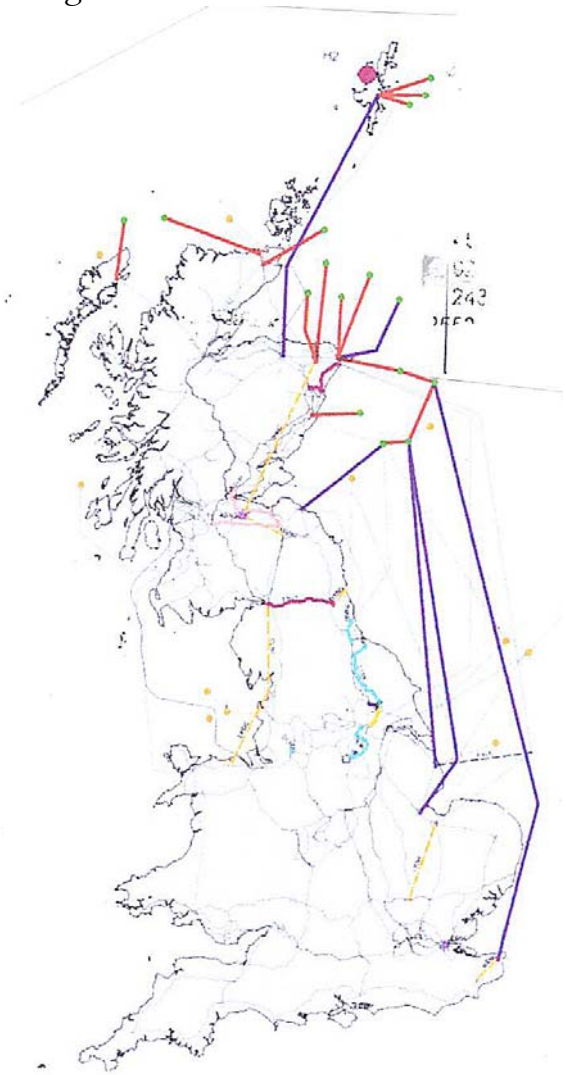
National Grid Electricity Transmission and Distribution - Preamble

National Grid has warned that Britain's power network needs to spend £60 billion investment in new offshore wind farms to achieve electricity decarbonisation by net zero by 2035.

In its "Beyond 2030 Technical Report" it has recommended a design for the offshore connections to the wind farms.

See Figure 4.



Apart from the cost of the offshore connections, there are upgrades needed of the onshore transmission elements in Scotland and in England.

National Grid plc, which owns the electricity transmission and electricity distribution systems, will need to provide the connections for this huge expansion of generation and electricity consumption.

These massive plans for offshore wind and nuclear power, requiring probably in excess of £500 billion, may be beyond the capacity of the UK economy.

UK's Electricity Transmission and Distribution

National Grid plc, which owns the electricity transmission system of pylons, poles and wires and switching stations, plus the West Country and Midlands electricity distribution systems, will need to provide the connections for this huge expansion of generation and electricity consumption.

It has a "Five-year financial framework 2024/2025 – 2028/2029" for the delivery of net zero, spending up to £60 billion in the UK and US.

There is ca. £23 bn for the UK's Electricity transmission (UK ET) and ca. £8 bn for the UK's Electricity distribution (UK ED), i.e £31 bn of the £60 billion.

National Grid has also demands for capital in the US where it owns transmission and distribution systems in New England and New York, Of its 5 year capital spending programme £28 bn of the £60 billion is dedicated to the US projects and ca. £1 bn for NG Ventures in both the UK and US.

England and Wales Electricity Transmission and Distribution

National Grid plc provides the high voltage electricity transmission system and its own distribution system, which is by four regional distribution subsidiaries, while 5 other separate distribution companies cover the remaining areas.

National Grid plc and its distribution partner companies in England and Wales are characterised by low amounts of initially paid-up shares and a high level of borrowings.

The figures extracted and tabled below are from the most up-to-date accounts (2023-2024) submitted and published in Companies House.

Paid-up shares

National Grid plc	£493m
Electricity North West	£238m
Northern Electric Power plc	£ 72m
Southern Electricity and Power Distribution plc	£108m
SP Distribution plc	£300m
UK Power Networks	£610m
Total	£1,821m

Borrowings

National Grid plc	£47,072m
Electricity North West	£ 1,763m
Northern Electric Power plc	£ !,380m
Southern Electricity and Power Distribution plc	£ 1,741m
SP Distribution plc	£ 1,561m
UK Power Networks Holdings Limited	£ 5,616m
Total	£59,842m

As is common for the UK's infrastructure the separate electricity and transmission distribution companies are also characterised by low levels of paid-up shares and extremely high levels of borrowing, mainly with issued bonds.

