Chapter 9

Republic of Korea Country Report

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CHAPTER 9

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1. Background

The Republic of South Korea (henceforth, South Korea) is located in the southern half of the South Korean Peninsula and shares a 238 km border with North Korea. It occupies just over 100,000 square kilometres and includes about 3,000, mostly small, uninhabited islands. South Korea is a mountainous country with lowlands accounting for only 30 percent of the total land area. The climate is temperate, with heavy rainfall in summer. As of 2014, South Korea had a population of 50,424, over 90 percent of which lives in urban areas. South Korea has recorded tremendous economic growth over the past half century. Gross domestic product (GDP) plunged by 7 percent in 1998 due to the financial crisis, but has since rebounded. Another recent global economic crisis in 2008 could not keep South Korea from continuing economic growth. Due to the recent deterioration in the global economy, growth has slowed down, recording 2.0 percent in 2012, but is projected to reach around 2.6 percent in 2013 and 3.8 percent in 2014.[1] The South Korean economy is dominated by manufacturing, particularly electronic products, passenger vehicles, and petrochemicals. Agriculture, forestry, and fishing made up only 2.5 percent of total GDP in 2012.

South Korea has no domestic oil resources and has produced only a small amount of anthracite coal. The country imports most of its coal supply, which is bituminous coal. Consequently, South Korea has to import 96 percent of its energy needs and is the fifth largest oil importer and the second largest importer of liquefied natural gas (LNG) in the world.

Although total primary energy consumption is dominated by oil and coal, nuclear power and LNG also supply a significant share of the country's primary energy. Total primary energy consumption increased by 4.9 percent per year on average between 1990 and 2012. The strongest growth occurred in natural gas (13.6 percent), coal (5.2 percent), and nuclear (4.9 percent). Oil use increased at a slower rate of 3.1 percent a year.

Total final energy consumption (TFEC) in 2012 was 166.4 Mtoe, increasing at an average annual rate of 4.4 percent from 1990. The industry sector accounted for 28.4 percent of final energy consumption in 2012, followed by 'Others' (27.3 percent), and transportation (18.2 percent). Consumption of natural gas in the industry sector increased eightfold in the last decade and oil accounts for a relatively large share of industry consumption.

[1] Bank of Korea (2013).

In 2012, electric power generators in South Korea produced 531.0 TWh of electricity, with coal and nuclear combined providing almost three-quarters of South Korea's electricity. Natural gas accounted for 21.1 percent of generation in 2012. Total electricity consumption grew at an average annual rate of 7.7 percent from 1990 to 2012. When broken down by fuel, coal, natural gas, and nuclear increased at an average annual rate of 12.6 percent, 11.8 percent, and 4.9 percent, respectively, over this period.

Since the 1990s, the South Korean government established three Basic Plans for Rational Energy Utilization in a row, which were revised at the end of each five-year period and contain a variety of policy tools and programmes developed and implemented under the auspice of the Ministry of Trade, Industry, and Energy (MOTIE). Several energy savings measures were announced to encourage the general public to voluntarily conserve energy. As part of the measures, 'Voluntary Energy Conservation Campaigns,' were launched to reduce heating fuel consumption. Furthermore, the government urged energy-intensive industries to enhance energy efficiency of their products. In addition, MOTIE and the Board of Audit and Inspection of South Korea formed a task force to examine 660 public and private organisations to measure their progress in implementing voluntary energy saving plans

The current Basic Plan for Rational Energy Utilization has a variety of key policy tools and programmes to attain the energy savings target. Amongst them are Voluntary Agreements (VAs), Energy Audits, Energy Service Companies (ESCOs), Appliance Labelling and Standards, Fuel Economy, and Public Transit and Mode Shifting. These policy tools have been and will continue to play important roles in energy savings.

2. Modelling Assumptions

South Korea's GDP had grown at an average annual rate of 4.9 percent between 1990 and 2012. In this report, South Korea's GDP is assumed to grow at an average annual growth rate of 2.8 percent from 2012 to 2035. Following the global recession in 2009, the South Korean economy has been a little bit shaken. However, the South Korean economy is still in a good shape and its economic growth is expected to recover to 3.5 percent per year from 2012 to 2020, slowing down to 2.5 percent per year from 2020 to 2035.

