

# KOREA

- Korea's primary energy demand is expected to grow annually at 2.0 percent, from 200 Mtoe in 2002 to 352 Mtoe in 2030; driven by the growth in the electricity and industry sectors.
- The change in industry structure, and energy efficiency improvements will result in the slower growth rate for energy demand compared with the past two decades.
- The economy's initiatives to strengthen inter-regional cooperation through electricity and natural gas supply linkages will help Korea to diversify energy supply sources.

## RECENT ENERGY TRENDS AND ENERGY POLICY

Korea's primary energy consumption grew at an average annual rate of 3.2 percent between 2002 and 2005, much slower than that of the last decade at 6.9 percent per year. The sluggish growth in energy consumption is due mainly to the economy's rather slow GDP growth at around 3.9 percent per year over the same period, dampened further by energy efficiency improvements in the industry and transport sectors.

With very limited indigenous energy resources, Korea relies heavily on imports of oil, natural gas and coal. Net imports have more than doubled from 72 Mtoe in 1990 to 190 Mtoe in 2005. In 2005, Korea was the world's fourth-largest importer of oil and the second-largest importer of both coal and liquefied natural gas (LNG).

As a net energy importer, the recent rise in energy prices has raised government concern on energy security issues. High oil and LNG prices have had an impact on the economy, particularly in the industry sector which is dominated by energy-intensive industries like steel, cement, petrochemical and ship building.

To ultimately reduce the economy's energy import dependency, and to enhance energy supply security, Korea has instituted a number of measures throughout the energy supply chain and end-use sectors. The government supported the expansion of nuclear electricity generation to decrease the dependence on fossil fuels for electricity generation. The industry sector has been required to meet stringent regulations on energy efficiency. Moreover, large-scale energy users, with an annual consumption of more than 0.2 Mtoe, have started developing voluntary agreements on energy savings. In 2005, the government announced that the economy would carry out the Average Fuel Economy (AFE) programme in an effort to improve the deteriorating fuel economy of passenger vehicles. In addition to the enhancement of energy supply security, Korea is

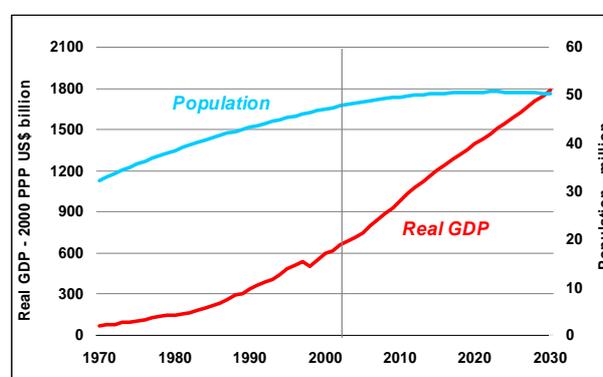
aiming to increase energy market efficiency through deregulation, and the establishment of an environmentally friendly energy supply system.

## ENERGY DEMAND DRIVERS

Korea's GDP is projected to grow at an annual rate of 3.6 percent over the outlook period – a slower rate than the past two decades at 7.0 percent per year. Non-energy intensive industries such as the Information Technology (IT), electronics, machinery, and service industries, are expected to lead the future economic growth.

Population is projected to contract at 0.2 percent per year over the outlook period, compared with that of 1.0 percent per year during the past two decades. Total population will reach a peak of 50.6 million around 2025, and is expected to decline thereafter.

Figure 50 GDP and Population



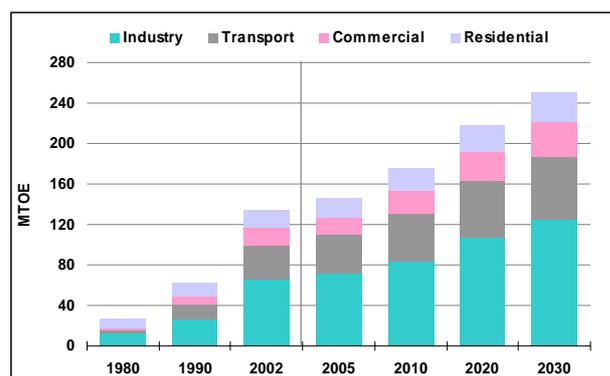
Source: Global Insights (2005)

## OUTLOOK

### FINAL ENERGY DEMAND

Final energy demand is projected to grow at 2.3 percent per year, much slower compared with the annual growth in the previous two decades of 7.5 percent. Energy demand in the industry sector will maintain the largest share at around 50 percent, followed by transport (25 percent), commercial (14 percent), and residential (11 percent).

