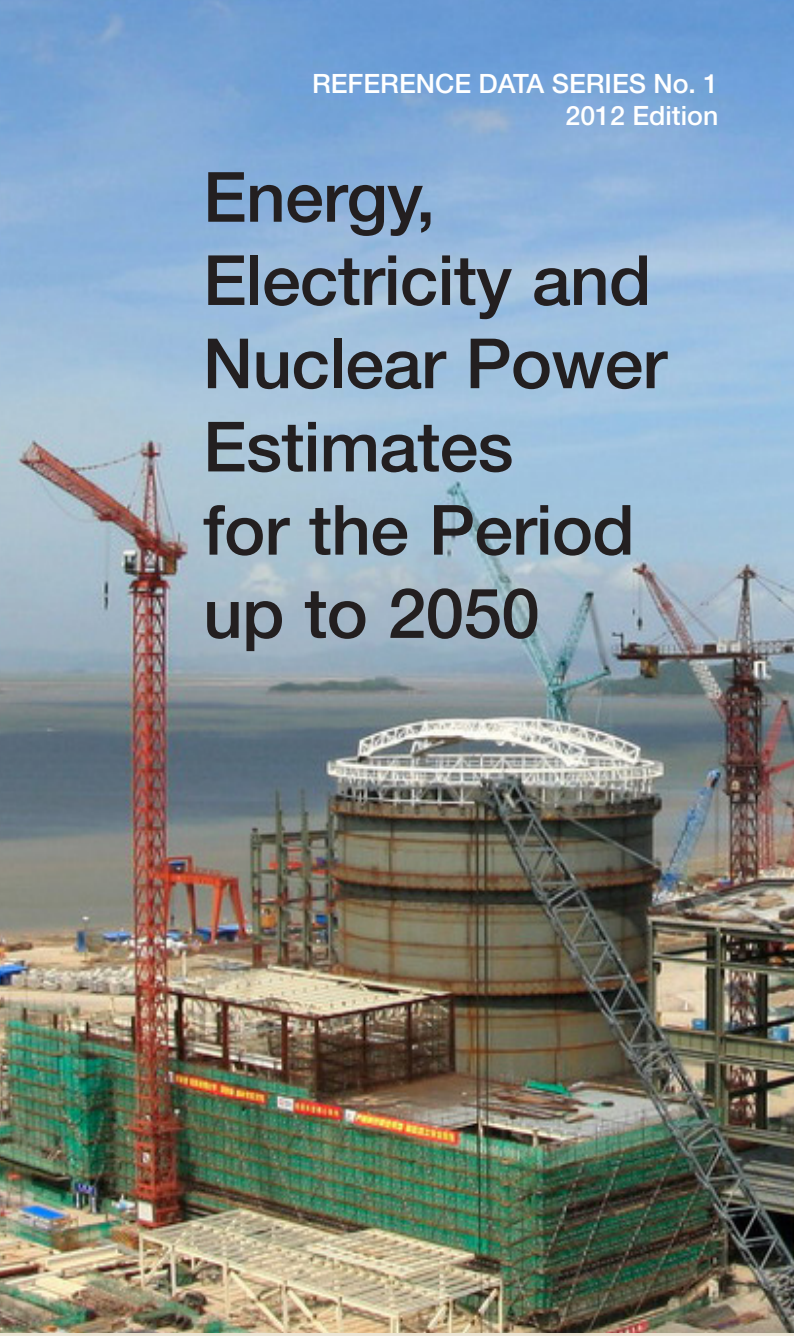
REFERENCE DATA SERIES No. 1
2012 Edition

Energy, Electricity and Nuclear Power Estimates for the Period up to 2050



IAEA
International Atomic Energy Agency

REFERENCE DATA SERIES No. 1

ENERGY, ELECTRICITY AND NUCLEAR POWER ESTIMATES FOR THE PERIOD UP TO 2050

2012 Edition

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2012

ENERGY, ELECTRICITY AND
NUCLEAR POWER ESTIMATES
FOR THE PERIOD UP TO 2050
IAEA-RDS-1/32
ISBN 978–92–0–133510–4
ISSN 1011–2642

Printed by the IAEA in Austria
August 2012

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Introduction

Reference Data Series No. 1 (RDS-1) is an annual publication — currently in its thirty-second edition — containing estimates of energy, electricity and nuclear power trends up to the year 2050.

RDS-1 starts with a summary of the situation of nuclear power in IAEA Member States as of the end of 2011. The data on nuclear power presented in Tables 1 and 2 are based on actual statistical data collected by the IAEA's Power Reactor Information System (PRIS). However, energy and electricity data for 2011 are estimated, as the latest information available from the United Nations Department of Economic and Social Affairs is for 2009 only. Population data originate from the World Population Prospects (2010 revision), published by the Population Division of the United Nations Department of Economic and Social Affairs. The 2011 values again are estimates.

As in previous editions, projections of future energy and electricity demand and the role of nuclear power are presented as low and high estimates encompassing the inherent uncertainties involved in projecting trends. The RDS-1 estimates should be viewed as very general growth trends whose validity must be constantly subjected to critical review.

Many international, national and private organizations routinely engage in energy demand and supply projections, including nuclear power. These projections are based on a multitude of different assumptions and aggregating procedures, which make a straightforward comparison and synthesis very difficult. The basic differences refer to such fundamental input assumptions as:

- Economic growth;
- Correlation of economic growth and energy use;
- Technology performance and costs;
- Energy resource availability and future fuel prices;
- Energy policy and physical, environmental and economic constraints.

The projections presented in this publication are based on a compromise between:

- National projections supplied by each country for a recent OECD/NEA study;

- Indicators of development published by the World Bank in its World Development Indicators;
- Global and regional energy, electricity and nuclear power projections made by other international organizations.

More specifically, the estimates of future nuclear generating capacity presented in Table 3 are derived from a country by country 'bottom up' approach. They are established by a group of experts participating each year in the IAEA's consultancy on Nuclear Capacity Projections and based upon a review of nuclear power projects and programmes in Member States. The experts consider all the operating reactors, possible licence renewals, planned shutdowns and plausible construction projects foreseen for the next several decades. They build the projections project by project by assessing the plausibility of each in light of, first, the low projection's assumptions and, second, the high projection's assumptions.

The low and high estimates reflect contrasting, but not extreme, underlying assumptions on the different driving factors that have an impact on nuclear power deployment. These factors, and the ways they might evolve, vary from country to country. The estimates presented provide a plausible range of nuclear capacity growth by region and worldwide. They are not intended to be predictive nor to reflect the whole range of possible futures from the lowest to the highest feasible.

The low case represents expectations about the future if current trends continued and there were few changes in policies affecting nuclear power other than those already in the pipeline. This case was explicitly designed to produce a 'conservative but plausible' set of projections. Additionally, the low case did not automatically assume that targets for nuclear power growth in a particular country would necessarily be achieved. These assumptions are relaxed in the high case.

The high case projections are much more optimistic, but still plausible and technically feasible. The high case assumes that the current financial and economic crises will be overcome in the not too distant future and past rates of economic growth and electricity demand, especially in the Far East, would essentially resume. In addition, the high

case assumes the implementation of stringent policies globally targeted at mitigating climate change.

Developing projections in 2012 remained challenging given that policy responses to the Fukushima accident remain to be determined in some regions, notably in the Far East. Since this region is anticipated to have the greatest growth in nuclear capacity to 2030, policy responses could yet have a significant impact on the scenario projections. To a lesser degree, the same is true in other regions with the exception, perhaps, of Western Europe. Once greater certainty about the causes, impacts, policy revisions and regulatory responses is established, these projections will likely need to be refined. There is considerable uncertainty about the actual impacts of the Fukushima accident in some regions. As time goes by, this uncertainty should hopefully be reduced.

Governments have asked a number of utilities to suspend operation of specific plants in response to the Fukushima accident. In this case, it should be kept in mind that there is a distinction between effective capacity (supplying electricity to the grid) and installed nominal capacity (connected to the grid but not supplying electricity) that may not be recognized in the published data.

The on-going financial crisis is still expected to present challenges in nuclear energy development. The assumption adopted by the expert group was that the current economic challenges, in addition to the Fukushima accident, are expected to delay, temporarily, deployment of some nuclear power plants. Moreover, the low price of natural gas and reduced demand for electricity are expected to impact nuclear growth prospects in some regions of the developed world. However, the underlying fundamentals of population growth and demand for electricity in the developing world, as well as climate change concerns, security of energy supply and price volatility for other fuels continue to point to nuclear generating capacity playing an important role in the energy mix in the longer term.

Accordingly to the 2012 projections, the world's installed nuclear power capacity expanded from 369 gigawatts (GW(e)) as of end of 2011 to 456 GW(e) in 2030, i.e. a decrease of 9% compared with last years's projection. In the updated high projection, it grows to 740 GW(e) in 2030,

down by less than 1% from last year, reflecting continued interest in nuclear power in some regions, particularly in the developing world. Some of the effects of the Fukushima accident may include earlier than anticipated retirements, delayed or possibly cancelled new builds and increased costs owing to changing regulatory requirements.

With respect to projections to 2050, assumptions were made about the general rate of development and retirements. Given all of the uncertainties, these estimates should be considered as suggestive of the actual outcomes, based on currently anticipated trends.

The data on electricity produced by nuclear power plants are converted to joules based on the average efficiency of a nuclear power plant, i.e. 33%; data on electricity generated by geothermal heat are converted to joules based on the average efficiency of a geothermal power plant, i.e. 10%. The conversion to joules of electricity generated by hydropower or by other non-thermal sources such as wind, tide and solar is based on the energy content of the electricity generated (the equivalent of assuming 100% efficiency).

The total energy requirement has been calculated by summing the primary energy production, the net energy trade minus changes in international bunkers and domestic stocks.

The values shown in Table 9 refer to primary energy used for the generation of electricity. Owing to differences in conversion efficiencies, the percentage values are different from the shares of electricity generation presented in Tables 1 and 5.

