

# Chapter 9

## Republic of Korea Country Report

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## CHAPTER 9

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### 1. Background

The Republic of Korea is located in the southern half of the Korean Peninsula and shares a 238 km border with North Korea. It occupies 98,480 square kilometres and includes about 3000, mostly small, uninhabited islands. 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. Korea has a population of 49 million, about 85 percent of which live in urban areas. Korea has recorded tremendous economic growth over the past half century. The 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 Korean from continuing economic growth. However, 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.<sup>1</sup> The Korean economy is dominated by manufacturing, particularly electronic products, passenger vehicles and petrochemicals. Agriculture, forestry and fishing made up only 2.7 percent of total GDP in 2010.

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 has to import 97% of its energy needed 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

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<sup>1</sup> Bank of Korea, 2013

energy. Total primary energy consumption increased by 5.0 percent a year between 1990 and 2010. The strongest growth occurred in natural gas (14.2 percent) and nuclear (5.3 percent). Oil use increased at a relatively slower rate of 3.3 percent a year.

Total final energy consumption (TFEC) in 2010 was 157.4 Mtoe, increasing at an average annual rate of 4.5 percent from 1990. The industry sector accounted for 28.4 percent of final energy consumption in 2010, followed by others (28.2 percent) and transportation (19.0 percent). Consumption of natural gas in the industry sector has grown eight-fold in the last decade and oil accounts for a relatively large share of industry consumption.

In 2010, electric power generators in Korea produced 496.7 TWh of electricity, with coal and nuclear combined providing almost three-quarters of Korea's electricity. Natural gas accounted for 20.4 percent of generation in 2010. Total electricity consumption grew at an average annual rate of 8.1 percent over the period from 1990 to 2010. When broken down by fuel, coal, natural gas and nuclear have grown by an average annual rate of 13.4 percent, 12.6 percent and 5.3 percent, respectively over the period from 1990 to 2010.

Since the 1990s, the 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 contained a variety of policy tools and programs 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 Korea formed a task force to examine 660 public and private organizations 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 programs to attain the energy savings target. Among them are Voluntary Agreements (VAs), Energy Audits, Energy Service Companies (ESCOs),

Appliance Labeling 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**

Korea's GDP had grown at an average annual rate of 5.1 percent between 1990 and 2010. In this report, Korea's GDP is assumed to grow at an average annual growth rate of 3.1 percent from 2010 to 2035. Following the global recession in 2009, the Korean economy has been a little bit shaken. However, the Korean economy is still in a good shape and its economic growth is expected to recover to 4.0 percent per year from 2010 to 2020, tapering off to 2.5 percent per year from 2020 to 2035.

Korea is expected to continue to rely heavily on coal and nuclear energy for power generation to meet the base load. Gas-fired power generation is projected to increase between 2010 and 2035, while oil-fired generation is projected to decline. Generation from hydro sources is projected to remain relatively stable. It is projected to be strong growth in electricity generation from wind power and solar PVs driven by the renewable portfolio standards (RPS) which was launched in January, 2012.

Korea's energy saving goal can be attained through implementing energy efficiency programs in all energy sectors. In the industrial sector, energy saving is expected from the expansion of Voluntary Agreement (VA), the highly efficient equipment program, 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 efficiency of vehicles. In the residential and commercial (other) sector, minimum efficiency standards program is projected to induce huge savings in addition to "e-Standby Korea 2010."

