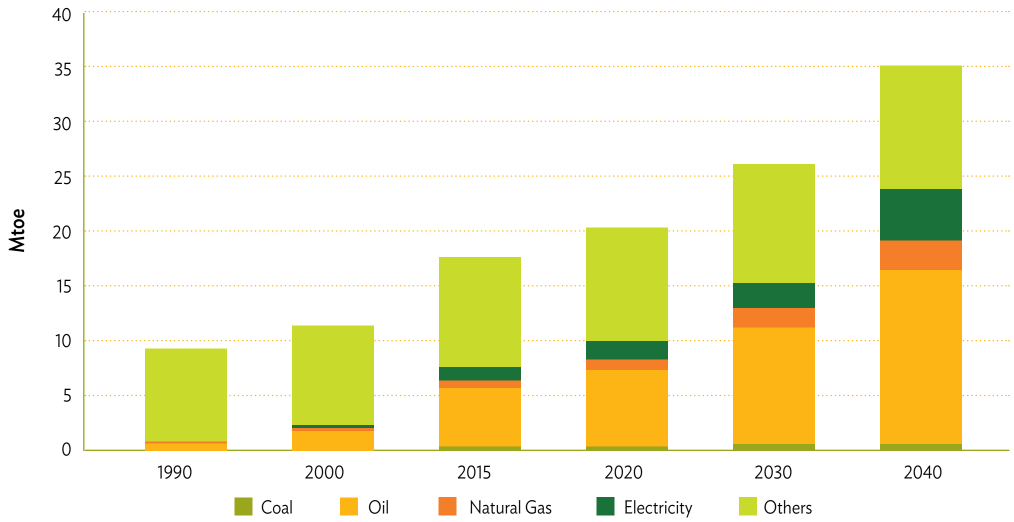
Source: Study outcome.

The growth of the respective sectors under BAU will result in a continuous increase of the transport, industry, and non-energy sector shares in the total final energy demand and a decline in the share of the 'others' sector. The share of the transport, industry, and non-energy sectors is projected to increase to 36.4%, 19.9 %, and 2.0%, respectively, in 2040. That of the 'others' sector will decline to around 41.7% from 66.3 % in 2015.

By fuel type, others, which are mostly biomass, were the most consumed fuel in 1990 with a share of 89.2% in the country's total final energy demand. Its share decreased to 56.8% in 2015 due to the higher growth of other fuels. The demand of natural gas increased from 0.23 Mtoe in 1990 to 0.71 Mtoe in 2015 while that for oil increased from 0.59 Mtoe to 5.43 Mtoe over the same period. Oil demand grew the fastest at an average rate of 9.3% per year in 1990–2015.

Under the BAU scenario, the share of other fuels will decline to 31.7% in 2040, indicating that its future use will grow slower than the other fuels. In contrast, oil share will continue to increase and will reach 44.9% in 2040 from 30.6% in 2015 with an average growth of 4.4% per year. This is due to the rapid increase of transport sector activities in 2015-2040. Figure 12.2 shows the final energy demand by fuel type to 2040 under the BAU scenario.

Figure 12.2: Final Energy Consumption by Fuel Type, BAU (1990-2040)



BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Study outcome.

Coal is projected to have an AAGR of 3.2% in 2015–2040, still slower than natural gas (5.2%). Electricity demand will still grow the fastest at an AAGR of 6% per year during the same period. Its share will increase from 6.5% in 2015 to 14.0% in 2040.

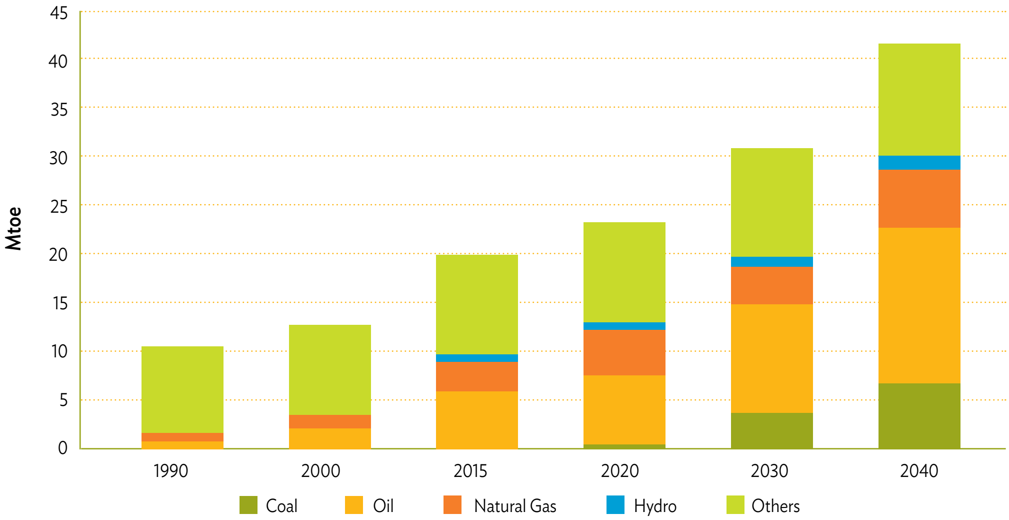
Primary Energy Consumption

The primary energy consumption in Myanmar grew at an average annual rate of 2.5%, from 10.68 Mtoe in 1990 to 19.85 Mtoe in 2015 (Figure 12.3). Amongst the major energy sources, hydro and oil grew the fastest, with AAGRs of 8.6% and 8.4%, respectively. Natural gas consumption grew at an average annual rate of 5.8% over the same period. Coal consumption increased at 7.1% per year on the average over the same period. Others, such as biomass, dominate the primary energy consumption mix in 2015, with a 50.9% share. Oil (27.6%) and natural gas (15.5%) had the next largest shares amongst the major fuels over the same period.