Energy Units

1 MW(e) = 10^6 watts (electrical)
1 GW(e) = 1000 MW(e) = 10^9 watts (electrical)
1 GJ = 1 gigajoule = 10^9 joules
1 EJ = 1 exajoule = 10^{18} joules
1 EJ = 23.9 megatonnes of oil equivalent (Mtoe)
1 TW·h = 1 terawatt-hour = 10^9 kW·h = 3.6×10^{-3} EJ

GROUPING OF COUNTRIES AND AREAS

The countries and geographical areas included in each grouping are listed below
(IAEA Member States are denoted by an asterisk)

North America

Canada*
United States of America*

Latin America

Anguilla
Antigua and Barbuda
Argentina*
Aruba
Bahamas
Barbados
Belize*
Bermuda
Bolivia*
Brazil*
Cayman Islands
Chile*
Colombia*
Costa Rica*
Cuba*
Dominica*
Dominican Republic*
Ecuador*
El Salvador*
Grenada
Guadeloupe
Guatemala*
Guyana
Haiti*
Honduras*
Jamaica*
Martinique
Mexico*
Montserrat
Netherlands Antilles
Nicaragua*
Panama*
Paraguay*
Peru*
Puerto Rico
S. Georgia & S. Sandwich Islands
Saint Kitts and Nevis
Saint Lucia
Saint Pierre and Miquelon
Saint Vincent & the Grenadines
Suriname
Trinidad and Tobago
Turks and Caicos Islands
Uruguay*
Venezuela*

Western Europe

Andorra
Austria*
Belgium*
Cyprus*
Denmark*
Finland*
France*
Germany*
Gibraltar
Greece*
Greenland
Holy See*
Iceland*
Ireland*
Italy*
Liechtenstein*
Luxembourg*
Malta*
Monaco*
Netherlands*
Norway*
Portugal*
San Marino
Spain*
Svalbard and Jan Mayen Islands
Sweden*
Switzerland*
Turkey*
United Kingdom*

Eastern Europe

Albania*
Armenia*
Azerbaijan*
Belarus*
Bosnia and Herzegovina*
Bulgaria*
Croatia*
Czech Republic*
Estonia*
Georgia*
Hungary*
Kazakhstan*
Kyrgyzstan*
Latvia*
Lithuania*
Montenegro*
Poland*
Republic of Moldova*
Romania*
Russian Federation*
Serbia*
Slovakia*
Slovenia*
Tajikistan*
The Frmr. Yug. Rep. of Macedonia*
Turkmenistan
Ukraine*
Uzbekistan*

Africa

Algeria*
Angola*
Benin*
Botswana*
Burkina Faso*
Burundi*
Cameroon*
Cape Verde
Central African Republic*
Chad*
Comoros
Congo*
Côte d'Ivoire*
Democratic Rep. of the Congo*
Djibouti
Egypt*
Equatorial Guinea
Eritrea*
Ethiopia*
Gabon*
Gambia
Ghana*
Guinea
Guinea-Bissau
Kenya*
Lesotho*
Liberia*
Libya*
Madagascar*
Malawi*
Mali*
Mauritania*
Mauritius*
Mayotte
Morocco*
Mozambique*
Namibia*
Niger*
Nigeria*
Reunion
Rwanda
Saint Helena
Sao Tome and Principe
Senegal*
Seychelles*
Sierra Leone*
Somalia
South Africa*
Sudan*
Swaziland
Togo
Tunisia*
Uganda*
United Republic of Tanzania*
Western Sahara
Zambia*
Zimbabwe*

Middle East and South Asia

Afghanistan*
Bahrain*
Bangladesh*
Bhutan
British Indian Ocean Territory
Cocos (Keeling) Islands
French Southern Territories
Heard Island & McDonald Islands
India*
Iran, Islamic Republic of*
Iraq*
Israel*
Jordan*
Kuwait*
Lebanon*
Nepal*
Oman*
Pakistan*
Qatar*
Saudi Arabia*
Sri Lanka*
Syrian Arab Republic*
T.T.U.T.J of T. Palestinian A.
United Arab Emirates*
Yemen*

South East Asia and the Pacific

Australia*
Brunei Darussalam
Cook Islands
Fiji
Indonesia*
Kiribati
Malaysia*
Maldives
Marshall Islands*
Micronesia (Fed. States of)
Myanmar*
New Zealand*
Niue
Norfolk Islands
Northern Mariana Islands
Palau*
Papua New Guinea*
Pitcairn Islands
Samoa
Singapore*
Solomon Islands
Thailand*
Timor Leste
Tokelau
Tonga
Tuvalu
US Minor Outlying Islands
Vanuatu
Wallis and Futuna Islands

Far East

Cambodia*
China*
Dem. P.R. of Korea
Japan*
Korea, Republic of*
Lao P.D.R.*
Macau, China
Mongolia*
Philippines*
Taiwan, China
Vietnam*

TABLE 1. NUCLEAR POWER REACTORS IN THE WORLD (end of 2011)

Group and Country	In Operation		Long-term Shut Down Reactors		Under Construction		Electricity Supplied by Nuclear Power Reactors in 2011	
	Number of Units	Total MW(e)	Number of Units	Total MW(e)	Number of Units	Total MW(e)	TWh	Percent of Total Electricity
North America								
Canada	18	12604	4	2726			88.3	15.3
United States of America	104	101465			1	1165	790.4	19.3
Latin America								
Argentina	2	935			1	692	5.9	5.0
Brazil	2	1884			1	1245	14.8	3.2
Mexico	2	1300					9.3	3.6
Western Europe								
Belgium	7	5927					45.9	54.0
Finland	4	2736			1	1600	22.3	31.6
France	58	63130			1	1600	423.5	77.7
Germany	9	12068					102.3	17.8
Netherlands	1	482					3.9	3.6
Spain	8	7567					55.1	19.5
Sweden	10	9326					58.1	39.6
Switzerland	5	3263					25.7	40.9
United Kingdom	18	9953					62.7	17.8
Eastern Europe								
Armenia	1	375					2.4	33.2
Bulgaria	2	1906			2	1906	15.3	32.6
Czech Republic	6	3766					26.7	33.0
Hungary	4	1889					14.7	43.3

TABLE 1. NUCLEAR POWER REACTORS IN THE WORLD (end of 2011)

Group and Country	In Operation		Long-term Shut Down Reactors		Under Construction		Electricity Supplied by Nuclear Power Reactors in 2011	
	Number of Units	Total MW(e)	Number of Units	Total MW(e)	Number of Units	Total MW(e)	TWh	Percent of Total Electricity
Romania	2	1300					10.8	19.0
Russian Federation	33	23643			10	8188	162.0	17.6
Slovakia	4	1816			2	782	14.3	54.0
Slovenia	1	688					5.9	41.7
Ukraine	15	13107			2	1900	84.9	47.2
Africa								
South Africa	2	1830					12.9	5.2
Middle East and South Asia								
India	20	4391			7	4824	29.0	3.7
Iran, Islamic Republic of	1	915					0.1	0.0
Pakistan	3	725			2	630	3.8	3.8
Far East								
China	16	11816			26	26620	82.6	1.9
Japan	50	44215	1	246	2	2650	156.2	18.1
Korea, Republic of	21	18751			5	5560	147.8	34.6
World Total (*)	435	368791	5	2972	65	61962	2518.0	12.3

Notes:

(*) Including the following data in Taiwan, China:

— 6 units in operation with total capacity of 5018 MW(e); 2 units under construction with total capacity of 2600 MW(e);

— 40.4 TWh of nuclear electricity generation, representing 19.0% of the total electricity generated.

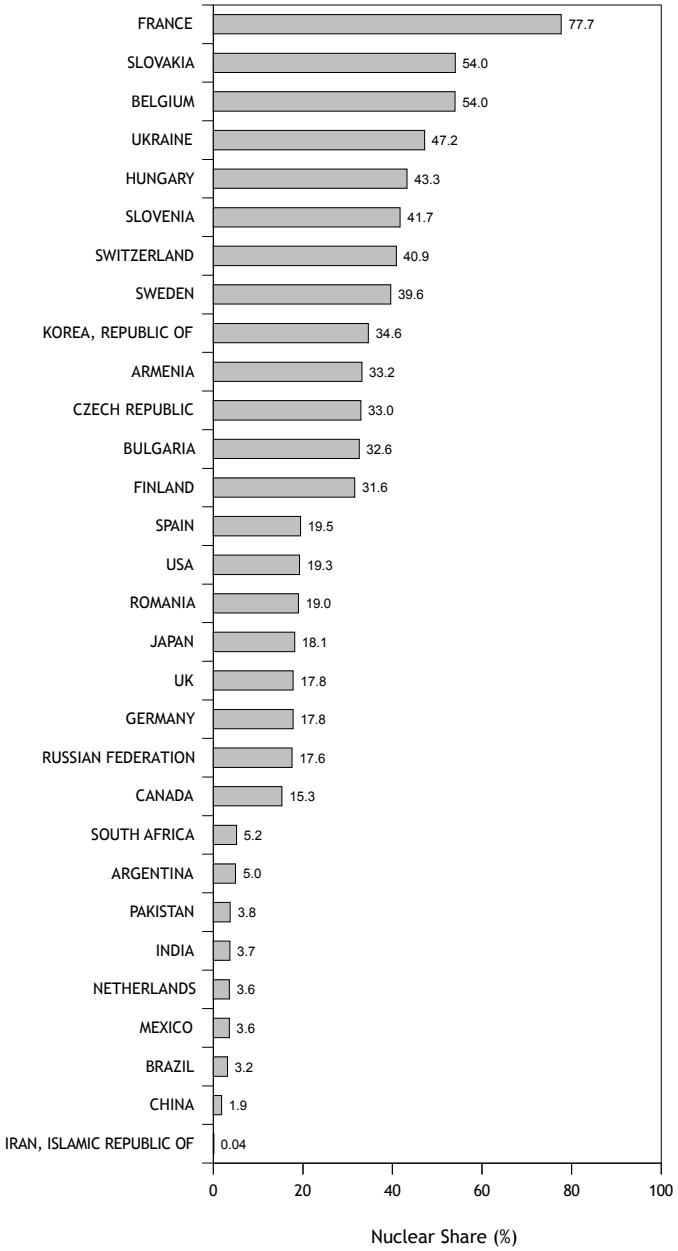


FIGURE 1. NUCLEAR SHARE OF TOTAL ELECTRICITY GENERATION IN 2011

Note: the nuclear share of electricity generation in Taiwan, China was 19.0%.

TABLE 2. NUMBER OF COUNTRIES WITH NUCLEAR POWER REACTORS IN OPERATION OR UNDER CONSTRUCTION (end of 2011)

Country Group	Number of Countries in Group	Countries with Nuclear Power Reactors			
		In Operation	Long-term Shut Down	Under Construction (1)	Total (2)
North America	2	2	1	1	2
Latin America	45	3		2	3
Western Europe	29	9		2	9
Eastern Europe	27	9		4	9
Africa	57	1			1
Middle East and South Asia	25	3		2	3
South East Asia and the Pacific	29				
Far East	11	3	1	3	3
World Total	225	30	2	14	30

Notes:
(1) May include countries having reactors already in operation.
(2) Total number of countries in each group that have nuclear power reactors in operation, or under construction.