South Korea is expected to continue to rely heavily on coal and nuclear energy for power generation to meet the base load electricity demand. Gas-fired power generation is projected to increase between 2012 and 2035, whereas oil-fired generation is projected to decline. Generation from hydro sources is projected to remain relatively stable. There is projected to be a strong growth in electricity generation from wind power and solar PVs driven by the renewable portfolio standards (RPS), which was launched in January 2012.

South Korea's energy saving goal can be attained through implementing energy efficiency improvement programmes in all energy sectors. In the industrial sector, energy saving is expected from the expansion of Voluntary Agreement (VA), the highly efficient equipment programme, the development of alternative energy, and improvements in efficient technologies. The transport sector aims to save energy by enhancing the efficiency of the logistics system, expanding public transportation, and improving the fuel economy of vehicles. In the residential and commercial (Other) sector, a minimum efficiency standards programme is projected to induce huge savings in addition to 'e-Standby Korea 2010'.

3. Outlook Results

3.1. Total Final Energy Consumption

South Korea's final energy consumption registered growth of 4.4 percent per year from 64.9 Mtoe in 1990 to 166.4 Mtoe in 2012.[2] The non-energy sector had the highest growth rate during this period, at 8.8 percent per year, followed by the industry sector with 4.2 percent. Energy consumption in the residential/commercial/public (Other) sector grew at a relatively slow pace of 2.9 percent per year. Oil was the most consumed product with a share of 67.3 percent in 1990, declining to 50.7 percent in 2012. The share of coal in final energy consumption declined by 12 percent a year between 1990 and 2012, whereas the share of electricity doubled to become the second most consumed product.

3.2. Business-as-Usual (BAU) Scenario

With an assumption of low economic and population growth, final energy consumption in South Korea is projected to increase at a low average rate of 0.9 percent a year between 2012 and 2035 under the Business-as-Usual (BAU) scenario. This is due largely to negative growth in energy consumption in the transportation sector, which is projected to decrease at an annual average rate of 0.3 percent between 2012 and 2035. Growth in final energy consumption is expected to be led by industrial and non-energy, with an identical increase at an average annual rate of 1.2 percent during the same period. Other sectors, such as the residential, commercial, and public sectors, are projected to increase at a rate of 1.0 percent per annum.

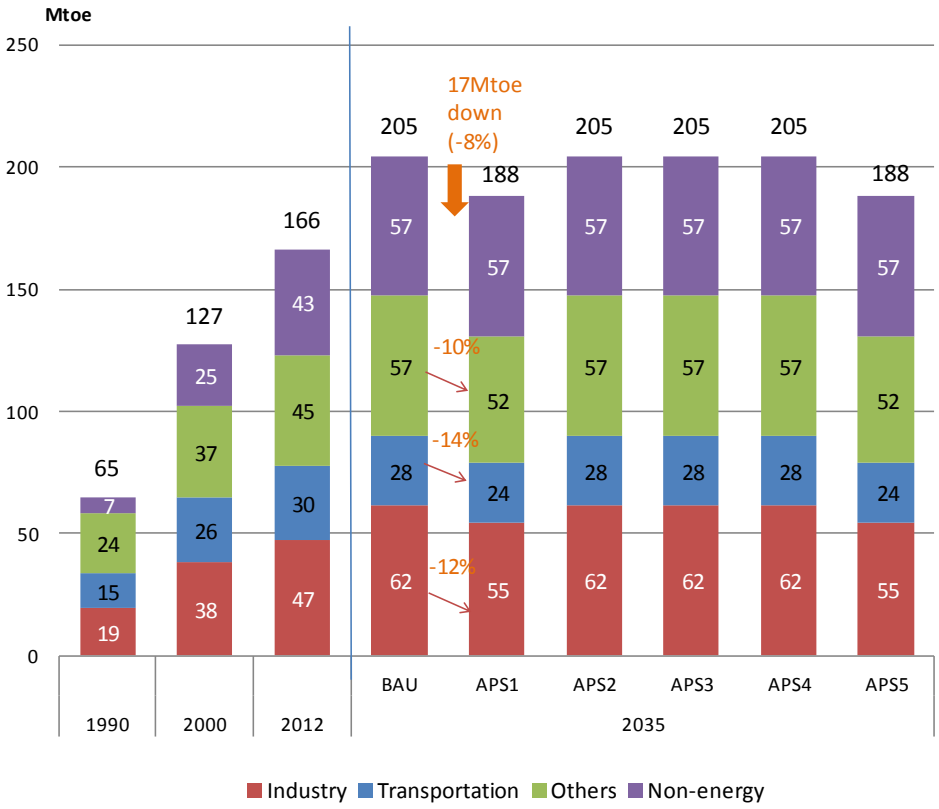
For each type of energy, the projected increases at average annual growth rates are 0.5 percent for coal, 0.2 percent for oil, 1.2 percent for natural gas, 2.1 percent for electricity, and 0.2 percent for heat from 2010 to 2035. Other energy types, including renewable energies, are estimated to grow at a rate of 1.8 percent per annum, which is faster than any other type of energy. Increasing use of renewable energy in addition to natural gas as clean and green energy will contribute to a considerable reduction in CO_2 emissions.

