REPUBLIC OF KOREA

REPUBLIC OF KOREA

1. ENERGY, ECONOMIC AND ELECTRICITY INFORMATION

1.1. General Overview

The Korean Peninsula is located on the eastern edge of the Asian continent and is covered by mountains over 70% of its land area. The Peninsula has been divided in two since 1945, the Republic of Korea, commonly referred to as South Korea and the Democratic People's Republic of Korea, called North Korea. The Korean Peninsula is 222,154 km^2, while the administrative area of South Korea is 99,260 km^2. The Republic of Korea (Korea) lies on the southern part of the Korean peninsula neighbouring China and Russia. The terrain is mostly rugged and mountainous with only 21% of the land being arable.

Located in the East Asian Monsoon belt, Korea has a temperate climate with four distinct seasons. During the winter, from December to January, it is bitterly cold and dry under the dominant influence of the Siberian air mass. Meanwhile summer, from June to August, is hot and humid with frequent heavy rainfalls associated with the East-Asian Monsoon. The transition seasons, spring and fall, are mild and serene with fairly periodic passages of the transient high and low pressure systems. Annual precipitation is about 1,500mm in the southern region and about 1,300mm in the central region. More than a half of the total rainfall is concentrated in the summer season, while the winter precipitation constitutes less than 10% of the total.

Korea has its own language, Korean, unique and creative alphabet, called Hangul.

As of 2002, the Republic of Korea had a population of 47.6 million inhabitants (Table 1).

Korea is an energy resource-poor country. Consequently, energy security is one of prime concerns of the Korean government. There are no significant oil or gas resources and only limited anthracite coal deposits. Uranium deposits identified are so low grade and uneconomical that development has never been made.

TABLE 1. POPULATION INFORMATION

									Growth rate(%/yr)
	1960	1970	1980	1990	1996	1999	2000	2002	1980 to 2002
Population (millions)	25.0	31.9	38.1	42.9	45.5	46.6	47.0	47.4	0.8
Population density (inhabitants/km^2)	251.9	321.4	383.8	432.2	458.4	469.5	473.5	479.0	
Urban population as percent of total	28	41	57	74	78.9	81.2	81.9	-	
Area (1000 km^2)	99.26								

Source: IAEA Energy and Economic Database; National Statistical Office in Korea.

1.1.1. Economic Indicators

The Korean economy has grown remarkably over the last thirty years. Korea's Gross Domestic Product (GDP) growth rate has averaged nearly 5.8% per year over the period 1990 to 2002 and GDP reached 494.4 billion US$ in 2002.

Foreign exchange reserves have substantially recovered(foreign exchange reserve amounts to US$ 123.8 billions recording 5th in the world as of March 2003), the currency has stabilised, the stock market has revived strongly, interests rates have fallen, the balance of payments on current account has staged a remarkable turnaround and there has been an upsurge of inward investment. Table 2 shows the historical GDP & GNI statistics.

TABLE 2. GROSS DOMESTIC PRODUCT (GDP) & GROSS NATIONAL INCOME (GNI)

	1970	1980	1990	1996	1999	2000	2002	Growth rate (%/yr) 1990 To 2002
GDP [1]	8.0	62.2	252.6	520.0	405.8	457.2	474.4	5.8
GNI [1]	8.0	60.9	252.3	518.3	400.7	459.2	477.0	-
GNI [2] per capita	249	1,632	5,893	11,385	8,595	9,762	10,424	4.9
GDP by sector (%):								
- Agriculture	27	14.8	8.5	6	5.1	4.6	5.0	
- Industry	29	39.9	43.1	43	42.5	42.7	42.0	
- Services	44	45.3	48.4	51	52.4	52.7	53.0	

[1] Billions of current US$
[2] Current US$
Source: IAEA Energy and Economic Database; National Statistical Office in Korea.

1.1.2. Energy Situation

Korea has poor energy resources.

Therefore, the primary objective of Korea's energy policy has been to secure an economical and stable supply of energy by diversifying energy sources. At present, environment-friendly energy policies gained ground due largely to a progress in Climate Change Convention negotiations. The impact of the two oil crises in the 1970s on the Korean economy was severe. In response, the government tried to limit the annual increase in energy consumption to about 7 ~ 8%. By the 1990s, however, consumption was growing at more than 10% annually.

Table 3 shows the Korean energy reserves and Tables 4 and 5 the primary and final energy consumption, respectively in Korea. As in many other countries that are not endowed with fossil fuel reserves, nuclear power is considered to be the most reliable energy source capable of meeting the soaring energy demand necessary for economic development (i.e. an economic growth rate of some 10% per year). Korea has, consequently, chosen nuclear power as one of its major energy sources. Under the government's Power Development Program, nuclear power is to become the major energy source by 2015 supplying about 46 percent of the nation's total electrical power.

TABLE 3. ESTIMATED ENERGY RESERVES

Exajoule

	Solid	Liquid	Gas	Uranium [1]	Hydro [2]	Total
Total amount in place	1.46	N/A	N/A	16.93	5.01	23.40

[1] This total represents essentially recoverable reserves.
[2] For comparison purposes, a rough attempt is made to convert hydro capacity to energy by multiplying the gross theoretical annual capability (World Energy Council - 1998) by a factor of 10.
Source: IAEA Energy and Economic Data Base.

TABLE 4. PRIMARY ENERGY CONSUMPTION

1000 toe

	1970	1975	1980	1985	1990	1995	1999	2000	2002
Coal	5,829	8,075	13,199	22,022	24,385	28,092	38,155	42,911	49,096
Petroleum	9,293	15,637	26,830	27,142	50,175	93,955	97,270	100,279	102,414
LNG	N/A	N/A	N/A	N/A	3,023	9,213	16,847	18,924	23,099
Hydro	305	421	496	915	1,590	1,369	1,517	1,402	1,027
Nuclear	0	0	869	4,186	13,222	16,697	25,766	27,241	29,776
Others	4,251	3,420	2,517	2,031	797	1,051	1,806	2,130	2,925
Total	19,678	27,553	43,911	56,296	93,192	150,437	181,363	192,887	208,636
- Domestic production	10,333	11,397	12,491	17,579	25,520	21,593	30,800	32,644	35,521
- Imports	9,345	16,156	31,420	38,717	68,673	128,844	150,563	160,243	173,115
Per capita (toe)	0.61	0.78	1.15	1.38	2.17	3.34	3.89	4.10	4.38

Source: Country Information.

TABLE 5. FINAL ENERGY CONSUMPTION

1000 toe

	1970	1975	1980	1985	1990	1995	1999	2000	2001
Total	17,882	23,424	37,597	46,998	75,107	121,962	143,060	149,852	152,950
- Coal	5,593	7,566	12,426	17,940	19,855	17,758	18,498	19,847	20,532
- Petroleum	7,373	11,004	19,824	22,580	45,252	82,876	92,821	93,596	93,357
- Town gas	-	4	15	84	1,011	5,594	10,513	12,561	13,290
- Electricity	666	1,430	2,815	4,363	8,117	14,041	18,422	20,600	22,165
- Others	4,250	3,420	2,517	2,031	872	1,692	2,806	3,248	3,606
Growth rate (%)	12.3	3.1	1.7	4.4	14	8.7	8.3	4.7	2.1
Per capita (toe)	0.55	0.66	0.99	1.15	1.75	2.70	3.07	3.19	3.23

Source: Country Information.

1.2. Energy Policy

The key objectives of Korea's general energy policies can broadly be described under four main headings:

- Korea has a high level of dependency on energy imports and particularly oil. Thus, the primary objective in energy policies has been to improve the country's energy security;
- The second concern has been the desire to ensure that the Korean energy sector is managed in such a way as to provide low cost energy supplies to encourage and sustain economic development and growth;
- The third one is energy conservation. However, energy conservation is now attracting increasing attention as a tool for improving energy;
- The fourth major aspect of energy policies is the sustainable energy development. Harmonization of development and environmental preservation is the important concern.

1.3. The Electricity System

1.3.1. Structure of the Electricity Sector

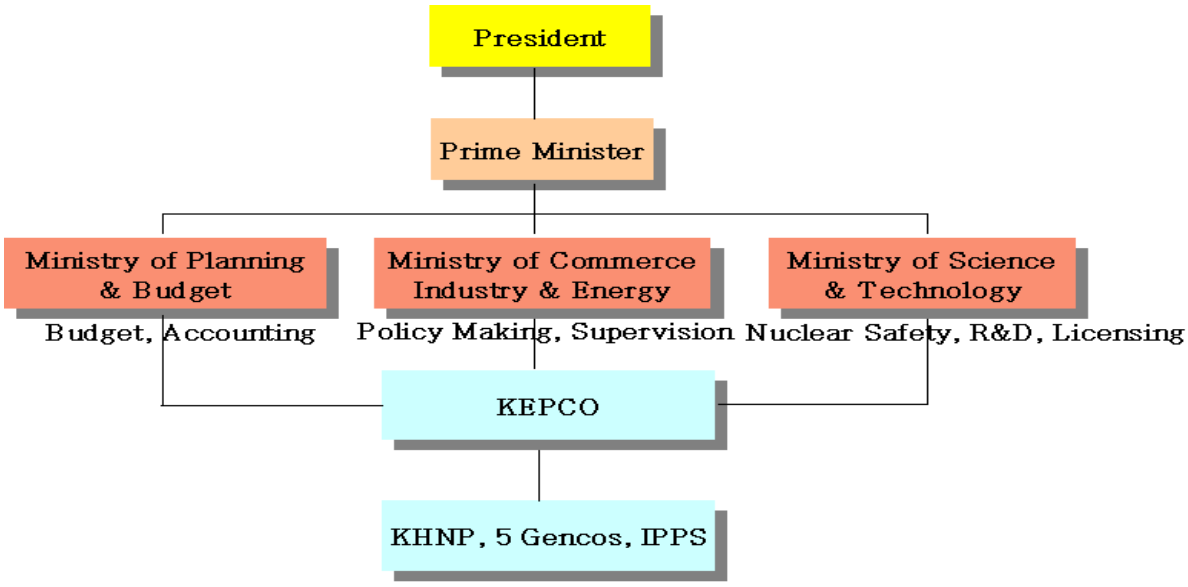

Fig. 1. Organization of the Electricity Sector

The ministries chiefly responsible for developing electricity policy in Korea are the Ministry of Commerce, Industry and Energy (MOCIE) in consultation and close co-operation with the Ministry of Planning and Budget (MPB) and six generation companies (GENCOs) along with the Korea Electric Power Corporation (KEPCO) among others. With energy being regarded as a key component of Korea's rapid economic development, the government has maintained a strong presence in the sector.

MOCIE, through the direct or indirect government ownership of energy companies, utilities and several energy research institutes, has maintained a high degree of control in all aspects of energy policy development and implementation.