### 3. Outlook Results

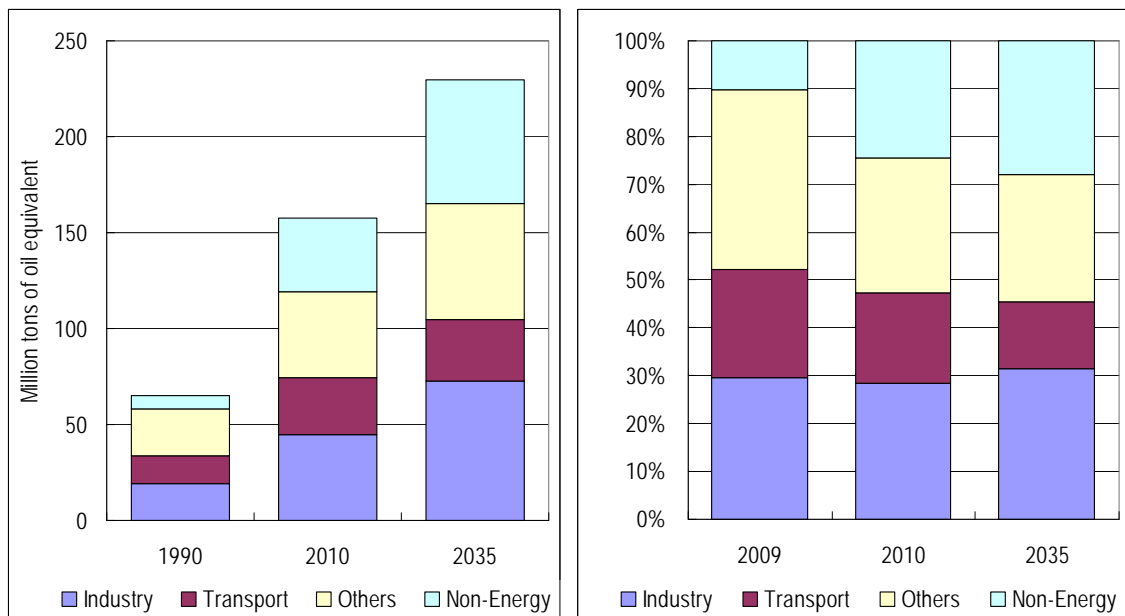
#### 3.1. Business as Usual (BAU) Scenario

##### 3.1.1. Total Final Energy Demand

Korea's final energy demand showed a growth of 4.4 percent per year from 64.9 Mtoe in 1990 to 157.4 Mtoe in 2010. The non-energy sector had the highest growth rate during this period at 9.1 percent per year followed by the industry sector with 4.3 percent. Energy consumption in the residential/commercial/public (other) sector grew at a relatively slow pace of 3.1 percent per year.

With an assumption of low economic and population growth, final energy demand in Korea is projected to increase at a low average rate of 1.5 percent a year between 2010 and 2035 under the BAU scenario. This stems largely from the slow growth in energy demand in the transportation sector. The strongest growth in demand is projected for the industrial sector, with an increase at an average annual rate of 1.9 percent between 2010 and 2035.

**Figure 9-1: Final Energy Demand by Sector, BAU**

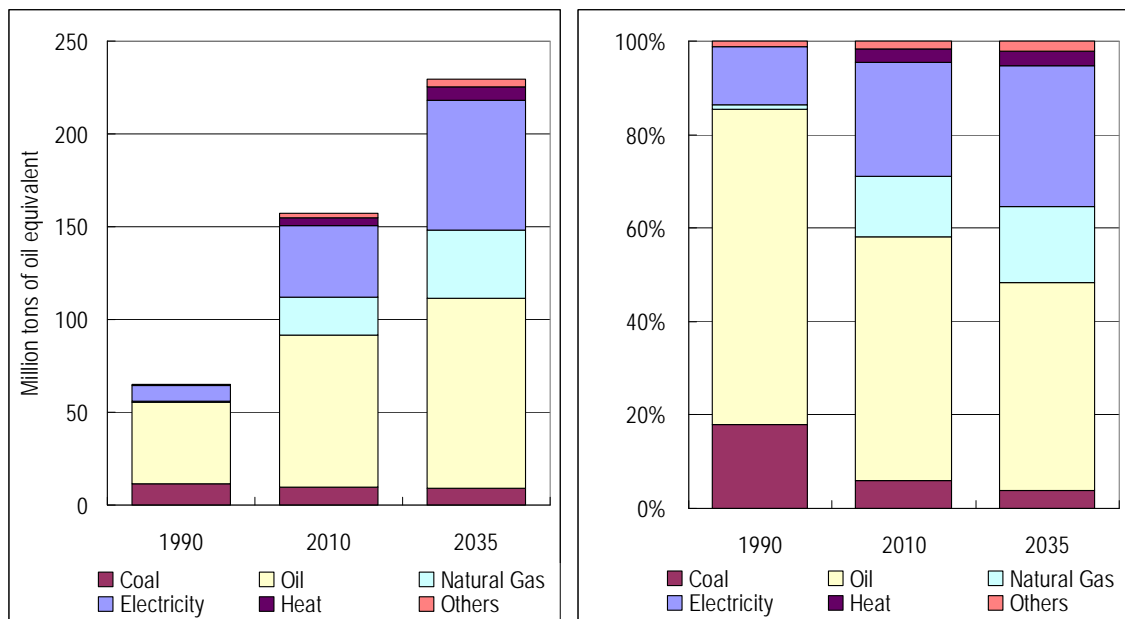


The residential/commercial/public (other) sector has the largest share in the total final energy mix of Korea for 1990 (37.5 percent). In 2010, the share of this sector declined to around 28 percent due to the rapid increase of demand in the non-energy

sector. The industry and transport sector also experienced a declining share in the total final energy mix over the same period. In the BAU scenario, the industry and non-energy sector will be growing at an faster than the transport and Other sector. Consequently, the share of these sectors will increase over the projection period. Industry sector share will increase from 28.4 percent in 2010 to almost 32 percent in 2035. Non-energy sector share will increase from 24.4 percent to 28 percent over the same period.

