CHAPTER 9

REPUBLIC OF KOREA COUNTRY REPORT

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1. Background

The Republic of Korea (henceforth, Korea) is in the southern half of the Korean Peninsula and shares a 238-kilometre border with the Democratic People's Republic of Korea (North Korea). It occupies 100,188 square kilometres and includes about 3,000 mostly small, uninhabited islands. Korea is a mountainous country with lowlands accounting for only 30% of the total land area. The climate is temperate, with heavy rainfall in summer. As of 2015, Korea had a population of 51.069 million, over 90% of whom live in urban areas. Korea has recorded tremendous economic growth over the past half century, overcoming the Asian financial crisis in 1998 and the global economic crisis in 2008. However, due to the global financial crisis of 2007–2008, growth has slowed down. The Korean economy is dominated by manufacturing, particularly electronic products, passenger vehicles, and petrochemicals.

Korea has no domestic oil resources and has produced only a small amount of anthracite coal, but imports most of its coal, which is bituminous coal. Consequently, Korea must import nearly all of its needed energy and is the fifth-largest oil importer and the second-largest importer of liquefied natural gas (LNG) in the world. The total primary consumption in 2015 was 272.7 million tons of oil equivalent (Mtoe), increasing by 4.4% a year since 1990. Although primary energy consumption is dominated by oil and coal, nuclear power and LNG also supply a significant share of the country's primary energy. The strongest growth occurred in natural gas (11.3% per year), followed by renewable energy (9.1% per year), coal (4.7% per year), and nuclear (4.7% per year). Oil has increased at a relatively slower 2.9% per year.

The total final energy consumption in 2015 was 174.2 Mtoe, increasing at an average annual rate of 4% from that in 1990. The industry sector accounted for 28.2% of final energy consumption in 2015, followed by non-energy (27.2%) and transport (19.2%).

While consumption of coal and oil has gradually decreased, natural gas in the final energy consumption rapidly grew at a rate of 14.9% per year between 1990 and 2015.

In 2015, electric power generation in Korea amounted to 549.2 terawatt-hours (TWh), with coal and nuclear combined providing nearly three-fourths of the country's electricity, followed by natural gas, sharing 22.4% of generation. Total electricity consumption has grown at an average annual growth rate (AAGR) of 6.8% between 1990 and 2015. When broken down by fuel, coal, natural gas, and nuclear grew by an average annual rate of 10.9%, 10.7%, and 4.7%, respectively, between 1990 and 2015. Over the same period, oil and hydro, however, recorded negative annual growth rates of -1.6% and -4.3%, respectively. Meanwhile, other energy sources such as new and renewable energy (NRE) rapidly grew at an annual rate of 44.7%.

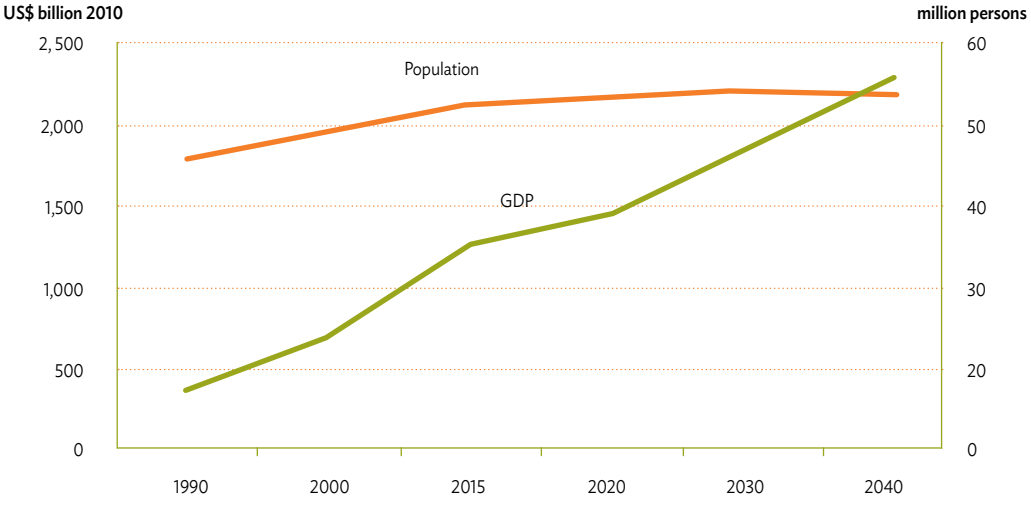
Since the 1990s, the Korean government has established five, Basic Plans for Rational Energy Use, which are being revised every 5 years and contain various policy tools and programmes developed and implemented under the auspices of the Ministry of Trade, Industry, and Energy. Several energy savings measures were announced to encourage the public to voluntarily conserve energy. As part of the measures, voluntary energy conservation campaigns were launched to reduce heating and fuel consumption. Furthermore, the government urged energy-intensive industries to enhance the energy efficiency of their products. In addition, the Ministry of Trade, Industry, and Energy and the Board of Audit and Inspection of Korea formed a task force to examine 660 public and private organisations to measure their progress in implementing voluntary energy saving plans.