National grid plc has Property, Plant and Equipment of asset value of £69+ billion and borrowings of £47 billion, supported by retained earnings of £32 billion, which presumably cannot be spent. National Grid plc exhibits the highest leverage of 95:1, with just £493 million equity and ca. £47 billion borrowings, supported by retained earnings of ca.£32 billion. It may be that the retained earnings reduce the leverage to 47/32 or 1.45:1 and the earnings are retained to support the borrowing.

NG's financial stability is dependent on the extent of the floating charge on it by the Norwegian Nord Pool Spot and the mortgage of the Swedish Stock Exchange NASDAQ Stockholm AB on its assets.

The floating charge would be on the cash flows to settle outstanding claims on interconnected electricity units and the mortgage is on the UK's transmission and distribution system, which is owned by NG. Does this also include a mortgage on NG's US assets?

NG's Five-year financial framework 2024/25 – 2028/29

A financial year is from 1st April to 31 March the following year.

Of the £60 billion, £23 billion is for electricity transmission in the UK and £8 billion for electricity distribution in the UK, but **£29 billion is for US projects** and NG Ventures. This means that 52%% of the capital spending is for electricity transmission and distribution in the UK, but 48% for US projects and NGV.

Capital spending in 2023-2024 was ca. £8 billion. As only 52% of the capital spending is for the UK ET and ED then so far, in the first year of the five years, only ca. £8 billion was spent in the UK. This means that over the remaining four years of the 5 years' plan, some £23 billion will be spent in the UK.

National Grid Electricity Transmission plc has three registered charges in Companies House. One is a floating charge lodged by Norwegian Nord Pool Spot. which is a European power exchange, setting the prices of electricity imported and exported across the North Sea and the Channel. Another charge is by the Swedish NASDAQ OMX Stockholm AB, which has a mortgage on National Grid ET and ED's assets, viz., the power lines listed on the Swedish stock exchange owned by NG. It may be that a tranche of the issued bonds are from Sweden.

OfGem should issue a statement on the financial stability of National Grid and whether the retained earnings can be released for capital spending or whether further borrowings need to be underwritten by the government. Perhaps, firstly its US subsidiaries should be separated.

As NGplc's borrowings by 31 March 2024 amounted to £47 billion, the question is by how much will the borrowings be raised to cover the capital investment in the following three years? The long waiting lists for new connections indicate that its capital spending was insufficient in the previous few years.

National Grid ESO

The ESO is the **Electricity System Operator** for Great Britain. It moves electricity round the UK's system of transmission and distribution. The control room attempts to keep homes and businesses supplied 24/7, 365 days a year.

The stability of the system is about to be compromised by the addition of nuclear power plant Hinkley Point C's 3.2 GW of electrical output, which if disconnected in full or in half will mean the strategic disconnection of ca. 10% to 5% of the national load to secure the other 90% to 95%. It is doubtful that Sizewell C will be built, but nuclear power plants are on base load and cannot be off-line to be able to be switched on a demand to maintain stability.

Net Zero has raised the need for more electricity generation capacity, but that with low carbon emissions. There are plans for an additional 86 GW of offshore wind turbines around Scotland and more on the England East Coast.

ESO has insufficient construction capacity to connect current demand for connections, so the move to Net Zero is delayed, perhaps by ten years.

ESO Connection Reform

National Grid Electricity System Operator (ESO) has stated:-

There is a clear and urgent need to reform Great Britain's electricity transmission connection process.

It has published a report on Connections Reform from which includes a block diagram illustrating an 11 stage application process.

The current problem is that new connections can only be made when sufficient new generation sources have been added to the grid and the grid itself has been extended.

New large consumers cannot wait until Hinkley Point C is commissioned and connected in 2027-2031, while offshore wind and solar farms need to be associated with storage to relieve their variability. Having already been subjected to planning permission delays, the developers will then be subjected to another bureaucratic process and have to await the actions of other developers, not least the electricity generators and the grid itself.

An alternative strategy

An alternative strategy is to insist that all new consumers begin their operations off-grid. They would start their projects with solar PV and on-shore wind supported by electricity storage in batteries or energy storage in hydrogen cylinders, backed up by LNG or LPG fuelled generators or NG from anaerobic digestion. The grid connections could then follow, but just as **standby** once the grid is extended and connected to new sources of electricity.

The grid is already adding batteries to it to moderate the variability of wind and solar PV, but priority could be given to new industries off grid. A first example would be battery manufacturing, which could begin by installing its own batteries.

The extension of the national grid will itself be subject to planning disputes, but may not need to be so much extended if the expansion of central generation is reduced, with just the provision of standby power. The amount of non-fossil generation would increase rapidly, with most applications being off-grid and net zero.

