REFERENCE DATA SERIES No. 1
2019 Edition

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

IAEA
International Atomic Energy Agency

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

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Introduction

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

RDS-1 starts with a summary of the status of nuclear power in IAEA Member States as of the end of 2018 based on the latest statistical data collected by the IAEA's Power Reactor Information System (PRIS). It then presents estimates of energy and electricity up to 2050 derived from various international studies, including the International Energy Agency's World Energy Outlook 2018 and the United States Energy Information Administration's International Energy Outlook 2018. The energy and electricity data for 2018 are estimated, as the latest information available from the United Nations Department of Economic and Social Affairs is for 2016. Population data originate from World Population Prospects 2019, published by the Population Division of the United Nations Department of Economic and Social Affairs. The 2018 values again are estimates.

As in previous editions of RDS-1, projections of nuclear power are presented as low and high estimates encompassing the uncertainties inherent in projecting trends. The projections are based on a critical review of (i) the global and regional energy, electricity and nuclear power projections made by other international organizations, (ii) national projections supplied by individual countries for a recent OECD Nuclear Energy Agency study and (iii) the estimates of the expert group participating in the IAEA's yearly consultancy on nuclear capacity projections.

The estimates of future nuclear electrical generating capacity presented in Table 5 are derived using a country by country 'bottom up' approach. In deriving these estimates, a group of experts considers all the operating reactors, possible licence renewals, planned shutdowns and plausible construction projects foreseen for the next several decades. The experts build the projections project by project by assessing the plausibility of

each in light of, first, the assumptions of the low projections and, second, the assumptions of the high projections.

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 assuming that current market, technology and resource trends continue and there are few additional changes in explicit laws, policies and regulations affecting nuclear power. This case was explicitly designed to produce a 'conservative but plausible' set of projections. Additionally, the low case does not assume that targets for nuclear power in a particular country will necessarily be achieved. These assumptions are relaxed in the high case. The high case projections are much more ambitious, but are still plausible and technically feasible. The high and low cases assume the same outlook of economic and electricity demand growth based on current expectations. Country policies toward climate change are also considered in the high case.

Over the short term, the low price of natural gas and the impact of subsidized intermittent renewable energy sources on electricity prices are expected to continue to affect nuclear growth prospects in some regions of the world. Moreover, natural gas has become more competitive owing to low prices and increased supply as a result of technological advances in gas extraction. In the near term, ongoing financial uncertainty and stagnant electricity demand in some regions will continue to present challenges for capital intensive projects such as nuclear power. Heightened safety requirements, challenges in deploying advanced technologies and other factors have increased construction times and costs, contributing to delays. The expert group assumed that these challenges, in addition to the accident at the Fukushima Daiichi nuclear power plant, will

continue to affect nuclear development plans. The underlying fundamentals of population growth and electricity consumption in the developing world, as well as climate change and air quality concerns, security of energy supply and price volatility of other fuels, continue to point to nuclear generating capacity playing an important role in the energy mix in the longer run.

Compared with the 2018 projections to 2050, the 2019 projections are reduced by 33 gigawatt (electrical) (GW(e))[1] in the high case and increased by 15 GW(e) in the low case, narrowing the range. These changes reflect responses to the Fukushima Daiichi accident and other factors noted above. There are fewer uncertainties in these projections owing to recent announcements regarding the future of the existing nuclear fleet in some regions and long term plans for expansion. Significant new nuclear capacity would be necessary to offset any potential retirements resulting from a variety of factors such as ageing fleets, economic difficulties, etc.

Interest in nuclear power remains strong in many regions, particularly in the developing world. Commitments agreed under the Paris Agreement and other initiatives have the potential to support nuclear energy development.

[1] The projections consist of both available capacity (currently supplying electricity to the grid) and installed nominal capacity (available, but not currently supplying electricity to the grid).

Geographical Regions

The nuclear electrical generating capacity projections presented in RDS-1 are grouped according to the geographical regions used by the Statistics Division of the United Nations Secretariat, available on-line at unstats.un.org/unsd/methodology/m49/.

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the IAEA concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Notes

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%); the 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 from hydropower or from 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).

Total final energy consumption refers to all fuel and energy delivered to users for their energy use and does not include non-energy use (i.e. deliveries of energy products for use as chemical feedstocks or as raw materials).

Owing to rounding, numbers presented throughout this publication may not add up precisely to the totals provided, and percentages may not precisely reflect the absolute figures.

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

World

Nuclear Power Development around the World in 2018

- There were 450 operational nuclear power reactors in the world at the end of 2018, with a total net installed power capacity of 396 GW(e).
- An additional 55 units with a total capacity of 57 GW(e) were under construction.
- During 2018, nine new nuclear power reactors with a total capacity of 10 358 MW(e) were connected to the grid, and seven reactors with a total capacity of 5424 MW(e) were retired. In 2018, construction began on five new units that are expected to add a total capacity of 6339 MW(e).
- Electricity generation from operational nuclear reactors increased about 2.4% in 2018, reaching 2563 TW·h.
- Nuclear power accounted for about 10% of total electricity production in 2018.

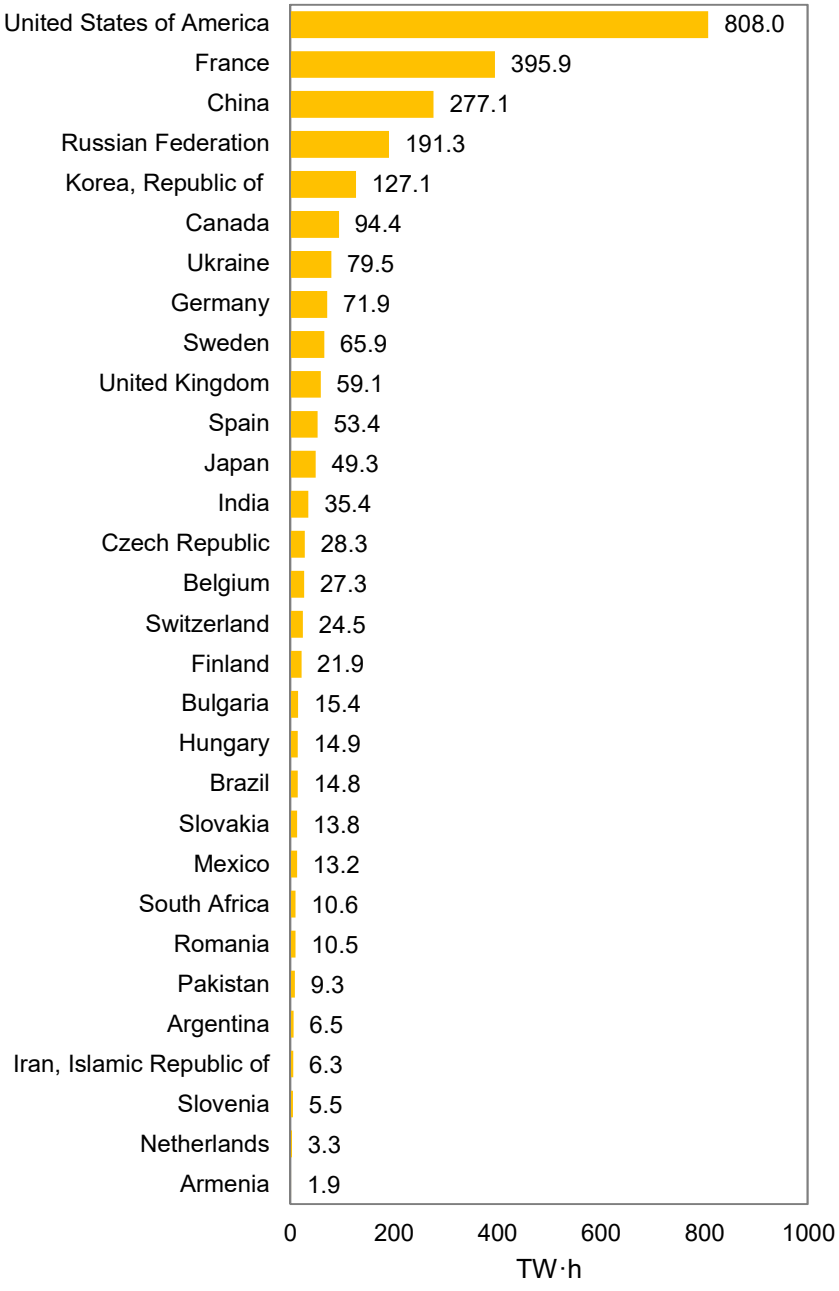
TABLE 1. NUCLEAR POWER REACTORS IN THE WORLD (end of 2018)

Country	Operational		Under Construction		Nuclear Electricity Production in 2018	
	Number of Units	Net Capacity (MW(e))	Number of Units	Net Capacity (MW(e))	TW·h	Per cent of Total
Argentina	3	1 633	1	25	6.5	4.7
Armenia	1	375			1.9	25.6
Bangladesh			2	2 160		
Belarus			2	2 220		
Belgium	7	5 918			27.3	38.1
Brazil	2	1 884	1	1 340	14.8	2.7
Bulgaria	2	1 966			15.4	34.7
Canada	19	13 554			94.4	14.9
China	46	42 858	11	10 982	277.1	4.2
Czech Republic	6	3 932			28.3	34.5
Finland	4	2 784	1	1 600	21.9	32.4
France	58	63 130	1	1 630	395.9	71.7
Germany	7	9 515			71.9	11.7
Hungary	4	1 902			14.9	50.6.1
India	22	6 255	7	4 824	35.4	2.3
Iran, Islamic Republic of	1	915			6.3	2.1
Japan	38	36 476	2	2 653	49.3	4.6

Korea, Republic of	24	22 444	5	6 700	127.1	22.3
Mexico	**2**	**1 552**			13.2	4.4
Netherlands	1	482			3.3	3.1
Pakistan	5	1 318	2	2 028	9.3	6.8
Romania	2	1 300			10.5	17.2
Russian Federation	36	27 252	6	4 573	191.3	17.0
Slovakia	4	1 814	2	880	13.8	55.0
Slovenia	1	688			5.5	35.9
South Africa	2	1 860			10.6	4.7
Spain	7	7 121			53.4	20.4
Sweden	8	8 613			65.9	40.3
Switzerland	5	3 333			24.5	38.5
Turkey			1	1 114		
Ukraine	15	13 107	2	2 070	79.5	53.0
United Arab Emirates			4	5 380		
United Kingdom	15	8 923	1	1 630	59.1	18.5
United States of America	98	99 061	2	2 234	808.0	19.3
World Total[a]	**450**	**396 413**	**55**	**56 643**	**2 563.0**	**10.2**

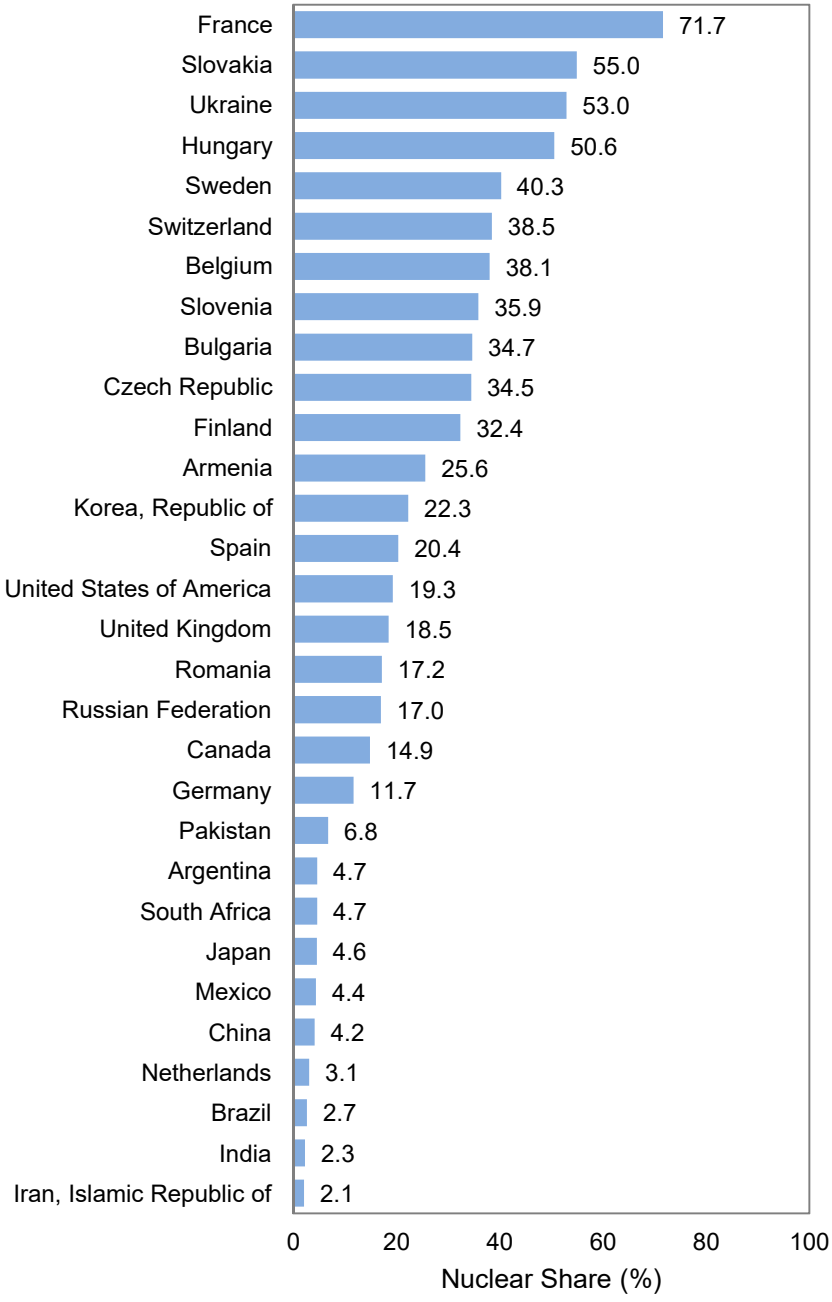
[a] Includes the following data from Taiwan, China: 5 units in operation with a total capacity of 4448 MW(e), 2 units under construction with a total capacity of 2600 MW(e), and 26.7 TW·h of nuclear electricity generation, representing 10.2% of the total electricity produced.

FIGURE 1. WORLD NUCLEAR ELECTRICITY PRODUCTION IN 2018



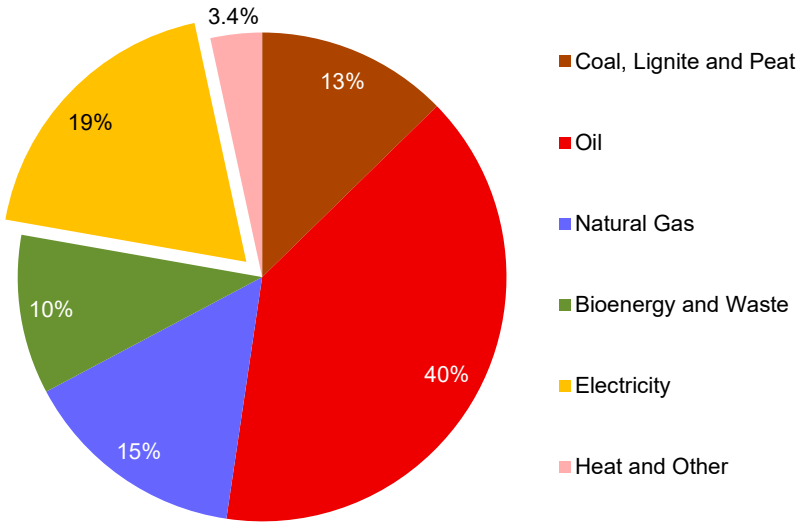
Note: The nuclear electricity production in Taiwan, China, was 26.7 TW·h.

FIGURE 2. SHARE OF NUCLEAR IN TOTAL ELECTRICITY PRODUCTION IN THE WORLD IN 2018



Note: The share of nuclear in the total electricity production of Taiwan, China, was 10.2%.

FIGURE 3. WORLD FINAL ENERGY CONSUMPTION BY ENERGY SOURCE IN 2018



Final Energy Consumption in 2018

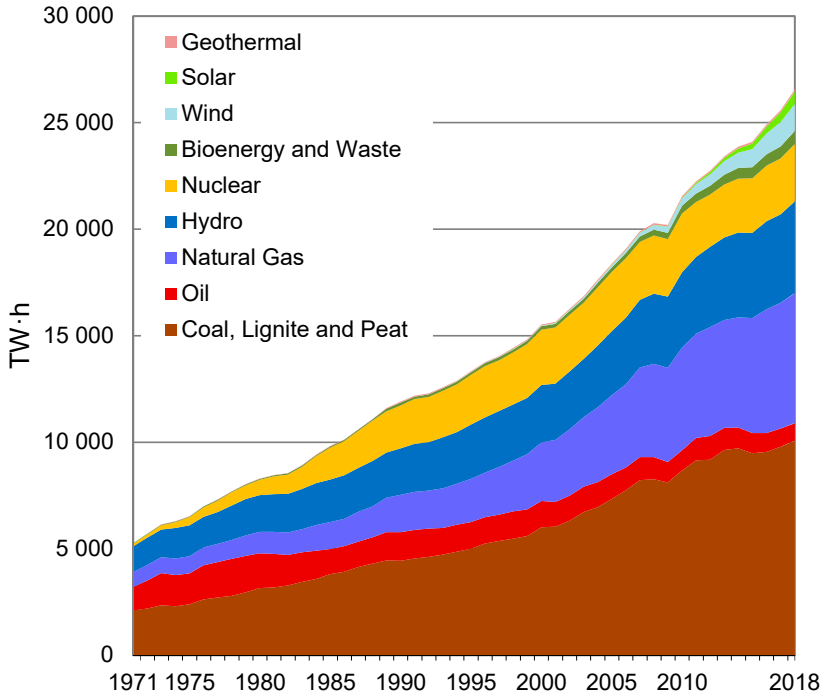
Globally, electricity accounted for about 19% of the total final energy consumption in 2018. About 70% of the final energy consumption was in the form of fossil fuels. Bioenergy and waste accounted for 10%.

As electricity consumption is expected to increase faster than total final energy consumption in the coming years, the share of electricity consumption is expected to rise.

Electricity Production

- Total electricity production grew by 3.9% in 2018, while the growth in nuclear electricity production was 2.4%.
- Among the various sources for electricity production, coal remained dominant despite the significant growth of renewable and natural gas based generation.
- The share of electricity production from natural gas remained at about 23% of total electricity production.
- The contribution of hydropower and renewable energy sources continued to increase significantly, reaching 25.8% in 2018, while the share of nuclear electricity production remained at about 10.2% of the total electricity production.

FIGURE 4. BREAKDOWN OF WORLD TOTAL ELECTRICITY PRODUCTION BY ENERGY SOURCE DURING THE PERIOD 1971–2018



Note: Estimates are expressed in gross figures. Gross electricity production is the total electrical energy produced by all generating units and installations, including pumped storage, measured at the output terminals of the generators.

Energy and Electricity Projections

- World energy consumption is expected to increase by 16% by 2030 and by 38% by 2050, at an annual growth rate of about 1%.
- Electricity consumption will grow at a higher rate of about 2.2% per year up to 2030 and around 2% per year thereafter.
- The share of electricity in total final energy consumption will thus increase from 18.8% in 2018 to 21% by 2030 and to 26% by the middle of the century.

FIGURE 5. WORLD FINAL CONSUMPTION OF ENERGY AND ELECTRICITY

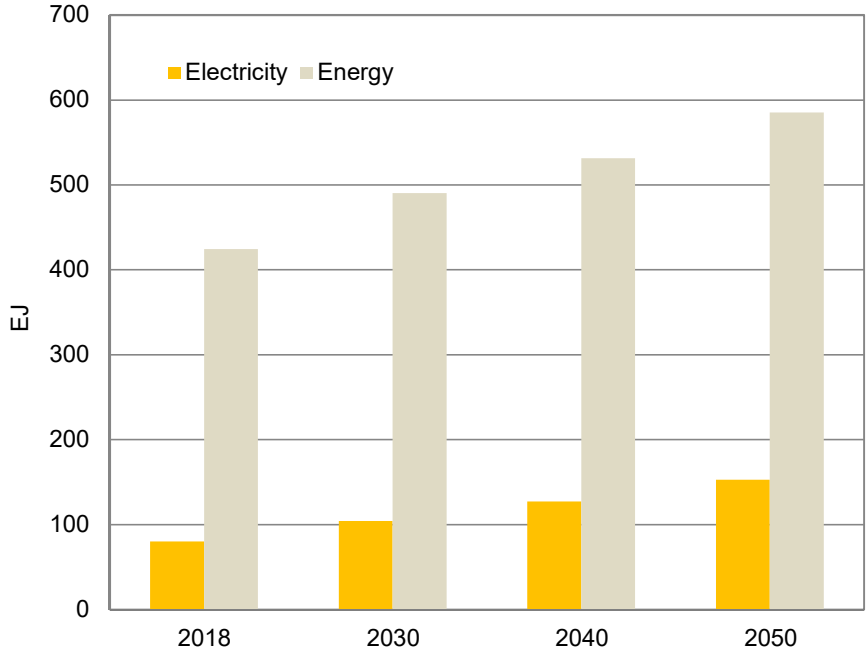


TABLE 2. WORLD FINAL CONSUMPTION[a] OF ENERGY AND ELECTRICITY

Final Consumption	2018	2030	2040	2050
Energy (EJ)	424.2	490.2	531.2	585.1
Electricity (EJ)	79.9	104.0	127.0	152.7
% of total	18.8	21.2	23.9	26.1

[a] Final consumption refers to all fuel and energy that is delivered to energy consumers.

Nuclear Electrical Generating Capacity Projections

- The world nuclear electrical generating capacity is projected to increase to 496 GW(e) by 2030 and to 715 GW(e) by 2050 in the high case. This represents a 25% increase over current levels by 2030 and an 80% increase in capacity by 2050.
- In the low case, the world nuclear electrical generating capacity is projected to gradually decline until 2040 and then rebound to 371 GW(e) by 2050.
- The world total electrical generating capacity is expected to increase from 7188 GW(e) in 2018 to 9782 GW(e) by 2030 and to 13 633 GW(e) by 2050.
- The share of nuclear electrical generating capacity in the world total electrical capacity will be about 3% in the low case and about 5% in the high case by the middle of the century.