TABLE 3. ESTIMATES OF TOTAL AND NUCLEAR ELECTRICAL GENERATING CAPACITY

Country Group	2011			2020 (a)			2030 (a)			2050 (a)(b)		
	Total Elect. GW(e)	Nuclear		Total Elect. GW(e)	Nuclear		Total Elect. GW(e)	Nuclear		Total Elect. GW(e)	Nuclear	
		GW(e)	%		GW(e)	%		GW(e)	%		GW(e)	%
North America	1180	114.1	9.7	1278 1312	121 123	9.4 9.4	1351 1528	111 148	8.2 9.7	1479	65 165	4.4 11.2
Latin America	330	4.1	1.2	463 581	4.8 6.1	1.0 1.1	997 1389	7 14	0.7 1.0	1988	13 58	0.7 2.9
Western Europe	873	114.5	13.1	1025 1071	93 117	9.1 10.9	1152 1406	70 126	6.1 9.0	1609	55 154	3.4 9.5
Eastern Europe	460	48.5	10.5	631 631	65 76	10.3 12.1	690 872	80 107	11.5 12.3	984	79 140	8.1 14.2
Africa	134	1.8	1.4	354 386	1.8 1.8	0.5 0.5	722 1001	5 13	0.7 1.3	2415	10 44	0.4 1.8
Middle East and South Asia	441	6.0	1.4	553 926	13 22	2.3 2.3	1454 1830	30 52	2.1 2.8	5194	50 139	1.0 2.7
South East Asia and the Pacific	190			304 322			491 542	0.0 6	0.0 1.1	1283	5 20	0.4 1.6
Far East	1604	79.8	5.0	2200 2364	123 162	5.6 6.9	2789 3321	153 274	5.5 8.2	5140	191 417	3.7 8.1
World Total Low Estimate	5210	368.8	7.1	6808	421	6.2	9645	456	4.7	20092	469	2.3
World Total High Estimate				7593	508	6.7	11889	740	6.2		1137	5.7

Notes:

(a) Nuclear capacity estimates take into account the scheduled retirement of the older units at the end of their lifetime.

(b) Projection figures for total electric generating capacities are the arithmetic average between low and high estimates.

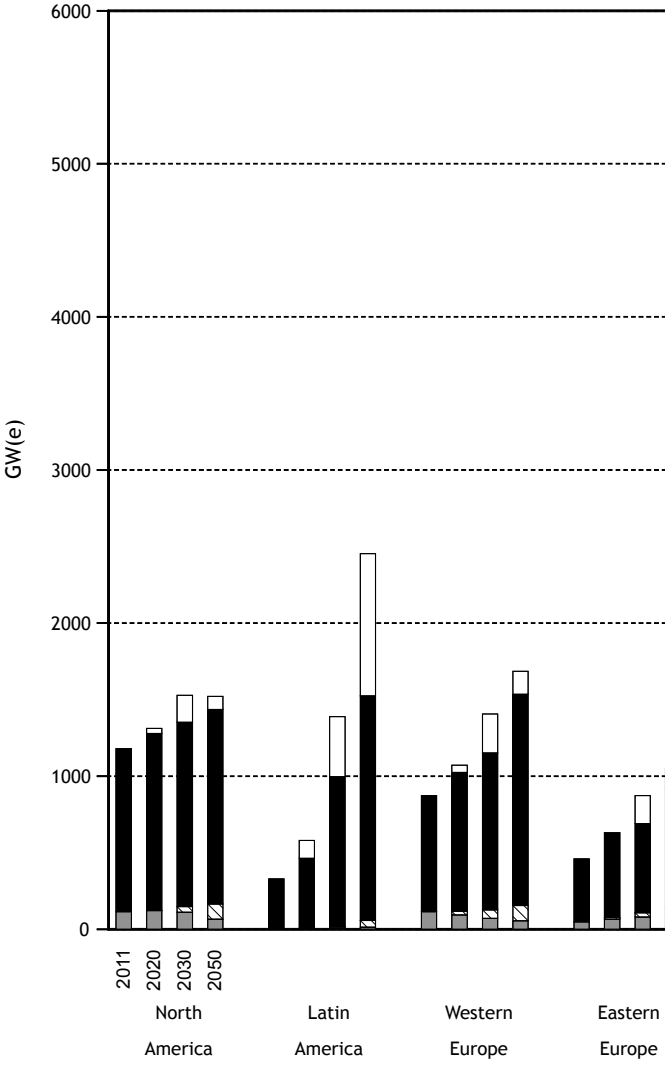


FIGURE 2. TOTAL AND NUCLEAR ELECTRICAL GENERATING CAPACITY

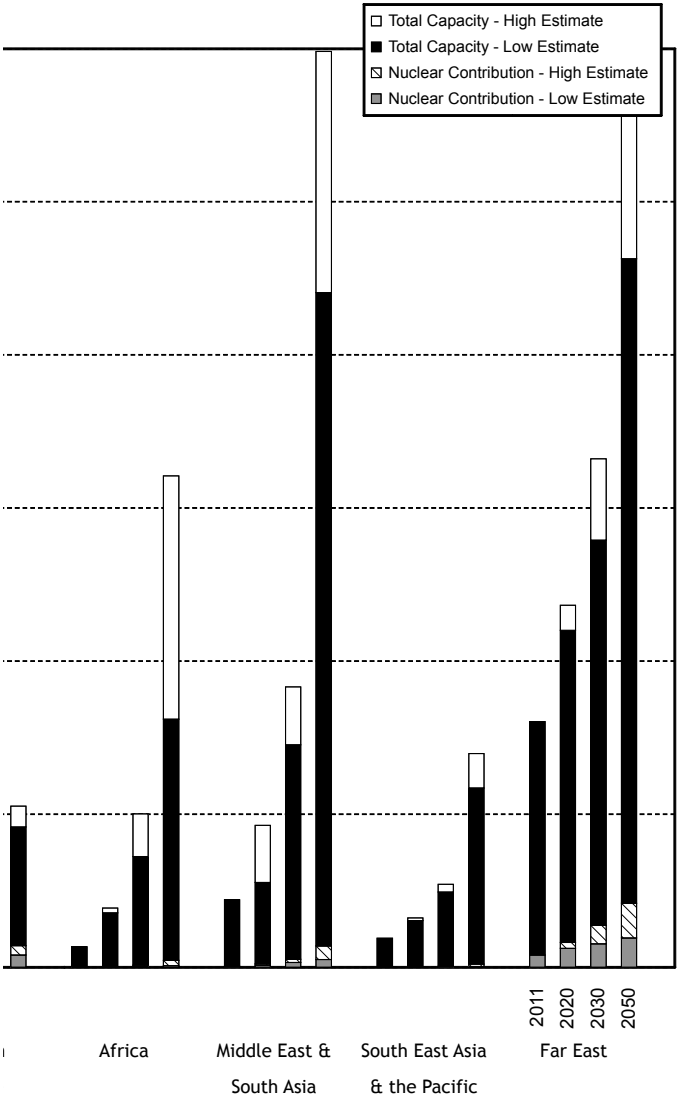

Total Capacity - High Estimate
Total Capacity - Low Estimate
Nuclear Contribution - High Estimate
Nuclear Contribution - Low Estimate
2011
2020
2030
2050
Africa
Middle East & South Asia
South East Asia & the Pacific
Far East

TABLE 4. ESTIMATES OF TOTAL ELECTRICITY GENERATION AND CONTRIBUTION BY NUCLEAR POWER (*)

Country Group	2011			2020			2030			2050 (a)		
	Total Elect. TWh	Nuclear		Total Elect. TWh	Nuclear		Total Elect. TWh	Nuclear		Total Elect. TWh	Nuclear	
		TWh	%		TWh	%		TWh	%		TWh	%
North America	4682	878.8	18.8	4978 5011	951 973	19.1 19.4	5221 5336	871 1163	16.7 21.8	5762	525 1330	9.1 23.1
Latin America	1352	30.0	2.2	2066 2263	36 45	1.7 2.0	3443 5118	56 114	1.6 2.2	7249	107 464	1.5 6.4
Western Europe	3116	799.5	25.7	3564 3733	696 868	19.5 23.3	4042 4788	554 993	13.7 20.7	5873	442 1238	7.5 21.1
Eastern Europe	1806	337.0	18.7	2190 2271	482 569	22.0 25.1	2587 3129	628 847	24.3 27.1	3737	641 1127	17.1 30.2
Africa	651	12.9	2.0	1210 1426	14 14	1.1 1.0	2366 3340	40 106	1.7 3.2	8707	82 358	0.9 4.1
Middle East and South Asia	1841	32.9	1.8	2425 3115	91 152	3.8 4.9	5342 6433	238 409	4.5 6.4	19212	401 1122	2.1 5.8
South East Asia and the Pacific	794			1051 1096			1672 1933	0 47	0.0 2.4	4417	40 161	0.9 3.6
Far East	6200	426.9	6.9	7407 8615	913 1207	12.3 14.0	9766 12731	1207 2157	12.4 16.9	19923	1542 3363	7.7 16.9
World Total Low Estimate	20442	2518.0	12.3	24891	3183	12.8	34440	3595	10.4	74880	3780	5.0
World Total High Estimate				27530	3829	13.9	42808	5837	13.6		9163	12.2

Notes:

(*) The nuclear generation data presented in this table and the nuclear capacity data presented in Table 3 cannot be used to calculate average annual capacity factors for nuclear plants, as Table 3 presents year-end capacity and not the effective capacity average over the year.

(a) Projection figures for total electricity generation are the arithmetic average between low and high estimates.

