Chapter 4

Energy and Environmental Outlook for the EAS Region

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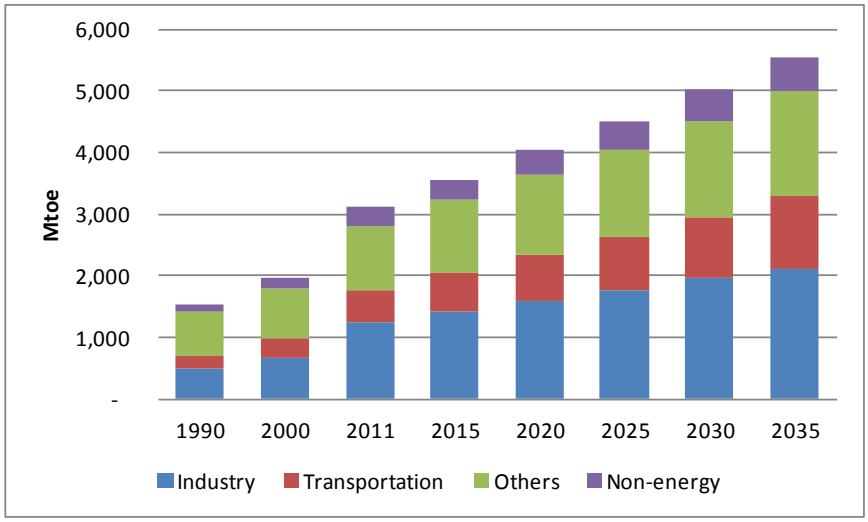
4. Energy And Environmental Outlook for the EAS Region

4.1. Business-as-Usual (BAU) Scenario

4.1.1. Final Energy Demand

Between 2011 and 2035, the total final energy demand[12] in the 16 EAS countries is projected to grow at an average annual rate of 2.4 percent, reflecting the assumed 4.2 percent annual GDP growth and 0.6 percent population growth. Final energy demand is projected to increase from 3112 Mtoe in 2011 to 5545 Mtoe in 2035. The transport sector demand is projected to grow most rapidly, increasing by 3.4 percent per year, as a result of motorization that is to be driven by increasing disposable income as EAS economies grow. The commercial and residential (Others) sectors' demand will grow at 2.0 percent per year slower than that of the industry sector. Energy demand in the industry sector is projected to grow at an average annual rate of 2.3 percent. Figure 10 shows final energy demand by sector under BAU in EAS, from 1990 to 2035.

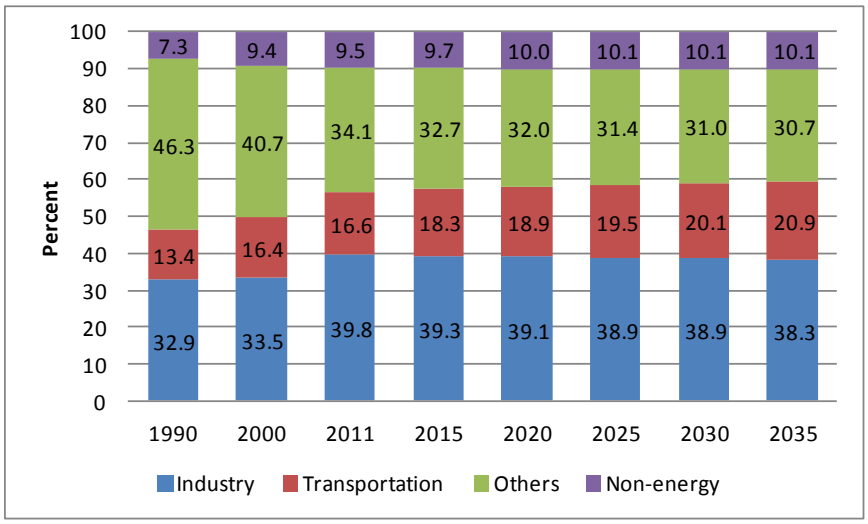
Figure 10: Final Energy Demand by Sector (1990 to 2035), BAU



[12] Refers to energy in the form in which it is actually consumed, that is, including electricity, but not including the fuels and/or energy sources used to generate electricity.

There will be a slight change in the shares of the sectors in final energy demand from 2011 to 2035 with the transport sector having an increasing share while the industrial and other (largely residential and commercial) sectors will have decreasing shares. The industrial sector's share will slightly decrease from 39.8 percent in 2011 to 38.3 percent in 2035. The other sectors' share will significantly decrease from 34.1 percent to 30.7 percent during the same period. The share of transport sector, on the other hand, will increase from 16.6 percent to 20.9 percent from 2011 to 2035. Non-energy demand will also increase from 9.5 percent to 10.1 percent during the same period. The sectoral shares to final energy demand are shown in Figure 11.

Figure 11: Final Energy Demand Share by Sector (1990 to 2035)



For the energy sources, natural gas demand in the BAU scenario is projected to exhibit the fastest growth, increasing by 4.7 percent per year, from 212 Mtoe in 2011 to 636 Mtoe in 2035. Although oil will retain the largest share of total final energy demand, it is projected to grow at a much lower rate of 2.6 percent per year, reaching 1897 Mtoe in 2035. This is compared with its 3.8 percent per year growth over the last two decades. However, its share will still increase from 33.0 percent in 2011 to 34.2 percent in 2035. Demand for electricity will grow at a relatively fast rate of 3.6 percent per year. Its share will increase from 19.1 percent in 2011 to 25.1 percent in 2035 surpassing the share of coal. The growth in coal demand will grow at a slower rate of 1.1 percent per year on average. Other fuels, which are mostly solid and liquid biofuels, will have a slow annual growth rate of 0.5 percent on average although there will be a rapid growth rate on the consumption of the liquid biofuels. Consequently the share of other fuels will decline from 16.0 percent in 2010 to 10.2 percent in 2035. This slow growth is due to the gradual shift from non-commercial biomass to conventional fuels like LPG and electricity

in the residential sector.

Figures 12 and 13 show the final energy demand and shares by energy in the EAS under the BAU from 1990 to 2035.

Figure 12: Final Energy Demand by Energy (1990 to 2035)

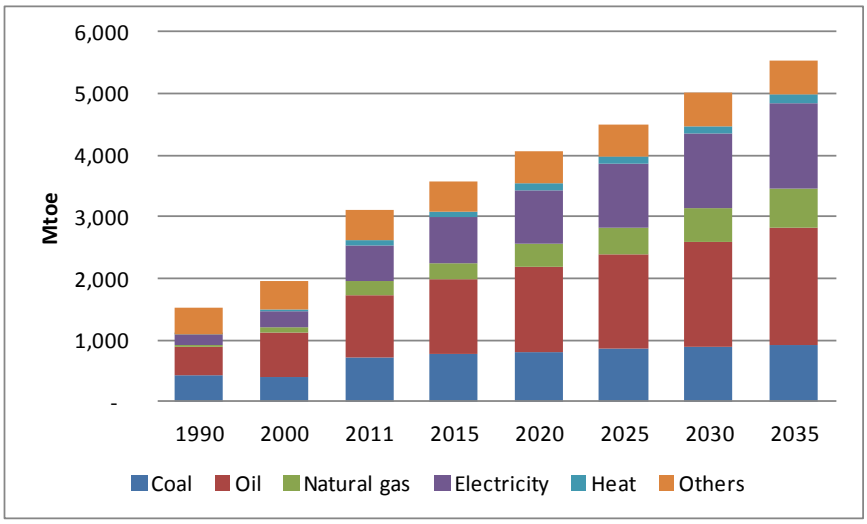
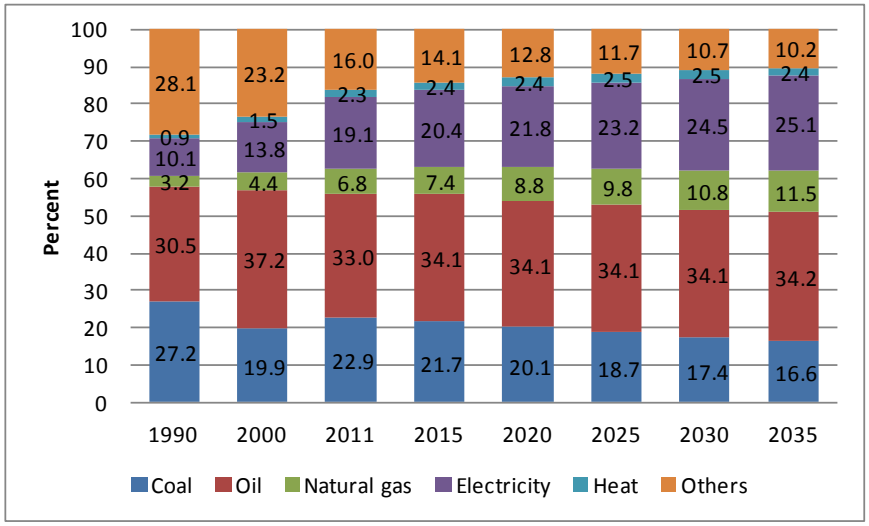