3.3. Alternative Policy Scenario (APS)

In this section, five alternative scenarios (APS) are developed based on varying focuses of policy options: improved efficiency of final energy demand (APS1); more efficient thermal power generation (APS2); higher contribution of renewable energy to total supply (APS3); contribution of nuclear energy to total supply (APS4); combined effects of APS 1–4 (APS5). Final energy demand by sector in each APS is shown in Figure 9-1. Total final energy demand is to be reduced only in the case of APS1 (improved efficiency), showing 187.9 Mtoe. Other alternative policy scenarios are the same with 204.6 Mtoe for APS2–4. Total and share of final energy demand by sector is the same as in the case of BAU. Accordingly, APS5, which combines all APS, shows 187.9 Mtoe, 16.7 Mtoe (8.2 percent) lower than in the BAU scenario, the same as in APS1.

[2] Energy consumption is calculated based on the net calorific values as converted by IEEJ from original data submitted by the Republic of Korea.

Figure 9-1. Final Energy Demand by Sector

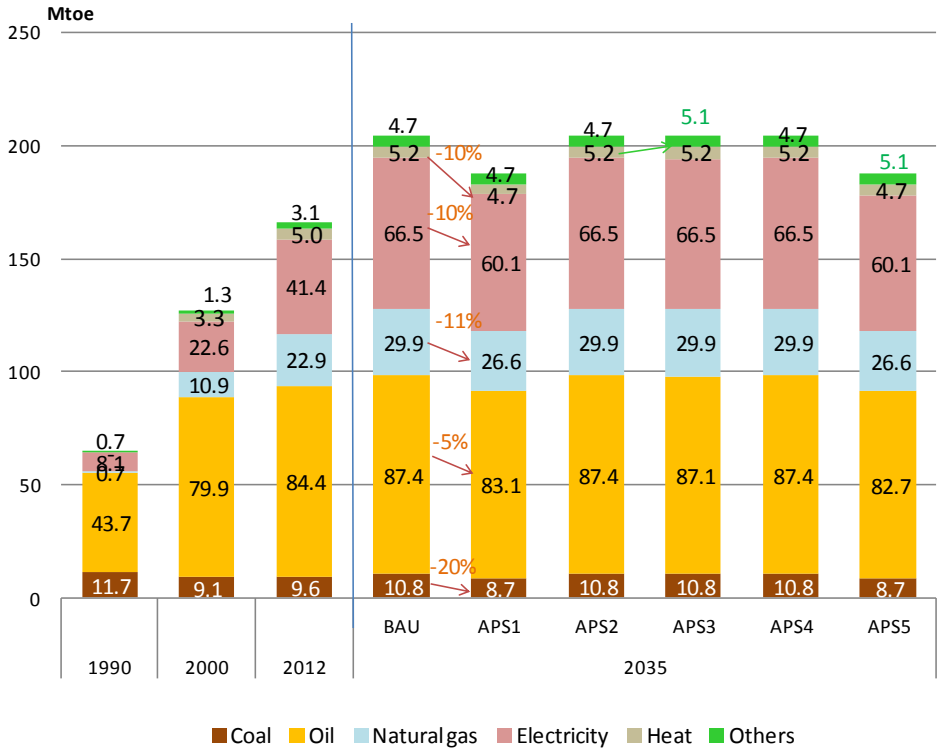


Source: Author's calculation.

