ANNEXES TO:

TWO SCENARIOS OF NUCLEAR POWER AND NUCLEAR WASTE PRODUCTION IN NORTHEAST ASIA

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ROUGH DRAFT, OCTOBER 30, 1997

ANNEX A:
UNDERLYING ASSUMPTIONS FOR ESTIMATES OF FUTURE ELECTRICITY DEMAND IN THE COUNTRIES OF NORTHEAST ASIA

1. Assumptions driving energy demand growth in China

HOUSEHOLD SECTOR

The **population** of China is assumed to increase to 1.45 billion by 2020. The number of **households** is assumed to increase to 430 million by 2020, representing a decrease in the average number of persons per household from 4.19 to 3.37. The fraction of the population living in cities is assumed to increase from 29 percent in 1990 to 46 percent in 2020.

Electricity use per urban household for lighting is assumed to increase at 3 percent/yr. Electricity use per urban household for appliances is assumed to roughly 6-fold to about 5,000 kWh per household (an average increase of more than 6 percent/yr) by 2020, relative to 1990 usage. The use of kerosene for rural lighting is assumed to be phased out by 2010. Electricity use for lighting per rural household increases by an average of 1.3 percent/yr, with most of the increase coming after 2000. Electricity use per rural household for appliances is assumed to roughly 14-fold to about 2,500 kWh per household (an average increase of more than 9 percent/yr) by 2020, relative to 1990 usage.

SERVICES SECTOR

Commercial and Other Services output is assumed to increase at an average rate between 9 and 10 percent/yr through 2020, with higher growth rates in the period before 2010 than after 2010. Electricity use per unit output is assumed to decrease slightly (Commercial) or remain at 1990 levels (Other Services).

AGRICULTURAL/FISHERIES SECTOR

The **land area cropped** is assumed to decrease from 95.7 million hectares to 85 million hectares by 2020. The fraction of the land area cultivated with tractors is assumed to increase from 50.5 percent in 1990 to 68 percent in 2020. Mechanical irrigation and drainage of fields is assumed to increase from 49.5% of agricultural area in 1990 to 60 percent in 2020, and the use of electric pumps is assumed to increase to 35% of all irrigated/drained area by 2010, decreasing again (as marginal lands are abandoned?) to 30 percent in 2020. Fisheries output is assumed to increase by a factor of 3.6 between 1990 and 2020 (about 4.4 percent per year). "Sideline Production", assumed to mean (primarily) agricultural product processing, is assumed to increase at between 2.5 and 2.8%/yr through 2020, with higher growth earlier in the period.

Agricultural subsector energy intensities (fuel use in tractors and pumps per hectare cultivated) are assumed to remain at 1990 levels through 2020.

INDUSTRIAL SECTOR

Changes in output vary by subsector, with three to ten-fold increases in output. Heavier industries, including iron and steel, non-ferrous metals, and (especially) cement and other building material show reduced growth rates in the later years of the projection period, as the economy matures. Light industry, machinery and chemicals are the fastest-growing subsectors.

Energy intensities in the industrial subsectors are assumed to decline nearly across the board, with substantial reductions (up to 75 percent) for some coal-fired devices, and more modest reductions in other applications.

BUILDING SECTOR

Gross output in the Building (construction) sector is assumed to increase by an average of 7.7 percent/yr through 2020, with growth at a slightly higher rate earlier in the period.
The intensity of electricity use in this sector is assumed to decline by a third over the projection period.

TRANSPORT SECTOR

The total passenger kilometers of **public passenger transport** are assumed to grow at 4.5 percent/yr through 2020. Passenger traffic is assumed to continue to shift from railroad and water transport to road and air transport. The use of steam locomotives continues to decline, and the use of electric locomotives increases, with the fraction of passengers carried on diesel trains increasing slightly until 2000, then decreasing.

The total tonne-kilometers of **freight transport** are assumed to grow at 5 percent/yr through 2020. Freight traffic is assumed to continue to shift from water transport to road, rail, and air transport. The use of steam locomotives continues to decline, and the use of electric and diesel locomotives increases. The kWh of electricity used per passenger-km in electric trains increases at 1 percent/yr (presumably as passengers demand more elbow room). The kWh per tonne-km in electric trains also increases at 1percent/yr.

2. Assumptions driving energy demand growth in Chinese Taipei

HOUSEHOLD SECTOR

Population is assumed to grow at 0.8 percent/yr from 1995 on. This increase is slightly lower than the 1990 to 1995 rate, but the rate of population increase in Chinese Taipei has been decreasing of late. The number of persons per household is assumed to decrease at 1.0 percent/yr, (a slightly slower decrease than in 1990 to 1995) until 2000, then set to decrease at 0.5 percent/yr.

The intensity of electricity use in households is assumed to increase at 1 percent/yr through 2000, but to stay stable thereafter as natural efficiency gains and decreasing household size balance increased use of electric appliances.

PUBLIC/COMMERCIAL SECTOR

Services GDP is assumed to increase at 7.5 percent/yr through 2000 (similar to recent trends), continuing to increase at 6 percent/yr from 2000 to 2010, and at 5 percent/yr thereafter as the economy matures. The energy intensity of electricity use in the public and commercial sector (fuel use per unit real services GDP) is assumed to decrease to 90 percent of its 1990 value by 2000, decreasing at 0.5 percent/yr thereafter.

AGRICULTURAL/FISHERIES/FORESTRY SECTOR

Agricultural GDP is assumed to increase at 3 percent/yr through 2000 (similar to recent trends), at 1.5 percent /yr to 2010, and at 1 percent/yr thereafter as the economy matures and population growth slows. Agricultural sector energy intensities are assumed to remain at 1990 levels, as increases in agricultural mechanization are (assumed to be) roughly balanced by increases in energy efficiency.

INDUSTRIAL SECTOR

In the **iron and steel, and non-metallic minerals**, steel and cement production are assumed to remain constant at 1995 levels until 2000, declining at 0.5 percent/yr thereafter. For the **chemicals, non-ferrous metals, machinery, mining and quarrying, and non-specified** subsectors, manufacturing GDP (which is used as the driving activity for these subsectors) is assumed to increase at 2.8 percent/yr through 2000 (similar to recent trends), and at 1.6 percent/yr thereafter as the economy continues to become more service-oriented. In the **transport equipment** subsector, automobile production is assumed to remain steady at 1995 levels through 2020. **Processed food and meat** production (tonnes) is assumed to follow the same trend as agricultural GDP. In the **pulp and paper** subsector, paper and paperboard production (tonnes) is assumed to remain constant at 1995 levels. **Construction** GDP is assumed to increase at 5 percent/yr through 2000 (similar to recent trends), at 3 percent/yr from

2000 to 2010, and at 2 percent/yr thereafter as the economy of Chinese Taipei continues to become more service-oriented. The tonnage output of **textiles and fiber** are assumed to increase at the rate of manufacturing GDP increase. The energy intensity of all manufacturing subsectors is assumed to decrease at 0.5 percent/yr from 1990 on.

TRANSPORT SECTOR

Rail passenger-km traveled is assumed to remain stable at 1995 levels throughout the projection period. Rail tonne-km is assumed to decline at 2 percent/yr until 2000, decreasing at 1 percent/yr thereafter. Energy intensities for all subsectors in the transport sector are assumed to remain constant in the Base Case for the projection period.

3. Assumptions Driving Changes in Electricity Demand for the DPRK

We based our estimate of electricity demand in the DPRK on a "Recovery" scenario for the years 2000 and 2005 that we have compiled earlier. Generally, the Recovery scenario assumes that as the DPRK complies with the Agreed Framework on nuclear issues (signed in October 1994 by the governments of the United States and the DPRK), relations with the U.S. and other trading partners improve. As a result, availability of scarce fuels and parts increases, and the DPRK is able to substantially (but not fully), revive its economic output relative to 1990 levels, and to make small inroads toward renewing its economic infrastructure. This scenario does not foresee a substantial rapprochement between the DPRK and the ROK before 2000; such a rapprochement is assumed possible only once the DPRK has fulfilled the terms of the Agreed Framework, when the outstanding special inspection of nuclear waste issue is resolved, and when the first nuclear components of the PWRs are delivered—at the earliest, 2001.

INDUSTRIAL OUTPUT

In the Recovery scenario, industrial output recovers to about 70 percent of 1990 levels by 2000—and to 120 percent of 1990 levels by 2005—in most industrial subsectors, as shown in Table A-1. One exception is the fertilizer industry, which expands output to 86 percent of 1990 levels by 2000 to feed the agriculture sector, which in turn must supply food to a growing population using croplands that are (in many cases, reportedly) stressed by the effects of flooding, overuse, and lack of proper soil conservation. Another exception is the "Other Minerals" subsector—which produces magnesite—which we assume to expand production to 100 percent of 1990 levels by 2000 and to 150 percent by 2005, in keeping with its probable role (under a Recovery scenario) as a major generator of foreign exchange for the DPRK. With the exception of fertilizer production, which is assumed to grow at 1 percent per year after 2005, and production of other minerals, which grows by about 2 percent per year after 2005, industrial output is assumed to increase at 3.5 percent/yr from 2005 through 2020. With industrial output (and use of productive capacity) generally nearing 1990 levels in 2000, we assume that the energy intensity of industrial production in the various subsectors will be near 1990 levels as well, and

will improve by an average of five percent (that is, use 95 percent as much energy per unit of output) between 2000 and 2005, and that the intensities of electricity use in industry will continue to decline at an average of 0.75 percent per year between 2005 and 2020.

Table A-1: Assumptions for Changes in DPRK Industrial Production by 2000 and 2005

	Production Relative to 1990		
Subsector	**1996**	**2000**	**2005**
Iron and Steel	36%	69%	93%
Cement	32%	69%	101%
Fertilizers	60%	86%	120%
Other Chemicals	30%	70%	120%
Pulp and Paper	30%	70%	120%
Other Metals	30%	70%	120%
Other Minerals	30%	100%	150%
Textiles	30%	70%	120%
Building Materials	30%	70%	120%
Non-Specified Industry--non-oil fuels	20%	70%	120%

Our Recovery scenario implies growth in industrial output averaging roughly 23 percent per year between 1996 and 2000, and over 11 percent per annum between 2000 and 2005[1]. Although these growth rates, considered in the context of developing economies, would seem unreachable, it is worth remembering that the DPRK already has most of the infrastructure that would be required to support the assumed levels of industrial production. We have been told that—at least for industrial facilities in the DPRK designed and installed with Soviet assistance—DPRK plant managers adhere to strict procedures, developed by the USSR, for maintaining and conserving plant equipment, so that bringing plants "out of mothballs" (reactivating deactivated industrial facilities) once fuels, key spare parts, and product markets become available, should be a relatively efficient process.