Figure 51 Final Energy Demand



Source: APERC Analysis (2006)

### Industry

Energy demand in the industrial sector is projected to grow at an average annual rate of 2.3 percent through 2030, slower than the average growth rate over the past two decades at 7.6 percent per year. The shift from energy-intensive industry to non-energy intensive industry will result in the lower projected growth for industrial energy demand. Over the past two decades, the value added of energy-intensive manufacturing sector has grown more than ten-fold, due to the production capacity expansion in industries such as steel, cement, shipbuilding<sup>62</sup> and petrochemicals. By contrast, future growth of industrial value-added is expected to be led by non-energy-intensive industries such as IT, electronics, machinery and services sector.<sup>63</sup> The impact of the changes in the economy's industrial structure will result in significant improvements in energy intensity, from 273 toe per US\$ million in 2002 to 164 toe per US\$ million in 2030.

Oil products are projected to maintain the largest share of industrial energy demand through 2030, but the share is expected to decrease from 59 percent in 2002 to 44 percent in 2030. Fuel oil for industrial boilers and naphtha as a feedstock for ethylene production are expected to account for the major share of industrial oil products demand. Increase in natural gas demand for boilers and cogeneration systems are expected to offset the decline in the share of oil products, growing at an annual rate of 5.2 percent. Demand for coal is expected to grow slowly at 2.7 percent per year, compared with 8.5 percent in the previous two decades. The slow growth of crude steel production at an annual rate of 1.5 percent, and increased efforts to improve the energy efficiency of

<sup>62</sup> Korea is the world's largest shipbuilding economy, accounting for 35 percent of world shipbuilding capacity in 2006.

<sup>63</sup> Over the outlook period, industrial value-added growth of non-energy-intensive industries is expected to grow at 4.4 percent per year, while that for energy-intensive industries is expected to grow at 3.5 percent.

the steel industry<sup>64</sup> will lead to the lower projected growth in coal demand. Electricity, the second-largest energy source for the industrial sector, is projected to grow at 3.2 percent per year, with the share increasing from 20 percent in 2002 to 26 percent in 2030. Heat and renewable energy is also expected to increase rapidly, but the share to total industrial energy demand will reach only 5 percent in 2030. Most of the growth in heat and renewable energy demand is likely to come from combined heat-and-electricity installations at industrial facilities.

### Transport

Korea's transport energy consumption is dominated by the road transport sub-sector, representing more than three quarters of the economy's total transport energy consumption in 2002. Over the past two decades, income growth, improvements in living standards, expansion of residential suburbs and development of vehicle manufacturing industries have all contributed to a thirty-fold increase in the stock of vehicles, which have in turn resulted in a ten-fold increase in gasoline and diesel consumption.<sup>65</sup> Managing road transport congestion<sup>66</sup>, and air pollution<sup>67</sup> caused by passenger vehicles and freight trucks continues to be a significant challenge for the economy.

Over the outlook period, the road sub-sector is projected to dominate energy demand, accounting for about three quarters of total transport energy demand. Demand for diesel is projected to grow robustly, at an annual rate of 2.4 percent due to the continued popularity of SUVs<sup>68</sup> and increased trade as a result of economic development. By contrast, gasoline demand is projected to grow at a slower rate of 1.7 percent per year through 2030.<sup>69</sup>

<sup>64</sup> Due to the introduction of advanced technologies, energy use per tonne of crude steel production declined to 0.19 toe per tonne in 2001, while that of the US, Japan, and China was at 0.24 toe, 0.17 toe, and 0.42 toe respectively.

<sup>65</sup> This means that vehicle ownership per 1,000 population increased from 6.5 in 1980 to 204 in 2002.

<sup>66</sup> During the past 10 years, the length of road increased by 1.5 times, while the number of passenger vehicle registrations increased 4 times. The imbalance in growth of road length and vehicle registration has resulted in serious traffic congestion.

<sup>67</sup> Between 1995 and 2000, trucks accounted for 80 percent of total NO<sub>2</sub> emissions in Seoul, which surpassed the WHO air quality guidelines.

