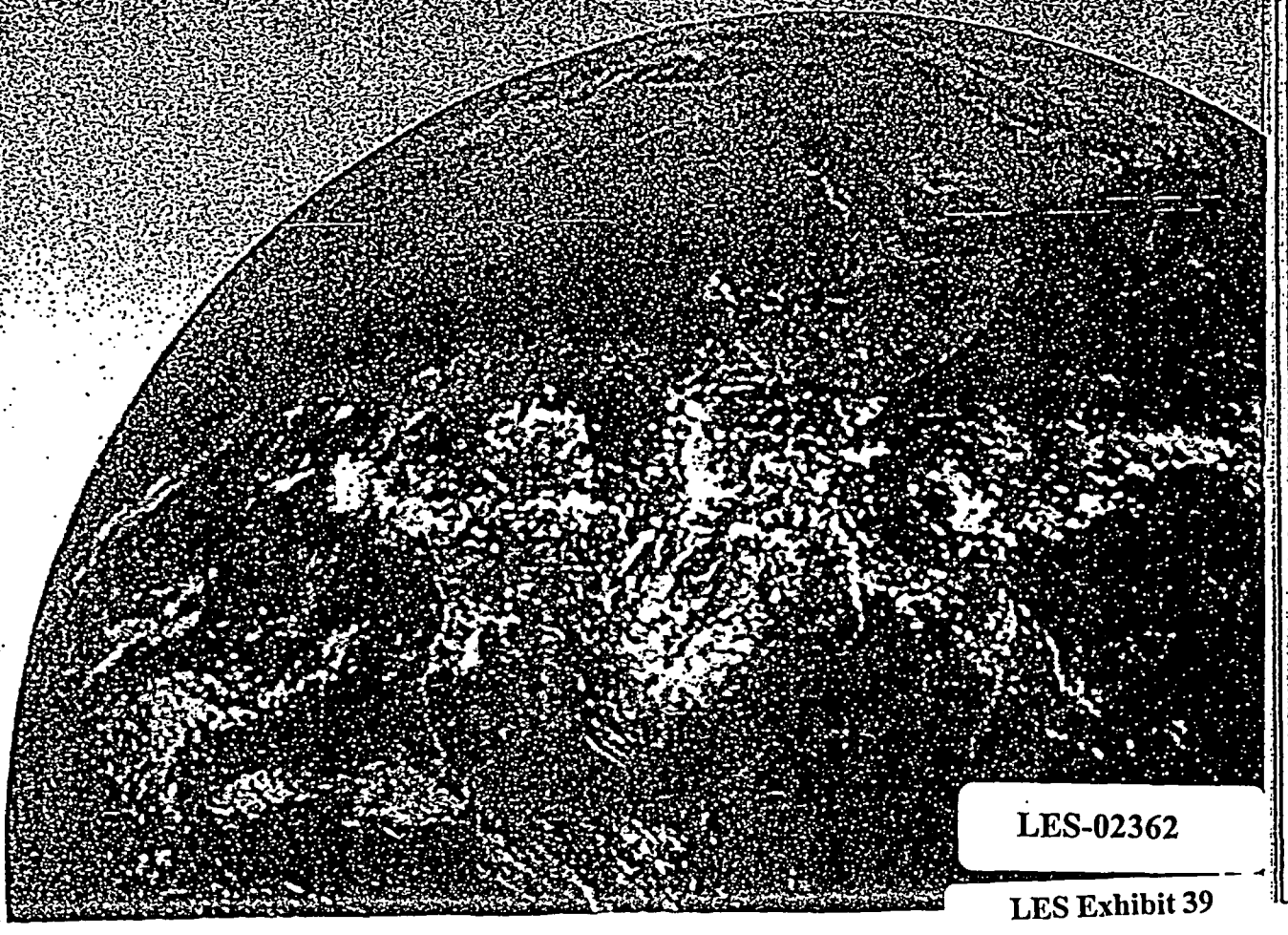
The World Nuclear Association Market Report 2003

