Nuclear electricity in the UK

This article looks at nuclear electricity in the UK, examining how its position within the UK energy mix has shifted from the 1950's to 2018, and how nuclear capacity is likely to change in the future. Please note that all data for 2018 are provisional and may be subject to revisions.

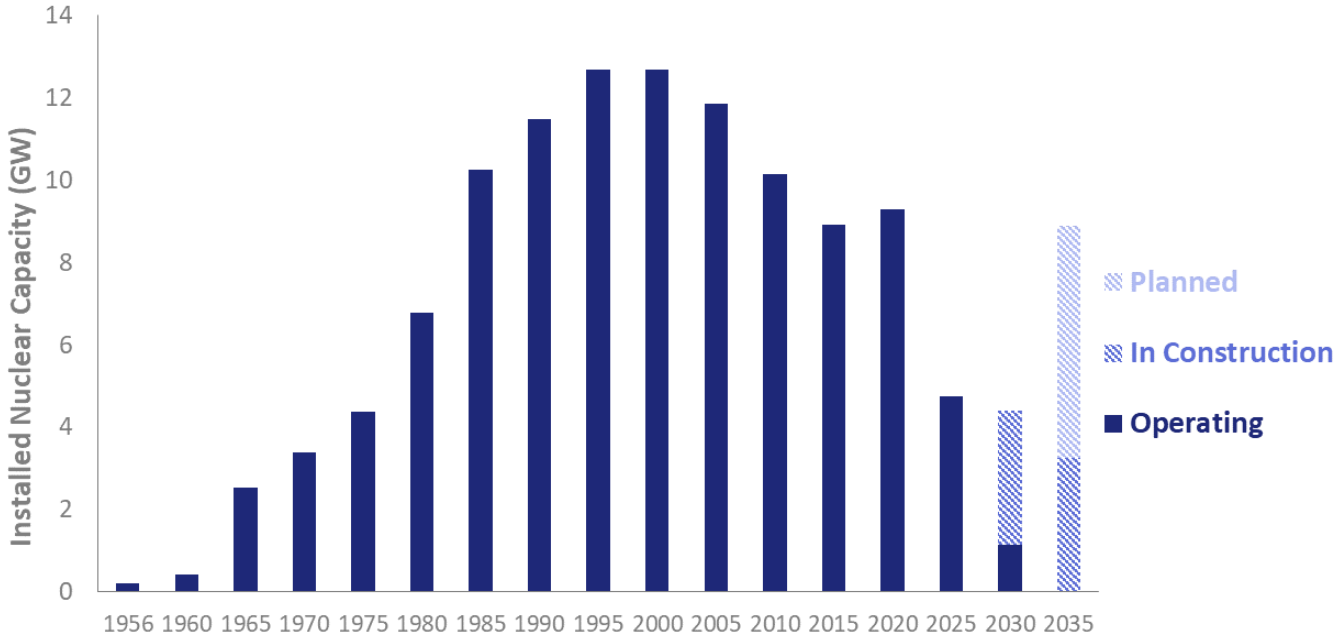
Key points

- The UK currently has eight operational nuclear power stations, which supplied 18.7 per cent of total electricity supply in 2018.
- Nuclear installed capacity peaked at 12.7 GW in 1995, with the opening of Sizewell B – the last nuclear reactor to be opened in the UK. In this year, nuclear accounted for more than a quarter of total electricity supply.
- Construction is underway for a new 3.2 GW nuclear power plant at Hinkley Point C, with the developer forecasting that Reactor One will begin commercial operations at the end of 2025.
- There are plans for further nuclear plants at Sizewell C and Bradwell B. Meanwhile, planned new build projects at Wylfa in Anglesey (Hitachi) and Moorside (Toshiba) were, respectively, paused and stopped by their sponsors, although new build remains an option at both sites.
- In 2017, the UK's average nuclear load factor was 77.4 per cent, 0.9 percentage points (pp) above the European average. However, for 1970 to 2017, the UK's average load factor was 67.4 per cent, 5.2 pp below the European average.

Nuclear power stations in the UK

Chart 1 shows how the UK's nuclear capacity has varied over time and how new planned and plants under construction will affect nuclear capacity in the future.

Chart 1: UK installed nuclear capacity: operating, under construction and planned plants, 1956-2035[1]



In 1956, Calder Hall opened in the UK as the world's first commercial nuclear power station and began to supply nuclear electricity to the public supply grid for the first time. This was a small-scale Magnox reactor, a design which was progressively scaled up and optimised, as 10 further Magnox power stations were opened in the subsequent 15 years. The design life of these reactors was

[1] Plant installed capacity, by connection – United Kingdom, July 2018 (DUKES 5.12), www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes

originally 20 years but the majority ran for at least twice as long, with the final Magnox reactors closing just four years ago at Wylfa.