MOST has the overall responsibility for ensuring the nuclear safety through the regulatory activities and related R&Ds.

In July 1998, in order to enhance economic efficiency, to improve the quality of public services, and to reduce the extent and level of the government's direct involvement in economic activities, the Korean government announced a privatization plan for state-owned enterprises (SOEs) including the KEPCO, Korea Heavy Industries and Construction Co., and KEPCO's subsidiaries (KOPEC, KPS, etc.).

Following the plan, the government announced the "Basic Plan for Restructuring of the Electricity Supply Industry" to introduce competition into the electricity supply industry in January 1999, as a precondition to the privatization, and sold a 5% stake of KEPCO to overseas investors in March 1999. According to the restructuring plan, KEPCO's power generation sector has been split-up in April 2001, into six generation companies (GENCOs), i.e. five non-nuclear GENCOs which will be privatized step-by-step, and one hydro-nuclear GENCO which is called KHNP(Korea Hydro & Nuclear Power Co., Ltd) will remain as a subsidiary of KEPCO in consideration of the importance of nuclear safety.

In the long-run, as the restructuring plan shows, KEPCO will undergo a split-up of the power distribution sector into several power distribution companies thereby introducing competition in the

wholesale and retail sectors, and opening-up of the transmission network to guarantee open access for private enterprises, thereby creating a fair competitive environment. Until April 2004, KPX will make a cyber test operations of potential wholesale market. Further restructuring plan in the future has not been decided.

While most of South Korea's generating capacity is controlled by the subsidiaries of KEPCO, a few independent power producers (IPPs) exist. LG Power co-owned by the LG Group and Texaco Inc.(USA) which holds 25% stake operates a 913-megawatt (MW) plant of Anyang and Puchon. LG Energy co-owned by SPI(Singapore) holding 50.1% stake operates 500-megawatt(MW) plant of Bugok at Asan Bay. Hanwha Energy co-owned by El Paso(USA) with 50% stake operates 1,650-megawatt(MW) Yuldo plant in Incheon, while Mirant co.(USA) with 100% stake operates 470-megawatt(MW) Suncheon plant in Jeonnam province. Nearly all of IPPs plants are combined cycle.

1.3.2. Decision Making Process

Under the vertically integrated system of electricity power industry in Korea, the establishment of the Long Term Power Development Plan by the Government and KPX had successfully balanced the electricity supply with the demand.

However, with the progress of restructuring, the competitive market mechanism has been introduced into the domestic electricity supply industry since April 2001. Thus the function of the Long-term Power Development Plan was inevitably changed into non-binding guidelines or reference under the deregulated scheme.

The Korean Government, in consultation with KPX(Korea Power Exchange), establishes the Basic Plan of Long-term Electricity Supply and Demand, the former Long Term Power Development Plan, as they did biennially before. However, the Plan is established not as a binding force but as a tool providing market participants with appropriate information and market based solution.

1.3.3. Main Indicators

The total installed capacity in 2002 was 53,801 MW(e), which accounts for an additional 32,780 MW(e) since 1990. The share of oil-fired power plants rapidly decreased from 65.5% in 1970 to 8.7% in 2002. Instead, nuclear energy became one of the largest electric power sources in Korea, with 29.2% share. The LNG, as a peak source, increased to 25.3%. This fuel mix shows a remarkable improvement in fuel diversity compared with the heavy reliance on oil that prevailed until the early 1980s.

The total power generation in 2002 increased from 184,661 GWh in 1995 to 306,474 GWh. This breaks down to 119,103 GWh (38.9%) from nuclear power, 118,022 GWh (38.5%) from coal-fired power, 25,095 GWh (8.2%) from oil-fired power, 38,943 GWh (12.7%) from LNG combined power, and 5,311 GWh (1.7%) from hydro power. The composition of installed capacity by power sources is shown in Figure 2. Table 6 gives the historical electricity production and installed capacities. The energy and economic data are given in Table 7.

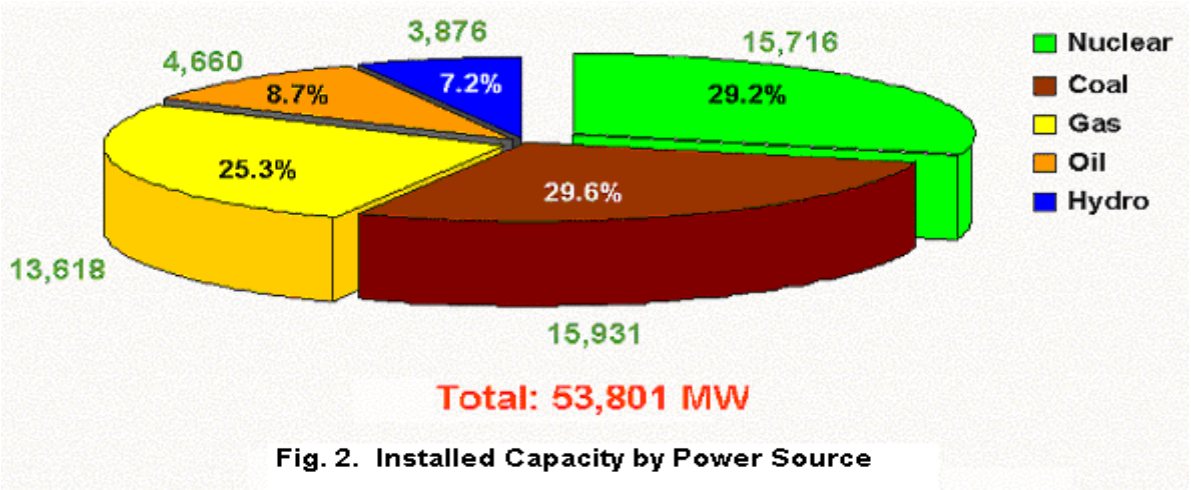

Fig. 2. Installed Capacity by Power Source

TABLE 6. ELECTRICITY PRODUCTION AND INSTALLED CAPACITY

								Avg. annual growth rate(%)	
	1961	1970	1980	1991	1995	2000	2002	1970 To 1990	1990 To 2002
Electricity Production (TWh)									
Total	1.77	9.17	37.24	118.62	184.66	266.4	306.47	13.40	8.52
Thermal	1.12	7.95	31.78	57.26	112.15	151.83	182.05	10.54	10.14
- Coal	1.12	0.87	2.48	20.14	48.81	97.54	118.02		
- Oil		7.08	29.30	27.18	42.05	26.14	25.09		
- LNG				9.93	21.29	28.15	38.94		
Hydro	0.65	1.22	1.98	6.36	5.48	5.61	5.31	8.60	- 1.04
Nuclear	-	-	3.48	52.89	67.03	108.96	119.10	-	7.00
Capacity of Electricity Plants (GWe)									
Total	0.37	2.51	9.39	21.11	32.18	48.45	53.80	11.19	8.36
Thermal	0.224	2.18	7.65	11.05	20.48	31.59	34.21	8.95	9.99
- Coal	0.224	0.54	0.75	3.70	7.82	14.03	15.93		
- Oil		1.64	6.90	4.80	4.94	4.76	4.66		
- LNG				2.55	7.72	12.80	13.62		
Hydro	0.143	0.33	1.16	2.34	3.09	3.15	3.88	10.31	2.58
Nuclear	-	-	0.59	7.62	8.62	13.72	15.72	-	6.22

Source: Country Information.

TABLE 7. ENERGY ECONOMIC DATA

	1970	1980	1990	1995	2000	2002
Energy consumption per capita (Toe/capita·yr)	0.61	1.15	2.17	3.35	4.08	4.37
Electricity per capita (kWh/capita·yr)	288	997	2,644	3,640	5,922	6,172
Electricity production/Energy production (%)	20	75	125	328	229	230
Nuclear/Total electricity (%)	-	9	42	36.3	36	36
Ratio of external dependency (%) [1]	47	75	78	96.8	90	92
Capacity factor of power plants						
- Total (%)	40	44	59	66.3	62	60
- Thermal	39	46	52	75.2	56	53
- Hydro	42	20	31	22.8	20	20
- Nuclear	-	68	79	87.3	91	87

[1] Net import / Total energy consumption

Source: IAEA Energy and Economic Database; Source: Country Information.

2. NUCLEAR POWER SITUATION

2.1. Historical Development and current nuclear power organizational structure

2.1.1. Overview

Nuclear activities in Korea were initiated in 1957 when Korea became a member of IAEA. In 1959, the Office of Atomic Energy was established as a government organization in conformity with the global trend toward developing peaceful uses of atomic energy. The Atomic Energy Law was promulgated in the preceding year.

The Republic of Korea has carried out a very ambitious nuclear power programme since the 1970's in parallel with the nation's industrialization policy, and has maintained a strong commitment to nuclear power development as an integral part of the national energy policy aimed at reducing external vulnerability and insuring against global fossil fuel shortage. Currently, Korea has one of the most dynamic nuclear power programmes in the world.

During the early years of nuclear power development, power plants were constructed mostly through "Turn-Key" contracts, providing little opportunity for domestic industries to participate in the construction. Since then, however, domestic participation in overall construction management, design, equipment supply, and civil construction has continuously increased through the adoption of the "Non Turn-Key" approach. A high degree of technological self-reliance was achieved through the construction of Yonggwang Nuclear Units(YGN) 3 and 4 in various fields of the nuclear industry. At present, nuclear power plant technology and related fuel cycle technologies are maturing.

The first domestic reactors were 1000 MW(e) PWRs Ulchin unit 3&4 so called Korea Standard Nuclear Power Plant(KSNP), which entered commercial operation in 1998. The Ulchin units 3 and 4 became the reference plant for KSNP plants thereafter. Six more of KSNP plants are being built at Ulchin, Shin-Kori and Shin-Wolsong as shown in table 8.

2.1.2. Current Organizational Chart(s)

In Korea, nuclear-related activities are planned and carried out by various organizations such as the Atomic Energy Commission (AEC), the Nuclear Safety Commission (NSC), the Ministry of Science and Technology (MOST), and the Ministry of Commerce, Industry and Energy (MOCIE).

Under the Atomic Energy Act, AEC is the highest decision-making body on policy issues and utilization of nuclear energy. The AEC is composed of nine to eleven members representing various sectors of the government, academia and industry. The chairman of the AEC is the Prime Minister.
MOST has the overall responsibility for the nation's nuclear research and development, regulatory and licensing works. In order to deal with important issues in nuclear safety, NSC was established under MOST in December 1996. The NSC consists of seven to nine members, including the Minister of Science and Technology who is its chairman.

MOCIE is responsible for the construction and operation of nuclear power plants, nuclear fuel supply, and the management of low- and intermediate-level radioactive waste.