The demand for natural gas in the end-use sector has increased significantly over the 1990 to 2010 period, increasing at an average annual growth rate of 18.6 percent. Coal, on the other hand, declined at an average rate of 1 percent per year reflecting that Korea is moving towards cleaner fuel.

**Figure 9-2: Final Energy Demand by Fuel, BAU**



In the BAU scenario, natural gas demand will continue to increase but at a slower rate of 2.4 percent per year over the 2010 to 2035 period. Electricity demand which before was growing at an average rate of 8.1 percent per year has also slowed down to 2.4 percent per year over the projection period. Coal demand is expected to continuously decline but only at a slower rate of 0.3 percent per year. Oil which are being used mainly in the transport sector, will still increase but at a rate of 0.9 percent per year.

Demand for oil, natural gas and electricity is projected to increase at an average annual growth rate of 0.9 percent, 2.4 percent and 2.4 percent, respectively over the period between 2010 and 2035. Coal demand is projected to decline by 0.3 percent per year reflecting a shift toward the increased use of natural gas in the industrial sector in order to reduce CO<sub>2</sub> emissions.

Oil was the most consumed product having a share of 67.3 percent in 1990, declining to 52.0 percent in 2010. The share of coal in the final energy demand has declined by 12 percent a year between 1990 and 2010 whereas the share of electricity has doubled to be the second largest consumed product. Natural gas with its rapid growth, has an increasing share from 1 percent in 1990 to almost 13 percent in 2010.

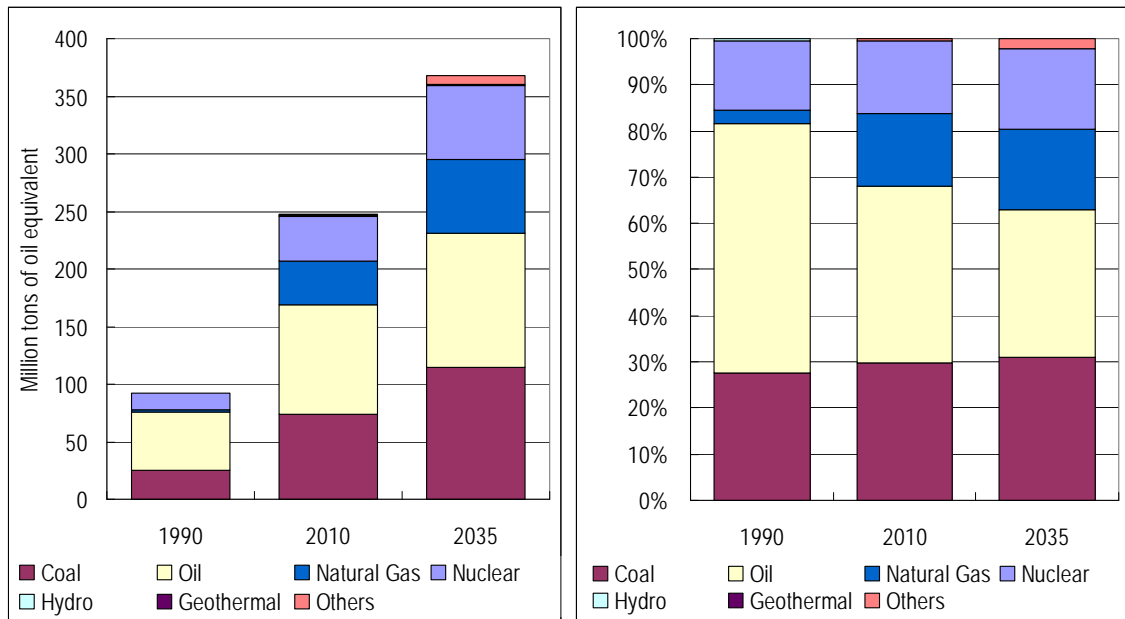
For the future, the share of oil will continue to decline. It is expected that oil share will decline to 44.6 percent by 2035 under the BAU scenario. Coal will also decline and replaced by natural gas. The share of coal will reach 3.8 percent 2035 as compared to 6.1 percent in 1990. Natural gas, on the other hand, will have an increasing share from 12.9 percent in 1990 to 16.2 percent in 2035. Electricity share in the total final energy will also increase from 20.4 percent to 30.3 percent.

