

## Renewables More Reliable Than Ageing Nuclear Power Plants?

As nuclear power plants age, they become increasingly prone to unplanned outages. In contrast, accuracy and range of forecasting for solar and wind power generation keep improving year by year amplifying the significance of their extraordinary growth rates

In 2018, the seven Belgian nuclear power reactors generated less than half of the electricity they were expected to produce based on their nominal net capacity. The reason: on average, the nearly 40-year-old reactors were down for a period of over 180 days. They did not produce anything during that time. Not a single kilowatt-hour.

### Scottish Offshore Wind Turbines Outperforming French Nuclear Plants

In 2022, the 56 French nuclear power reactors – then 37 years old – were offline for an average of 152 days.

Hywind Scotland, the first floating offshore wind farm does a better job. For their first five years of operation, the turbines have been operating with an average “load factor” of 54 percent,<sup>1</sup> better than France’s nuclear plants in 2022 at 52 percent.

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<sup>1</sup> If a power plant was to produce electricity at full capacity 8,760 hours a year, the load factor would be 100%. Theoretically, a power plant could run at maximum capacity half the time and produce nothing the rest of the time. In reality, offshore wind power plants nearly always generate some electricity, but at variable levels, whereas nuclear power plants tend to be “all-or-nothing” producers.

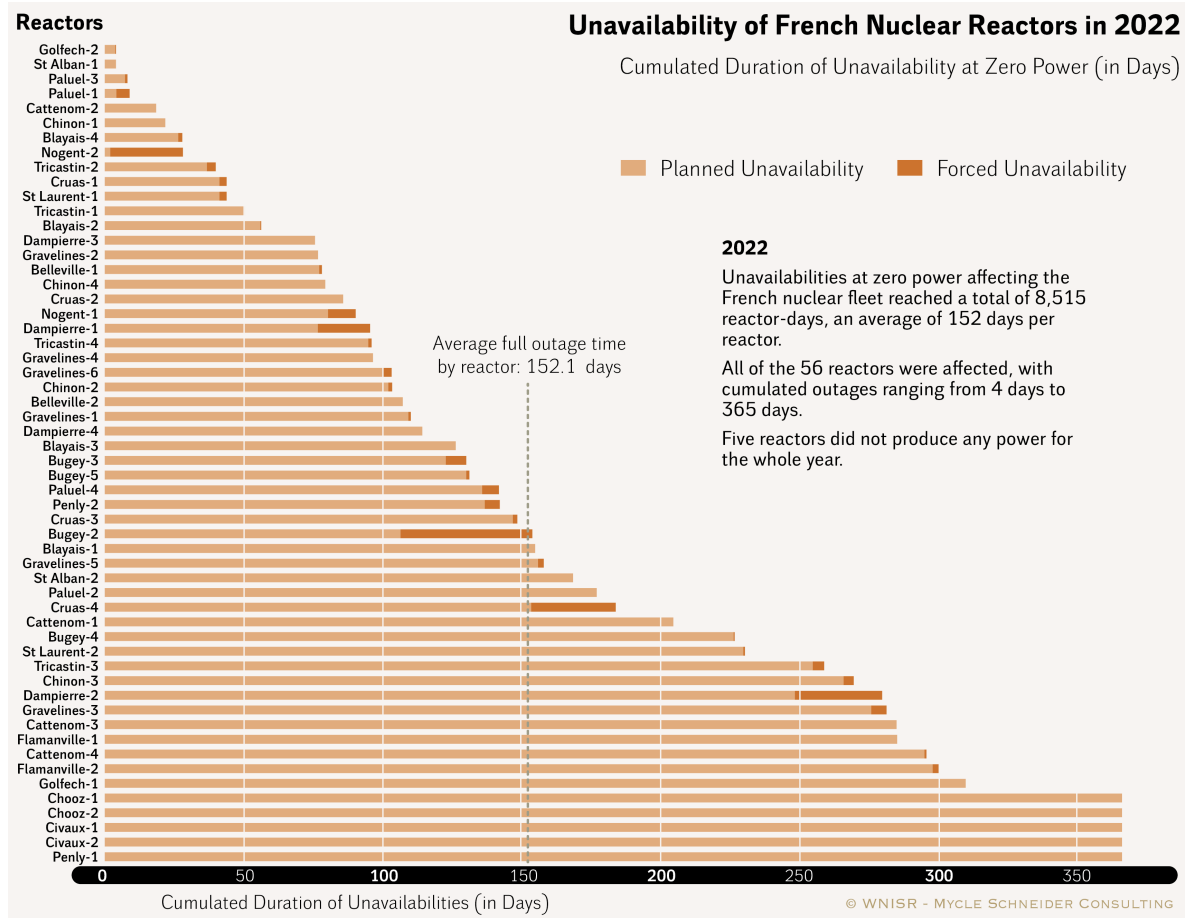
Meanwhile, the small European countries Denmark, Netherlands and Belgium have become the world's fourth, fifth and sixth largest offshore wind power plant operators in the world. Offshore turbines generate variable output, but they do so during 95 percent of the hours in a year. Better still, wind supplies electricity primarily during the winter months, thus remarkably balancing out the low output from solar plants at this time of the year.