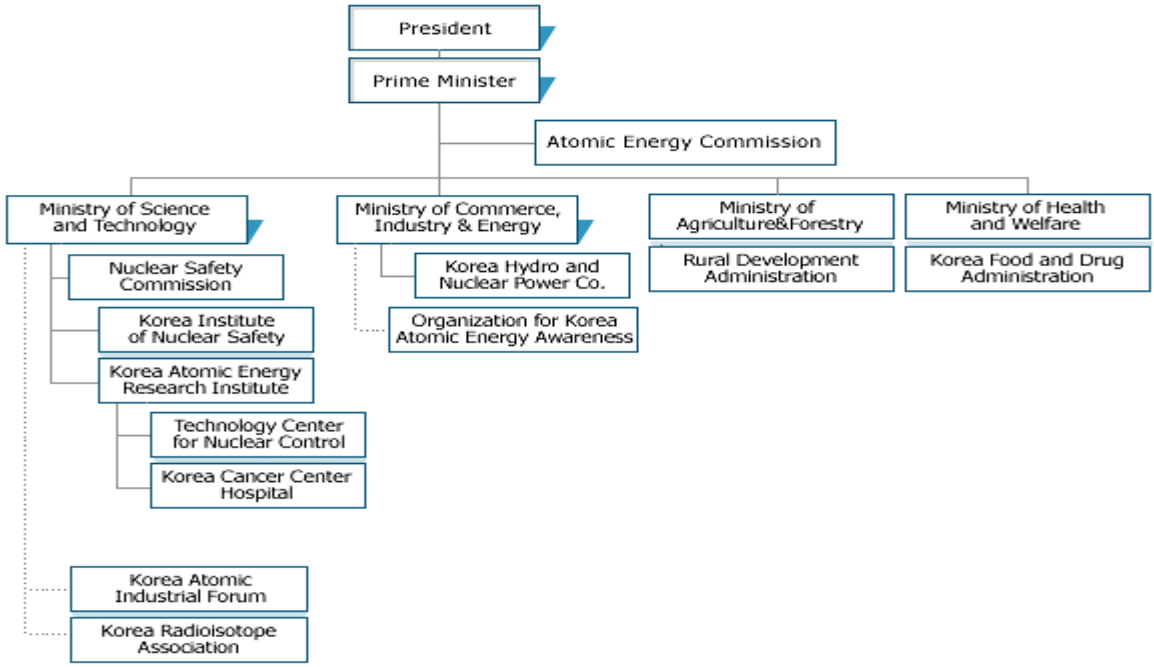

Fig. 3. Main Nuclear-Related Organizations in Korea

2.2. Nuclear Power Plants: Status and Operations

Since the first commercial operation of Kori unit 1 in 1978, nuclear energy has been an important energy in Korea. In spite of the slowdown of the nuclear energy industry in the U.S. and Europe, the Korean government has been steadily promoting the nuclear power generation business in response to Korea's increasing electricity demand, seeking new sites for nuclear power plants and supporting the development of commercial technology.

As of Dec. 2003, a total of eighteen nuclear power units are in operation, and eight units are under construction or planning as shown in Table 8. Korea has more than 15 GW of nuclear power capacity, which accounts for 29.2% of its total electric power capacity. The volume of nuclear power generation in 2002 was around 119 TWh, accounting for 38.9% of total power generation. Korea also has a high capacity factor of its nuclear units, which was 90.4% in 2000, 92.7% in 2002 as shown in Table 9.

TABLE 9. THE AVERAGE CAPACITY FACTOR OF THE KOREAN NUCLEAR POWER PLANTS

	1980	1985	1990	1995	1996	1997	1998	1999	2000	2002
Capacity Factor	67.4	78.7	79.3	87.3	87.5	87.6	90.2	88.2	90.4	92.7

Source : Country Information

According to the "the Basic Plan of Long-term Electricity Supply and Demand", which was finalized by MOCIE in August 2002, ten new nuclear power units will be constructed by 2015, including the eight units that are currently under construction or planning. The share of nuclear power capacity and nuclear power generation will be increased to 34.6% and 46.1%, respectively by 2015 as shown in Figure 5.

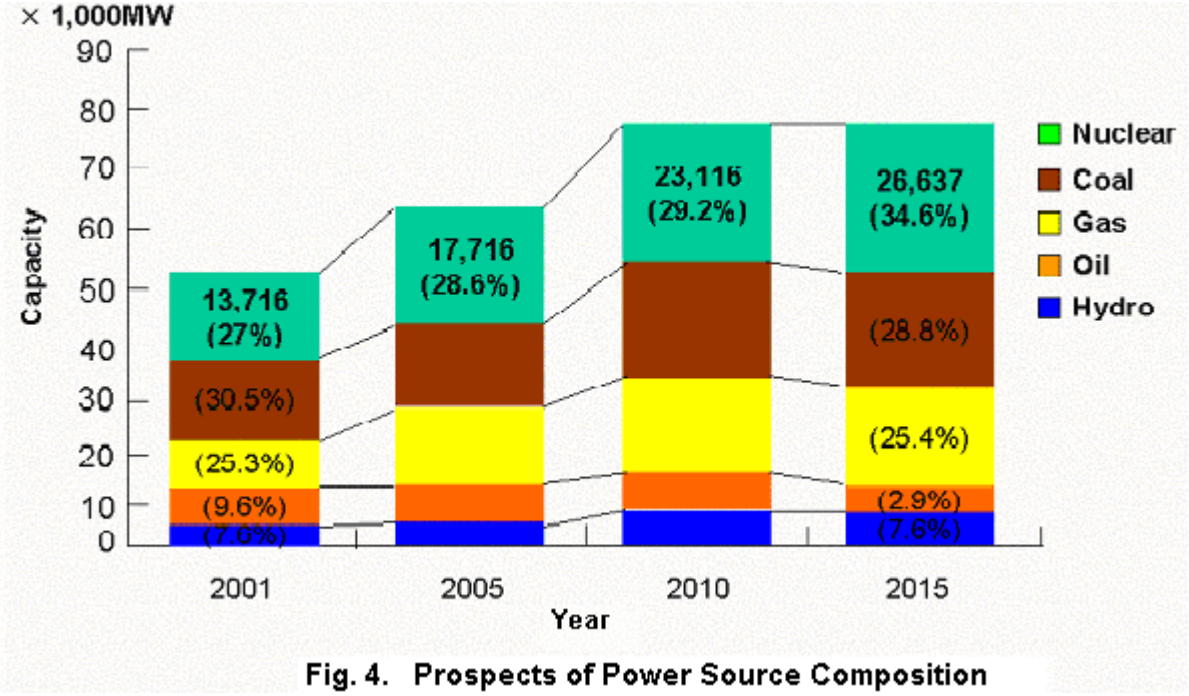

Fig. 4. Prospects of Power Source Composition

To enhance safety and economy of nuclear power plants, KHNP has developed an advanced power reactor with a capacity of 1,400MWe, called APR1400 since 1995, on the basis of technological self-reliance of KSNP.

The APR1400 is an improved version of a light water reactor. It is expected to be ten times safer than the KSNP. In terms of economic benefits, it will be more competitive than any existing nuclear power units or thermal plant. The APR1400 Standard design was certified through a stringent safety review by the Korean regulatory agency in May 2002 and appraised as the new design concept with enhanced safety and economical competitiveness. Shin-Kori Units 3 & 4 will be the first APR1400 plant and constructed at the site adjacent to the present Kori nuclear power station. They are scheduled to start commercial operation in September 2010 and 2011 respectively.

2.3. Supply of NPPs

In 1985, the Korean government made a milestone decision to implement the national self-reliance policy and allocated the roles and duties among domestic nuclear organizations to streamline the nuclear power industry

- *Total Project Management*	KHNP
- *Architectural Engineering and NSSS Design*	KOPEC
- *Research & Development*	KAERI
- *Maintenance Services*	KPS
- *NSSS, Turbine and Generator Manufacturing*	DOOSAN (formerly HANJUNG)
- *Nuclear Fuel Design and Fabrication*	KNFC

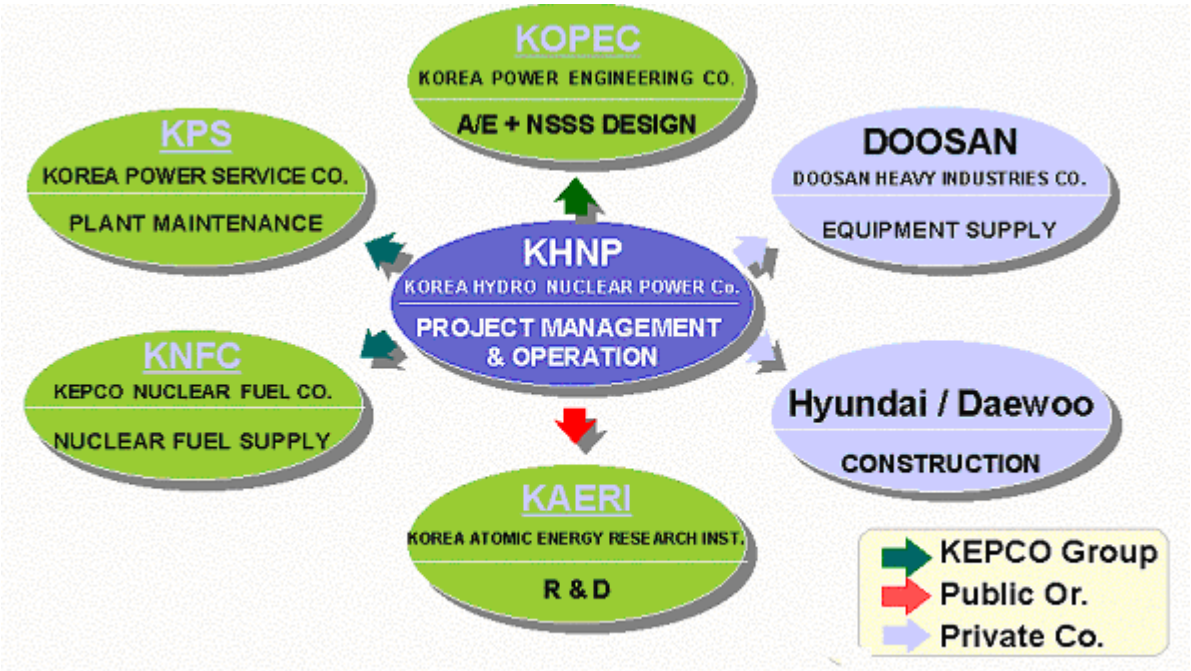

Fig. 5. Structure of Nuclear Power Industry

DOOSAN took part of plant manufacturing by virtue of its capability to supply heavy industrial construction equipment and machinery. KOPEC was established in 1975 to foster the nation's self-reliance in power technologies, particularly in nuclear power engineering for pressurized water reactors. KOPEC took the prime architect engineer's responsibility. KPS was decided to provide maintenance services for all the operating nuclear power plants and 5 individual companies including DOOSAN are providing maintenance services for Ulchin 5,6 plants under start-up. KNFC was established in November 1982 by the joint investment of KEPCO and KAERI to localize the nuclear fuel fabrication for pressurized water reactors and CANDU reactors.