TRANSPORT ACTIVITIES

Total freight carried by all modes increases to 75 percent of 1990 levels by 2000, and to 120 percent by 2005. After 2005, rail freight volumes are assumed to increase at 3.5 percent/yr. Use of personal public transport per capita by electric trains increases to 100 percent of 1990 levels by 2000 as economic and entertainment opportunities increase, rising to 150 percent of 1990 levels by 2005, and continuing to grow at a an annual rate 4 percent. To put these increased mobility figures in perspective, it should be remembered that the baseline use of personal transport in the DPRK is extremely low by United States or ROK standards.

[1] Given that 1996 and most of 1997 have already lapsed (as of this writing) without any signs of a recovery, the effective growth rate in industrial output between 1998 and 2000 would have to be even higher than indicated to reach the level of industrial output in our Recovery Scenario for 2000.

RESIDENTIAL SECTOR

For our estimate of residential sector energy use, we assume that population (and household) growth continues at 0.8 percent per year after 1996[2]. We assume that per-household consumption of electricity recovers to 85 percent of 1990 levels by 2000, and is 140 percent of its level in 1990 (as a result of greater affluence and greater availability of electrical appliances) by 2005. After 2005, we assume that this trend continues, with growth in per-household use of electricity at 5 percent annually.

AGRICULTURAL SECTOR

In the agricultural sector, the use of oil fuels per unit of land cropped is assumed to return to 90 percent of 1990 levels by 2000 in response to the increased availability of diesel fuels and the need to provide food for a growing population. By 2005, agricultural area is assumed to return to its 1990 level, growing at 0.5 percent/yr thereafter. We assume that electricity use per hectare of land cropped will increase to 105 percent of its 1990 level by 2005, increasing at 2 percent per year from 2005 through 2020.

COMMERCIAL/PUBLIC/INSTITUTIONAL SECTOR

We assume that floor space in this sector per unit residential floor space increases to 105 percent of 1990 levels by 2000, and to 125 percent by 2005, reflecting more small "private" enterprise. After 2005, commercial/public/institutional floor space increases at about 2.75 percent/yr. Electricity use per unit area increases to 1990 levels by 2000—and by 50 percent above 1990 levels by 2005—to reflect a combination of the needs of buildings in the sector to serve more people, and the use of electricity in small "private" enterprises such as garment shops and tourist hotels. Electricity use per unit floor area is assumed to grow at roughly 5 percent per year between 2005 and 2020, as is other electricity use in the sector.

MILITARY SECTOR ACTIVITIES

We assume that electricity use in military-sector buildings climbs, by 2010, to about 60 percent above its level in 1990, remaining stable thereafter. In our Maximum Nuclear scenario, we assume that military electricity use will be 10 percent higher in the year 2020 than in the base

[2] This lower population growth assumption represents a rough attempt on our part to take into account the effects of the food shortages of the 1990s on population growth in the DPRK. It is certainly reasonable to think that fecundity will decrease, at least in the short-term, as a result of people being on short rations, and this decrease in fertility would probably continue in the decline scenario, as a poor economy probably translates, on average, into poor nutrition. Although it might be reasonable to expect that population growth would pick up again in the Recovery scenario, as food and medical supplies become more plentiful, we have chosen to assume that population growth will stay low, in keeping with the phenomenon in places like the ROK and Malaysia. In these fast-growing economies, rapid economic growth over the last decade has been accompanied by a marked decrease in population growth.

Case. This increase in military electricity use is intended to reflect the probability of heightened military activity to help safeguard larger amounts of nuclear materials.

4. Assumptions Driving Changes in Electricity Demand for Hong Kong

We chose to model Hong Kong separately from the rest of China for several reasons. First and foremost, the composition of energy use in demand is very different from that in China, both in terms of fuel types used and in terms of the sectoral breakdown of energy use. Even long after 1997, when China formally took over governance of Hong Kong, these distinctions will undoubtedly persist. Second, data for Hong Kong are compiled separately (at present) from data for China. Third, per-capita energy use in Hong Kong is much higher than that in China, even if differences for efficiency are not accounted for.

Data on energy use in Hong Kong, and on related sectoral activity, have been compiled from IEA energy balances, UN publications, Hong Kong Government statistical office WWW sites, USDOE EIA statistics, and other sources. Our assumptions about the changes in activities that drive energy use and changes in electricity use intensities per unit of activity are described below.

HOUSEHOLD SECTOR

Population is assumed to grow at 1.65 percent/yr (as in 1990-1995) through 2005, then at 1 percent/yr, mostly through migration from the mainland to Hong Kong. The number of persons per household (HH) is assumed to decrease at 1percent/yr from 1995 to 2010, remaining stable thereafter (at 2.96 persons/HH). Electric energy intensity in the household sector is assumed to increase to 17 GJ/HH-yr (4700 kWh/yr) by 2000, remaining steady thereafter.

PUBLIC/COMMERCIAL SECTOR

For Commercial and Services GDP, it is assumed that the recent trend of about 8 percent/yr real growth in sectoral GDP continues through 2010, increasing at a slower 5 percent/yr thereafter. Electric energy intensity in the sector (fuel used per unit commercial and services GDP) is assumed to remain the same as in 1995 through the projection period.

INDUSTRIAL SECTOR

We have assumed that the output of the (small) **iron and steel** production sector will not change over the projection period. In the **chemicals and non-specified** subsector, we assume that the trend in real manufacturing GDP continues its decline (at -10 percent/yr) until 2000, then declines at a less precipitous -3 percent/yr as manufacturing continues to shift to mainland China. We have assumed no changes (on average) in energy intensity between 1995 and 2020 for the

industrial subsectors, as any efficiency gains are offset by sub-optimal operating efficiency due to lower capacity factors.

TRANSPORT SECTOR

Electrically-powered transport (primarily rail) is assumed to increase at the rate of population growth. The energy intensity of electrically-powered trainsports is assumed not to change between 1995 and 2020.

STREET LIGHTING

Electricity use for street lighting is assumed to rise to 300,000 GJ by 2000 (increasing at approximately 1 percent/yr, as per recent trends), remaining the same thereafter as efficiency gains are balanced by additions of lamps to the street lighting network.

5. Assumptions Driving Changes in Electricity Demand for Japan

Our main source for recent Japanese energy data has been a set of very detailed (41 fuel categories by 45 rows) Japanese-language energy balances complied by the Japanese Institute for Energy Economics (IEEJ) and the Energy Conservation Center, and published by the MITI (Ministry of International Trade and Industry) Research Institute. These data were augmented by data from the USDOE EIA (the US Department of Energy's Energy Information Administration), the IEA (International Energy Agency), United Nations documents, Japanese government statistics World-Wide Web (WWW) sites, and other sources.

HOUSEHOLD SECTOR

Our assumptions for population growth are taken from the Japan Department of the Census Projections (figures in millions): 1995 = 125.57; 2000 = 127.39, 2010 = 130.40, 2020 = 128.35. The number of persons per household declined from 2.99 in 1990 to 2.82 in 1995, an average decline of 1.16 percent/yr. We assume a continued decline in average household size of 0.8%/yr through 2000, 0.5%/yr to 2010, and 0.3 percent/yr thereafter. We assume that the average usage of electricity per household increases at 2 percent/yr through 1995 (it actually grew faster between 1990 and 1993), then remains constant, as improvements in efficiency (which have been slowing or stopping in Japan in recent years) and decreases in the number of persons per household (which should lower per-household use) are balanced by increasing use of household energy services.

COMMERCIAL/PUBLIC SECTOR

The growth in Commercial/Services GDP is assumed to be 3.5%/yr—consistent with growth during the early 1990's—until 2000, then decreases to 2.5%/yr from 2000 to 2010, and 2%/yr

thereafter. Electricity use per unit of Commercial/Services GDP) is assumed to increase at 1.3 percent/yr through 2000, 0.75 percent/yr from 2000 to 2010, and 0.3 percent/yr thereafter.

INDUSTRIAL SECTOR

Our assumptions for subsectoral activity in the industrial sector include:

- In the **water treatment** subsector, the volume of water to be treated scales with population.
- **Mining and quarrying** subsectoral GDP grows at 1.5 percent/yr from 1993-2000, and 0.5 percent/yr between 2000-2010, with no growth thereafter.
- **Processed food** output is assumed to increase at 1.3 percent/yr (comparable to recent trends) from, 1993 to 2000 and 0.75 percent/yr from 2000 to 2010, with no change, on average, thereafter (as population starts to decline)
- Output of **textiles and fiber**, which contracted sharply in the early 1990's, is assumed to continue to decline at 5 percent/yr through 2000, then at 2.5 percent/yr from 2000 to 2010, remaining stable thereafter.
- Output of **Paper and Paperboard, and Chemicals** is assumed to increase at 1.0 percent/yr (comparable to recent trends) from, 1993 to 2000, and at 0.5 percent/yr from 2000 to 2010, with no change, on average, thereafter.
- **Ceramics** output is set to increase by 1.0 percent/yr (somewhat lower than cement output change from 1990 to 1995, but output in 1995 seems to have been unusually high) through 2000, then at 0.75%/yr from 2000 to 2010, and 0.5 percent/yr from 2010 to 2020.
- Output of **iron and steel** decreased during the early 1990's. We assume that the decrease continues at 1.5 percent/yr through 2000, changing to a decline of 1 percent/yr through 2010, and at 0.5 percent/yr thereafter.
- Manufacturing GDP (a benchmark for the **Non-ferrous Metals, Metal Finishing**, and **Other Manufacturing** subsectors) is assumed to grow at 1.5 percent/yr from 1993 to 2000 and 0.5 percent/yr from 2000 to 2010, with no growth thereafter.

The intensities of electricity use in industrial subsectors in Japan are assumed, with the exceptions noted below, to remain constant at the 1993 level from 1995 through 2020. In food processing, we assume that electricity use intensity increases at 1 percent/yr. In the ceramics and steel industries, electric intensity is assumed to continue to increase modestly until 2000, then remain constant.