Figure 13: Final Energy Demand Share by Energy (1990 to 2035)



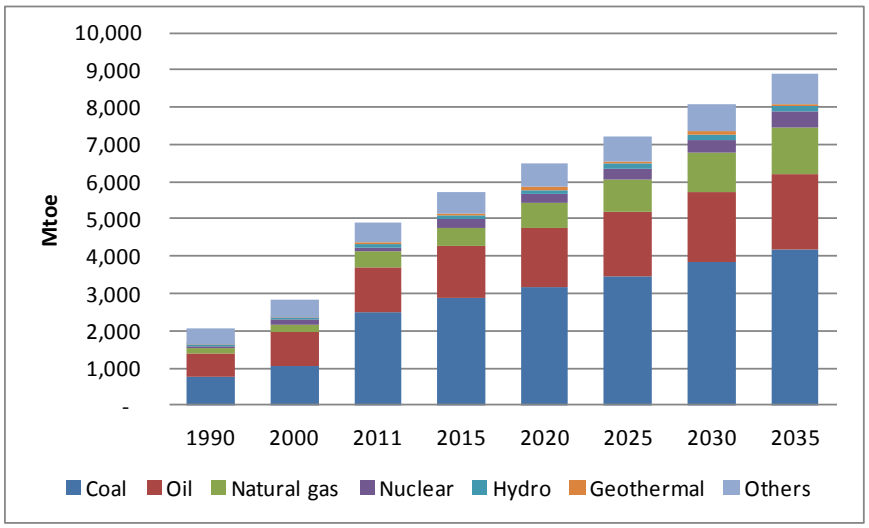
4.1.2. Primary Energy Demand

Primary energy demand[13] in EAS is projected to grow at a faster pace of 2.5 percent per year on average than the final energy demand of 2.4 percent. The EAS primary energy demand is projected to increase from 4910 Mtoe in

[13] Refers to energy in its raw form, before any transformations, most significantly the generation of electricity.

2011 to 8912 Mtoe in 2035. Coal will still constitute the largest share of primary demand, but its growth is expected to be slower, increasing at 2.1 percent per year. Consequently, the share of coal in total primary energy demand will decline from 51.1 percent in 2011 to 46.6 percent in 2035. Figure 14 shows the primary energy demand from 1990 to 2035.

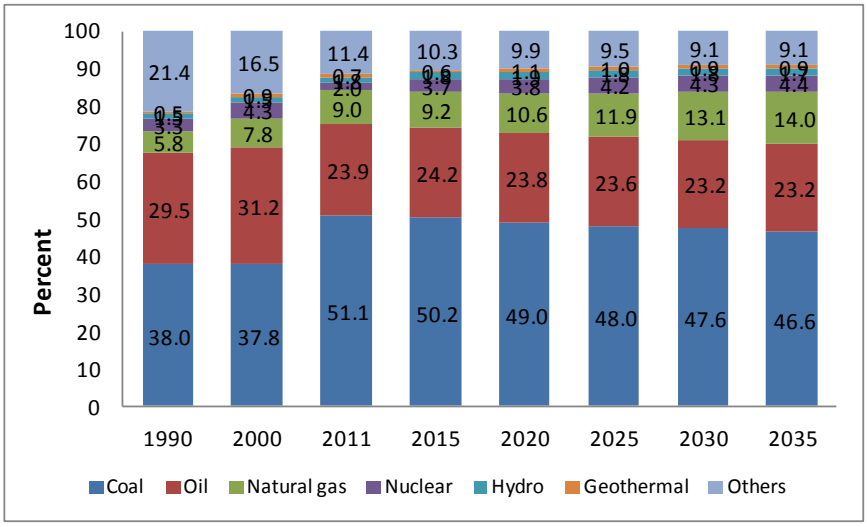
Figure 14: Primary Energy Demand in EAS (1990 to 2035)



Among fossil sources of energy, natural gas is projected to exhibit the fastest growth between 2011 and 2035, increasing at an annual average rate of 4.4 percent. Its share to the total will subsequently increase from 9.0 percent in 2011 to 14.0 percent in 2035. Nuclear energy is also projected to increase at a rapid rate of 6.0 percent per year on average and its share will improve from 2.0 percent in 2011 to 4.4 percent in 2035. This is due to the expansion of power generation capacity in China and India and the introduction of this energy source in Viet Nam.

Among the energy sources, "Others" - which constitute solar, wind as well as solid and liquid biofuels - will have the slowest growth rate of 1.6 percent. Consequently, the share of these other sources of energy will decrease from 11.4 percent in 2011 to 9.1 percent in 2035. Geothermal energy will increase at a rapid pace of 3.7 percent per year but its share will remain low at 0.9 percent in 2035, slightly increasing from 0.7 percent in 2011. The growth of hydro will be 2.3 percent per year and its share will remain low at below 2.0 percent from 2010 to 2035. Figure 15 shows the shares of each energy source to the total primary energy mix from 1990 to 2035.

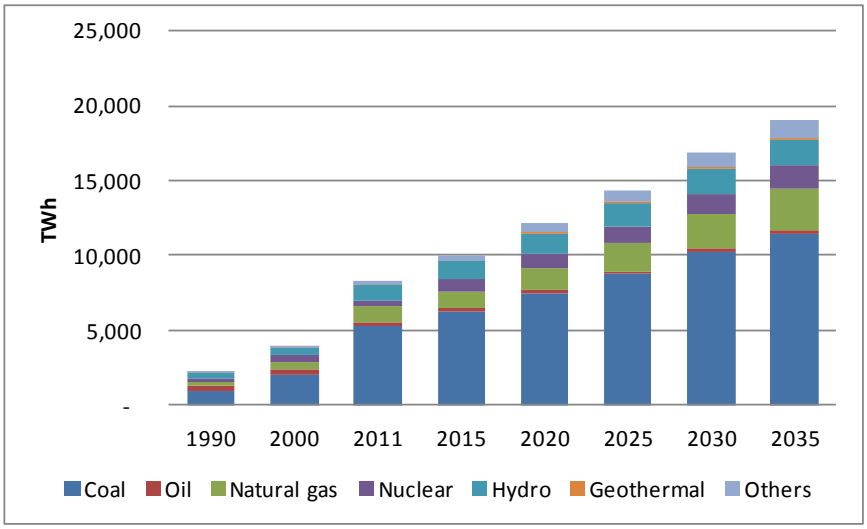
Figure 15: Primary Energy Mix in EAS (1990 to 2035)



4.1.3. Power Generation

Power generation in EAS is projected to grow at 3.5 percent per year on average from 2011 (8308 TWh) to 2035 (19,050 TWh), slower than the 6.5 percent annual rate of growth from 1990 to 2011 (Figure 16).