FIGURE 6. WORLD NUCLEAR ELECTRICAL GENERATING CAPACITY

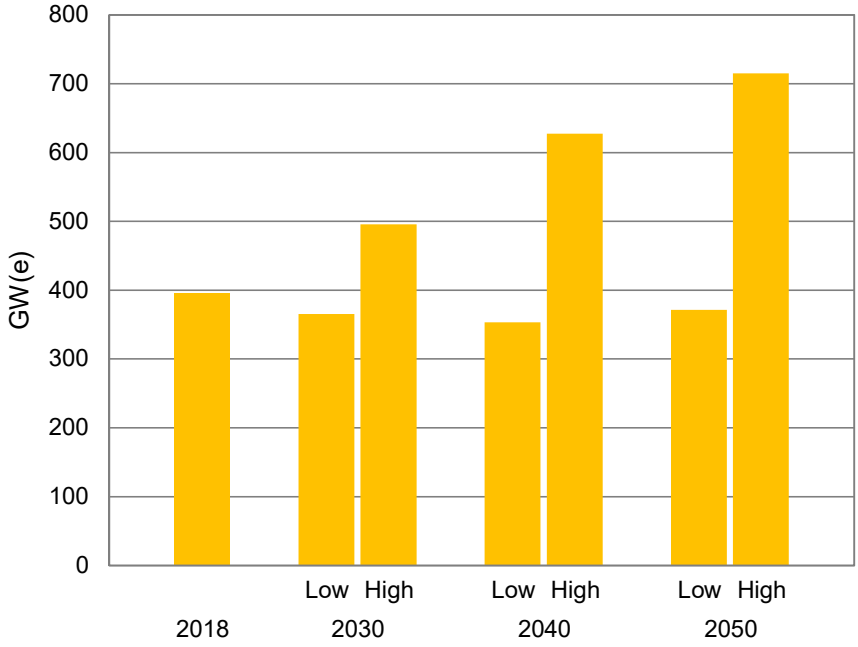


TABLE 3. WORLD TOTAL AND NUCLEAR ELECTRICAL GENERATING CAPACITY

Electrical Capacity	2018	2030[a]		2040[a]		2050[a]	
		Low	High	Low	High	Low	High
Total (GW(e))	7 188	9 782		11 811		13 633	
Nuclear (GW(e))	396	366	496	353	628	371	715
% of total	5.5	3.7	5.1	3.0	5.3	2.7	5.2

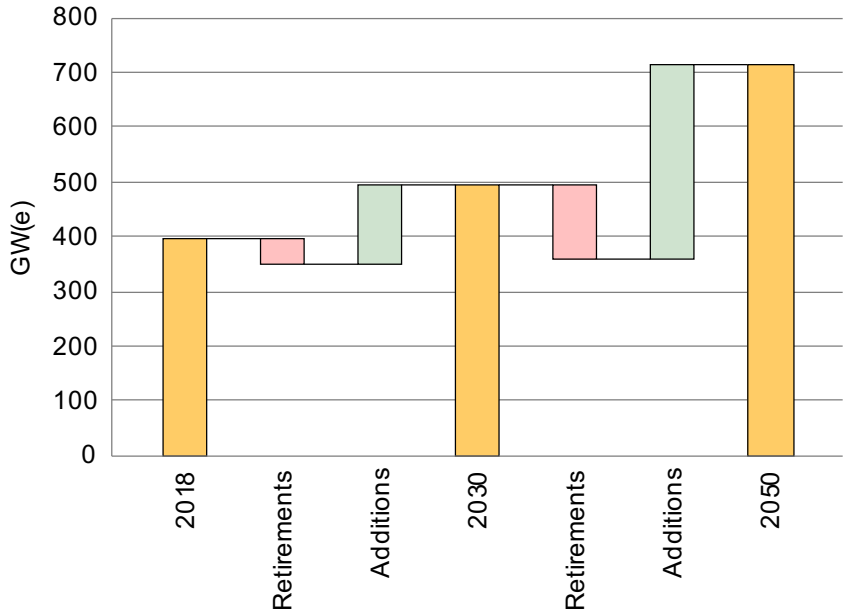
[a] Nuclear capacity estimates take into account the scheduled retirement of older units at the end of their lifetime.

Reactor Retirements and Additions

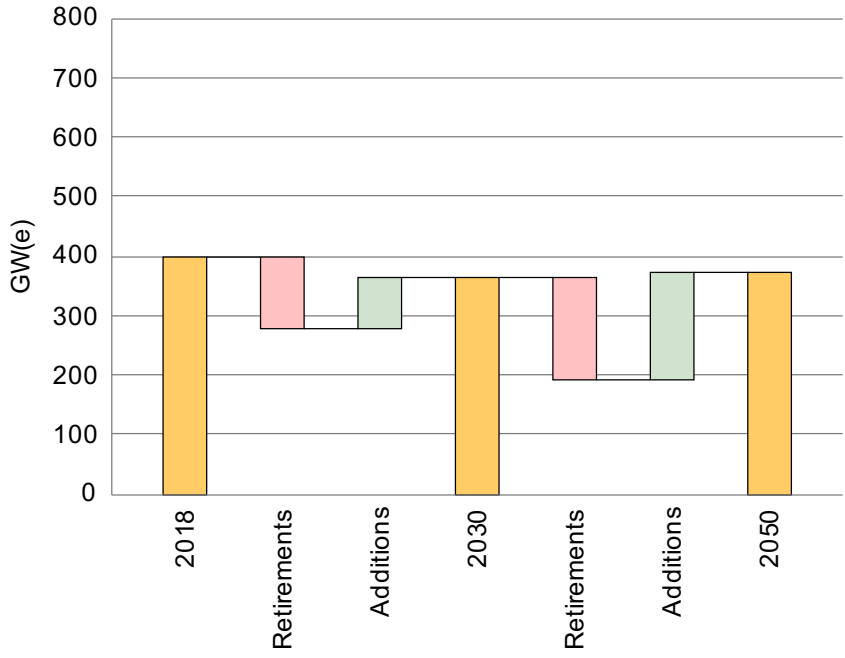
- More than half the existing nuclear power reactors are over 30 years old and are scheduled to be retired in the coming years.
- In the low case, about 117 GW(e) of nuclear electrical generating capacity will be retired and new reactors will add 85 GW(e) of capacity by 2030. Between 2030 and 2050, an additional 173 GW(e) will be retired and 179 GW(e) of new capacity will be added.
- In the high case, it is assumed that several of the nuclear power reactors scheduled for retirement will be given a life extension, so that only 49 GW(e) of nuclear electrical generating capacity will be retired by 2030, with an additional 137 GW(e) retired by 2050. In this case, the new reactors will add 148 GW(e) of nuclear electrical generating capacity by 2030 and about 356 GW(e) of capacity by 2050.

FIGURE 7. WORLD NUCLEAR CAPACITY: ACTUAL, RETIREMENTS AND ADDITIONS

HIGH CASE



LOW CASE



Electricity and Nuclear Production Projections

- The total nuclear electricity production in the world will continue to increase between now and 2050.
- In the high case, by 2030 nuclear electricity production will increase by 50% from the 2018 level of 2563 TW·h, and a further increase of 50% will occur over the next 20 years. Altogether, a 2.2-fold increase over the present level is expected by 2050.
- In the low case, despite nuclear electrical generating capacity declining from the present level until 2040 and then rebounding, nuclear electricity production will increase by about 11% by 2030 and about 16% by 2050.
- The share of nuclear electricity in total electricity production in the world will decrease in the low case from about 10.2% in 2018 to 8.5% in 2030 and 6.1% in 2050. However, in the high case, its share will increase to 11.5% in 2030 and to 11.7% in 2050.

FIGURE 8. WORLD NUCLEAR ELECTRICITY PRODUCTION

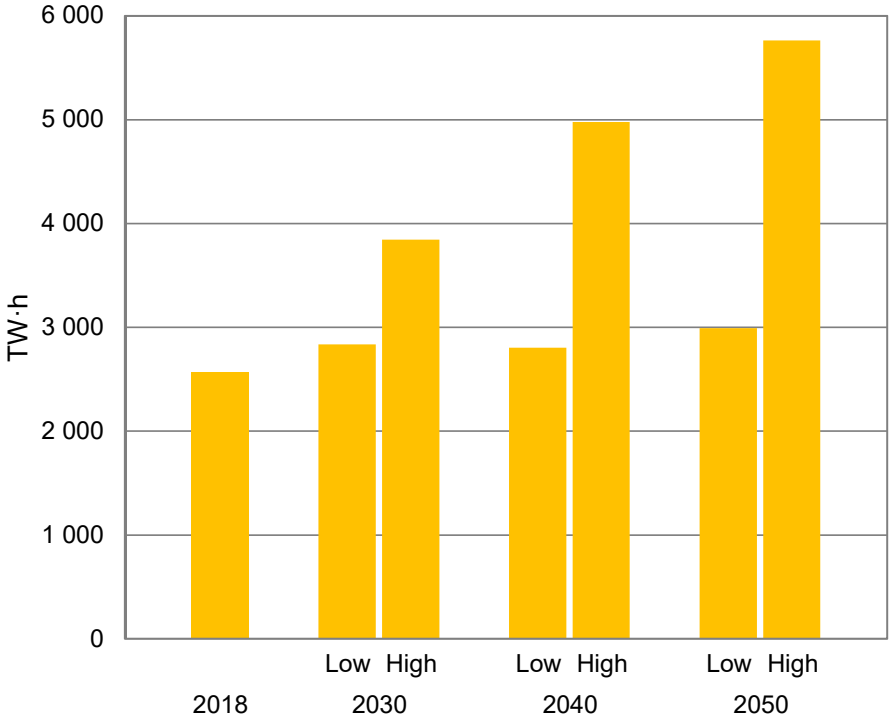


TABLE 4. WORLD TOTAL AND NUCLEAR ELECTRICAL PRODUCTION[a]

Electricity Production	2018	2030		2040		2050	
		Low	High	Low	High	Low	High
Total (TW·h)	25 196	33 538		41 101		49 032	
Nuclear (TW·h)	2 563	2 836	3 844	2 804	4 977	2 990	5 761
% of total	10.2	8.5	11.5	6.8	12.1	6.1	11.7

[a] The nuclear production data presented in this table and the nuclear electrical generating 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.

TABLE 5. WORLD NUCLEAR ELECTRICAL GENERATING CAPACITY, GW(e)

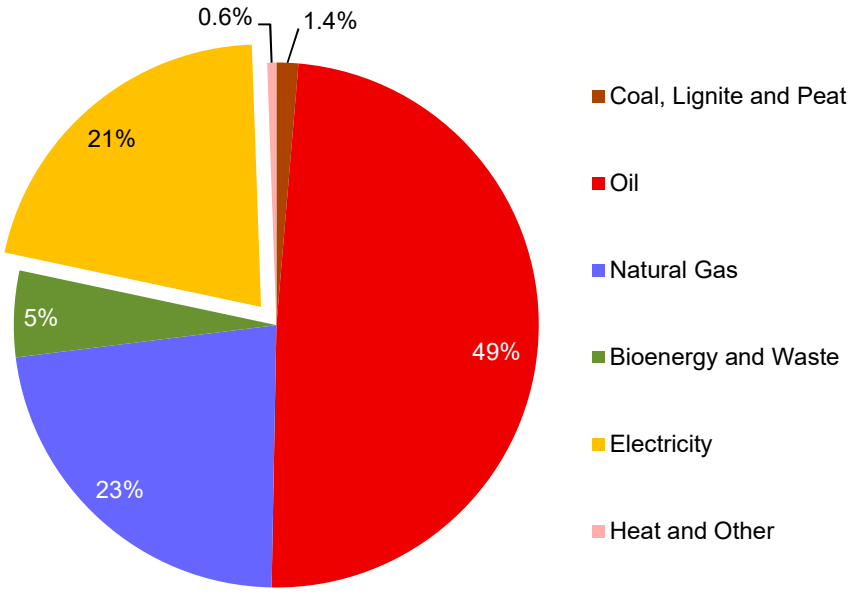
Region	2018	2030		2040		2050	
		Low	High	Low	High	Low	High
Northern America	112.6	88	111	64	109	40	113
Latin America and the Caribbean	5.1	6	8	7	14	9	19
Northern, Western and Southern Europe	110.5	75	94	50	88	42	67
Eastern Europe	51.3	52	68	52	80	55	79
Africa	1.9	3	4	3	11	7	15
Western Asia	0.4	8	9	12	19	15	24
Southern Asia	8.5	19	27	32	47	51	84
Central and Eastern Asia	106.2	115	175	132	257	149	304
South-eastern Asia				1	3	3	8
Oceania							2
World Total	**396.4**	**366**	**496**	**353**	**628**	**371**	**715**

TABLE 6. WORLD NUCLEAR ELECTRICITY PRODUCTION, TW·h

Region	2018	2030		2040		2050	
		Low	High	Low	High	Low	High
Northern America	902.4	699	880	510	868	324	909
Latin America and the Caribbean	34.5	46	62	56	112	74	155
Northern, Western and Southern Europe	728.7	589	740	401	707	335	538
Eastern Europe	353.7	408	535	420	643	442	636
Africa	10.6	23	32	27	83	60	119
Western Asia	1.9	59	71	96	146	122	190
Southern Asia	51.0	147	210	255	376	407	680
Central and Eastern Asia	480.2	865	1 314	1 031	2 018	1 202	2 453
South-eastern Asia				8	24	24	65
Oceania							16
World Total	**2 563.0**	**2 836**	**3 844**	**2 804**	**4 977**	**2 990**	**5 761**

Northern America

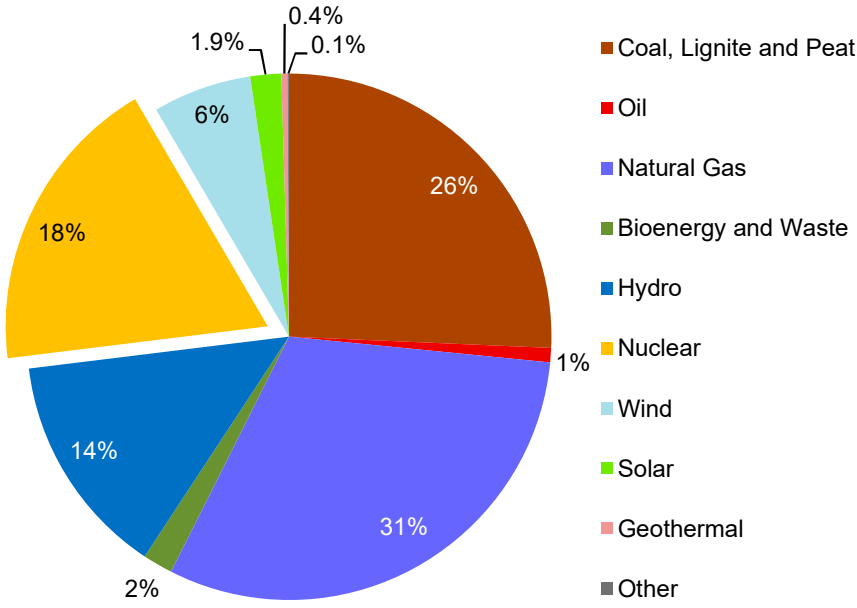
FIGURE 9. FINAL ENERGY CONSUMPTION BY ENERGY SOURCE IN THE NORTHERN AMERICA REGION IN 2018



Final Energy Consumption in 2018

Final energy consumption in the Northern America region in 2018 was dominated by the use of oil. Gas made up 23% of the total consumption, followed by electricity, accounting for 21%.

FIGURE 10. ELECTRICITY PRODUCTION BY ENERGY SOURCE IN THE NORTHERN AMERICA REGION IN 2018



Electricity Production in 2018

In the electricity production mix in 2018, gas based electricity production grew to over 30% of the total, exceeding the level of coal. Nuclear electricity remained at about 18% of the total. Hydropower and other renewables provided about 25% of the total electricity production.

Energy and Electricity Projections

- Final energy consumption in the Northern America region is expected to decrease owing to efficiency improvements and structural changes in the economy. A decrease of about 4% from the present level of 74 EJ is expected by 2030, reaching about 6% by 2050.
- In contrast, electricity consumption will continue to increase, albeit at a slow pace (0.5% growth annually).
- The share of electricity in final energy consumption will gradually increase to about 26% by the middle of the century.

FIGURE 11. FINAL CONSUMPTION OF ENERGY AND ELECTRICITY IN THE NORTHERN AMERICA REGION

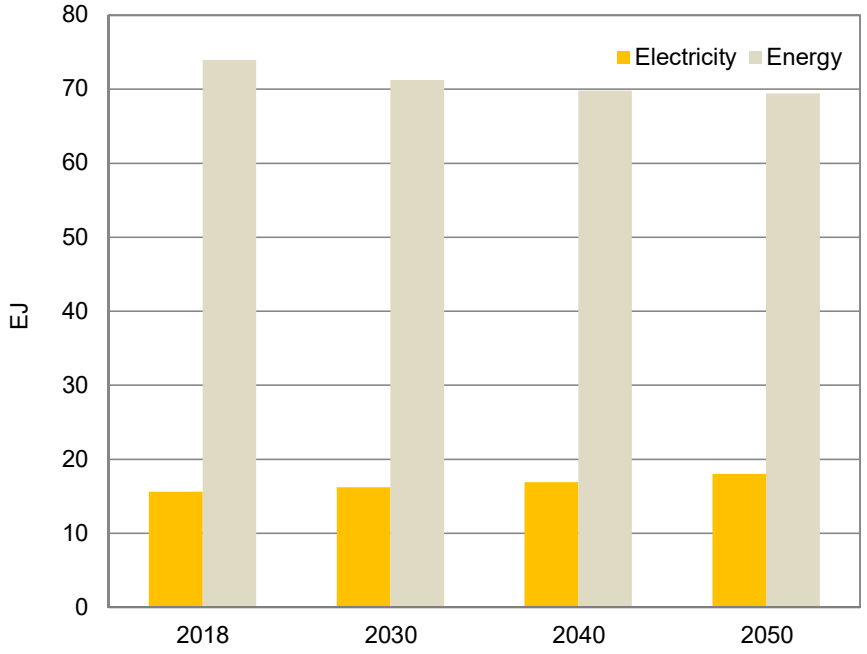


TABLE 7. FINAL CONSUMPTION[a] OF ENERGY AND ELECTRICITY IN THE NORTHERN AMERICA REGION

Final Consumption	2018	2030	2040	2050
Energy (EJ)	73.9	71.2	69.8	69.4
Electricity (EJ)	15.6	16.2	16.9	18.0
% of total	21.1	22.8	24.2	25.9

[a] Final consumption refers to all fuel and energy that is delivered to energy consumers.

Nuclear Electrical Generating Capacity Projections

- Electrical generating capacity in the Northern America region is projected to increase by 2% to reach 1391 GW(e) by 2040, and then to decrease to 1351 GW(e) by 2050.
- Nuclear electrical generating capacity is expected to change significantly in this region over the next three decades in the low case, but remain relatively stable in the high case.
- In the low case, nuclear electrical generating capacity is projected to decrease from the 2018 level of 113 GW(e) to 88 GW(e) by 2030 and then to 40 GW(e) by 2050. The share of nuclear electrical generating capacity in total electricity capacity is projected to decrease from 8.2% in 2018 to 6.4% by 2030 and to 3% by 2050.
- In the high case, nuclear electrical generating capacity is projected to remain near its current level throughout the period. It will first decrease to 111 GW(e) in 2030, then decrease to 109 GW(e) in 2040, and finally return to the 2030 level. The share of nuclear electrical generating capacity in total electricity capacity will, however, decrease from 8.2% to 7.8% in 2040 and then increase slightly to 8.3% by 2050.

FIGURE 12. NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE NORTHERN AMERICA REGION

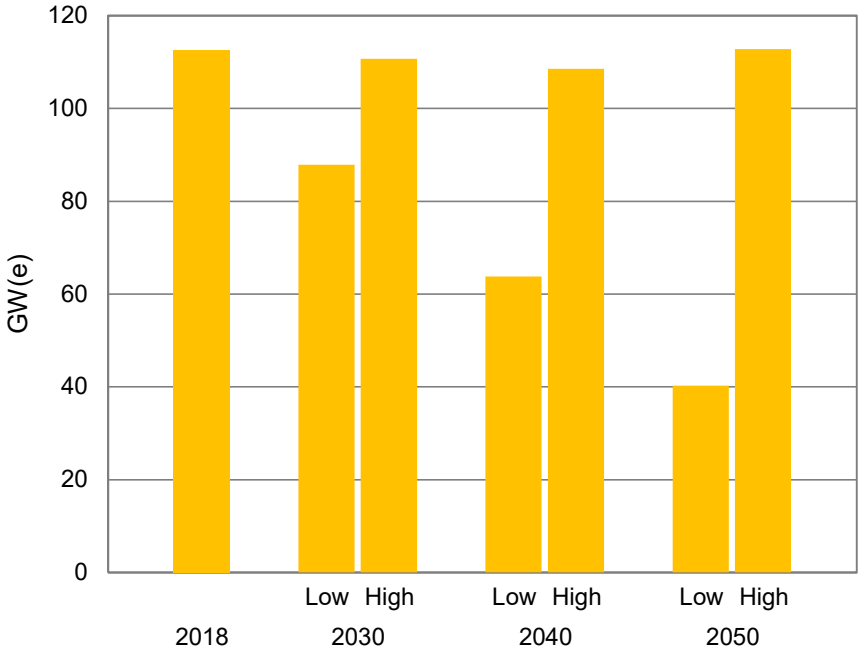


TABLE 8. TOTAL AND NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE NORTHERN AMERICA REGION

Electrical Capacity	2018	2030[a]		2040[a]		2050[a]	
		Low	High	Low	High	Low	High
Total (GW(e))	1 366	1 377		1 391		1 351	
Nuclear (GW(e))	113	88	111	64	109	40	113
% of total	8.2	6.4	8.0	4.6	7.8	3.0	8.3

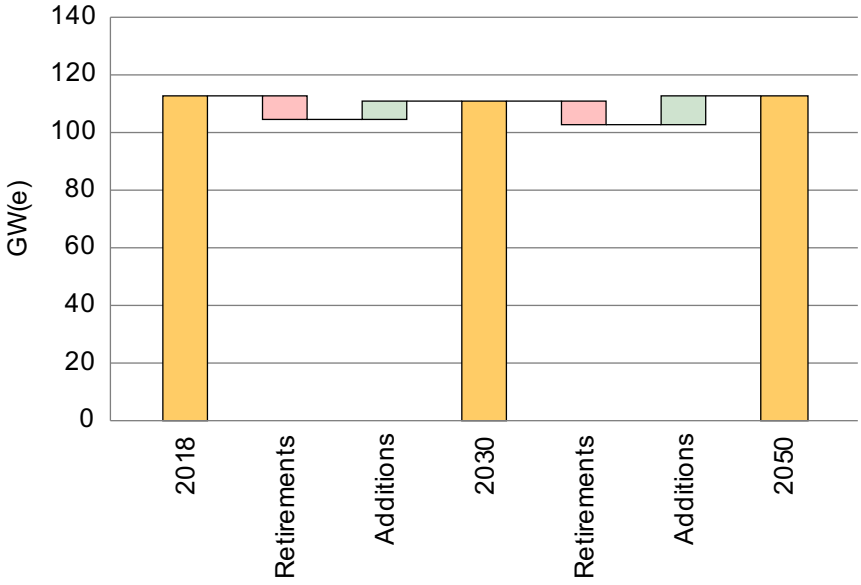
[a] Nuclear capacity estimates take into account the scheduled retirement of older units at the end of their lifetime.

Reactor Retirements and Additions

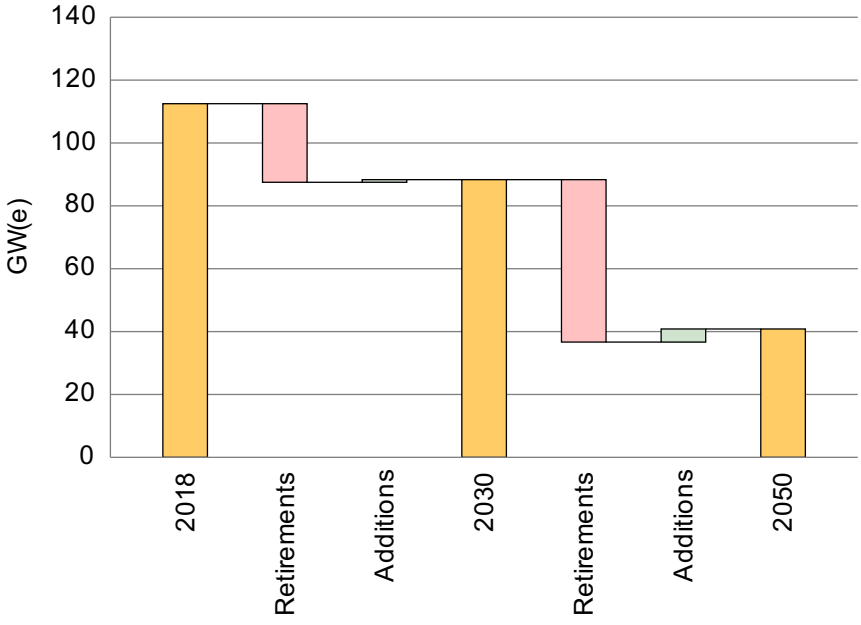
- Almost all of the existing nuclear power reactors in the Northern America region are scheduled to be retired by the middle of the century unless plant life extensions allowing operation up to 80 years are granted or approved.
- In the low case, about 25 GW(e) of nuclear electrical generating capacity will be retired by 2030. An additional 52 GW(e) of capacity will be retired between 2030 and 2050. The projected additions of nuclear electrical generating capacity, in this case, are minimal by 2030 and some 4 GW(e) by 2050.
- In the high case, most of the nuclear power reactor retirements will be delayed by plant life extensions; however, these plants will also be close to retirement by the middle of the century. The additions of nuclear electrical generating capacity, in this case, are projected to be 6 GW(e) by 2030 and some 10 GW(e) by 2050.

