Climate Change and the Role of Nuclear Power

IAEA

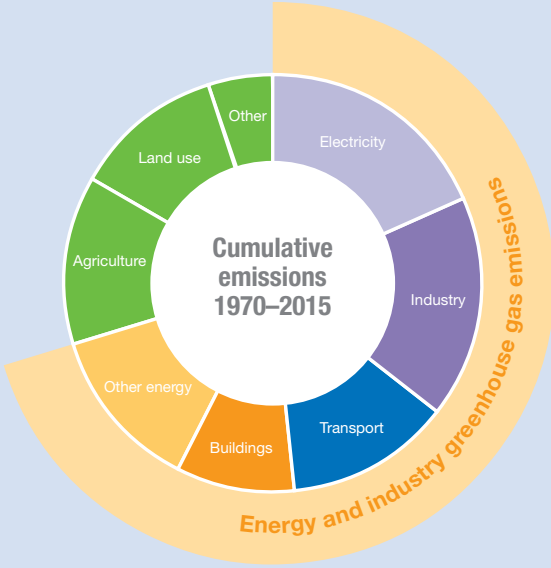
Nuclear Energy

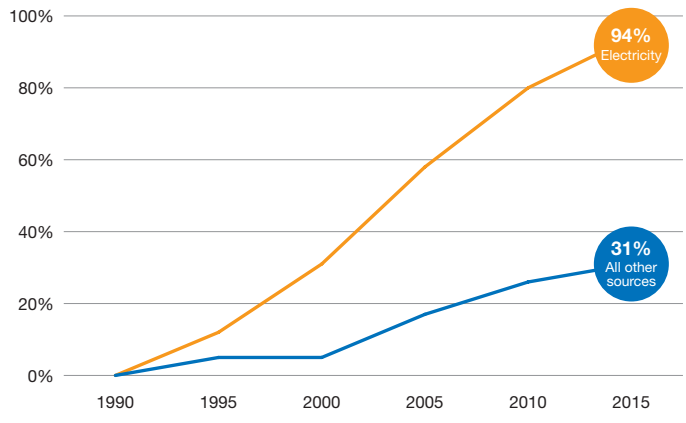
The climate and energy challenge

According to the United Nations, limiting global warming to 1.5°C is necessary to avoid catastrophic consequences and irreversible changes.

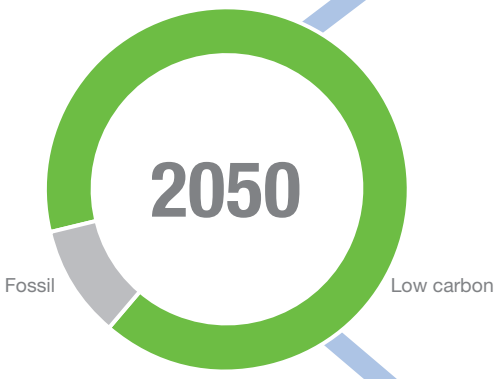
In order to limit the global temperature increase to 1.5°C above pre-industrial levels, 90% of electricity in 2050 will likely need to be from low carbon options.

Since 1970, energy and industry activities have contributed roughly 70% of total emissions.



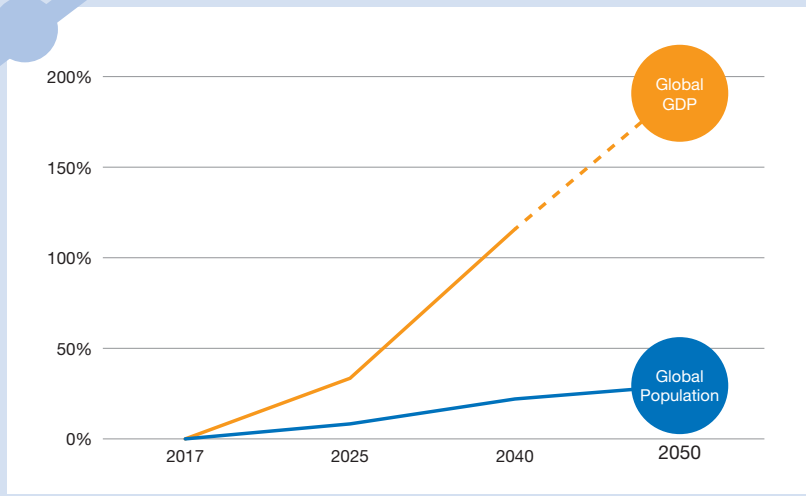


Nearly half of the increase in greenhouse gas emissions since 1990 came from increased electricity demand. As transport and other sectors electrify, global electricity demand could double by 2050.