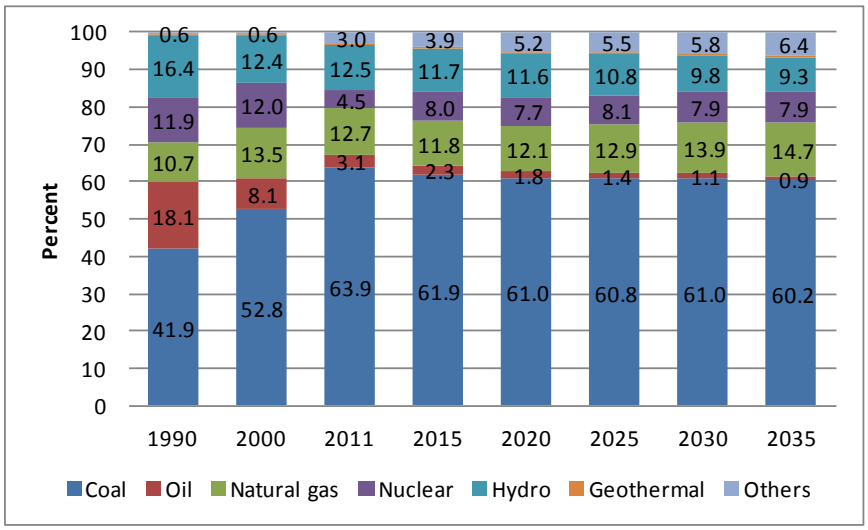
Figure 16: Power Generation in EAS (1990 to 2035)



The share of coal–fired generation is projected to continue to be the largest and will remain above 60 percent of the total until 2035. Natural gas share is projected to increase from 12.7 percent in 2011 to 14.7 percent in 2035 along with those of nuclear (4.5 percent in 2011 to 7.9 percent in 2035), geothermal (0.3 percent to 0.5 percent) and others (wind, solar, biomass, etc at 3.0 percent

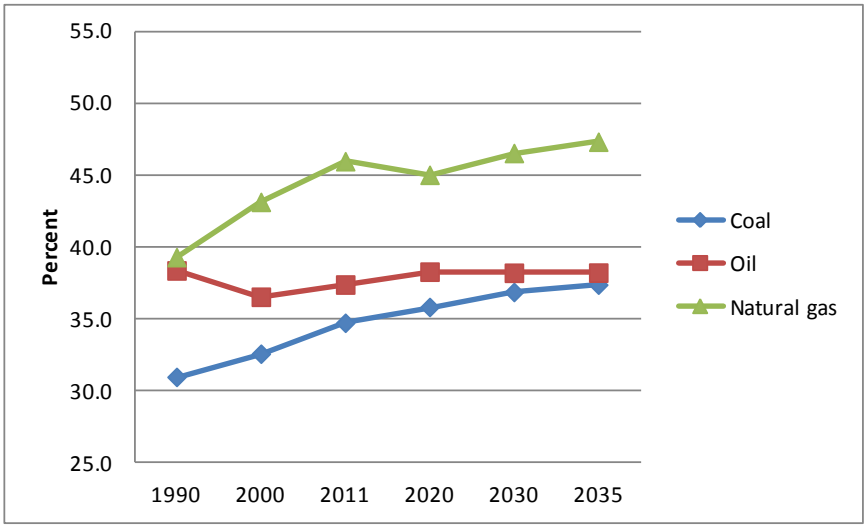
to 6.4 percent). The shares of oil and hydro are projected to decrease from 3.1 percent to 0.9 percent and 12.5 percent to 9.3 percent, respectively, during the same period. Figure 17 shows the shares of each energy source in electricity generation from 1990 to 2035.

Figure 17: Power Generation Mix in EAS (1990 to 2035)



Thermal efficiency is projected to grow in EAS from 2011 to 2035 due to improvement in electricity generation technologies like combined-cycle gas turbines and advanced coal power plant technologies. From 34.7 percent in 2011, the efficiency of coal thermal power plants, which is a mix of old and new power plants, will increase to 37.3 percent in 2035. Efficiency of natural gas power plants will also increase from 45.9 percent in 2011 to 47.3 percent in 2035. Even oil power plants, which will not be used significantly in the future, will have improved efficiency from 37.3 percent in 2011 to 38.2 percent in 2035. Figure 18 shows the thermal efficiency of coal-, oil- and natural gas-fired power plants from 1990 to 2035.

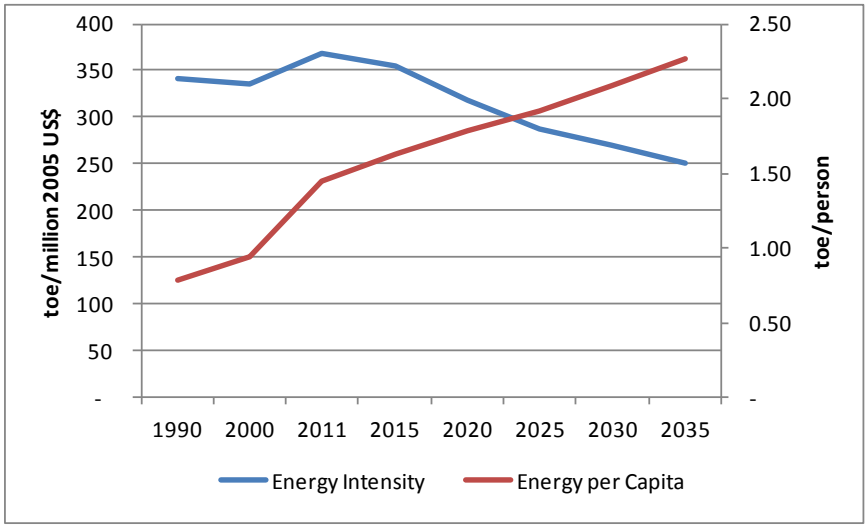
Figure 18: Thermal Efficiency by Fuel, BAU (1990 to 2035)



4.1.4. Energy Intensity and per Capita Energy Demand

Even in the BAU, energy intensity in EAS is projected to decline from 368 toe/million US$ (constant 2005) in 2011 to 250 toe/million US$ in 2035. In contrast, energy demand per capita is projected to continue to increase from 1.45 toe per person in 2011 to 2.26 toe per person in 2035. This could be attributed to the projected continuing economic growth in the region, which will bring about a more energy intensive lifestyle as people are able to purchase vehicles, household appliances and other energy consuming devices as disposable income increases. Figure 19 shows the energy intensity and energy per capita from 1990 to 2035.

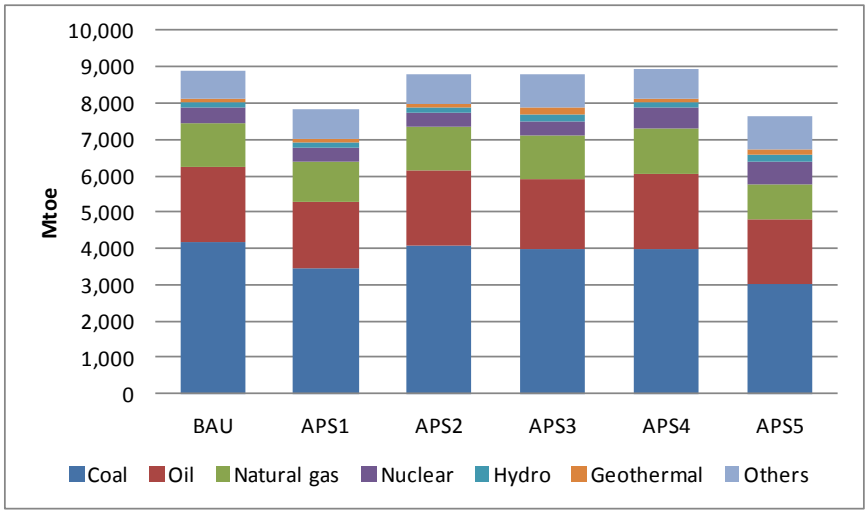
Figure 19: Energy Intensity and per Capita Energy Demand in EAS



4.2. Alternative Policy Scenario (APS)

As mentioned above, the assumptions in the APS were analysed separately in order to determine the individual impacts of each assumption in APS1, APS2, APS3, APS4 and the combination of all these assumptions (APS or APS5). Figure 20 shows the total primary energy supply in all the scenarios.