FIGURE 13. NUCLEAR CAPACITY IN THE NORTHERN AMERICA REGION: ACTUAL, RETIREMENTS AND ADDITIONS

HIGH CASE



LOW CASE



Electricity and Nuclear Production Projections

- The total electricity production in the Northern America region is projected to increase from 4867 TW·h in 2018 to 5121 TW·h in 2030 — an increase of about 5% over 12 years — and then to 5729 TW·h by 2050.
- The contribution of nuclear electricity is projected to undergo significant changes in both the low and the high case, but remain relatively stable in the high case.
- In the low case, nuclear electricity production is projected to decrease significantly — from 902 TW·h in 2018 to 699 TW·h in 2030 and to 324 TW·h in 2050. The share of nuclear electricity in total electricity production will thus decrease from 18.5% in 2018 to 13.6% in 2030 and to only about 6% in 2050.
- In the high case, nuclear electricity production is projected to decrease by about 4% from 902 TW·h in 2018 to 868 TW·h in 2040, and then to increase to 909 TW·h in 2050. The share of nuclear electricity production in total electricity will likewise decrease, falling from 18.5% to 17.2% in 2030 and to about 16% in 2050.

FIGURE 14. NUCLEAR ELECTRICITY PRODUCTION IN THE NORTHERN AMERICA REGION

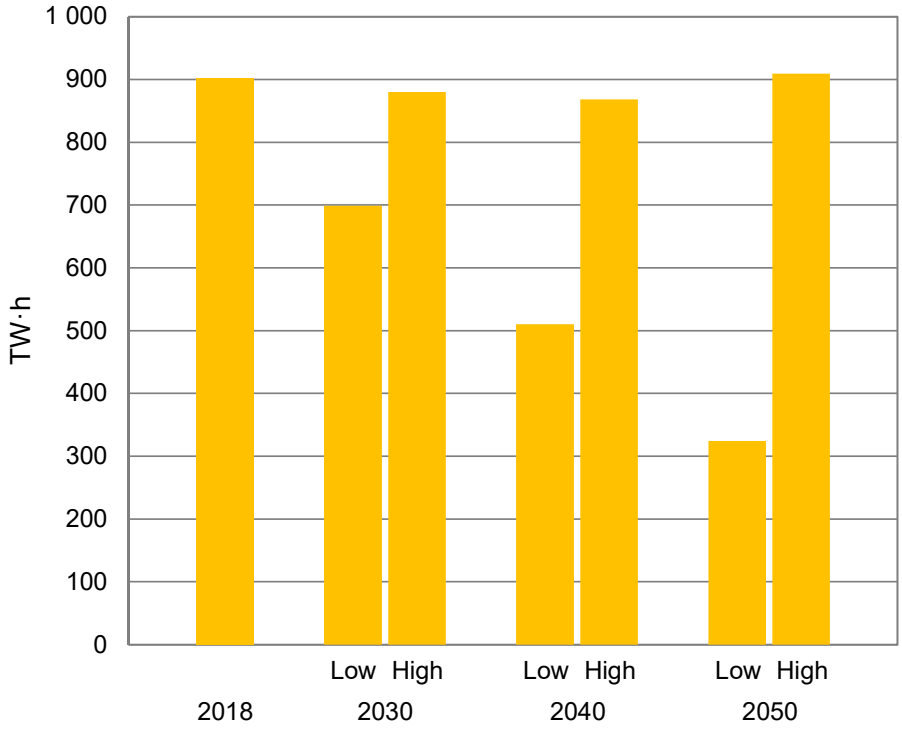


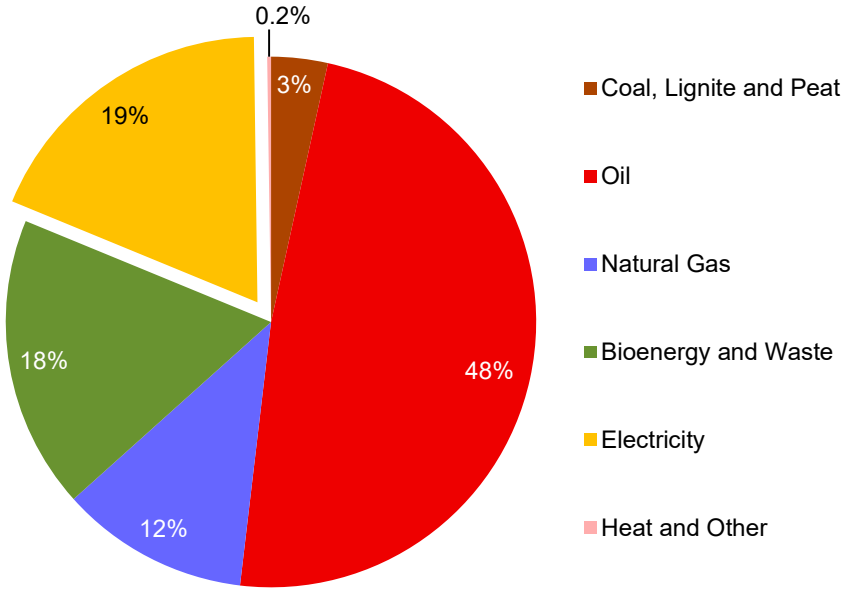
TABLE 9. TOTAL AND NUCLEAR ELECTRICAL PRODUCTION IN THE NORTHERN AMERICA REGION[a]

Electricity Production	2018	2030		2040		2050	
		Low	High	Low	High	Low	High
Total (TW·h)	4 867	5 121		5 366		5 729	
Nuclear (TW·h)	902	699	880	510	868	324	909
% of total	18.5	13.6	17.2	9.5	16.2	5.7	15.9

[a] The nuclear production data presented in this table and the nuclear electrical generating capacity data presented in Table 8 cannot be used to calculate average annual capacity factors for nuclear plants as Table 8 presents year-end capacity.

Latin America and the Caribbean

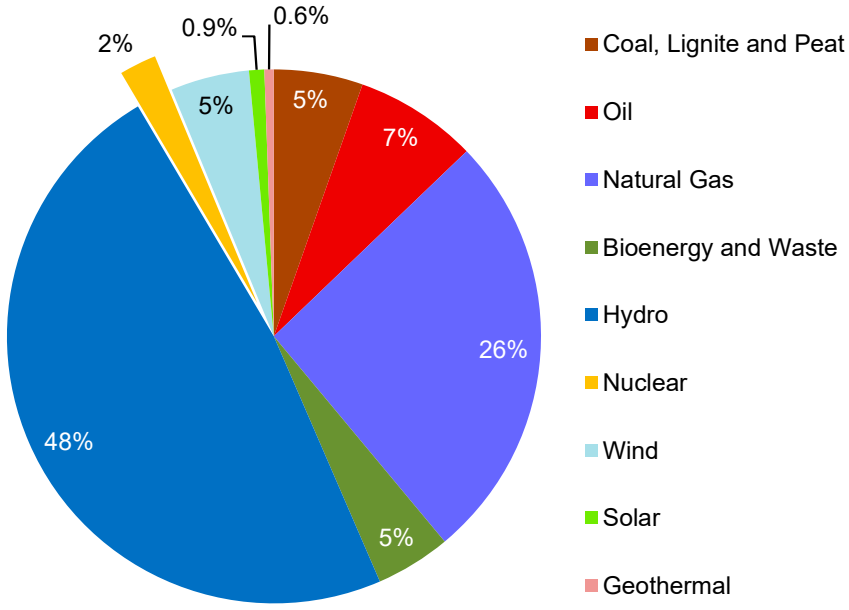
FIGURE 15. FINAL ENERGY CONSUMPTION BY ENERGY SOURCE IN THE LATIN AMERICA AND THE CARIBBEAN REGION IN 2018



Final Energy Consumption in 2018

Final energy consumption in the Latin America and the Caribbean region was dominated by oil and gas, which together accounted for over 60% of the total, with coal accounting for only 3% of the final energy consumption in 2018. Electricity use in 2018 was 19% of the total final energy consumption, while bioenergy and waste (including traditional fuels) accounted for about 18%.

FIGURE 16. ELECTRICITY PRODUCTION BY ENERGY SOURCE IN THE LATIN AMERICA AND THE CARIBBEAN REGION IN 2018



Electricity Production in 2018

Hydropower is the main source of electricity production in the Latin America and the Caribbean region, providing about 48% of the total electricity production. Fossil fuel based electricity production accounted for about 38% of the total, led by gas at 26%. Renewables and other sources contributed about 13% to the total electricity production in 2018. Nuclear electricity had only a 2% share in total electricity production in the region.

Energy and Electricity Projections

- The total final energy consumption in the Latin America and the Caribbean region is expected to increase by about 1.5% per year up to the middle of the century.
- Electricity consumption, however, will increase at a faster rate of 2.4% growth annually.
- The share of electricity in final energy consumption will increase from 18.6% in 2018 to 19.5% in 2030 and about 24.2% by the middle of the century.

FIGURE 17. FINAL CONSUMPTION OF ENERGY AND ELECTRICITY IN THE LATIN AMERICA AND THE CARIBBEAN REGION

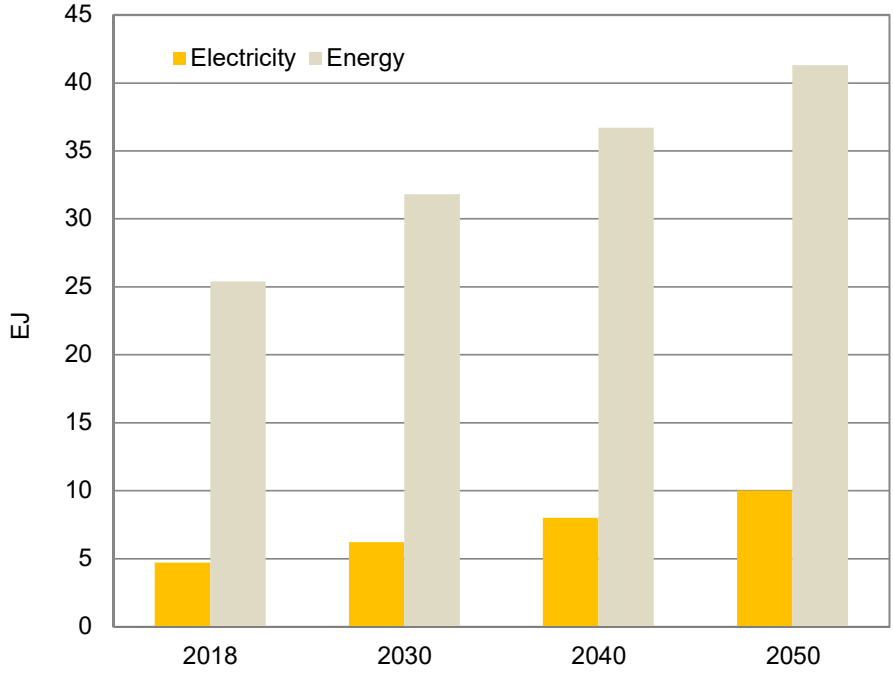


TABLE 10. FINAL CONSUMPTION[a] OF ENERGY AND ELECTRICITY IN THE LATIN AMERICA AND THE CARIBBEAN REGION

Final Consumption	2018	2030	2040	2050
Energy (EJ)	25.4	31.8	36.7	41.3
Electricity (EJ)	4.7	6.2	8.0	10.0
% of total	18.6	19.5	21.8	24.2

[a] Final consumption refers to all fuel and energy that is delivered to energy consumers.

Nuclear Electrical Generating Capacity Projections

- Electrical generating capacity in the Latin America and the Caribbean region is projected to increase by 34% by 2030, reaching 571 GW(e), and to almost double by 2050.
- Nuclear electrical generating capacity is projected to increase in both the low and the high cases, but the role of nuclear electricity will remain small.
- In the low case, nuclear electrical generating capacity is projected to increase from 5 GW(e) in 2018 to 6 GW(e) by 2030 and to 9 GW(e) by 2050. The share of nuclear in the total electrical generating capacity is projected to decrease slightly from 1.2% to 1.1% by 2050.
- In contrast, in the high case, nuclear electrical generating capacity is projected to increase to 8 GW(e) in 2030 and to 19 GW(e) in 2050. The share of nuclear electrical generating capacity in total electrical capacity will thus increase to 1.4% in 2030 and to 2.3% in 2050.

FIGURE 18. NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE LATIN AMERICA AND THE CARIBBEAN REGION

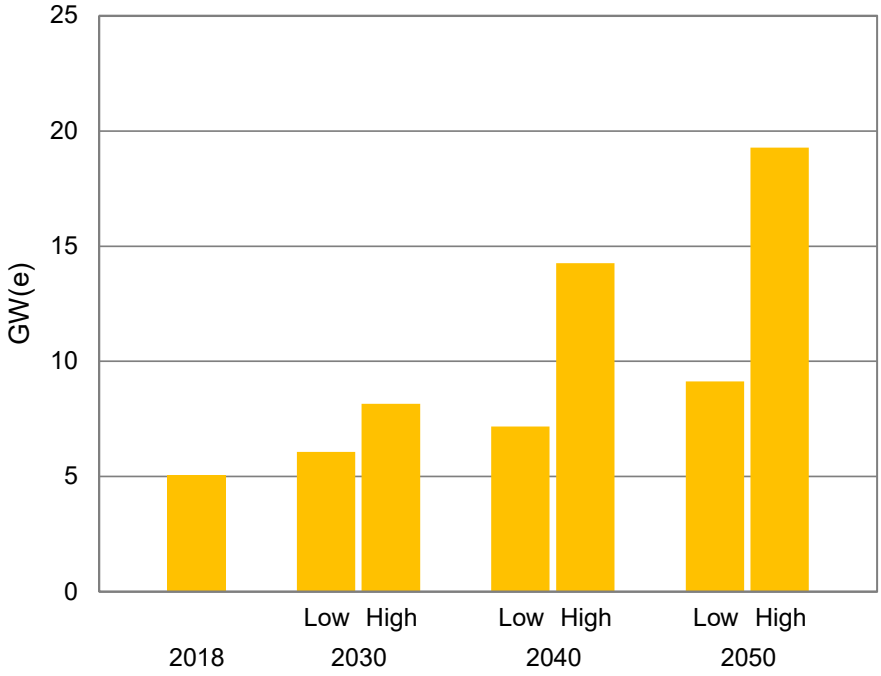


TABLE 11. TOTAL AND NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE LATIN AMERICA AND THE CARIBBEAN REGION

Electrical Capacity	2018	2030[a]		2040[a]		2050[a]	
		Low	High	Low	High	Low	High
Total (GW(e))	427	571		717		847	
Nuclear (GW(e))	5	6	8	7	14	9	19
% of total	1.2	1.1	1.4	1.0	2.0	1.1	2.3

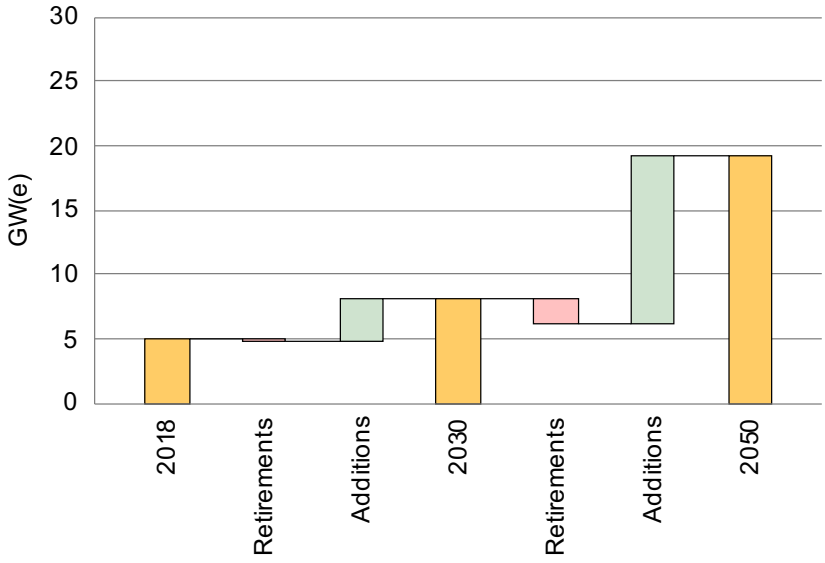
[a] Nuclear capacity estimates take into account the scheduled retirement of older units at the end of their lifetime.

Reactor Retirements and Additions

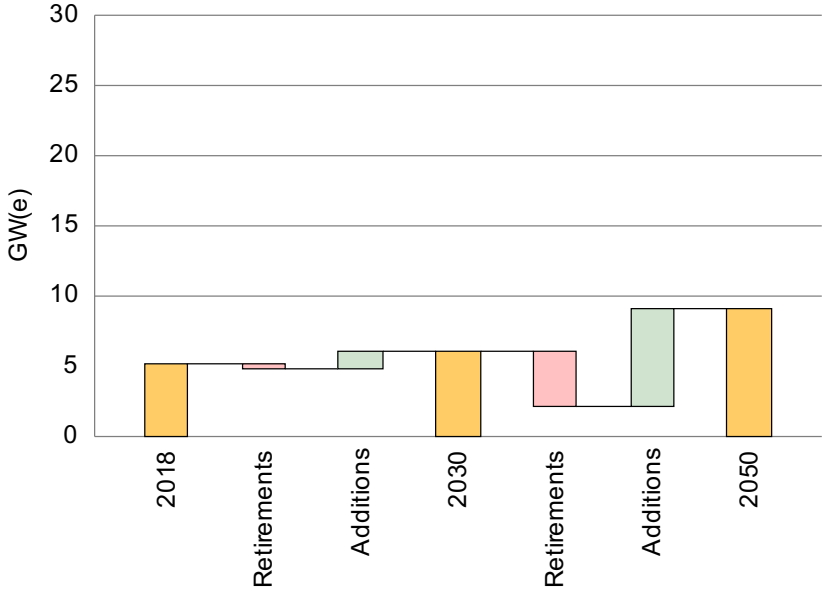
- There are seven nuclear power reactors operating in the Latin America and the Caribbean region. All but one were constructed before 2001 and are scheduled to be retired by the middle of the century.
- In the low case, 4.4 GW(e) of the existing nuclear electrical generating capacity will be retired by 2050. In the high case, retirement of some of the nuclear power reactors will be delayed by plant life extensions, and about half the existing nuclear capacity will be retired.
- The projected additions of nuclear electrical generating capacity in the high case are 3.4 GW(e) by 2030 and an additional 13 GW(e) by 2050. In the low case, only 8 GW(e) of additional capacity is projected for the entire period.

FIGURE 19. NUCLEAR CAPACITY IN THE LATIN AMERICA AND THE CARIBBEAN REGION: ACTUAL, RETIREMENTS AND ADDITIONS

HIGH CASE



LOW CASE



Electricity and Nuclear Production Projections

- Total electricity production in the Latin America and the Caribbean region is projected to increase by around 2.4% per year.
- Nuclear electricity production is projected to increase in both the low and the high cases, but its role will remain small in the coming decades.
- In the low case, nuclear electricity production will double in the next 32 years to reach 74 TW·h in 2050. The share of nuclear electricity in total electricity production will remain at about 2.2%.
- In the high case, nuclear electricity production will almost double by 2030 to reach 62 TW·h, and with a further doubling by 2050. The share of nuclear electricity in total electricity production will therefore increase from 2.2% in 2018 to 2.9% in 2030 and to 4.7% in 2050.

FIGURE 20. NUCLEAR ELECTRICITY PRODUCTION IN THE LATIN AMERICA AND THE CARIBBEAN REGION

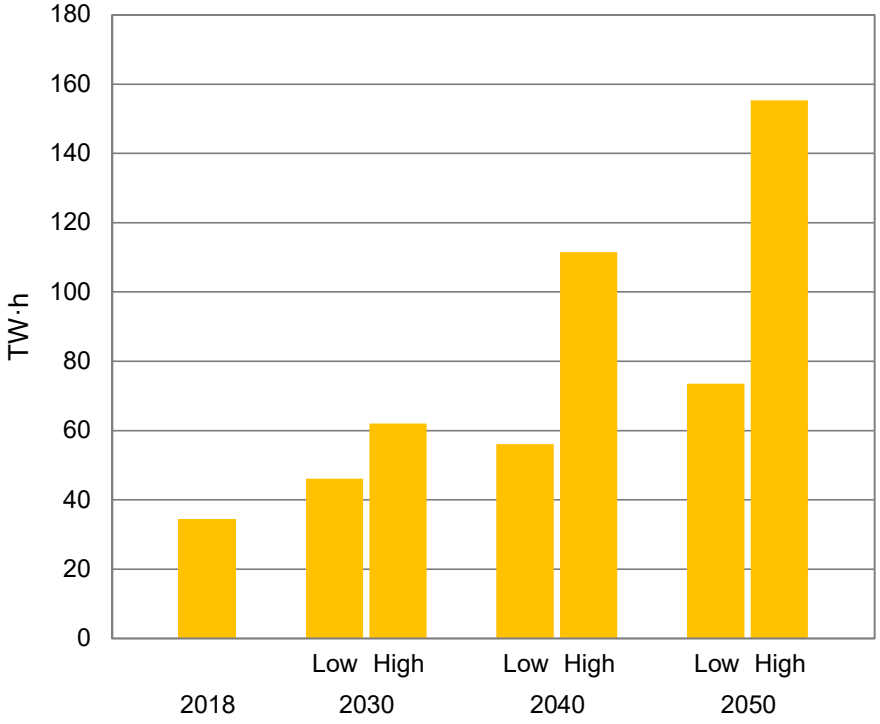


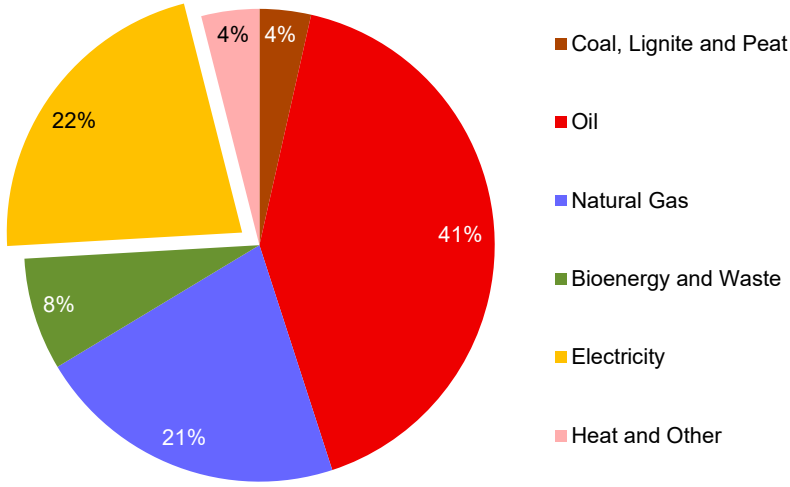
TABLE 12. TOTAL AND NUCLEAR ELECTRICAL PRODUCTION IN THE LATIN AMERICA AND THE CARIBBEAN REGION[a]

Electricity Production	2018	2030		2040		2050	
		Low	High	Low	High	Low	High
Total (TW·h)	1 565	2 122		2 715		3 326	
Nuclear (TW·h)	35	46	62	56	112	74	155
% of total	2.2	2.2	2.9	1.9	4.8	2.2	4.7

[a] The nuclear production data presented in this table and the nuclear electrical generating capacity data presented in Table 11 cannot be used to calculate average annual capacity factors for nuclear plants as Table 11 presents year-end capacity.