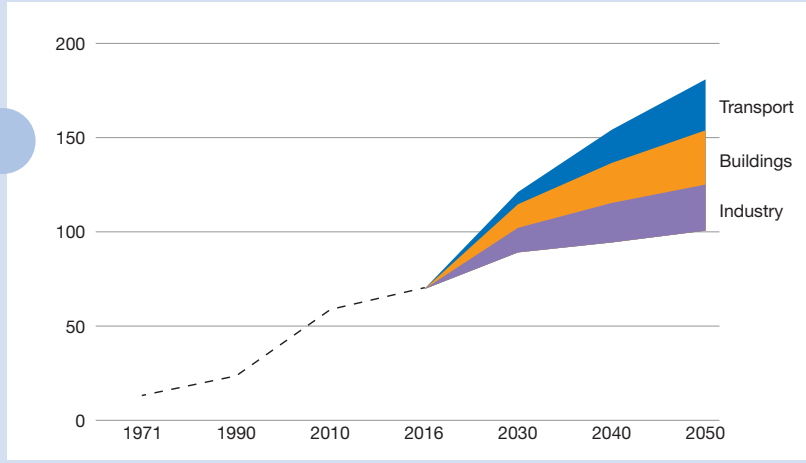
Global population and economic growth will drive increased demand for electricity.

Global Population and GDP Growth from 2017



This will include more demand from industry, buildings, and transport, with their electrification:

Final Electricity Demand (Exajoules)

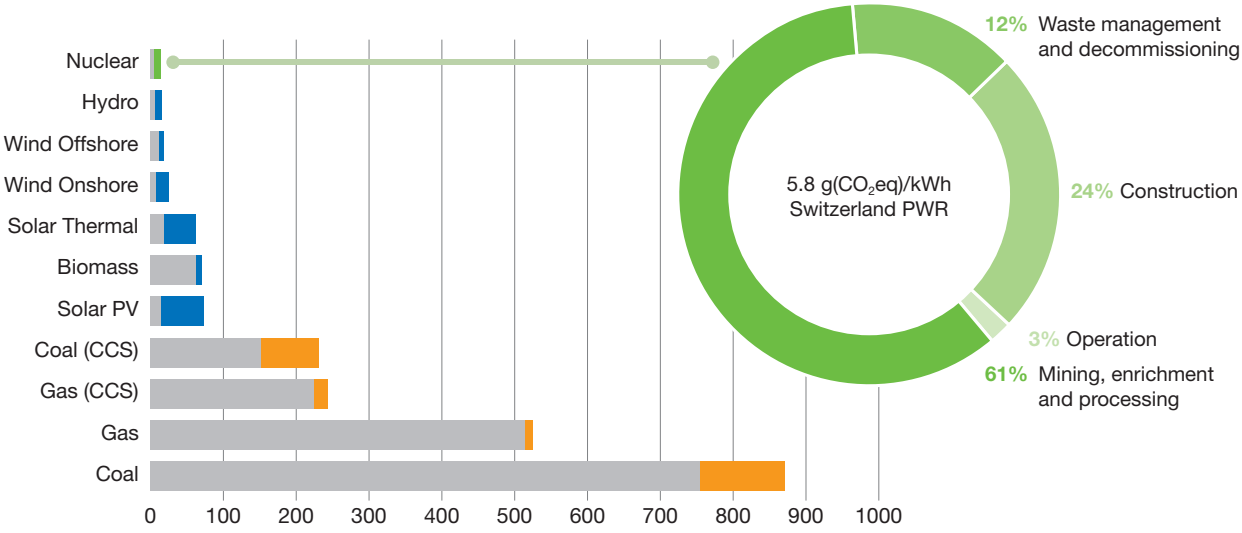


The Paris Agreement aims to hold the increase in the global average temperature to well below 2°C above pre-industrial levels. Recognizing that it would significantly reduce the risks and impact of climate change, as reiterated in the 2018 IPCC Special Report, the Paris Agreement also aims to pursue efforts to limit the temperature increase to below 1.5°C. Given these goals, what is the role of nuclear power?