The self-reliance strategy has been applied since construction of the Yonggwang 3&4 project. Domestic nuclear industries became the project's prime contractors on the condition of technology support and transfer from foreign subcontractors.

2.4. Operation of NPPs

KEPCO was the sole electricity generator in Korea. As mentioned in Section 1.3, KEPCO's generation sector has been split up into five non-nuclear GENCOs and one hydro-nuclear GENCO: KHNP. KHNP is the sole entity in Korea responsible for long-term planning, development and generation of nuclear and hydro power. It has implemented a comprehensive programme for improving the performance of NPPs leading to world top class.

TABLE 8. STATUS OF NUCLEAR POWER PLANTS

Station	Type	Capacity MWe	Operator	Reactor Supplier	Construction Start	First Criticality	Grid Connection	Commercial Operation	Shutdown Date
KORI-1	PWR	587	KHNP	Westinghouse	1971 November	1977 June	1977 June	1978 April	
KORI-2	PWR	650	KHNP	Westinghouse	1977 March	1983 April	1983 April	1983 July	
KORI-3	PWR	950	KHNP	Westinghouse	1979 April	1985 January	1985 January	1985 September	
KORI-4	PWR	950	KHNP	Westinghouse	1979 April	1985 October	1985 December	1986 April	
SHIN KORI-1	PWR	1000	KHNP	DHIC	-	-	-	(2008 September)	
SHIN KORI-2	PWR	1000	KHNP	DHIC	-	-	-	(2009 September)	
SHIN KORI-3	PWR	1000	KHNP	-	-	-	-	(2010 September)	
SHIN KORI-4	PWR	1000	KHNP	-	-	-	-	(2011 September)	
YONGGWANG-1	PWR	950	KHNP	Westinghouse	1980 December	1986 January	1986 March	1986 August	
YONGGWANG-2	PWR	950	KHNP	Westinghouse	1980 December	1986 October	1986 November	1987 June	
YONGGWANG-3	PWR	1000	KHNP	KHI/KAERI	1989 June	1994 October	1994 October	1995 March	
YONGGWANG-4	PWR	1000	KHNP	KHI/KAERI	1989 June	1995 July	1995 July	1996 January	
YONGGWANG-5	PWR	1000	KHNP	DHIC/KOPEC	1996 September	2001 November	2001 December	2002 May	
YONGGWANG-6	PWR	1000	KHNP	DHIC/KOPEC	1996 September	2002 September	2002 September	2002 December	
WOLSONG-1	PHWR	679	KHNP	AECL	1977 May	1982 November	1982 December	1983 April	
WOLSONG-2	PHWR	700	KHNP	AECL/KHI	1991 October	1997 January	1997 April	1997 July	
WOLSONG-3	PHWR	700	KHNP	KHI/AECL	1993 August	1998 February	1998 March	1998 July	
WOLSONG-4	PHWR	700	KHNP	KHI/AECL	1993 August	1999 April	1999 May	1999 October	
SHIN WOLSONG-1	PHWR	1000	KHNP	DHIC	-	-	-	(2009 September)	
SHIN WOLSONG-2	PHWR	1000	KHNP	DHIC	-	-	-	(2010 September)	
ULCHIN-1	PWR	950	KHNP	Framatom	1982 March	1988 February	1988 April	1988 September	
ULCHIN-2	PWR	950	KHNP	Framatom	1982 March	1989 February	1989 April	1989 September	
ULCHIN-3	PWR	1000	KHNP	KHI/KAERI	1992 May	1997 December	1998 January	1998 August	
ULCHIN-4	PWR	1000	KHNP	KHI/KAERI	1992 May	1998 December	1998 December	1999 December	
ULCHIN-5	PWR	1000	KHNP	DHIC/KOPEC	1999 January	2003 November	-	(2004 June)	
ULCHIN-6	PWR	1000	KHNP	DHIC/KOPEC	1999 January	-	-	(2005 June)	

Source: KHNP Annual Report 2002

( ) estimated commercial operation date

2.5. Fuel Cycle and Waste Management

Korea's demand for Uranium and nuclear fuel cycle service has continuously increased with the expansion of its nuclear power capacity. The demand is expected to account for more than 5% of the world's demand from the year 2000. Korea imports Uranium concentrates from Australia, Canada, the U.K, France, Russia, the U.S. and South Africa. In 2002, Korea imported a total of 6.0 million pounds of Uranium.

KHNP, the sole consumer of nuclear fuel in Korea, has a basic guideline to ensure the stable supply of nuclear fuel and to pursue the economic efficiency at the same time by applying an international open bid. For Uranium concentrates, KHNP has tried to maintain the optimal contract condition through both long-term contracts and spot-market purchase. Whereas conversion and enrichment services come from the U.S., the U.K., France, Canada, and Russia by long-term contracts. Fuel fabrication services are fully localized to meet domestic needs.

The Radwaste Disposal Facility Project of KHNP was established as the responsible organization for management of low-level radwaste and spent fuels in the nation. In order to carry out radioactive waste management programme more successfully, the government promulgated a law to enable such support to neighbouring local communities and inhabitants as fund to improve the standard of their living.

KHNP established the plan to build an Away From Reactor Interim Storage Facility for the spent fuel and a permanent disposal facility for the low/intermediate level radwaste under government’s auspice.

The plan was approved by the Atomic Energy Commission in September 1998. According to the plan, a low-and-intermediate-level radioactive waste (LILW) repository will be constructed by 2008 and spent fuels will be stored at each nuclear power plant site until interim storage facilities are constructed by 2016.

2.6. Research and Development

The Atomic Energy Act stipulates that the Minister of Science and Technology shall formulate the National Nuclear R&D Programme according to the sector-by-sector implementation plan.

The Nuclear R&D Programme, otherwise called the "National Medium-and-Long-term Nuclear R&D Programme", is implemented mainly by KAERI, KCCH(Korea Cancer Center Hospital) and KINS. Besides, industry-led R&D Programs are implemented by KHNP, KOPEC, KPS and KNFC etc.

Originally, the "National Medium-and-Long-term Nuclear R&D Programme" was launched in June 1992 as a 10-year (1992-2001) programme. It was modified into a new R&D programme for 1997-2006 term, to take account of major changes in national and international situations. The programme is funded by both the government and the nuclear industry.

The R&D Program is focused on five research fields such as; ❶ advanced reactor & fuel, ❷ nuclear safety, ❸ radioactive waste management, ❹ application of radiation and radioisotopes ❺ fundamental technologies.

A couple of projects for development of advanced reactors and fuel cycle technology are in progress under the mid and long-term nuclear R&D program. As the near term reactor options, KNGR(Korea Next Generation Reactor so called APR1400) and SMART(System-integrated Modular Advanced Reactor) are under development. As mid and long-term reactor options, KALIMER(Korea Advanced Liquid Metal Reactor) for power generation and a number of advanced reactors, as a member of Gen IV program, are also under development.

Even though Korea has a “wait and see policy” for spent fuel management, several alternative studies on spent fuel management have been carried out for a long time. The DUPIC program is one of the prominent approaches among the KAERI R&D activities. Also active R&D activities on the treatment of radioactive wastes from the nuclear fuel cycles as well as the decontamination and decommissioning of nuclear facilities are in progress.

Several research projects on the application of radiation and radioisotopes including the production of radioisotopes have been being conducted for various areas such as medicine, agriculture, food, industry etc.

2.7. International Co-operation and Initiatives

Until recently, Korea's Science & Technology cooperation with foreign partners largely took the form of technological imports or assistance of reciprocal nature. There were few joint R&D projects that benefited both participants. Furthermore, partnerships were limited to such advanced countries as the United States, Japan, and several European countries.

Korea has accomplished considerable S&T development by international cooperation. Now, as a newly industrialized country, Korea recognizes the need for a new approach to international cooperation. Korea is seeking a more active role in the international science and technology community, not only to contribute to scientific advancement but also to harness new knowledge for the nation's social and economic development. To this end, it is actively pursuing both bilateral and multilateral cooperation

Bilateral cooperation

As of October 2002, the Korean government has concluded 18 bilateral agreements on cooperation in the peaceful uses of nuclear energy with the governments of the USA, Canada, Spain, Australia, Belgium, France, Germany, the UK, China, Japan, Argentina, Vietnam, Turkey, Russia, Brazil, Czech, Ukraine and Egypt.

Korea also engages in talks on bilateral agreements with developing countries which have programs for the peaceful uses of nuclear energy. Through the conclusion of such an agreement, technology transfer and the safety of nuclear installations can be facilitated.

In general, bilateral cooperation with foreign countries is based on an inter-governmental S&T cooperation agreement. The joint research projects agreed on at bilateral meetings have been implemented mainly through the International Joint Research Programs. Although the United States, Japan and European countries have been major partners, bilateral cooperation with Eastern European Countries (EEC) has increased in recent years.

United States of America

Following the conclusion of the Korea-U.S. Agreement on S&T cooperation in 1976, a wide range of joint research projects as well as exchanges of scientists and engineers were carried out. The agreement, amended in 1993 and 1999, prescribes the allocation of intellectual property rights (IPR's) and strengthens its protection through mutual cooperation. In accordance with that agreement, the Korea-U.S. Joint Committee on S&T has been held every two years since 1993 and conducted a joint review of cooperative activities in order to keep pace with rapid advances in science and technology. The Korea-U.S. Special Cooperative Program in S&T has also been used to promote the exchange of scientists and engineers since 1995. The Korea-U.S. S&T Cooperation Forum, held every year since 1993, is expected to expedite joint cooperation in the field of mutual interests. The Korean government carries out S&T cooperation with the state government as well as the federal government.

United Kingdom

Korea-United Kingdom S&T cooperation has been fostered by the Korea-United Kingdom S&T Cooperation Agreement of 1985. The annual Korea-U.K. Round Table Meeting on S&T cooperation, which contributes to the promotion of S&T cooperation, has been held since 1996. They have greatly contributed to the promotion of S&T cooperation. As a result of these meetings, the Korea-U.K. Joint Research Fund Program, the KIMM-Rolls Royce Collaborative Research Project, and the S&T Joint Scholarship Program have been set up, and are being actively carried out.

Japan

Since the Korea-Japan S&T Cooperation Agreement was signed in 1985, the Korea-Japan Committee on S&T Cooperation, made up of officials from both governments, has held meetings once a year. Through this committee, a wide range of joint research projects as well as exchange of scientists and engineers have been carried out. The Korea and Japan Science and Technology Forum was held twice in October 1999 and November 2000, respectively, that laid the groundwork for active joint research projects. Also, the Korea-Japan Joint Committee for Basic Scientific Research, which holds its meetings annually from 1991, has played a pivotal role in promoting bilateral cooperation in basic science. In addition, province-to-province cooperative programs between the two countries, started in 1995, are being actively developed.