Final energy demand by energy source is shown in Figure 9-2. In APS1 (improved efficiency) electricity accounts for the largest portion of energy saving, followed by oil and natural gas. Unlike in the case of final energy demand by sector, energy demand by energy source shows some change depending on the specific policy approach of each scenario. In APS3 (higher contribution of renewable energy to total supply), 'other' energy sources, including renewable energy, are to be increased by 0.4 Mtoe compared with all other APS. Other than that, APS1 and APS5 are identical in terms of total energy demand, share of energy demand by sector, and energy source.

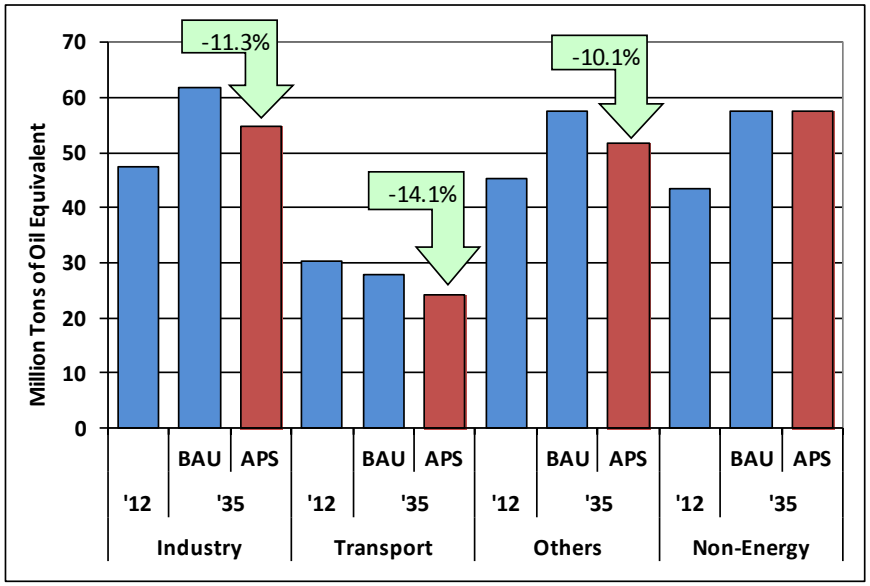
In APS5, which combines APS1, APS2, APS3, and APS4, final energy consumption is projected to increase at an average annual growth rate of 0.5 percent, from 166.4 Mtoe in 2012 to 187.9 Mtoe in 2035. Energy demand in the transport sector is projected to decrease at an annual average growth rate of 1.0 percent over the same period. The rate of growth is much slower across all sectors compared with the BAU scenario (Figure 9-3).

Figure 9-2. Final Energy Demand by Energy Source



Source: Author's calculation.

Figure 9-3. Final Energy Consumption by Sector, BAU and APS



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

3.4. Primary Energy Demand

Primary energy demand in South Korea grew at an average annual rate of 4.9 percent from 92.9 Mtoe in 1990 to 263.4 Mtoe in 2012. Amongst the major energy sources, natural gas was the fastest growing at an average annual rate of 13.6 percent. Coal increased at a rate of 5.2 percent a year, followed by nuclear and oil at 4.9 percent and 3.1 percent, respectively, over the same period. Other energy sources, mainly renewable energies such as solar and wind showed rapid growth, at a rate of 8.6 percent, during the same period, which indicates that the South Korean government has been successfully implementing its 'Low Carbon Green Growth' policy.

Business-as-Usual Scenario

In the BAU scenario, primary energy demand in South Korea is projected to increase at an annual average rate of 1.1 percent, from 263.4 Mtoe in 2012 to 338.2 Mtoe in 2035. Growth in all the energy sources is projected to slow. Consumption of nuclear shows the fastest growth, increasing at a rate of 2.7 percent per year. Natural gas and coal are projected to grow at much slower average annual rates, of 1.0 percent and 1.3 percent, respectively, from 2010 to 2035. Growth of nuclear will largely be at the expense of oil, with the share of oil projected to decline from 36.9 percent in 2012 to 28.7 percent in 2035.