TRANSPORT SECTOR

We assume no growth in rail freight over the scenario period. The period from 1990 to 1995 showed an overall slight decline in rail freight volume, although freight increased between 1985 and 1990 and between 1994 and 1995. We assume rail passenger volumes will grow at 1 percent/yr through 2000, and 0.5 percent/yr thereafter. Electric rail is assumed to provide 75 percent of rail passenger and goods transport by 2010, and 80 percent by 2020.

The trend in Japan in the last few years, in virtually all transport sectors[3], has been for energy intensities to increase slightly from a 1990 minimum. For the base case scenario, we assume that the intensity of electricity use in electric trains will remain the same, on average, through 2000, then decrease slowly (0.2 percent /yr) through 2020.

6. Assumptions Driving Changes in Electricity Demand for the Republic of Korea

Our assumptions as to future growth in the activities for which electricity is used in the ROK are summarized in Table A-2. Our growth rates for the years 1995 to 2000 for most activities assume a general continuation of trends in recent years, and we generally assume that growth in the ROK economy slows in the period from 2000 to 2020 as the ROK economy continues to mature. As shown in Table A-3, we used a similar approach to estimate trends in energy intensities of activities in the ROK economy, generally continuing recent trends through 2000 (most of which show increasing intensity of electricity use), with progressive reduction in the growth of electricity intensity in most sectors and subsectors through 2020.

Table A-2:
Assumptions for Growth in Activities that Drive ROK Electricity Demand

Sector	Subsector	Value in 1995	Assumed Growth Rates (%/yr) 95-2000	2000-2010	2010-2020	Units
Residential		44,851	0.91%	0.80%	0.70%	population (thousands)
Public		14,831	2.52%	2.00%	1.50%	Gov. Serv. GDP, billion 1990 Won
Services						
	Water	22,886	6.80%	4.00%	2.00%	kcu.m./day capacity
	Commercial/Other	111,537	8.00%	6.00%	4.00%	Services GDP (5 categories), billion 1990 Won
Agriculture/Fisheries		16,832	1.54%	1.00%	0.70%	Agriculture. Fish, Forestry GDP, billion 1990 Won
Mining		887	-2.85%	-1.00%	-0.50%	Mining GDP, billion 1990 Won
Manufacturing						
	Food					
	Textile	459	-5.00%	-3.00%	-2.00%	million cu.m cloth
	Wood	4,755	-1.35%	0.00%	0.00%	th. cu.m. (wood and plywood)
	Paper and Printing	1,738	4.61%	3.00%	2.00%	kte
	Chemicals	77,075	7.50%	3.50%	2.50%	Manufacturing GDP, billion 1990 Won
	Ceramics	56,101	7.50%	4.00%	3.00%	th te cement
	Basic Metals	22,344	7.82%	4.00%	2.00%	th. te pig iron
	Machinery and Equip.	77,075	7.50%	3.50%	2.50%	Manufacturing GDP, billion 1990 Won
	Other Manufact.	77,075	7.50%	3.50%	2.50%	Manufacturing GDP, billion 1990 Won

[3] The Energy Conservation Center, Japan (1996), Japan Energy Conservation Handbook, 1996/7, Pages 60-61.

Table A-3: Assumptions as to Changes in Intensity of Electricity Use in Economic Activities in the ROK, 1995 to 2020[4]

Sector	Subsector	Value in 1995	Assumed Growth Rates (%/yr) 95-2000	2000-2010	2010-2020	Units
Residential		2.272	7.50%	4.00%	1.50%	population (thousands)
Public Services		1.240	5.00%	2.00%	1.50%	Gov. Serv. GDP, billion 1990 Won
	Electricity	1.00E+06				[Total Electricity Use (GJ)]
	Water	0.631	2.00%	1.00%	0.00%	kcu.m./day capacity
	Commercial/Other	0.888	7.00%	3.50%	1.00%	Services GDP (5 categories), billion 1990 Won
Electric Railway		5.79E+06	7.00%	3.00%	1.00%	[Total Electricity Use (GJ)]
Agriculture/Fisheries		0.721	7.00%	2.50%	1.00%	Agriculture. Fish, Forestry GDP, billion 1990 Won
Mining		4.140	2.50%	1.00%	0.00%	Mining GDP, billion 1990 Won
Manufacturing						
	Food	1.83E+07	6.00%	2.00%	0.50%	[Total Electricity Use (GJ)]
	Textile	96.389	8.00%	2.00%	0.50%	million cu.m cloth
	Wood	0.595	5.00%	2.00%	0.50%	th. cu.m. (wood and plywood)
	Paper and Printing	12.920	5.00%	2.00%	0.50%	kte
	Chemicals	0.883	2.50%	0.00%	0.00%	Manufacturing GDP, billion 1990 Won
	Ceramics	0.598	0.01%	0.00%	0.00%	th te cement
	Basic Metals	2.594	1.50%	0.50%	0.00%	th. te pig iron
	Machinery and Equip.	1.042	4.00%	2.00%	0.50%	Manufacturing GDP, billion 1990 Won
	Other Manufact.	0.047	5.00%	2.50%	0.50%	Manufacturing GDP, billion 1990 Won

[4] 1995 values shown are in GJ per unit activity.

ANNEX B:
DETAILS OF CALCULATIONS OF
NUCLEAR WASTE GENERATION ESTIMATES

LEAP Output Data: Annual Electricity Production by Country and Plant

Units: Thousand GWh

Country: China	SUM OF GENERATION (GWH)					
BASE CASE	1990 to 1994	1995 to 1999	2000 to 2009	2010 to 2020	1995 to 2020	1990 to 2020
COAL THERMAL	2,537	3,512	9,650	13,772	26,934	29,471
COGENERATION	238	335	936	1,742	3,012	3,250
WASHED COAL THER	54	104	477	1,698	2,278	2,332
DESULFURIZATION	28	189	926	1,916	3,031	3,058
COMBINED CYCLE	34	50	185	406	641	675
OIL THERMAL-1	95	39	-	-	39	133
OIL THERMAL-2	26	129	547	1,176	1,852	1,878
GAS THERMAL-1	72	113	504	439	1,056	1,128
GAS THERMAL-2	-	-	-	609	609	609
HYDRO POWER	779	1,069	2,972	5,008	9,050	9,829
NUCLEAR--PWR	12	75	464	1,158	1,698	1,709
WIND POWER	2	7	45	139	191	193
GEOTHERMAL	0	1	3	5	8	9
SOLAR POWER	0	1	12	74	87	87
Pumped Storage	5	13	25	26	64	69
Tidal Power	0	0	0	0	1	1
TOTAL	3,882	5,636	16,746	28,169	50,552	54,434

	SUM OF GENERATION (GWH)					
MAXIMUM NUCLEAR CASE	1990 to 1994	1995 to 1999	2000 to 2009	2010 to 2020	1995 to 2020	1990 to 2020
COAL THERMAL	2,537	3,512	9,455	12,926	25,893	28,430
COGENERATION	238	335	936	1,747	3,018	3,256
WASHED COAL THER	54	104	477	1,572	2,152	2,206
DESULFURIZATION	28	189	926	1,922	3,037	3,065
COMBINED CYCLE	34	50	185	407	643	676
OIL THERMAL-1	95	39	-	-	39	133
OIL THERMAL-2	26	129	548	1,179	1,856	1,882
GAS THERMAL-1	72	113	504	441	1,058	1,131
GAS THERMAL-2	-	-	-	611	611	611
HYDRO POWER	779	1,069	2,974	4,915	8,958	9,738
NUCLEAR--PWR	12	75	697	2,659	3,432	3,444
WIND POWER	2	7	45	139	191	193
GEOTHERMAL	0	1	3	5	8	9
SOLAR POWER	0	1	12	75	88	88
Pumped Storage	5	13	25	26	65	70
Tidal Power	0	0	0	0	1	1
TOTAL	3,882	5,636	16,787	28,626	51,049	54,931

Country: Chinese Taipei	SUM OF GENERATION (GWH)					
BASE CASE	1990 to 1994	1995 to 1999	2000 to 2009	2010 to 2020	1995 to 2020	1990 to 2020
Pumped-storage	10	18	36	39	93	102
Thermal Plants	238	259	559	610	1,428	1,666
Hydro Plants	51	48	104	113	265	316
Existing PWR	119	169	338	372	879	998
Existing BWR	61	62	123	136	320	382
Lungmen Nuc--PWR	-	-	41	181	222	222
New Thermal	-	29	206	482	717	717
TOTAL	479	584	1,407	1,932	3,923	4,402

	SUM OF GENERATION (GWH)					
MAXIMUM NUCLEAR CASE	1990 to 1994	1995 to 1999	2000 to 2009	2010 to 2020	1995 to 2020	1990 to 2020
Pumped-storage	10	18	36	39	93	102
Thermal Plants	238	259	552	421	1,232	1,471
Hydro Plants	51	48	106	95	249	300
Existing PWR	119	169	338	372	879	998
Existing BWR	61	62	123	136	320	382
Other New PWR	-	-	8	402	411	411
Lungmen Nuc--PWR	-	-	41	181	222	222
New Thermal	-	29	202	287	519	519
TOTAL	479	584	1,407	1,933	3,924	4,403

Country: DPRK	SUM OF GENERATION (GWH)					
BASE CASE	1990 to 1994	1995 to 1999	2000 to 2009	2010 to 2020	1995 to 2020	1990 to 2020
Existing Coal-90	83	5	-	-	5	88
Existing Coal-96	-	82	-	-	82	82
Exist. Coal-2000	-	-	98	-	98	98
Exist. Coal-2005	-	-	59	41	101	101
East Pyongyang	-	1	8	3	12	12
Existing Oil	7	5	4	-	9	15
Expanded Oil	-	-	24	42	66	66
Existing Hydro	106	49	185	234	468	575
Nuclear--PWRs	-	-	79	145	223	223
New Coal Plants	-	-	53	384	437	437
Oil Comb. Cycle	-	-	6	7	13	13
New Hydro	-	2	26	47	76	76
TOTAL	196	145	541	903	1,589	1,785