China

Scientific and technological cooperation with China has been carried out under the provision of the Korea- China S&T Cooperation Agreement signed in 1992. A variety of cooperative activities such as the exchange of technology survey teams, post-doctoral training programs, joint research projects and others have been undertaken. S&T exchange between the two nations is active and continuously expanding into new areas. MOST will work closely with China not only to strengthen bilateral S&T cooperation but also to advance regional development.

Germany

S&T cooperation with Germany was launched by the signing of the Korea-Germany S&T CooperationAgreement concluded in 1986. It has promoted the cooperative activities in high-tech fields such as new materials, laser technology, and automation. In recognition of the necessity to strengthen cooperation between the private sectors of the two countries, Korea and Germany established the Korea-German Non- Governmental Committee on Science and Technology in 1997. The Committee meeting was held three times in Korea and Germany and made a big contribution to promoting collaborative activities between the two countries. To strengthen the cooperation between the two countries Korea-Germany Non-Governmental S&T Forum is being considered. Experts from various areas of S&T will participate in this Forum to exchange information and discuss specific cooperative mechanisms.

Russia

Since Korea and Russia laid the foundation for bilateral S&T cooperation by signing the Korea-Russia S&T Cooperation Agreement in December 1990, S&T cooperation between the two countries has been actively promoted through the exchange of scientists and joint research projects.
Moreover, the establishment of joint research centers in such areas as aerospace, material, energy, and optics has greatly increased bilateral cooperation. Total number of the centers has increased so far. These cooperative activities have been reviewed by the Korea-Russia Joint Committee on S&T Cooperation and have encouraged contacts between scientists and specialists of the two countries. The two countries will seek further mutually beneficial activities such as the exhibition of Russian advanced optic technologies and R&D management and business training program for Russian scientists.

Multilateral cooperation

APEC

As a founding member, the Korean government has actively participated in APEC's Economic and Technical Cooperation (ECOTECH) activities, including cooperation on industrial S&T, marine resources, and development of human resources. In 1996, Korea hosted the APEC Ministers Conference on Regional Science and Technology Cooperation under the main theme of "Creativity and Mobility: Researchers Across APEC". At the conference, APEC ministers discussed ways to enhance the mobility and creativity of scientists and engineers in the region.

As a follow-up, Korea hosted the 1st APEC Youth Science Festival in Seoul in August 1998. It was attended by more than 460 boys and girls along with 170 teachers from twelve member economies. The festival served as an excellent opportunity for the young students from the APEC economies to share scientific ideas and to develop friendship among themselves. MOST is currently implementing four Korea-initiated projects to promote the exchange of researchers and S&T information.

OECD

Korea joined the OECD at the end of 1996. Before that, Korea joined its committee for Scientific and Technological Policy (CSTP) in 1994 and actively participated in its sub-committee and working group activities. Korea held the OECD Seoul Conference on International Technology Cooperation under the theme of "Facilitating International Technology Cooperation in a Knowledge-based Economy" in 1997 and "International Scientific and Technological Cooperation for Sustainable Development" in 2000.

Korea is also leading a research group on the "National Innovation Systems in Catching-up Economies." Moreover, Korea took part in the 10th Ministerial Meeting of CSTP in June 1999, and made a lead speech under the theme of "Benefiting from Globalization."

ISTC

In November 1997, the Governing Board of International Science and Technology Center (ISTC) approved Korea's request to be a party to the ISTC Agreement. Korea joined ISTC in May 1998.

In accordance with the terms of the Agreement and other regulations, Korea has taken part in international efforts to support the research projects of weapons scientists and engineers in Russian Federation for peaceful purposes.

Korea has actively participated in all the activities of the ISTC, including the support of research projects and the sharing of ISTC administrative budget. Korea has maintained close and cooperative ties with all ISTC members, including USA, Japan, EU, Russia, and Norway to promote the goals of the ISTC. The government has also supported ISTC Secretariats by dispatching a staff as Senior Project Manager.

EU

Korea and the EU have been maintained a close relationship since the conclusion of the Arrangement on S&T cooperation in 1992. Four S&T Joint Seminars have been held since then, and scientists and students have been exchanged between two. In addition, since 1996 Korea has stationed an official in the Joint Research Center (JRC) to get first-hand experience on the EU's advanced S&T system and to find ways to enhance cooperation.

2.8. Human Resources Development

Basic research in Korea

In Korea, universities are the biggest brain pool consisting of 78% Ph. D. researchers at work. Yet,the research conditions in universities are not optimum due to lack of funds, research equipments, and other facilities. Faculties are also suffering from teaching overloads, another reason for the low R&D performance. In 2001, only 10.4% of national R&D expenditures was allocated to universities, whereas the figure for GRIs was 13.4%, and for industry 76.2%. The government plans to increase basic research expenditure in R&D up to 20% by 2002. The government's support for basic research is funded mainly by the Ministry of Science and Technology (MOST) and the Ministry of Education & Human Resources Development (MOE) via their respective agencies: the Korean Science and Engineering Foundation (KOSEF) and the Korea Research Foundation (KRF).

Centers of excellence

There are major Centers of Excellence (COE) in Korea, namely: Science Research Centers (SRCs),Engineering Research Centers (ERCs), and Regional Research Centers (RRCs). These COEs were put up to implement programs that encourage basic research in major universities. The SRCs and ERCs, founded, in May 1989, focus on the creative and innovative research in basic sciences and new technologies, while the RRCs, which started in 1995, emphasize cooperative research between regional universities and industries. SRCs and ERCs were selected on the basis of creativity and research capability. In the selection of RRCs, both research capability and contribution to the regional economy and community are important factors. Once the centers are selected, they receive government's funding for nine years provided that the interim evaluation done every three years shows good progress. So far, 36 SRCs, 47 ERCs, and 37 RRCs have been selected and funded.

R&D Equipment, Materials, and Information

Building up research infrastructure is another way to improve basic research in science and engineering. The Ministry of Science and Technology (MOST) fully supports various universities to boost research capabilities. Its programs include strengthening the academic research environment and to enhance the efficiency of research investment. It optimizes the use of university research resources such as equipments, materials, and information. Three major programs are underway. These programs support university research groups managing the following:

- costly research equipments
- special research materials bank
- specialized research information center

The cost of operating scientific equipments and special research materials are provided to individual laboratories to promote collaborative studies. Through the specialized research information centers, researchers can access various research data maintained by centers. This ensures optimum exploitation of research experience by rationally gathering information. Three programs are being carried out by The Korea Basic Science Institute (KBSI) and KOSEF.

World class Institutes

In 1996, Korea established the Korea Institute for Advanced Study (KIAS) as a world-class institute with strong commitment towards excellent research in basic sciences (mathematics, physics, chemistry, and biology). The main objectives of KIAS include the training of young scientists to advance the knowledge of basic sciences, and the promotion of sciences and technologies in Korea to a world-class level. KIAS aims to achieve this mission through high-quality research programs and a

strong faculty members composed of distinguished scientists and visiting scholars. In 1999, KIAS had over 180 visiting scholars from home and abroad, and organized numerous international conferences, symposia, and workshops, in which several world-renowned scientists had participated. The Asia-Pacific Center for Theoretical Physics (APCTP) was placed in Korea in 1997. The establishment of APCTP in Korea is expected to make the Korean physics community one of the international hubs of theoretical physics research, provide young scientists with excellent training opportunities within their reach, and hasten contact with the forefront information and development in basic sciences. Both KIAS and APCTP are giving Asia-Pacific scientists an opportunity to work together and advance the regional level of basic sciences.

High-caliber Manpower

The prerequisite for meeting the growing demand for R&D is to secure a highly competent research manpower. Thus, the government is making an effort to transform graduate programs at Korean universities into ones that are more research-oriented. It has provided financial support to universities selectively on the basis of their research performances. Science and engineering universities are training and producing 99% of the science and technology manpower in Korea. The number of graduates in 2000 receiving BS degree, MS degree, and Ph.D degree was 258,126, 64,259 and 7,240 respectively, for a total of 329,625 up by 6.2% from 1999.

Research-oriented Institutes

The Korea Advanced Institute of Science and Technology (KAIST) is a research-oriented science and engineering university established in 1971. Since its founding, KAIST has been funded by the government, and its industrial funding continues to increase. By 2003, KAIST is expected to produce 26,707 graduates. This number represents 6,526 for BS degree, 14,801 for MS, and 5,380 for Ph.D, respectively. As a new challenge for KAIST, the government has given the task of raising the level of research and education capabilities to that of the world's top 10 in the 21st century. KAIST is located in Daedok Science Town and enjoys the advantage of being involved in many cooperative programs with nearby research institutes. The Gwangju Institute of Science and Technology (K-JIST) opened in March 1995 as a graduate school. The institute has integrated graduate education with mission-oriented research in highly advanced technological fields such as information and communications, new materials, mechatronics, environment, and life sciences. All the lectures at the institute are given in English so that students of other countries may attend as well. From 1997 to 2000, K-JIST produced 654 MS graduate students and six Ph.D. students, for a total of 660 graduate students. With a strong vision on the role of science and technology in stimulating future economic growth in the Gwangju area, K-JIST is in the forefront of developing cooperation in R&D between industry and academia. K-JIST plays a key role in both education and R&D in the optical communications industry sector, which is an emerging field, that is a focus of intense research by the local government for future investment and development.

Science and Technology Education

To provide better education for gifted and talented school children, MOST introduced in 1998 to 2000 special programs at 15 universities nationwide, the four basic science and information science. These special programs target to educate about 2,200 students in a year. In addition, KAIST provides a distance-learning program that educates about 1,300 children every year. To promote the science awareness of the youth, MOST gives financial support for their participation in international science Olympiads, as well as to host them. The International Mathematics Olympiad 2000 (IMO 2000) was held in Daejon, in which around 500 students from 82 countries participated. Korea will hold the International Olympiad in Informatics 2002 (IOI 2002), and will participate in five international scientific Olympiads every year.