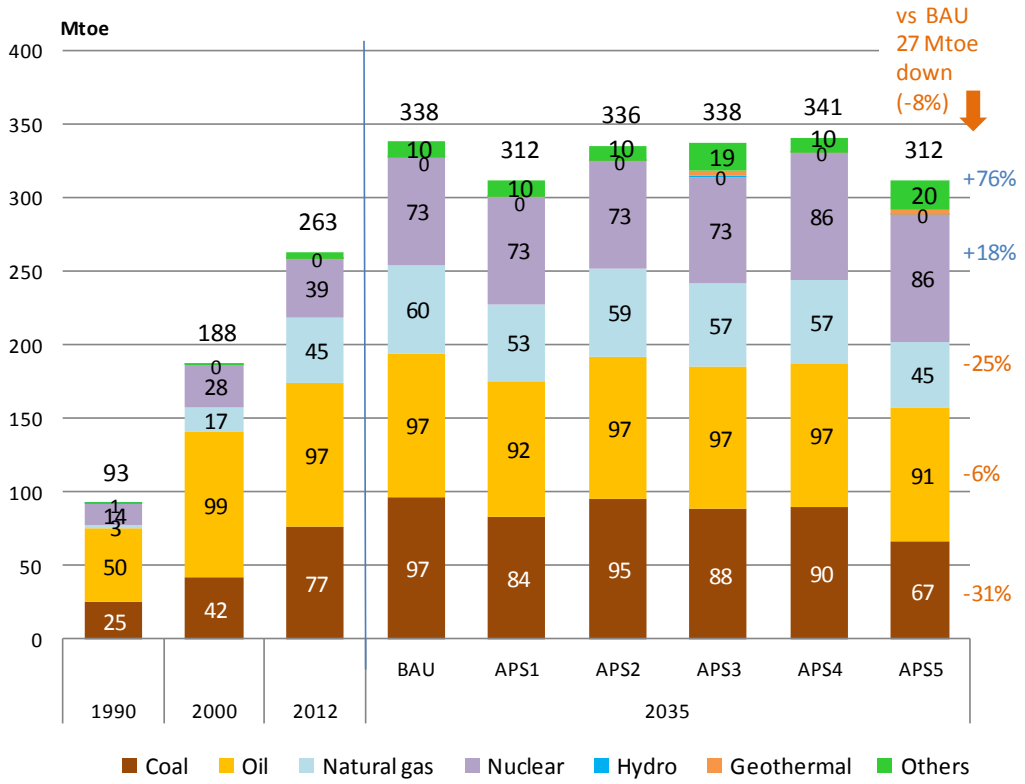
Alternative Policy Scenario

Based on the projections and analysis of final energy demand by sector and energy source, primary energy demand is projected for each of the five alternative scenarios. Unlike in the case of final energy demand, each APS has a different amount and share by energy source, depending on the specific policy focus of each APS. Except for APS3, APS5 has more demand for renewable energy – 19.8 Mtoe, which is 9.4 Mtoe more than in the other APS. The largest reduction is in the demand for coal (31.3 percent), followed by natural gas, and oil. Nuclear and 'others' (renewable energies) are projected to increase by 17.6 percent and 90.8 percent, respectively.

In APS5, which combines all other APS, primary energy demand is projected to increase at a lower annual average rate of 0.7 percent, from 263.4 Mtoe in 2012 to 312.0 Mtoe in 2035. Consumption of fossil fuels such as coal, oil, and natural gas will gradually decrease from 2012 to 2035, whereas nuclear and renewable energies will increase by 3.5 percent and 6.6 percent per year, respectively, over the same period (Figure 9-4). Energy efficiency and conservation measures on the demand side will be the main contributors to the reduction in consumption growth.

Major energy policy approaches to reduce energy demand in South Korea are as follows:

Figure 9-4. Primary Energy Demand in South Korea



Source: Author's calculation.