Nuclear power as a low carbon power source

Nuclear power, along with hydropower and wind energy, produces very low greenhouse gas emissions per unit of electricity generated on a life cycle basis.

Even when accounting for the entire life cycle from mining to waste management, nuclear power is proven to be a low carbon electricity source.



Life cycle greenhouse gas emissions per kilowatt-hour (g CO_2-equivalent/kW-h)

Nuclear power as part of an integrated low carbon solution to combat climate change

Nuclear generation can provide continuous reliable low carbon power, day and night, rain or shine. As a dispatchable source of power, nuclear generation can also respond to changes in electricity load and contribute to frequency regulation. These characteristics enable nuclear power to complement and support other low carbon electricity sources, such as variable solar and wind generation, as part of an integrated low carbon electricity grid.

24/7

Baseload low carbon

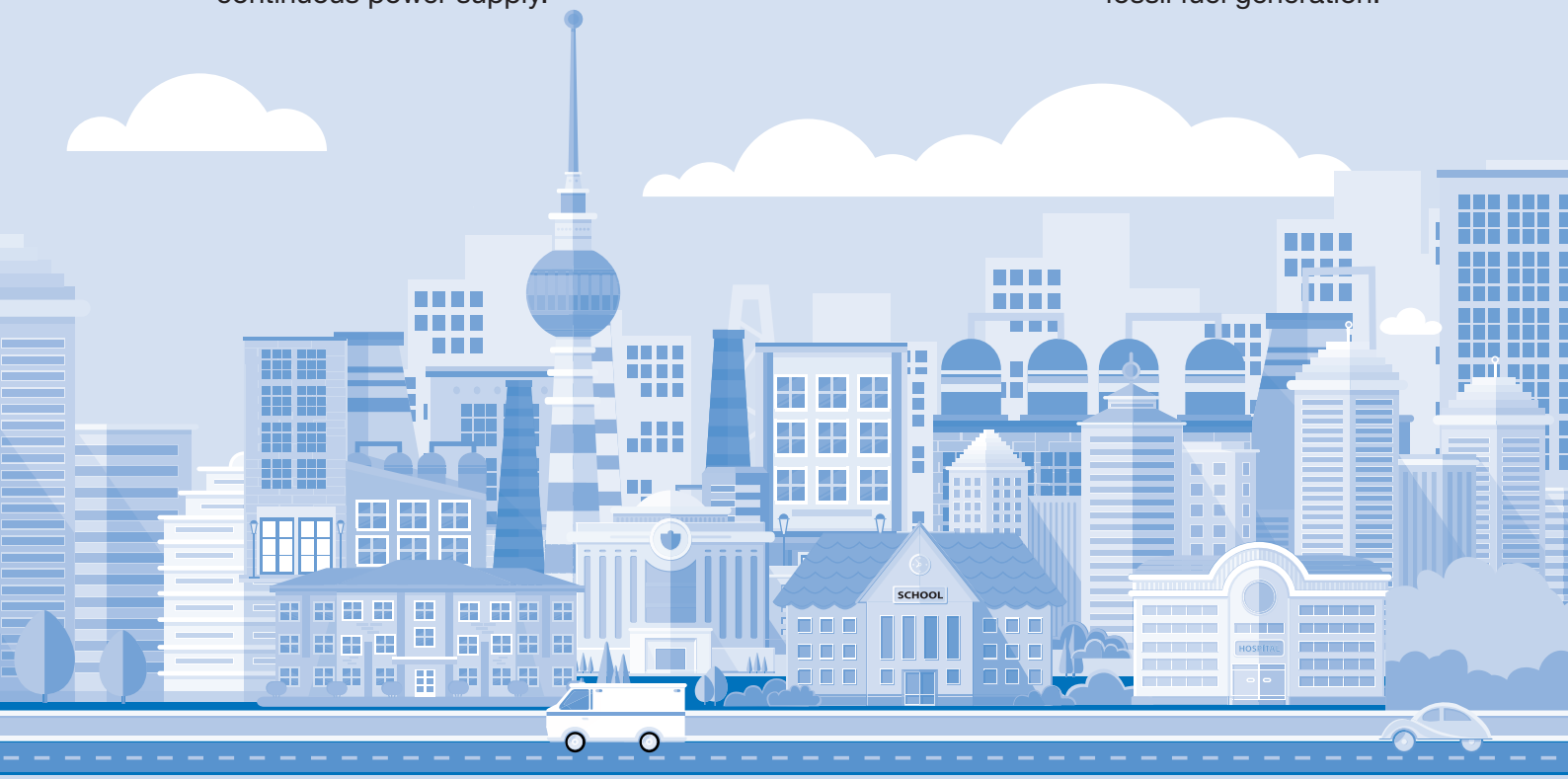
Nuclear power provides baseload low carbon electricity, displacing fossil fuels in applications requiring a concentrated and continuous power supply.