<sup>68</sup> Diesel-powered SUVs have become popular because of the lower diesel price compared with gasoline.

<sup>69</sup> The stock of passenger vehicles is projected to increase from 9.7 million in 2002 to 15 million in 2020, growing at an annual rate of 2.4 percent. Thereafter, slower population growth will lead to lower growth in the stock of passenger vehicles, growing at 0.3 percent per year.

The marine sub-sector will maintain the second largest share of total transport energy demand. Marine is projected to remain an important mode of transport for the internal movement of raw materials and finished products.

The air sub-sector is expected to grow at the fastest rate of 3.0 percent. Korea has four international and 175 domestic airports, the largest of which is Incheon airport. Incheon is ranked the 10<sup>th</sup> largest in the world and the second largest in Asia in terms of passenger handling capacity. With the completion of the second phase of Incheon's capacity expansion in 2007, the airport will serve as an air transport hub in Asia.

Energy demand of the rail sub-sector is expected to increase 1.5 times, while the share of rail in total transport energy demand is projected to decrease from 1.6 percent in 2002 to 1.3 percent in 2030. Rail electricity demand is projected to increase at a rate of 3.7 percent per year as electrification of the rail network proceeds.<sup>70</sup> By contrast, demand for diesel in the rail sub-sector will decline at 1.0 percent per year.

#### Residential and Commercial

Energy demand in the residential sector is projected to grow at an annual rate of 1.8 percent, compared with that of 5.0 percent per year between 1971 and 2002. Natural gas is projected to maintain the largest share of total residential energy demand increasing from 45 percent in 2002 to 57 percent in 2030 as a result of fuel switching from coal and LPG. In Korea, most households utilise gas for heating, and since 70 percent of households are already connected to the gas supply network, slower growth in natural gas demand is expected over the outlook period compared with the last two decades. Electricity is projected to grow at 2.0 percent per year and account for the second largest share of total residential energy demand at 22 percent in 2030. The growth is lower than the previous two decades due to the slow growth in the number of households, and saturation of electrical appliances.

Supported by strong growth in the services sector<sup>71</sup>, energy demand in the commercial sector is projected to grow at 2.5 percent per year. Electricity, the main energy source for the commercial sector, is expected to grow at 3.6 percent per year, driven by increasing demand for cooling and lighting in commercial buildings. Demand for gas is expected to

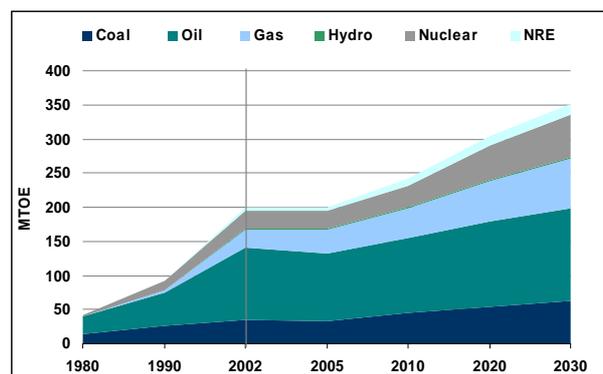
grow at the fastest rate of 4.6 percent annually. Gas will continue to replace coal and diesel for boilers in commercial buildings, and the share in total commercial energy demand is expected to increase from 10 percent in 2002 to 17 percent in 2030.

#### PRIMARY ENERGY DEMAND

Korea's primary energy demand is projected to grow at an annual rate of 2.0 percent through 2030, compared with that of 7.4 percent between 1980 and 2002. The change in industry structure from heavy industry to services, and IT industries, and energy efficiency improvements across the sectors will result in the slower growth rate for energy demand over the outlook period. As a result, GDP to energy elasticity is expected to improve to 0.6 compared with 1.1 over the previous two decades.

Natural gas is projected to grow annually at 3.6 percent, followed by nuclear at 3.2 percent, coal at 2.2 percent, and oil at 0.9 percent. Renewables is projected to grow at an annual rate of 4.2 percent, while the share in total primary energy demand is expected to increase slightly from 3 percent in 2002 to 5 percent in 2030.