In 2023, Denmark maintains two world records, at 58 percent the highest share of wind – three times the European Union's average – and at 23 percent by far the highest share of biomass in its electricity mix; while the Netherlands maintained their leading position in installed solar capacity per capita in Europe, and Belgium generated 30 percent of its power from renewables for the first time.

## **French Operator Cannot Reliably Predict Nuclear Production**

France operates more than half of the nuclear reactors located in the European Union. In 2022, the 56 French operating reactors did not generate any electricity at all on a total of 8,515 reactor-days.

Figure 1: Unavailability of French nuclear power reactors in 2022. Sources: compiled by WNISR, with RTE and EDF REMIT Data, 2021–2023



The world’s largest nuclear power plant operator, the state-controlled utility Électricité de France (EDF), has lost control over its means of production. EDF can no longer reliably predict when nor which reactors will be operational. The 2022 record:

- On 357 days (98 percent of the year), at least 10 units and up to 34 were down during the same day.
- On 280 days (77 percent of the year), 19 or more units were shut down for at least part of the day.
- At least nine reactors were down simultaneously on any day of the year.
- At least 20 reactors were offline simultaneously during the equivalent of 273 days.
- On 28 August 2022, a total of 32 reactors, or 59 percent of the fleet, was offline.

These figures refer exclusively to the total outage of the reactors and do not take into account capacity reductions caused by a lack of cooling water as a result of climate change, worker strikes or a lack of electricity demand.

## In China and India Solar and Wind Individually Have Outpaced Nuclear Generation

Since as early as 2012, China has been producing more electricity with wind turbines alone than with nuclear power plants. 2016, India's emerging economy reached the same milestone and since 2018, electricity generation by solar photovoltaic systems also exceeds that of nuclear fission. In China, in 2023, wind and solar together generated 3.5 times more than nuclear. India is now the third largest solar producer behind China and the U.S. Projections 24-hours ahead for solar and wind power have become so accurate that some Indian grid operators apply penalties whenever the output differs by more than 15 percent from forecasts for electricity production levels issued the previous day in 15-minute intervals.

New, data-driven probabilistic forecasting is revolutionizing solar and wind generation forecasting capabilities hours, days, or a full week ahead as already implemented in Texas.<sup>2</sup>

EDF continues to demonstrate that it is unable to predict availability of its nuclear fleet to the gigawatt even one week in advance. For example, on 21 May 2024, there were 42.8 gigawatt of nuclear capacity operating—just 70 percent of a total of 61.3 gigawatt installed—which was 2.1 gigawatt below EDF's forecast from one week before.<sup>3</sup> In addition, the grid reliability in the nuclear country is surprisingly weak. Compared to Germany, average electricity service interruptions to customers are about five to six times longer in France.<sup>4</sup>

Not to mention the difficult commissioning of the Flamanville-3 European Pressurized Water Reactor (EPR). When construction started in 2007, it was scheduled to start up in

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<sup>2</sup> ERCOT, "Update to Reports Related to Photo Voltaic (PV) Forecasts and Implementation of PV Regions Workshop", 16 May 2022, see [ercot.com/calendar/event?id=1649367299535](https://ercot.com/calendar/event?id=1649367299535).

<sup>3</sup> Montel News, "Capacité nucléaire inférieure de 2,1 GW aux prévisions d'EDF", 22 May 2024, see [montelnews.com/fr/news/6cbea39a-2805-4186-80f2-5c120e11bf3e/capacite-nucleaire-inferieure-de-21-gw-aux-previsions-dedf](https://montelnews.com/fr/news/6cbea39a-2805-4186-80f2-5c120e11bf3e/capacite-nucleaire-inferieure-de-21-gw-aux-previsions-dedf), accessed 22 May 2024.

<sup>4</sup> System Average Interruption Duration Index (SAIDI) of 73.2 minutes (2023)/59.5 min (2022) in France versus 12.2 min in Germany (2022). See EDF, "Universal Registration Document 2023", March 2024; and Bundesnetzagentur, "Kennzahlen der Versorgungsunterbrechungen Strom", 7 July 2023.

2012 but as of mid-2024, Flamanville-3 still did not generate any electricity. France has no penalties for nuclear power plant operators who fail to produce on schedule.

Last update: 2024