The Global Nuclear Fuel Market

Supply and Demand 2003 - 2025



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LES Exhibit 39

Table I.1. Nuclear Generating Capacities (MWe net) — Reference Scenario

Country/Area	Region	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Argentina	Americas	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935
Armenia	Non-EU	376	376	376	376	376	376	376	376	376	376	376	376	376	376	376	0	0	0	0	0	0	0	0	0
Belgium	EU	5713	5713	5713	5713	5713	5713	5713	5713	5713	5713	5713	5713	5713	5321	3970	3970	3970	3970	3970	3970	3970	2005	2005	2005
Brazil	Americas	1871	1871	1871	1871	1871	1871	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116
Bulgaria	Non-EU	3538	2710	2710	2710	2710	2710	2710	2710	2710	2710	2710	2710	2710	3669	3669	3669	3669	3669	3669	3669	3264	2859	2859	2859
Canada	Americas	9998	12051	12868	13061	13598	13598	13598	13598	13598	13598	13598	13598	13598	13598	13598	13598	13598	13598	13598	13598	13598	13598	14448	14448
Chile	Americas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greater China																									
CHINC	ESSE Asia	5600	6370	6370	7220	8940	8410	8410	10340	13170	13170	16020	16020	16870	16870	19620	19620	20770	20770	20770	21720	23305	24255	25840	25840
Taipower	ESSE Asia	4884	4884	4884	4884	6160	7440	7440	7440	7440	7440	7440	7440	7440	7440	7440	7440	7440	7440	7440	7440	7440	7440	7440	7440
Czech Republic	Non-EU	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472
DPRK	ESSE Asia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	950	950	950	950	950	1900	1900
Egypt	Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Finland	EU	2650	2650	2650	2650	2650	2650	2650	2650	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700
France	France	62940	62940	62940	62940	62940	62940	62940	62940	62940	62940	62940	62940	62940	64390	64390	64390	64390	64390	64390	64390	64390	65840	65840	65840
Germany	EU	21044	21044	20404	20404	20064	20064	20064	19293	18503	18503	17653	16743	16743	15576	15576	14536	14536	13051	13051	11743	7846	6498	5220	5220
Hungary	Non-EU	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720	1720	1290	860
India	Other	2577	2577	2577	3027	4127	5730	6695	6695	8593	8593	7233	8043	8492	8898	10796	12649	13059	13549	13999	13812	15215	15665	16418	16418
Indonesia	ESSE Asia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iran	Other	0	0	950	950	950	950	950	950	950	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Japan	Japan	43890	43890	43890	48282	48282	47588	47588	40783	51074	52543	58556	58555	58555	60555	59222	61115	62453	62453	62453	62115	61874	61204	63622	61843
Kazakhstan	Other	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	1200	1200	1200	1200	1200	1200	1200	1200	1200
Korea	ESSE Asia	14890	14890	14890	15656	16616	16616	16616	17204	18114	21024	21974	23224	23845	23845	23845	25095	26345	27596	29845	29845	29845	29845	29845	29240
Lithuania	Non-EU	2500	2500	2500	2500	1250	1250	1250	1250	1250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mexico	Americas	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308
Netherlands	EU	449	449	449	449	449	449	449	449	449	449	449	449	449	0	0	0	0	0	0	0	0	0	0	0
Pakistan	Other	425	425	425	425	425	425	425	425	725	725	600	600	600	600	600	600	600	600	1500	1500	1500	1500	1500	1500
Romania	Non-EU	630	630	630	630	630	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1890	1890	1890	1890	1890	1890
Russia	Russia	20180	20180	20180	20180	21114	22684	24584	25439	25539	25584	26189	26789	26269	27439	28639	28279	28844	29583	29172	29227	29222	29222	29222	29222
Slovakia	Non-EU	2450	2450	2450	2450	2450	2025	2025	1620	1620	1620	1620	1620	1620	1215	810	810	810	810	810	810	810	810	810	810
Slovenia	Non-EU	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620
South Africa	Other	1840	1840	1840	1840	1840	1840	1840	1840	1840	1840	2040	2040	2140	2140	2240	2240	2240	2240	2240	2240	2240	2240	2240	2240
Spain	EU	7730	7730	7730	7730	7730	7577	7577	7577	7577	7577	7123	7123	7123	7123	7123	7123	7123	7123	7123	7123	7123	7123	7123	7123
Sweden	EU	9325	9325	9325	9325	9325	9325	9325	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725
Switzerland	Non-EU	3184	3184	3184	3184	3184	3184	3184	3184	2929	2929	2124	2124	2124	2124	2124	2124	2124	2124	2124	2124	2124	2124	2124	2124
Turkey	Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ukraine	Non-EU	11220	11220	11220	11220	13134	13134	13134	13134	14087	15040	15040	15040	15040	15040	15040	15040	15040	15040	15040	15040	15040	15040	15040	15040
UK	EU	12520	12150	12080	11860	11460	11020	10588	9636	9636	9636	9636	9636	9636	9636	9636	7792	6188	6188	6188	6188	6188	6188	6188	6188
USA	USA	98290	98290	98440	98440	100590	100590	101740	102905	103955	103955	105105	105105	106255	106255	107405	107405	108555	108555	108555	109705	110999	113199	113300	113370
Vietnam	ESSE Asia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	950
World Total		358700	360377	362302	367149	374717	380659	385472	388587	396448	400703	410956	413726	420897	421507	422711	425487	431516	430020	433429	432894	435065	435153	440165	437896

Regional Totals (GWe net) — Reference Scenario

Region	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Americas (ex. USA)	14.1	18.2	18.7	17.2	17.7	17.7	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0
USA	98.3	98.3	98.4	98.4	100.6	100.6	101.7	102.9	104.0	104.0	105.1	105.1	106.3	106.3	107.4	107.4	108.6	108.6	108.6	109.7	110.9	113.2	113.3	113.4
European Union (ex. France)	59.4	59.0	58.4	57.8	57.4	56.8	56.4	54.0	54.3	53.3	52.1	52.1	50.1	48.7	45.6	46.0	44.7	44.7	44.4	40.5	37.2	35.8	35.6	35.6
France	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9	64.4	64.4	64.4	64.4	64.4	64.4	65.8	65.8	65.8	65.8	65.8
Non-EU Europe (ex. Russia)	29.7	28.9	28.9	28.9	29.5	29.8	29.8	29.4	30.0	29.7	28.9	28.9	28.9	29.5	29.1	28.7	28.7	28.7	29.3	29.3	28.9	28.5	28.1	27.7
Russia	20.2	20.2	20.2	20.2	21.1	22.7	24.6	25.6	25.5	25.6	26.2	26.8	26.3	27.4	28.6	28.3	28.8	29.6	29.2	29.3	29.2	29.2	29.2	29.2
East & SE Asia (ex. Japan)	23.4	26.1	26.1	26.1	31.8	33.7	33.7	35.9	39.7	41.8	45.4	48.7	50.2	50.2	51.1	52.4	54.6	56.8	58.0	59.0	60.5	61.3	64.0	64.4
Japan	43.9	43.9	43.9	48.3	48.3	47.6	47.6	40.8	51.1	52.5	58.5	58.5	58.5	59.6	59.3	61.1	62.4	62.4	62.4	62.1	61.7	61.2	63.6	61.8
Other Asia, Africa	4.0	4.0	5.8	6.2	7.3	8.9	8.9	8.9	10.0	11.1	11.8	13.2	13.7	15.1	16.1	18.6	19.0	19.5	20.9	20.7	22.1	22.5	22.3	22.3
World Total	358.0	360.4	362.3	367.1	374.7	380.7	385.5	388.4	396.4	400.7	410.0	413.2	420.9	421.5	422.7	425.5	431.5	430.0	433.4	432.9	435.7	435.2	440.2	436.0