Figure 52 Primary Energy Demand



Source: APERC Analysis (2006)

Reducing the economy's oil dependency has been one of the important energy policy goals of Korea. By 2030, the share of oil in total primary energy demand is projected to decrease from 53 percent in 2002 to 39 percent in 2030. Fuel switching by the industry and electricity sectors and slower growth in oil demand for transport, are expected to contribute to reduction in the share of oil in total primary energy demand.

Natural gas demand is projected to increase from 27.4 Mtoe in 2002 to 72.9 Mtoe 2030, due to the fast growth in the industrial sector and expansion of natural gas-fired electricity generation. As a result of this increasing demand, the volume of LNG that is unsecured through long-term contracts is projected to increase, and will account for about 30 percent of demand in 2010, and 70 percent in 2020.

<sup>70</sup> Ministry of Construction and Transport has set a target to electrify 82 percent of total rail system in Korea from 39 percent in 2004.

<sup>71</sup> Value added for the services industry is projected to grow at 3.3 percent per year.

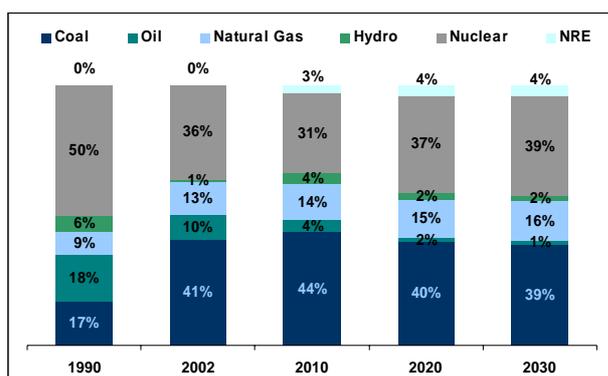
Demand for coal is projected to increase from 34.5 Mtoe in 2002 to 62.8 Mtoe in 2030. The growth is largely attributed to the electricity sector, accounting for 93 percent of the incremental growth between 2002 and 2030.

**ELECTRICITY**

Electricity demand is projected to grow at 3.2 percent per year over the outlook period. Growth is expected to be faster in the near-term 2002-2015 at an annual growth rate of 4.4 percent.

The electricity generation mix is not expected to change significantly over the outlook period. In 2030, coal and nuclear will maintain the largest combined share of 78 percent, followed by natural gas (16 percent), renewable (4 percent), hydro (2 percent), and oil (1 percent). The share of oil in the electricity generation mix is expected to decline from 10 percent in 2002 to 1 percent in 2030. On the other hand, the share of renewables is projected to increase from near zero in 2002 to 4 percent in 2030.

Figure 53 Electricity Generation Mix

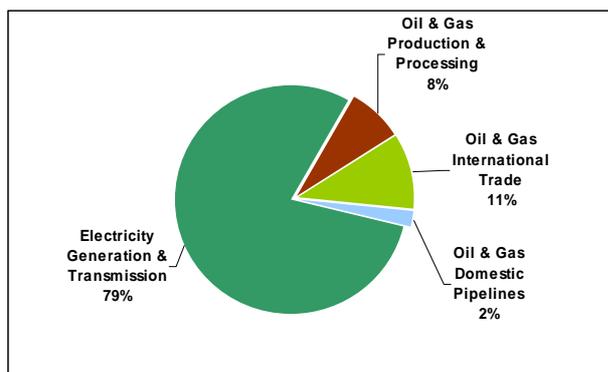


Source: APERC Analysis (2006)

**INVESTMENT REQUIREMENTS**

Total investment requirement is projected to reach between US\$227-276 billion over the outlook period. Of the total investment requirements, 79 percent will be allocated to electricity generation and transmission to cater for Korea’s high electricity demand.

Figure 54 Investment Requirements

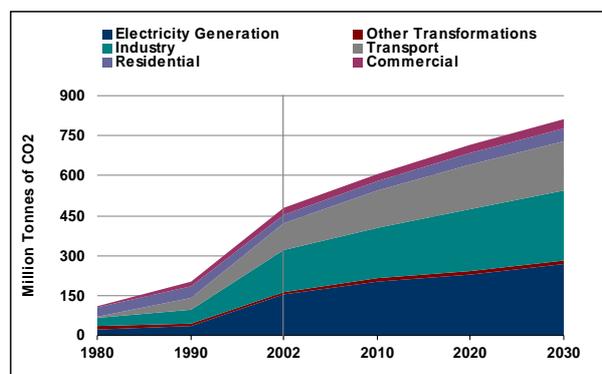


Source: APERC Analysis (2006)

**CO<sub>2</sub> EMISSIONS**

Despite the increasing share of nuclear, the dominant share of coal in the economy’s electricity generation mix over the outlook period is projected to increase CO<sub>2</sub> emissions from 480 million tonnes of CO<sub>2</sub> in 2002 to 881 million tonnes of CO<sub>2</sub> by 2030.