Figure 20: Total Primary Energy Supply in EAS in 2035 (All Scenarios)



APS1 and APS5 have the largest reduction in total primary energy supply due to the energy efficiency assumptions in the demand-side. Energy efficiency assumptions in APS1 could reduce total primary energy supply in BAU by as much as 1104 Mtoe or 12.4 percent.

APS2 which assumes higher efficiency in thermal electricity generation has lower impact than APS1. This is due to the assumptions that only the newly constructed power plants will have higher efficiency. It is expected that existing power plants will continue to operate until the end of their lifetimes. This is why, only 129 Mtoe or 1.4 percent of the total primary energy supply in the BAU is saved in this scenario. This energy saving is almost equal to the total primary energy consumption of Australia in 2011.

APS3 assumes higher penetration of renewable energy in electricity generation and higher consumption of biofuels in the transportation sector. Like APS2, there is only a small reduction in the BAU value of 96 Mtoe or 1.1 percent reduction. Although hydro, solar and wind energy are assumed to have 100 percent thermal efficiency when converted to primary energy, the contributions of these energy sources were dwarfed by the contribution of biomass and geothermal energy, which have lower thermal efficiencies than the fossil-fired electricity generation that were replaced in this scenario. However, this 1.1 percent reduction in primary energy consumption can result in a 5.0 percent reduction in BAU CO_2 emission.

APS4 assumes higher contribution of nuclear energy in power generation. In this, the total primary energy supply is higher by 27 Mtoe or 0.3 percent than the total primary energy supply in the BAU. This is due to the relatively lower thermal efficiency of nuclear power generation (33%) compared to new coal and natural gas-fired power plants. However, due to the reduction in fossil fuels that would be replaced by nuclear energy, there could be a 3.0 percent reduction in the BAU CO2 emission in this scenario.

Figure 21 shows the total electricity generation mix in EAS in 2035 in all scenarios. In APS1, due to the lower electricity demand, the shares of fossil-fired electricity generation were lower than in the BAU scenario. In APS2, the shares are the same as those of the BAU. In APS3, due to the assumption of more renewable energy, fossil fuel-fired generation could be reduced by 9.5 percent while in APS4, nuclear energy could reduce fossil fuel share by 5.7 percent. In APS5, reduction in fossil energy-based generation could be reduced by as much as 33.5 percent.

Figure 21: Electricity Generation in 2035 in EAS in all Scenarios

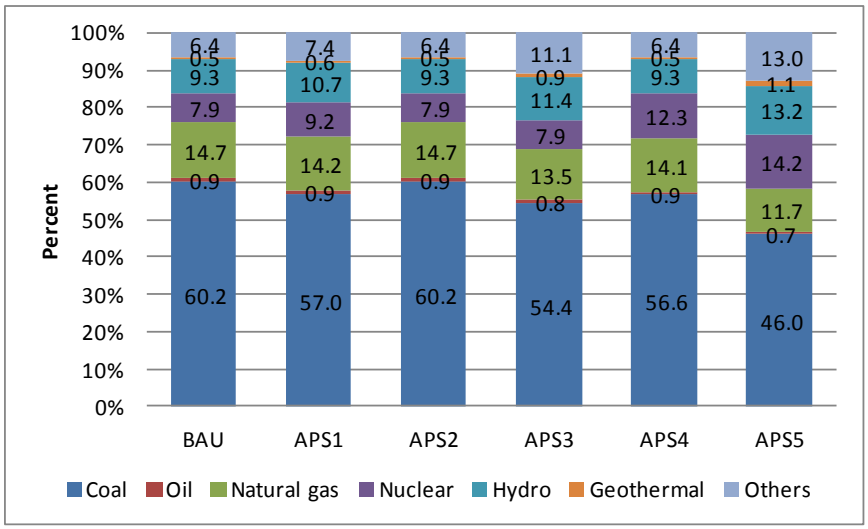
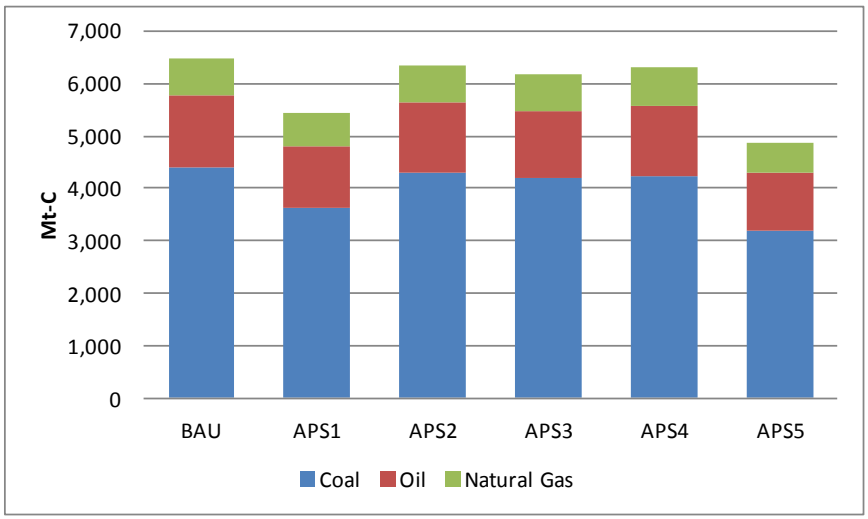


Figure 22: Total EAS CO_2 Emissions in 2035 in all Scenarios



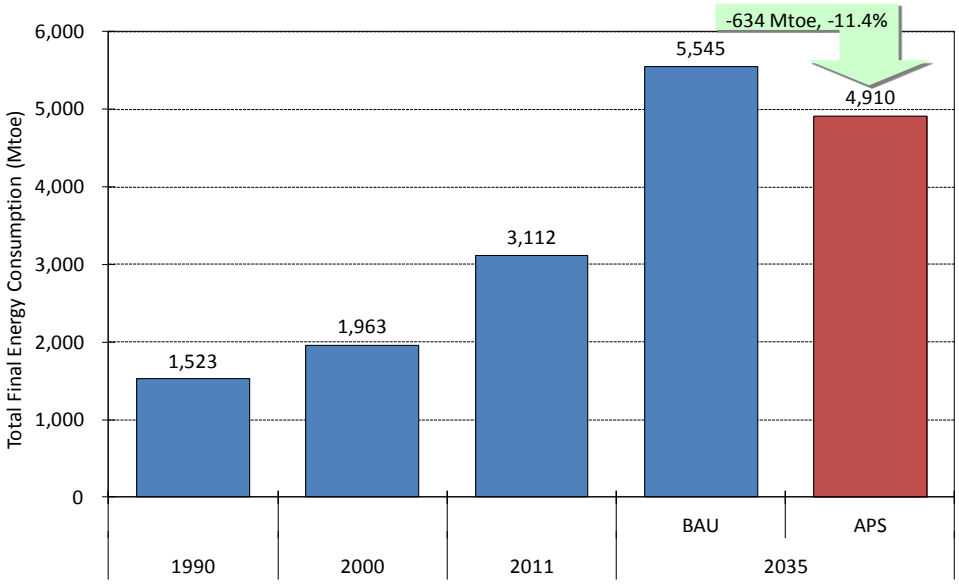
In terms of CO_2 emission reduction, energy efficiency assumption in APS1 could reduce emissions in the BAU by 16.1 percent in 2035. In APS2, the installation of more efficient new power plants is able to reduce emissions by 2.2 percent. Higher contributions from renewable energy could reduce emissions by 5.0 percent while higher contribution from nuclear energy could result in emission reduction of 2.9 percent. All these assumptions combined could reduce BAU CO_2 emissions by 25.2 percent in 2035. Figure 22 shows the estimated CO_2 emissions in all the analysed scenarios.