In the BAU scenario, Myanmar's primary energy consumption is projected to increase at an annual average rate of 3% per year to 41.79 Mtoe in 2040. Hydro and natural gas are expected to grow at average annual rates of 2.7% and 2.5%, respectively. Coal will grow fastest at 12.3% over the period 2015–2040. Oil will grow at 4.4% per year.

The share of oil and hydro in the total primary energy mix of Myanmar will increase to 38.3% and 3.8%, respectively, in 2040. Coal share will also increase from 1.9% in 2015 to 16.4% in 2040. Natural gas shares will increase to 13.8% over the projection period. Notably, the share of biomass will decrease due to its slow growth that is driven just by the growth of the rural population. From 50.9% in 2015, its share will decline to 27.6% in 2040.

Figure 12.3: Primary Energy Supply by Source, BAU (1990-2040)



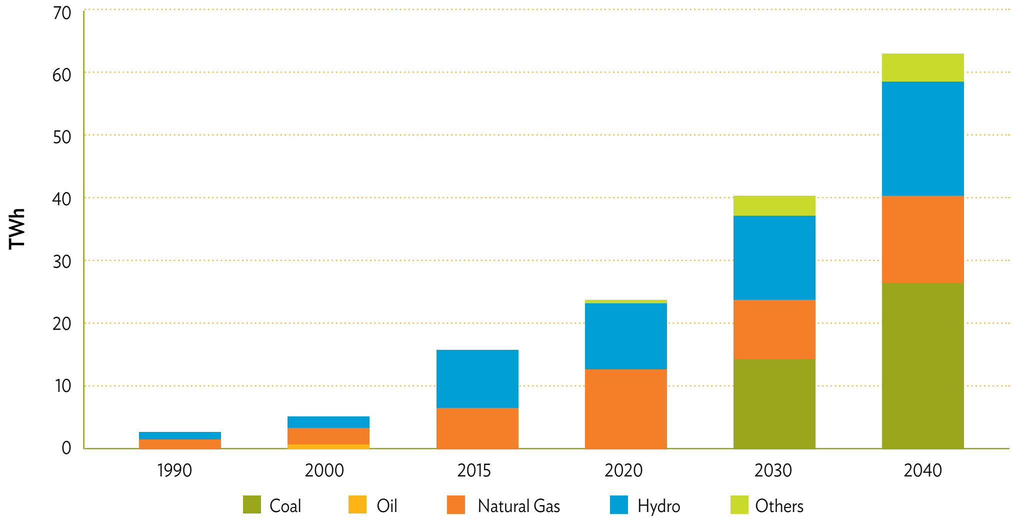
BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Study outcome.

Power Generation

Hydro and natural gas dominated the power sector fuel mix in Myanmar (Figure 12.4). In 2015, the share of hydro in the power generation mix reached 58.9%, while that of natural gas was 40.8%. The remaining fuel (coal and oil) accounted for only 0.3% of the total generation mix.

Figure 12.4: Power Generation Mix, BAU (1990-2040)



BAU = Business-As-Usual, TWh = terawatt-hour.

Source: Study outcome.

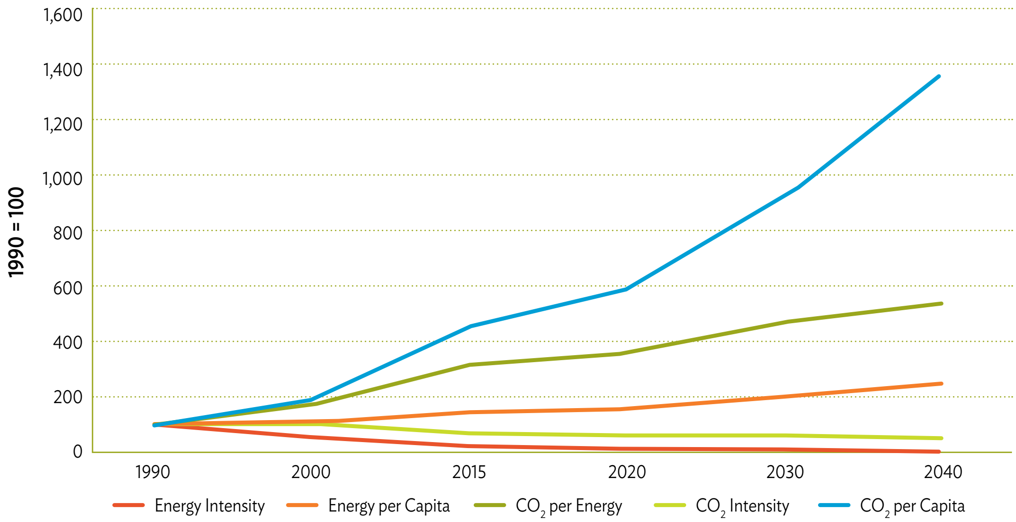
Under the BAU scenario, oil-based power plants will cease operation by 2030 while hydro and natural gas still have shares in the power sector mix of Myanmar in 2040. The share, however, has changed. Hydro-based power plants will have a 29.1% share while that of natural gas will be 21.8%.