The current 'Fifth Basic Plan for Rational Energy Use (2013–2017)' encompasses various key policy tools and programmes to attain the country's energy savings target. Amongst them are voluntary agreements, energy audits, energy service companies, appliance labelling and standards, fuel economy, and public transit and mode shifting. These policy tools have played and will continue to play important roles in energy savings.

2. Modelling Assumptions

Korea's GDP grew at an average annual rate of 5% between 1990 and 2015. In this report, Korea's GDP is assumed to grow at an AAGR of 2.4% from 2015 to 2040 as shown in figure 9.1. Affected by the 2008–2009 global economic slowdown, the Korean economy has been a bit shaken. However, the economy is still in good shape and its economic growth is expected to recover to 2.9% per year from 2015 to 2020, slowing down to 2.2% per year between 2020 and 2040.

Figure 9.1: Assumptions for GDP and Population (1990–2040)



GDP = gross domestic product.

Source: Author.

Korea is expected to continue to rely heavily on coal and nuclear energy for power generation to meet the baseload. Gas-fired power generation is projected to increase from 2013 to 2040, while oil-fired generation is projected to decline. Generation from hydro sources is projected to remain relatively stable. Also projected is a strong growth in electricity generation from wind power and solar photovoltaics driven by renewable portfolio standards, which were launched in January 2012.

Korea's energy-saving goals can be attained by implementing energy efficiency improvement programmes in all energy sectors. In the industry sector, energy savings are expected from the expansion of voluntary agreements, the highly efficient equipment programme, and 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 transport, and improving the fuel economy of vehicles. In the residential/commercial ('others') sector, the minimum energy efficiency standards programme is projected to induce huge savings in addition to 'e-Standby Korea 2010.'[1]

[1] The Korea Energy Agency introduced the 'E-Standby Korea' programme, which urges the manufacturers to minimise standby power and select sleep mode during the standby. It is a voluntary agreement.

3. Outlook Results

3.1. Final Energy Consumption

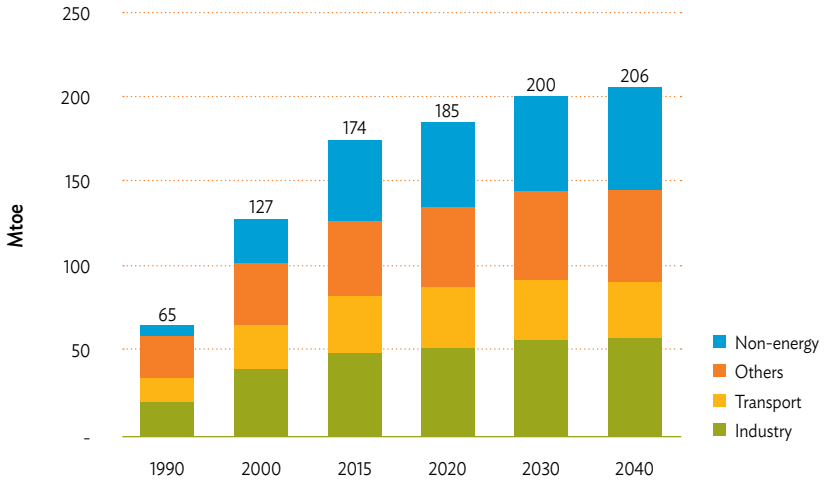
Korea's final energy consumption grew 4.4% per year, from 64.9 Mtoe in 1990 to 174.2 Mtoe in 2015.[2] The non-energy sector had the highest growth rate during this period at 8.1% per year, followed by the industry sector with 4.0%. Energy consumption in the residential/commercial/public ('others') sector had grown at a relatively slow pace of 2.4% per year. Oil was the most consumed product, with a share of 67.3% in 1990, declining to 51.8% in 2015. The share of coal in the final energy consumption declined by 11.3% between 1990 and 2015 whereas the energy share of electricity had doubled to be the second-largest consumed product.

Business-As-Usual Scenario

With an assumption of low economic and population growth, final energy consumption in Korea is projected to increase at a low average rate of 0.7% a year between 2015 and 2040 under the Business-As-Usual (BAU) scenario as shown in figure 9.2. This is largely due to the negative growth in energy consumption in the transport sector, which is projected to decrease at an AAGR of -0.01% between 2015 and 2040. The growth in final energy consumption is expected to be led by the 'others' and industry sectors up to 2020 at 1.4% and 1.2% per year, respectively, then be taken over by the non-energy sectors such as the residential/commercial, and public sectors at 1.0% thereafter up to 2040. Nevertheless, all sectors are expected to slow down at a rate less than 0.8%, or a negative average growth rate per year except for the 'others' sectors.