3. NATIONAL LAWS AND REGULATIONS

3.1. Safety Authority and the Licensing Process

3.1.1. Safety Authority

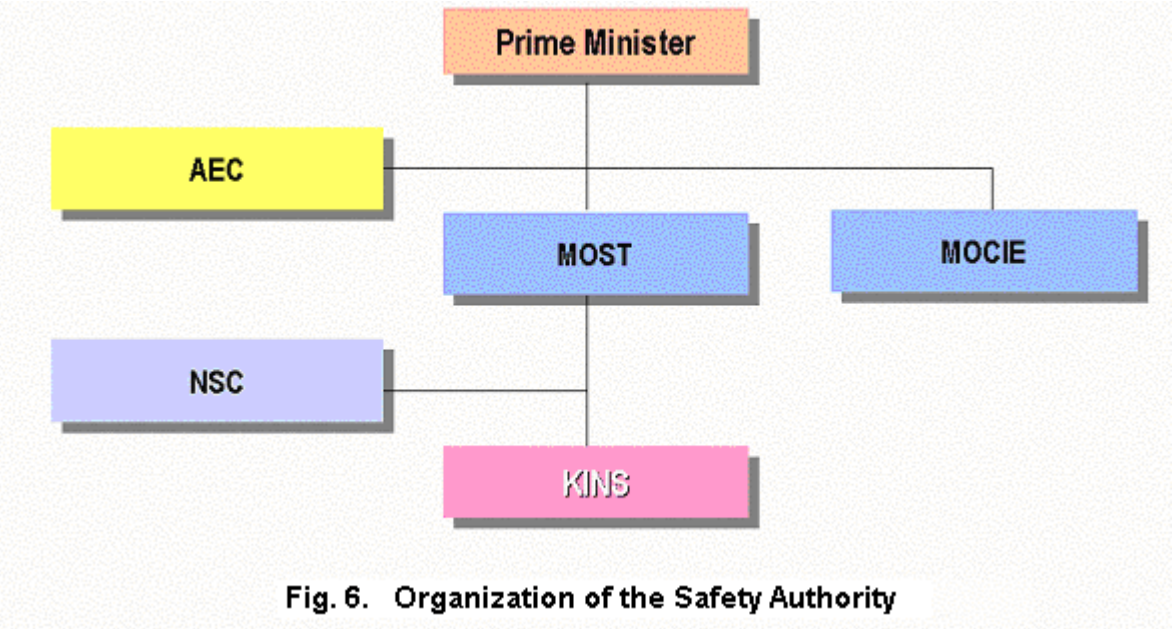

Fig. 6. Organization of the Safety Authority

The assurance of nuclear safety is the highest priority in the use and development of nuclear energy in Korea. The goal is to protect plant personnel and neighbouring inhabitants by keeping radiation effects as low as possible.

Nuclear regulatory organizations are mainly composed of MOST as a regulatory authority, the Nuclear Safety Commission (NSC), and Korea Institute of Nuclear Safety (KINS) as an technical expert body. The NSC's function is to deliberate and decide on important issues related to nuclear safety. The NSC is independent of the Atomic Energy Commission.

MOST has the overall responsibility for ensuring the protection of public health and safety through regulatory control and safety inspections, based on the provisions of the Atomic Energy Act. KINS entrusted with the regulatory works by MOST, carries out technical assessments according to the licensing documents prepared by the utility and conducts safety inspections on all nuclear facilities. The basic concept of nuclear safety is not only to protect the public health and safety from radiation hazards, but also to protect the environment from any subsequent harmful effects.

In September 1994, the MOST issued the "Nuclear Safety Policy Statement" containing five regulatory principles of nuclear safety: "Independence, Openness, Clarity, Efficiency, and Reliability" in order to secure consistency, adequacy, and rationality of regulatory activities. The Nuclear Safety Policy Statement declares that securing safety is a prerequisite to the development and utilization of nuclear energy, and that all personnel engaged in nuclear activities must adhere to the principle of "priority to safety". It emphasizes the importance of developing the nuclear safety culture that the International Atomic Energy Agency (IAEA) has referred to.

It also prescribes that the ultimate responsibility for nuclear safety rests with the operating organizations of nuclear installations, and is in no way diluted by the separate activities and responsibilities of designers, suppliers, constructors, or regulators. Finally, it prescribes that the government shall fulfilI its overall responsibility to protect the public and the environment from

radiation hazards that might accompany the development and utilization of nuclear energy.

3.1.2. Licensing Procedures

Regulation and licensing procedures for nuclear power plants in Korea are divided into three stages:

- In the site selection stage, the conceptual design is examined to determine the appropriateness of the proposed site. The safety requirements of the site are reviewed from standpoints of the design, the construction, and the operation of the plant;
- For the construction permit, the utility submits a Preliminary Safety Analysis Report (PSAR) and an overall quality assurance programme for the Project along with the reference design of the plant. Additionally, the utility is required to prepare an environmental impact statement;
- When the utility requests an operating license, MOST must confirm that the as-built plant conforms to the submitted design. In this stage, operational technical specification, and emergency plans and procedures against radiation hazards are submitted.

Regulatory inspections of NPPs under construction or in operation are implemented according to the procedure of a pre-operational inspection of the nuclear installation, a periodic inspection of the operating nuclear installations, a quality assurance audit, a daily inspection by resident inspectors, and a special inspection.

Of the eighteen nuclear power plants in the country, nine units have been in operation for more than ten years as of the end of 2002. In compliance with the Article of the Convention on Nuclear Safety, the Periodic Safety Review (PSR) was adopted by the Ministry of Science and Technology through technical review by the Nuclear Safety Commission as a safety evaluation process during the lifetime of operating nuclear power plants to maintain the safety level at current safety standards and practices.

Kori Unit 1 was designated as the first plant to apply PSR in Korea and has been implemented by KHNP since May of 2000. The result was submitted to MOST in November 2002 for intensive review. The other plants which have been operating for over 10 years will have PSR implemented by 2006

The Korean government is continually improving its nuclear control system as the amount of domestic nuclear material increases in parallel with the growth of the nuclear industry. The government established a State System for the Accounting and Control of nuclear materials (SSAC) within MOST. In order to develop nuclear control technology and to technically assist the government, the Technology Center for Nuclear Control (TCNC) at KAERI was established in 1994.

3.1.3. Radiation Protection Policy

The Atomic Energy Act prescribes the basic matters on radiation protection to be applied to nuclear installations, as follows:

- provisions on protective measures against radiation hazards that keep the radioactive material release and the occupational radiation exposure as low as reasonably achievable (ALARA);
- provisions on safety measures relating to operations stipulating the necessary actions to be taken for protecting human life, materials, and the environment from radiation hazards which may accompany the operation of nuclear installations;
- performance criteria for the personnel dosimetry service for radiation workers or persons having access to nuclear installations; and
- training requirements for the workforce involving radiation exposure.

The Enforcement Decree and Regulation of the Atomic Energy Act specifies the details necessary for implementing the basic matters referred to in the Act. The Notice of the Minister of Science and Technology (titled "Radiation Protection Standards") prescribes technical requirements on radiation protection such as the conditions of radioactive effluent release and dose limits.

The safety regulatory activities for radiation protection are classified into safety reviews, regulatory inspections, and the development of technical standards. In the safety review, items are examined concerning ALARA assurance of radiation exposure to workers, source term assessment, characteristics of radiation protection design, dose assessment, health physics programme, and the appropriateness of equipment.

The regulatory inspection confirms whether or not the radiation monitoring system in nuclear installations is properly operated. It also confirms that any personal exposure to radiation is maintained as low as reasonably achievable (ALARA) by checking the health physics programme, the procedures for the radiation exposure control, the ALARA programme, and radiation work management.

Korea is now developing the Information System on Integrated Radiation Safety (ISIRS). This system can easily trace and monitor all processes related to the use of radioactive sources from production and importation to final disposal through the Internet. ISIRS can provide a more accurate and extensive information on radiation safety on a real time basis to the general public and to all other related organizations.

As of December 2002, the number of licensed organizations for radiation utilization in Korea is 1,998, which consists of industrial firms 56.7%(1,132), educational and research institutes 20.9%(417), public institution 15.4%(308), hospitals 6.5%(130), others 0.6%(11).

3.1.4. National Environmental Radiation Monitoring Network

KINS, entrusted by MOST, installs and operates the nation-wide environment radiation monitoring network in addition to the above safety regulatory activities. KINS measures the radioactivity in airborne dust, fallout, rainwater, livestock products, farm products, soil, drinking water, and background radiation levels throughout the nation. This enables KINS to quickly detect and properly respond to any abnormal situations or symptoms in environmental radioactivity.

The nationwide environmental radiation monitoring network consists of an environmental radiation monitoring center in KINS, local monitoring stations situated at ten cities of large population, monitoring posts located in Ulnongdo and Baekryongdo which are islands located far away from the peninsular in the eastern and western sea respectively, monitoring posts around four nuclear installation sites, and a monitoring network connected with a military monitoring post.

3.2. Main National Laws and Regulations in Nuclear Power

The Korean government promulgated the Atomic Energy Act as a fundamental legislation to regulate the nuclear activities in Korea. The regulatory organizations and functions are also described in the Act. MOST has ultimate responsibility for the protection of the public and environment, while the prime responsibility rests with the utilities.

The legislative system of Atomic Energy law has several levels according to origination and applicability, i.e., the Atomic Energy Act, Enforcement Decree, Enforcement Regulation, Notice of the Minister of MOST, and Technical Specification which is a part of the safety analysis reports. The regulatory authority for regulating nuclear industry activities is based on the Atomic Energy Act. In conformity with the atomic energy laws, the licensee submits to MOST various documents demonstrating the adequacy of the proposed design.

There are two major legislative instruments regarding civil nuclear third party liability, namely the "Act on Compensation for Nuclear Damage" (so-called Compensation Act) and the "Act on Indemnification Agreements for Nuclear Liability" (so-called Indemnity Agreement Act).

Reflecting developments in related international conventions, the Compensation Act was amended in December 2000 and entered into force on January 1, 2002. Highlights of amendment are as follows;

- Expansion of applicable scope not only to nuclear incidents in the territory but also in the EEZ (Exclusive Economic Zone);
- Increase of operator's liability to 300 million SDRs;
- Extension and clarification of the definition for "nuclear damage" according to the 1997 Protocol to Amend the Vienna Convention;
- Exclusion of a grave natural disaster such as earthquakes from exonerations;
- Extension of prescription period for personal injury to 30 years.

A Nuclear Damage Compensation Deliberation Committee within MOST co-ordinates extra-judicial settlement of claims for nuclear damage compensation and surveys and evaluates nuclear damage.

In 2001, the Atomic Energy Act was amended to reflect the reorganization of the government, deregulation, and the rearrangement of the legal system. The relevant lower level enactment was completed in the first half of 2000. Subsequently, the Atomic Energy Act was amended again in 2001 to take into account the strengthening of nuclear safety as follows;

- Increase of NSC members to guarantee more participation of specialists in the policy and decision-making process;
- Introduction of the Periodic Safety Review (PSR) to ensure that the safety of operating NPPs is maintained at current safety standards and practices;
- Introduction of the Standard Design Certificate to streamline the licensing process for the construction of NPPs with same design.
- Introduction of the ICRP Pub. 60 on a step-by-step basis with full implementation starting in January 2003.