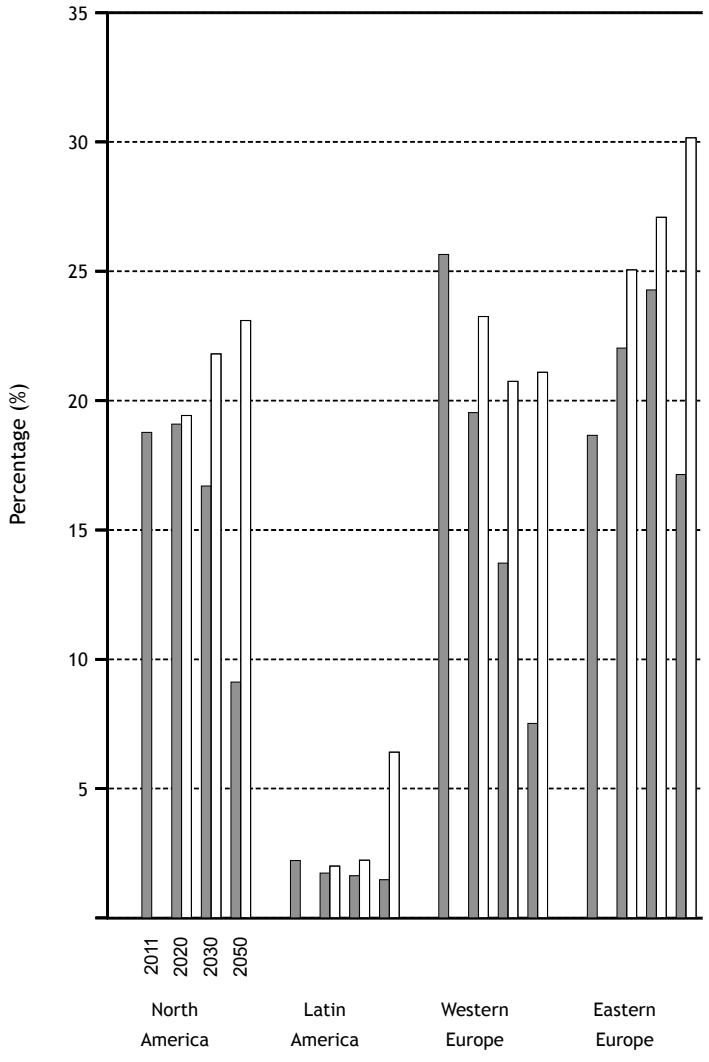
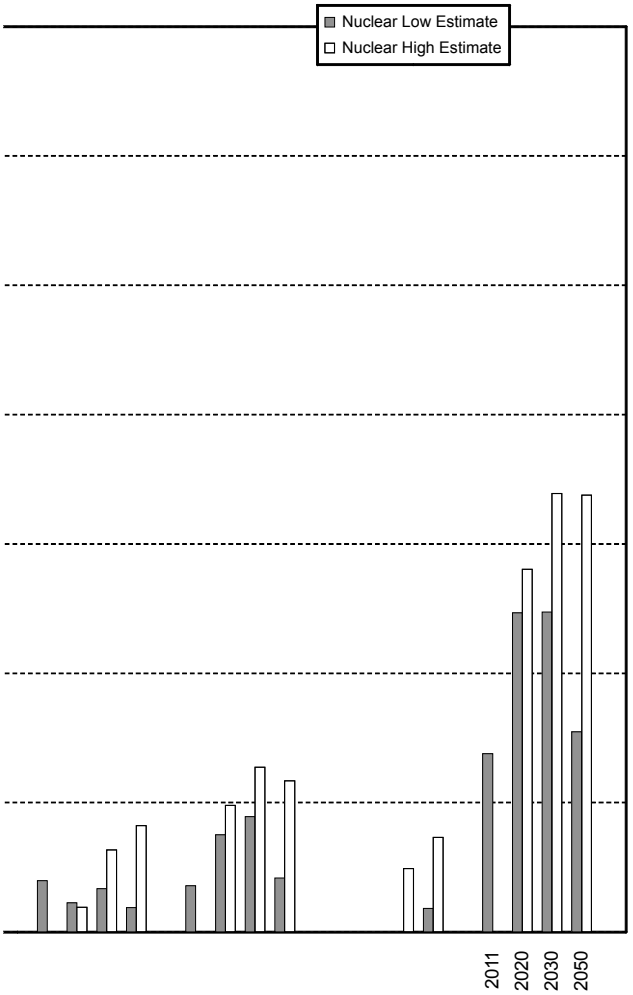


FIGURE 3. PERCENTAGE OF ELECTRICITY SUPPLIED BY NUCLEAR


Nuclear Low Estimate
Nuclear High Estimate
2011
2020
2030
2050
Africa
Middle East & South Asia
South East Asia & the Pacific
Far East

POWER

TABLE 5. ESTIMATES OF TOTAL ENERGY REQUIREMENT (EJ), PERCENTAGE USED FOR ELECTRICITY GENERATION, AND PERCENTAGE SUPPLIED BY NUCLEAR ENERGY (*)

Country Group	2011			2020			2030			2050 (a)		
	Total Energy Requirement	% Used for Elect. Gen.	% Supplied by Nuclear	Total Energy Requirement	% Used for Elect. Gen.	% Supplied by Nuclear	Total Energy Requirement	% Used for Elect. Gen.	% Supplied by Nuclear	Total Energy Requirement	% Used for Elect. Gen.	% Supplied by Nuclear
North America	107.1	40.5	9.0	107 114	43 41	9.7 9.3	106 113	45 44	9.0 11.2	107	49	5.5 13.1
Latin America	35.4	25.3	0.9	51 54	27 28	0.8 0.9	64 89	35 38	1.0 1.4	111	43	1.3 3.9
Western Europe	66.3	38.4	13.2	73 75	39 40	10.5 12.6	82 89	38 43	7.4 12.1	96	47	5.4 13.2
Eastern Europe	58.7	38.2	6.3	65 69	41 41	8.1 9.0	67 81	47 47	10.2 11.4	93	50	8.2 12.2
Africa	30.3	21.7	0.5	35 39	35 37	0.4 0.4	54 95	44 36	0.8 1.2	198	44	0.7 1.5
Middle East and South Asia	72.1	33.3	0.5	93 110	34 37	1.1 1.5	157 183	44 46	1.7 2.4	489	51	1.0 2.2
South East Asia and the Pacific	26.3	31.2		30 33	36 35		41 43	42 47	0.0 1.2	101	45	0.5 1.6
Far East	143.9	41.8	3.2	177 194	41 43	5.6 6.8	225 288	43 44	5.9 8.2	389	50	4.9 8.4
World Total Low Estimate	539.9	36.9	5.1	631	38	5.5	796	43	4.9	1584	49	2.9
World Total High Estimate				688	39	6.1	980	43	6.5			5.7

Notes:

(*) Total energy requirement is estimated as production of primary energy plus net trade (import - export) minus international bunkers and stock changes.

(a) Projection figures for total energy requirement and percentage used for electricity generation are the arithmetic average between low and high estimates.

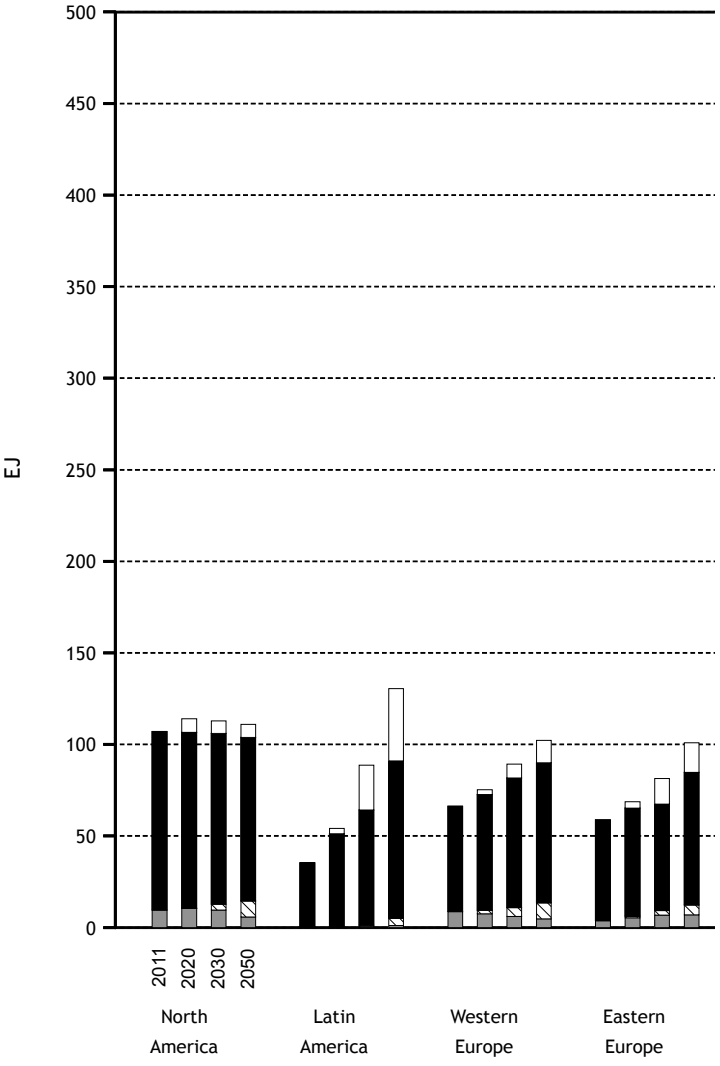


FIGURE 4. ESTIMATES OF ENERGY REQUIREMENT

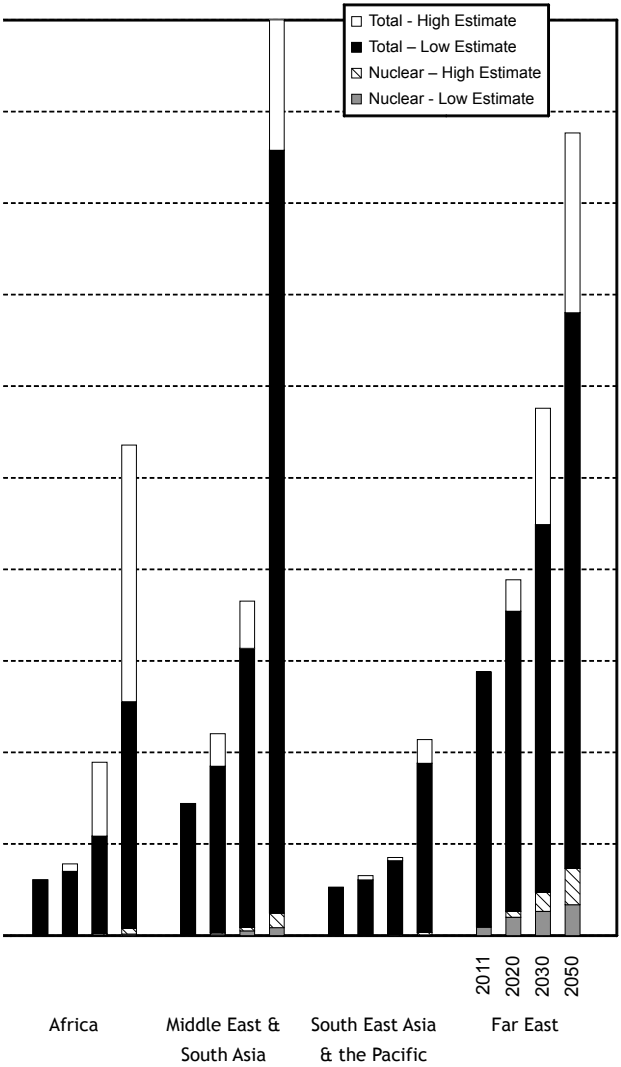

Total - High Estimate
Total – Low Estimate
Nuclear – High Estimate
Nuclear - Low Estimate
2011
2020
2030
2050
Africa
Middle East & South Asia
South East Asia & the Pacific
Far East

TABLE 6. TOTAL ENERGY REQUIREMENT (EJ) BY TYPE OF FUEL IN 2011 (*)

Country Group	Solids (a)	Liquids	Gases	Biomass (b)	Hydro	Nuclear	Renewables (c)	Total
North America	21.43	35.66	30.69	6.07	2.62	9.59	0.99	107.06
Latin America	1.66	16.01	8.54	5.64	2.79	0.33	0.38	35.35
Western Europe	9.05	22.25	18.43	4.76	1.88	8.72	1.16	66.25
Eastern Europe	12.01	12.18	28.53	1.36	1.01	3.68	-0.03	58.74
Africa	4.85	8.11	4.34	12.38	0.39	0.14	0.11	30.31
Middle East and South Asia	17.63	23.83	19.76	9.76	0.72	0.36	0.02	72.08
South East Asia and the Pacific	6.16	9.09	6.10	4.24	0.26		0.42	26.27
Far East	84.05	34.52	12.72	4.12	3.11	4.66	0.70	143.89
World Total	156.83	161.66	129.11	48.34	12.79	27.47	3.75	539.94

Notes:
(*) Total energy requirement is estimated as production of primary energy plus net trade (import - export) minus international bunkers and stock changes.
(a) Solids do not include commercial wood.
(b) The column headed 'Biomass' includes commercial wood, combustible renewables, waste and other biomass products.
(c) The column headed 'Renewables' includes geothermal, wind, solar, tide energy and net electricity trade.