Reliable balancing

Nuclear power contributes to grid balancing and management to ensure a stable and reliable energy system.

Variable renewables

Nuclear power can support higher deployment of variable solar and wind generation without the need for backup capacity from fossil fuel generation.



70-80s

Between the 1970s and 1990s, large scale growth of nuclear power represented some of the most significant contributions to low carbon electricity.

2019

Today, nuclear power represents one of the largest contributors to low carbon electricity generation, supplying nearly a third of the world's available low carbon electricity.

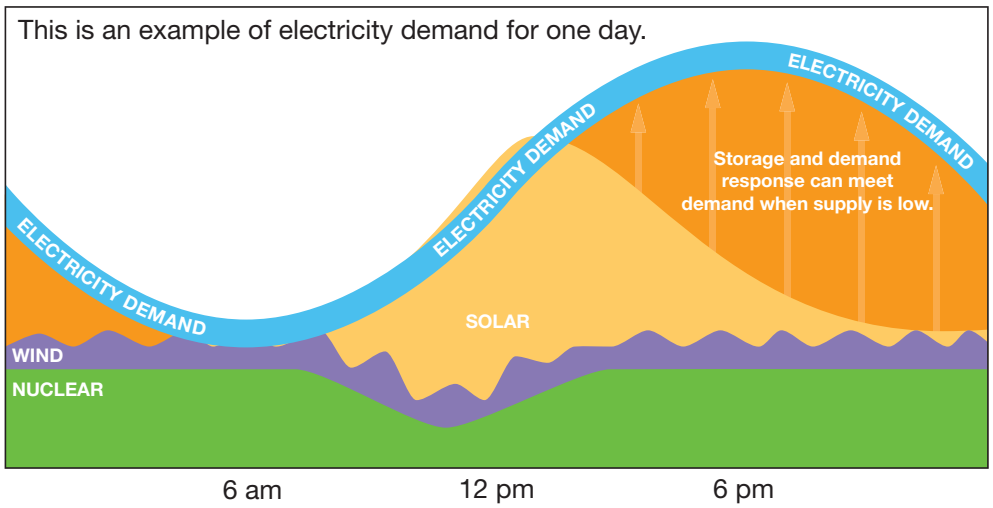
2050

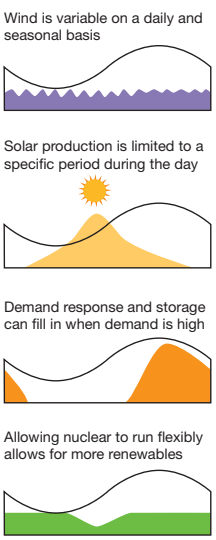
IPCC energy pathways consistent with the Paris Agreement's 1.5°C ambition call for a doubling or more of nuclear generation by 2050.