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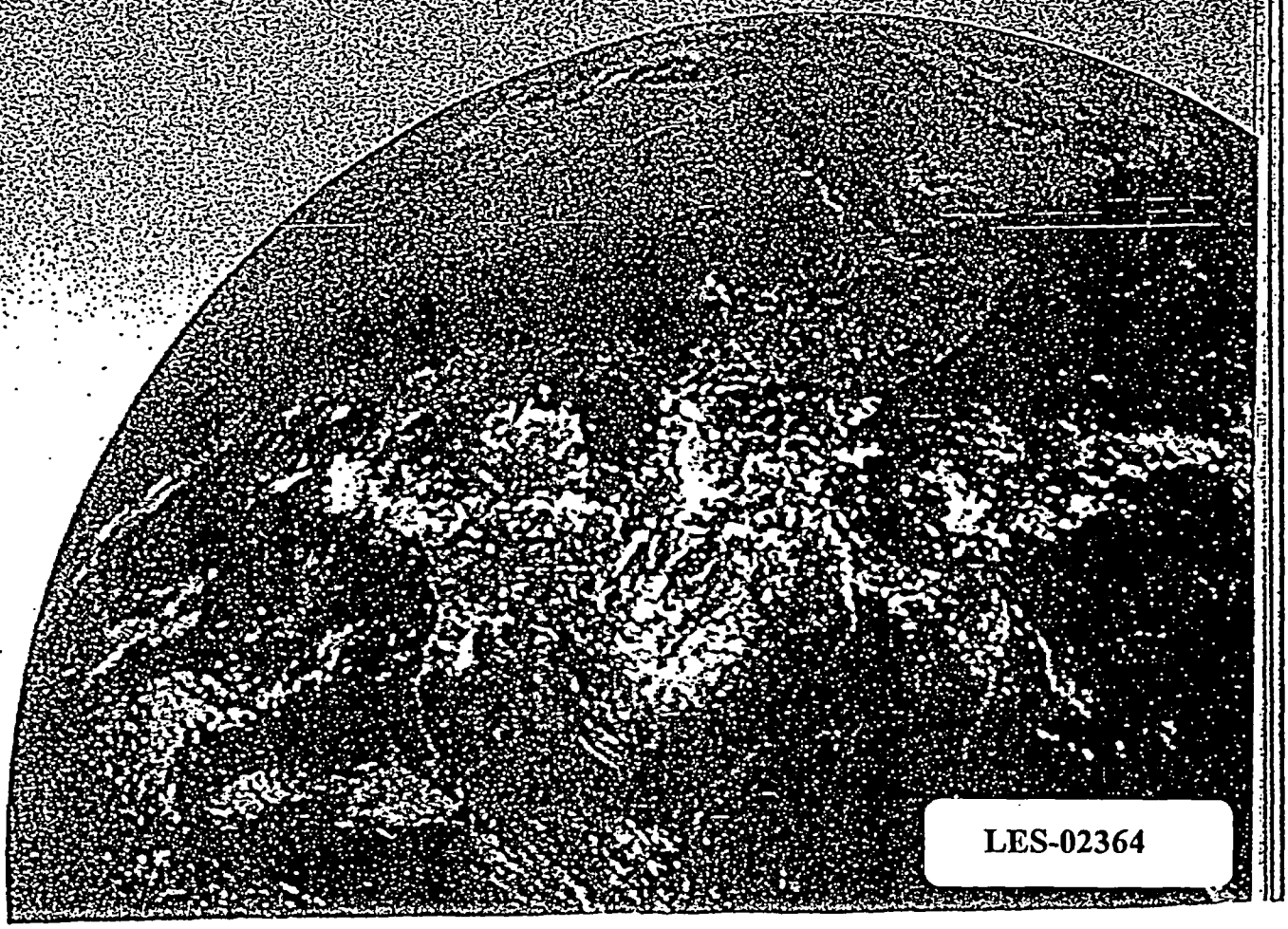

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Table III.1. Enrichment Requirements (thousand SWU) — Reference Scenario