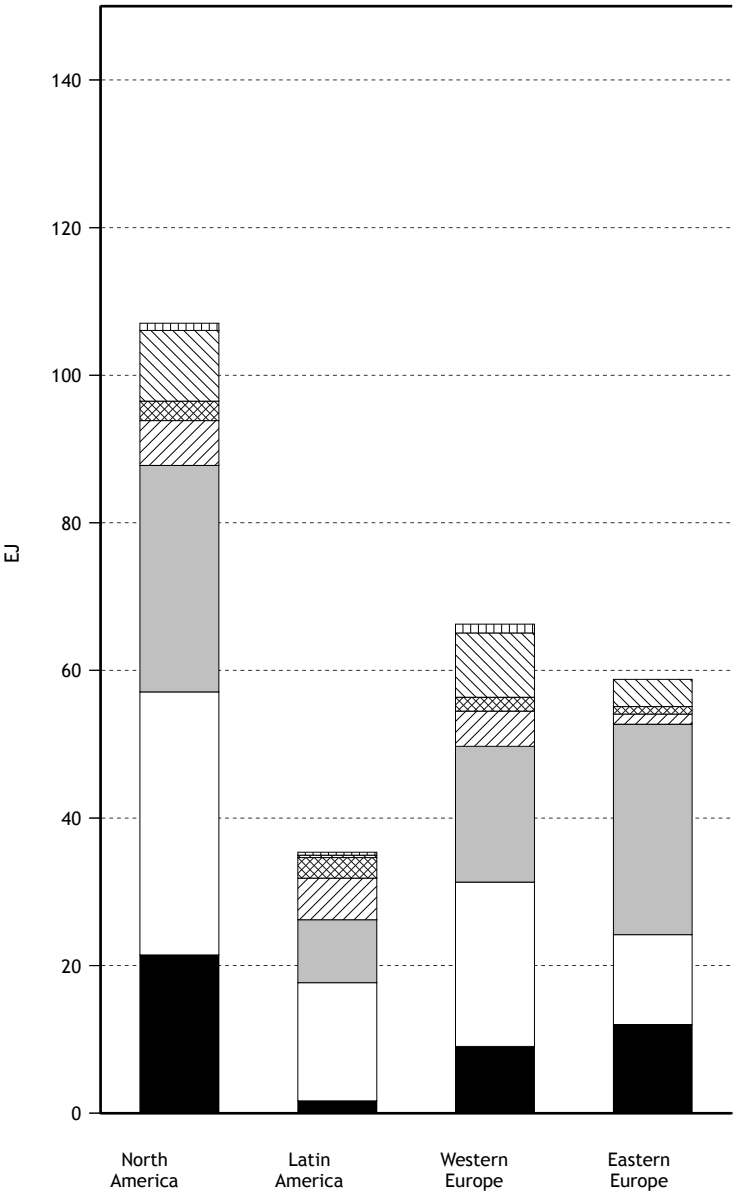
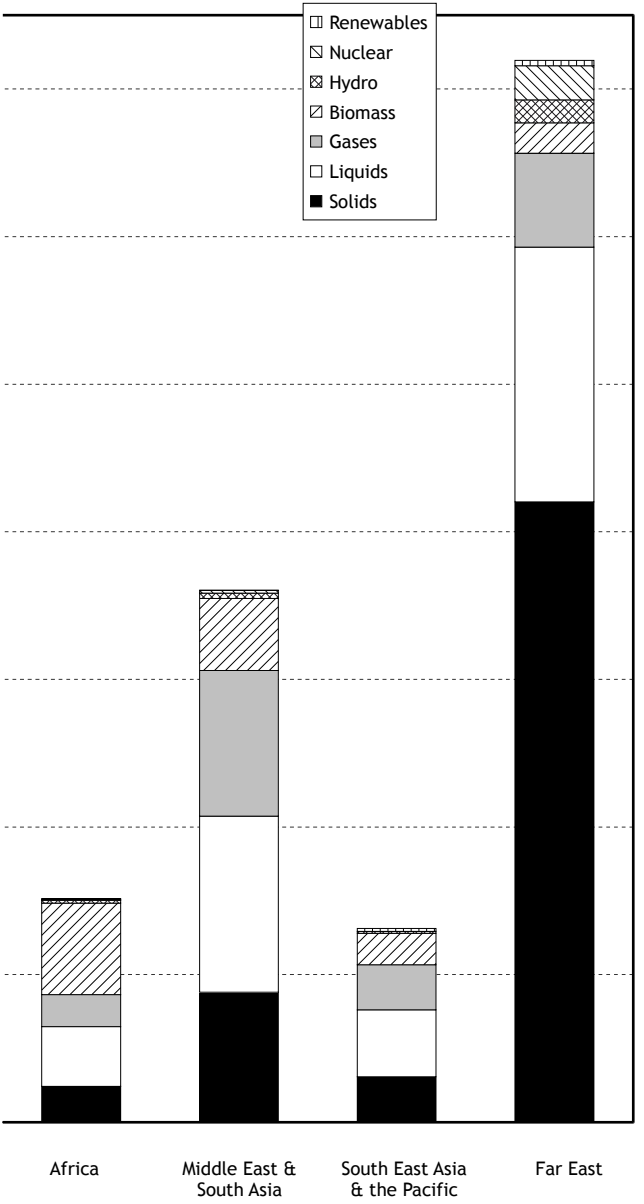


FIGURE 5. TOTAL ENERGY REQUIREMENT BY FUEL TYPE IN 2011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Nuclear
Hydro
Biomass
Gases
Liquids
Solids
Africa
Middle East & South Asia
South East Asia & the Pacific
Far East

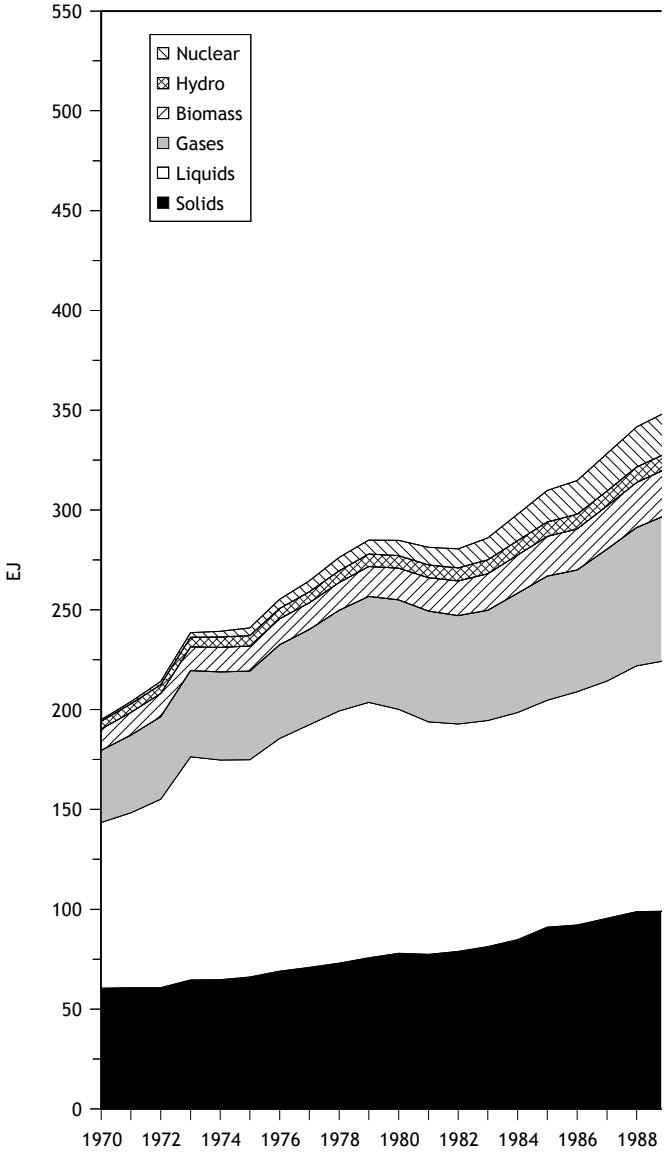


FIGURE 6. BREAKDOWN OF WORLD TOTAL ENERGY REQUIREMENT DURING THE PERIOD 1970 — 2011

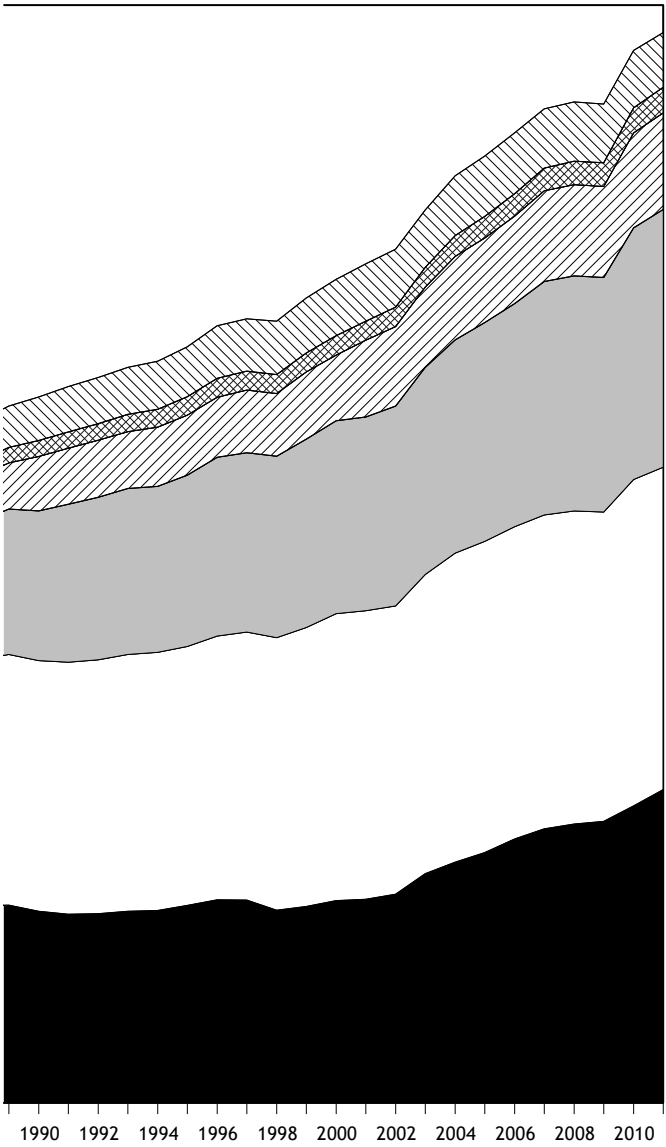

1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year

TABLE 7. FUEL SHARES (%) OF ENERGY REQUIREMENT IN 2011 (*)