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

Figure 9.2: Final Energy Consumption by Sector, BAU (1990–2040)

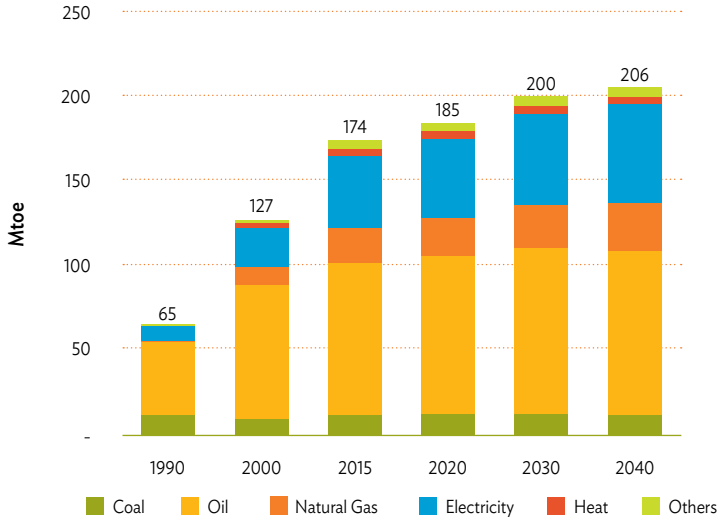


BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Author's calculation.

Final energy consumption by energy type is expected to be patterned after energy consumption by sector as shown in figure 9.3. The AAGR shows -0.1% for coal, 0.3% for oil, 1.3% for natural gas, 1.2% for electricity, and 0.3% for heat over the 2015–2040 period. Coal and oil consumption is expected to peak around 2020, then gradually decrease thereafter, showing a negative growth rate. Heat energy consumption is anticipated to follow the same pattern as oil because of the expected decrease in population and the changing lifestyle oriented towards using more electricity for heating. The case of oil is more like due to the decreasing energy consumption in the transport sector caused by an increasing deployment of electrical vehicles. Other energy types, including NRE, show a growth rate of 1.8% a year, faster than natural gas, electricity, and heat. The use of renewable energy, in addition to natural gas, will increase as clean and green energy will considerably contribute to reduced CO_2 emissions.

Figure 9.3: Final Energy Consumption by Energy Type, BAU (1990–2040)



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

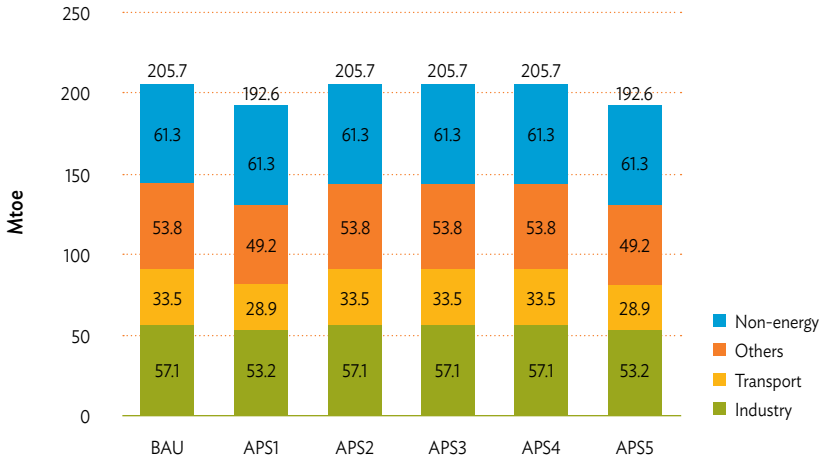
Source: Author's calculation.

Alternative Policy Scenarios

This section discusses the five alternative scenarios developed based on the focus of policy options: (i) improved efficiency of final energy demand (APS1), (ii) more efficient thermal power generation (APS2), (iii) higher contribution of renewable energy to total supply (APS3), (iv) contribution of nuclear energy to total supply (APS4), and (v) combined effects of APS1 to APS4 (APS5).

Figure 9.4 shows final energy demand by sector in each APS. Total final energy demand is to be reduced in the case of APS1 (improved efficiency) and APS5 (combined effects of APS1 to APS 4) at 192.6 Mtoe, 13.1 Mtoe or 5.2% lower than that in BAU. APS2, APS3, and APS4 show 205.7 Mtoe. The total amount and share of final energy demand by sector are the same as those of the BAU scenario. Accordingly, APS5 which is a combination of all APSs shows 192.6 Mtoe, 19.7 Mtoe or 9.5% lower than in the BAU scenario, the same as in APS1.