Country/area	Region	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Argentina	Americas	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Armenia	Non-EU	72	72	74	74	74	74	73	73	73	73	73	73	73	73	0	0	0	0	0	0	0	0	0	0
Belgium	EU	629	629	629	629	629	629	629	629	629	629	629	629	629	586	437	437	437	437	437	437	437	221	221	0
Brazil	Americas	166	168	176	176	177	181	300	306	309	309	309	309	309	309	309	309	309	309	309	309	309	309	309	309
Bulgaria	Non-EU	604	472	481	486	489	489	490	503	509	509	509	509	509	496	496	496	496	496	496	496	532	532	532	532
Canada	Americas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chile	Americas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greater China																									
CNNC	ESE Asia	444	603	676	686	859	919	918	1014	1312	1315	1625	1829	2008	2013	2103	2157	2249	2305	2305	2476	2537	2658	2770	2770
Taipower	ESE Asia	551	547	543	543	665	828	828	828	819	812	804	797	921	813	806	830	822	846	846	846	846	846	846	846
Czech Republic	Non-EU	688	671	652	651	650	651	651	664	663	664	664	665	676	676	675	675	675	686	686	686	686	686	686	686
DPRK	ESE Asia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	102	102	102	102	102	203	203
Egypt	Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Finland	EU	307	301	306	303	303	302	300	299	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417
France	France	5876	5834	5814	5838	6066	6220	6472	6726	6817	6724	6603	6709	6813	6935	6920	6907	6894	7103	7153	7153	7305	7305	7305	7305
Germany	EU	2069	2074	2073	2064	2072	2013	2005	1991	1908	1908	1819	1727	1727	1608	1608	1480	1480	1348	1348	1218	813	543	543	543
Hungary	Non-EU	405	395	368	368	366	390	391	395	395	395	395	395	395	395	395	395	395	395	395	395	395	395	296	197
India	Other	43	43	43	43	43	223	425	362	362	362	362	362	673	681	764	790	807	817	817	1022	1022	1227	1227	1227
Indonesia	ESE Asia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iran	Other	0	0	179	179	179	179	179	179	179	358	358	358	358	358	362	368	374	378	384	384	384	384	384	384
Japan	Japan	4181	4248	4412	4677	4673	4789	4793	5193	5328	5480	6052	6028	6084	6182	6150	6321	6444	6444	6444	6405	6363	6304	6247	6239
Kazakhstan	Other	0	0	0	0	0	0	0	0	0	0	0	119	122	123	123	245	245	245	245	245	245	245	245	245
Korea	ESE Asia	1624	1471	1515	1632	1750	1750	1750	1708	2032	2262	2417	2589	2764	2793	2793	2941	3098	3258	3414	3414	3414	3414	3414	3335
Lithuania	Non-EU	327	327	327	327	164	164	164	164	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mexico	Americas	131	131	135	138	135	139	139	143	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Netherlands	EU	56	56	56	56	56	56	56	56	56	56	56	56	0	0	0	0	0	0	0	0	0	0	0	0
Pakistan	Other	23	23	23	23	23	23	23	23	46	46	47	47	49	48	50	49	51	52	136	136	136	136	136	136
Romania	Non-EU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Russia	Russia	3448	3513	3897	4488	4880	4206	5575	4948	5640	5163	6266	5118	6286	5869	6117	5579	5899	5295	6204	4991	5277	5277	5277	5277
Slovakia	Non-EU	500	504	500	504	504	420	420	356	354	353	331	329	340	255	170	170	169	170	170	170	170	170	170	170
Slovenia	Non-EU	79	79	77	76	77	76	76	79	79	80	80	81	82	82	82	82	82	82	82	82	82	82	82	82
South Africa	Other	220	217	215	215	215	215	215	215	231	231	248	248	263	263	278	278	278	278	278	278	278	278	278	278
Spain	EU	948	948	949	944	940	917	914	906	905	901	844	840	836	833	829	826	823	847	847	847	847	847	847	847
Sweden	EU	838	838	838	838	838	838	838	789	789	789	789	789	789	789	789	789	789	789	789	789	789	752	752	752
Switzerland	Non-EU	549	547	546	546	544	544	543	542	301	301	227	227	227	227	227	227	227	227	227	227	227	227	227	227
Turkey	Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ukraine	Non-EU	2102	2130	2169	2196	2580	2600	2620	2640	2979	3010	3000	2989	3068	3056	3046	3037	3027	3017	3032	3032	3032	3032	3032	3032
UK	EU	987	987	987	987	987	987	987	987	987	987	987	987	987	987	987	987	901	847	847	847	954	954	1001	990
USA	USA	10928	11192	11550	11447	11467	11780	11800	12227	12248	12144	12583	12478	12918	12812	12852	13181	13201	13508	13508	13658	13797	14078	14070	14063
Vietnam	ESE Asia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	117
World Total		38576	38803	39903	40928	42181	42406	44358	44843	46184	46445	48679	47867	50079	49898	49929	50098	50661	51029	52261	51153	51549	51418	51959	51451