Existing reactors and future advanced nuclear models, like small modular reactors, can meet baseload power needs and operate flexibly to accommodate renewables and respond to demand.

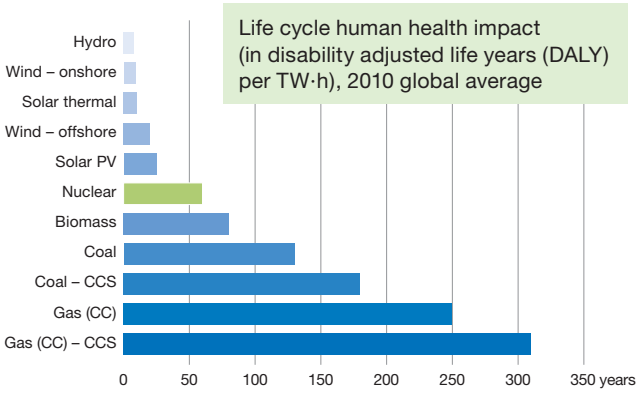
Every day, electricity demand rises and falls. That demand is met by multiple energy sources based on availability and cost.

Solar and wind are variable by nature, and in areas where there is no low carbon baseload option, the backup to accommodate that variability is often provided by fossil fuels. Every unit of electricity provided by nuclear is low carbon, making it a better backup energy source to intermittent renewables.





Nuclear power performs well in evaluations of health impacts



DALY is a measure of overall disease burden, expressed as the cumulative number of years lost due to ill health, disability or early death.

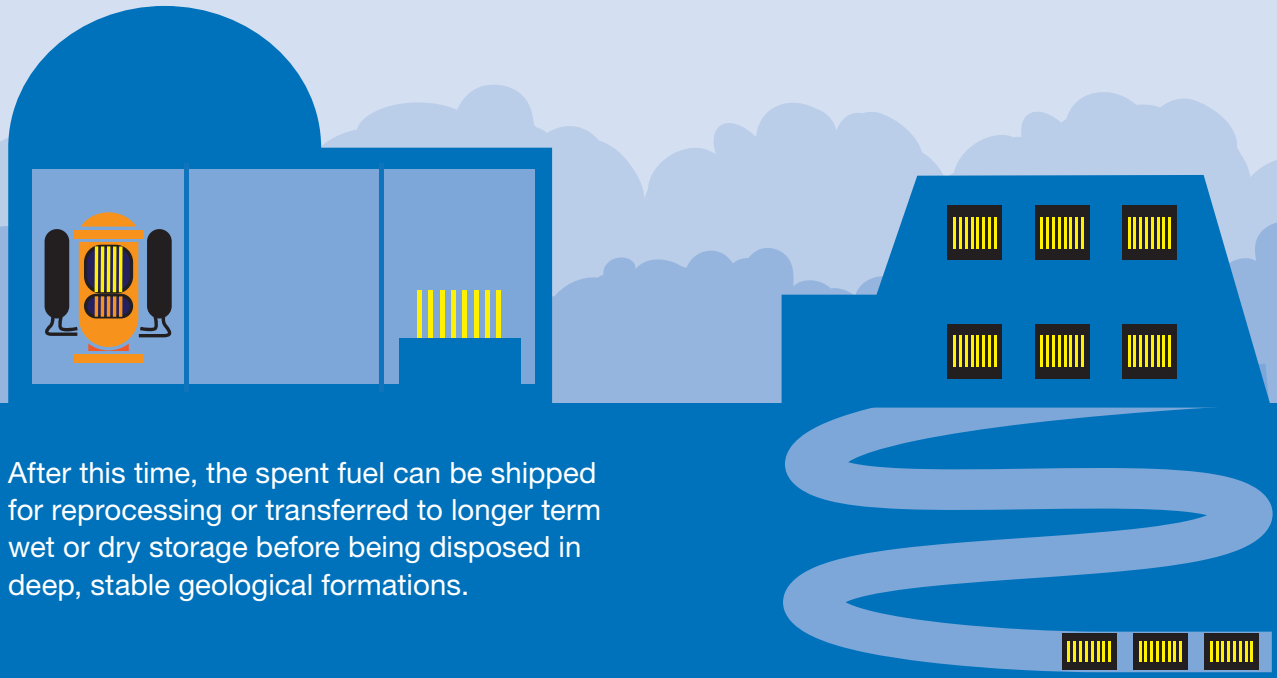
Left: Nuclear performs well in terms of health compared to other technologies.