They were followed by seven Advanced Gas-cooled Reactor (AGR) power stations, which opened between 1976 and 1988, each with an installed capacity of over 1 GW. The most recently opened plant in the UK is Sizewell B, the UK's only Pressurised Water Reactor (PWR) power station, which began generating in 1995. With the additional 1.2 GW of capacity provided by Sizewell B, nuclear installed capacity peaked in 1995 at 12.7 GW, pushing nuclear's share of supply to a peak of 26.9 per cent in 1997.

Since then, no new plants have opened and eight have closed. This means that the UK's nuclear capacity in 2018 was more than a quarter smaller than its peak in 1995, leaving its share of supply at 18.7 per cent. However, further nuclear plants have been proposed. Of those, Hinkley Point C is currently the only approved nuclear power station, with construction already in progress on the site, for a proposed opening of the first reactor at the end of 2025.

Both the Magnox and AGR were British designs. The two pairs of reactors at Hinkley Point C and Sizewell C will be European Pressurised Reactors (EPRs), whilst Bradwell B plans to use the Chinese-designed Hualong One. Oldbury B and Wylfa Newydd were due to use the Advance Boiling Water Reactor (ABWR), designed by GE-Hitachi, however, both projects were suspended in January 2019.

Table 1: Nuclear power stations in the UK supplying electricity to the public distribution network, 1956 - 2035

Power Station	Opening Date	Closure Date	Installed Capacity (MW)	Current Status	Reactor Type
Calder Hall	1956	2003	220	Closed	Magnox
Chapelcross	1959	2004	196	Closed	Magnox
Berkeley	1962	1989	276	Closed	Magnox
Bradwell	1962	2002	242	Closed	Magnox
Hunterston A	1964	1989	180	Closed	Magnox
Dungeness A	1965	2006	450	Closed	Magnox
Trawsfynydd	1965	1991	470	Closed	Magnox
Hinkley Point A	1965	2000	500	Closed	Magnox
Sizewell A	1966	2006	420	Closed	Magnox
Oldbury	1967	2012	434	Closed	Magnox
Wylfa	1971	2015	980	Closed	Magnox
Hinkley Point B	1976	2023	1061	Operational	AGR
Hunterston B	1976	2023	1074	Operational	AGR
Hartlepool	1983	2024	1207	Operational	AGR
Heysham I	1983	2024	1179	Operational	AGR
Dungeness B	1983	2028	1120	Operational	AGR
Heysham II	1988	2030	1254	Operational	AGR
Torness	1988	2030	1250	Operational	AGR
Sizewell B	1995	2035[2]	1216	Operational	PWR
Hinkley Point C 1	2025	2086	1630	In construction	EPR
Hinkley Point C 2	2026	2087	1630	In construction	EPR
Sizewell C	*2030 - 2035*	*2090 - 2095*	*3340*	Proposed	Hualong One
Bradwell B	*2030 - 2035*	*2090 - 2095*	*2300*	Proposed	Hualong One

[2] Site owner plans to apply for 20 year extension.

Nuclear electricity's changing position in the UK energy mix

As the UK's nuclear capacity has changed over time, so too has its position within the UK energy mix. Chart 2 shows how the proportions of electricity supplied by nuclear, fossil fuels and renewables have varied since 1955. Please note that Chart 2 excludes net imports and pumped storage, whilst non-biodegradable waste is included in fossil fuels, so the shares of supply discussed here may differ from those quoted in other parts of Energy Trends.

Chart 2: Electricity supply from nuclear, fossil fuels[3] and renewables, 1955-2018[4,5]