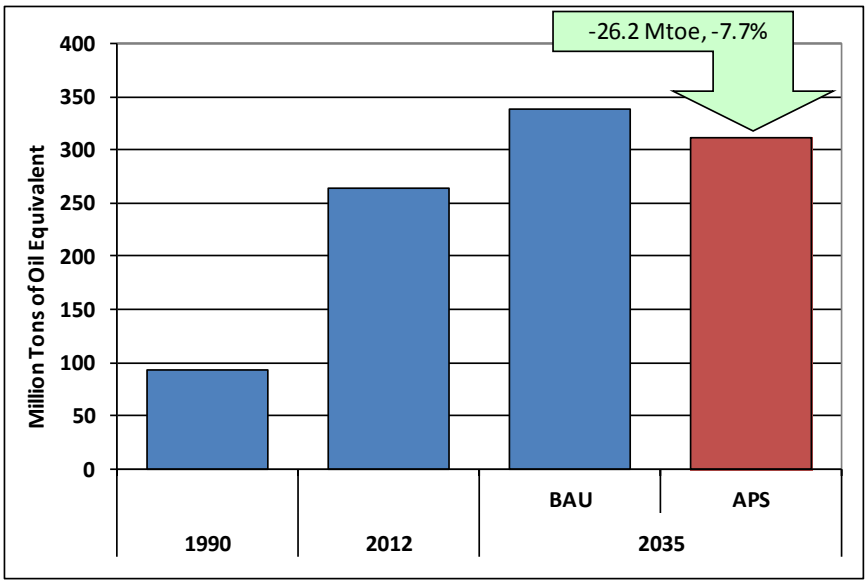
First, energy policy should be shifted from a supply-oriented approach to a demand-oriented one. Reform of energy pricing and energy taxation are the most pressing issues. In this context, market mechanism should be introduced in energy pricing, by which rational energy use is induced through sharing information on the full cost of energy production and consumption. Second, transformation of the industrial structure into a less energy-intensive one, which is currently underway, should be accelerated towards knowledge-based, service, and green industries (which consume less), and clean energies. Third, energy efficiency standards and codes should be applied in product designing and production processes, as well as in designing and constructing a system such as factory, building and plant. Based on these policy directions, the South Korean government should develop and implement an action plan containing milestones and strategies with specific and cost-effective policy tools.

Projected Energy Saving

The energy savings that could be derived from the energy saving targets, action plans, and policy tools in South Korea is 26.2 Mtoe, i.e. the difference between primary energy demand in the BAU scenario and the APS in 2035 (Figure 9-5). This is equivalent to 9.9 percent of South Korea's consumption in 2012.

In terms of final energy consumption savings in 2035, savings are estimated at 7.0 Mtoe in the industry sector, 5.8 Mtoe in the residential/commercial (other) sector, and 4.0 Mtoe in the transportation sector

Figure 9-5. Total Primary Energy Demand to 2030, BAU and APS



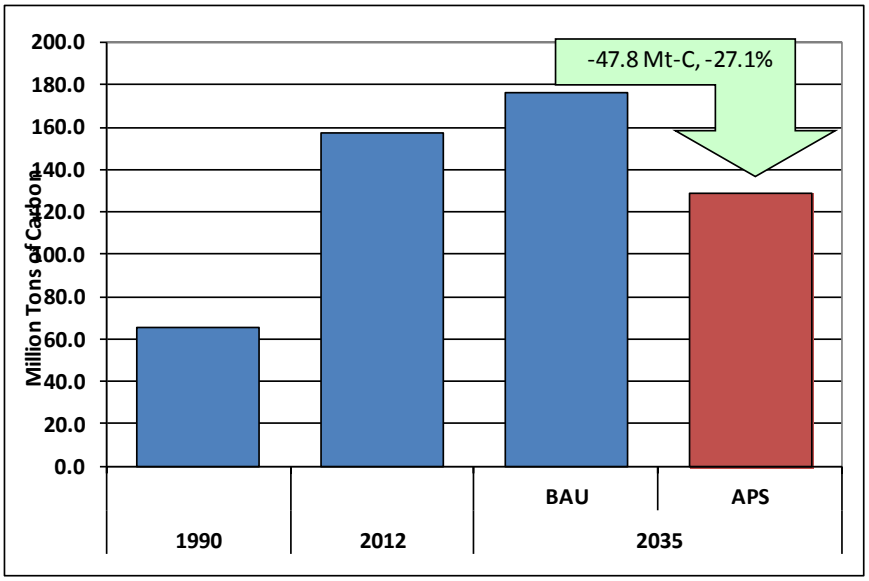
BAU = Business-as-Usual; APS = Alternative Policy Scenario.
Source: Author's calculation.