4. CURRENT ISSUES AND DEVELOPMENTS ON NUCLEAR POWER

4.1. Energy Policy

Long-term Nuclear Energy Policy Towards the year 2030

In order to realize the goal of the Atomic Energy Act, the Atomic Energy Commission has decided the "Direction to Long-term Nuclear Energy Policy Towards the Year 2030" in July 1994. The Direction emphasizes the safe and peaceful use of nuclear energy under a spirit of pursuing a better life in harmony with nature. It describes 4 primary objectives contributing to the economic and technological development and ultimately to the improvement of human welfare as follows:

- to enhance the stability in energy supply by promoting nuclear energy as a major energy source of domestic electricity generation,
- to achieve self-reliance in a nuclear reactor and proliferation-resistant nuclear fuel cycle technology through comprehensive and systematic nuclear energy research and development,
- to foster nuclear energy as a strategic export industry by securing international competitiveness through the advancement of nuclear technology, on the basis of active participation and initiatives of the civil sector, and

- to play a leading role in the improvement of human welfare and the advancement of science and technology by expanding the use of nuclear technology in agriculture, engineering, medicine, and industry, and by enacting basic research of nuclear technology.

For the effective achievement of these 4 objectives, 10 basic directions of a long-term nuclear energy policy were established as follows:

- to continue expanding the development and utilization of nuclear energy in the future, unless an epoch-making alternative energy source becomes available in the forseeable future,
- to develop and utilize nuclear energy for peaceful purposes only, and to consistently uphold this policy,
- to further strengthen the efforts to improve nuclear safety, recognizing the fact that securing nuclear safety is a prerequisite to the development and utilization of nuclear energy,
- to improve the economy and to strengthen the international competitiveness of domestic industries through the advancement of nuclear technology,
- to increase the public's understanding of and support for nuclear energy while respecting the public's right to know under the ideals of democracy and openness,
- to implement the nuclear energy policy in such a way as to promote a balanced development of the entire spectrum of both nuclear industries and technologies,
- to promote creative research and development activities so that nuclear energy can play a leading role in demonstrating the possibilities of technological innovation and to challenge new areas of science and technology, as an integral part of the national science and technology policies,
- to conduct nuclear research and development activities in collaboration with industries, universities and research institutes by rational division of the responsibilities between the governmental and the non-governmental sectors, in view of the specialization, complexity, and the immensity of nuclear research,
- to implement the nuclear energy policy on the basis of international understanding and cooperation in order to keep up with international harmonization, and
- to consistently implement the nuclear energy policy on the basis of long-term perspectives on the techno-economic and socio-political environment.

Comprehensive Nuclear Energy Promotion Plan

In order to achieve the objectives of the long-term nuclear energy policy, the government established a legal basis to formulate the "Comprehensive Nuclear Energy Promotion Plan (CNEPP)" every five years through the amendment to the Atomic Energy Act in January 1995. The CNEPP includes long-term nuclear policy objectives and basic directions, sector-by-sector objectives, budget and investment plan etc.

The Atomic Energy Act stipulates that the Minister of Science and Technology and the heads of the concerned Ministries shall formulate sector-by-sector implementation plans for those areas under their jurisdiction every five years in accordance with the CPPNE and shall establish and implement annual action plans according to the sector-by-sector implementation plans.

The 1st CNEPP was formulated in June 1997. As of July 2001, the Korean government formulated the second CNEPP which includes implementation plan for five years from 2002 to 2006, and a direction to nuclear energy ploicy towards the year of 2015.

10 promotion areas of the CNEPP are as follows;
(1) Nuclear Electricity Generation and Reactor Development
(2) Nuclear Fuel Cycle
(3) Utilization of Radiation and Radioisotopes
(4) Fostering and Promotion of Nuclear Industry
(5) Enhancement of Public Understanding and Site Acquisition

(6) Nuclear Safety and Radiation Protection
(7) Radioactive Waste Management
(8) Basic and Fundamental Nuclear Research and Development
(9) Training of Nuclear Manpower
(10) Nuclear Diplomacy and International Cooperation

In 2002, to accelerate Radiation Technology(RT) development, Korea has enacted the "Act on the Utilization of Radiation and Radioisotopes". This act aims to secure RT research fund and formulation of related industries and manpower development, and establishment of Radiation and Radioisotopes R&D Center under KAERI by 2005.

4.2. Privatisation and deregulation

The deregulation of the electricity market including privatisation of the sector and an increasing awareness of environmental issues create new challenges and opportunities for the different generation technologies, including nuclear power.

Market liberalization is expected to affect not only price level of electricity power, but also competitiveness of various power generation technologies. Liberalized market implies the possibility of business failure and capital loss for incompetent power generation companies. Power generation companies including KHNP in liberalized market bear more business risk in return for the possibility of higher return, being in favor of less capital-intensive technologies. This will impose additional challenge for the future of nuclear power. Nuclear power has relatively larger burden for risk management due to its characteristics such as higher capital cost, longer construction time, less flexible operation conditions, and higher political and technical risks related to safety, waste disposal and decommissioning issues.

However, the nuclear power plants have achieved the lowest generation cost among other power sources such as coal, LNG and oil etc in Korea. And deregulation of electricity market is expected to be positive for nuclear power. And it is expected to give more chances to enhance operational performance of nuclear power plants. The potential costs related to reduce gases and other pollutant emissions by coal-fired power would strengthen the competitiveness of nuclear power.

4.3. Role of the government in the nuclear R& D

The Atomic Energy Act stipulates that the Minister of Science and Technology shall formulate the National Atomic Energy R&D Program according to the sector-by-sector implementation plan as described in 3.B. The Atomic Energy R&D Program, so called the "National Mid- and Long-term Atomic Energy R&D Program", is implemented mainly by KAERI, KCCH and KINS.

Originally, the "National Mid and Long-term Atomic Energy R&D Program" was launched in June 1992 as a 10 year (1992-2001) program. It was modified into a new R&D program to be implemented for 1997-2006 term, to take account of major changes in national and international situations. 28 Major projects are being carried out currently and are funded by both the Government budget and the Atomic Energy R&D Endowment fund.

In 2001, 167.3 billion Won had been funded to the R&D programs, the fund was raised with the government budget (30 billion Won), the Atomic Energy R&D Endowment Fund (123.4 billion Won), and the balance carried-over, etc (13.9 billion Won).

The Intermediate and Long term R&D Program covers 6 fields as follows; □) nuclear reactor & nuclear fuel, □) nuclear safety, □) radioactive waste management, □) radiation/radioisotopes application & radiation protection, □) current issues related to the NPP, and □) basic technology. The R&D fund distribution by each sector is shown in Figure 7.

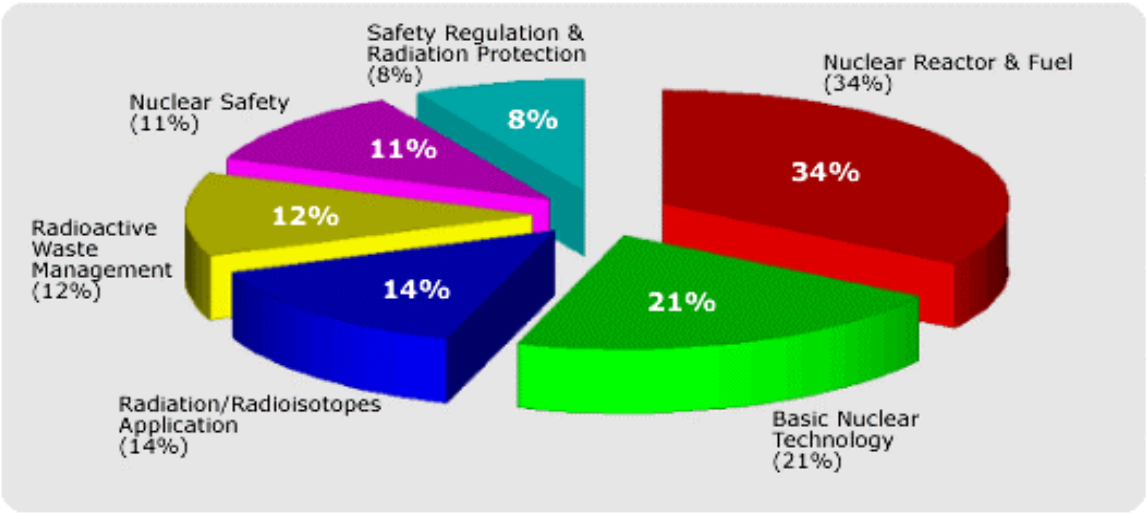

Fig. 7. R&D Fund Distribution by Sector (2001)

4.4. Nuclear Energy and Climate Change

Korea has been implementing policies concerning energy, environmental protection and economic development through a variety of programs. In order to formulate and implement measures to deal more efficiently with the United Nations Framework Convention on Climate Change(UNFCCC), an Inter-Ministerial Committee on the UNFCCC comprised of related government agencies, research institutions and private companies, was established in April 1998 with the Prime Minister as the head of the committee. The committee are preparing and implementing comprehensive measures to cope with the UNFCCC every three years. It is noteworthy that since 1995 the Korean government has budgeted more than 5.3 trillion Won(US$ 6 billion) to finance various projects aimed at mitigating the adverse effects of climate change through the “Energy Project Special Account”.

Since more than 97% of Korea’s energy demand is met through imports, Korea’s energy policy has always placed top priority on energy conservation and energy efficiency even before the adoption of the UNFCCC in 1992. After the Rio Conference, such efforts have been further strengthened. In addition, the use of energy sources with low carbon intensity, such as nuclear energy and LNG is continuing to be expanded and the policy of promoting energy-related technology development is being vigorously implemented . The Korean government will promote less energy-intensive economic activities and encourage a more environmentally friendly life style. Furthermore, the government will develop and commercialize innovative technology to reduce the emissions of greenhouse gases, such as a next-generation nuclear reactor and a fuel cell. At the same time it will promote a “Clean Energy Community” to enhance energy efficiency in the residential and commercial sectors.

4.5. Safety and waste management issues

4.5.1. Nuclear Safety

In September 1994, MOST issued the "Nuclear Safety Policy Statement" containing 5 regulatory principles of nuclear safety: independence, openness, clarity, efficiency, and reliability.

The Nuclear Safety Policy Statement declares that securing safety is a prerequisite to the development and utilization of nuclear energy, and that all workers engaged in nuclear activities must adhere to the principle of "priority to safety". It emphasizes the importance of developing the nuclear safety culture that the International Atomic Energy Agency (IAEA) has referred to.

It also prescribes that the ultimate responsibility for nuclear safety rests with the operating organizations of nuclear installations, and is in no way diluted by the separate activities and

responsibilities of designers, suppliers, constructors, or regulators. Finally, it prescribes that the Government shall fulfill its overall responsibility to protect the public and the environment from radiation hazards that might accompany the development and utilization of nuclear energy.