Figure 9.4: Final Energy Consumption by Sector, BAU and APS



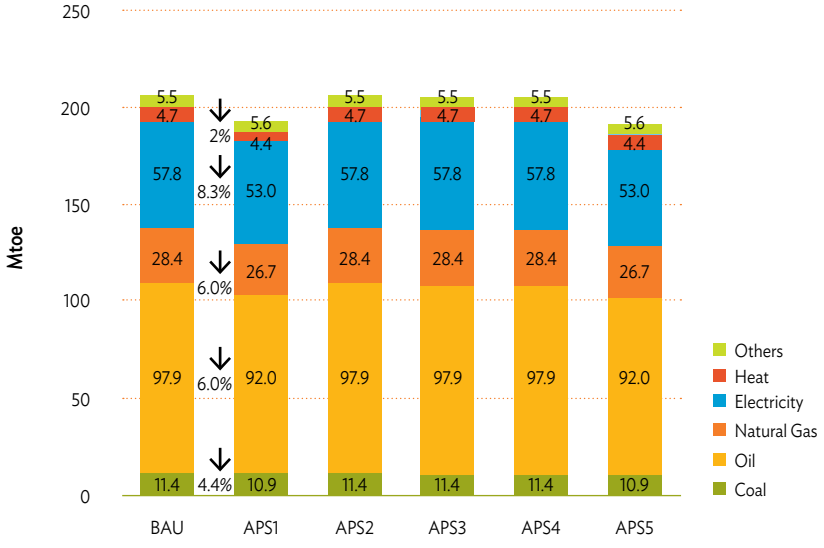
APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Author's calculation.

Final energy demand by energy type is shown in Figure 9.5. In APS1 (improved efficiency), oil accounts for 5.9 Mtoe of energy savings, the largest energy savings, followed by electricity (4.8 Mtoe) and natural gas (1.7 Mtoe). In terms of percentage, electricity shows the largest (8.3%), followed by oil and natural gas, both at 6.0%. APS2, APS3, and APS4 are identical in terms of energy demand by energy source, and APS1 and APS5 are identical in terms of total energy demand, share of energy demand by sector, and energy source.

In APS5, final energy consumption is projected to increase at an AAGR of 0.4%, from 174.2 Mtoe in 2015 to 192.6 Mtoe in 2040. Energy demand in the transport sector is projected to decrease at an AAGR of -2.7% over the same period, whereas other sectors have increased energy consumption over the same period. The rate of growth is much slower across all sectors, except for the industry sector, compared to the BAU scenario (Figure 9.6). The non-energy sector shows an AAGR of 1.0%, followed by the 'others' sector at 0.4%, and the industry sector at 0.3%.

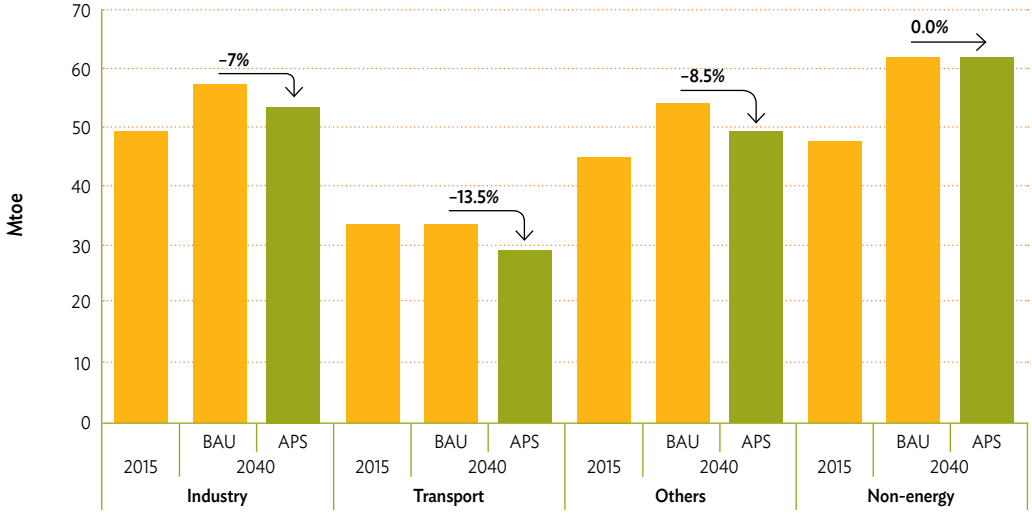
Figure 9.5: Final Energy Consumption by Energy, BAU and APS



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

Source: Author's calculation.

Figure 9.6: Final Energy Consumption by Sector, BAU and APS (2015 and 2040)



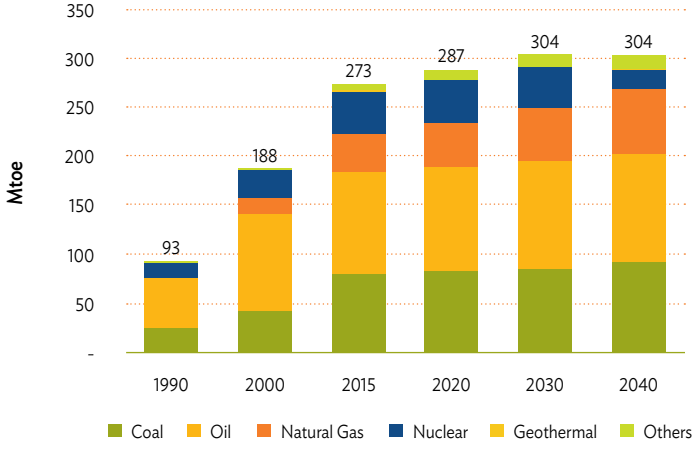
APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mtoe = million tons of oil equivalent.