The remaining fuel will have an increasing role in the future. Coal-based power generation share in the total fuel mix will increase to 42.2% in 2040, becoming the dominant power generation sector while other renewable shares (solar, wind, and biomass) will reach 6.8%. Total electricity generation from the different plants will grow at an average annual rate of 5.6% in 2015–2040, with natural gas–based power plants growing at an average annual rate of 3.0%. Hydropower generation will increase but at a slower average annual rate of 2.7% during the same period.

Energy Intensity, Energy per Capita, and Energy Elasticity

Myanmar's primary energy intensity (TPES/GDP) has been declining since 1990. In 2015, the primary energy intensity was 281 toe/million 2010 US$, lower than what it was in 1990 which was 1,333 toe/million 2010 US$. The intensity is projected to continue to decrease to 132 toe/million 2010 US$ by 2040 at an average rate of 3% per year. Energy consumption per capita grew from 0.3 toe in 1990 to 0.4 toe in 2015 and will increase to 0.67 toe by 2040, at an AAGR of 2.3%. CO_2 intensity was 140t-C/million 2010 US$ in 1990 and decreased to 93t-C/million 2010 US$ in 2015. CO_2 intensity is projected to continue to decrease to 74 t-C/million 2010 US$ in 2040 at an AAGR of 0.9%. Figure 12.5 shows the evolution of these energy indicators from 1990 to 2040.

Figure 12.5: Energy Intensity, CO_2 Intensity, and Energy per Capita (1990–2040)



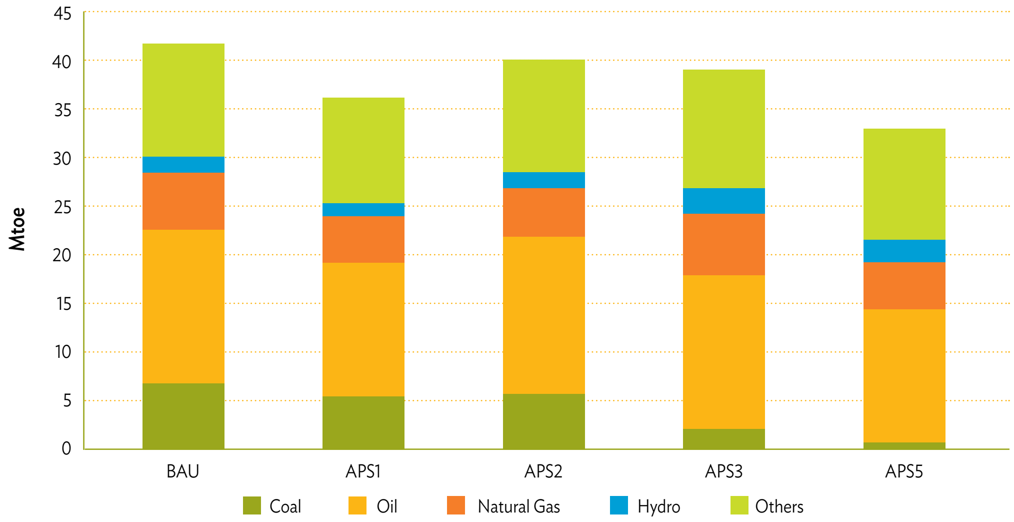
CO_2 = carbon dioxide.

Source: Study outcome.

3.2. Energy Savings Potential (APS)

The APS was analysed separately to determine the individual impacts of the policy interventions assumed in APS1, APS2, and APS3. The combination of all these policy interventions was further analysed in APS5. Figure 12.6 shows the changes in total primary energy consumption (TPEC) in all scenarios.

Figure 12.6: Comparison of Scenarios to Total Primary Energy Supply in 2040



APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Study outcome.