Northern, Western and Southern Europe

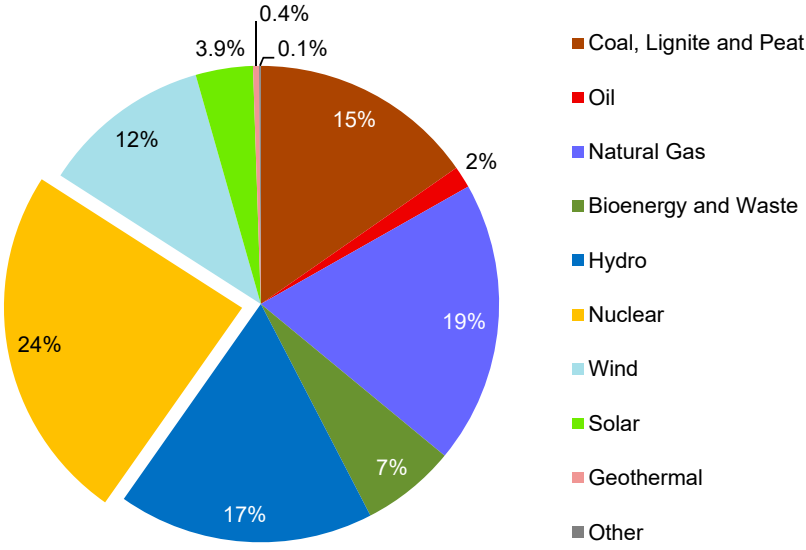
FIGURE 21. FINAL ENERGY CONSUMPTION BY ENERGY SOURCE IN THE COMBINED REGIONS OF NORTHERN, WESTERN AND SOUTHERN EUROPE IN 2018



Final Energy Consumption in 2018

Final energy consumption in the combined regions of Northern, Western and Southern Europe continued to be dominated by fossil fuels in 2018. Electricity provided 22% of the total final energy consumed.

FIGURE 22. ELECTRICITY PRODUCTION BY ENERGY SOURCE IN THE COMBINED REGIONS OF NORTHERN, WESTERN AND SOUTHERN EUROPE IN 2018



Electricity Production in 2018

The electricity production mix in the combined regions of Northern, Western and Southern Europe was very diverse in 2018. Nuclear electricity contributed about a quarter of the total production in this region, while hydropower, other renewables and other sources provided about a third of the total.

Energy and Electricity Projections

- Total final energy consumption in the combined regions of Northern, Western and Southern Europe is expected to decrease as a result of efficiency improvements and structural changes in the economy. Decreases of about 7% and about 15% from the present level of 45 EJ are expected by 2030 and by 2050, respectively.
- Electricity consumption will initially remain almost the same but will increase after 2030, with a 14% increase expected between 2030 and 2050.
- The share of electricity in final energy consumption will thus increase from 21.9% in 2018 to 24.5% by 2030 and to 30.5% by 2050.

FIGURE 23. FINAL CONSUMPTION OF ENERGY AND ELECTRICITY IN THE COMBINED REGIONS OF NORTHERN, WESTERN AND SOUTHERN EUROPE

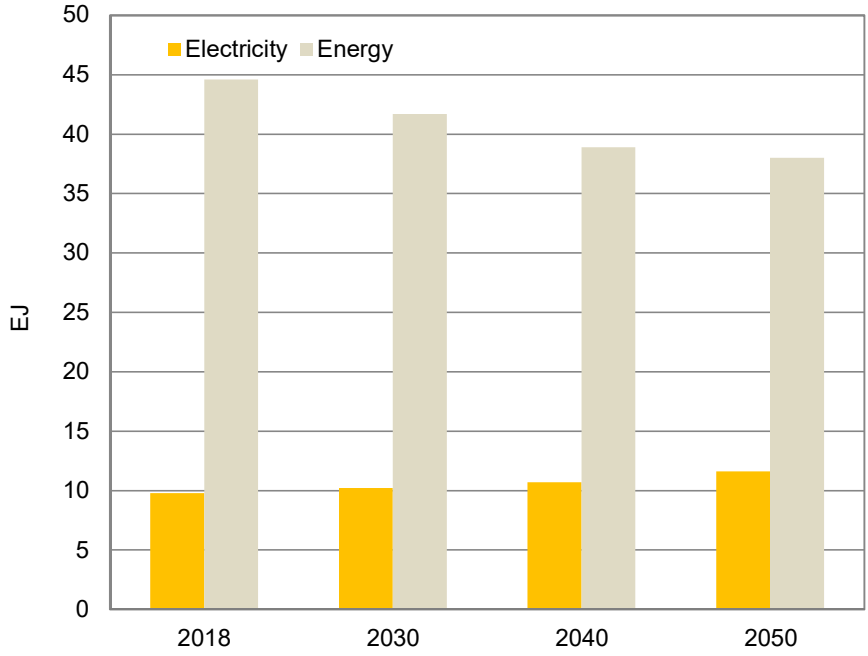


TABLE 13. FINAL CONSUMPTION[a] OF ENERGY AND ELECTRICITY IN THE COMBINED REGIONS OF NORTHERN, WESTERN AND SOUTHERN EUROPE

Final Consumption	2018	2030	2040	2050
Energy (EJ)	44.7	41.7	38.9	38.0
Electricity (EJ)	9.8	10.2	10.7	11.6
% of total	21.9	24.5	27.5	30.5

[a] Final consumption refers to all fuel and energy that is delivered to energy consumers.

Nuclear Electrical Generating Capacity Projections

- Total electrical generating capacity in the combined regions of Northern, Western and Southern Europe is projected to increase by 16% by 2030 and by a further 13% to reach 1290 GW(e) by 2050.
- Several countries in these regions have announced a phaseout of nuclear power. The regions' nuclear power capacity will therefore change significantly in the coming years.
- In the low case, nuclear electrical generating capacity is projected to decrease by 32% by 2030 and by a further 44% by 2050. The share of nuclear power capacity in total electricity capacity will thus decrease from 11.2% in 2018 to 6.5% by 2030 and to 3.2% by 2050.
- In the high case, the nuclear electrical generating capacity is projected to decrease to 94 GW(e) by 2030 and to 67 GW(e) in 2050. The share of nuclear power capacity in the total electricity production capacity will therefore decrease from 11.2% in 2018 to 8.2% in 2030 and to 5.2% in 2050.

FIGURE 24. NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE COMBINED REGIONS OF NORTHERN, WESTERN AND SOUTHERN EUROPE

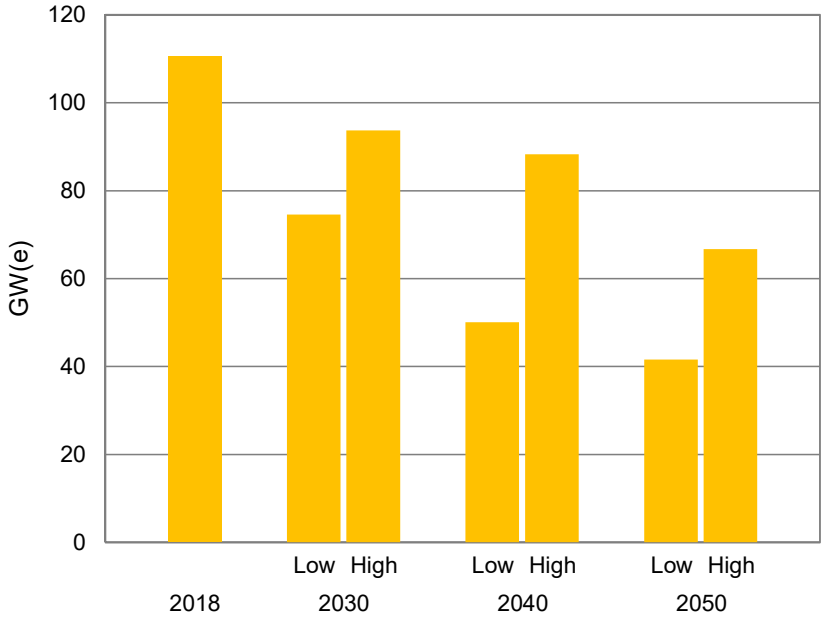


TABLE 14. TOTAL AND NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE COMBINED REGIONS OF NORTHERN, WESTERN AND SOUTHERN EUROPE

Electrical Capacity	2018	2030[a]		2040[a]		2050[a]	
		Low	High	Low	High	Low	High
Total (GW(e))	989	1 144		1 198		1 290	
Nuclear (GW(e))	111	75	94	50	88	42	67
% of total	11.2	6.5	8.2	4.2	7.4	3.2	5.2

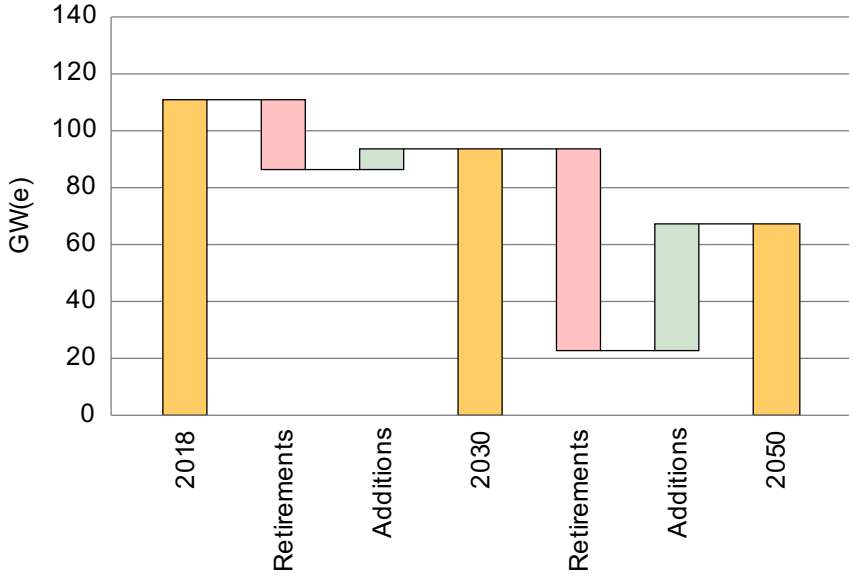
[a] Nuclear capacity estimates take into account the scheduled retirement of older units at the end of their lifetime.

Reactor Retirements and Additions

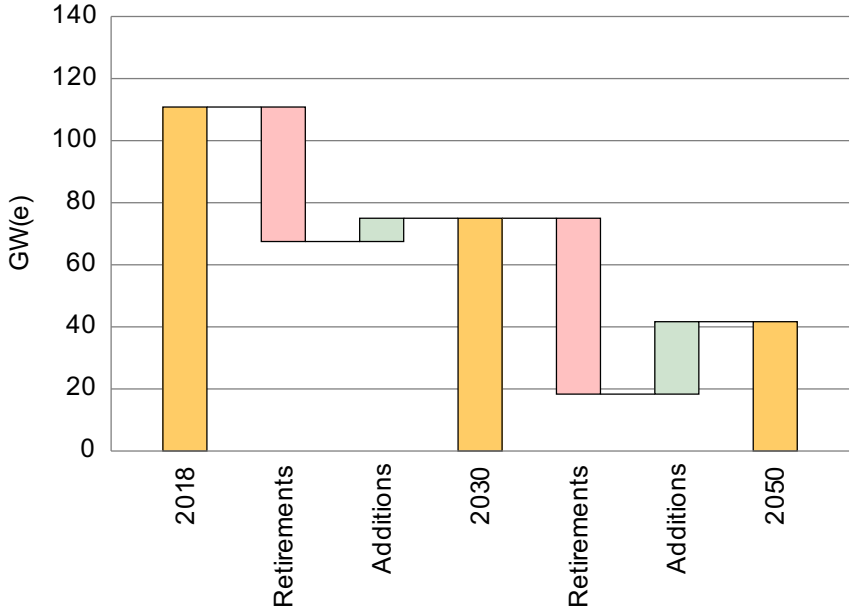
- Almost all of the existing nuclear power reactors in the combined regions of Northern, Western and Southern Europe are scheduled to be retired by the middle of the century.
- In the low case, about 44 GW(e) of nuclear electrical generating capacity will be retired by 2030 and an additional 57 GW(e) of capacity will be retired between 2030 and 2050. The projected additions of nuclear capacity in this case are only 8 GW(e) by 2030 and some 24 GW(e) by 2050.
- In the high case, nuclear power reactor retirements will be delayed; the majority of the reactors will be retired between 2030 and 2050. The additions of nuclear capacity in this case are projected to be 8 GW(e) by 2030 and an additional some 44 GW(e) by 2050.

FIGURE 25. NUCLEAR CAPACITY IN THE COMBINED REGIONS OF NORTHERN, WESTERN AND SOUTHERN EUROPE: ACTUAL, RETIREMENTS AND ADDITIONS

HIGH CASE



LOW CASE



Electricity and Nuclear Production Projections

- Total electricity production in the combined regions of Northern, Western and Southern Europe is projected to increase from 3013 TW·h in 2018 to 3167 TW·h in 2030 — an increase of about 5% over 12 years — with an additional increase of 12% to reach 3556 TW·h by 2050.
- In the low case, nuclear electricity production will decrease significantly from 729 TW·h in 2018 to 589 TW·h in 2030 and to 335 TW·h in 2050. The share of nuclear electricity in the total will thus decrease from 24.2% in 2018 to 18.6% by 2030 and to 9.4% by 2050.
- In the high case, nuclear electricity production is projected first to increase by about 1.5% by 2030, and then to decrease significantly by 27% between 2030 and 2050. The share of nuclear electricity in total electricity production will decrease to reach 15.1% by 2050.

FIGURE 26. NUCLEAR ELECTRICITY PRODUCTION IN THE COMBINED REGIONS OF NORTHERN, WESTERN AND SOUTHERN EUROPE

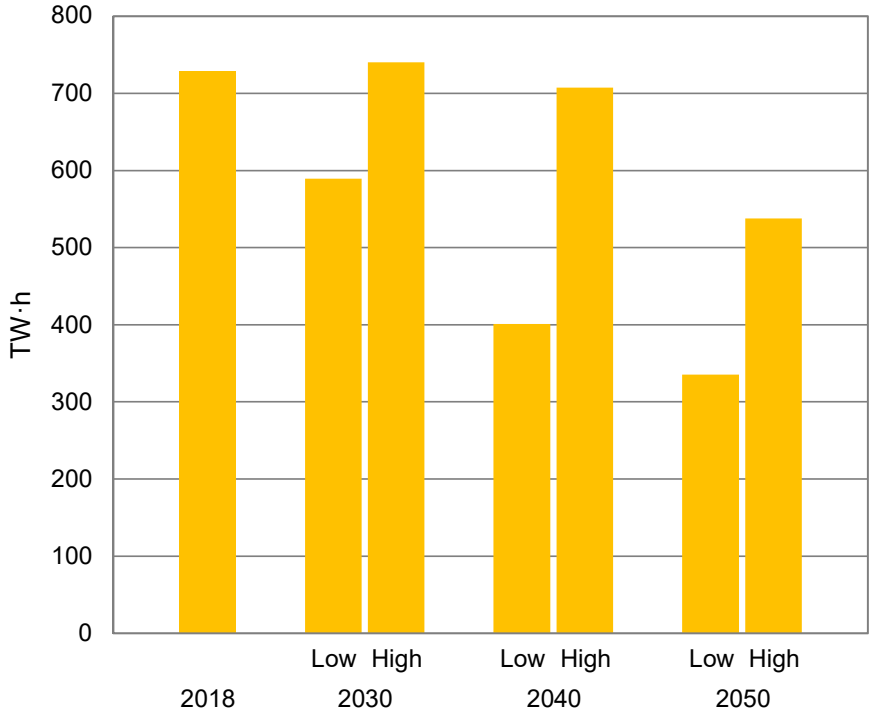


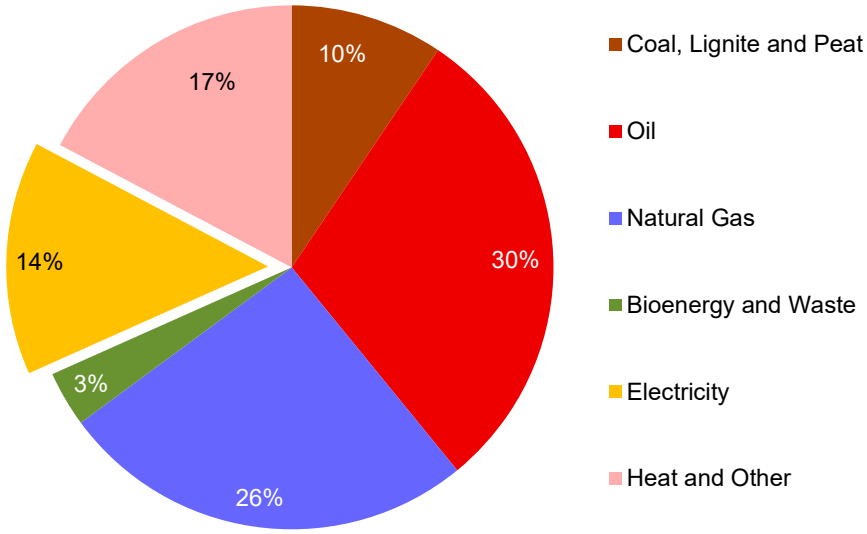
TABLE 15. TOTAL AND NUCLEAR ELECTRICAL PRODUCTION IN THE COMBINED REGIONS OF NORTHERN, WESTERN AND SOUTHERN EUROPE[a]

Electricity Production	2018	2030		2040		2050	
		Low	High	Low	High	Low	High
Total (TW·h)	3 013	3 167		3 338		3 556	
Nuclear (TW·h)	729	589	740	401	707	335	538
% of total	24.2	18.6	23.4	12.0	21.2	9.4	15.1

[a]The nuclear production data presented in this table and the nuclear electrical generating capacity data presented in Table 14 cannot be used to calculate average annual capacity factors for nuclear plants as Table 14 presents year-end capacity.

Eastern Europe

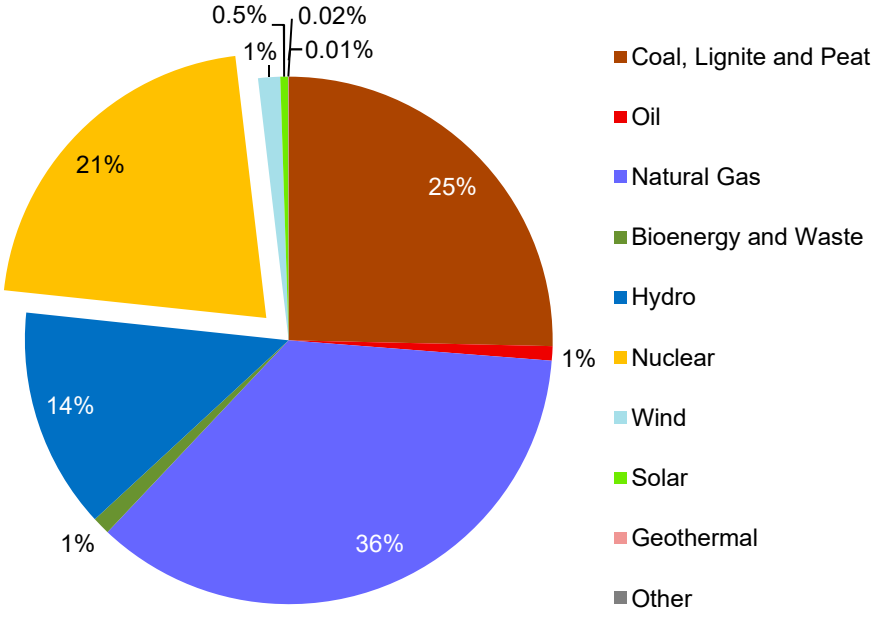
FIGURE 27. FINAL ENERGY CONSUMPTION BY ENERGY SOURCE IN THE EASTERN EUROPE REGION IN 2018



Final Energy Consumption in 2018

Final energy consumption in the Eastern Europe region in 2018 was based on a diverse mix of fuels: oil (30%), gas (26%), coal (10%), electricity (14%), heat and other sources (17%).

FIGURE 28. ELECTRICITY PRODUCTION BY ENERGY SOURCE IN THE EASTERN EUROPE REGION IN 2018



Electricity Production in 2018

Nuclear electricity production is very significant in this region, accounting for 21% of total electricity production in 2018. Nonetheless, fossil fuel based generation accounted for more than 60% of the total electricity production (gas (36%), coal (25%) and oil (1%)). Hydropower accounted for 14%, and other renewables and other sources provided about 2% of the total electricity production.

Energy and Electricity Projections

- The final energy consumption in the Eastern Europe region is expected to increase by 1% in the next 12 years, with an additional 11% increase in the subsequent 20 years to 2050. Throughout the period, the average annual growth rate will only be 0.4%.
- Electricity consumption will increase much faster, with a 22% increase between 2018 and 2030, and an additional 47% increase in the subsequent 20 years.
- The share of electricity in final energy consumption will thus increase from 14.4% in 2018 to 17.6% in 2030 and to about 23.5% by the middle of the century.

FIGURE 29. FINAL CONSUMPTION OF ENERGY AND ELECTRICITY IN THE EASTERN EUROPE REGION

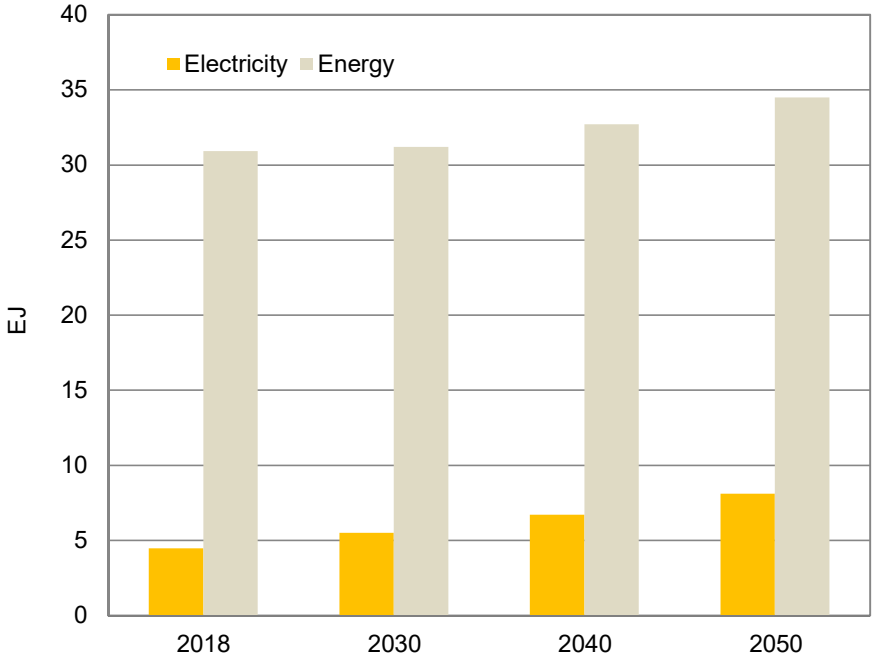


TABLE 16. FINAL CONSUMPTION[a] OF ENERGY AND ELECTRICITY IN THE EASTERN EUROPE REGION

Final Consumption	2018	2030	2040	2050
Energy (EJ)	30.9	31.2	32.7	34.5
Electricity (EJ)	4.5	5.5	6.7	8.1
% of total	14.4	17.6	20.5	23.5

[a] Final consumption refers to all fuel and energy that is delivered to energy consumers.

Nuclear Electrical Generating Capacity Projections

- Electrical generating capacity in the Eastern Europe region is projected to increase significantly, by about 9% by 2030 and by an additional 31% in the subsequent 20 years.
- Nuclear electrical generating capacity is also projected to increase in both the low and the high cases.
- In the low case, nuclear electrical generating capacity is projected to grow slowly, from 51 GW(e) in 2018 to 52 GW(e) in 2030, and to 55 GW(e) by 2050. The share of nuclear capacity in the total electrical generating capacity declines from 11.2% to 8.4% over the period in this case.
- In the high case, the nuclear electrical generating capacity is projected to increase at a faster rate — from 51 GW(e) in 2018 to 68 GW(e) by 2030, and to 79 GW(e) by 2050. The share of nuclear capacity in the total electrical generating capacity will therefore increase from 11.2% in 2018 to 13.7% in 2030 before falling to 12.1% in 2050.