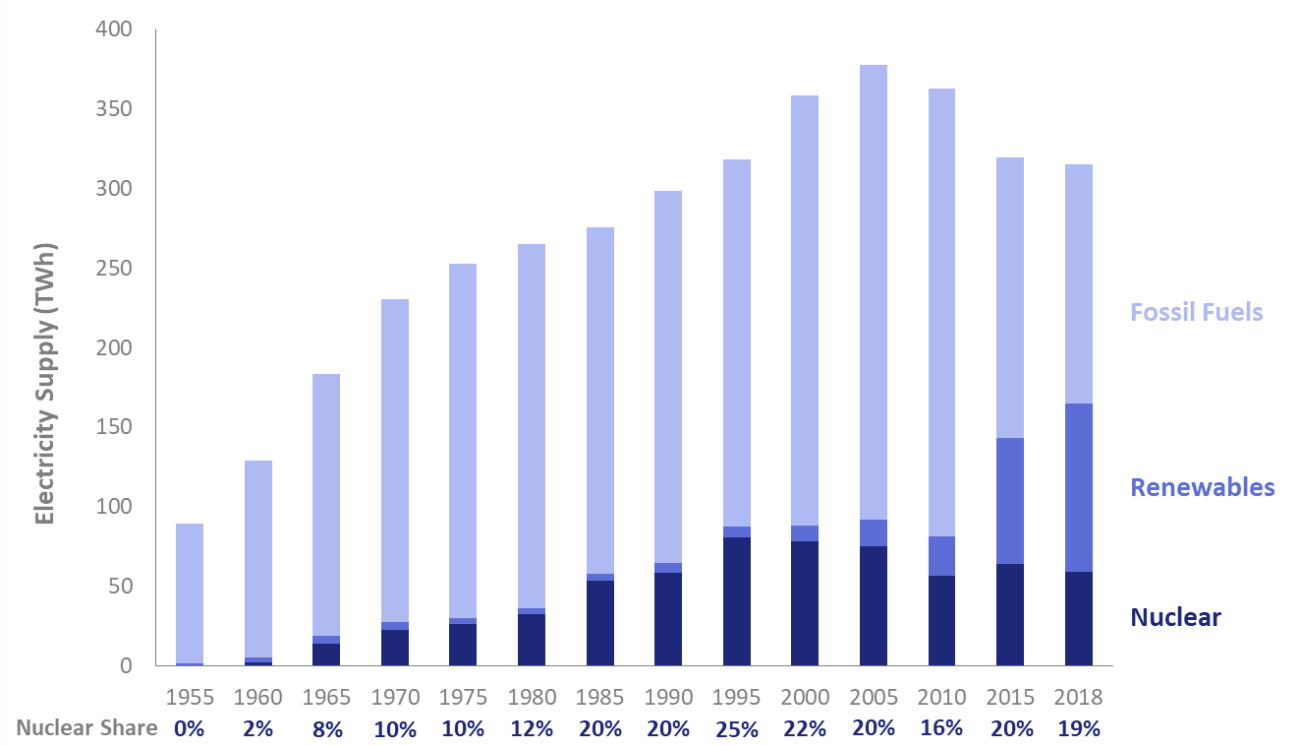


Chart 2 shows the pivotal role that nuclear has played in the UK's electricity supply mix since the 1960s, with increasing nuclear generation helping to meet rapidly rising demand in the 1980s and 90s, that would have otherwise been met by burning more high-emission fossil fuels.

In 2018, nuclear accounted for 18.7 per cent of the total electricity supplied to the grid, with fossil fuels supplying 47.7 per cent and renewables 33.6 per cent; for the first time, more than half of supply was from low carbon sources. The energy mix has changed completely since nuclear capacity peaked in 1995, when nuclear supplied 25.3 per cent and fossil fuels dominated with a share of 72.5 per cent.

Between 1983 and 1998, nuclear accounted for more than 90 per cent of the low carbon electricity supplied to the grid. However, renewables have since seen rapid growth and are now making a significant contribution to meeting demand. Consequently, nuclear power's share of low carbon supply has decreased from a peak of 93.8 per cent in 1996, to 69.3 per cent in 2010, to 35.8 per cent in 2018. Though in 2018, more than 70 per cent of renewable generation was from weather-dependent energy sources, such as wind, solar and hydro. The fluctuating generation of these technologies contrasts with nuclear, which provides a continuous reliable base-load supply that helps to ensure that demand can always be met. This difference is shown clearly by comparing the load factors (calculated as the total electricity generated as a proportion of total potential generation) of different generation types with nuclear. In 2017, the average load factor for nuclear