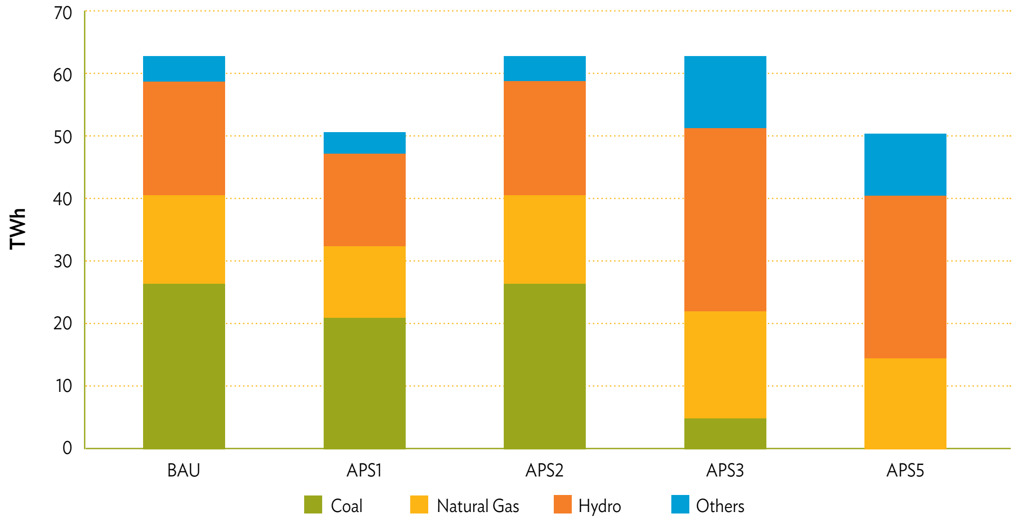
Figure 12.6 shows that APS5 has the largest reduction in the TPEC due to the implementation of EEC action plans, improvement of thermal efficiency of fossil-fuelled power plants, and higher penetration of NRE in the country's supply mix. The AAGR of the TPEC under APS5 will be around 2.1% over the projection period. In 2040, the reduction of primary energy consumption in APS5 compared to the BAU scenario will be 8.64 Mtoe or 20.7%. Individually, implementation of energy efficiency targets and masterplan as defined in APS1 will reduce the TPEC of Myanmar by 5.49 Mtoe or 13.1% in 2040 compared to the BAU scenario. The AAGR of primary energy consumption in APS1 will be 2.4%, slightly higher than APS5. APS2, which assumes higher efficiency in thermal electricity generation, will reduce the TPES by 1.53 Mtoe or 3.7% compared to the BAU scenario. The country's TPES under APS2 will grow at an annual average rate of 2.9%, slightly slower than the BAU scenario. Since no final energy demand efficiency measures were assumed for APS2, the impact on primary energy supply will be lower than APS1 or APS5. Of all the fossil fuels considered, implementation of this higher efficiency in thermal power generation policy intervention will reduce the use of coal and natural gas for power generation. A highly efficient power generation could lead to higher reduction in coal use by almost 14% in 2040.

If a policy for higher penetration of NRE is implemented, then the TPEC will decrease, compared to the BAU scenario, by 2.63 Mtoe or 6.3%. By fuel type, coal consumption will decrease but the use of renewable energy will increase by 12% (1.60 Mtoe).

The impact of implementing policy interventions will also be reflected in the power generation of the country. Figure 12.7 shows total electricity generation in 2040 in all scenarios. In both APS1 and APS5, due to lower electricity demand, power generation will be reduced by 11.47 Mtoe or 20% compared to the BAU scenario. The reduction in power generation will be from natural gas, coal, and hydro plants; highest reduction will be in coal power plants (5.32 Mtoe in APS1 and 26.1 Mtoe in APS5).

Under APS2 and APS3, the total amount of electricity generated will be similar to the BAU scenario because no efficiency measures were imposed on the final sector. The differences, however, lie in the fuel mix for power generation under APS3. More 'others' renewable power plants such as solar, wind, biomass, etc. will be in operation over the projection period, replacing coal-based power plants, which are supposed to be in operation up to 2040.

Figure 12.7: Comparison of Scenarios of Electricity Generation in 2040

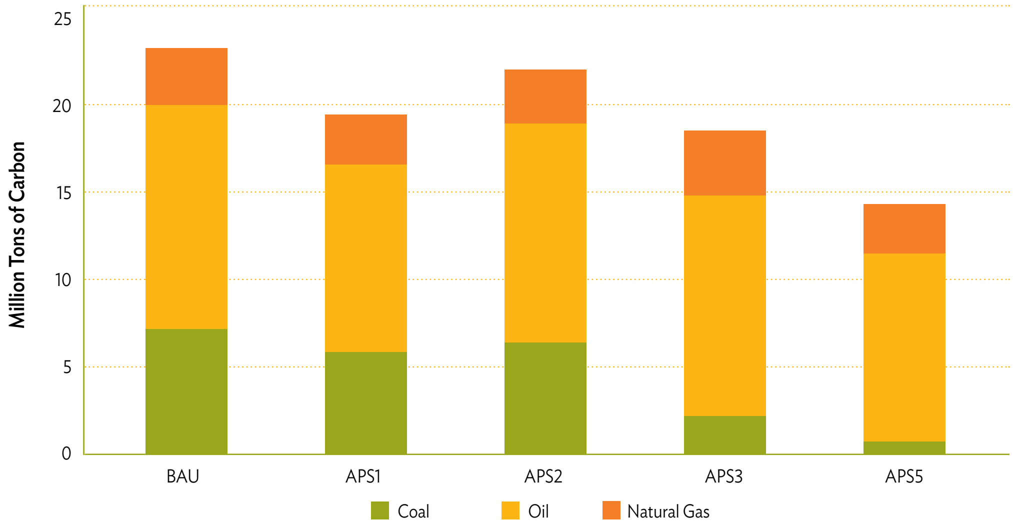


APS = Alternative Policy Scenario, BAU = Business-As-Usual, TWh = terawatt-hour.

Source: Study outcome.

In terms of CO_2 emissions reduction, the energy efficiency assumption in APS5 is expected to reduce emissions at the largest by around 8.9 million metric tons of carbon (Mt-C) or 38% lower than the BAU scenario. The decrease in CO_2 indicates that the energy-saving goals, action plans, and policies in the promotion of programmes, and switching to less carbon-intensive technologies such as renewable sources in the supply mix will be effective in reducing CO_2 emissions. Figure 12.8 shows the projected CO_2 emissions in 2040 in all scenarios.