FIGURE 30. NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE EASTERN EUROPE REGION

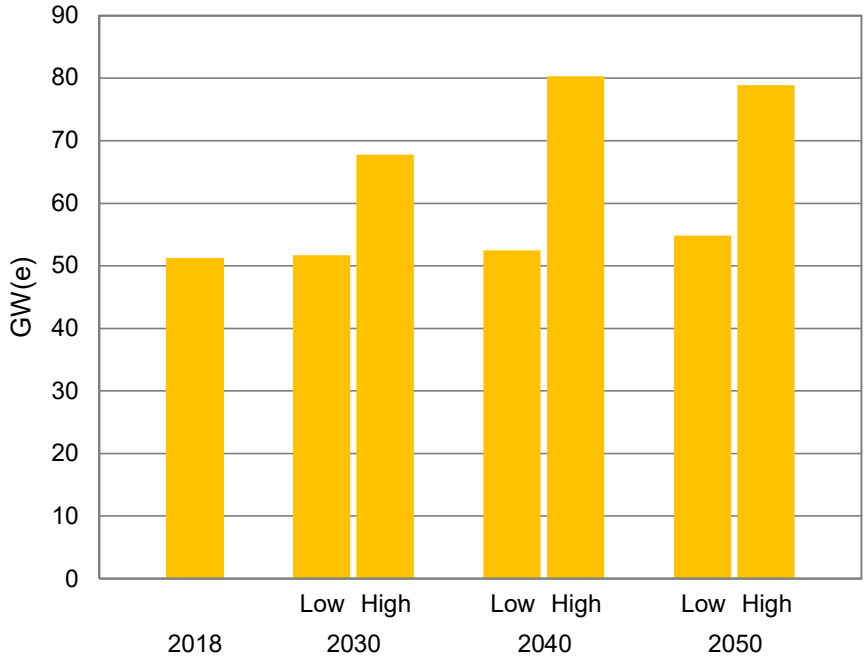


TABLE 17. TOTAL AND NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE EASTERN EUROPE REGION

Electrical Capacity	2018	2030[a]		2040[a]		2050[a]	
		Low	High	Low	High	Low	High
Total (GW(e))	456	496		580		652	
Nuclear (GW(e))	51	52	68	52	80	55	79
% of total	11.2	10.4	13.7	9.0	13.8	8.4	12.1

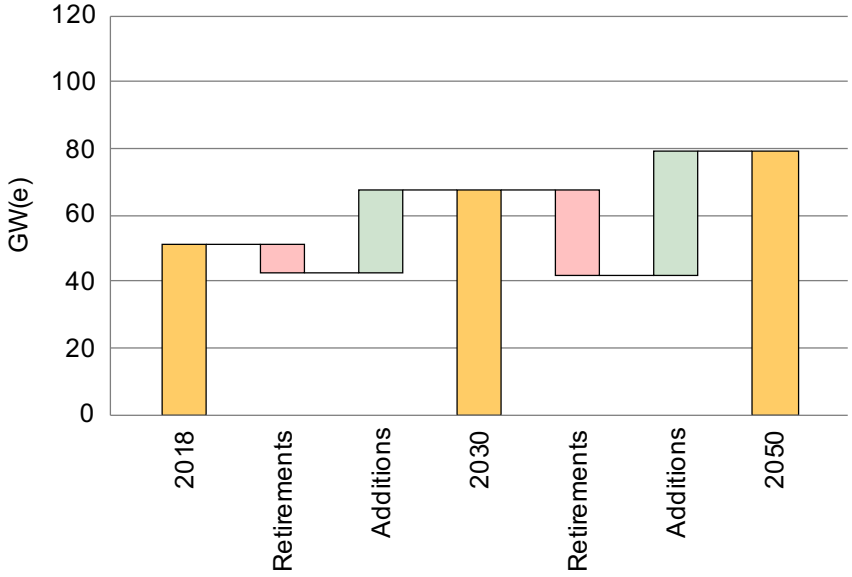
[a] Nuclear capacity estimates take into account the scheduled retirement of older units at the end of their lifetime.

Reactor Retirements and Additions

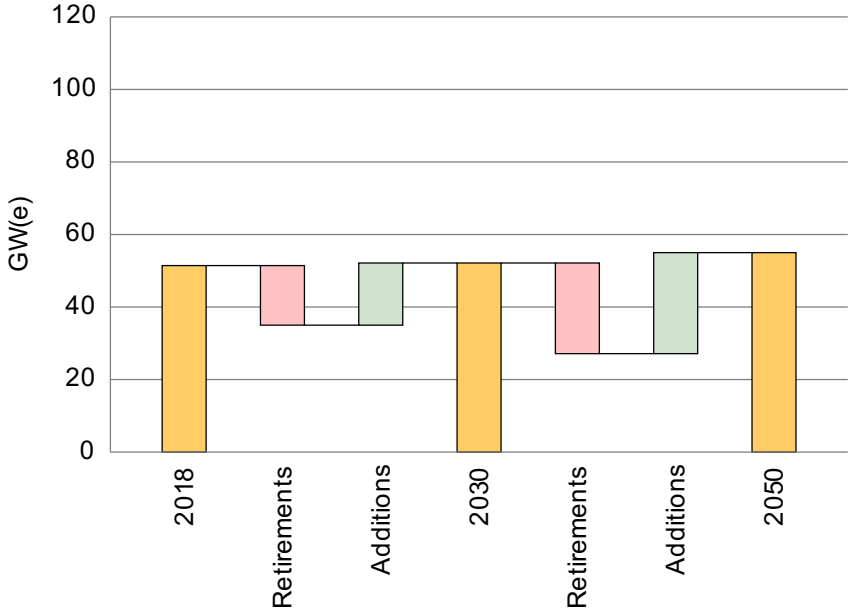
- The majority of the existing nuclear power reactors in the Eastern Europe region are scheduled to be retired by the middle of the century.
- In the low case, about 16 GW(e) of nuclear electrical generating capacity will be retired by 2030 and another 25 GW(e) of capacity will be retired between 2030 and 2050. The projected additions in this case will compensate for the retirements between 2018 and 2030; thereafter, nuclear capacity will increase, with the addition of about 34 GW(e) of nuclear power capacity by 2050.
- In the high case, nuclear power reactor retirements will be delayed. Only 9 GW(e) of nuclear capacity will be retired by 2030, but about 26 GW(e) will be retired between 2030 and 2050. The additions of nuclear capacity in this case are projected to be 25 GW(e) by 2030 and some 37 GW(e) by 2050.

FIGURE 31. NUCLEAR CAPACITY IN THE EASTERN EUROPE REGION: ACTUAL, RETIREMENTS AND ADDITIONS

HIGH CASE



LOW CASE



Electricity and Nuclear Production Projections

- Total electricity production in the Eastern Europe region is expected to grow substantially by the middle of the century, with an annual growth rate of 1.8%.
- Nuclear electricity production is also projected to continue to grow in both the low and the high cases, albeit at different rates.
- In the low case, nuclear electricity production is projected to increase moderately from 354 TW·h in 2018 to 408 TW·h in 2030 and then at a relatively slower rate, reaching 442 TW·h in 2050. The share of nuclear electricity in total electricity production will, however, decrease from 21.6% in 2018 to 20% in 2030 and to 15.4% in 2050.
- In the high case, nuclear electricity production is projected to increase much faster, with a 51% increase by 2030 and a further 19% increase between 2030 and 2050. The share of nuclear electricity in total electricity production will increase from 21.6% in 2018 to 26.2% in 2030, but will decrease to 22.2% in 2050.

FIGURE 32. NUCLEAR ELECTRICITY PRODUCTION IN THE EASTERN EUROPE REGION

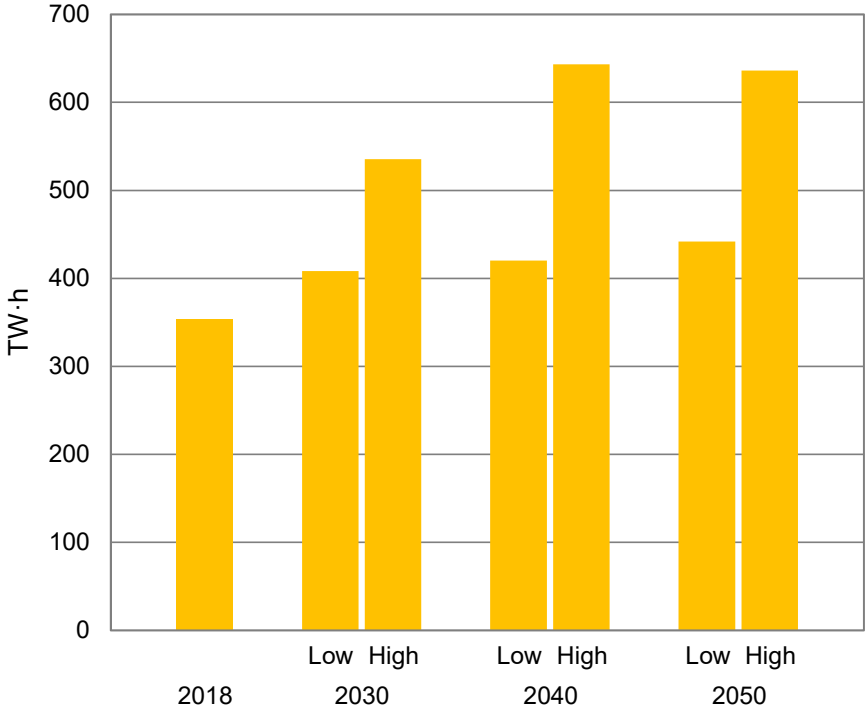


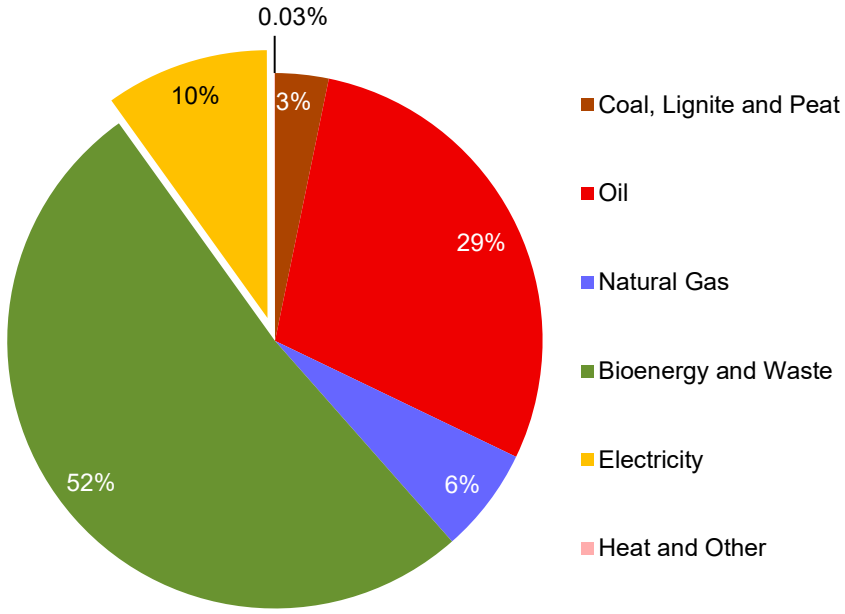
TABLE 18. TOTAL AND NUCLEAR ELECTRICAL PRODUCTION IN THE EASTERN EUROPE REGION[a]

Electricity Production	2018	2030		2040		2050	
		Low	High	Low	High	Low	High
Total (TW·h)	1 634	2 046		2 451		2 864	
Nuclear (TW·h)	354	408	535	420	643	442	636
% of total	21.6	20.0	26.2	17.1	26.2	15.4	22.2

[a] The nuclear production data presented in this table and the nuclear electrical generating capacity data presented in Table 17 cannot be used to calculate average annual capacity factors for nuclear plants as Table 17 presents year-end capacity.

Africa

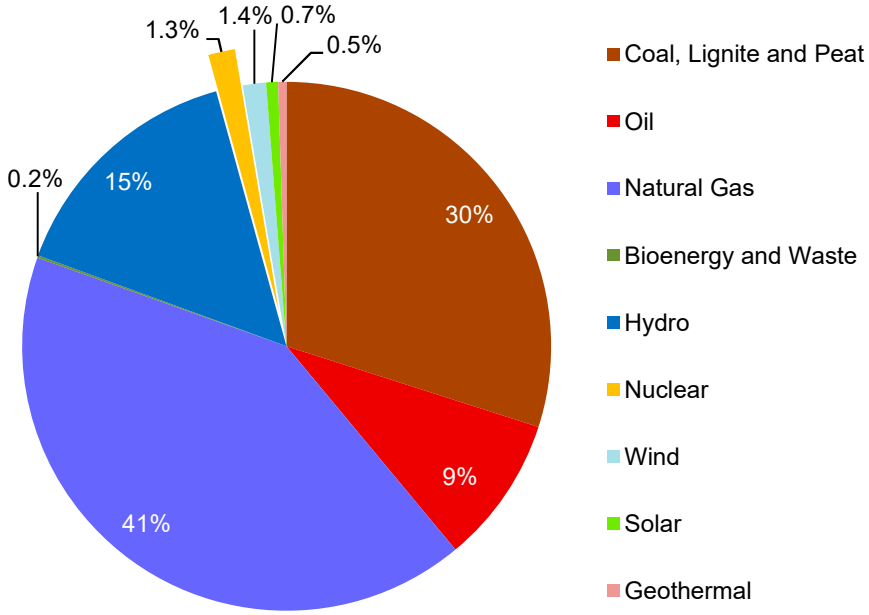
FIGURE 33. FINAL ENERGY CONSUMPTION BY ENERGY SOURCE IN THE AFRICA REGION IN 2018



Final Energy Consumption in 2018

Final energy consumption in the Africa region in 2018 was dominated by the use of bioenergy and waste (inluding traditional fuels); electricity accounted for only 10% of the total final energy consumption.

FIGURE 34. ELECTRICITY PRODUCTION BY ENERGY SOURCE IN THE AFRICA REGION IN 2018



Electricity Production in 2018

About 80% of electricity production in 2018 was based on fossil fuels (gas (41%), coal (30%) and oil (9%)). Hydropower provided 15% of the total, while other renewables contributed about 3%. Only one country in this region uses nuclear power. Nuclear generated electricity accounted for 1.3% of total electricity production for the region.

Energy and Electricity Projections

- Final energy consumption in the Africa region is expected to initially increase by about 2% per year and then to grow by 2.4% per year.
- Electricity consumption is expected to grow at a faster rate — about 4.5% per year during the entire period. It is expected to increase from 2.4 EJ in 2018 to 4.0 EJ and 9.8 EJ by 2030 and 2050, respectively.
- The share of electricity in final energy consumption will thus increase from 9.9% in 2018 to 13.0% in 2030 and to 19.8% by the middle of the century.

FIGURE 35. FINAL CONSUMPTION OF ENERGY AND ELECTRICITY IN THE AFRICA REGION

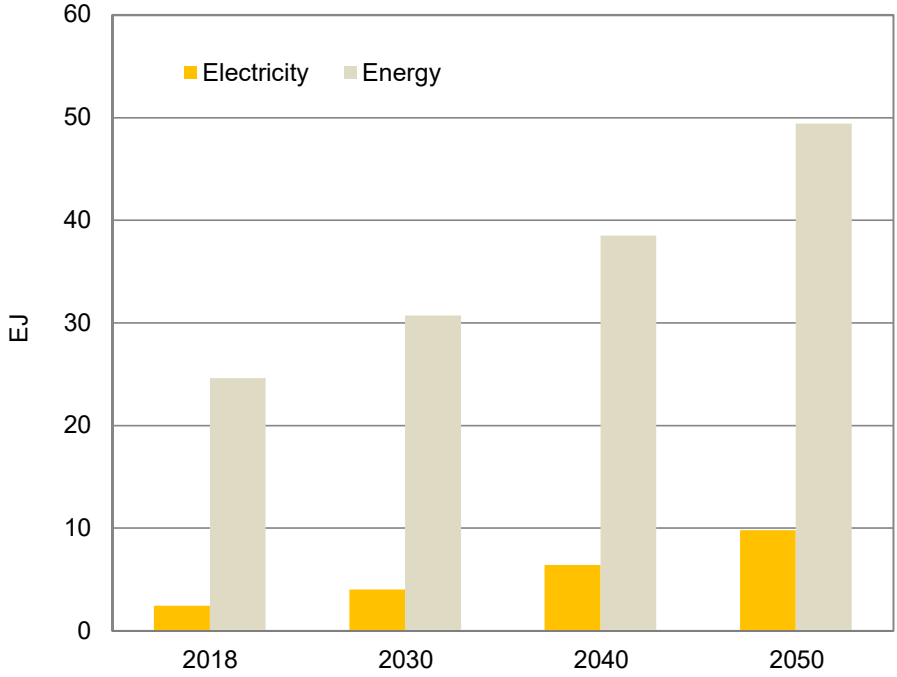


TABLE 19. FINAL CONSUMPTION[a] OF ENERGY AND ELECTRICITY IN THE AFRICA REGION

Final Consumption	2018	2030	2040	2050
Energy (EJ)	24.6	30.7	38.5	49.4
Electricity (EJ)	2.4	4.0	6.4	9.8
% of total	9.9	13.0	16.6	19.8

[a] Final consumption refers to all fuel and energy that is delivered to energy consumers.

Per Capita Energy and Electricity

- The region's final energy consumption on a per capita basis is not expected to increase by 2030 owing to continued population growth. However, between 2030 and 2050, there will be a some increase in per capita energy consumption.
- Electricity consumption on a per capita basis is expected to increase significantly, with a 34% increase in the next 12 years, from 0.6 MW·h per person in 2018 to 0.8 MW·h per person in 2030, and a further 53% increase to reach 1.2 MW·h per person in 2050.

FIGURE 36. PER CAPITA ELECTRICITY PRODUCTION IN THE AFRICA REGION

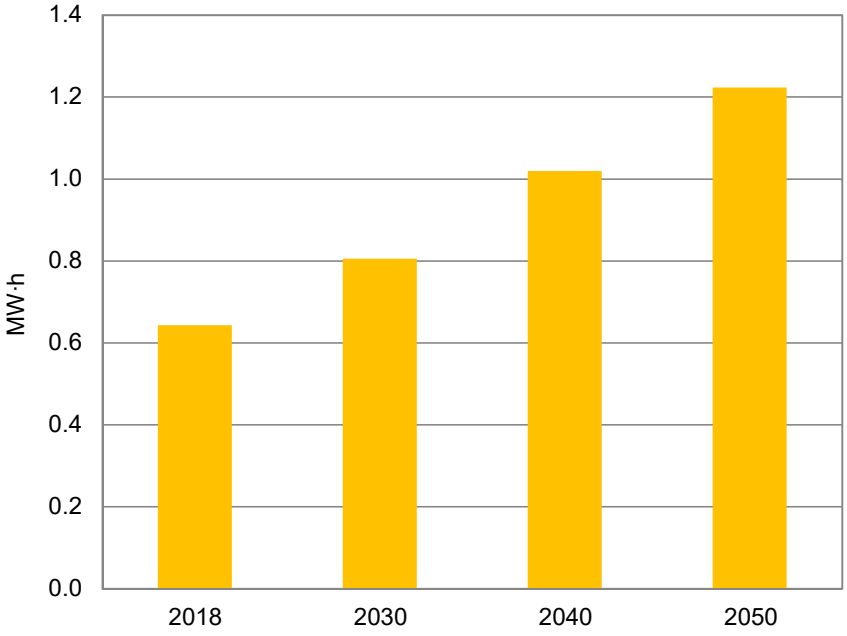
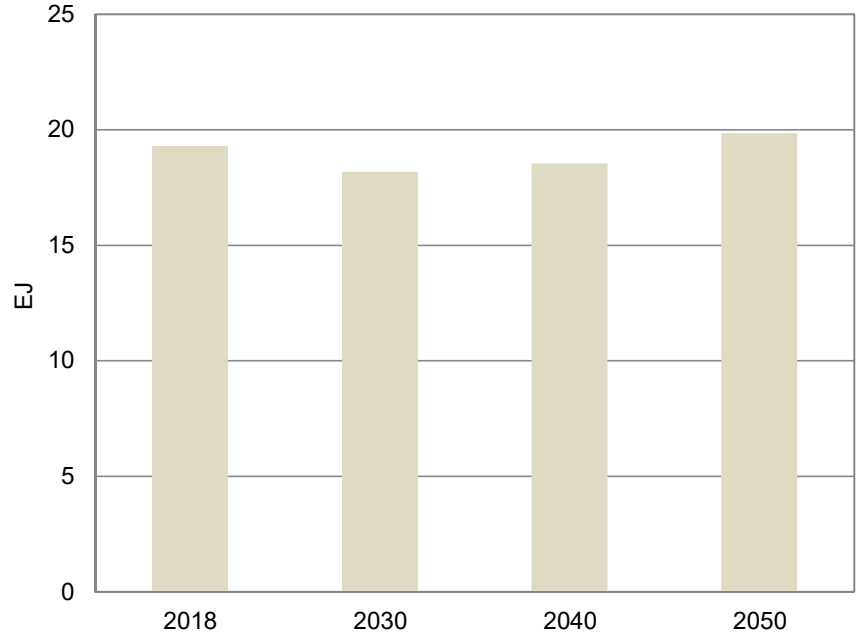


FIGURE 37. PER CAPITA FINAL ENERGY CONSUMPTION IN THE AFRICA REGION



Nuclear Electrical Generating Capacity Projections

- Electrical generating capacity in the Africa region is expected to increase substantially, from 229 GW(e) in 2018 to 359 GW(e) by 2030 and to 770 GW(e) by 2050.
- The development of nuclear power is expected to face significant uncertainty.
- In the low case, nuclear electrical generating capacity is projected to increase from the present level of 2 GW(e) to 3 GW(e) by 2030 and then to 7 GW(e) by 2050. The share of nuclear electrical generating capacity in the total electrical generating capacity is thus projected to increase slowly from 0.8% in 2018 to 1.0% in 2050.
- In the high case, nuclear electrical generating capacity is projected to increase to 4 GW(e) by 2030 and then to 15 GW(e) by 2050. The share of nuclear electrical generating capacity in total electrical capacity is expected to reach about 1.9% by 2050.

FIGURE 38. NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE AFRICA REGION

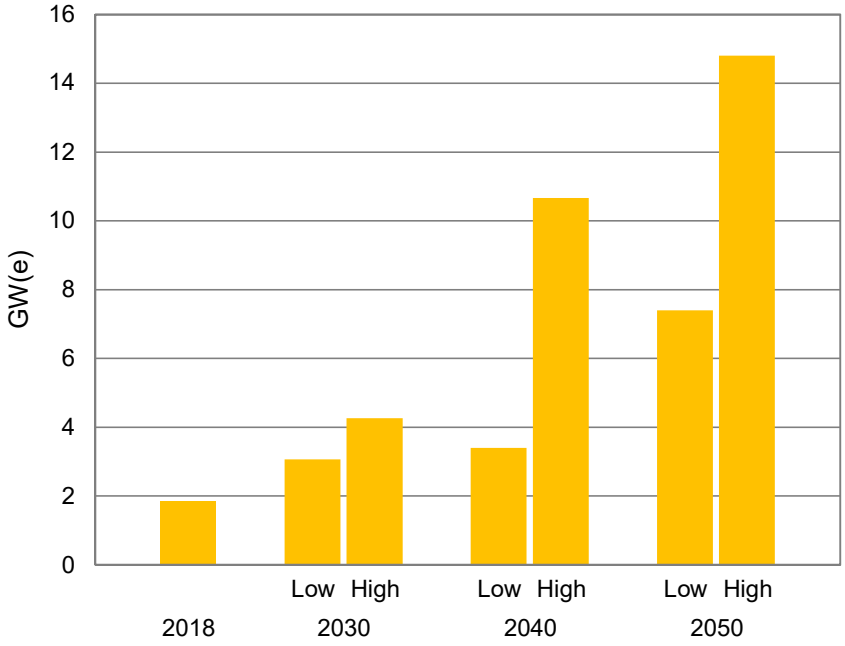


TABLE 20. TOTAL AND NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE AFRICA REGION

Electrical Capacity	2018	2030[a]		2040[a]		2050[a]	
		Low	High	Low	High	Low	High
Total (GW(e))	229	359		556		770	
Nuclear (GW(e))	2	3	4	3	11	7	15
% of total	0.8	0.9	1.2	0.8	1.9	1.0	1.9

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

Electricity and Nuclear Production Projections

- Total electricity production in the Africa region is expected to significantly increase by 2030 and then grow further, at an even faster rate, reaching 3045 TW·h by 2050.
- Nuclear electricity production is projected to follow the nuclear electrical generating capacity trends.
- In the low case, nuclear electricity production is projected to increase to 23 TW·h by 2030 and then to 60 TW·h by 2050. The share of nuclear electricity in total electricity production will increase from 1.3% in 2018 to 1.7% in 2030 and then to 2.0% in 2050.
- In the high case, nuclear electricity production is projected to first increase by about 200%, growing from 11 TW·h in 2018 to 32 TW·h by 2030, and then to increase substantially, reaching 119 TW·h by 2050. The share of nuclear electricity in total electricity production will increase from 1.3% in 2018 to 2.3% in 2030 and then to about 4% in 2050.