	SUM OF GENERATION (GWH)					
MAXIMUM NUCLEAR CASE	1990 to 1994	1995 to 1999	2000 to 2009	2010 to 2020	1995 to 2020	1990 to 2020
Existing Coal-90	83	5	-	-	5	88
Existing Coal-96	-	82	-	-	82	82
Exist. Coal-2000	-	-	98	-	98	98
Exist. Coal-2005	-	-	60	43	103	103
East Pyongyang	-	1	8	3	12	12
Existing Oil	7	5	4	-	9	15
Expanded Oil	-	-	24	42	66	66
Existing Hydro	106	49	185	234	468	575
Nuclear--PWRs	-	-	79	145	223	223
Additional Nucl.	-	-	12	184	196	196
New Coal Plants	-	-	40	195	235	235
Oil Comb. Cycle	-	-	6	8	13	13
New Hydro	-	2	26	47	76	76
TOTAL	196	145	541	900	1,586	1,782

Country: Hong Kong	SUM OF GENERATION (GWH)					
BASE CASE	1990 to 1994	1995 to 1999	2000 to 2009	2010 to 2020	1995 to 2020	1990 to 2020
Existing Coal	162	131	348	424	903	1,066
Black Point (NG)	-	10	108	135	253	253
Cast.Pk Using NG	-	8	26	31	65	65
Guangdong PWR Fr	-	42	85	93	220	220
Guangzhou PS Shr	-	7	13	14	34	34
New Coal Plants	-	-	11	153	164	164
New Gas Steam	-	-	5	85	90	90
Natural Gas CC	-	-	5	85	90	90
TOTAL	162	198	601	1,021	1,819	1,982

	SUM OF GENERATION (GWH)					
MAXIMUM NUCLEAR CASE	1990 to 1994	1995 to 1999	2000 to 2009	2010 to 2020	1995 to 2020	1990 to 2020
Existing Coal	162	131	347	411	889	1,051
Black Point (NG)	-	10	107	131	248	248
Cast.Pk Using NG	-	8	26	30	64	64
Guangdong PWR Fr	-	42	85	93	220	220
Other China PWR	-	-	7	144	151	151
Guangzhou PS Shr	-	7	13	14	34	34
New Coal Plants	-	-	6	62	68	68
New Gas Steam	-	-	5	58	63	63
Natural Gas CC	-	-	5	77	83	83
TOTAL	162	198	601	1,021	1,819	1,982

Country: Japan	SUM OF GENERATION (GWH)					
BASE CASE	1990 to 1994	1995 to 1999	2000 to 2009	2010 to 2020	1995 to 2020	1990 to 2020
Nucl.--Exist BWR	696	811	1,623	1,576	4,011	4,707
Nucl.--Exist PWR	413	419	838	743	1,999	2,413
Nucl.--Exist HWR	5	5	10	9	25	30
Nucl.--Exist GCR	5	6	6	-	11	17
Nucl.--New BWRs	-	65	364	550	979	979
Nucl.--New PWRs	-	8	79	87	174	174
Nucl. New ABWRs	-	-	66	310	376	376
Nucl., FBR	-	9	17	19	45	45
Hydro--Convent.	456	473	947	1,041	2,461	2,917
Pumped St. Hydro	70	83	175	232	490	560
Geothermal--Util	8	9	18	20	47	56
Geothermal--Auto	1	1	3	3	7	8
Gas Turbine-Util	56	61	123	135	319	375
Int. Comb--Util	63	68	136	150	354	417
Coal Steam--Util	445	525	1,049	1,154	2,728	3,173
Coal Steam--Auto	97	117	235	258	610	707
Coal/Ck Gas-Util	119	122	244	268	633	752
Coal/Ck Gas-Auto	93	97	195	214	506	599
Std. Coal, New	-	24	382	1,041	1,447	1,447
Stm NG/LNG--Util	656	731	1,555	1,726	4,012	4,668
Stm Nat Gas-Auto	1	1	1	1	3	4
Steam LNG--New	-	28	288	769	1,085	1,085
LNG CC, New	-	6	178	653	836	836
Steam Oil--Util	936	1,028	2,186	2,427	5,642	6,577
Stm Hvy Oil-Auto	243	206	412	453	1,071	1,314
Stm Lt Oil--Auto	48	40	81	89	209	257
Oil CC, New	-	6	144	622	771	771
MSW-Fired Plants	8	9	17	19	45	53
Biomass/Wst-Auto	51	54	107	118	278	330
TOTAL	4,472	5,011	11,477	14,687	31,175	35,647

	SUM OF GENERATION (GWH)					
MAXIMUM NUCLEAR CASE	1990 to 1994	1995 to 1999	2000 to 2009	2010 to 2020	1995 to 2020	1990 to 2020
Nucl.--Exist BWR	696	811	1,623	1,576	4,011	4,707
Nucl.--Exist PWR	413	419	838	743	1,999	2,413
Nucl.--Exist HWR	5	5	10	9	25	30
Nucl.--Exist GCR	5	6	6	-	11	17
Nucl.--New BWRs	-	65	398	1,416	1,879	1,879
Nucl.--New PWRs	-	16	127	420	563	563
Nucl. New APWRs	-	-	-	219	219	219
Nucl. New ABWRs	-	-	84	876	960	960
Nucl., FBR	-	9	17	19	45	45
Hydro--Convent.	456	473	947	1,041	2,461	2,917
Pumped St. Hydro	70	84	180	232	496	566
Geothermal--Util	8	9	18	20	47	56
Geothermal--Auto	1	1	3	3	7	8
Gas Turbine-Util	56	61	123	135	319	375
Int. Comb--Util	63	68	136	150	354	417
Coal Steam--Util	445	525	1,027	894	2,445	2,891
Coal Steam--Auto	97	117	235	258	610	707
Coal/Ck Gas-Util	119	122	244	268	633	752
Coal/Ck Gas-Auto	93	97	195	214	506	599
Std. Coal, New	-	24	382	915	1,321	1,321
Stm NG/LNG--Util	656	731	1,551	1,546	3,828	4,484
Stm Nat Gas-Auto	1	1	1	1	3	4
Steam LNG--New	-	28	286	695	1,009	1,009
LNG CC, New	-	6	176	578	760	760
Steam Oil--Util	936	1,027	2,136	1,480	4,644	5,580
Stm Hvy Oil-Auto	243	206	412	453	1,071	1,314
Stm Lt Oil--Auto	48	40	81	89	209	257
Oil CC, New	-	-	127	365	492	492
MSW-Fired Plants	8	9	17	19	45	53
Biomass/Wst-Auto	51	54	107	118	278	330
TOTAL	4,472	5,013	11,487	14,752	31,251	35,723

Country: Republic of Korea	SUM OF GENERATION (GWH)					
BASE CASE	1990 to 1994	1995 to 1999	2000 to 2009	2010 to 2020	1995 to 2020	1990 to 2020
Existing Hydro	23	23	52	58	133	157
Pumped Storage	11	15	29	32	76	87
Coal-fired steam	126	284	571	628	1,482	1,608
Oil-fired Steam	126	127	187	209	523	650
Gas-fired Steam	91	44	66	74	185	275
Combined Cycle	27	122	190	213	525	552
Internal Combust	10	4	6	7	18	28
Existing PWRs	243	284	556	612	1,452	1,695
Wollsong 1--PHWR	24	24	48	52	124	148
New Yonggw. PWR	-	27	166	220	413	413
New Ulchin PWRs	-	13	194	294	502	502
New Wolsong PHWR	-	9	148	193	350	350
Other New PWRs	-	-	-	74	74	74
New Pumped-Stor.	-	-	7	37	44	44
New Coal Plants	-	76	1,230	2,852	4,158	4,158
New Comb. Cycle	-	70	424	1,059	1,553	1,553
New Conv. Hydro	-	3	30	34	67	67
TOTAL	680	1,126	3,907	6,647	11,681	12,361

	SUM OF GENERATION (GWH)					
MAXIMUM NUCLEAR CASE	1990 to 1994	1995 to 1999	2000 to 2009	2010 to 2020	1995 to 2020	1990 to 2020
Existing Hydro	23	23	52	58	133	157
Pumped Storage	11	15	29	32	76	87
Coal-fired steam	126	284	571	628	1,482	1,608
Oil-fired Steam	126	121	177	218	516	642
Gas-fired Steam	91	42	63	77	182	272
Combined Cycle	27	116	180	221	517	544
Internal Combust	10	4	6	7	17	28
Existing PWRs	243	284	556	612	1,452	1,695
Wollsong 1--PHWR	24	24	48	52	124	148
New Yonggw. PWR	-	27	186	220	433	433
New Ulchin PWRs	-	20	214	294	529	529
New Wolsong PHWR	-	23	156	193	371	371
Other New PWRs	-	-	84	652	736	736
Other New PHWRs	-	-	27	364	392	392
New Pumped-Stor.	-	-	7	37	44	44
New Coal Plants	-	76	1,118	1,842	3,037	3,037
New Comb. Cycle	-	64	403	1,104	1,571	1,571
New Conv. Hydro	-	3	30	34	67	67
TOTAL	680	1,127	3,909	6,645	11,681	12,361