3.5. CO_2 Emissions from Energy Consumption

Carbon dioxide (CO_2) emissions from energy consumption are projected to increase at an annual average rate of 0.5 percent, from 157.0 Mt C in 2012 to 176.5 Mt C in 2035, based on the BAU scenario. This growth rate is slower than that of primary energy consumption, indicating that South Korea will be using less-carbon intensive fuels such as nuclear, natural gas, and renewable energies and employing more energy efficient, green technologies.

In the APS, CO_2 emissions are projected to decline at an annual average rate of 0.9 percent between 2012 and 2035. The difference in CO_2 emissions between BAU and APS is 47.8 Mt C or 27.1 percent (Figure 9-5). To attain such an ambitious target, the South Korean government has to develop and implement cost-effective and consensus-based action plans for energy saving and CO_2 emissions reduction.

Figure 9-6. CO_2 Emission from Energy Consumption, BAU and APS



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

4. Implications and Policy Recommendations

South Korea, even without any economically available domestic energy resources, has been making great strides in economic growth. Such very high economic growth would not have been possible without a stable and continuous supply of energy, which is a basic element in modern economic activities. This nexus between economic development and energy consumption had been accepted as inseparable until the end of the 20th century. But at the beginning of the 21st century, the South Korean government shifted its energy policy to a sustainable, efficient, and energy saving approach, which was to some extent reflected in the first (2008) and second (2013) National Energy Basic Plan.

South Korea's total primary and final energy consumption in the 1990s rapidly increased at a rate faster than that of GDP, growth of which had been driven by energy-intensive industries such as the petrochemical, steel, and cement industries. Since 1997, the contribution of these industries to South Korea's GDP has gradually declined, resulting in reduced energy intensity. But the shift to a less energy–intensive industrial structure takes time, so energy-intensive industry will prevail in the short term and medium term. In the longer term, however, South Korea has to and will transform its industrial structure into a less energy-intensive one.

As mentioned above, the South Korean government has recently released the second National Energy Basic Plan.[3] Its approach shifted from a supply-oriented one to a demand-oriented one. Its basic policy direction consists of six major agendas, with demand-oriented energy policy as the first priority. The other five key agendas are: building a distributed generation, harmonisation of the environment and safety, strengthened energy security and more stable energy supply, implementation of energy policy with people's support.

[3] The Government of the Republic of Korean worked on the Second National Energy Basic Plan in 2013, releasing its report in early 2014.

As regards the first priority, a shift in energy policy to a demand-oriented approach, the target is to save 13 percent of total primary energy consumption along with 15 percent of electric power consumption. Under this agenda, four policy tasks are proposed: 1) reform of energy-related taxation; 2) reform of energy pricing; 3) ICT-based demand management; and 4) strengthening programmes by sector. Reform of energy-related taxation as well as energy pricing are intended to induce rational use of electricity by coordinating relative prices between electricity and non-electricity energy. Additionally, it was proposed that social costs such as nuclear safety, reinforcement of transmission line, reduction in GHG emissions. Concerning the ICT-based demand management,

Throughout the past three decades, some major concerns of the South Korean government have been energy security, energy efficiency, and environmental preservation. The energy security issue has been dealt with by promoting foreign resource development importation and renewable energy development. The issue of energy efficiency improvement has been addressed through programmes supported by consecutive editions of the Five Year Basic Plan of Rational Energy Use. The environmental issue caused by consumption of fossil and nuclear energy has been approached in the relevant offices of Ministry of Environment. Now is the time for South Korea to synergise those efforts exerted so far, by selection and concentration of policy tools and programmes through better coordination between relevant ministries, as clearly specified in the Second National Energy Basic Plan.

We recommend that South Korea sticks to its current policy goals of transforming the economy into one with a less energy-intensive, greener economic structure and implementing policies to decouple the long-cherished nexus of economic growth and energy consumption by implementing its current policy agenda and its policy tools and programmes. Such nation-wide efforts and campaigns should eventually transform the South Korean economy into a less energy-intensive and greener one in terms of energy savings as well as reduced CO_2 emissions. This would make South Korea one of the leading nations globally in terms of low-carbon green growth.