Source: Author's calculation.

3.2. Primary Energy Demand

The primary energy demand in Korea had increased at an average rate of 4.4%, from 92.9 Mtoe in 1990 to 272.7 Mtoe in 2015. Amongst the major energy sources, natural gas grew the fastest at an average annual rate of 11.3%. The next was coal (4.7%), followed by oil (29%) and nuclear (4.7%) over the same period. Other energy sources, mainly renewable energy such as solar, wind, biomass, and ocean energy, have been rapidly growing at a rate of 9.1% over the same period. This indicates that the Korean government has been successfully implementing its 'Low Carbon Green Growth' and, Energy New Industry' policies initiated by previous administrations.

Figure 9.7: Primary Energy Supply by Energy Type, BAU and APS (1990–2040)



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

Source: Author's calculation.

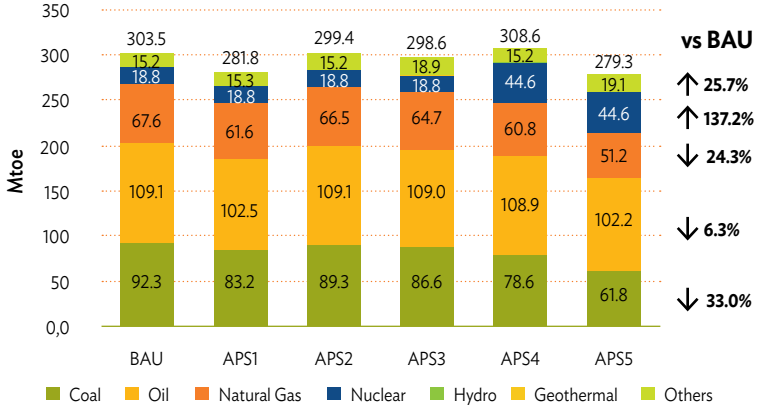
Business-As-Usual Scenario

In the BAU scenario, the primary energy demand in Korea is projected to increase at an average annual rate of 0.4%, from 272.7 Mtoe in 2015 to 303.5 Mtoe in 2040. Growth in all energy sources is projected to slow down. While the consumption of natural gas shows the fastest growth with a rate of 2.2% per year, coal and oil show much slower AAGRs of 0.5% and 0.2%, respectively, over the period 2015–2040. The growth in natural gas will largely be at the expense of nuclear, with the share of nuclear declining from 15.7% in 2015 to 6.2% in 2040.

Alternative Policy Scenario

Based on the projection and analysis in the final energy demand by sector and by energy source, primary energy demand is projected in figure 9.8 for all five scenarios. Unlike in final energy demand, each APS has a different amount and share by energy source depending on a specific policy focus of each APS. Except for APS4 (contribution of nuclear energy to total supply), APS1, APS2, and APS3 have primary energy demand less than the BAU scenario. Amongst those APSs, APS1 (improved efficiency of final energy demand) is the lowest, 281.8 Mtoe, 7.1% lower than that in the BAU scenario, APS3 (higher contribution of renewable energy to total supply) follows at 298.6 Mtoe; and APS2 (more efficient thermal power generation), at 299.4 Mtoe. In APS1, the largest reduction is in the demand for coal, 9.9%, followed by natural gas (8.9%), and oil (6.0%). Nuclear is to be the same as in the BAU scenario, but others (renewable energy) are to increase by 6.6%.

Figure 9.8: Total Primary Energy Supply, BAU and APS



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

Source: Author's calculation.

In APS5, which combines APS1 to APS4, primary energy demand is projected to increase at a lower rate of 0.1% per year, from 272.7 Mtoe in 2015 to 279.3 Mtoe in 2040. The consumption of fossil fuels, such as coal and oil, will gradually decrease in 2015–2040 whereas that of clean energy such as natural gas, nuclear, and others (NRE) will increase by 1.1%, 0.2%, and 4.4% per year, respectively, over the projection period (Figure 9.7). Aggressive implementation of energy efficiency and conservation measures on the demand side, along with a larger uptake of renewable energy on the supply side, will be the main contributors to reduced consumption of fossil fuels.