Summary of Cumulative TWh Electricity Production by Country and Plant Type

	SUM OF GENERATION (TWH)					
	1990 to 1994	1995 to 1999	2000 to 2009	2010 to 2020	1995 to 2020	1990 to 2020
China-Base Case						
Sum of Thermal	3,084	4,469	13,224	21,759	39,453	42,537
Hydro/Other	787	1,091	3,057	5,253	9,401	10,188
PWRs	12	75	464	1,158	1,698	1,709
China-Max. Nuclear						
Sum of Thermal	3,084	4,469	13,031	20,806	38,307	41,391
Hydro/Other	787	1,091	3,059	5,160	9,311	10,097
PWRs	12	75	697	2,659	3,432	3,444
Chinese Taipei-Base Case						
Sum of Thermal	238	288	765	1,091	2,145	2,383
Hydro/Other	61	66	139	152	358	418
PWRs	119	169	379	553	1,101	1,220
BWRs	61	62	123	136	320	382
Chinese Taipei-Max. Nuclear						
Sum of Thermal	238	288	754	708	1,751	1,989
Hydro/Other	61	66	142	135	342	403
PWRs	119	169	387	955	1,511	1,630
BWRs	61	62	123	136	320	382
DPRK-Base Case						
Sum of Thermal	90	93	251	477	821	911
Hydro/Other	106	52	211	281	545	651
PWRs	-	-	79	145	223	223
DPRK-Max. Nuclear						
Sum of Thermal	90	93	239	290	622	711
Hydro/Other	106	52	211	281	545	651
PWRs	-	-	91	329	420	420
Hong Kong-Base Case						
Sum of Thermal	162	149	503	913	1,565	1,728
Hydro/Other	-	7	13	14	34	34
PWRs	-	42	85	93	220	220
Hong Kong-Max. Nuclear						
Sum of Thermal	162	149	496	770	1,414	1,577
Hydro/Other	-	7	13	14	34	34
PWRs	-	42	92	237	371	371
Japan-Base Case						
Sum of Thermal	2,816	3,122	7,331	10,097	20,550	23,366
Hydro/Other	536	567	1,142	1,296	3,006	3,541
PWRs	413	427	917	830	2,173	2,586
BWRs	696	876	2,053	2,436	5,366	6,062
HWR	5	5	10	9	25	30
Other Nuclear	5	14	23	19	56	61
Japan-Max. Nuclear						
Sum of Thermal	2,816	3,115	7,236	8,177	18,528	21,344
Hydro/Other	536	568	1,147	1,296	3,011	3,547
PWRs	413	435	965	1,382	2,781	3,195
BWRs	696	876	2,106	3,868	6,850	7,546
HWR	5	5	10	9	25	30
Other Nuclear	5	14	23	19	56	61
ROK-Base Case						
Sum of Thermal	380	727	2,675	5,042	8,444	8,824
Hydro/Other	34	41	119	161	321	355
PWRs	243	324	917	1,200	2,441	2,684
PHWRs	24	33	196	245	474	498
ROK-Max. Nuclear						
Sum of Thermal	380	707	2,517	4,097	7,322	7,702
Hydro/Other	34	41	119	161	321	355
PWRs	243	331	1,041	1,778	3,150	3,393
PHWRs	24	47	231	609	887	911

LEAP Output Data: Generation Capacity by Country and Plant (GW)

Country: China							
BASE CASE							
	1990	1995	2000	2005	2010	2015	2020
COAL THERMAL	75.44	114.34	150	196	242	263.5	285
COGENERATION	10	15.04	16	23	30	40	50
WASHED COAL THER	1.4	2.86	5	10	15	32.5	50
DESULFURIZATION	0	4.29	12	21	30	40	50
COMBINED CYCLE	1	1.48	2.18	3.86	5.53	7.77	10
OIL THERMAL-1	10	5	0	0	0	0	0
OIL THERMAL-2	0	6.43	15	22.5	30	45	60
GAS THERMAL-1	4	5.29	6	12	18	9	0
GAS THERMAL-2	0	0	0	0	0	12.5	25
HYDRO POWER	36.04	47.56	55	72.5	90	115	140
NUCLEAR--PWR	0	2.17	2.7	8	12	18	23
WIND POWER	0.01	0.51	1	2.5	4	7	10
GEOTHERMAL	0.02	0.04	0.06	0.08	0.1	0.13	0.15
SOLAR POWER	0	0.03	0.11	0.56	1	3	5
Pumped Storage	0	1.2	1.2	1.2	1.2	1.2	1.2
Tidal Power	0	0.01	0.01	0.01	0.01	0.01	0.01
TOTAL	137.91	206.22	266.26	373.2	478.84	594.6	709.36
MAXIMUM NUCLEAR CASE							
	1990	1995	2000	2005	2010	2015	2020
COAL THERMAL	75.44	114.34	150	191.5	233	246.5	260
COGENERATION	10	15.04	16	23	30	40	50
WASHED COAL THER	1.4	2.86	5	10	15	30	45
DESULFURIZATION	0	4.29	12	21	30	40	50
COMBINED CYCLE	1	1.48	2.18	3.86	5.53	7.77	10
OIL THERMAL-1	10	5	0	0	0	0	0
OIL THERMAL-2	0	6.43	15	22.5	30	45	60
GAS THERMAL-1	4	5.29	6	12	18	9	0
GAS THERMAL-2	0	0	0	0	0	12.5	25
HYDRO POWER	36.04	47.56	55	72.5	90	112.5	135
NUCLEAR--PWR	0	2.17	2.7	12	22.2	39.4	61
WIND POWER	0.01	0.51	1	2.5	4	7	10
GEOTHERMAL	0.02	0.04	0.06	0.08	0.1	0.13	0.15
SOLAR POWER	0	0.03	0.11	0.56	1	3	5
Pumped Storage	0	1.2	1.2	1.2	1.2	1.2	1.2
Tidal Power	0	0.01	0.01	0.01	0.01	0.01	0.01
TOTAL	137.91	206.22	266.26	372.7	480.04	594	712.36

Country: Chinese Taipei							
BASE CASE							
	1990	1995	2000	2005	2010	2015	2020
Pumped-storage	0.91	2.04	2.04	2.04	2.04	2.04	2.04
Thermal Plants	11.05	13.93	13.93	13.93	13.93	13.93	13.93
Hydro Plants	2.57	2.58	2.58	2.58	2.58	2.58	2.58
Existing PWR	3.27	5.14	5.14	5.14	5.14	5.14	5.14
Existing BWR	1.88	1.88	1.88	1.88	1.88	1.88	1.88
Lungmen Nuc--PWR	0	0	0	0	2.5	2.5	2.5
New Thermal	0	0.6	3	6.3	7.5	11.5	15
TOTAL	19.67	26.18	28.58	31.88	35.58	39.58	43.08
MAXIMUM NUCLEAR CASE							
	1990	1995	2000	2005	2010	2015	2020
Pumped-storage	0.91	2.04	2.04	2.04	2.04	2.04	2.04
Thermal Plants	11.05	13.93	13.93	13.93	12.75	11.5	10.25
Hydro Plants	2.57	2.58	2.58	2.58	2.58	2.58	2.58
Existing PWR	3.27	5.14	5.14	5.14	5.14	5.14	5.14
Existing BWR	1.88	1.88	1.88	1.88	1.88	1.88	1.88
Other New PWR	0	0	0	0	2.5	6.25	7.5
Lungmen Nuc--PWR	0	0	0	0	2.5	2.5	2.5
New Thermal	0	0.6	3	6.3	6.3	7.2	11
TOTAL	19.67	26.18	28.58	31.88	35.69	39.09	42.89

Country: DPRK							
BASE CASE							
	1990	1995	2000	2005	2010	2015	2020
Existing Coal-90	3.2	3.2	0	0	0	0	0
Exist. Coal-2000	0	0	3.2	0	0	0	0
Exist. Coal-2005	0	0	0	2.74	2.54	1.94	1.44
East Pyongyang	0	0.05	0.15	0.15	0.15	0.15	0.15
Existing Oil	0.2	0.2	0.2	0	0	0	0
Expanded Oil	0	0	0	0.5	0.5	0.5	0.5
Existing Hydro	4.5	4.5	2.7	4.5	4.5	4.5	4.5
Nuclear--PWRs	0	0	0	2	2	2	2
New Coal Plants	0	0	0	0.9	2.7	5.4	8.5
Oil Comb. Cycle	0	0	0	0.5	0.6	1	1
New Hydro	0	0	0.4	0.63	0.7	0.9	1.1
TOTAL	7.9	7.95	6.65	11.91	13.69	16.39	19.19
MAXIMUM NUCLEAR CASE							
	1990	1995	2000	2005	2010	2015	2020
Existing Coal-90	3.2	3.2	0	0	0	0	0
Exist. Coal-2000	0	0	3.2	0	0	0	0
Exist. Coal-2005	0	0	0	2.74	2.54	1.94	1.44
East Pyongyang	0	0.05	0.15	0.15	0.15	0.15	0.15
Existing Oil	0.2	0.2	0.2	0	0	0	0
Expanded Oil	0	0	0	0.5	0.5	0.5	0.5
Existing Hydro	4.5	4.5	2.7	4.5	4.5	4.5	4.5
Nuclear--PWRs	0	0	0	2	2	2	2
Additional Nucl.	0	0	0	0	1	3	4
New Coal Plants	0	0	0	0.9	1.7	2.5	4.5
Oil Comb. Cycle	0	0	0	0.5	0.6	1	1
New Hydro	0	0	0.4	0.63	0.7	0.9	1.1
TOTAL	7.9	7.95	6.65	11.91	13.69	16.49	19.19

Country: Hong Kong							
BASE CASE							
	1990	1995	2000	2005	2010	2015	2020
Existing Coal	8.34	8.28	7.62	7.62	7.62	7.62	7.62
Black Point (NG)	0	0	1.98	2.6	2.6	2.6	2.6
Cast.Pk Using NG	0	0	0.6	0.6	0.6	0.6	0.6
Guangdong PWR Fr	0	1.38	1.38	1.38	1.38	1.38	1.38
Guangzhou PS Shr	0	0.6	0.6	0.6	0.6	0.6	0.6
New Coal Plants	0	0	0	0	1.8	3	3.6
New Gas Steam	0	0	0	0	0.9	1.8	2.4
Natural Gas CC	0	0	0	0	0.9	1.8	2.4
TOTAL	8.34	10.25	12.17	12.79	16.39	19.39	21.19
MAXIMUM NUCLEAR CASE							
	1990	1995	2000	2005	2010	2015	2020
Existing Coal	8.34	8.28	7.62	7.62	7.62	7.62	7.62
Black Point (NG)	0	0	1.98	2.6	2.6	2.6	2.6
Cast.Pk Using NG	0	0	0.6	0.6	0.6	0.6	0.6
Guangdong PWR Fr	0	1.38	1.38	1.38	1.38	1.38	1.38
Other China PWR	0	0	0	0	1.2	2.4	3
Guangzhou PS Shr	0	0.6	0.6	0.6	0.6	0.6	0.6
New Coal Plants	0	0	0	0	0.6	1.2	1.8
New Gas Steam	0	0	0	0	0.9	1.2	1.5
Natural Gas CC	0	0	0	0	0.9	1.8	2.1
TOTAL	8.34	10.25	12.17	12.79	16.39	19.39	21.19

