The Nautilus Institute

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 BASE CASE	SUM OF GENERATION (GWH)					
	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

MAXIMUM NUCLEAR CASE	SUM OF GENERATION (GWH)					
	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-contained 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

Assumptions:				***Sources/Notes***
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.