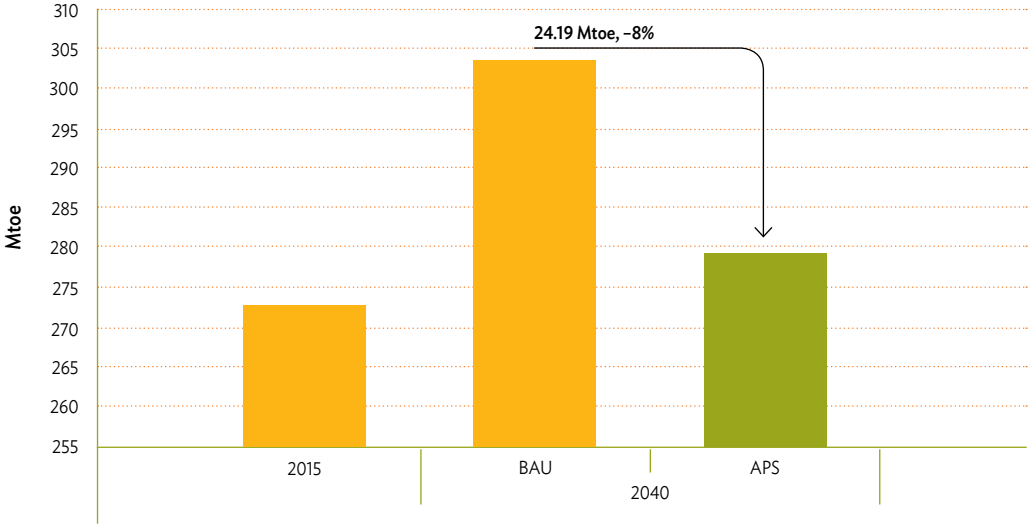
Projected Energy Savings

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

1. Shift of energy policy from a supply-oriented approach to a demand-oriented one. More than anything else, reform in energy pricing and energy taxation is a most pressing issue. In this context, market mechanisms should be introduced in energy pricing where rational energy use is induced by sharing information on the full cost of energy production and consumption.
2. Transformation of industrial structure into a less energy-intensive one, currently under way, should be accelerated towards knowledge-based, service, and green industries, which consume less and clean energies.
3. Application of energy efficiency standards and codes in product design and production processes as well as in designing and constructing a system such as factories, buildings, and plants. Under these policy directions, the Korean government should develop and implement an action plan that contains milestones and strategies with specific and cost-effective policy tools.

The energy savings that could be derived from the energy saving targets, action plans, and policy tools in Korea briefly mentioned in the previous paragraph is 24.19 Mtoe, the difference between primary energy demand in the BAU scenario and the APS in 2040 (Figure 9.9). This is equivalent to only 2.4% increase compared to the primary energy consumption in 2015. Figure 9.10 shows the energy savings potential by energy source. Amongst energy sources, coal has the largest reduction in energy demand, -33.1%, followed by natural gas (-24.3%) and oil (-6.4%). In contrast, other energy sources, such as nuclear and renewable energy, will increase by 86.2% than in the BAU scenario, whose major contributor is renewable energy.

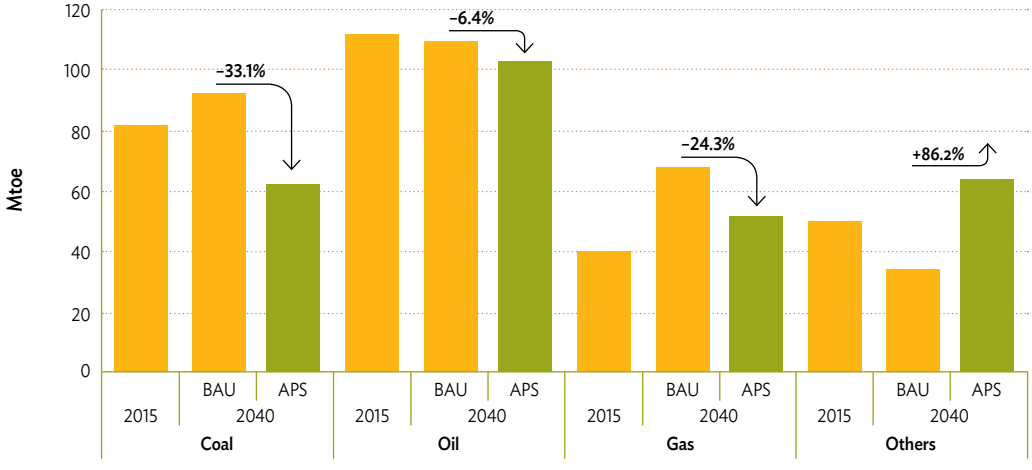
Figure 9.9: Total Primary Energy Supply, BAU and APS (2015 and 2040)



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

Source: Author's calculation.

Figure 9.10: 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.