Country Group	Solids (a)	Liquids	Gases	Biomass (b)	Hydro	Nuclear	Renewables (c)	Total
North America	20.02	33.31	28.67	5.67	2.45	8.95	0.93	100.00
Latin America	4.69	45.30	24.15	15.97	7.90	0.93	1.08	100.00
Western Europe	13.66	33.58	27.82	7.19	2.84	13.17	1.75	100.00
Eastern Europe	20.45	20.73	48.58	2.31	1.72	6.26	-0.06	100.00
Africa	15.99	26.74	14.31	40.85	1.28	0.47	0.36	100.00
Middle East and South Asia	24.46	33.07	27.42	13.53	1.00	0.50	0.03	100.00
South East Asia and the Pacific	23.45	34.60	23.21	16.15	1.01		1.58	100.00
Far East	58.42	23.99	8.84	2.86	2.16	3.24	0.49	100.00
World Total	29.05	29.94	23.91	8.95	2.37	5.09	0.69	100.00

Notes:

(*) Total energy requirement is estimated as production of primary energy plus net trade (import - export) minus international bunkers and stock changes.

(a) Solids do not include commercial wood.

(b) The column headed 'Biomass' includes commercial wood, combustible renewables, waste and other biomass products.

(c) The column headed 'Renewables' includes geothermal, wind, solar, tide energy and net electricity trade.

TABLE 8. FUEL USE (EJ) FOR ELECTRICITY GENERATION BY TYPE OF FUEL IN 2011

Country Group	Thermal (a)	Hydro	Nuclear	Renewables (b)	Total
North America	30.19	2.62	9.59	0.99	43.39
Latin America	5.50	2.79	0.33	0.37	8.99
Western Europe	14.36	1.88	8.72	1.13	26.09
Eastern Europe	17.79	1.01	3.68	0.03	22.50
Africa	6.05	0.39	0.14	0.06	6.64
Middle East and South Asia	22.91	0.72	0.36	> 0.01	23.99
South East Asia and the Pacific	7.52	0.26		0.41	8.20
Far East	48.56	3.11	4.66	0.70	57.02
World Total	152.87	12.79	27.47	3.69	196.83

Notes:
(a) The column headed 'Thermal' is the total for solids, liquids, gases, biomass and waste.
(b) The column headed 'Renewables' includes geothermal, wind, solar and tide energy.

TABLE 9. PERCENTAGE CONTRIBUTION OF EACH FUEL TYPE TO ELECTRICITY GENERATION IN 2011

Country Group	Thermal (a)	Hydro	Nuclear	Renewables (b)	Total
North America	63.09	15.56	18.77	2.58	100.00
Latin America	39.51	57.39	2.22	0.88	100.00
Western Europe	51.27	16.78	25.66	6.29	100.00
Eastern Europe	65.60	15.52	18.66	0.22	100.00
Africa	80.93	16.54	1.99	0.54	100.00
Middle East and South Asia	87.32	10.87	1.79	0.02	100.00
South East Asia and the Pacific	88.43	9.25		2.31	100.00
Far East	78.03	13.94	6.89	1.14	100.00
World Total	68.22	17.38	12.32	2.08	100.00

Notes:
(a) The column headed 'Thermal' is the total for solids, liquids, gases, biomass and waste.
(b) The column headed 'Renewables' includes geothermal, wind, solar and tide energy.

TABLE 10. ESTIMATES OF POPULATION GROWTH BY REGION (*)

Country Group	2011		2020		2030		2050	
	Million Inhabitants	Growth Rate (%/a) 2000 – 2011	Million Inhabitants	Growth Rate (%/a) 2011 – 2020	Million Inhabitants	Growth Rate (%/a) 2020 – 2030	Million Inhabitants	Growth Rate (%/a) 2030 – 2050
North America	349	0.89	374	0.79	402	0.71	447	0.53
Latin America	599	1.16	652	0.96	702	0.73	751	0.34
Western Europe	488	0.50	504	0.36	515	0.21	520	0.05
Eastern Europe	391	-0.35	389	-0.06	381	-0.21	356	-0.34
Africa	1058	2.54	1278	2.13	1562	2.03	2192	1.71
Middle East and South Asia	1883	1.86	2119	1.32	2357	1.07	2679	0.64
South East Asia and the Pacific	448	1.39	488	0.96	526	0.75	564	0.35
Far East	1786	0.59	1852	0.40	1878	0.14	1798	-0.22
World Total	7001	1.35	7657	1.00	8321	0.84	9306	0.56

(*) Projection figures are the arithmetic average between low and high estimates.

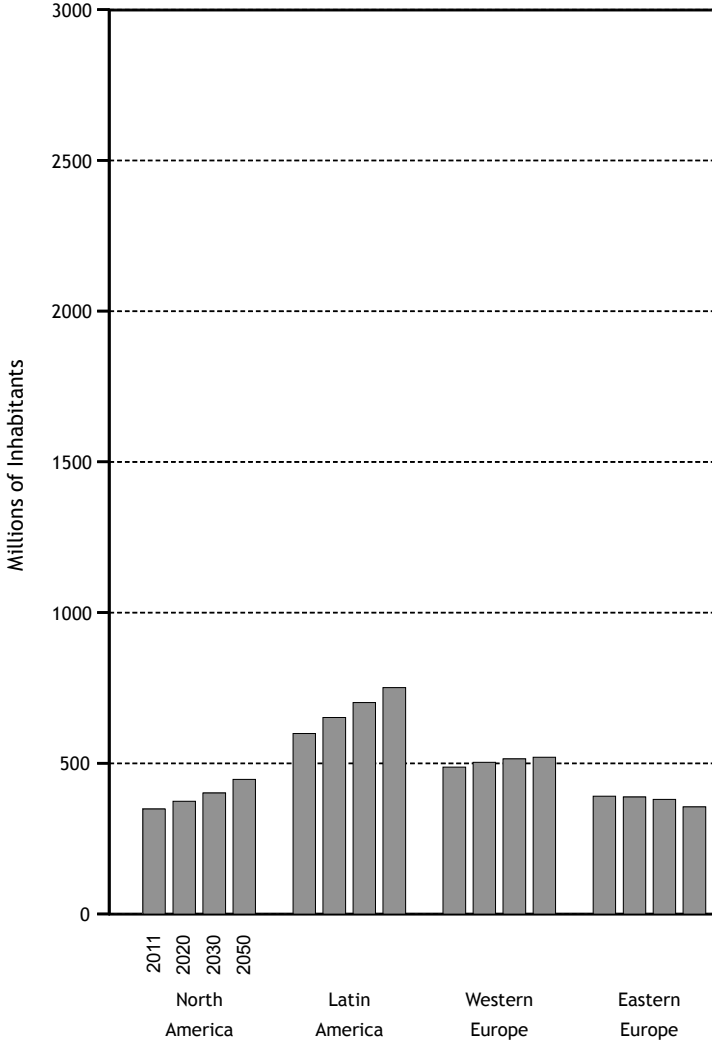


FIGURE 7. POPULATION ESTIMATES

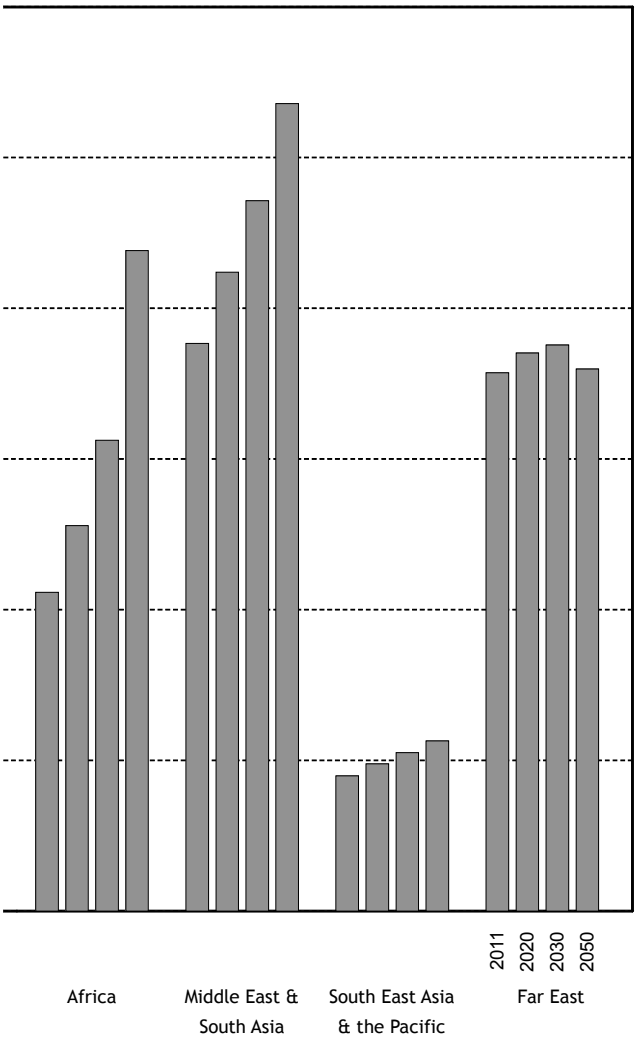

2011
2020
2030
2050
Africa
Middle East &
South Asia
South East Asia
& the Pacific
Far East