### **3.2. Primary Energy Demand**

Primary energy demand in Korea grew at an average rate of 5.0 percent from 92.4 Mtoe in 1990 to 247.3 Mtoe in 2010. Among the major energy sources, natural gas was the fastest growing at an average annual rate of 14.2 percent. In contrast, coal grew at the rate of 5.4 percent a year, followed by nuclear and oil at 5.3 percent and 3.3 percent, respectively, over the same period.

In the BAU scenario, primary energy demand in Korea is projected to increase at an average annual rate of 1.6 percent to 367.8 Mtoe in 2035. Growth in all the energy sources is projected to slow down. While consumption of nuclear, natural gas, and coal will show an annual growth rate of around 2 percent, oil and other energy are projected to increase at a much lower rate or decrease over the period 2010-2035.

**Figure 9-3: Primary Energy Demand, BAU**



The growth in nuclear will largely be at the expense of oil. Between 1990 and 2010, oil share declined almost 30 percent, from 53.9 percent in 1990 to 38.5 percent in 2010. At the same time, the share of nuclear increased from 14.9 percent to 15.7 percent.

Natural gas share in the total primary energy mix increased significantly between 1990 and 2010; from 2.9 percent to 15.6 percent. Coal, however, increased slightly from 27.7 percent to 28.7 percent.

Under the BAU scenario, the share of oil continued to decline to around 32 percent by 2035, while nuclear share will increase to 17.5 percent. Natural gas share in the total mix will be similar to that of nuclear while coal share almost that of oil. Hydro share;s in the total energy mix will remain constant.

### 3.3. Power Generation

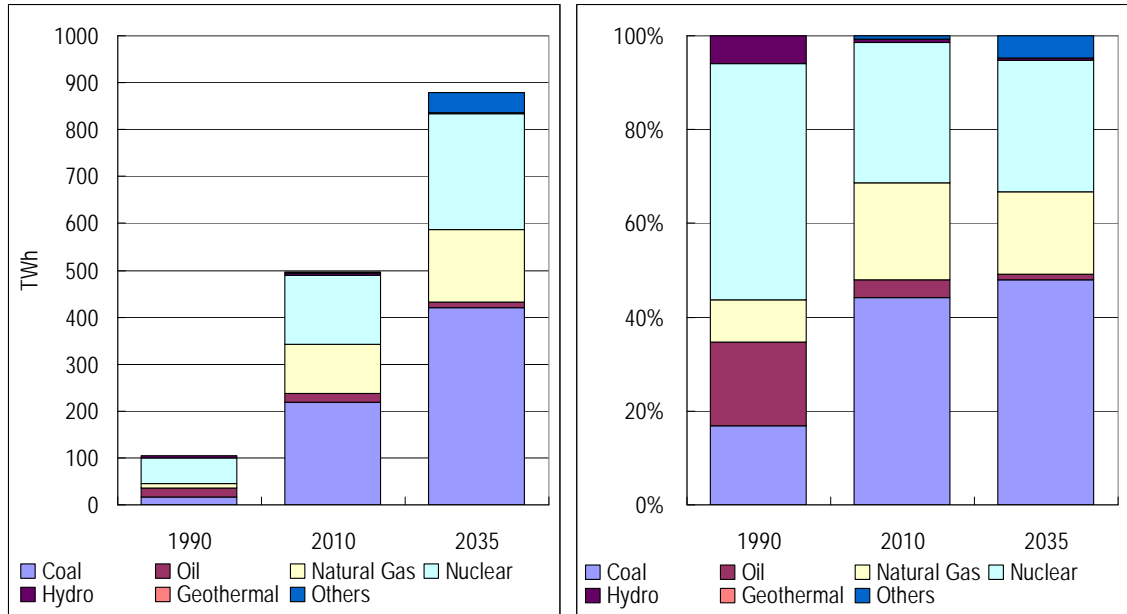
The power generators in Korea produced 496.7 TWh of electricity in 2010, almost 5 times that of 1990 production. For fossil fuel, generation of electricity from coal grew the fastest over the 1990 to 2010 period at an average annual rate of 13.4 percent. Power generation from natural gas also grew rapidly during that time, but slower than coal at 12.6 percent. Oil power plants generates almost the same amount