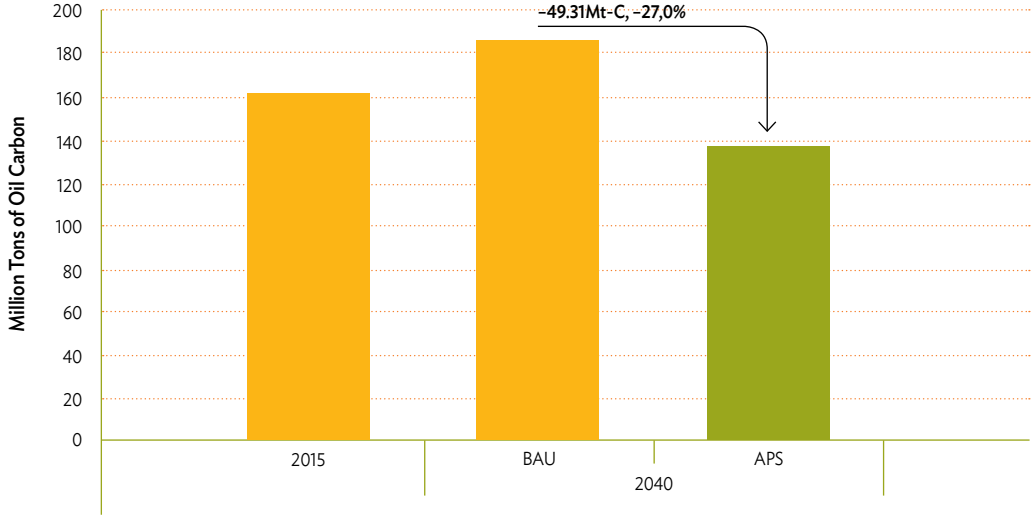
Source: Author's calculation.

3.3. CO_2 Emissions from Energy Consumption

Carbon dioxide (CO_2) emissions from energy consumption are projected to increase at an AAGR of 0.4%, from 158.7 million tons of carbon (Mt-C) in 2015 to 176.7 Mt-C in 2040 based on the BAU scenario. Such a growth rate is slower than that in primary energy consumption. This indicates that Korea will be using less carbon-intensive fuels – such as nuclear, natural gas, and renewable energy – and employing more energy-efficient green technologies.

In the APS, CO_2 emissions are projected to decline at an AAGR of -0.7% between 2015 and 2040. The difference in CO_2 emissions between the BAU scenario and the APS is 49.31 Mt-C or -27.0% (Figure 9.11). To attain such an ambitious target, the government must develop and implement cost-effective and consensus-based action plans to save energy and reduce CO_2 emissions.

Figure 9.11: CO_2 Emissions from Energy Consumption, BAU and APS (2015 and 2040)



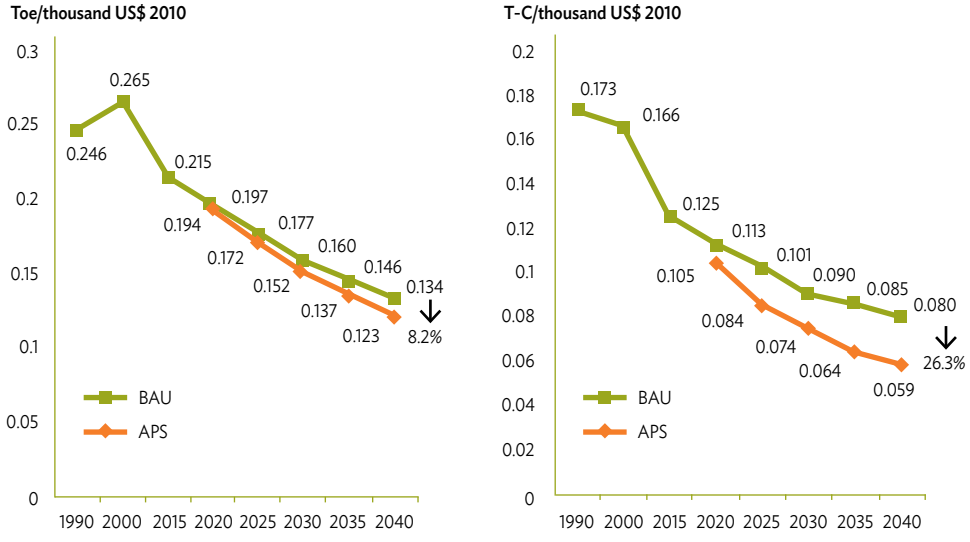
APS = Alternative Policy Scenario, BAU = Business-As-Usual, Mt-C = million tons of carbon.

Source: Author's calculation.

3.4. Energy and Carbon Intensity

As a result of energy savings, the energy intensity of GDP is projected to improve (Figure 9.12). In the BAU scenario, energy consumption per unit of GDP (toe/thousand 2010 US$) is projected to be reduced from 0.197 down to 0.123, indicating a 37.7% improvement. In the APS, it was accelerated by 42.8%. Energy intensity in the APS is 8.2% below that in the BAU scenario. Carbon intensity is also projected to improve in both the BAU scenario and the APS mainly due to the reduction in primary energy consumption in terms of energy intensity. Improvement in carbon intensity, CO_2 emissions per unit of GDP (t-C/thousand 2010 US$), is more salient than that in energy intensity. It is projected to be reduced from 0.113 down to 0.080 and 0.059 t-C/thousand 2010 US$ for the BAU scenario and APS, 36.0% and 52.8%, respectively. Carbon intensity in the APS is 26.3% below that in the BAU scenario.