Regional Totals (thousand SWU) — Reference Scenario

Region	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Americas (ex. USA)	301	303	315	319	319	324	443	455	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456
USA	10928	11192	11550	11447	11467	11780	11800	12227	12248	12144	12583	12478	12918	12812	12852	13181	13201	13508	13508	13658	13797	14078	14070	14063
European Union (ex. France)	5854	5853	5857	5821	5775	5742	5729	5659	5691	5687	5541	5445	5395	5220	5067	4750	4793	4685	4685	4060	4257	3781	3779	3539
France	5876	5834	5814	5838	6066	6220	6472	6726	6817	6724	6603	6709	6813	6935	6920	6907	6894	7103	7153	7153	7305	7305	7305	7305
Non-EU Europe (ex. Russia)	5135	4986	4982	5018	5250	5198	5219	5198	5183	5365	5779	5288	5370	5450	5281	5272	5261	5269	5284	5284	5150	5130	5031	4932
Russia	3448	3513	3897	4488	4880	4206	5575	4948	5640	5163	6266	5118	6286	5869	6117	5579	5899	5295	6204	4991	5277	5277	5277	5277
East & SE Asia (ex. Japan)	2519	2921	2836	2861	3294	3497	3484	3840	4163	4409	4846	5015	5593	5809	5892	5928	6189	6509	6667	6788	6859	7020	7223	7271
Japan	4181	4248	4412	4677	4673	4789	4793	5193	5328	5480	6052	6028	6084	6182	6150	6321	6444	6444	6444	6405	6363	6304	6247	6239
Other Asia, Africa	296	293	480	480	480	650	642	799	858	1017	1035	1152	1174	1365	1394	1774	1744	1760	1840	1889	2045	2045	2270	2270
World Total	38576	38803	39903	40928	42181	42406	44358	44843	46184	46445	48679	47867	50079	49898	49929	50098	50661	51029	52261	51153	51549	51418	51959	51451

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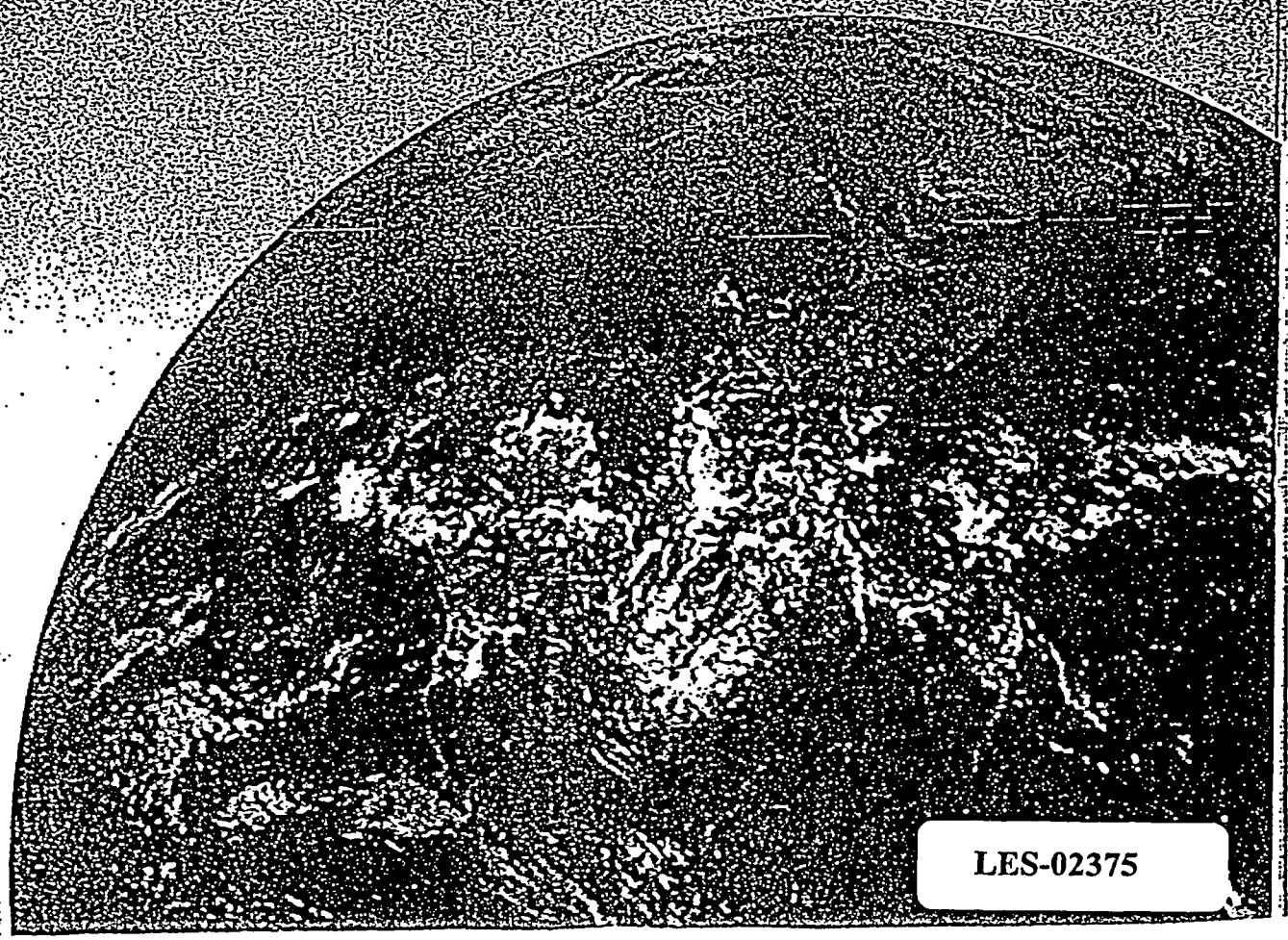

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The USEC Privatisation Act set annual quotas for the entry of the uranium component into the US market. Table 4.14 shows the delivery schedule and US market quotas for the balance of the HEU agreement.