In 1994, the government designated the 10th of September as "Nuclear Safety Day". Various events highlighting nuclear safety have been conducted, through government initiatives, for the purpose of having workers engaged in all nuclear-related organizations recognize the importance of nuclear safety and to solidify their commitment to nuclear safety.

In 2000, the Atomic Energy Act was amended, to strengthen nuclear safety, as follows:

- Increase of NSC member to guarantee more participation of specialists in the policy decision making process.
- Introduction of the Periodic Safety Review (PSR) to ensure that the safety of operating NPPs is maintained at current safety standards and practices.
- Introduction of the Standard Design Certificate to streamline the licensing process for the construction of NPPs with same design.
- Introduction of the ICRP Pub. 60 on a step-by-step basis with full implementation starting in January 2003.

4.5.2. Waste Management

Basic Policy

- Management under Government Auspice

  Since radioactive waste needs long-term and safe management, the government takes total responsibility.

- Safety First

  By safe management of radioactive waste for the preservation of the environment and the ecosystem, we prevent possible impact on human health and environment abiding by the international regulation on the safe management of radioactive waste.

- Minimization of Radioactive Waste

  We strive to minimize radioactive wastes that result from nuclear power generation and radioisotope utilization.

- Polluter Pays Principle

  The necessary cost for management of radioactive waste is charged to the polluter from the time the pollution was generated : therefore avoiding imputing the responsibility to the next generation.

- Trust from General Public

  We will increase public acceptance and trust through open and honest management of radioactive waste. Also, our project will contribute to community development.

Project Plan

- Construction and Operation of Facility for Disposal of Low and Intermediate Level Radioactive Wastes
  - Disposal capacity : initial 100,000drums (final 800,000 drums)
  - Operation start year : 2008
  - Disposal type : to determine after site selection(vault or cavern type)

- Construction and Operation of Interim Storage Facility for Spent Fuels
  - Storage capacity : initial 2,000 tons (final 20,000 tons)
  - Operation start year : 2016

- Storage type : to determine later considering the site condition and the technology..development trend (wet or dry type)

- Research and Development
  - Treatment and disposal of low and intermediate level radioactive wastes
  - Storage and transportation of spent fuels

REFERENCES

[1] Yearbook of Energy Statistics, MOCIE, Korea Energy Economic Institute, (2001).
[2] Atomic Energy Activities in Korea, MOST, (2001)
[3] Atomic Energy Laws of the Republic of Korea, MOST, (2001).
[4] Korean Statistical Yearbook, No. 40, National Statistical Office, ROK, (2001).
[5] Korea Economic Yearbook, The Federation of Korean Industries, (2001).
[6] Korean Atomic Yearbook, Korea Atomic Industry Forum, (2002).
[7] Korean Nuclear White Book, MOCIE, KHNP, (2002).
[8] IAEA Energy and Economic Data Base (EEDB).
[9] IAEA Power and Reactor System (PRIS).
[10] Data & Statistics. The World Bank, www.worldbank.org/data.
[11] Yearbook of Energy Statistics, MOCIE, Korea Energy Economic Institute (2002).
[12] Comprehensive Nuclear Energy Promotion Plan, MOST, ROK (2002).
[13] Korean Statistical Yearbook, National Statistical Office, ROK (2002).
[14] Major Statistics of Korean Economy, National Statistical Office, ROK (2001).
[15] Korea Energy Review Monthly, Korea Energy Economics Institute, ROK (2001).
[16] Korean Atomic Yearbook, Korea Atomic Industry Forum, ROK (2002).
[17] Korean Nuclear White Book, MOCIE & KHNP, ROK (2002).
[18] Korean Nuclear Generation Yearbook, KHNP, (2002).

Appendix 1

INTERNATIONAL, MULTILATERAL AND BILATERAL AGREEMENTS

AGREEMENTS WITH THE IAEA

• Amendments to Articles VI and XIV of the Agency Statute	Not Ratified	
• Agreement on privileges and immunities	Entry into force:	17 January 1962
• NPT related agreement INFCIRC/236	Entry into force:	14 November 1975
• Additional protocol	Signature:	21 June 1999
• Supplementary agreement on provision of technical assistance by the IAEA	Entry into force:	21 January 1980

OTHER MULTILATERAL SAFEGUARDS AGREEMENTS

• Korea/USA INFCIRC/111	Entry into force:	5 January 1968
• Korea/France INFCIRC/233	Entry into force:	22 September 1975
• RCA	Entry into force:	4 December 1992

OTHER RELEVANT INTERNATIONAL TREATIES etc.

• NPT	Entry into force:	23 April 1975
• Convention on physical protection of nuclear material	Entry into force:	8 February 1987
• Convention on early notification of a nuclear accident	Entry into force:	9 July 1990
• Convention on assistance in the case of a nuclear accident or radiological emergency	Entry into force:	9 July 1990
• Vienna convention on civil liability for nuclear damage	Not signed	
• Joint protocol relating to the application of Vienna and Paris conventions	Not signed	
• Protocol to amend the Vienna convention on civil liability for nuclear damage	Not signed	
• Convention on supplementary compensation for nuclear damage	Not signed	

• Convention on nuclear safety	Entry into force:	24 October 1996
• Joint convention on the safety of spent fuel management and on the safety of radioactive waste management	Entry into force:	16 September 2002

OTHER UNDERTAKINGS

• Improved procedures for designation of safeguards inspectors	Not yet accepted	
• ZANGGER Committee	Member	
• Nuclear Suppliers Group	Member	
• Acceptance of NUSS Codes	Not yet accepted	
• Partial Test-Ban Treaty	Entry into force:	24 July 1964

BILATERAL AGREEMENTS

- Agreement for Co-operation between the ROK and the USA concerning Civil Uses of Atomic Energy, in effect since 1956.
- Agreement, on Technical Co-operation between Korea and France; in effect since 1974.
- Agreement between Korea and France for the Peaceful Uses of Nuclear Energy, signed in April 1981.
- Agreement between Korea and Canada for Co-operation in the Peaceful Uses of Atomic Energy, in effect since 1976.
- Agreement between Korea and Australia concerning Co-operation in Peaceful Uses of Nuclear Energy and the Transfer of Nuclear Materials, in effect since 1979.
- Notes between Korea and Japan for co-operation in the field of peaceful uses of nuclear energy, exchanged in May 1990.
- Protocol on co-operation in the field of peaceful uses of nuclear energy between the Ministry of Science and Technology of the ROK and the Ministry of Atomic Power and Industry of the USSR, in effect since December 1990.
- Agreement between the ROK and the UK for co-operation in the peaceful use of nuclear energy, signed in November 1991.

Appendix 2

DIRECTORY OF THE MAIN ORGANIZATIONS, INSTITUTIONS AND COMPANIES INVOLVED IN NUCLEAR POWER RELATED ACTIVITIES

NATIONAL ATOMIC ENERGY AUTHORITY

Atomic Energy Commission (AEC)
Government Complex-Gwacheon City
Chungang-dong, Gyeonggi-do 427-760
Republic of Korea
Tel: +82-2-503-7646
Fax: +82-2-503-7673

Ministry of Science and Technology (MOST)
Government Complex-Gwacheon City
Chungang-dong, Gyeonggi-do 427-760
Republic of Korea
Tel: +82-2-503-7600
Fax: +82-2-504-7636
http://www.most.go.kr

Ministry of Commerce, Industry & Energy (MOCIE)
Government Complex-Gwacheon City
Chungang-dong, Gyeonggi-do 427-760
Republic of Korea
Tel: +82-2-503-7171
Fax: +82-2-503-9603
http://www.mocie.go.kr

NUCLEAR INDUSTRY

Korea Atomic Energy Research Institute (KAERI)
150, Dukjin-dong Yusong-gu
Daejon 305-353, Republic of Korea
Tel: +82-42-868-2000
Fax: +82-42-868-9161
http://www.kaeri.re.kr

Korea Institute of Nuclear Safety (KINS)
19, Kusong-dong Yusong-gu
Daejon 305-338, Republic of Korea
Tel: +82-42-868-0014
Fax: +82-42-861-1700
http://www.kins.re.kr

Korea Cancer Center Hospital(KCCH)
215-4, Gongneung-dong
Nowon-gu
Seoul 139-706, Republic of Korea
Tel: +82-2-974-2501
Fax: +82-2-978-2005
http://www.kcch.re.kr

Korea Electric Power Corporation (KEPCO)
167, Samseong-dong
Gangnam-gu
Seoul 135-791, Republic of Korea
Tel: +82-2-3456-3511
Fax: +82-2-3456-3599
http://www.kepco.co.kr

Korea Hydro & Nuclear Power Co., LTD (KHNP)
167, Samseong-dong
Gangnam-gu
Seoul 135-791, Republic of Korea
Tel: +82-2-3456-2206
Fax: +82-2-3456-2219
http://www.khnp.co.kr

Doosan Heavy Industries and Construction Co.
555, Guygok-dong
Changwon
Kyungnam 641-792, Republic of Korea
Tel: +82-55-278-6114
Fax: +82-55-264-5551
http://www.doosanheavy.co.kr

Korea Power Engineering Co., Inc. (KOPEC)
360-9, Mabuk-ri, Guseong-eup,
Yongin-si
Geonggi-do 449-910, Republic of Korea

Tel: +82-31-289-3114
Fax: +82-31-283-6215
http://www.kopec.co.kr

Korea Nuclear Fuel Co., Ltd. (KNFC)
493, Deokjin-dong
Yuseong-gu
Daejon 305-353, Republic of Korea

Tel: +82-42-868-1000
Fax: +82-42-861-2380
http://www.knfc.co.kr

Korea Plant Services and Engineering Co., Ltd. (KPS)
196, Bundang-gu Geumgok-dong
Seongnam-si
Geonggi-do 463-480, Republic of Korea

Tel: +82-31-710-4114
Fax: +82-31-710-4115
http://www.kps.co.kr

ENERGY RESEARCH INSTITUTES

Korea Basic Science Institute — http://comp.kbsi.re.kr/

Korean Superconducting Tokamak Advanced Research (KSTAR) — http://www.knfp.net/

Korea Institute of Energy Research (KIER) — http://www.kier.re.kr/indexe.htm

Korea Advanced Institute of Science and Technology (KAIST) — http://www.kaist.ac.kr/

Pohang University of Science and Technology — http://www.postech.ac.kr/e/

Pohang Accelerator Laboratory (PAL) — http://pal.postech.ac.kr/docs/english/index.htm

OTHER ORGANIZATIONS

Korean Nuclear Society — http://www.nuclear.or.kr/

Korea Nuclear Information System (KORNIS) — http://kornis.kaeri.re.kr

Organization for Korea Atomic Energy Awareness (OKAEA) — http://okaea.or.kr/english/index.php

Korea Atomic Industrial Forum — http://www.kaif.or.kr/