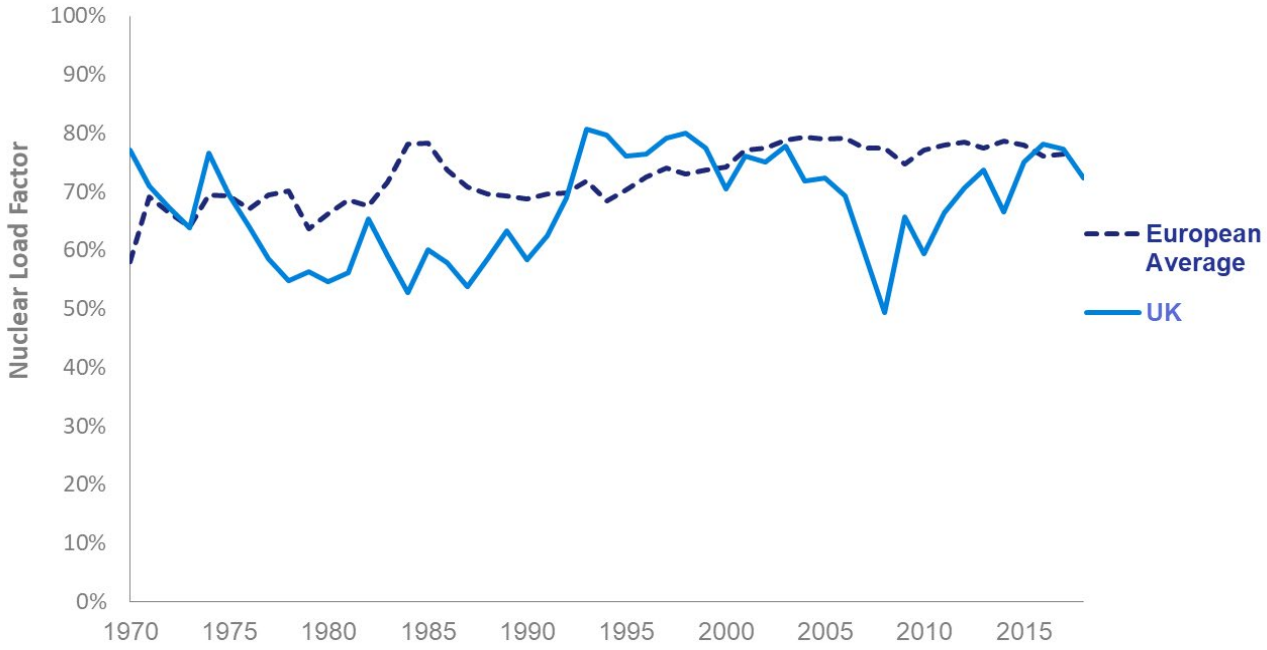
[3] Note that in this article, 'fossil fuels' also includes non-biodegradable wastes, which differs from the typical definition.
[4] Historical electricity data: 1920 to 2017, www.gov.uk/government/statistical-data-sets/historical-electricity-data
[5] Fuel used in electricity generation and electricity supplied, March 2019 (ET 5.1), www.gov.uk/government/statistics/electricity-section-5-energy-trends

was 77 per cent, compared to 45 per cent for gas-fired generation, 36 per cent for hydro, 32 per cent for wind and just 11 per cent for solar.

Nuclear load factors

Chart 3 shows the variation of the UK's annual average nuclear load factor since 1970 in comparison with the European average. Nuclear reactors provide a continuous supply of electricity when they are running, however they undergo planned outages for inspection, maintenance and re-fuelling, and occasional unplanned outages if there are problems with the plant. This is why nuclear load factors are not 100% and why they vary from year-to-year.

Chart 3: Annual nuclear load factors for the UK[6,7] and Europe[8], 1970-2018



In 2017, the UK's average nuclear load factor was 77.4 per cent, 0.9 pp above the European average. However, the UK's average load factor for 1970 to 2017 was 5.2 pp below Europe's, at 67.4 per cent, with the UK's annual load factor below Europe's in 71 per cent of the years since 1970. From 1976 to 1992, the UK's average load factor was 59.1 per cent, well below Europe's. At this point, the old Magnox reactors lifetime had been extended beyond their 20-year design life, possibly increasing the number of statutory and unplanned outages. Meanwhile, the UK constructed its fleet of AGR reactors, Europe (mainly France) constructed PWR nuclear reactors.

The UK's nuclear load factor increased in the 1990's with the closure of some of the Magnox reactors and the opening of Sizewell B. In the early 2000s, load factors decreased, as infrastructure aged and no new reactors were built. The UK's load factor fell to its lowest ever level in 2008 (49.4 per cent) due to unplanned outages. Recently, the closure of the last remaining Magnox plants led to a resurgence in the UK's nuclear load factor, pushing above the European average in 2016 and 2017. In 2018, it dropped to 72.4 per cent, down 5.0 pp from 2017, after a prolonged unplanned outage at Hunterston B limited nuclear generation for much of the year.

Tim Roberts
Electricity Statistics
Tel: 0300 068 5046
E-mail: Tim.Roberts@beis.gov.uk

Helene Clark
Electricity Statistics
Tel: 020 7215 1259
E-mail: Helene.Clark@beis.gov.uk

[6] Plant loads, demand and efficiency, July 2018 (DUKES 5.10), www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes
[7] Historical electricity data: 1920 to 2017, www.gov.uk/government/statistical-data-sets/historical-electricity-data
[8] IAEA, Power Reactor Information System (PRIS), https://pris.iaea.org/PRIS/home.aspx