FIGURE 39. ELECTRICITY PRODUCTION BY NUCLEAR POWER IN THE AFRICA REGION

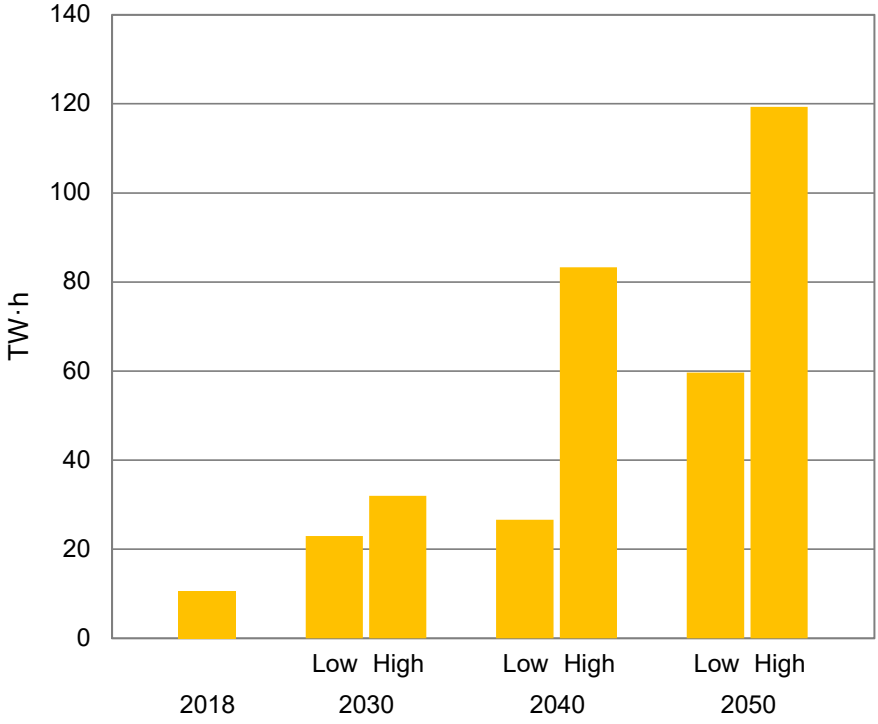


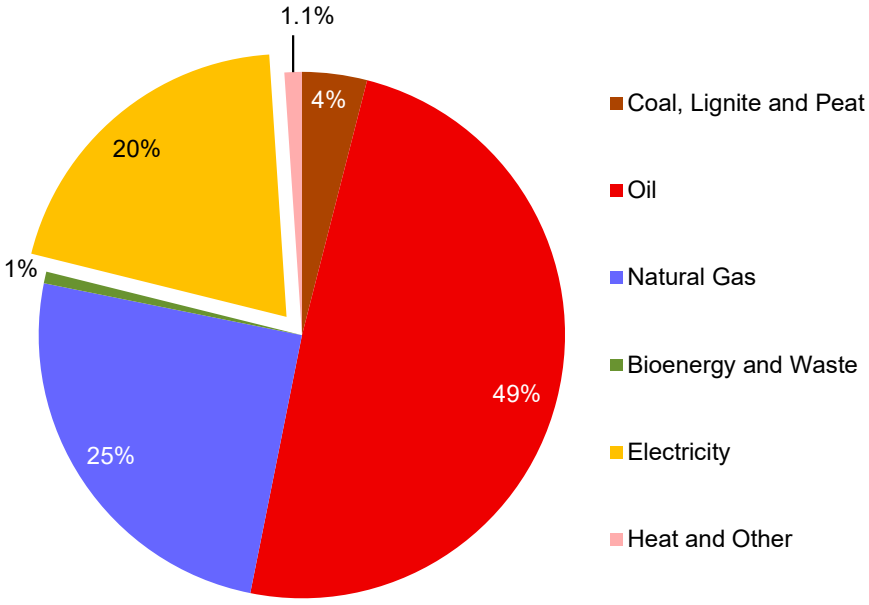
TABLE 21. TOTAL AND NUCLEAR ELECTRICAL PRODUCTION IN THE AFRICA REGION[a]

Electricity Production	2018	2030		2040		2050	
		Low	High	Low	High	Low	High
Total (TW·h)	820	1 360		2 117		3 045	
Nuclear (TW·h)	11	23	32	27	83	60	119
% of total	1.3	1.7	2.3	1.3	3.9	2.0	3.9

[a] The nuclear production data presented in this table and the nuclear electrical generating capacity data presented in Table 20 cannot be used to calculate average annual capacity factors for nuclear plants as Table 20 presents year-end capacity.

Western Asia

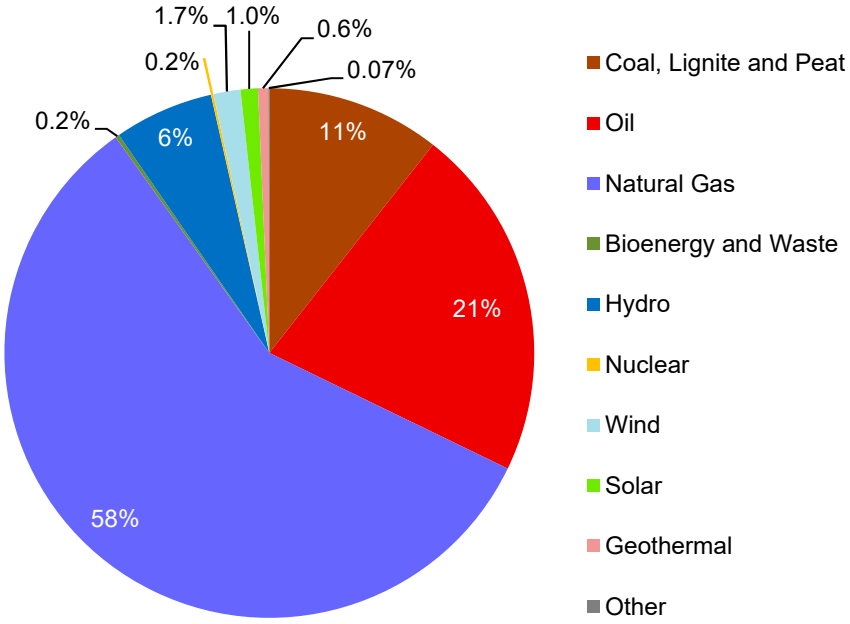
FIGURE 40. FINAL ENERGY CONSUMPTION BY ENERGY SOURCE IN THE WESTERN ASIA REGION IN 2018



Final Energy Consumption in 2018

Around three quarters of the final energy consumed in the Western Asia region in 2018 was in the form of oil and gas. Electricity accounted for 20% of the total energy consumption.

FIGURE 41. ELECTRICITY PRODUCTION BY ENERGY SOURCE IN THE WESTERN ASIA REGION IN 2018



Electricity Production in 2018

The electricity production mix in the Western Asia region in 2018 was dominated by gas (58%), followed by oil (21%) and coal (11%). Hydropower and other renewables contributed about 9.5%. Nuclear electricity accounted for only 0.2% of total electricity production in the region.

Energy and Electricity Projections

- Final energy consumption in the Western Asia region is expected to increase by about 1.7% per year during the entire period.
- Electricity consumption, however, is expected to increase by about 2.3% per year over the entire period — by 2.1% per year between 2018 to 2030 and by 2.4% per year over the subsequent 20 years.
- Consequently, the share of electricity in final energy consumption will increase from 20.1% in 2018 to 20.8% by 2030 and to 24.3% by the middle of the century.

FIGURE 42. FINAL CONSUMPTION OF ENERGY AND ELECTRICITY IN THE WESTERN ASIA REGION

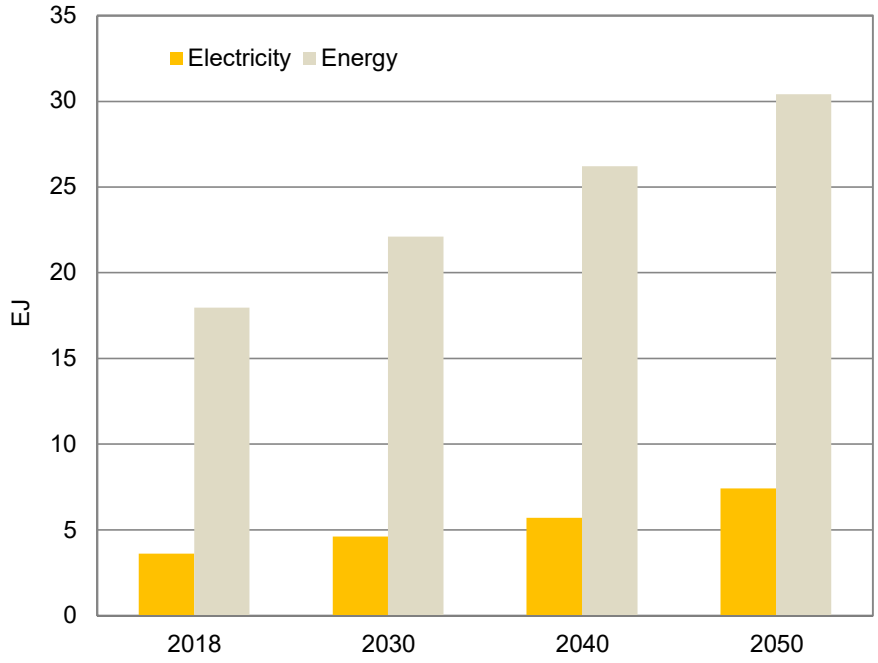


TABLE 22. FINAL CONSUMPTION[a] OF ENERGY AND ELECTRICITY IN THE WESTERN ASIA REGION

Final Consumption	2018	2030	2040	2050
Energy (EJ)	18.0	22.1	26.2	30.4
Electricity (EJ)	3.6	4.6	5.7	7.4
% of total	20.1	20.8	21.8	24.3

[a] Final consumption refers to all fuel and energy that is delivered to energy consumers.

Nuclear Electrical Generating Capacity Projections

- Electrical generating capacity in the Western Asia region is projected to increase by 33% to reach 456 GW(e) by 2030, from 343 GW(e) in 2018, and then by a father 53% to reach 696 GW(e) by 2050.
- Although there currently is only one nuclear power reactor operating in this region, more nuclear electrical generating capacity is projected in the coming years.
- In the low case, the nuclear electrical generating capacity is projected to be 8 GW(e) in 2030 and 15 GW(e) by 2050. The share of nuclear electrical generating capacity in the total electrical capacity will thus increase from 0.1% to 1.7% by 2030 and to about 2.2% by 2050.
- In the high case, the nuclear electrical generating capacity is projected to increase to 9 GW(e) in 2030 and to about 24 GW(e) in 2050. The share of nuclear electrical generating capacity in total electricity capacity will reach 2.1% in 2030 and about 3.4% in 2050.

FIGURE 43. NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE WESTERN ASIA REGION

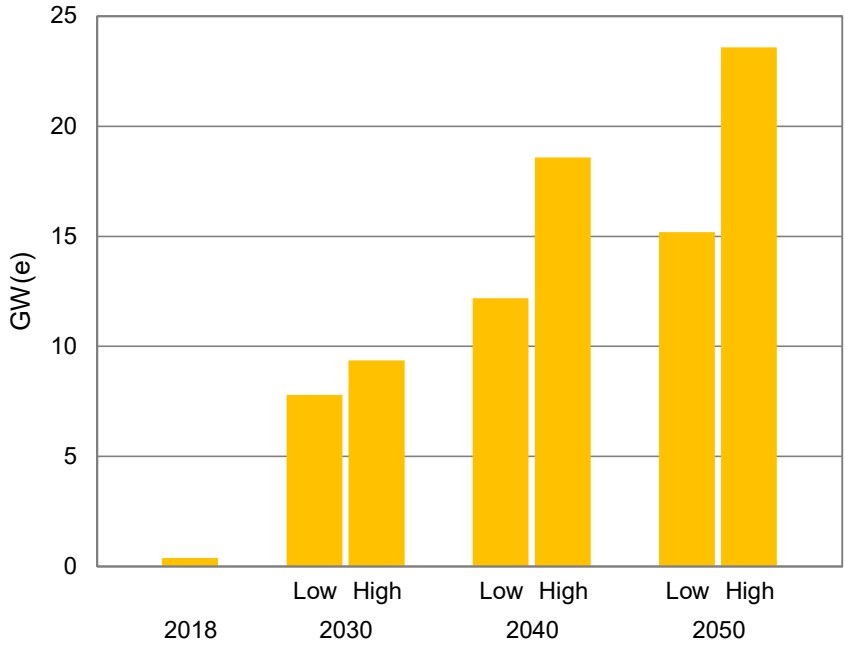


TABLE 23. TOTAL AND NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE WESTERN ASIA REGION

Electrical Capacity	2018	2030[a]		2040[a]		2050[a]	
		Low	High	Low	High	Low	High
Total (GW(e))	343	456		575		696	
Nuclear (GW(e))	0.38	8	9	12	19	15	24
% of total	0.1	1.7	2.1	2.1	3.2	2.2	3.4

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

Electricity and Nuclear Production Projections

- Total electricity production in the Western Asia region is projected to increase from 1211 TW·h in 2018 to 1576 TW·h in 2030 — an increase of about 30% — and then to 2536 TW·h by 2050 — an additional increase of about 61%.
- Although the single nuclear power reactor in the region provided only 2 TW·h in 2018, nuclear electricity production is expected to increase significantly in both the low and the high cases.
- In the low case, nuclear electricity production is projected to increase to 59 TW·h in 2030 and to 122 TW·h in 2050. The share of nuclear electricity in total electricity production will thus increase from 0.2% in 2018 to 3.8% in 2030 and to about 4.8% in 2050.
- In the high case, nuclear electricity production is projected to grow faster, reaching 71 TW·h by 2030 and 190 TW·h by 2050. The share of nuclear electricity in total electricity production will thus increase to 4.5% in 2030 and to 7.5% in 2050.

FIGURE 44. NUCLEAR ELECTRICITY PRODUCTION IN THE WESTERN ASIA REGION

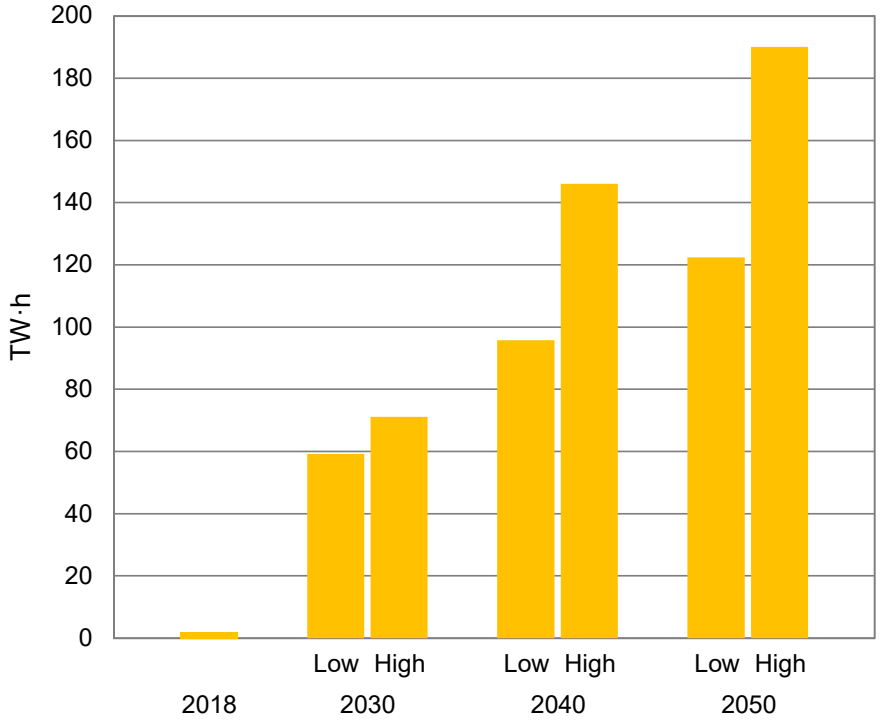


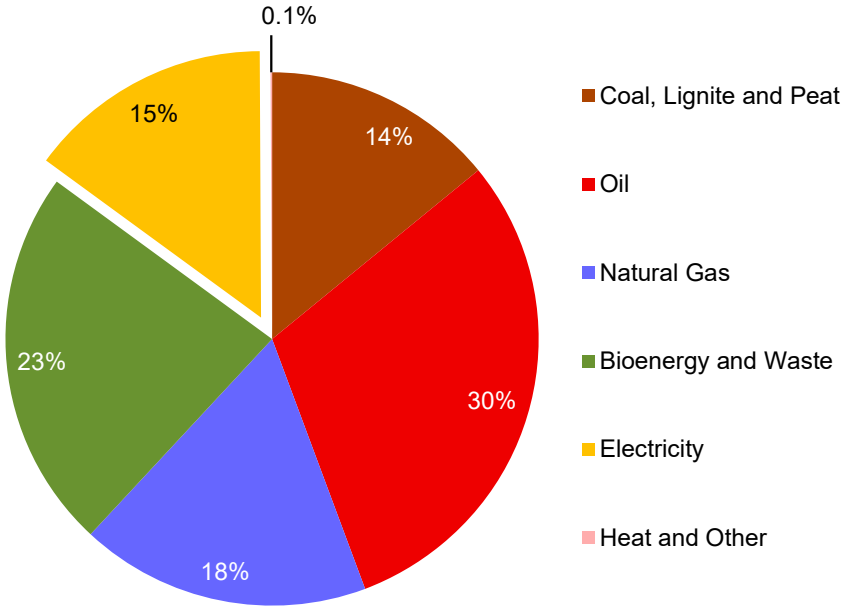
TABLE 24. TOTAL AND NUCLEAR ELECTRICAL PRODUCTION IN THE WESTERN ASIA REGION[a]

Electricity Production	2018	2030		2040		2050	
		Low	High	Low	High	Low	High
Total (TW·h)	1 211	1 576		2 026		2 536	
Nuclear (TW·h)	2	59	71	96	146	122	190
% of Nuclear	0.2	3.8	4.5	4.7	7.2	4.8	7.5

[a] The nuclear production data presented in this table and the nuclear electrical generating capacity data presented in Table 23 cannot be used to calculate average annual capacity factors for nuclear plants as Table 23 presents year-end capacity.

Southern Asia

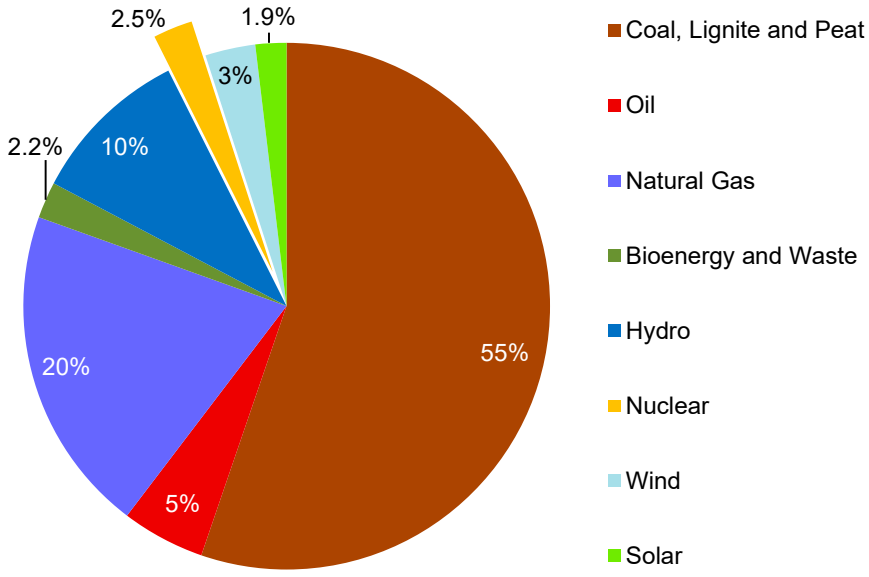
FIGURE 45. FINAL ENERGY CONSUMPTION BY ENERGY SOURCE IN THE SOUTHERN ASIA REGION IN 2018



Final Energy Consumption in 2018

Final energy consumption in the Southern Asia region was dominated by the use of fossil fuels in 2018, but bioenergy and waste (including traditional fuels) continued to provide a large proportion, accounting for 23% of the total. The use of electricity is growing but still accounted for only 15% of total consumption.

FIGURE 46. ELECTRICITY PRODUCTION BY ENERGY SOURCE IN THE SOUTHERN ASIA REGION IN 2018



Electricity Production in 2018

About 80% of electricity production in 2018 was fossil fuel based (coal (55%), gas (20%) and oil (5%)). Hydropower accounted for 10%, while nuclear power contributed only 2.5% of the total. Other renewables accounted for about 5% of the total electricity production.

Energy and Electricity Projections

- Final energy consumption in the Southern Asia region is expected to increase at an average annual growth rate of 2.9% — more than doubling between 2018 and 2050. The growth rate is expected to be 4.1% per year until 2030, decreasing to 2.2% per year thereafter.
- Electricity consumption is expected to grow even faster, almost doubling in the next 12 years and doubling again between 2030 and 2050.
- The share of electricity in final energy consumption will thus increase from 14.9% in 2018 to 16.6% in 2030 and to 21.6% by the middle of the century.

FIGURE 47. FINAL CONSUMPTION OF ENERGY AND ELECTRICITY IN THE SOUTHERN ASIA REGION

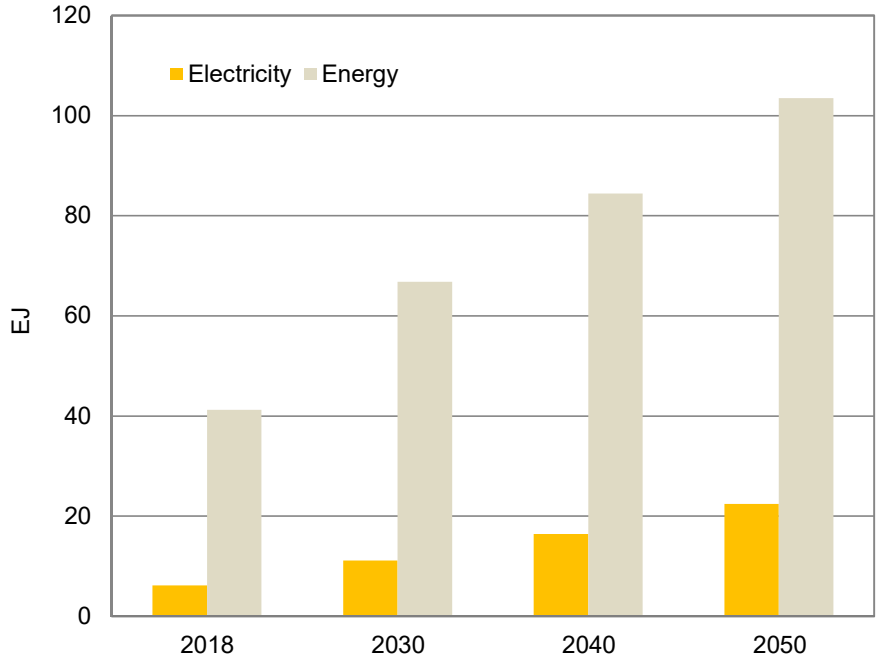


TABLE 25. FINAL CONSUMPTION[a] OF ENERGY AND ELECTRICITY IN THE SOUTHERN ASIA REGION

Final Consumption	2018	2030	2040	2050
Energy (EJ)	41.2	66.8	84.4	103.5
Electricity (EJ)	6.1	11.1	16.4	22.4
% of total	14.9	16.6	19.4	21.6

[a] Final consumption refers to all fuel and energy that is delivered to energy consumers.