The more detailed analysis of the differences between the BAU and the APS follows below.

4.2.1. Total Final Energy Demand

In the APS case, final energy demand is projected to rise to 4,910 Mtoe, 634 Mtoe or 11.4 percent lower than in the BAU case in 2035. This is due to the various energy efficiency plans and programs presented in Section 3 above in both the supply and demand sides that are to be implemented by EAS countries. Figure 23 shows the evolution of final energy demand from 1990 to 2035 in both the BAU and APS scenarios.

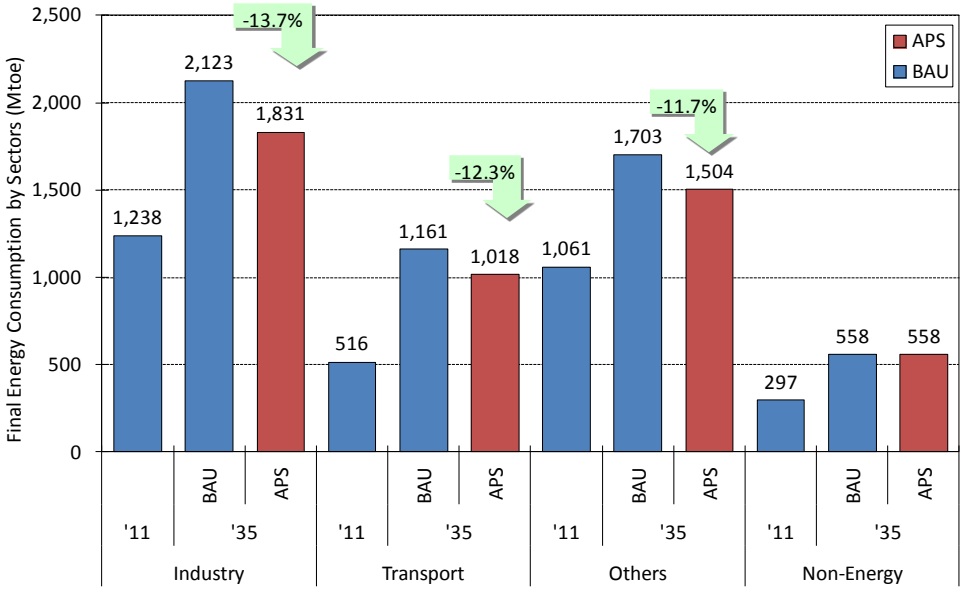
Figure 23: Total Final Energy Demand, BAU and APS



4.2.2. Final Energy Demand by Sector

Figure 24 shows the composition of final energy demand by sector in both the BAU and APS. Final energy demand in most sectors is significantly reduced in the APS case compared with the BAU case. In percentage terms, the reduction is largest in the industry sector at 13.7 percent, followed by the transport sector at 12.3 percent and the 'others' sector at 11.7 percent. Non-energy demand will not be different from the BAU.

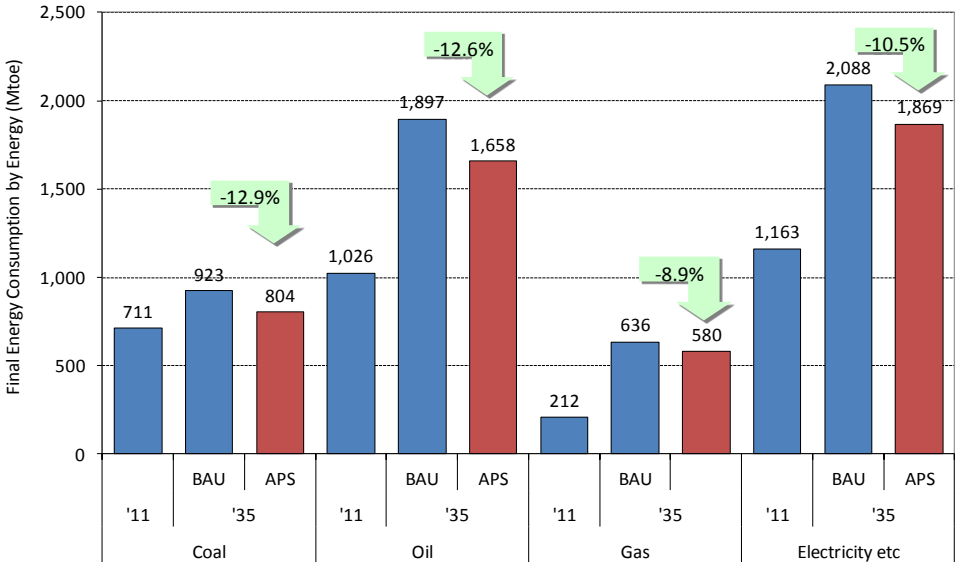
Figure 24: Final Energy Demand by Sector, BAU and APS



4.2.3. Final Energy Demand by Fuel

Figure 25 shows final energy demand by type of fuel. In the APS case, growth in final demand for all fuels is lower compared with the BAU case. The growth rate of 1.9 percent per year on average is lower than the BAU's 2.4 percent. The largest reduction will be in oil demand at 239 Mtoe or 12.6 percent from the BAU's 1,897 Mtoe to 1,658 Mtoe in the APS. This potential saving in oil is equivalent to 59 percent of China's final oil demand in 2011. The saving potential in other fuels which includes electricity and heat is second largest at 220 Mtoe, equivalent to a reduction of 10.5 percent from BAU. This is to be brought about by improvement in the efficiencies of household appliances and more efficient building designs. The saving potential for coal is 119 Mtoe and this will come mostly from energy efficiency in the industrial sector. The saving potential for natural gas is around 57 Mtoe or 8.9 percent from the BAU demand.

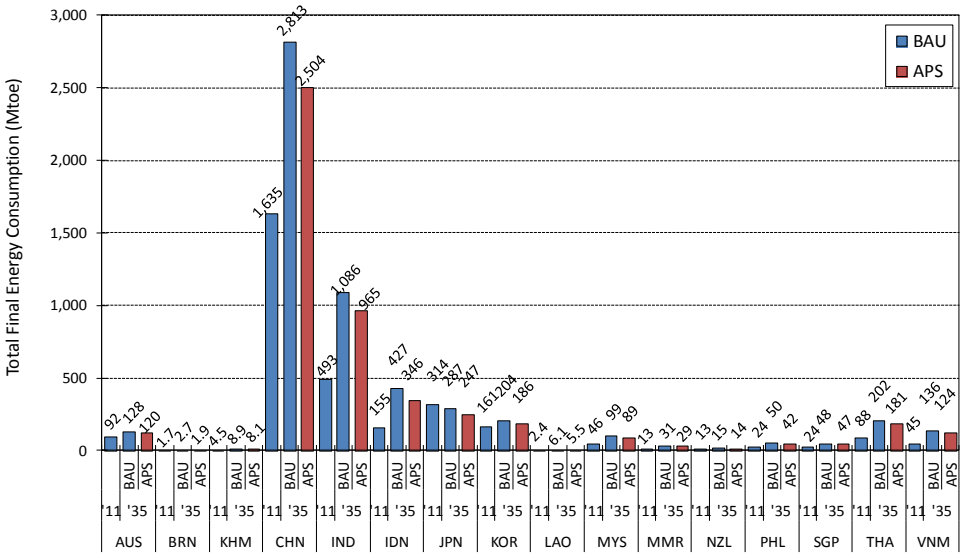
Figure 25: Final Energy Demand by Fuel, BAU and APS



4.2.4. Final Energy Demand by Country

Figure 26 shows final energy demand by country. The most striking result is that China is projected to continue to dominate EAS region's final energy demand until 2035. China is projected to account for about 50.7 percent of the EAS region's final energy demand in 2035, down from about 52.5 percent in 2011. Just five countries—China, India, Indonesia, Japan, and Republic of Korea—are projected to account for 86.9 percent of the EAS region's final energy demand in 2035, with the growth in final energy demand concentrated in just three countries: China, India, and Indonesia. In fact, these "big three" countries are projected to account for 84.0 percent of the growth in energy demand for the entire EAS region between 2011 and 2035. In the APS case, growth in most countries, including the "big three", is significantly lower relative to the BAU scenario. However, the "big three" are still projected to account for 85.2 percent of the growth in energy demand in the EAS region between 2011 and 2035.