Figure 12.8: Comparison of Scenarios to CO_2 Emissions in 2040



APS = Alternative Policy Scenario, BAU = Business-As-Usual.

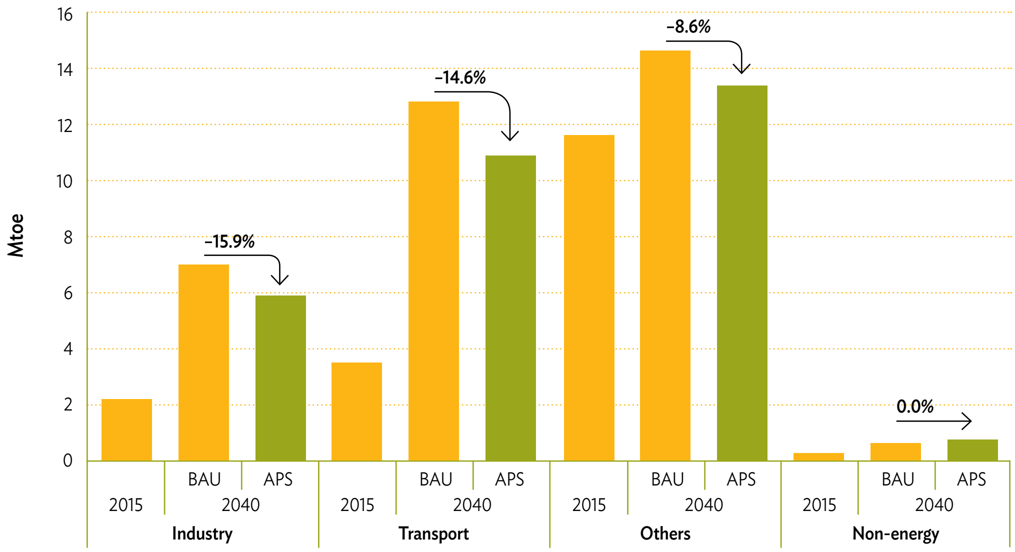
Source: Study outcome.

In APS1, total final energy demand will be lower so that CO_2 emissions from energy consumption will also be lower, reaching 19.50 Mt-C. This is a reduction of CO_2 emissions by around 3.9 Mt-C, which is about 17% lower than the BAU scenario. In APS3, higher contributions from renewable energy could reduce emissions by 21% compared to the BAU scenario. Total CO_2 emissions under APS3 will be around 18.6 Mt-C. The decrease in CO_2 indicates that increasing renewable energy shares in the total supply will reduce further CO_2 emissions.

3.2.1 Final energy consumption in the APS

In APS5, the growth in final energy demand is projected to grow at a lower average annual rate of 2.3% compared to the 2.8% annual growth in the BAU scenario. The reason for the slower growth rate is the result of technological improvement in manufacturing processes and the reduction of final energy demand of electricity and oil in the residential and commercial ('others') sectors. Figure 12.9 shows the differences in final energy demand in 2040 by sector in the BAU scenario and the APS.

Figure 12.9: Final Energy Consumption by Sector, BAU and APS (2015–2040)



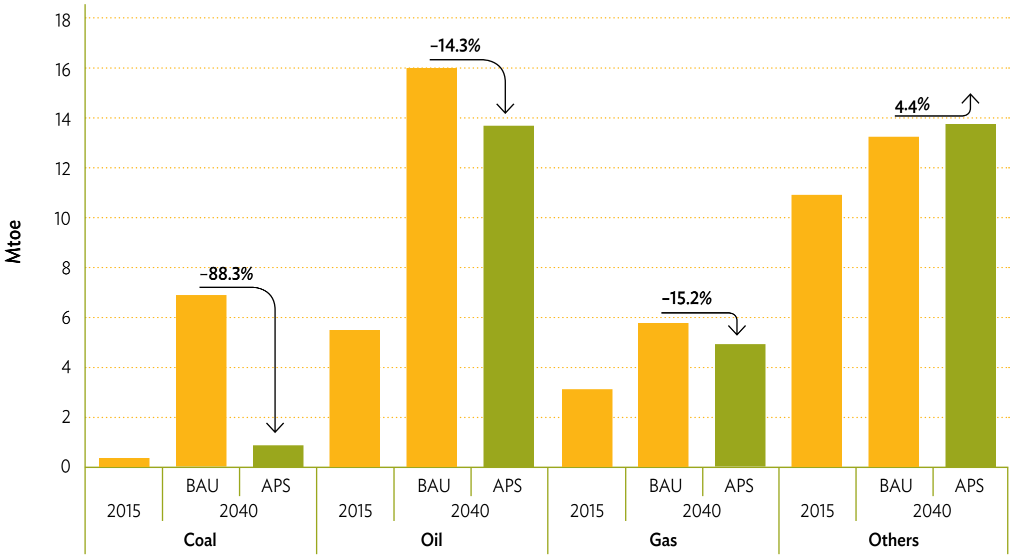
APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Study outcome.