Figure 55 CO<sub>2</sub> Emissions by Sector



Source: APERC Analysis (2006)

**MAJOR ISSUES**

**GAS AND ELECTRIC POWER GRID INTERCONNECTIONS WITHIN NORTHEAST ASIA**

Korea is heavily dependent on Middle East oil and natural gas, at 80 percent and 54 percent respectively in 2003. As such, the economy is highly vulnerable to supply disruptions in the region, not to mention the impacts of rising energy prices. To secure a stable supply of energy to meet increased energy demand over the outlook period, Korea is actively pursuing energy cooperation in Northeast Asia. The northern part of Northeast Asia – Eastern Siberia and the Russian Far East – has been regarded as an energy “treasure house”, for which China, Japan and Korea could be good market players. From the perspective of creating a Northeast Asian economic community, possibly including North Korea, the Korean government has added to its to-do list the policy goal of constructing an energy system linked to the Asian Continent.

**GHG EMISSIONS REDUCTION**

Korea is not included in the Kyoto Protocol, in which a total of 38 economies are required to reduce their emissions of greenhouse gases by 5.2 percent below the 1990 level during the first commitment period. Korea, however, will likely be pressured to join the scheme from 2013 because it is a member of the Organization for Economic Cooperation and Development (OECD) and is the ninth-largest emitter of greenhouse gases in the world. According to an estimate by the Korea Energy Economics Institute (KEEI), if Korea cuts the carbon dioxide

emissions by 5 percent of 1995 level by 2015, it will cost it about 0.78 percent of its gross domestic product. Therefore, it is not easy for Korea to join the mandatory reduction regime, and it is demanding a new kind of reduction method to guarantee more sustainable economic development and to encourage the participation of developing countries.

Various programmes have been listed to cope with rising greenhouse gas emissions. Among these include the government's introduction of emissions trading system in 2006, with efforts to develop a greenhouse gas reduction registry. Other programmes include the nationwide energy saving plan aimed at reducing energy intensity to 8.6 percent below the 2004 level by 2007 and a plan to increase the share of NRE to 5 percent in total primary energy consumption by 2011.

## IMPLICATIONS

Primary energy demand in Korea is expected to grow at an annual average rate of 2.0 percent over the outlook period, compared with 7.4 percent per year in the previous two decades. Despite the slow-down in the projected growth rate of energy demand, 77 percent of the energy demand would have to be met by import through 2030, rendering concerns over future energy supply security.

Establishment of trans-boundary energy supply system with the economies in Northeast Asia will serve as an option for Korea to ensure energy supply security and reduce the Middle East dependence on oil and natural gas imports. One of the promising projects is a natural gas pipeline from the Kovykta natural gas deposit of Eastern Siberia through China. Another promising project is the electric power grid interconnections with Russia, China, and North Korea.

To realize these projects, the first step would be for the policy makers of each economy to recognise the potential benefits in the region. In addition, in order to deal with these issues effectively, the region needs to establish a stable international legal framework.

## REFERENCES

- APEREC (2004a). *Electric Power Grid Interconnections in the APEC Region*. Tokyo.
- APEREC (2004b). *Nuclear Power Generation in the APEC Region*. Tokyo.
- KEEI (2004). *Research on Middle- and Long-term Policy and Strategy in Response to the UNFCCC*.

KPX (2004). *Power Statistics website*. Korea Power Exchange. Website: www.kpx.or.kr.

MOCIE (2004a). *Energy Policies of Korea*. Ministry of Commerce, Industry and Energy. Korea.

MOCIE (2004b). *2<sup>nd</sup> Basic Plan of Electricity Demand and Supply (2004-2017)*. Ministry of Commerce, Industry and Energy. Korea.

Podkovaalnikov (2002). *Study for Russia, Democratic People Republic of Korea, Republic of Korea, and China Power Interconnection: Analysis of Current Status*.