Country: Japan

BASE CASE

	1990	1995	2000	2005	2010	2015	2020
Nucl.--Exist BWR	18.63	23.16	23.16	23.16	22.82	19.9	16.51
Nucl.--Exist PWR	11.96	11.96	11.96	11.96	11.96	10.39	5.52
Nucl.--Exist HWR	0.15	0.15	0.15	0.15	0.15	0.15	0
Nucl.--Exist GCR	0.16	0.16	0.16	0	0	0	0
Nucl.--New BWRs	0	0.8	3.43	6.07	7.14	7.14	7.14
Nucl.--New PWRs	0	0	1.13	1.13	1.13	1.13	1.13
Nucl. New ABWRs	0	0	0	1.89	1.89	4.49	4.49
Nucl., FBR	0	0.25	0.25	0.25	0.25	0.25	0.25
Hydro--Convent.	19.45	19.65	19.65	19.65	19.65	19.65	19.65
Pumped St. Hydro	17	18.94	18.94	21	23	25	25
Geothermal--Util	0.24	0.26	0.26	0.26	0.26	0.26	0.26
Geothermal--Auto	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Gas Turbine-Util	2.37	2.55	2.55	2.55	2.55	2.55	2.55
Int. Comb--Util	2.82	2.82	2.82	2.82	2.82	2.82	2.82
Coal Steam--Util	12.42	15.97	15.97	15.97	15.97	15.97	15.97
Coal Steam--Auto	2.78	3.57	3.57	3.57	3.57	3.57	3.57
Coal/Ck Gas-Util	3.71	3.71	3.71	3.71	3.71	3.71	3.71
Coal/Ck Gas-Auto	2.96	2.96	2.96	2.96	2.96	2.96	2.96
Std. Coal, New	0	0	2.4	6.6	9.6	14.4	20.4
Stm NG/LNG--Util	35.41	38.18	38.18	38.18	38.18	38.18	38.18
Stm Nat Gas-Auto	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Steam LNG--New	0	0	3.6	6	10.2	13.2	16.8
LNG CC, New	0	0	1.2	3.6	7.8	10.8	16.8
Steam Oil--Util	53.89	53.68	53.68	53.68	53.68	53.68	53.68
Stm Hvy Oil-Auto	10.35	7.84	7.84	7.84	7.84	7.84	7.84
Stm Lt Oil--Auto	2.02	1.53	1.53	1.53	1.53	1.53	1.53
Oil CC, New	0	0	1.2	3	6.6	12	15
MSW-Fired Plants	0.23	0.28	0.28	0.28	0.28	0.28	0.28
Biomass/Wst-Auto	1.73	1.75	1.75	1.75	1.75	1.75	1.75
TOTAL	198.34	210.21	222.37	239.6	257.33	273.65	283.84

MAXIMUM NUCLEAR CASE

	1990	1995	2000	2005	2010	2015	2020
Nucl.--Exist BWR	18.63	23.16	23.16	23.16	22.82	19.9	16.51
Nucl.--Exist PWR	11.96	11.96	11.96	11.96	11.96	10.39	5.52
Nucl.--Exist HWR	0.15	0.15	0.15	0.15	0.15	0.15	0
Nucl.--Exist GCR	0.16	0.16	0.16	0	0	0	0
Nucl.--New BWRs	0	0.8	3.43	7.14	14	20	26
Nucl.--New PWRs	0	0	1.13	2.5	4	6	8
Nucl. New APWRs	0	0	0	0	0	2.6	7.8
Nucl. New ABWRs	0	0	0	1.89	7	12.2	18
Nucl., FBR	0	0.25	0.25	0.25	0.25	0.25	0.25
Hydro--Convent.	19.45	19.65	19.65	19.65	19.65	19.65	19.65
Pumped St. Hydro	17	18.94	20	21	23	25	25
Geothermal--Util	0.24	0.26	0.26	0.26	0.26	0.26	0.26
Geothermal--Auto	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Gas Turbine-Util	2.37	2.55	2.55	2.55	2.55	2.55	2.55
Int. Comb--Util	2.82	2.82	2.82	2.82	2.82	2.82	2.82
Coal Steam--Util	12.42	15.97	15.97	15.3	14	11.5	10
Coal Steam--Auto	2.78	3.57	3.57	3.57	3.57	3.57	3.57
Coal/Ck Gas-Util	3.71	3.71	3.71	3.71	3.71	3.71	3.71
Coal/Ck Gas-Auto	2.96	2.96	2.96	2.96	2.96	2.96	2.96
Std. Coal, New	0	0	2.4	6.6	9.6	13.8	13.8
Stm NG/LNG--Util	35.41	38.18	38.18	38.18	38.18	38.18	38.18
Stm Nat Gas-Auto	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Steam LNG--New	0	0	3.6	6	10.2	13.2	18
LNG CC, New	0	0	1.2	3.6	7.8	10.8	16.8
Steam Oil--Util	53.89	53.68	53.68	51.5	42	35	25
Stm Hvy Oil-Auto	10.35	7.84	7.84	7.84	7.84	7.84	7.84
Stm Lt Oil--Auto	2.02	1.53	1.53	1.53	1.53	1.53	1.53
Oil CC, New	0	0	0	3	5.4	7.8	9.6
MSW-Fired Plants	0.23	0.28	0.28	0.28	0.28	0.28	0.28
Biomass/Wst-Auto	1.73	1.75	1.75	1.75	1.75	1.75	1.75
TOTAL	198.34	210.21	222.23	239.19	257.32	273.74	285.43

Country: Republic of Korea							
BASE CASE							
	1990	1995	2000	2005	2010	2015	2020
Existing Hydro	1.34	1.49	1.49	1.49	1.49	1.49	1.49
Pumped Storage	1	1.6	1.6	1.6	1.6	1.6	1.6
Coal-fired steam	3.7	8.14	8.14	8.14	8.14	8.14	8.14
Oil-fired Steam	3.66	4.35	4.35	4.35	4.35	4.35	4.35
Gas-fired Steam	2.55	1.54	1.54	1.54	1.54	1.54	1.54
Combined Cycle	0.84	6.18	6.18	6.18	6.18	6.18	6.18
Internal Combust	0.31	0.26	0.26	0.26	0.26	0.26	0.26
Existing PWRs	6.94	7.94	7.94	7.94	7.94	7.94	7.94
Wollsong 1--PHWR	0.68	0.68	0.68	0.68	0.68	0.68	0.68
New Yonggw. PWR	0	0	0.95	2.85	2.85	2.85	2.85
New Ulchin PWRs	0	0	1.92	2.87	3.82	3.82	3.82
New Wolsong PHWR	0	0	1.95	1.95	2.5	2.5	2.5
Other New PWRs	0	0	0	0	0	1	2
New Pumped-Stor.	0	0	0	0.5	1	2	2.5
New Coal Plants	0	0	11	19	31	38	43
New Comb. Cycle	0	0	8.02	14.5	24	32	37
New Conv. Hydro	0	0	0.79	0.89	0.89	0.89	0.89
TOTAL	21.02	32.18	56.81	74.74	98.24	115.24	126.74

MAXIMUM NUCLEAR CASE							
	1990	1995	2000	2005	2010	2015	2020
Existing Hydro	1.34	1.49	1.49	1.49	1.49	1.49	1.49
Pumped Storage	1	1.6	1.6	1.6	1.6	1.6	1.6
Coal-fired steam	3.7	8.14	8.14	8.14	8.14	8.14	8.14
Oil-fired Steam	3.66	4.35	4.35	4.35	4.35	4.35	4.35
Gas-fired Steam	2.55	1.54	1.54	1.54	1.54	1.54	1.54
Combined Cycle	0.84	6.18	6.18	6.18	6.18	6.18	6.18
Internal Combust	0.31	0.26	0.26	0.26	0.26	0.26	0.26
Existing PWRs	6.94	7.94	7.94	7.94	7.94	7.94	7.94
Wollsong 1--PHWR	0.68	0.68	0.68	0.68	0.68	0.68	0.68
New Yonggw. PWR	0	0	1.9	2.85	2.85	2.85	2.85
New Ulchin PWRs	0	0	1.92	3.82	3.82	3.82	3.82
New Wolsong PHWR	0	0	1.95	2.5	2.5	2.5	2.5
Other New PWRs	0	0	0	1	6	8	12
Other New PHWRs	0	0	0	0	2.6	5.2	6.5
New Pumped-Stor.	0	0	0	0.5	1	2	2.5
New Coal Plants	0	0	11	18	22.4	24.8	24.8
New Comb. Cycle	0	0	8.02	14.5	24	32	37
New Conv. Hydro	0	0	0.79	0.89	0.89	0.89	0.89
TOTAL	21.02	32.18	57.76	76.24	98.24	114.24	125.04

Summary of Annual TWh Electricity Production by Country and Plant Type

	1990	1995	2000	2005	2010	2015	2020
China-Base Case							
Sum of Thermal	494	793	1,019	1,360	1,652	1,976	2,308
Hydro/Other	126	197	246	313	369	477	586
PWRs	-	13	18	50	71	107	137
China-Max. Nuclear							
Sum of Thermal	494	793	1,019	1,336	1,612	1,898	2,160
Hydro/Other	126	197	246	313	370	471	565
PWRs	-	13	18	75	132	236	361
Chinese Taipei-Base Case							
Sum of Thermal	44	51	67	82	81	99	119
Hydro/Other	10	13	14	14	13	14	14
PWRs	21	34	34	34	50	50	50
BWRs	12	12	12	12	12	12	12
Chinese Taipei-Max. Nuclear							
Sum of Thermal	44	51	67	82	66	60	72
Hydro/Other	10	13	14	14	13	12	12
PWRs	21	34	34	34	67	91	100
BWRs	12	12	12	12	12	12	12
DPRK-Base Case							
Sum of Thermal	25	6	22	25	34	43	55
Hydro/Other	21	21	15	24	25	26	26
PWRs	-	-	-	13	13	13	13
DPRK-Max. Nuclear							
Sum of Thermal	25	6	22	25	28	24	29
Hydro/Other	21	21	15	24	25	26	26
PWRs	-	-	-	13	19	32	38
Hong Kong-Base Case							
Sum of Thermal	28	25	38	52	66	82	103
Hydro/Other	-	1	1	1	1	1	1
PWRs	-	8	8	8	8	8	8
Hong Kong-Max. Nuclear							
Sum of Thermal	28	25	38	52	58	67	85
Hydro/Other	-	1	1	1	1	1	1
PWRs	-	8	8	8	16	23	27
Japan-Base Case							
Sum of Thermal	566	594	667	730	823	911	1,054
Hydro/Other	88	113	113	115	117	119	119
PWRs	78	84	92	92	92	81	47
BWRs	122	168	186	218	223	221	197
HWR	1	1	1	1	1	1	-
Other Nuclear	1	3	3	2	2	2	2
Japan-Max. Nuclear							
Sum of Thermal	566	594	668	713	721	721	736
Hydro/Other	88	113	114	115	117	119	119
PWRs	78	84	92	101	112	133	149
BWRs	122	168	186	226	307	365	424
HWR	1	1	1	1	1	1	-
Other Nuclear	1	3	3	2	2	2	2
ROK-Base Case							
Sum of Thermal	48	112	198	268	372	457	547
Hydro/Other	6	5	11	12	13	15	16
PWRs	48	62	76	96	102	109	116
PHWRs	5	5	18	18	22	22	22
ROK-Max. Nuclear							
Sum of Thermal	48	112	191	250	312	372	431
Hydro/Other	6	5	11	12	13	15	16
PWRs	48	62	82	109	144	158	186
PHWRs	5	5	18	22	41	59	68