Primary Energy Supply

In the APS, Myanmar's primary energy supply is projected to increase at a slightly lower rate than the BAU scenario's at 2.1% per year, from 19.85 Mtoe in 2015 to 33.15 Mtoe in 2040. Hydro will be the fastest growing at 4.3% per year, followed by oil at 3.7% per year in 2015–2040. Coal is expected to grow at an average annual rate of 3.1% over the same period and natural gas, at 1.9% per year. Figure 12.10 shows the primary energy consumption by source in 2040 under the BAU scenario and the APS.

Figure 12.10: **Primary Energy Supply by Source, BAU and APS (2015 and 2040)**



APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

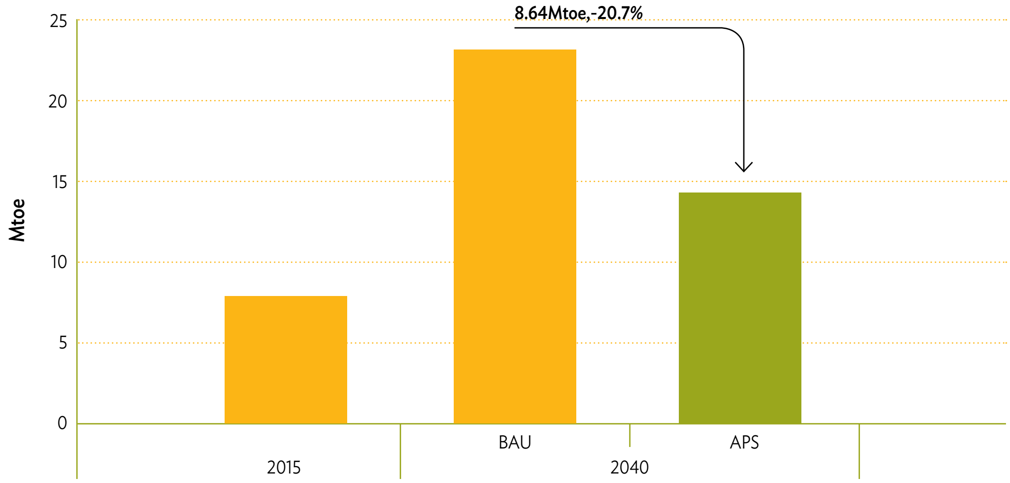
Source: Study outcome.

Projected Energy Savings

In Myanmar, commercial energy consumption is projected based on the energy requirements of the major sectors (industry, transport, agriculture, and households). The choice of fuel type is determined by available supply, since energy demand must be met mainly by domestic sources. Obviously, there is a gap between demand and supply, but the demand is much higher than the actual requirement. Due to these constraints, coefficients, derived by time series regression, have been applied to allocate energy. These allocations are made according to the priority of state organisations and enterprises. For the private sector, allocations are made according to the registered licensed capacity of the firm.

Future savings in energy could be due to savings in primary energy consumption in the residential, commercial, transport, and industry sectors. In this regard, Myanmar has implemented a range of EEC goals and action plans which target energy savings in all sectors of the economy and in cooperation with the private and the public sectors. There is an estimated saving of 8.64 Mtoe in 2040 in the APS relative to the BAU scenario. This is equivalent to 20.7% saving of the primary energy consumption in 2040 of the BAU scenario (Figure 12.11). Myanmar has plans to decrease the growth in primary energy consumption by implementing a range of EEC measures on the demand side.

Figure 12.11: Evolution of Primary Energy Supply, BAU and APS (2015 and 2040)



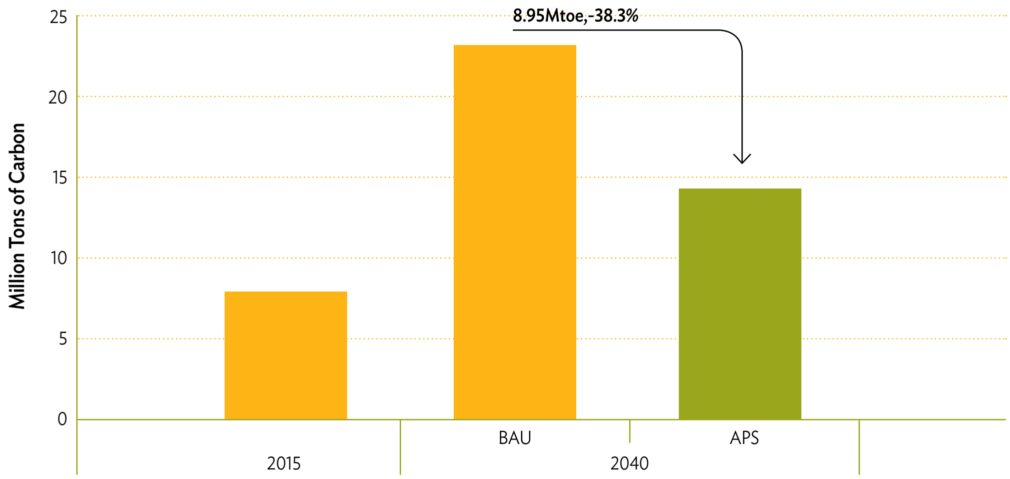
APS = Alternative Policy Scenario, BAU = Business-As-Usual scenario, Mtoe = million tons of oil equivalent.

Source: Study outcome.