Nuclear also generates very little waste. In Sweden, the average person's annual electricity consumption could be provided entirely by nuclear power and the waste would be slightly larger than a tennis ball.

Management solutions exist for all types of waste arising from nuclear power plant operations

Following removal from the reactor, the spent fuel is stored under water for several years to allow cooling.

Other types of waste are routinely processed and disposed in near surface disposal facilities.



After this time, the spent fuel can be shipped for reprocessing or transferred to longer term wet or dry storage before being disposed in deep, stable geological formations.

Notes and sources

[1] European Commission, Joint Research Centre (JRC)/ Netherlands Environmental Assessment Agency (PBL). Emission Database for Global Atmospheric Research (EDGAR), release version 4.3.1 http://edgar.jrc.ec.europa.eu/overview.php?v=431, 2016.

[2] IEA (2018), CO2 Emissions from Fuel Combustion 2018, IEA, Paris, https://doi.org/10.1787/co2_fuel-2018-en.

[3] GLOBAL CARBON PROJECT (2018) Carbon budget and trends 2018. [www.globalcarbonproject.org/carbonbudget] published on 5 December 2018.

[4] Global Warming potentials: CH4 = 25, N2O = 298

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Climate Change and Nuclear Power 2018, IAEA, Vienna (2018).

[6] IEA (2018), World Energy Outlook 2018, IEA, Paris, https://doi.org/10.1787/weo-2018-en.

[7] INTERNATIONAL ATOMIC ENERGY AGENCY, Energy, Electricity and Nuclear Power Estimates for the Period up to 2050, Reference Data Series No. 1, IAEA, Vienna (2018).

[8] CC – combined cycle, GHG – greenhouse gas, PV – photovoltaic, CCS – carbon capture and storage.

[9] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Power for Sustainable Development, Information Booklet, IAEA, Vienna (2017).

[10] ECOINVENT, Ecoinvent Database Version 3.3, Ecoinvent, Zurich (2016).

[11] HERTWICH, E.G., et al., Green Energy Choices: The benefits, risks and trade-offs of low-carbon technologies for electricity production, Report of the International Resource Panel, United Nations Environment Programme, Nairobi (2016).

[12] GIBON, T., HERTWICH, E., ARVESEN, A., SINGH, B., VERONES, F., Health benefits, ecological threats of low-carbon electricity, Environ. Res. Lett. 12 (2017) 034023.

[13] STEFAN HIRSCHBERG, Life Cycle Analysis of Carbon Dioxide Emissions from Different Energy Sources, Paul Scherrer Institut, Brussels (2008), www.sauvonsleclimat.org/images/articles/pdf_files/ec_2008/Hirschberg.pdf

[14] JESSE JENKINS, Getting to Zero: Pathways to Zero Carbon Electricity Systems, Kleinman Center for Energy Policy, Philadelphia, (2018), https://kleinmanenergy.upenn.edu/sites/default/files/Getting_to_Zero.pdf

[15] STATISTICS SWEDEN, Stockholm, (2019), www.scb.se/en/finding-statistics

[16] SKB, TR-10-14, Design, production and initial state of the canister, Technical Report, Stockholm (2010).

[17] SKB, TR-17-02 Plan 2016, Costs from and including 2018 for the radioactive residual products from nuclear power, Basis for fees and guarantees for the period 2018–2020, Stockholm (2017).

For more information, please contact:

Planning and Economic Studies Section
Department of Nuclear Energy
International Atomic Energy Agency
Vienna International Centre
PO Box 100, 1400 Vienna, Austria
Tel: +43-1-2600-22776, Fax: +43-1-26007-22529
Email: NE.Communication@iaea.org

IAEA Nuclear Energy

19-04099E