TABLE 11. ESTIMATES OF TOTAL ENERGY AND ELECTRICITY REQUIREMENT PER CAPITA

Country Group	2011		2020		2030		2050 (*)	
	Energy Requirement per Capita (GJ/cap)	Electricity Requirement per Capita (MWh/cap)	Energy Requirement per Capita (GJ/cap)	Electricity Requirement per Capita (MWh/cap)	Energy Requirement per Capita (GJ/cap)	Electricity Requirement per Capita (MWh/cap)	Energy Requirement per Capita (GJ/cap)	Electricity Requirement per Capita (MWh/cap)
North America	307	13.4	285 – 305	13.3 – 13.4	264 – 281	13.0 – 13.3	240 ± 8	12.9 ± 0.3
Latin America	59	2.3	78 – 83	3.2 – 3.5	91 – 126	4.9 – 7.3	148 ± 26	9.7 ± 2.1
Western Europe	136	6.4	144 – 149	7.1 – 7.4	159 – 173	7.9 – 9.3	185 ± 12	11.3 ± 1.1
Eastern Europe	150	4.6	168 – 177	5.6 – 5.8	177 – 214	6.8 – 8.2	261 ± 23	10.5 ± 1.2
Africa	29	0.6	27 – 31	0.9 – 1.1	35 – 61	1.5 – 2.1	90 ± 32	4.0 ± 1.5
Middle East and South Asia	38	1.0	44 – 52	1.1 – 1.5	67 – 77	2.3 – 2.7	183 ± 22	7.2 ± 0.9
South East Asia and the Pacific	59	1.8	62 – 67	2.2 – 2.2	78 – 81	3.2 – 3.7	178 ± 12	7.8 ± 0.9
Far East	81	3.5	96 – 105	4.0 – 4.7	120 – 153	5.2 – 6.8	216 ± 27	11.1 ± 1.6
World Average	77	2.9	82 – 90	3.3 – 3.6	96 – 118	4.1 – 5.1	170 ± 24	8.0 ± 1.3

Note:
(*) Projection figures are the arithmetic average between low and high estimates with indicated range.

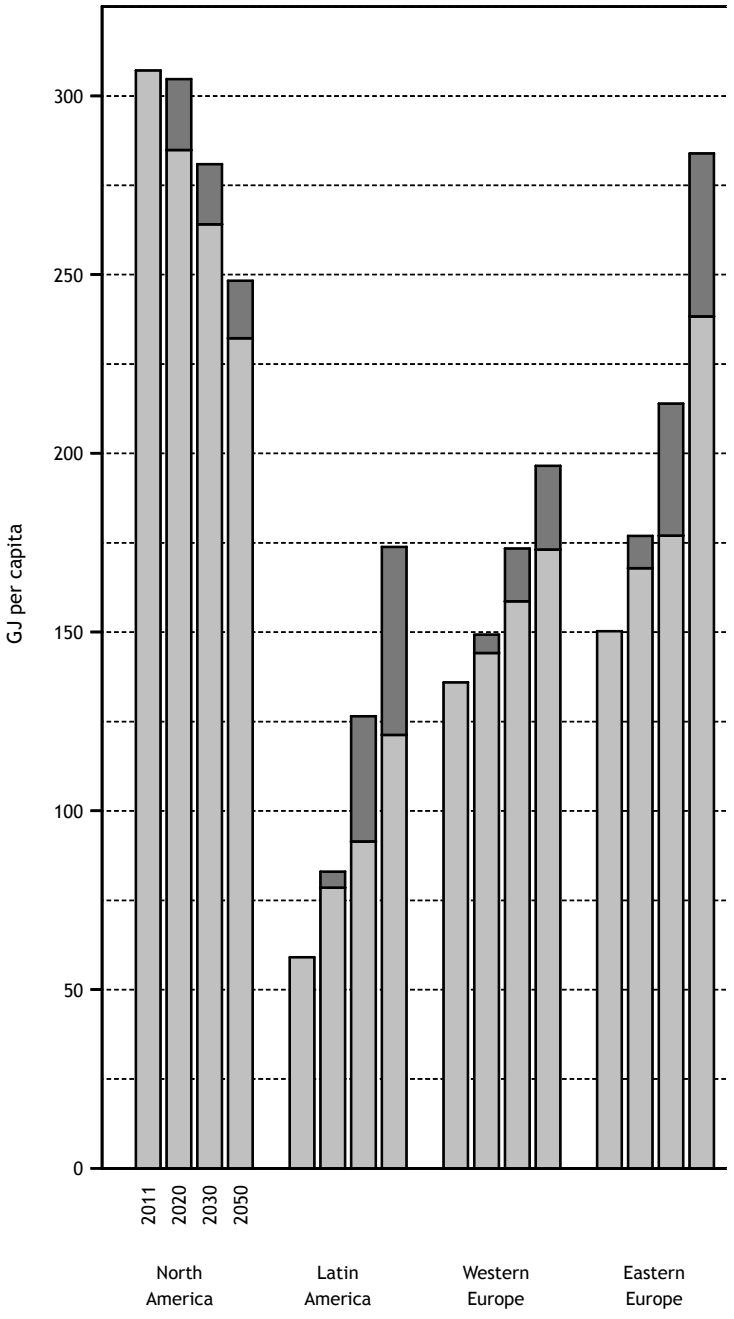
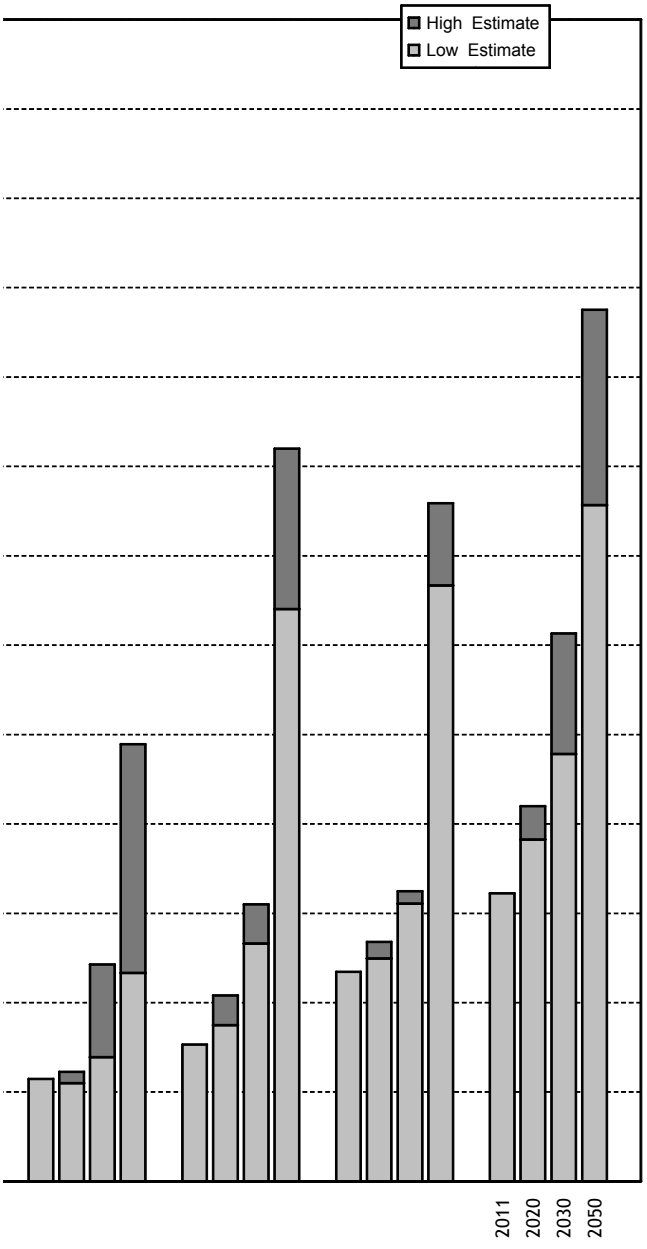


FIGURE 8. TOTAL ENERGY REQUIREMENT PER CAPITA


High Estimate
Low Estimate
2011
2020
2030
2050
Africa
Middle East & South Asia
South East Asia & the Pacific
Far East