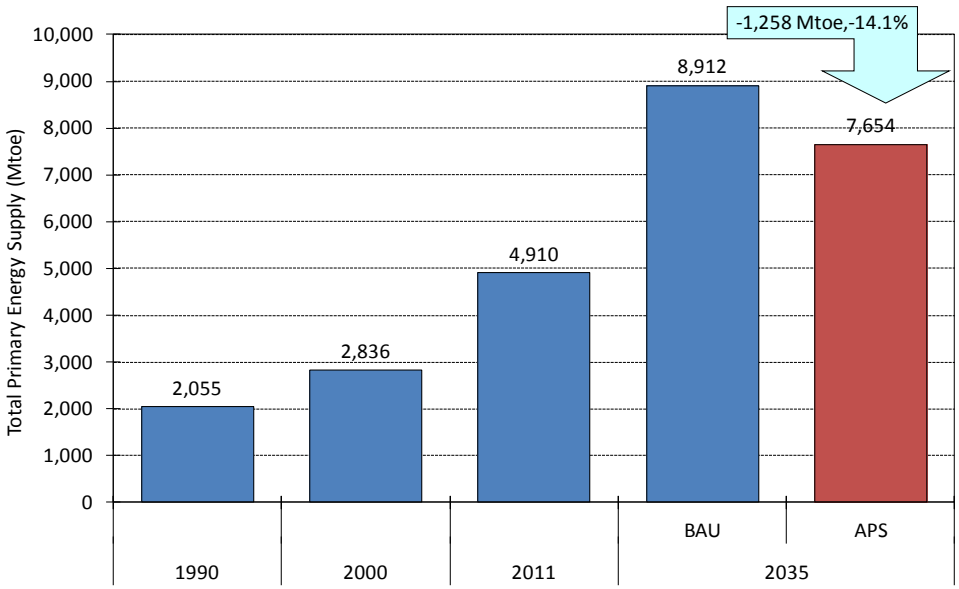
Figure 26: Total Final Energy Demand by Country, BAU and APS



4.2.5. Total Primary Energy Demand

The pattern followed by primary energy demand is, as one would expect, similar to final energy demand. Figure 27 shows that total primary energy demand is projected to increase from 4,910 Mtoe in 2011 to 8,912 Mtoe in 2035 in the BAU case, an increase on average of 2.5 percent per year. In the APS case, demand is projected to grow to 7,654 Mtoe by 2035, 14.1 percent lower than in the BAU case. The reduction in 2035 primary energy demand in the APS case, compared with the BAU case of 1,258 Mtoe, is roughly equivalent to 46 percent of China's demand in 2011.

Figure 27: Total Primary Energy Demand, BAU and APS

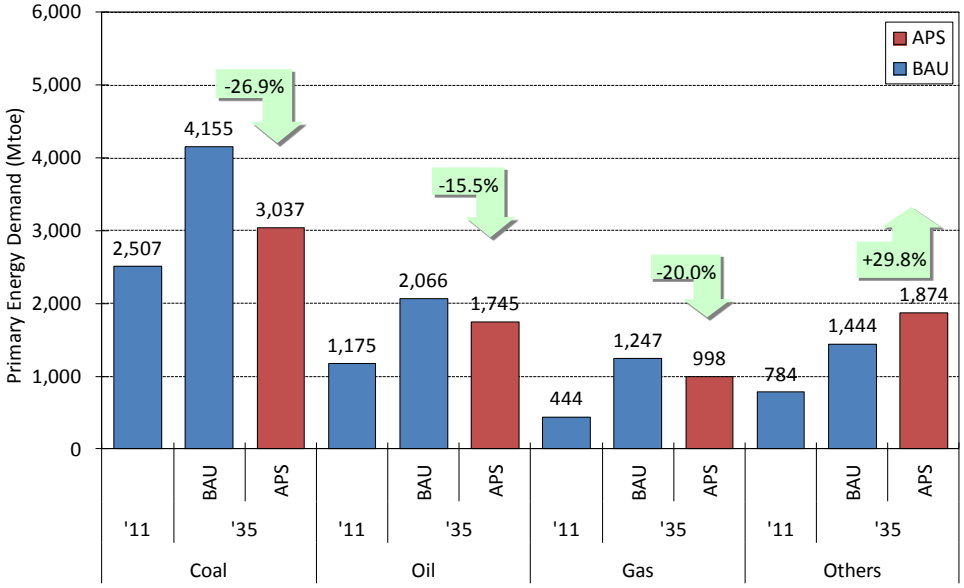


4.2.6. Primary Energy Demand by Source

In the APS scenario, growth in coal, oil and natural gas primary demand is projected to be considerably lower than the BAU. Coal demand for example, will be 26.9 percent lower in the APS or equivalent to 1,118 Mtoe, 44.6 percent of EAS coal demand of 2,507 Mtoe in 2011. This reflects a shift from coal-fired electricity generation to nuclear and renewable energy in the APS case. Demand for oil will also be lower in the APS, by 321 Mtoe or 15.5 percent. This is due to the combined effect or more efficient vehicles and the utilisation of alternative fuels in the transport sector such as natural gas, electricity and biofuels. The demand of natural gas will also be lower in the APS at 20.0 percent of the BAU, equivalent to 249 Mtoe. This is mainly due to reduced electricity demand in the APS and the introduction of more efficient power generation technologies and alternative fuels such as nuclear, solar and wind energy. Other fuels, which include these alternative energy sources, on the other hand, will be higher by 29.8 percent in the APS as compared to BAU.

Figure 28 shows primary energy demand by energy source in both scenarios.

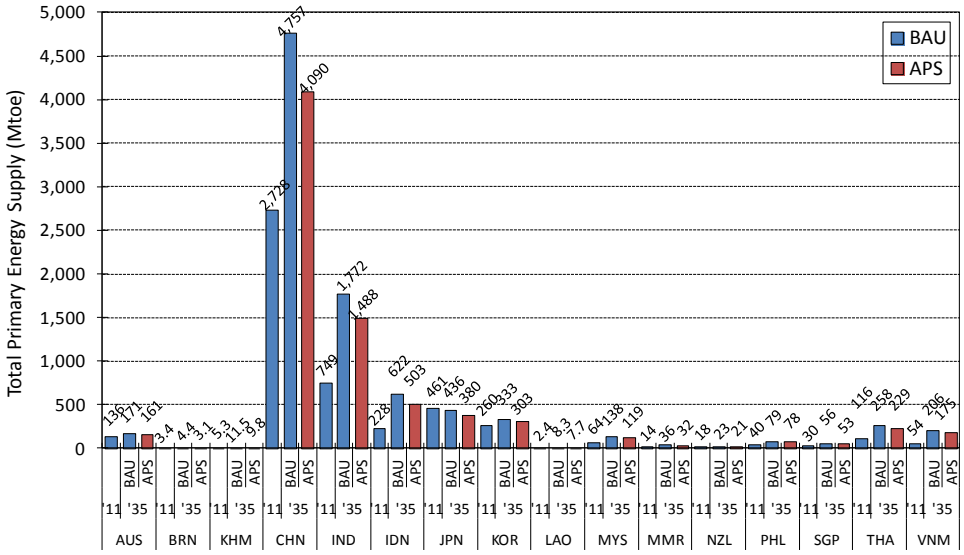
Figure 28: Primary Energy Demand by Source, BAU and APS



4.2.7. Primary Energy Demand by Country

Figure 29 shows primary energy demand by country, which is similar to the pattern for final energy demand by country shown in Figure 26. Five countries - China, India, Indonesia, Japan, and Republic of Korea - are projected to account for 88.8 percent of EAS region's primary energy in 2035. The 'big three' - China, India, and Indonesia - will dominate the growth in EAS region's primary energy, accounting for 86.1 percent of the growth between 2011 and 2035. In the APS case, growth in primary energy demand in most countries is significantly lower, but the dominance of demand by five countries and the relative importance of the growth in three countries remain unchanged.