Nuclear Electrical Generating Capacity Projections

- Electrical generating capacity in the Southern Asia region is projected to reach 1040 GW(e) by 2030, from the 2018 level of 525 GW(e), representing almost a doubling of the capacity in 12 years. This trend will continue in the subsequent 20 years, resulting in another doubling of the capacity.
- Nuclear electrical generating capacity is also projected to increase considerably in both the low and the high cases.
- In the low case, nuclear electrical generating capacity is projected to increase from the 2018 level of 8.5 GW(e) to 19 GW(e) by 2030 and to 51 GW(e) by 2050. The share of nuclear electrical generating capacity in total electricity capacity is thus projected to increase from 1.6% in 2018 to 1.8% by 2030 and 2.4% by 2050.
- In the high case, nuclear electrical generating capacity is projected to increase substantially, from 8.5 GW(e) in 2018 to 27 GW(e) by 2030 and 84 GW(e) by 2050. The share of nuclear in total electrical generating capacity will thus increase from 1.6% in 2018 to 2.6% by 2030 and to 4.0% by 2050.

FIGURE 48. NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE SOUTHERN ASIA REGION

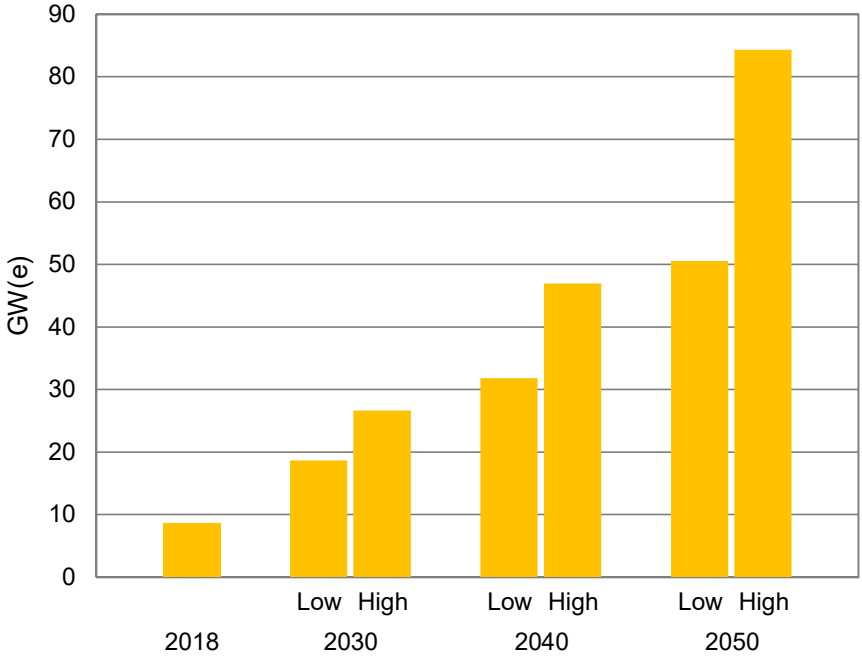


TABLE 26. TOTAL AND NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE SOUTHERN ASIA REGION

Electrical Capacity	2018	2030[a]		2040[a]		2050[a]	
		Low	High	Low	High	Low	High
Total (GW(e))	525	1 040		1 592		2 117	
Nuclear (GW(e))	8.5	19	27	32	47	51	84
% of total	1.6	1.8	2.6	2.0	2.9	2.4	4.0

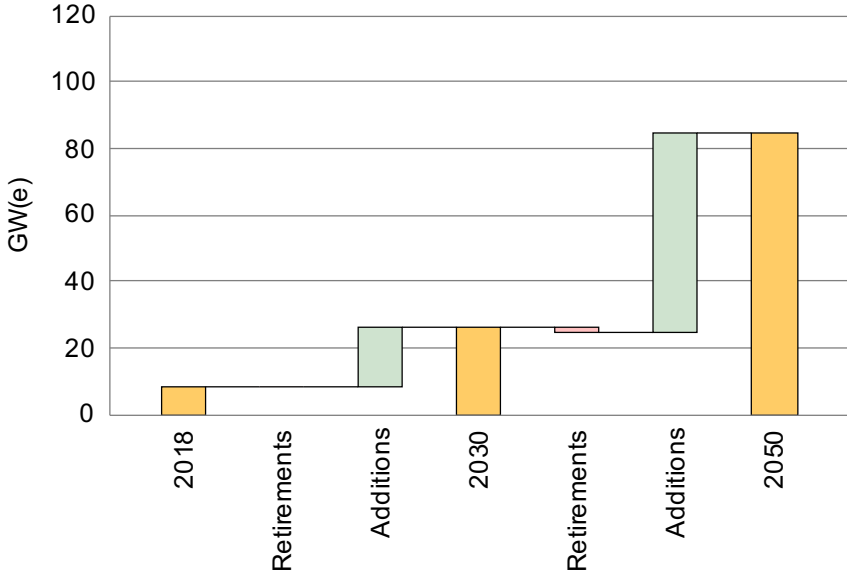
[a] Nuclear capacity estimates take into account the scheduled retirement of older units at the end of their lifetime.

Reactor Retirements and Additions

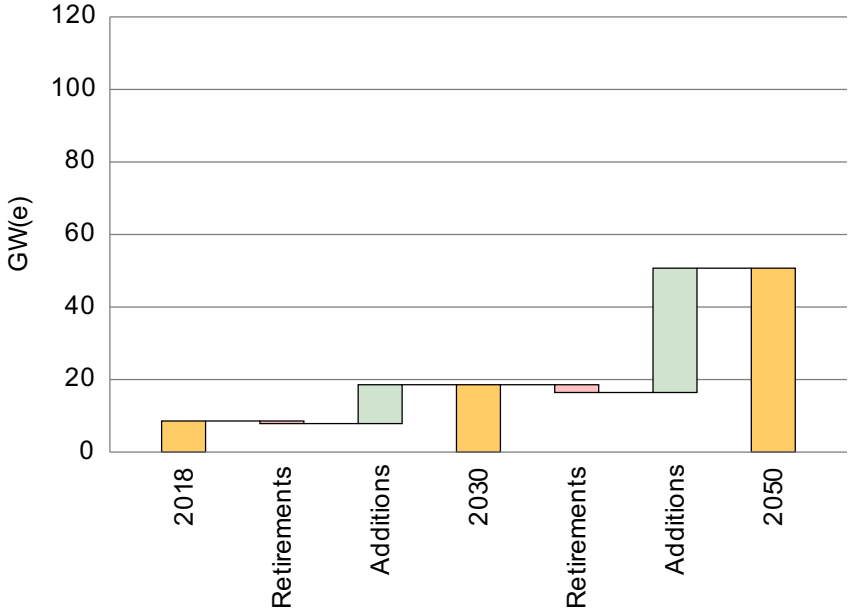
- The existing nuclear power reactors in the Southern Asia region are relatively young, and the majority are expected to remain in operation until the middle of the century.
- In the low case, only 1 GW(e) of nuclear electrical generating capacity will be retired by 2030 and an additional 2 GW(e) of capacity will be retired between 2030 and 2050. The projected additions of nuclear capacity in this case are 11 GW(e) by 2030 and some 34 GW(e) by 2050.
- In the high case, the nuclear capacity retired will be even smaller — only 2 GW(e) over the entire period. The projected additions of nuclear electrical generating capacity in this case are very substantial — about 19 GW(e) added by 2030 and some 60 GW(e) added by 2050.

FIGURE 49. NUCLEAR CAPACITY IN THE SOUTHERN ASIA REGION: ACTUAL, RETIREMENTS AND ADDITIONS

HIGH CASE



LOW CASE



Electricity and Nuclear Production Projections

- The total electricity production in the Southern Asia region is expected to nearly double in the next 12 years, and nearly double again over the following 20 years.
- The nuclear generated electricity is projected to grow at an even faster rate in both cases.
- In the low case, nuclear electricity production is projected to increase threefold in the next 12 years, with a further almost threefold increase and more than double over the subsequent 20 years. The share of nuclear electricity in the total will thus increase from 2.5% in 2018 to 3.7% in 2030 and to 5.2% in 2050.
- In the high case, much more significant increases in nuclear electricity production are projected: around a fourfold increase in the next 12 years by 2030 followed by another a more than threefold increase in the subsequent 20 years. The share of nuclear electricity in total electricity production will increase from 2.5% in 2018 to 5.3% in 2030 and to 8.7% in 2050.

FIGURE 50. NUCLEAR ELECTRICITY PRODUCTION IN THE SOUTHERN ASIA REGION

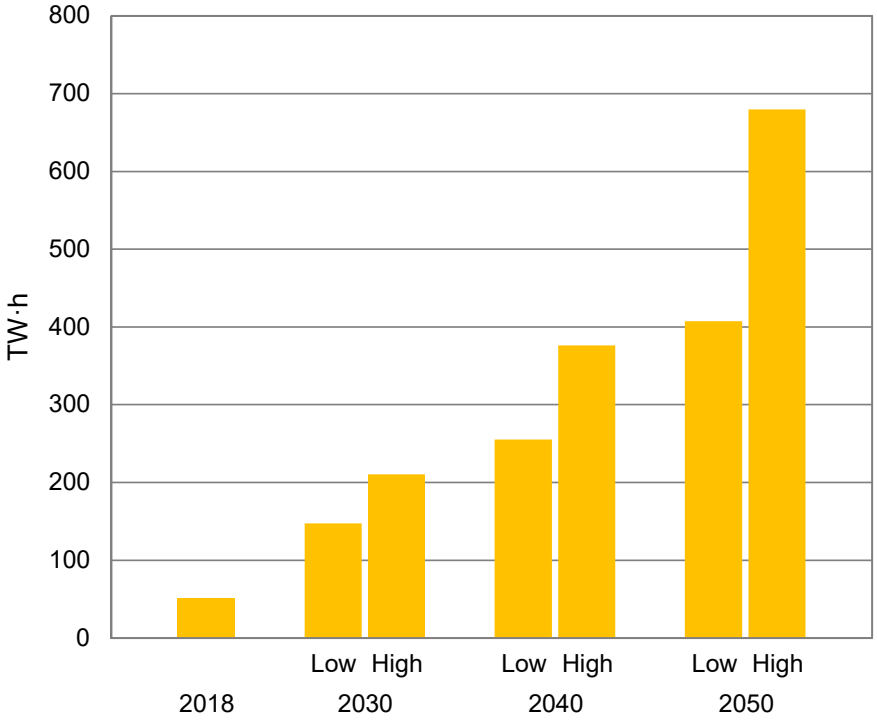


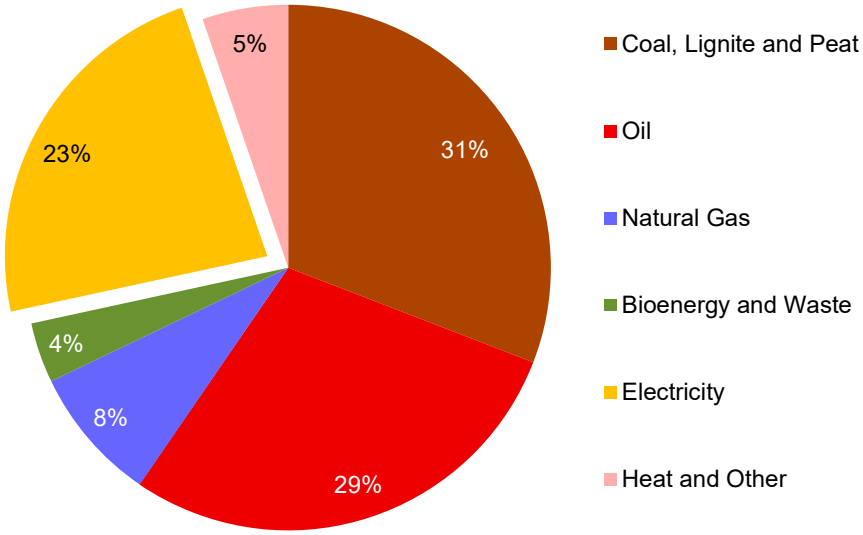
TABLE 27. TOTAL AND NUCLEAR ELECTRICAL PRODUCTION IN THE SOUTHERN ASIA REGION[a]

Electricity Production	2018	2030		2040		2050	
		Low	High	Low	High	Low	High
Total (TW·h)	2 049	3 950		5 827		7 826	
Nuclear (TW·h)	51	147	210	255	376	407	680
% of total	2.5	3.7	5.3	4.4	6.5	5.2	8.7

[a] The nuclear production data presented in this table and the nuclear electrical generating capacity data presented in Table 26 cannot be used to calculate average annual capacity factors for nuclear plants as Table 26 presents year-end capacity.

Central and Eastern Asia

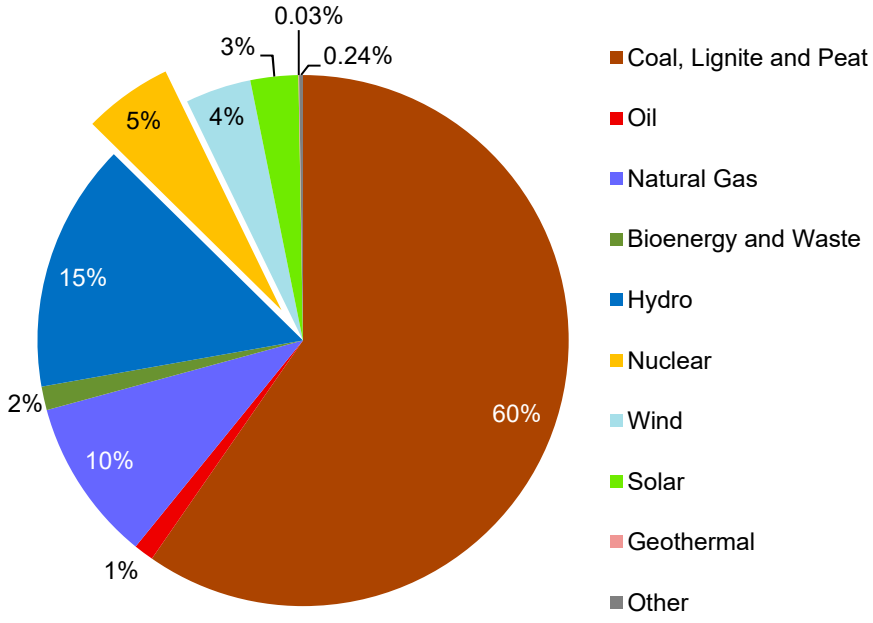
FIGURE 51. FINAL ENERGY CONSUMPTION BY ENERGY SOURCE IN THE COMBINED REGIONS OF CENTRAL AND EASTERN ASIA IN 2018



Final Energy Consumption in 2018

Fossil fuels accounted for about two thirds of the final energy consumption in the combined regions of Central and Eastern Asia in 2018. Electricity supplied 23% of the total final energy used.

FIGURE 52. ELECTRICITY PRODUCTION BY ENERGY SOURCE IN THE COMBINED REGIONS OF CENTRAL AND EASTERN ASIA IN 2018



Electricity Production in 2018

The electricity production mix in 2018 was dominated by coal (60%), followed by hydropower (15%) and gas (10%). Nuclear power contributed about 5%, while other renewable sources accounted for about 9% of total electricity production.

Energy and Electricity Projections

- Final energy consumption in the combined regions of Central and Eastern Asia is expected to increase significantly (by 14%) between 2018 and 2030, and to slow down thereafter, increasing only by a futher 8% from 2030 to 2050.
- Electricity consumption will increase much faster, with a 37% increase from 2018 to 2030. This trend will continue thereafter, with an additional increase of 39% in the subsequent 20 years until 2050. Altogether, electricity use will almost double between 2018 and 2050.
- The share of electricity in final energy consumption will thus increase from 23.1% in 2018 to 27.8% in 2030 and to 35.1% in 2050.

FIGURE 53. FINAL CONSUMPTION OF ENERGY AND ELECTRICITY IN THE COMBINED REGIONS OF CENTRAL AND EASTERN ASIA

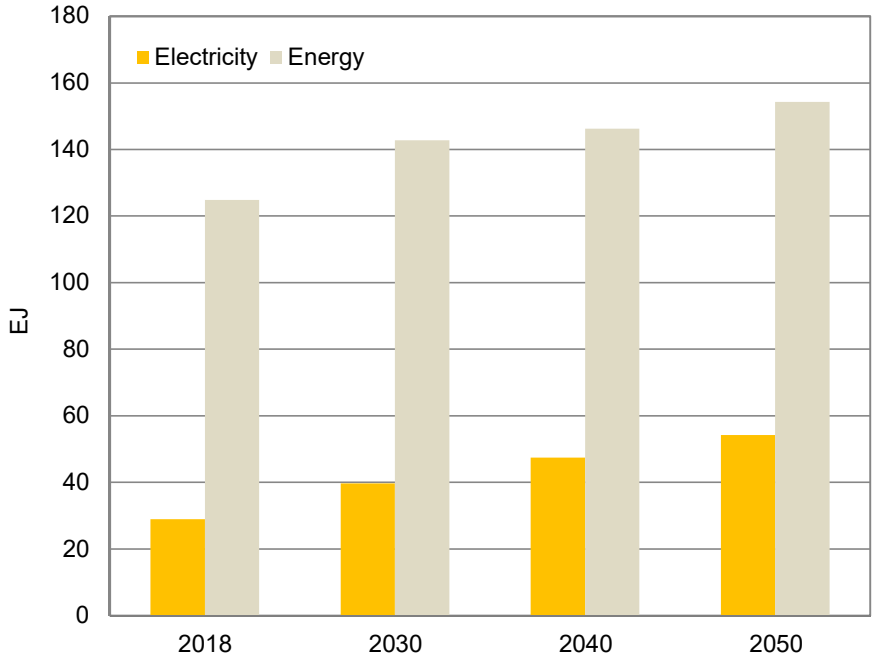


TABLE 28. FINAL CONSUMPTION[a] OF ENERGY AND ELECTRICITY IN THE COMBINED REGIONS OF CENTRAL AND EASTERN ASIA

Final Consumption	2018	2030	2040	2050
Energy (EJ)	124.8	142.7	146.2	154.0
Electricity (EJ)	28.9	39.6	47.4	55.2
% of total	23.1	27.8	32.4	35.1

[a] Final consumption refers to all fuel and energy that is delivered to energy consumers.

Nuclear Electrical Generating Capacity Projections

- Electrical generating capacity is projected to grow at a fast pace, increasing by 51% to reach 3805 GW(e) by 2030, and to reach 5014 GW(e) by 2050.
- Nuclear electrical generating capacity is also projected to increase significantly in both the low and the high cases.
- In the low case, nuclear electrical generating capacity is projected to increase from the 2018 level of 106 GW(e) to 115 GW(e) by 2030 and 149 GW(e) by 2050. However, since the growth of nuclear electrical generating capacity is projected to be slower than that of total electrical capacity, the share of nuclear electrical generating capacity is projected to decrease from 4.2% in 2018 to around 3% from 2030 onwards and to remain flat thereafter.
- In the high case, nuclear electrical generating capacity is projected to increase much faster, growing by 65% in the next 12 years and increasing by a further 74% by 2050. The share of nuclear electrical generating capacity in total electrical generating capacity will thus increase from 4.2% in 2018 to 4.6% in 2030 and to 6.1% in 2050.

FIGURE 54. NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE COMBINED REGIONS OF CENTRAL AND EASTERN ASIA

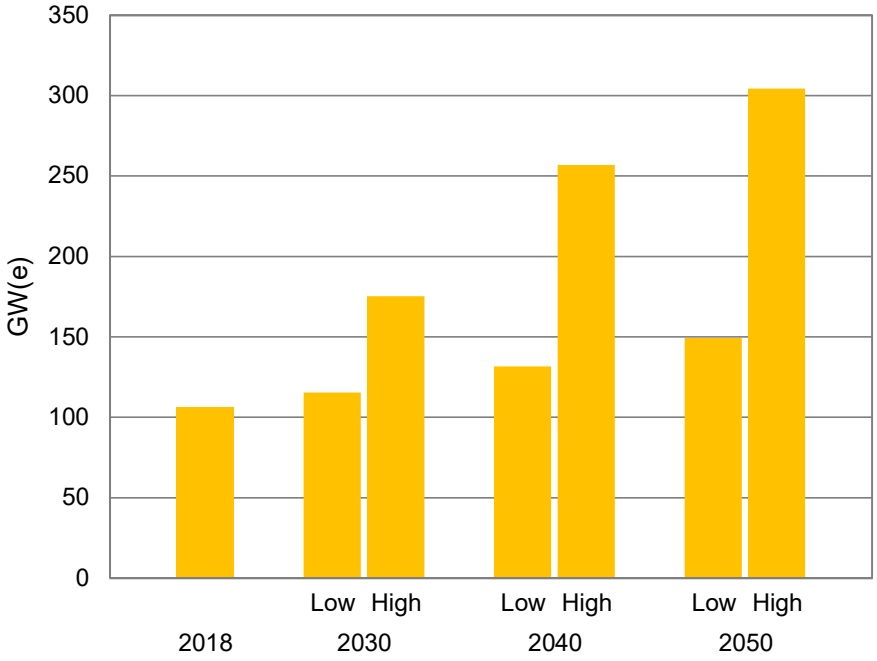


TABLE 29. TOTAL AND NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE COMBINED REGIONS OF CENTRAL AND EASTERN ASIA

Electrical Capacity	2018	2030[a]		2040[a]		2050[a]	
		Low	High	Low	High	Low	High
Total (GW(e))	2 526	3 805		4 484		5 014	
Nuclear (GW(e))	106	115	175	131	257	149	304
% of total	4.2	3.0	4.6	2.9	5.7	3.0	6.1

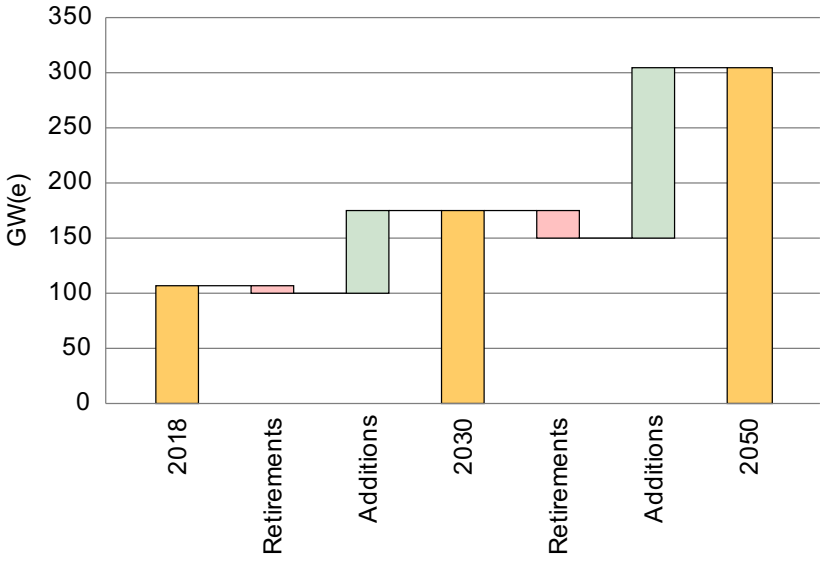
[a] Nuclear capacity estimates take into account the scheduled retirement of older units at the end of their lifetime.