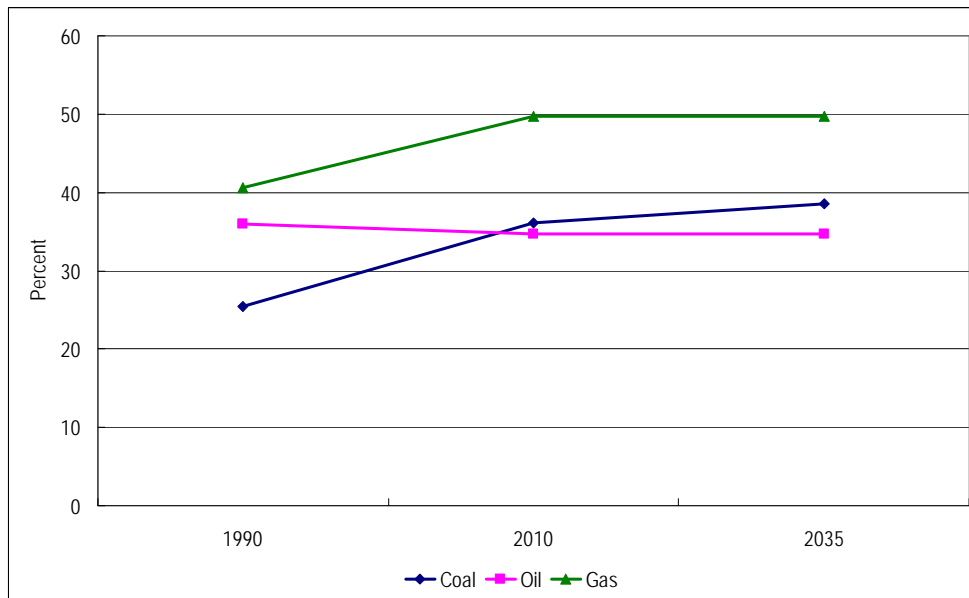
of electricity

Generation from nuclear plants has been growing at an average rate of 5.3 percent per year while from oil power plants remains the same.

**Figure 9-4: Power Generation by Fuel Type, BAU**



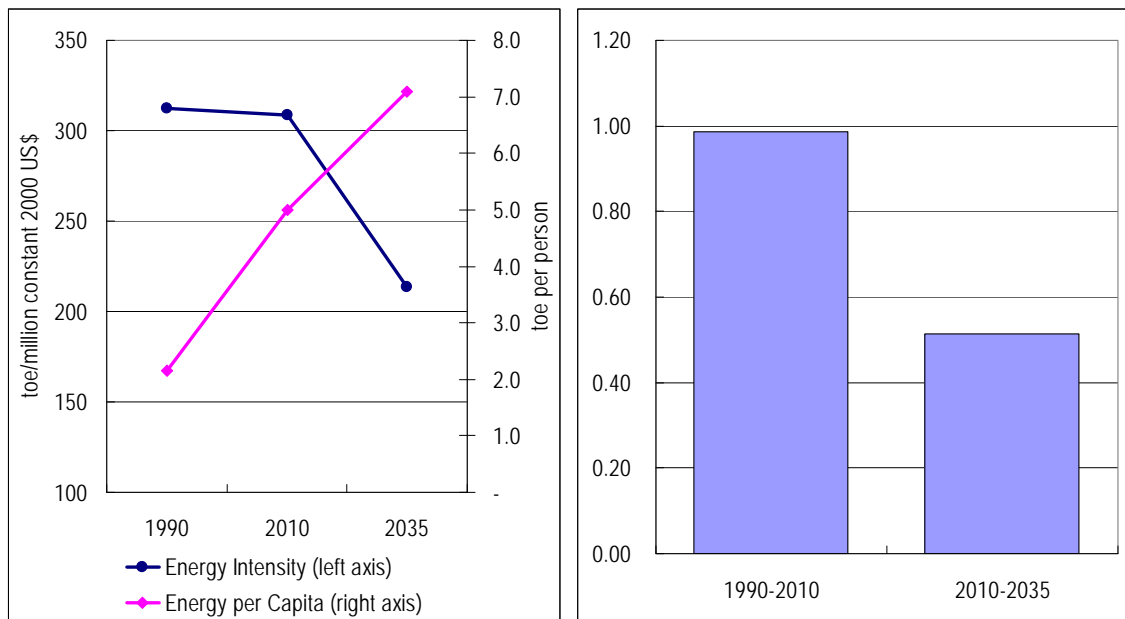
**Figure 9-5: Thermal Efficiency of Electricity Generation**



### 3.3.1. Energy Intensity

Korea's energy intensity from 1990 to 2010 decreased by 0.1 percent per year on the average from 312 toe/million US\$ in 1990 to 309 toe/million US\$ in 2010. The energy elasticity, or the growth rate of energy consumption divided by the growth rate of GDP, during this period was 0.99. Energy intensity is projected to further decrease by 1.8 percent per annum to reach 213 toe/million USD in 2035. Energy elasticity from 2010-2035 is projected to be 0.51.