Figure 29: Primary Energy Demand by Country, BAU and APS



4.2.8. Primary Energy Intensity by Country

In Table 5, the impacts of the energy saving goals and policies submitted by each WG member on energy intensities are summarized. It should be noted that these results are illustrative of the potential energy savings that can be achieved and should not be interpreted as official country projections.

Table 5: Quantitative Impact of Energy Saving Goals and Policies: Illustrative Impacts

	2011	2035		Variance		
		BAU	APS	APS/BAU	2011/2035 BAU	2011/2035 APS
	(toe/million 2005 US$)	(toe/million 2005 US$)	(toe/million 2005 US$)	%	%	%
Australia	166	107	100	-6.1	-35.6	-39.5
Brunei Darussalam	336	228	161	-29.3	-32.1	-52.0
Cambodia	573	373	318	-14.6	-34.9	-44.4
China	650	312	268	-14.0	-52.1	-58.8
India	563	288	241	-16.0	-48.9	-57.1
Indonesia	565	439	355	-19.1	-22.3	-37.2
Japan	100	68	59	-12.8	-32.5	-41.1
Korea	246	161	146	-8.9	-34.8	-40.6
Lao PDR	553	373	346	-7.3	-32.5	-37.4
Malaysia	343	334	288	-13.6	-2.8	-16.0
Myanmar	655	311	282	-9.5	-52.5	-57.0
New Zealand	153	117	105	-10.1	-23.9	-31.6
Philippines	298	136	135	-1.0	-54.3	-54.8
Singapore	171	135	129	-4.7	-21.3	-24.9
Thailand	551	483	429	-11.3	-12.3	-22.3
Viet Nam	680	540	458	-15.1	-20.6	-32.6
Total	368	250	215	-14.1	-32.0	-41.6

4.3. Carbon Dioxide (CO_2) Emissions from Energy Consumption

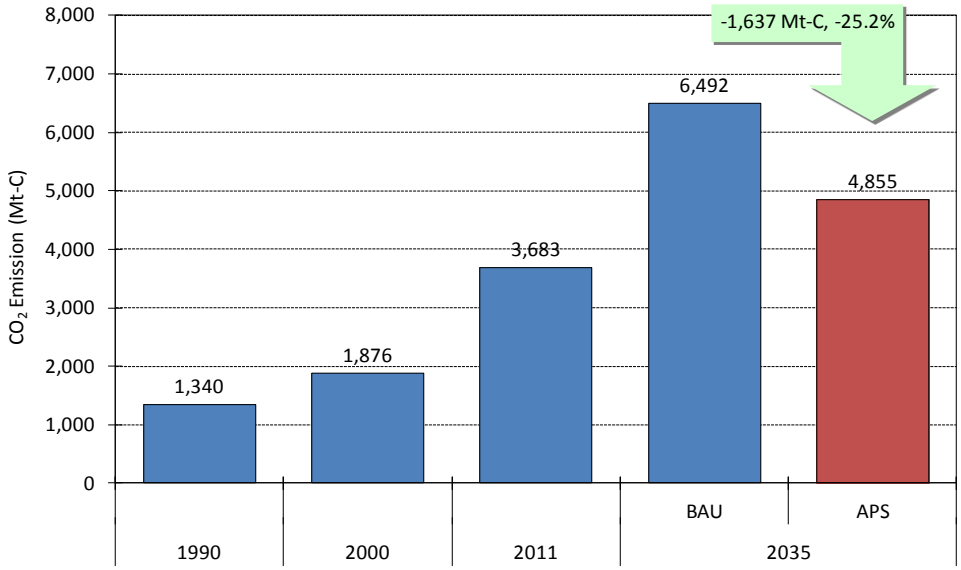
4.3.1. CO_2 Emissions

As shown in Figure 30, CO_2 emissions from energy consumption in the BAU case are projected to increase from 3,683 million tonnes of Carbon (Mt-C) in 2011 to 6,492 Mt-C in 2035, implying an average annual growth rate of 2.4 percent. This is slightly lower than the growth in total primary energy demand of 2.5 percent per year. In the APS case, CO_2 emissions are projected to be 4,855 Mt-C in 2035, 25.2 percent lower than under the BAU case.

While the emission reductions under the APS are significant, CO_2 emissions from energy demand under the APS case in 2035 will still be above 2011 levels and more than 3 times above 1990 levels. Scientific evidence suggests that these reductions will not be adequate to prevent severe climate change impacts. Analysis by the Intergovernmental Panel on Climate Change (IPCC) (reference) suggests that to keep the increase in global mean temperature to not more than 2°C compared with pre-industrial levels, global CO_2 emissions would need to peak between 2000 and 2015 and be reduced to between 15 and 50 percent of year 2000 levels (that is, a reduction of between 85 and 50 percent) by 2050. To keep temperature rises in the 3°C range, CO_2 emissions would need to peak between 2010 and 2030 and be 70 to 105 percent of year 2000 levels by 2050.[14]

[14] See "Summary for Policymakers" in *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Table SPM.5.

Figure 30: Total CO_2 Emissions, BAU and APS

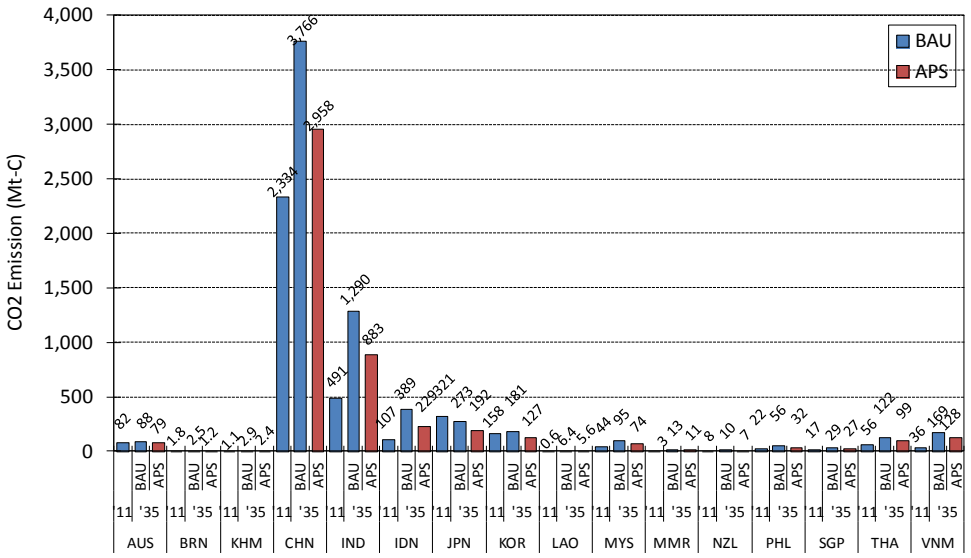


Although much depends on the mitigation achieved in other regions, it would appear unlikely that global emissions could meet either of these profiles given the contribution of the EAS region to global total emissions under the APS results. Yet, the consequences of insufficient reductions in emissions could be severe. For example, at 2°C above pre-industrial levels, up to 30 percent of species become at increasing risk of extinction, most corals become bleached, and droughts and water availability become an increasing problem worldwide. At 3°C, millions of people could experience coastal flooding each year.[15]

As shown in Figure 31, emissions and emission growth in the EAS region is projected to be dominated by China and India. In fact, China and India will account for 1,432 Mt-C and 799 Mt-C, respectively, of the projected 2,809 Mt-C increase in EAS region emissions from 2011 to 2035 under the BAU case, or 79.4 percent of the total growth in the EAS region. Adding Indonesia's growth of 281 Mt-C, these three countries account for 2,469 Mt-C or 89.4 percent of the total growth in EAS region. No other country will account for growth of more than 133 Mt-C. Japan is the only country in the EAS region whose emissions are projected to decline under the BAU case as a result of improved energy efficiency and increased utilisation of renewable energy.