Reactor Retirements and Additions

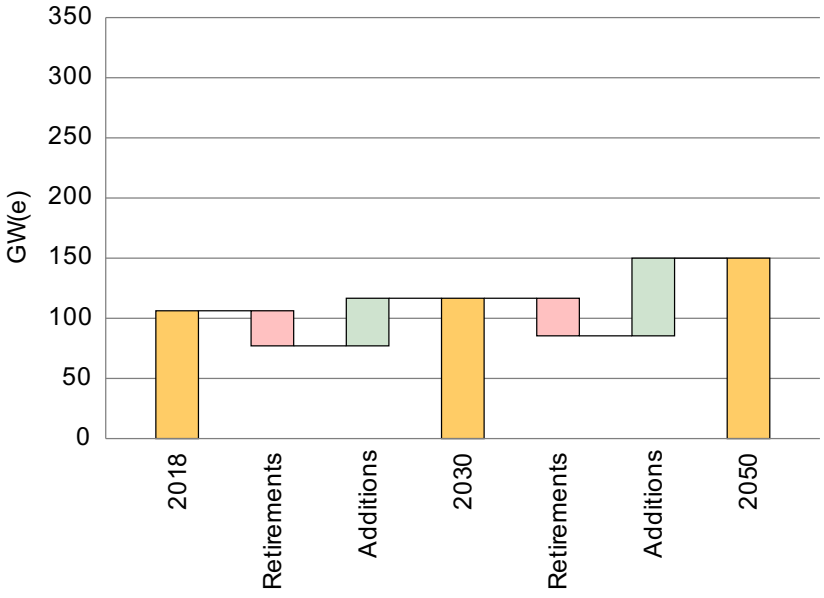
- Most of the existing nuclear power reactors in the combined regions of Central and Eastern Asia are relatively new, and only a few are scheduled to be retired by 2030.
- In the low case, several of the nuclear power reactors in this region currently out of operation in the aftermath of the Fukushima Daiichi accident will not be put back into operation. Consequently, some 30 GW(e) of nuclear power capacity will be retired by 2030 and an additional 31 GW(e) will be retired by 2050. The projected additions of nuclear capacity in this case are 40 GW(e) by 2030 and an additional 65 GW(e) by 2050.
- In the high case, it is assumed that most of the units taken out of operation after the Fukushima Daiichi accident will resume operation. As such, only 6 GW(e) of nuclear capacity will be retired by 2030; thereafter, some 27 GW(e) of capacity will be retired by 2050. Construction of new capacity in this case is projected to be extensive: about 75 GW(e) by 2030 in the next 12 years and some 156 GW(e) between 2030 and 2050.

FIGURE 55. NUCLEAR CAPACITY IN THE COMBINED REGIONS OF CENTRAL AND EASTERN ASIA: ACTUAL, RETIREMENTS AND ADDITIONS

HIGH CASE



LOW CASE



Electricity and Nuclear Production Projections

- To meet the fast growing demand for electricity in the combined regions of Central and Eastern Asia, electricity production will increase by 40% by 2030, with a further increase of 37% by 2050.
- The contribution of nuclear power is projected to undergo significant changes in both the low and the high cases.
- In the low case, nuclear electricity production is projected to increase from 480 TW·h in 2018 to 865 TW·h by 2030 and to 1202 TW·h by 2050. The share of nuclear electricity in the total will thus increase from 5.5% in 2018 to around 7% in 2030 onwards.
- In the high case, nuclear electricity production will roughly triple by 2030 — from 480 TW·h in 2018 to 1314 TW·h by 2030 — with a further 87% increase, to 2453 TW·h, by 2050. The share of nuclear electricity in total electricity will thus increase from 5.5% in 2018 to 10.7% in 2030 and to 14.6% in 2050.

FIGURE 56. NUCLEAR ELECTRICITY PRODUCTION IN THE COMBINED REGIONS OF CENTRAL AND EASTERN ASIA

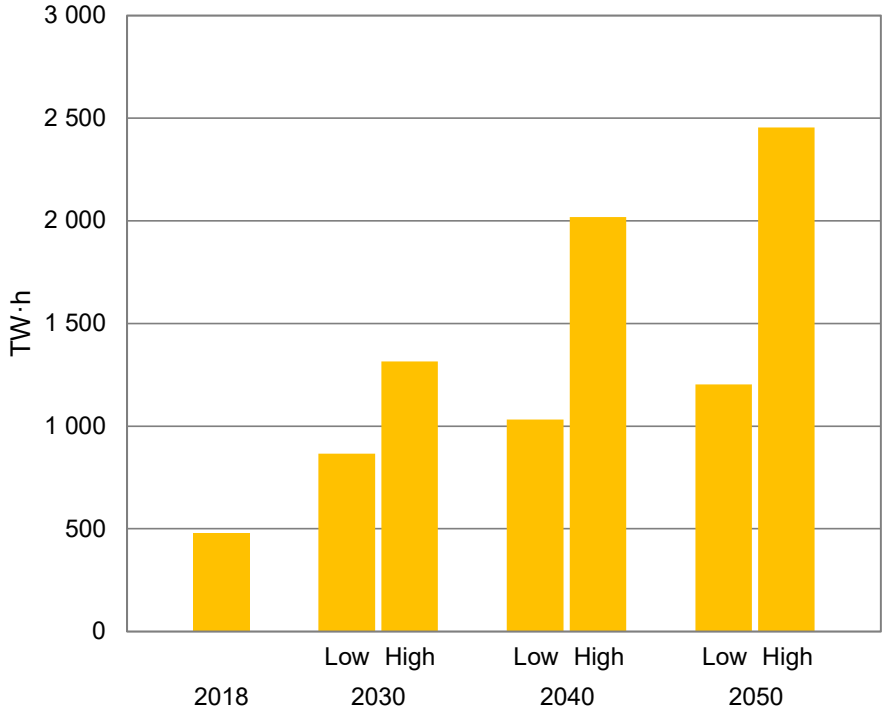


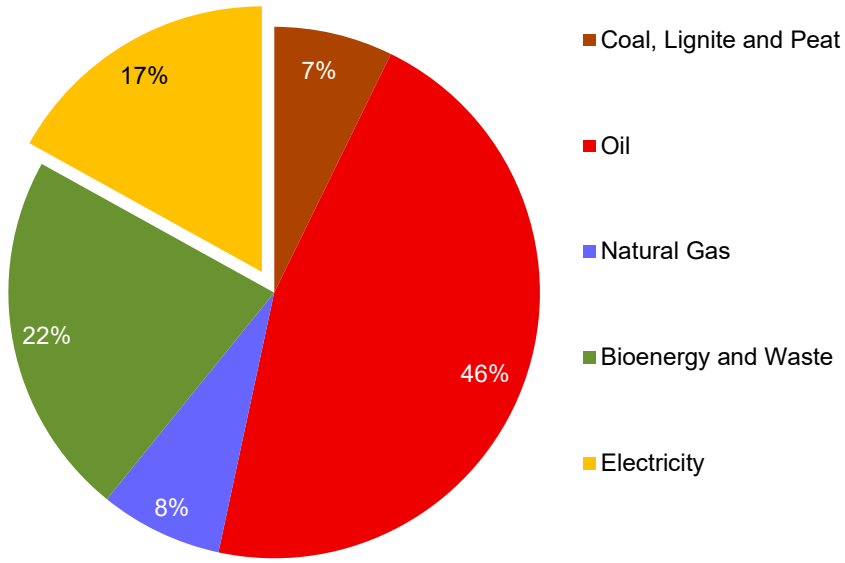
TABLE 30. TOTAL AND NUCLEAR ELECTRICAL PRODUCTION IN THE COMBINED REGIONS OF CENTRAL AND EASTERN ASIA[a]

Electricity Production	2018	2030		2040		2050	
		Low	High	Low	High	Low	High
Total (TW·h)	8 760	12 264		14 656		16 851	
Nuclear (TW·h)	480	865	1 314	1 031	2 018	1 202	2 453
% of total	5.5	7.0	10.7	7.0	13.8	7.1	14.6

[a] The nuclear production data presented in this table and the nuclear electrical generating capacity data presented in Table 29 cannot be used to calculate average annual capacity factors for nuclear plants as Table 29 presents year-end capacity.

South-eastern Asia

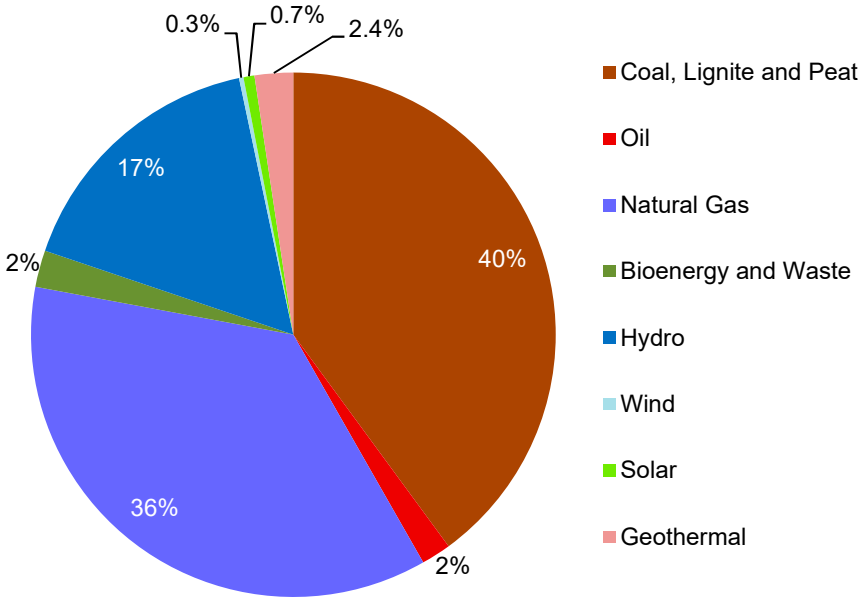
FIGURE 57. FINAL ENERGY CONSUMPTION BY ENERGY SOURCE IN THE SOUTH-EASTERN ASIA REGION IN 2018



Final Energy Consumption in 2018

Final energy consumption in the South-eastern Asia region was dominated by the use of fossil fuels (oil (46%), gas (8%) and coal (7%)). Electricity use in 2018 was about one sixth of the total energy consumption.

FIGURE 58. ELECTRICITY PRODUCTION BY ENERGY SOURCE IN THE SOUTH-EASTERN ASIA REGION IN 2018



Electricity Production in 2018

Coal was the primary source of electricity production in 2018, followed by gas. Hydropower and other renewables accounted for more than one fifth of the total electricity production. At present, nuclear power is not used in this region.

Energy and Electricity Projections

- Final energy consumption in the South-eastern Asia region is expected to continue to increase at a relatively rapid rate up to 2030, with about a 41% increase between 2018 and 2030. In the subsequent 20 years, the growth is expected to slow to about 1% per year.
- Electricity consumption is expected to increase at an even faster rate: 4% per year from 2018 to 2030 and about 3% per year in the subsequent 20 years to 2050.
- The share of electricity in final energy consumption will thus increase from 16.9% in 2018 to 19.4% in 2030 and to 26.8% by the middle of the century.

FIGURE 59. FINAL CONSUMPTION OF ENERGY AND ELECTRICITY IN THE SOUTH-EASTERN ASIA REGION

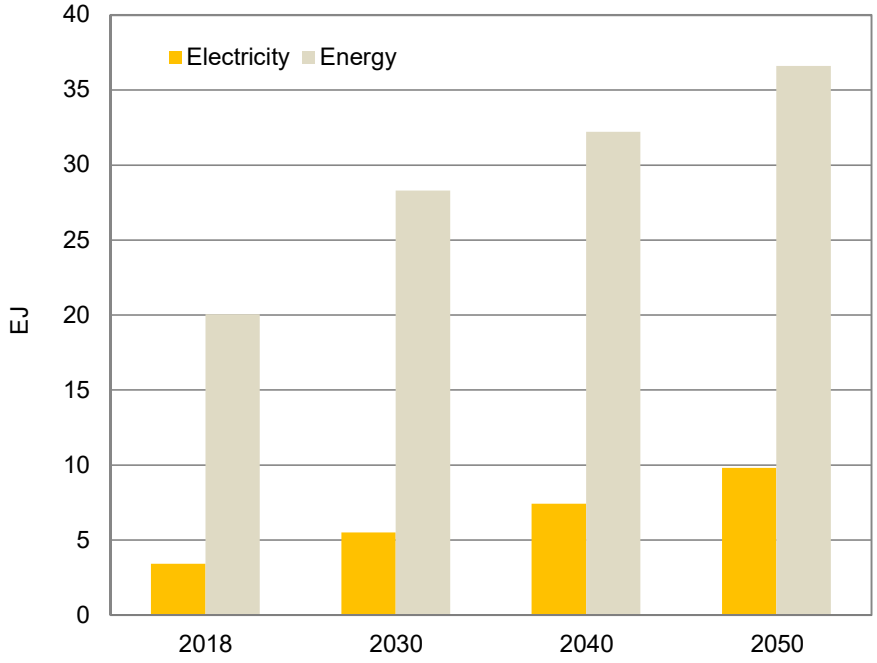


TABLE 31. FINAL CONSUMPTION[a] OF ENERGY AND ELECTRICITY IN THE SOUTH-EASTERN ASIA REGION

Final Consumption	2018	2030	2040	2050
Energy (EJ)	20.1	28.3	32.2	36.6
Electricity (EJ)	3.4	5.5	7.4	9.8
% of total	16.9	19.4	23.0	26.8

[a] Final consumption refers to all fuel and energy that is delivered to energy consumers.

Nuclear Electrical Generating Capacity Projections

- Electrical generating capacity in the South-eastern Asia region is projected to increase by 74% to reach 429 GW(e) by 2030 and then to increase by 73% to 744 GW(e) by 2050.
- Total electricity production is expected to grow at an average annual rate of almost 3.4%.
- In the low case, no nuclear reactor is projected to be operational up to 2030 and only 3 GW(e) of nuclear electrical generating capacity is projected by 2050. The share of nuclear electrical generating capacity is projected to be only 0.4% in 2050, while the share of nuclear electricity production is projected to reach 0.9% of total electricity production.
- In the high case, no nuclear power plant is projected to be on-line by 2030. However, some 8 GW(e) of nuclear power capacity is projected to be operational by 2050, accounting for 1.1% of total electrical capacity. The share of nuclear electricity production is projected to be 2.3% of total electricity production in 2050.

TABLE 32. TOTAL AND NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE SOUTH-EASTERN ASIA REGION

Electrical Capacity	2018	2030[a]		2040[a]		2050[a]	
		Low	High	Low	High	Low	High
Total (GW(e))	247	429		588		744	
Nuclear (GW(e))	0	0	0	1	3	3	8
% of total	0	0	0	0.2	0.5	0.4	1.1

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

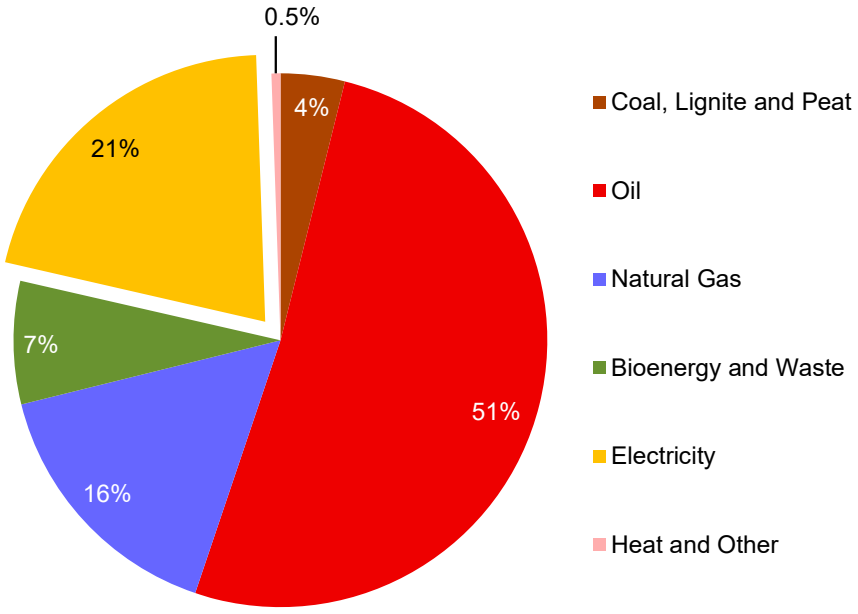
TABLE 33. TOTAL AND NUCLEAR ELECTRICAL PRODUCTION IN THE SOUTH-EASTERN ASIA REGION[a]

Electricity Production	2018	2030		2040		2050	
		Low	High	Low	High	Low	High
Total (TW·h)	978	1 592		2 195		2 827	
Nuclear (TW·h)	0	0	0	8	24	24	65
% of total	0	0	0	0.4	1.1	0.9	2.3

[a] The nuclear production data presented in this table and the nuclear electrical generating capacity data presented in Table 32 cannot be used to calculate average annual capacity factors for nuclear plants as Table 32 presents year-end capacity.

Oceania

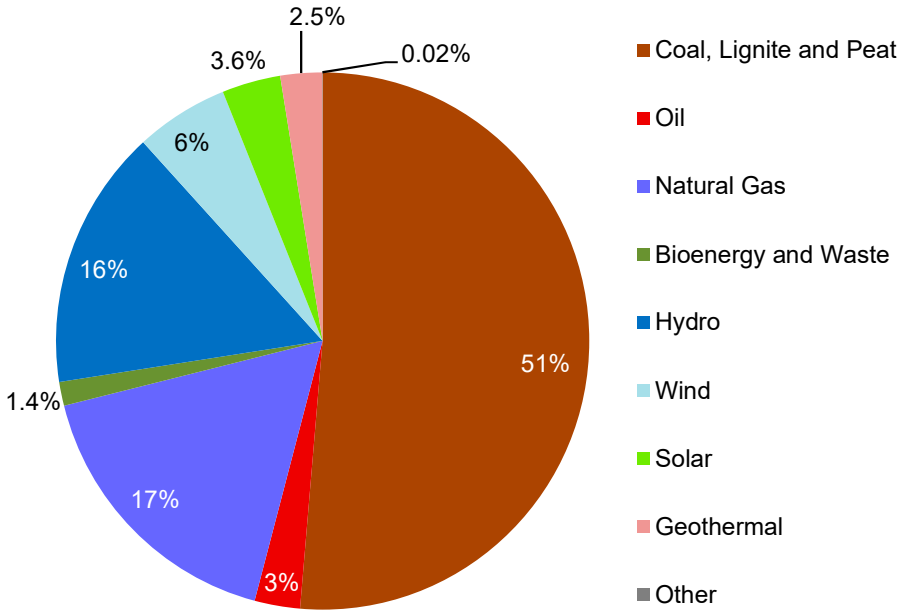
FIGURE 60. FINAL ENERGY CONSUMPTION BY ENERGY SOURCE IN THE OCEANIA REGION IN 2018



Final Energy Consumption in 2018

Final energy consumption in the Oceania region was dominated by oil in 2018. Electricity contributed 21% to total consumption, followed by gas at 16%.

FIGURE 61. ELECTRICITY PRODUCTION BY ENERGY SOURCE IN THE OCEANIA REGION IN 2018



Electricity Production in 2018

Coal based electricity production was 51% in the Oceania region in 2018, while natural gas contributed 17% and hydropower about 16%. Other renewables together provided about 13% of the total electricity production.

Energy and Electricity Projections

- Final energy consumption in the Oceania region is expected to increase at about 1% per year to 2050 — an increase of about 9% by 2030 and another 15% by 2050.
- Electricity consumption will grow faster, at an average annual rate of about 1.6%.
- The share of electricity in final energy consumption will thus increase from 20.5% in 2018 to 27.3% by the middle of the century.

FIGURE 62. FINAL CONSUMPTION OF ENERGY AND ELECTRICITY IN THE OCEANIA REGION

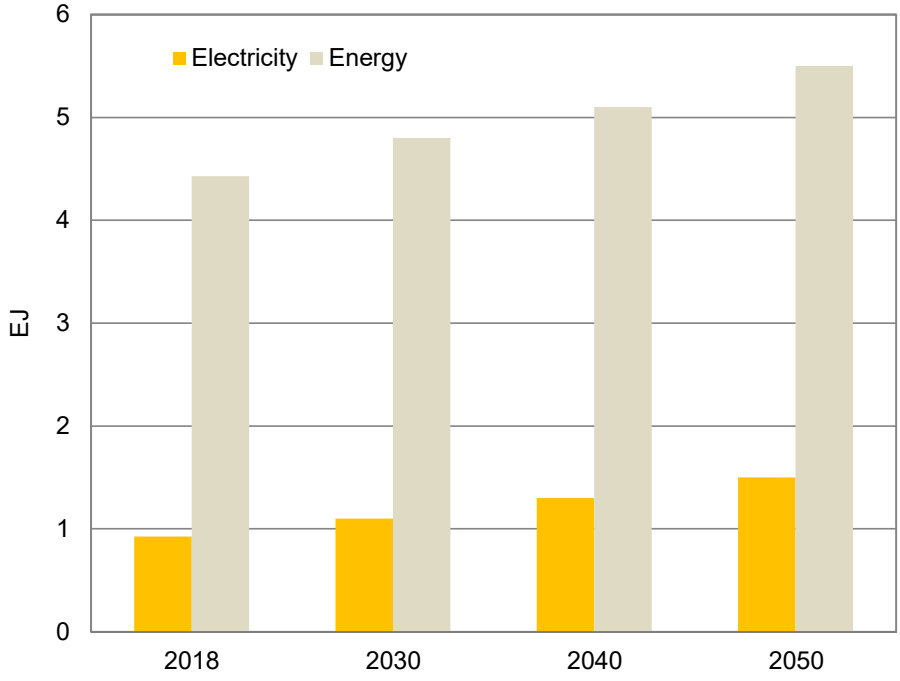


TABLE 34. FINAL CONSUMPTION[a] OF ENERGY AND ELECTRICITY IN THE OCEANIA REGION

Final Consumption	2018	2030	2040	2050
Energy (EJ)	4.4	4.8	5.1	5.5
Electricity (EJ)	0.9	1.1	1.3	1.5
% of total	20.5	22.9	25.5	27.3

[a] Final consumption refers to all fuel and energy that is delivered to energy consumers.

Nuclear Electrical Generating Capacity Projections

- Electrical generating capacity in the Oceania region is projected to increase at a higher rate than electricity consumption. A 30% increase in electrical generating capacity is expected, reaching 104 GW(e) by 2030, followed by a further increase of 47% over the next 20 years, reaching 153 GW(e) by 2050.
- Total electricity production is expected to grow at an average annual growth rate of about 1.5%.
- In the low case, nuclear power is not projected to be introduced into the electricity generation mix of this region in the low case.
- In the high case, nuclear power is projected to become part of the electricity production system by the middle of the century, reaching 2 GW(e) of capacity in 2050, providing some 3.4% of total electricity production in the region.

TABLE 35. TOTAL AND NUCLEAR ELECTRICAL GENERATING CAPACITY IN THE OCEANIA REGION

Electrical Capacity	2018	2030[a]		2040[a]		2050[a]	
		Low	High	Low	High	Low	High
Total (GW(e))	80	104		130		153	
Nuclear (GW(e))	0	0	0	0	0	0	2
% of total	0	0	0	0	0	0	1.2

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

TABLE 36. TOTAL AND NUCLEAR ELECTRICAL PRODUCTION IN THE OCEANIA REGION[a]

Electricity Production	2018	2030		2040		2050	
		Low	High	Low	High	Low	High
Total (TW·h)	294	341		410		472	
Nuclear (TW·h)	0	0	0	0	0	0	16
% of total	0	0	0	0	0	0	3.4

[a] The nuclear production data presented in this table and the nuclear electrical generating capacity data presented in Table 35 cannot be used to calculate average annual capacity factors for nuclear plants as Table 35 presents year-end capacity.

Regional Population Data

TABLE 37. POPULATION GROWTH BY REGION

Region	2018 (Million Inhabitants)	2050 (Million Inhabitants)	Growth Rate (%/a) 2018–2050	Ratio (2050:2018)
Northern America	364	425	0.48	1.17
Latin America and the Caribbean	642	762	0.54	1.19
Northern, Western and Southern Europe	453	449	– 0.03	0.99
Eastern Europe	294	262	– 0.36	0.89
Africa	1 276	2 489	2.11	1.95
Western Asia	271	383	1.08	1.41
Southern Asia	1 896	2 396	0.73	1.26
Central and Eastern Asia	1 739	1 718	– 0.04	0.99
South-eastern Asia	655	794	0.60	1.21
Oceania	42	57	1.01	1.38
World Total	**7 631**	**9 735**	**0.76**	**1.28**

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