**Figure 9-6: Energy Intensity, Energy per Capita and Energy Elasticity**

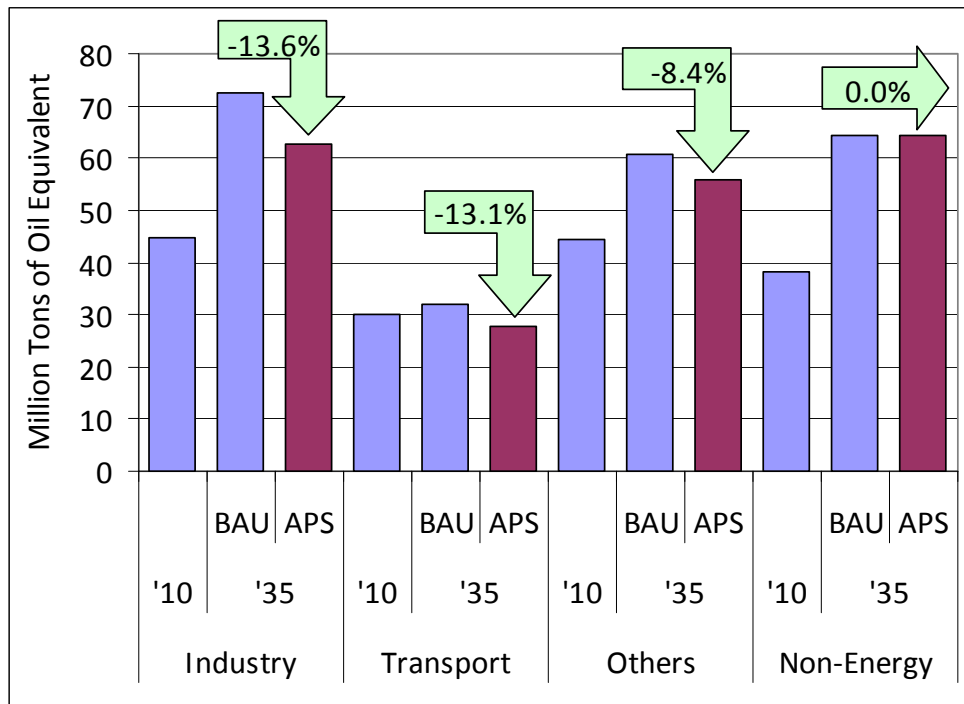


### 3.3.2. Energy Saving and CO<sub>2</sub> Reduction Potential

#### **Final Energy Demand**

In the APS, final energy consumption is projected to increase at an average annual growth rate of 0.5 percent from 157.4 Mtoe in 2010 to 210.6 Mtoe in 2035. The Non-energy sector is projected to have the fastest average annual consumption growth, increasing by 2.1 percent a year between 2010 and 2035. Energy consumption in the transportation sector is projected to decrease by 0.3 percent per year over the same period. The rate of growth is much slower across all sectors as compared to the BAU scenario (Figure 9-7).