SUMMARY OF NUCLEAR GENERATING CAPACITY SCENARIOS

BASE CASE (GW capacity)

	1990	1995	2000	2010	2020
China	-	2	3	12	23
Chinese Taipei	5	7	7	10	10
DPRK	-	-	-	2	2
Japan	31	36	40	45	35
ROK	8	9	13	18	20
TOTAL	**44**	**54**	**63**	**87**	**89**

MAXIMUM NUCLEAR CASE (GW capacity)

	1990	1995	2000	2010	2020
China	-	2	3	22	61
Chinese Taipei	5	7	7	12	17
DPRK	-	-	-	3	6
Japan	31	36	40	60	82
ROK	8	9	14	26	36
TOTAL	**44**	**54**	**64**	**124**	**202**

FRACTION OF CAPACITY AS NUCLEAR BY COUNTRY

BASE CASE	1990	1995	2000	2010	2020
China	0.0%	4.0%	4.3%	13.8%	25.7%
Chinese Taipei	11.8%	12.9%	11.1%	11.0%	10.7%
DPRK	0.0%	0.0%	0.0%	2.3%	2.2%
Japan	70.8%	67.2%	63.5%	52.3%	39.2%
ROK	17.4%	15.9%	21.2%	20.5%	22.1%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%

MAX. NUCLEAR	1990	1995	2000	2010	2020
China	0.0%	4.0%	4.2%	17.9%	30.1%
Chinese Taipei	11.8%	12.9%	10.9%	9.7%	8.4%
DPRK	0.0%	0.0%	0.0%	2.4%	3.0%
Japan	70.8%	67.2%	62.5%	48.6%	40.6%
ROK	17.4%	15.9%	22.4%	21.3%	17.9%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%

Electricity Demand Projections by Country (TWh)

Country	1990	1995	2000	2010	2020	Annual Ave. Growth 1995 to 2020
China	570	893	1,198	1,911	2,778	4.6%
Chinese Taipei	72	89	104	129	162	2.4%
DPRK	31	18	25	45	63	5.2%
Hong Kong	24	30	42	68	102	5.0%
Japan	747	834	931	1,107	1,260	1.7%
ROK	99	163	265	458	626	5.5%
TOTAL	**1,543**	**2,027**	**2,564**	**3,718**	**4,992**	**3.7%**
China	**37%**	**44%**	**47%**	**51%**	**56%**	
Chinese Taipei	**5%**	**4%**	**4%**	**3%**	**3%**	
DPRK	**2%**	**1%**	**1%**	**1%**	**1%**	
Hong Kong	**2%**	**1%**	**2%**	**2%**	**2%**	
Japan	**48%**	**41%**	**36%**	**30%**	**25%**	
ROK	**6%**	**8%**	**10%**	**12%**	**13%**	
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	

Estimates of Waste Generation per Unit Activity

Assumptions for Calculation of Low-Level Wastes
Sources: Lipschutz, 1980; Reviews of Modern Physics, 1978; The Nuclear Almanac (J. Dennis, Ed.)

	Cu.m./GW cap./yr		Curies/cu.m.		Curies/GW cap/yr	
Reactor Type	High Est.	Low Est.	High Est.	Low Est.	High Est.	Low Est.
PWR	750	439	6.452	1.5	4000	1,139
BWR	1,303	983	6.452	1.3	4000	1,748

Assuming an annual capacity factor of	80%	
Annual Generation per GW cap./yr =	7.008	TWhe

Low-Level Waste Ranges per TWh_e

	Cubic Meters		Curies	
Reactor Type	High Est.	Low Est.	High Est.	Low Est.
PWR	107	63	571	163
BWR	186	140	571	249

Estimates of Mass/Ci of Isotopes in Spent Fuel for Range of Fuel Consumption
(Assumptions primarily from F. von Hippel, personal communication)

Assumptions	
Mass fraction Pu in PWR/BWR spent fuel	1%
Mass fraction Pu in HWR spent fuel	0.4%
Grams U-235 fissioned per MW_{th}-day	1.0
Power plant efficiency (TWh_e/TWh_{th})	33.3%
Curies Strontium-90 per gm U235 fissioned	3.0
Curies Cesium-137 per gm U235 fissioned	3.0
Grams Pu fissioned per gm Pu in spent fuel	1.0
Curies Strontium-90 per gm Pu fissioned	1.0
Curies Cesium-137 per gm Pu fissioned	3.0
MWe-days/TWhe	41,667
MWth-days/TWhe	125,125
Grams U235 fissioned per TWhe	125,125
Curies Strontium-90 from U235 per TWhe	3.75E+05
Curies Cesium-137 from U235 per TWhe	3.75E+05

For PWRs and BWRs:

Years	MW_{th}-days/ Te Heavy Metal	Te Heavy Metal per MWth-day	Te Heavy Metal per TWhe	kg Pu in Spent fuel per TWhe	kg Pu Fissioned per TWhe	Ci Str-90 from Pu per TWhe	Ci Cs-137 from Pu per TWhe	Total Ci Str-90 per TWhe	Total Ci Cs-137 per TWhe
1990 - 1999	40,000	2.50E-05	3.13	31.3	31.3	31,281	93,844	4.07E+05	4.69E+05
2000 - 2009	44,000	2.27E-05	2.84	28.4	28.4	28,438	85,313	4.04E+05	4.61E+05
2010 - 2020	48,000	2.08E-05	2.61	26.1	26.1	26,068	78,203	4.01E+05	4.54E+05
For HWRs (all)	7,000	1.43E-04	17.88	71.5	71.5	71,500	214,500	4.47E+05	5.90E+05

Estimate of Wastes from Reprocessing (data primarily from Lipschutz, 1980)

TWhe electric assumed by Lipschutz for annual LWR operation: 8.76

Fraction of Spent Fuel Reprocessed: 50%

Wastes from Reprocessing Included in Estimate:

High-Level Liquid Wastes	1.5	gallon/kg spent fuel reprocessed
or	0.20	cubic feet/kg processed
with	56,250	Ci/cubic foot
Plutonium with	14,074	Ci/kg
Spent fuel cladding hulls	61	cubic feet/TWh_e
containing	1,642	Ci/cubic foot
for a total of	9.93E+04	Ci/TWhe
Transuranium-containated waste	121	cubic feet/TWh_e
containing	1,604	Ci/cubic foot
for a total of	1.94E+05	Ci/TWh_e
Additional Low-level wastes	23	cubic feet/TWh_e

Estimates of Waste Generation in Northeast Asia

Notes: Does not include Japan's GCR or FBR. Hong Kong accounted for in China data.

ESTIMATES OF LOW-LEVEL WASTE GENERATION

HIGHER-RANGE ESTIMATES: BASE CASE

	Waste Volume (Cubic Meters)				Radioactivity in Wastes (Curies)			
Country	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020
China	9.32E+03	4.97E+04	1.24E+05	1.83E+05	4.97E+04	2.65E+05	6.61E+05	9.76E+05
Chinese Taipei	5.37E+04	6.35E+04	8.44E+04	2.02E+05	2.35E+05	2.87E+05	3.93E+05	9.14E+05
DPRK	0.00E+00	8.44E+03	1.55E+04	2.39E+04	0.00E+00	4.50E+04	8.25E+04	1.28E+05
JAPAN	3.83E+05	4.81E+05	5.43E+05	1.41E+06	1.38E+06	1.70E+06	1.87E+06	4.95E+06
ROK	6.68E+04	1.19E+05	1.55E+05	3.41E+05	3.56E+05	6.35E+05	8.25E+05	1.82E+06
TOTAL	**5.13E+05**	**7.22E+05**	**9.21E+05**	**2.16E+06**	**2.02E+06**	**2.93E+06**	**3.83E+06**	**8.79E+06**

HIGHER-RANGE ESTIMATES: MAXIMUM NUCLEAR CASE

	Waste Volume (Cubic Meters)				Radioactivity in Wastes (Curies)			
Country	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020
China	9.32E+03	7.46E+04	2.85E+05	3.69E+05	4.97E+04	3.98E+05	1.52E+06	1.97E+06
Chinese Taipei	5.37E+04	6.44E+04	1.27E+05	2.45E+05	2.35E+05	2.91E+05	6.22E+05	1.15E+06
DPRK	0.00E+00	9.75E+03	3.52E+04	4.49E+04	0.00E+00	5.20E+04	1.88E+05	2.40E+05
JAPAN	3.84E+05	4.96E+05	8.68E+05	1.75E+06	1.39E+06	1.76E+06	3.00E+06	6.15E+06
ROK	6.90E+04	1.36E+05	2.56E+05	4.61E+05	3.68E+05	7.26E+05	1.36E+06	2.46E+06
TOTAL	**5.16E+05**	**7.81E+05**	**1.57E+06**	**2.87E+06**	**2.04E+06**	**3.23E+06**	**6.69E+06**	**1.20E+07**