Table 4.14: Delivery schedule for Russian HEU

	Delivery schedule to USEC		Maximum deliveries to US market	For use ex-US or return to Russia
	t HEU	tU equiv.	tU equiv.	tU equiv.
2003	30	9000	4615	4385
2004	30	9000	5385	3615
2005	30	9000	6154	2846
2006	30	9000	6540	2460
2007	30	9000	6920	2080
2008	30	9000	7310	1690
2009	30	9000	7690	1310
2010	30	9000	7690	1310
2011	30	9000	7690	1310
2012	30	9000	7690	1310
2013	20	6000	6000	0
	320	96000	73684	22316

A major question concerns what is to happen after the deal runs out in 2013. It is clear that Russia by then will still have a lot of remaining HEU. The political push to reduce weapons stocks may remain but it may not be economically so attractive for Russia to enter into a second deal. With the build-up of oil and gas exports, Russia may not need the foreign revenues so badly, while the fissile material may be needed to fuel the domestic and captive Russian reactor programme by this time. This is particularly likely to be the case if Russian uranium production cannot be increased from the current level of around 3 000 tU per annum.

4.3.3 Ex-Military Plutonium in US and Russia

Both the United States and the former Soviet Union produced substantial quantities of military plutonium for use in military warheads. In the United States, 103.4 tonnes

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were produced in 14 reactors while in the former Soviet Union, 177 tonnes were produced in 13 reactors.

Both the United States and Russia have declared 34 tonnes of military plutonium as surplus to requirements and have reached a framework agreement on the disposition of this as mixed oxide fuel (MOX). This is another kind of fuel which can be introduced in a nuclear reactor (so named because of the joint use of plutonium and uranium dioxides).

For this purpose, MOX fabrication plants are planned in both the USA and Russia, each with a capacity of 2 tonnes Pu per annum. In MOX fuel, this may displace a combined 840 tU per annum or a total of 14 300 tU over the life of the programme.

Many issues need still to be clarified with the financing of the Russian plant, including the G8 country group financing of it and the possibility of burning some Russian MOX outside Russia. The magnitude of the total cost will depend on the reactors in which the MOX will be burned. The US MOX fuel will all be burned in US reactors, initially in those owned by Duke Power.

The earliest of these two MOX plants could come into operation is 2008 but delays are likely. The market impact, nevertheless, will clearly be relatively minor when compared with the HEU deal.

4.3.4 Recycling of Materials from Reprocessing

Nuclear fuel elements, after having been used in a reactor, are discharged and cooled down for some time in a pool. Such spent nuclear fuel can then be reprocessed in order to extract the remaining uranium it is containing, and the plutonium that has been generated during irradiation of the fuel in the reactor.

The recovered uranium, called reprocessed uranium (RepU), is re-enriched in order to serve as a basis for manufacturing new nuclear fuel elements usable in reactors. The re-enrichment is achieved by the mean of centrifuge or blending technologies. Some studies have also been initiated in order to use RepU directly in fuel elements for CANDU reactors, without enrichment or with just a slight enrichment.

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The extracted plutonium (Pu) is introduced as the primary fissile component in MOX fuel, just as ex-military plutonium (above, which contains plutonium of a different isotopic composition). Nuclear fuel manufactured on the basis of RepU and plutonium allows the production of electricity with the use of less or even no natural uranium. We can therefore consider that by recycling RepU and plutonium, nuclear power utilities are satisfying some of their usual natural uranium requirements – it is an alternative source of supply for a given reactor. Conversion and enrichment services are also substituted by this alternative source of supply.

Recycling of reprocessed materials takes place both in Western countries and in Russia. In the West, it is progressively becoming a commercial operation which replaces some amounts of natural uranium and SWUs, but in Russia it is still a state-directed operation which is integral to the whole fuel cycle there. It therefore makes sense to examine the picture separately.

4.3.4.1 Western Civil Recycling

The quantities of natural uranium and enrichment services likely to be saved between 2003 and 2025 by the use of RepU and MOX from the commercial nuclear fuel cycle can be evaluated. These can be expressed as equivalent quantities of natural uranium (in tonnes per year of use) and as equivalent quantities of enrichment services (in thousands SWU per year).

Summary Tables 4.15 and 4.16 show the quantities declared by utilities to WNA through the questionnaire, with more detailed data included in the Appendix. They can be considered as their best estimate at the present time. In order to calculate the saved quantities of enrichment services, the following ratios have been used:

- 1t Pu is equivalent to 180t NatU and 155 000 SWU (Light Water Reactors).
- 1t RepU is equivalent to 1.08t NatU and 60 SWU.

In addition, an estimate has been made in the Tables of an upper scenario for the use of MOX, which is based on the full utilisation of expected MOX fuel fabrication capacity.