**Figure 9-7: Final Energy Demand by Sector, BAU and APS**



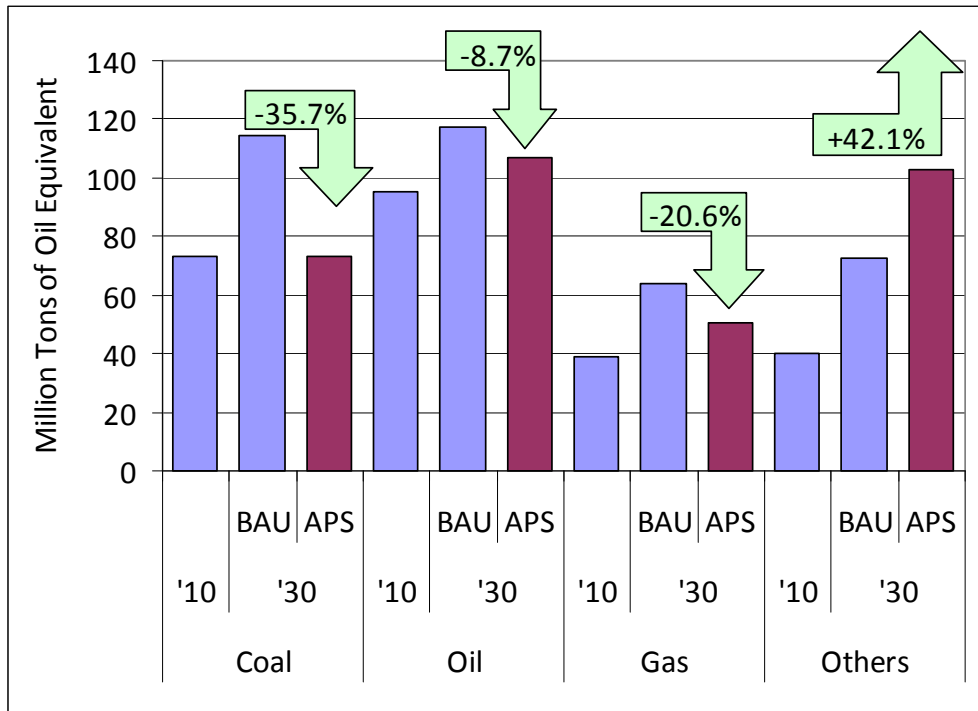
**Primary Energy Demand**

In the APS, primary energy demand is projected to increase at a lower rate of 1.2 percent per year to 334.2Mtoe in 2035. Coal and oil will stay at the same level of consumption as in 2010 whereas nuclear and natural gas will increase by 3.6 percent and 1.1 percent per year, respectively, between 2010 and 2035 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 Korea are as follows: First, market mechanism should be introduced in energy pricing in which rational energy use is induced through sharing information on full cost of energy production and consumption. Second, industrial structure should be transformed from the current energy-intensive industry into knowledge-based, service industries and green industries which consume less and clean energies. Third, energy efficiency standards and codes should be applied in product designing and production process as well as in designing and constructing a system such as factory, building and plant. Under these policy directions, the Korean government should develop and implement an action plan which contains milestones and strategies with

specific and cost-effective policy tools.

**Figure 9-8: Primary Energy Demand by Source, BAU and APS**

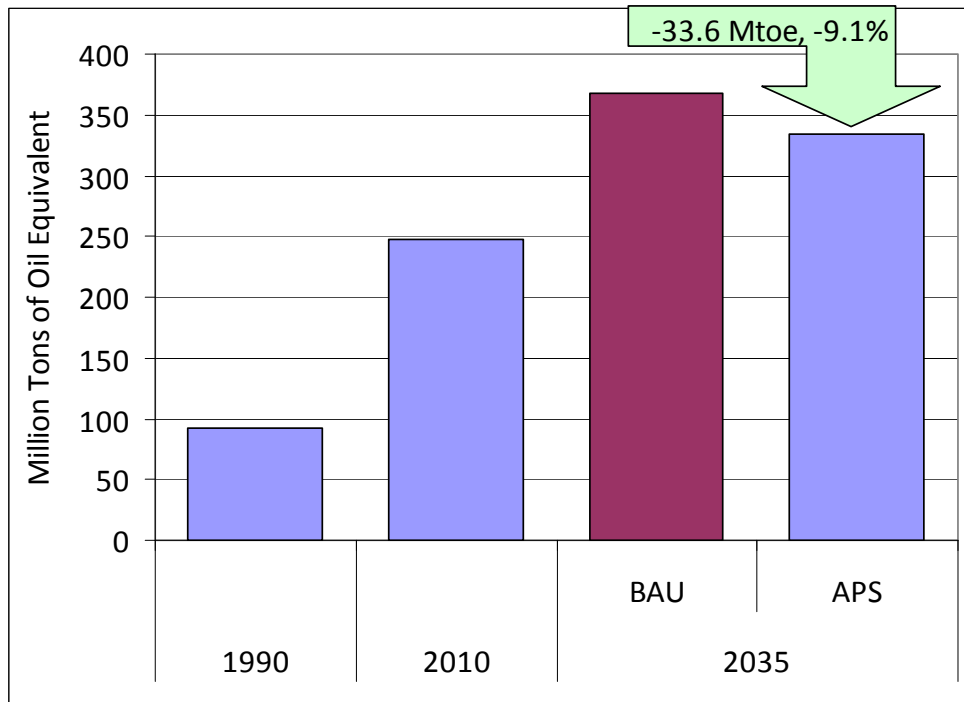


***Projected Energy Saving***

The energy savings that could be derived from the energy saving targets, action plans and policy tools in Korea is 33.6 Mtoe, the difference between primary energy demand in the BAU scenario and the APS in 2035. This is equivalent to 13.6 percent of Korea’s consumption in 2010.