CO_2 Reduction Potential

In the APS, the energy efficiency policy of Myanmar is projected to reduce growth in CO_2 emissions from energy consumption. In 2040, in the APS, CO_2 emissions from energy consumption are projected to reach about 14.4 million tons of carbon (Mt-C) which is about 38% below the the BAU scenario level (Figure 12.12).

Figure 12.12: CO_2 Emissions from Energy Consumption, BAU and APS (2015 and 2040)



APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Study outcome.

3.3. Intended Nationally Determined Contributions/Nationally Determined Contributions

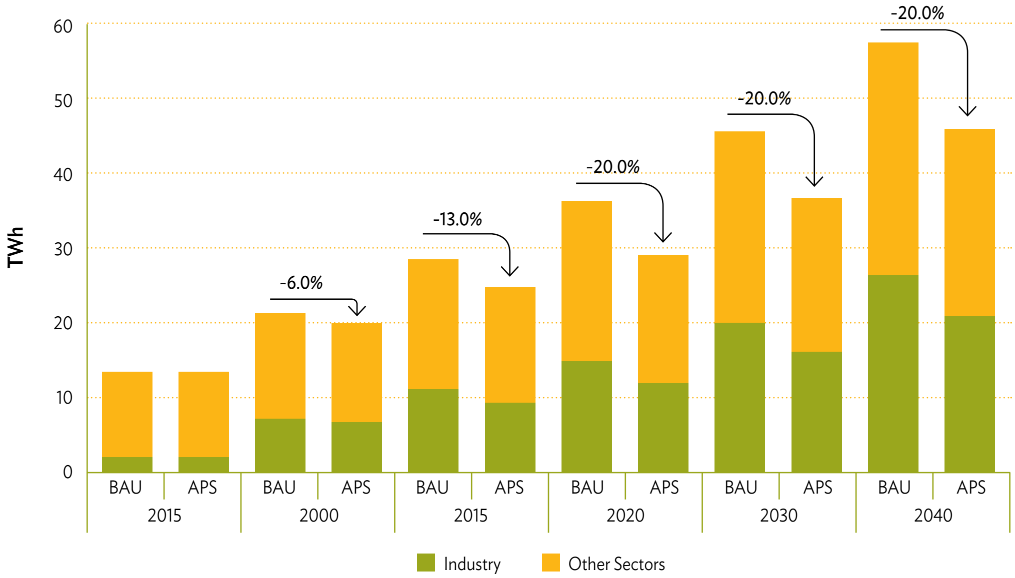
The current energy outlook model considered the Mitigation Actions and Policies of Myanmar in the Energy Sector as specified above in section 2.5 on INDC/NDC. These are the 20% electricity saving potential by 2030 and the 9.4 GW hydroelectricity generation by 2030. The 30% renewable in rural electrification (mini hydropower; biomass; solar, wind, and solar mini-grid technologies) is considered in the share of renewable in the total power supply mix of Myanmar.

The energy sector mitigation actions and policies are represented in the APS scenario since the scenario includes:

- Energy savings (APS1) in the different final sectors (industry, transport, residential, commercial, and others) as a result of introducing more efficient technologies. The assumptions were:
  - Electricity: 20% reduction of demand compared to the BAU scenario
  - Oil: 15% saving from the BAU scenario
  - Others (biomass): 5% reduction compared to the BAU scenario
- Introduction of highly efficient technologies for fossil fuel use in the power sector (APS2)
- Increasing renewable energy share in the electricity-generating capacity (APS3):
  - Hydro-installed capacity of 9.4 GW by 2030 (including mini- and micro-hydro)
  - Other renewables such as wind, solar, and biomass with total capacity of 3 GW by 2030.

Electricity demand reached 36 TWh in 2030 under the BAU scenario. Under the APS, electricity demand was expected to be reduced by 20% compared to the BAU scenario. As a result, electricity demand in the APS will be only 29 TWh in 2030. The electricity saving of 20% has been assumed to continue to 2040 as no additional target is available after 2030. Figure 12.13 shows the electricity demand of the final sectors over the projection period. 'Others' comprises the residential, commercial, agriculture, construction, and other sectors. Electricity demand in the transport sector has been excluded in the current outlook.

Figure 12.13: Electricity Demand, BAU and APS (2015 and 2040)