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Table 4.15: Savings of natural uranium through the usage of RepU and Pu (all quantities expressed in tonnes of equivalent quantities of natural uranium)

	Use of RepU	Use of Pu (MOX)	Total	MOX fuel fabrication capacity (upper case for Pu)
2003	769	1422	2191	1368
2004	1003	1368	2371	1620
2005	1264	1556	2820	1764
2006	1230	1556	2786	2160
2007	675	1406	2081	2160
2008	558	1386	1945	2160
2009	947	1514	2461	2426
2010	947	1441	2388	2808
2015	804	1528	2264	3722
2020	804	830	1634	3096
2025	804	830	1634	3096

Table 4.16: Savings of enrichment services through the usage of RepU and Pu (all quantities expressed in thousands of SWU)

	Use of RepU	Use of Pu (MOX)	Total	MOX fuel fabrication capacity (upper case for Pu)
2003	43	909	951	874
2004	56	874	930	1035
2005	70	994	1064	1127
2006	68	994	1063	1380
2007	38	898	936	1380
2008	31	886	917	1380
2009	53	967	1020	1550
2010	53	921	973	1794
2015	45	933	977	2378
2020	45	530	575	1978
2025	45	530	575	1978

Quantities of reprocessed spent fuel

Reprocessing of the spent fuel is the first necessary step for obtaining RepU and plutonium. The major reprocessing plants are in France and in the UK. A further plant is under construction in Japan. China and India also have some reprocessing capacity, but their production is not covered here, as they can be regarded (at least for now) as self-sufficient markets.

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Table VII. Supply/Demand Data for Cases in Chapter 5

Eastern	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Requirements Lower	6214	6260	6319	6579	6719	6551	6196	7155	7719	7714	7912	7850	7927	7951	7427	6700	6468	6466	6487	6416	6000	5507	5881	5681
Requirements Reference	6314	6260	6657	7272	7679	7507	8026	8115	8424	8542	8316	8500	8574	9211	9275	9050	9105	9105	9510	9757	9958	9751	9369	9757
Requirements Upper	6314	7074	7946	8015	7979	8702	9020	9030	10290	10462	11247	11273	11068	12400	12278	12799	12604	12717	13400	13756	13940	13710	13630	13474
Primary Uranium Lower	4105	3600	3400	3400	3400	4000	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200	5200
Primary Uranium Upper	4105	3600	3400	3400	3400	4000	5200	5200	5200	5200	5200	5200	5200	6400	6400	6400	6400	6400	6400	6400	6400	6400	6400	7200
HEU Downblended	500	500	500	500	500	500	500	500	500	500	500	500	0	0	0	0	0	0	0	0	0	0	0	0
Re-enriched Tails	2500	2500	2750	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
PuO2	500	500	500	500	500	500	500	500	500	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540
Ex Military MOX	0	0	0	0	0	0	0	0	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
Supply Lower	7000	7000	7550	7900	7900	8000	8700	9700	9800	9840	9940	9940	9540	9540	9540	9540	9540	9540	9540	9540	9540	9540	9540	9540
Supply Upper	7000	7000	7550	7900	7900	8000	8700	9700	9800	9840	9940	9940	9940	10140	10140	10140	10140	10140	10540	10540	10540	10540	10540	10540
Western	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Requirements Lower	51000	51773	51832	60433	61956	61773	63194	67993	62539	62942	63767	67953	63575	69114	67118	61545	61051	66007	66015	66005	61006	67020	66440	61677
Requirements Reference	51000	51773	60663	61955	63790	63756	63750	64865	66160	66370	66850	66970	66885	70174	70511	70640	71704	72110	72740	72800	72950	73535	73400	72000
Requirements Upper	51000	51773	60163	61903	63131	64130	66095	67440	69473	70100	72724	73520	75000	77436	79297	81004	83005	85105	86954	87300	87979	88270	88830	89001
Primary Uranium Lower	31002	30400	32700	34500	34500	34000	32700	32700	30500	30500	30500	32700	32700	32700	32700	32700	32700	32700	32700	32700	32700	32700	32700	32700
Primary Uranium Upper	31002	30000	32700	34500	34500	37400	38700	39700	43000	43000	43000	44000	45100	47000	47000	47000	47000	47000	41700	41700	41700	41700	41700	40100
HEU Downblended	5010	4015	5385	6154	6540	6070	7310	7000	7000	7500	7500	8000	0	0	0	0	0	0	0	0	0	0	0	0
Re-enriched Tails	2500	2500	2750	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
PuO2	1000	700	1003	1204	1230	875	850	917	917	884	884	884	884	884	884	884	884	884	884	884	884	884	884	884
MOX Lower	1500	1422	1566	1550	1550	1486	1346	1514	1441	1430	1520	1520	1520	1400	1520	1520	1520	1430	830	880	880	880	880	830
MOX Upper	1500	1700	1970	1764	2100	2100	2100	2420	2000	2270	2722	2722	2722	2722	2722	2722	2722	2970	2090	2090	2090	2090	2090	2090
Recycling Lower	2500	2101	2371	2420	2760	2011	1944	2441	2340	2242	2232	2232	2232	2264	2232	2232	2232	2242	1834	1702	1702	1702	1702	1834
Recycling Upper	2500	2137	2423	2020	2090	2035	2710	2073	2755	4010	4520	4520	4520	4520	4520	4520	4520	4440	2000	2000	2000	2000	2000	2000
Russian LEU Export	5500	5000	4500	4000	3500	4000	3500	3000	2500	2000	1500	1000	500	0	0	0	0	0	0	0	0	0	0	0
Inventory Production Lower	12000	10000	8000	6000	4000	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inventory Production Upper	12000	11000	10000	8000	6000	2000	0	0	4000	2000	2000	1000	0	0	0	0	0	0	0	0	0	0	0	0
Ex Military MOX	0	0	0	0	0	0	0	0	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
Supply Lower	53270	53290	55290	56474	56720	54901	53154	53154	52970	51472	51072	49572	50572	47964	50572	50572	50572	47942	47374	47402	47402	47402	47402	47374
Supply Upper	54270	54152	57451	59662	58730	61156	61221	61743	65245	64070	63010	60520	54220	54020	54020	54020	54020	54440	50000	50000	50000	50000	50000	54000
World	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Requirements Lower	65374	65992	66251	66962	67975	68311	70264	69155	70750	70656	70670	70500	71452	68105	66143	65314	67000	67483	67402	66071	64105	63264	59970	57714
Requirements Reference	65374	65992	66658	66367	70160	70742	72264	72770	74790	75416	77973	77460	79757	79905	79757	79747	80960	80981	87294	81543	81997	81793	82700	81040
Requirements Upper	65374	66781	67750	68517	71000	72441	75173	76466	79433	80851	83971	84001	87050	89064	91576	93983	97500	97000	100382	101850	103320	101000	102460	102520
Primary Uranium Lower	36497	34700	36000	38300	38100	41500	43000	43700	41700	41700	41700	37900	37900	37900	37900	37900	37900	37900	37900	37900	37900	37900	37900	37900
Primary Uranium Upper	36497	34700	36000	38300	38100	42900	43900	44000	48100	48100	48100	49000	51000	53400	53400	53400	53400	53400	55500	55500	55500	55500	55500	58100
HEU Downblended	4340	5115	5885	6654	7040	7470	7110	8190	8190	8190	8190	8500	0	0	0	0	0	0	0	0	0	0	0	0
Re-enriched Tails	5000	5000	5500	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
Recycling Lower	2000	2001	2371	2520	2310	2511	2444	2981	2144	3542	3072	2072	2072	2004	2072	2072	2072	2542	1874	2042	2042	2042	2042	1874
Recycling Upper	2000	2037	2123	2020	2090	2076	2210	2073	4755	4120	4164	4568	4160	4020	4160	4164	4160	4760	4240	4240	4240	4240	4240	4240
Russian LEU Export	5500	5000	4500	4000	3500	4000	3500	3000	2500	2000	1500	1000	500	0	0	0	0	0	0	0	0	0	0	0
Western Inventory Production Lower	12000	10000	8000	6000	4000	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Western Inventory Production Upper	12000	10000	9000	8000	7000	6000	5000	4000	3000	2000	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex Military MOX	0	0	0	0	0	0	0	0	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
Supply Lower	85543	82500	83750	81274	81920	83503	82354	83353	81770	80472	80062	74472	47972	48844	48572	48572	48572	48442	45874	45842	45842	45842	45842	45874
Supply Upper	85543	82452	84003	84412	85830	84755	86420	86943	75446	77510	71450	84100	81160	85060	85060	85060	85060	84910	80540	80540	80540	80540	80540	87540