In terms of final energy consumption savings in 2035, savings is estimated to be 9.9 Mtoe in the industry sector, 5.1 Mtoe in the residential/commercial (other) sector and 4.2 Mtoe in the transportation sector

**Figure 9-9: Total Primary Energy Demand to 2030, BAU and APS**

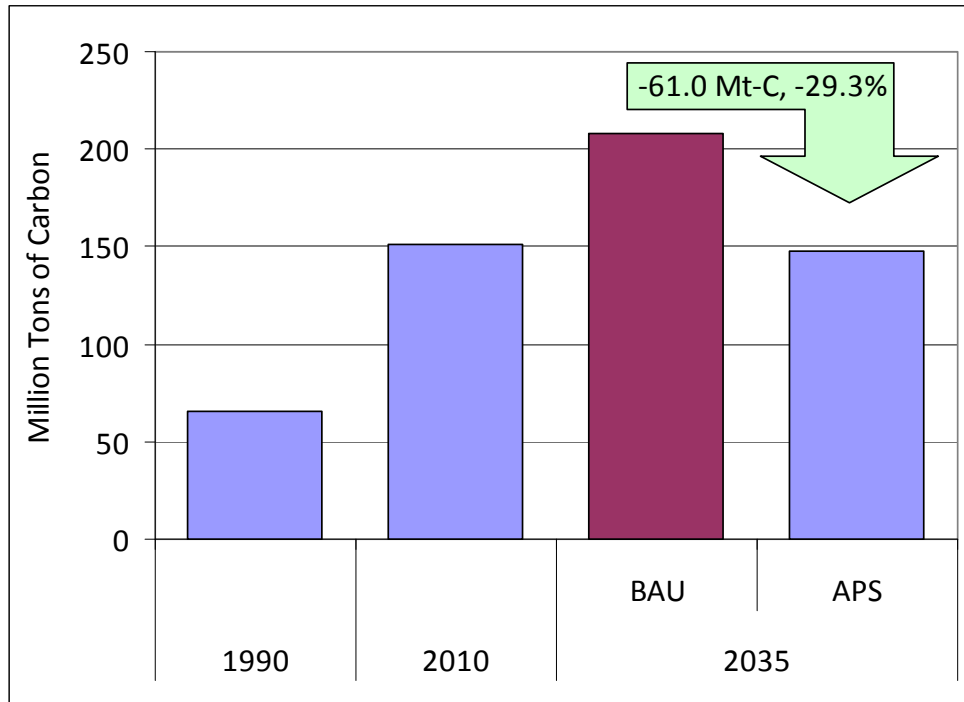


### **3.4. CO<sub>2</sub> Emissions from Energy Consumption**

Carbon dioxide (CO<sub>2</sub>) emissions from energy consumption are projected to increase at an annual average growth rate of 1.3 percent from 151.5 Mt C in 2010 to 208.4 Mt C in 2035 based on the BAU scenario. Such a growth rate is slower than that in primary energy consumption, indicating that Korea will be using less-carbon intensive fuels such as natural gas and renewable energies and employing more energy efficient, green technologies.

In the APS, CO<sub>2</sub> emissions are projected to decline at an annual average growth rate of -0.1 percent between 2010 and 2035. Difference in CO<sub>2</sub> emissions between BaU and APS is 61 Mt C, 29%. To attain such an ambitious target, the Korean government has to develop and implement cost-effective and consensus-based action plans for energy saving and CO<sub>2</sub> emissions reduction

**Figure 9-10: CO<sub>2</sub> Emission from Energy Consumption, BAU and APS**



#### **4. Implications and Policy Recommendations**

Korea's total primary and final energy consumption in the 1990s had rapidly increased at a rate faster than that of GDP whose growth has been driven by energy-intensive industries such as 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, which indicates that energy-intensive industry will prevail for the short- to mid-term future. However, Korea will and has to transform its industrial structure into a less energy-intensive one in the longer term.

Up until now, Korea has promoted the diversification of energy resources and suppliers to reduce excessive external energy dependence and new & renewable energy sources, which contributes to enhance energy security as well as environmental preservation. It is highly recommended that Korea keep up with the current policy goals of transforming into a less energy-intensive, greener economic structure and implementation of policies to keep a balance between energy, economy,

and the environment. Such nation-wide efforts and campaigns would eventually transform the Korean economy into a less energy-intensive and greener one in terms of energy savings as well as reduced CO<sub>2</sub> emissions. Such an achievement will position Korean as one of global leading nations in terms of low-carbon green growth.