[15] These examples are taken from "Summary for Policymakers" in *Climate Change 2007: Synthesis Report. Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Figure SPM.7. The examples assume that 1° C of temperature increase has already occurred, as per this same report, Figure SPM.1.

Figure 31: CO_2 Emissions by Country, BAU and APS



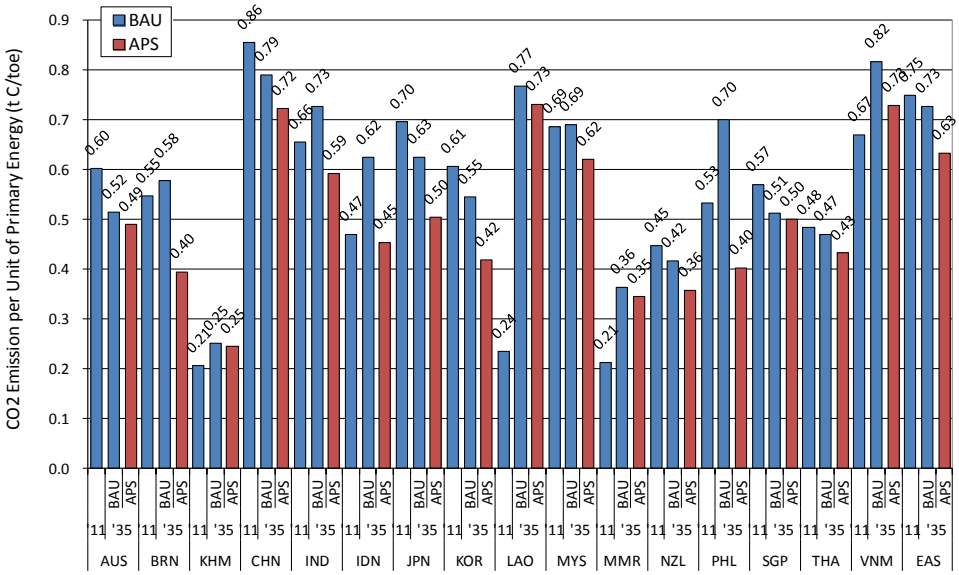
Under the APS case, China and India are still dominant, accounting for 624 and 392 Mt-C, respectively, of the projected 1,172 Mt-C growth in emissions in the EAS region between 2011 and 2035, or 86.7 percent. Adding 122 Mt-C from Indonesia, these three countries account for 1,138 Mt-C or 97.1 percent of the EAS region total. No other country will account for a growth of more than 92 Mt-C. Emissions from Australia, Brunei Darussalam, Japan, the Republic of Korea and New Zealand are expected to decline under the APS case relative to 2011 levels due to effective mitigation policies.

4.3.2. Fundamental Drivers of CO_2 Emissions from Energy Demand

The CO_2 emissions discussed above may be viewed as the net result of four drivers, two of which are moving in a direction favourable to CO_2 emission reductions, and two of which are moving in an unfavourable direction.

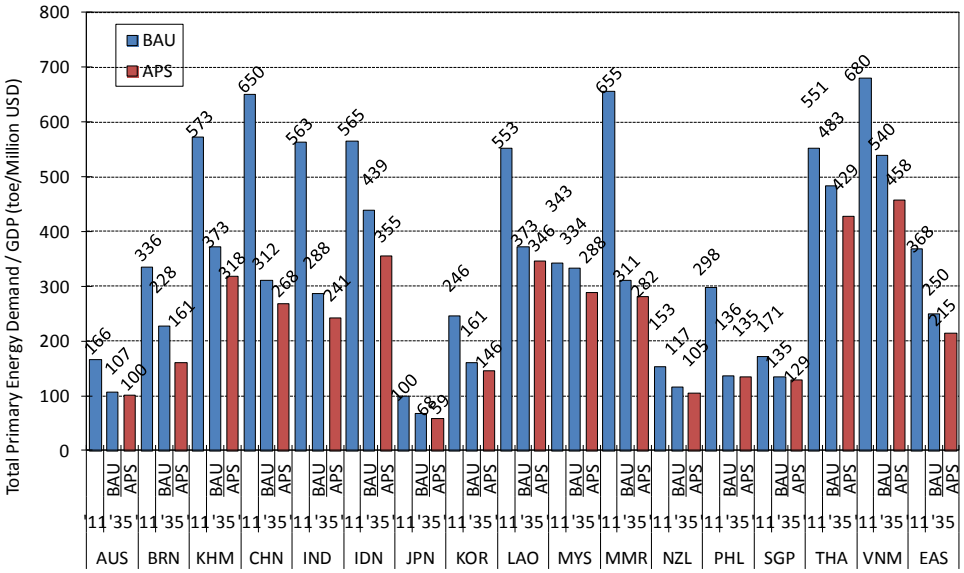
i) Emissions per unit of primary energy are projected to decline to 0.73 t-C/toe in 2035 from 0.75 t-C/toe in 2011 under the BAU case. Under the APS case, this will decline to 0.63 t-C/toe in 2035, equivalent to a decline of 15.4 percent from 2011 (Figure 32). The reduction under the APS case reflects a shift away from coal and oil, the two most emission-intensive fuels.

Figure 32: Emissions per Unit of Primary Energy, BAU and APS



ii) Primary energy per unit of GDP is projected to decline from 368 toe/million US$ in 2011 to 250 toe/million US$ in 2035 under the BAU case, or by 32.0 percent (Figure 33). Under the APS case, this will decline to 215 toe/million US$ in 2035, or by 41.6 percent. The lower emissions under the APS case reflect projected improvements in energy intensity. Looking at (i) and (ii) in combination, emissions per unit of GDP will decrease from 276 t-C/million US$ in 2011 to 182 t-C/million US$ in 2035 under the BAU case, or by 34.0 percent. Under the APS, this will decline to 136 t-C/million US$ in 2035, 50.6 percent lower than 2011.

Figure 33: Primary Energy Demand per Unit of GDP, BAU and APS



iii) Working against these declines in emissions per unit of primary energy and primary energy per unit of GDP is the projected significant increase in GDP per person in the EAS region, from around US$3,900/person in 2011 to US$9,000/person in 2035, an increase of 129.7 percent. Looking at (i), (ii), and (iii) in combination, emissions per person are projected to increase from 1.09 t-C/person in 2011 to 1.65 t-C/person in 2035 under the BAU case, or by 51.6 percent. Under the APS, emissions rise to only 1.23 t-C/person in 2035, or 13.4 percent higher than 2011. However, the rising emissions per capita are associated with increase in GDP/person and improvement in living standards.

iv) Finally, population in the EAS Region is expected to grow from 3,391 million in 2011 to 3,943 million in 2035, or by 16.3 percent. Combined, all these drivers lead to growth in emissions from 3,683 Mt-C in 2011 to 6,449 Mt C in 2035 under the BAU case, or 76.3 percent. Under the APS, emissions grow to 4,845 Mt-C in 2035, or 31.8 percent.

5. Conclusions and Recommendations

The working group members discussed the key findings and implications of the analysis based on the two energy outlook scenarios, BAU and APS.