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The Global Nuclear Fuel Market

Supply and Demand 2003 - 2025

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Enrichment requirements

There is a fundamental link between enriched uranium and natural uranium (feed) requirements, although the relationship is not simply linear. A number of factors have the potential to significantly affect the demand for enrichment. Apart from nuclear generating capacity, these include enrichment assays, load factors, burnups, cycle lengths and tails assays. As discussed in Section 3.2, the impact of most of these factors produces a change in uranium and enrichment requirements in the same direction (i.e. both increase or both decrease). However, for changes in tails assay the opposite is true: an increase in the tails assay lowers the requirements for enrichment, but increases uranium requirements, and vice versa.

Enriched uranium, or SWU, requirements are considered over the forecast period under the three scenarios for nuclear generating capacity outlined in Chapter 2. Assumptions are made about changes in enrichment levels, in accordance with data obtained from the questionnaire and other sources. Average levels are expected to rise slightly over the report period. Contract tails assays are assumed to remain at present levels of 0.30-0.33% throughout, except for VVER and RBMK reactors which have their fuel supplied from Russia, for which tails are taken to be 0.10%. The resulting forecast of annual SWU requirements to 2025 is presented in Table 3.4.

Under the reference scenario, SWU requirements maintain a slow increase over most of the report period. Requirements reach 51 million SWU in 2025, compared with 38 million SWU in 2002. In the lower scenario requirements grow only slightly, reaching a high of about 42 million SWU in 2015, before beginning to fall off through the remainder of the report period. This reflects declining requirements in North America and Europe, only partially offset by growth in Asia. By 2025, requirements under the lower scenario have fallen to 36 million SWU, representing a reduction of 6% from 2002. In the upper scenario, requirements rise throughout the forecast period, reaching 64 million SWU by 2020, two thirds above the 2002 level.

SWU requirements by region for each of the three scenarios are shown in Figures 3.5 to 3.7.

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Table IV.4. Tails Assays, %						Lower						Reference						Upper
	2002	2005	2010	2015	2020	2025	2002	2005	2010	2015	2020	2025	2002	2005	2010	2015	2020	2025
Argentina	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Armenia	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Belgium	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Brazil	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Bulgaria	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Canada	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chile	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Chinese Organisations																		
Mainland	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Taiwan	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Czech Republic	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
DPRK	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Egypt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Finland	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
France	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Germany	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
Hungary	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
India	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Indonesia	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Iran.	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Japan	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Kazakhstan	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Korea	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Lithuania	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Mexico	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Netherlands	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Pakistan	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Romania	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Russia	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Slovakia	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Slovenia	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
South Africa	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Spain	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Sweden	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Switzerland	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Turkey	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Ukraine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
UK	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
USA	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Vietnam	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30