Figure 9.12: Energy and Carbon Intensities (1990–2040)



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

Source: Author's calculation.

4. Implications and Policy Recommendations

Without any domestic energy resources economically available, Korea has been importing 97% of the energy needed for economic growth. Thus, Korea's top policy agenda on energy is energy security, that is, how to maintain a stable energy supply to keep the economy going. However, on entering the 21st century, the Korean government shifted its energy policy into a sustainable, efficient, and energy-saving approach, which was to some extent reflected in the first (2009) and second (2014) National Energy Basic Plan.

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

The Second National Energy Basic Plan[3] released in 2014 sets the policy approach of completely shifting the industrial structure from a supply-oriented into a demand-oriented one. Its basic policy direction consists of six major agendas with demand-oriented energy policy as a priority. Five other key agendas are to build a distributed generation system, an improved sustainable energy policy, to strengthen energy security, an enhanced stable energy supply, and to implement an energy policy with people's support.

As regards the priority of an energy policy shift to a demand-oriented approach, the target is to save 13% of the total primary energy consumption along with 15% of electric power consumption. Under this agenda, four policy tasks are proposed: (i) reform of energy-related taxation, (ii) reform of energy pricing, (iii) information and communications technology–based demand management, and (iv) strengthen programmes by sector. The reform of energy-related taxation as well as energy pricing are intended to induce a 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 lines, and a reduction in greenhouse gas (GHG) emissions should be reflected.

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

Another policy agenda includes an approach from the environmental side, namely, setting a target of for reduced GHG emissions in response to global climate change. The Korean government announced an ambitious, aggressive target to reduce its GHG emissions by 37% from that of the BAU scenario (850.6 $MtCO_2e$) by 2030 across all economic sectors. Out of this target of 37%, 25.7% will be met by domestic activities and the rest, 11.3%, will be attained by emissions trade in the international market. It is a proactive response to and a fulfilment of its international responsibility for the new climate regime established as a follow-up action to the Paris Agreement in December 2015.

Throughout the past 3 decades, the Korean government has been mostly concerned with energy security, energy efficiency, and environmental preservation. The energy security issue has been dealt with by promoting foreign resource development imports and renewable energy development. Energy efficiency improvement has been addressed through programmes supported by a series of the Five-Year Basic Plans of Rational Energy Use. Relevant offices of the Ministry of Environment have approached the environmental issue caused by the consumption of fossil fuels and nuclear energy. Now is the time for Korea to synergise those efforts exerted so far by the selection and concentration of policy tools and programmes through coordination amongst relevant ministries, as clearly specified in the Second National Energy Basic Plan.

In 2017, the new government led by President Moon Jae-In proposed reforms to the current energy policy, announcing a new energy policy direction, 'Energy Transition', which has completely shaken up the existing national energy policy. Energy Transition rests on two major energy policy agendas: (i) step-wise reduction of nuclear power plants and coal-fired plants ('de-nuclearisation' and 'de-coalisation' policies), and (ii) expansion of renewable energy with the share of renewable electricity raised to 20% by 2030 (RE 3020). These policy agendas will be reflected in subsequent energy plans: the Eighth Electricity Demand and Supply Basic Plan (completed and announced) and the Third National Energy Master Plan (under way).

If successfully implemented, Energy Transition will result in a complete turnaround from traditional energy based on coal and nuclear power to a sustainable energy system based on renewable energy and gas-fired power generation. This change in energy mix, nevertheless, does not necessarily signify the end for the nuclear industry in Korea. Recent polling suggests that the public is marginally in favour of continued investment in nuclear power. In 2017, five nuclear reactor units were being constructed. Keeping nuclear power in the energy mix, along with a larger uptake of renewable energy, will give Korea more options to meet its Paris Agreement targets which were set by Nationally Determined Contributions (NDC).

The impacts and implications of the reform in the energy mix remain to be seen. Such reform calls for a vast amount of investment in rebuilding infrastructure, hardware, and software, along with institutional arrangements. It also entails a change not only in the energy sector per se but also in the cultural, political, and social domains. Having successfully gone through several energy transitions in the past, the Korean government is highly confident to go ahead with the current policy goals of transforming into a less energy-intensive, greener economic structure and implementing major policy agendas and their corresponding policy tools and programmes. Such nationwide efforts and campaigns would eventually transform the Korean economy into a less energy-intensive and greener one in terms of energy savings and reduced CO_2 emissions. Such an achievement will position Korea as one of the leading global nations in terms of low-carbon green growth.