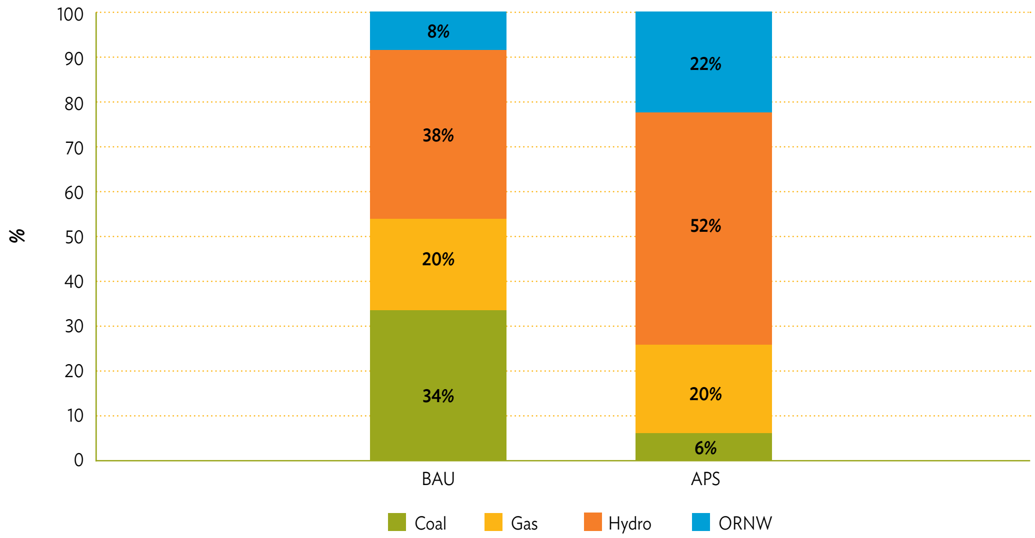


APS = Alternative Policy Scenario, BAU = Business-As-Usual, TWh = terawatt-hour.

Sources: Study outcome.

The APS generation capacity will be more towards renewable energy compared to the BAU scenario (Figure 12.14). As explained earlier in the modelling assumption, the APS excludes some of the additional capacity for the coal-based and natural gas capacity after 2025. More capacity will be made available from renewable energy sources. Hydro resources will reach the 9.4 GW capacity by 2030 as stipulated in the mitigation actions and policies for the energy sector of Myanmar. These include not only the large hydro but also the mini- and micro-hydro plants. Hydro share reached 52% under the APS compared to 38% under the BAU scenario while other renewable sources such as solar, wind, and biomass will also have increasing share compared to the BAU scenario (22% compared to 8%).

Figure 12.14: Power Generation Capacity in 2030, BAU and APS



APS = Alternative Policy Scenario, BAU = Business-As-Usual scenario, ORNW = other renewable sources.
Source: Study outcome.

Considering lower final energy demand and more renewable share under the APS, the impact of the APS to the environment would be a lower CO_2 emissions. The total CO_2 emissions under the BAU scenario in 2030 will be 55.2 Mt-CO_2e (or 15.1 Mt-C). Under the APS, CO_2 emissions will be around 36.4 Mt-CO_2e (or 9.9 Mt-C) in 2030. This is a reduction of CO_2 emissions by 18.8 Mt-CO_2e (or 5.1 Mt-C) compared to the BAU scenario, which is approximately around 34%.

As previously shown, the CO_2 emission reductions in the APS will be 38% by 2040, which is around 32.8 Mt-CO_2e (or 8.9 Mt-C).

4. Conclusions and Policy Implications

Although energy intensity will decline, energy consumption will still increase due to economic, population, and vehicle growth. Myanmar should increase adoption of energy-efficient technologies to mitigate growth in energy consumption; it should also diversify energy availability. The energy-saving programme will target the residential, commercial, transport, and industry sectors.

The current energy supply has been kept below its potential due to the scarcity of technical and financial resources needed first to reverse the decline and then to accelerate natural gas and oil development and production.

The country has been experiencing serious energy shortages, which will become more acute in the absence of further energy sector investment. First, there should be more aggressive exploration of the upstream energy sector and more financial and technical assistance in each energy subsector to secure the national energy supply.

To increase electricity production, Myanmar should rehabilitate existing electricity transmission and distribution, expand rural electrification, build coal- or gas-fired power plants, and promote renewable energy in the country's fuel mix as secure energy sources. The framework should list all potential renewable energy projects in the area, outlining priorities and sequencing, along with funding requirements which would be based on completed studies.

In this regard, the following actions are proposed to be considered:

- The Ministry of Electricity and Energy should formulate an integrated national energy policy, including on energy efficiency.
- Adopt a coordination mechanism and institutional arrangement and legal framework.
- Improve energy statistics for better analysis of energy saving potential in Myanmar.
- Conduct a demand-side survey for energy consumption, which can be done by combining this survey with existing ones.
- Due to the continuous dominance of the transport sector in final energy consumption, set an energy efficiency target for the transport sector in addition to those that have been calculated for the industry, commercial, and household sectors.
- Create a detailed policy mechanism for the renewable energy sector to implement potential programmes and projects. This mechanism should be developed and planned in conjunction with external stakeholders, who offer experiences, advanced technologies, new markets, and investment.
- Improve energy management practices of the industrial and commercial sectors.
- Establish a dedicated energy efficiency body to oversee the energy efficiency programme of Myanmar.
- Refine the current energy efficiency target to include the numerical targets and detailed action plans of all sectors.
- Establish a comprehensive integrated energy plan to guide the development of the sector, including an energy efficiency labelling programme for energy service companies and appliances.
- Since the electrification rate is still low, formulate schemes to enhance private participation, including foreign companies, to accelerate power sector development, including transmission and distribution system to ensure reliable electricity supply to the consumers.

- The Ministry of Industry should set specific targets for each sector on energy efficiency and government should implement to achieve these targets.
- Consider the import of LNG in floating terminals in the short term to meet the projected rapid growth of electricity demand while exploration of new domestic natural gas resources is still being undertaken.
- Consider civilian nuclear energy policy and exploration of geothermal energy potential to generate electricity.
- Remove taxes in LPG and kerosene to reduce biomass consumption, which is increasing continuously, in the residential sector.
- Encourage private companies to invest in new refinery capacities to meet domestic petroleum products demand.

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