LOWER-RANGE ESTIMATES: BASE CASE

	Waste Volume (Cubic Meters)				Radioactivity in Wastes (Curies)			
Country	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020
China	5.45E+03	2.91E+04	7.25E+04	1.07E+05	1.42E+04	7.55E+04	1.88E+05	2.78E+05
Chinese Taipei	3.53E+04	4.10E+04	5.36E+04	1.30E+05	7.75E+04	9.24E+04	1.24E+05	2.93E+05
DPRK	0.00E+00	4.94E+03	9.05E+03	1.40E+04	0.00E+00	1.28E+04	2.35E+04	3.63E+04
JAPAN	2.74E+05	3.46E+05	3.94E+05	1.01E+06	5.30E+05	6.63E+05	7.44E+05	1.94E+06
ROK	3.91E+04	6.97E+04	9.05E+04	1.99E+05	1.01E+05	1.81E+05	2.35E+05	5.17E+05
TOTAL	**3.54E+05**	**4.91E+05**	**6.20E+05**	**1.46E+06**	**7.23E+05**	**1.02E+06**	**1.31E+06**	**3.06E+06**

LOWER-RANGE ESTIMATES: MAXIMUM NUCLEAR CASE

	Waste Volume (Cubic Meters)				Radioactivity in Wastes (Curies)			
Country	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020
China	5.45E+03	4.37E+04	1.67E+05	2.16E+05	1.42E+04	1.13E+05	4.32E+05	5.60E+05
Chinese Taipei	3.53E+04	4.15E+04	7.88E+04	1.56E+05	7.75E+04	9.37E+04	1.89E+05	3.60E+05
DPRK	0.00E+00	5.71E+03	2.06E+04	2.63E+04	0.00E+00	1.48E+04	5.34E+04	6.82E+04
JAPAN	2.74E+05	3.56E+05	6.30E+05	1.26E+06	5.32E+05	6.84E+05	1.19E+06	2.41E+06
ROK	4.04E+04	7.97E+04	1.50E+05	2.70E+05	1.05E+05	2.07E+05	3.88E+05	7.00E+05
TOTAL	**3.55E+05**	**5.27E+05**	**1.05E+06**	**1.93E+06**	**7.28E+05**	**1.11E+06**	**2.25E+06**	**4.09E+06**

ESTIMATES OF SPENT FUEL MASS AND PLUTONIUM CONTENT

BASE CASE

	Total Spent Fuel (Tonnes)				Total Plutonium in Spent Fuel (kg)			
Country	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020
China	2.72E+02	1.32E+03	3.02E+03	4.61E+03	2.72E+03	1.32E+04	3.02E+04	4.61E+04
Chinese Taipei	1.29E+03	1.43E+03	1.79E+03	4.51E+03	1.29E+04	1.43E+04	1.79E+04	4.51E+04
DPRK	0.00E+00	2.24E+02	3.77E+02	6.01E+02	0.00E+00	2.24E+03	3.77E+03	6.01E+03
JAPAN	7.73E+03	8.63E+03	8.68E+03	2.50E+04	7.62E+04	8.52E+04	8.58E+04	2.47E+05
ROK	2.80E+03	6.11E+03	7.51E+03	1.64E+04	2.18E+04	4.01E+04	4.88E+04	1.11E+05
TOTAL	**1.21E+04**	**1.77E+04**	**2.14E+04**	**5.12E+04**	**1.14E+05**	**1.55E+05**	**1.86E+05**	**4.55E+05**

MAXIMUM NUCLEAR CASE

	Total Spent Fuel (Tonnes)				Total Plutonium in Spent Fuel (kg)			
Country	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020
China	2.72E+02	1.98E+03	6.93E+03	9.19E+03	2.72E+03	1.98E+04	6.93E+04	9.19E+04
Chinese Taipei	1.29E+03	1.45E+03	2.84E+03	5.58E+03	1.29E+04	1.45E+04	2.84E+04	5.58E+04
DPRK	0.00E+00	2.59E+02	8.56E+02	1.12E+03	0.00E+00	2.59E+03	8.56E+03	1.12E+04
JAPAN	7.76E+03	8.92E+03	1.39E+04	3.05E+04	7.64E+04	8.81E+04	1.38E+05	3.02E+05
ROK	3.06E+03	7.09E+03	1.55E+04	2.57E+04	2.30E+04	4.61E+04	8.99E+04	1.59E+05
TOTAL	**1.24E+04**	**1.97E+04**	**4.00E+04**	**7.21E+04**	**1.15E+05**	**1.71E+05**	**3.34E+05**	**6.20E+05**

ESTIMATES OF SPENT FUEL RADIOACTIVITY IN ST-90 AND CS-137

BASE CASE

	Total Curies Strontium-90 in Spent Fuel				Total Curies Cesium-137 in Spent Fuel			
Country	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020
China	3.54E+07	1.87E+08	4.65E+08	6.88E+08	4.09E+07	2.14E+08	5.25E+08	7.80E+08
Chinese Taipei	1.67E+08	2.03E+08	2.76E+08	6.46E+08	1.93E+08	2.31E+08	3.12E+08	7.36E+08
DPRK	0.00E+00	3.18E+07	5.80E+07	8.99E+07	0.00E+00	3.63E+07	6.56E+07	1.02E+08
JAPAN	9.86E+08	1.20E+09	1.32E+09	3.50E+09	1.14E+09	1.37E+09	1.49E+09	4.00E+09
ROK	2.56E+08	4.58E+08	5.91E+08	1.31E+09	3.00E+08	5.38E+08	6.89E+08	1.53E+09
TOTAL	**1.44E+09**	**2.08E+09**	**2.71E+09**	**6.23E+09**	**1.67E+09**	**2.39E+09**	**3.08E+09**	**7.14E+09**

MAXIMUM NUCLEAR CASE

	Total Curies Strontium-90 in Spent Fuel				Total Curies Cesium-137 in Spent Fuel			
Country	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020	1990 to 1999	2000 to 2009	2010 to 2020	1990 to 2020
China	3.54E+07	2.81E+08	1.07E+09	1.38E+09	4.09E+07	3.21E+08	1.21E+09	1.57E+09
Chinese Taipei	1.67E+08	2.06E+08	4.38E+08	8.11E+08	1.93E+08	2.35E+08	4.95E+08	9.23E+08
DPRK	0.00E+00	3.68E+07	1.32E+08	1.69E+08	0.00E+00	4.20E+07	1.49E+08	1.91E+08
JAPAN	9.89E+08	1.24E+09	2.11E+09	4.35E+09	1.14E+09	1.42E+09	2.39E+09	4.95E+09
ROK	2.65E+08	5.24E+08	9.86E+08	1.77E+09	3.11E+08	6.16E+08	1.17E+09	2.09E+09
TOTAL	**1.46E+09**	**2.29E+09**	**4.73E+09**	**8.48E+09**	**1.69E+09**	**2.63E+09**	**5.40E+09**	**9.72E+09**

Estimates of Area Required and Costs for Dry Cask Storage of Spent Fuel

				Sources/Notes
Assumptions:				
Tonnes of Heavy Metal per Assembly	0.46			*1*
Assemblies per Cask	21			*2*
Tonnes of Heavy Metal Spent Fuel per Cask	9.7			*Calculated*
Storage area required per cask	20	sq. meters		*Rough Estimate based on 4x5m grid*
Cask Volume (outer dimensions)	19.2	cubic meters		*3*
Capital Cost of Dry Storage Casks	$ 350,000	per cask		*4*
Capital Cost of Dry Storage Facility	$ 9,350,000	per site		*7*
Annual O&M Cost per Reactor Site	$ 300,000	for operating reactors		*5*
Annual O&M Cost per Reactor Site	$ 1,040,000	for shut-down reactors		*5*
Assuming a real discount rate of	5%			
Performing cask O&M indefinitely will cost (per reactor)	$ 20,800,000	in NPV terms for shut-down reactors		

Estimate of Dry Cask Storage Requirements for 1000 MW LWR

Assumptions

Capacity	1000	MW_e	Average Capacity Factor		80%
Lifetime	40	years	MW_e per MW_{th}	33%	
Average Fuel Burn Rate		44,000	MW_{th}-days/tonne heavy metal		

Results

Implied Tonnes Heavy Metal in Spent Fuel over Reactor Life:	798		
Implied Dry Storage Casks Required over Reactor Life:	83		
Implied Area for Storage Casks Required over Reactor Life:	0.17	hectares	
Implied undiscounted O&M costs while reactor is operating:	$ 42,800	per TWh_e	
Implied NPV Capital Cost for Dry Cask Storage (Casks and Facility):	$ 21,750,000		
Implied NPV O&M Cost for Dry Cask Storage:	$ 8,100,000		*6*
Implied NPV Capital and O&M Cost for Dry Cask Storage:	$ 29,850,000		
Implied NPV Cost for Dry Cask Storage per unit generation:	0.11	mills/kWh	

Sources/Notes

1 Data from US Department of Energy (1994), Multi-purpose Canister Evaluation: A Systems Engineering Approach. Report DOE/RW-0445, September, 1994. Multipurpose canister (interim storage, transport, and final disposal) designed for PWR spent fuel.

2 Assemblies per container depend on container design and reactor type. Other cask designs for PWR spent fuel hold 21 to 28 assemblies. A particular BWR cask is designed to hold 51 assemblies, but BWR fuel bundles are smaller than PWR assemblies by roughly a factor of 2.

3 Based on data in 1, above. Multipurpose container 2.15 m in diameter, 5.3 m high.

4 Reference 1 lists cost of $354,000 (presumably in $1994) for multi-purpose container. $350,000 is used here as a rough estimate--costs of designs will differ by reactor type and by country. HWR storage units will be larger, and thus will probably cost less per unit of heavy metal stored. The $350,000 figure is probably in the upper range of ultimate costs of casks that would be used in Northeast Asia, particularly if the casks were used for interim storage only (not transport or ultimate disposal).

5 "Midrange" estimates for costs of O&M of dry storage facilities at operating and shut-down reactors from TRW Environmental Safety Systems, Inc., At Reactor Dry Storage Issues, Report # E00000000-01717-2200-00002, September, 1993. We have updated costs from this document to roughly 1996 dollars using an inflator of 3 percent per year.

6 Includes O&M costs for dry cask storage both over the life of the reactor and into the indefinite future after the reactor is shut down, discounted back to 1996.

7 Capital cost for construction of an Independent Spent Fuel Storage Installation as presented in Source 5, updated to 1996 dollars.