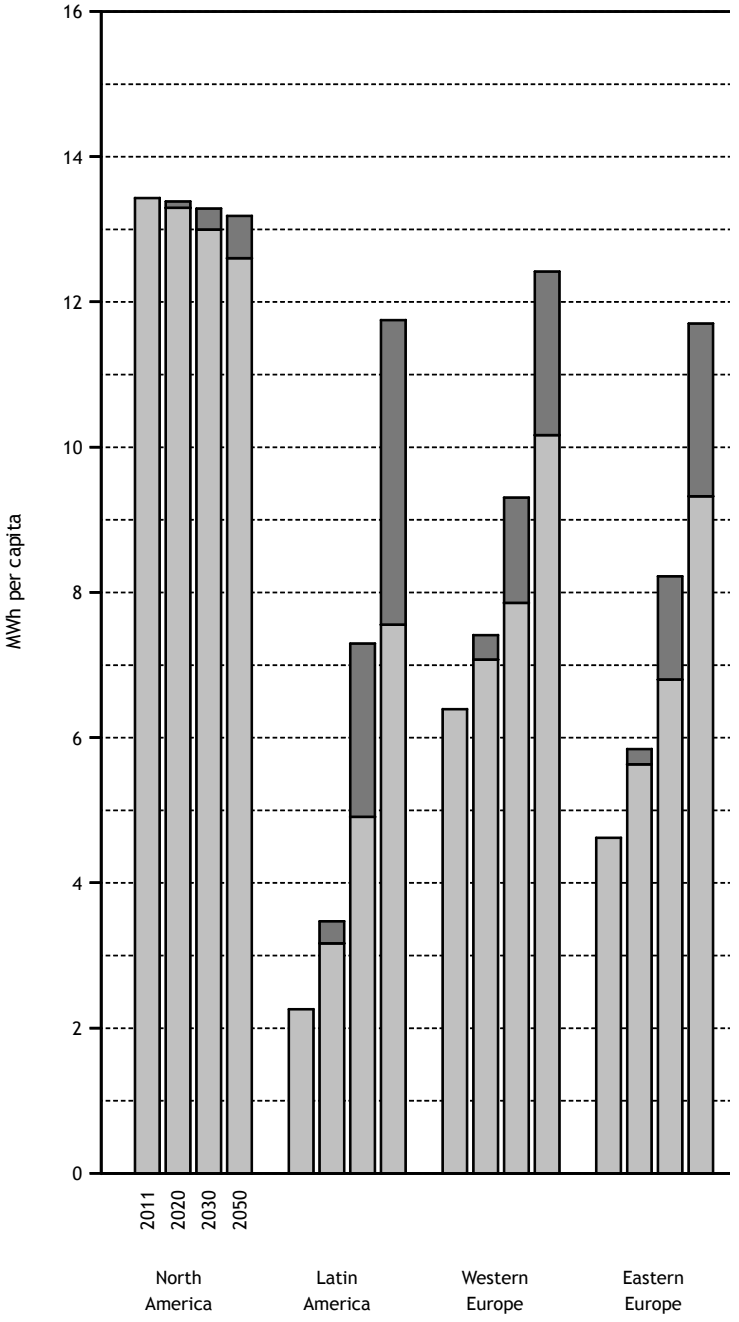


FIGURE 9. TOTAL ELECTRICITY REQUIREMENT PER CAPITA

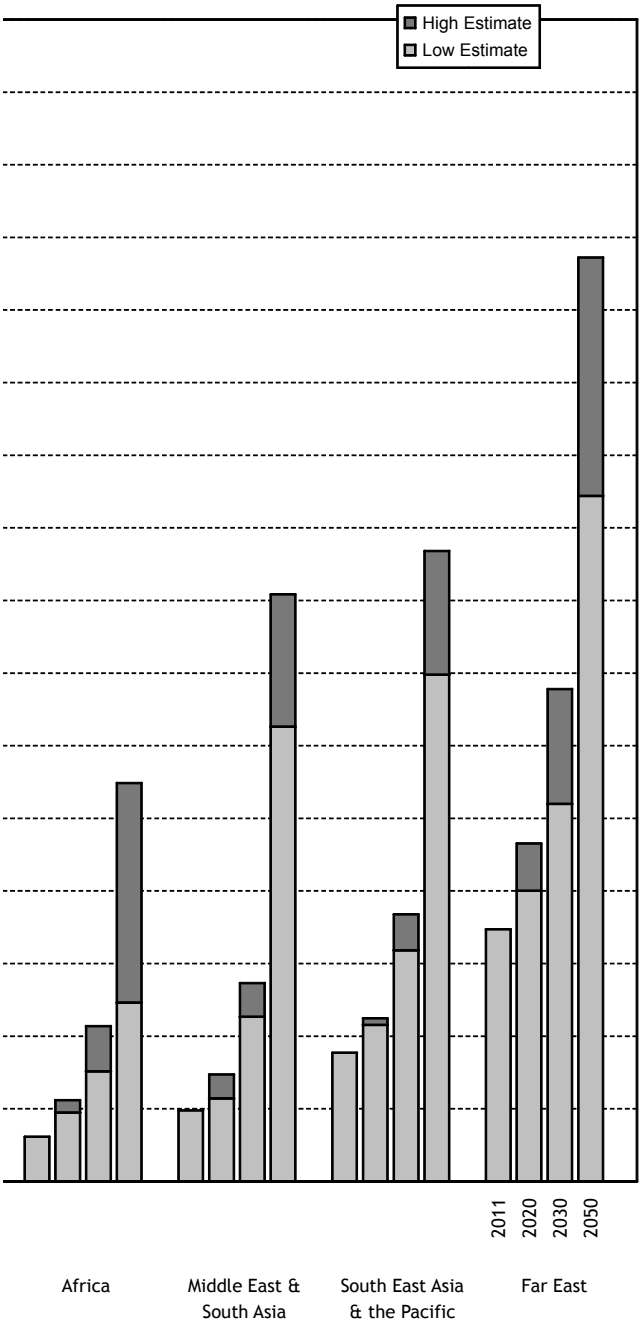

High Estimate
Low Estimate
2011
2020
2030
2050
Africa
Middle East & South Asia
South East Asia & the Pacific
Far East

TABLE 12. AVERAGE ANNUAL GROWTH RATES DURING THE PERIOD 2001—2011 (%)

Country Group	Population	Total Energy	Total Electricity	Nuclear Energy	Nuclear Capacity
North America	1.0	0.1	0.8	0.4	0.6
Latin America	1.3	2.7	3.4	0.3	-0.2
Western Europe	0.6	-0.3	0.8	-0.9	-0.9
Eastern Europe	-0.4	0.9	1.0	1.7	0.5
Africa	2.8	3.4	4.2	-0.3	0.0
Middle East and South Asia	2.0	5.0	5.3	5.5	7.5
South East Asia and the Pacific	1.5	3.0	3.5		
Far East	0.6	5.8	7.6	-1.3	2.2
World Average	1.4	2.5	3.3	-0.1	0.4

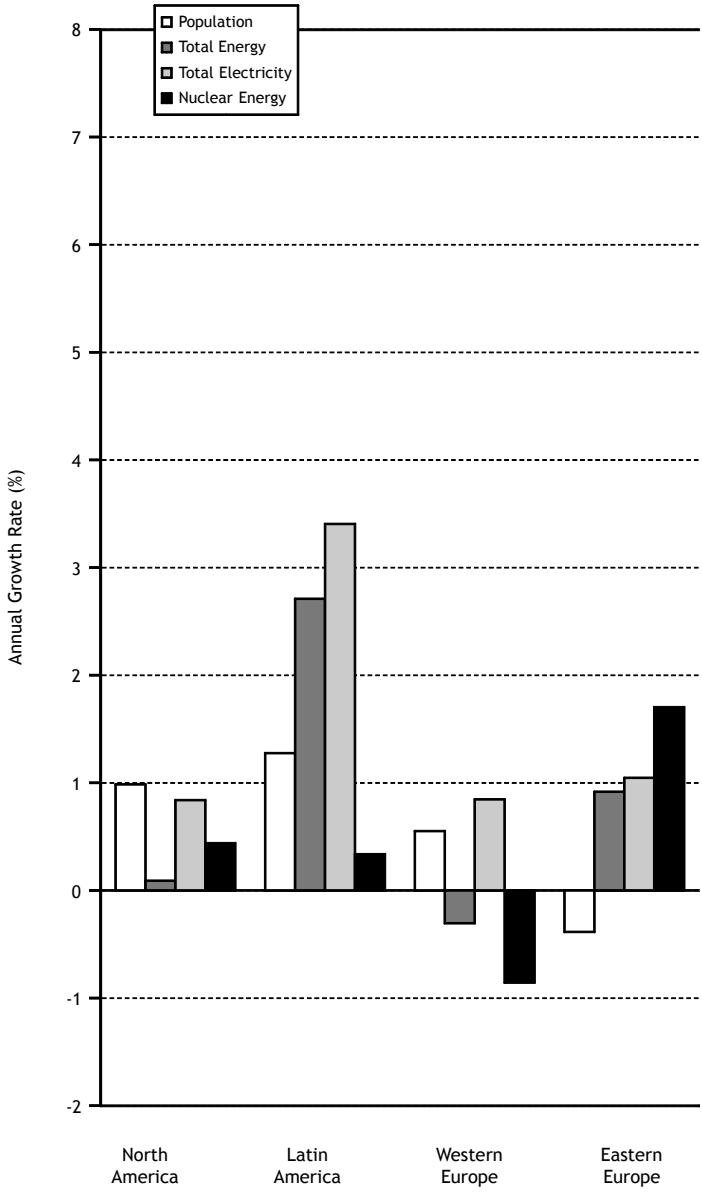


FIGURE 10. AVERAGE ANNUAL GROWTH RATES DURING THE PERIOD 2001—2011

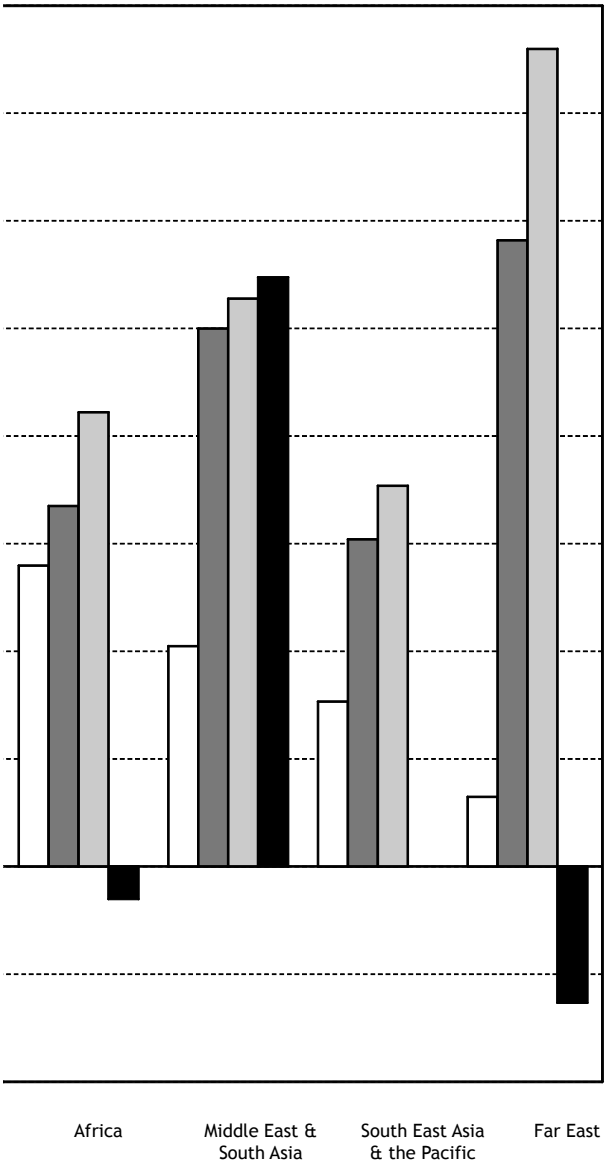

Africa
Middle East & South Asia
South East Asia & the Pacific
Far East

TABLE 13. ESTIMATES OF AVERAGE ANNUAL GROWTH RATES DURING THE PERIOD 2011—2030 (%)

Country Group	Population	Total Energy	Total Electricity	Nuclear Energy	Nuclear Capacity
North America	0.7	0.0 – 0.3	0.6 – 0.7	0.0 – 1.5	-0.2 – 1.4
Latin America	0.8	3.2 – 5.0	5.0 – 7.3	3.3 – 7.3	2.9 – 6.8
Western Europe	0.3	1.1 – 1.6	1.4 – 2.3	-1.9 – 1.1	-2.5 – 0.5
Eastern Europe	-0.1	0.7 – 1.7	1.9 – 2.9	3.3 – 5.0	2.6 – 4.3
Africa	2.1	3.1 – 6.2	7.0 – 9.0	6.1 – 11.7	5.5 – 11.1
Middle East and South Asia	1.2	4.2 – 5.0	5.8 – 6.8	11.0 – 14.2	8.8 – 12.0
South East Asia and the Pacific	0.8	2.4 – 2.6	4.0 – 4.8		
Far East	0.3	2.4 – 3.7	2.4 – 3.9	5.6 – 8.9	3.5 – 6.7
World Average	0.9	2.1 – 3.2	2.8 – 4.0	1.9 – 4.5	1.1 – 3.7

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