This practice could also apply to housing schemes encouraging most to be off-grid initially. This is just a first attempt to formulate a better connection process and move to Net Zero.

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Off-Grid Net Zero instead of waiting for a NG ESO Connection

By the way, distribution costs add 20% to 40% to electricity costs, so working off grid may indeed continue without a connection indefinitely while the march of the pylons may be avoided.

24 Gigawatts of nuclear power

The building of 24GW of nuclear power plants (NPPs) would require 16 EPRs, or 50 R-R SMRs, or 80 GEH BWRX 300s. France also wants to build another 16 EPRs.

There is only sufficient process vessels and civil engineering capacity in the UK and France for one (or two) EPRs at a time. Twin EPRs would require a shore site and take 10 years to build.. China has 28GW of NPPs under construction and is stocking natural uranium in advance, as currently uranium mining production is in a 25% deficit.

See "Uranium Fuel Supply for Hinkley Point C and Sizewell C" on https://www.after-oil.co.uk/uranium_fuel_supply_for_hinkley_.htm which calculates the natural uranium required for 50 years generation from HPC and SZC of 70,000 tonnes.

Also natural uranium, according to the World Nuclear Association's extrapolated plot will run out by 2050.

The massive civil engineering at HPC to contain radioactive fallout and a melted core in an incident, has caused the cost to rise to £46+ billion. As the same design with some latter improvements will be applied at SZC, the claim that it will cost "only" £20 billion is unwarranted as cost inflation is still rising.

Perhaps it will be decided just to build just one EPR at Hinkley Point C, especially if the problems at Taishan in China mean design changes. It is unlikely that a second EPR at HPC or Sizewell C will ever be built because of the rising costs as it will mean that more carbon is released in the construction that can ever be amortised in the subsequent operation, especially as the nuclear fuel may run out before the 60 years have elapsed.

Haleu and Advanced Modular Reactors

DESNZ has launched an investment in Haleu production, which could be categorised as part of "Specified Secondary Supply" on the bottom line of the WNA plot, with a very minor contribution to future requirements.

Haleu is "High-assay low-enriched uranium" and is uranium enriched to greater than 5% and less than 20% content of the U-235 isotope.

Natural uranium (Unat) has 0.7% U-235 so 1 tonne of a 5% content requires 5/0.7 = 7 tonnes of Unat. So a 1 tonne of 20% content of U-235 requires 20/0.7 = 28.6 tonnes of Unat per tonne of Haleu.

So if Unat production is in deficit, this is not a practical solution for some types of SMR, 50 to 80 of which would be required for 24GW. (24GW would require 16 EPRs, or 50 R-R SMRs, or 80 GEH BWRX 300s.)

WNA has published the 2021 edition of The Nuclear Fuel Report

Also natural uranium, according to WNA's extrapolated plot, will run out by 2050. BEIS's position on uranium supply was that the market will provide the requirement. Inevitably with falling ore grades the uranium price will rise.

The report notes that world production dropped from 63,207 metric tons of uranium in 2016 to 47,731 tU in 2020, adding that unfavourable market conditions, compounded by the pandemic, led to a sharp decrease in investment in the development of new and existing mines.

The past depressed uranium market, says the report, caused not only a sharp decrease in uranium exploration activities (by 77 percent from $2.12 billion in 2014 to nearly $483 million in 2018), but also the curtailment of uranium production at existing mines, with more than 20,500 tons of annual production being idled. Uranium production volumes at existing mines are projected to remain fairly stable until the late 2020s, then decrease by more than half from 2030 to 2040.

Asserting that intense development of new uranium mining projects will be needed in the current decade to avoid potential supply disruptions, the report calls for a doubling in the development pipeline for new projects by 2040. The report was the source of the plot.

The Essex/Suffolk/Norfolk 400 kV transmission line

The transmission power line to Sizewell B was for 1.4 GW and without Sizewell A is adequate, so the building of the proposed doubling up of the South/North power lines through Suffolk is dependent on the building of 3.2 GW Sizewell C.

Without SZC "daisy chains" of HVDC power cables could run up the Suffolk and Norfolk coast off-shore from an extended SZB switching station, coupling up the off-shore wind landfalls until it reaches Sutton Bridge, where HVDC cables from the Northern off-shore wind landfalls terminate.

Subject: Net Zero attainment

As the England and Wales transmission and distribution sector is loaded with £55 billion of borrowings and NG has plans to spend £25 billion in the US and on NGV, it is difficult to envisage how NG will pay for the backlog of connections holding up the move to net zero. The alternative is for developments to start off-grid with energy storage and at net zero and with private captital.

The grid costs amount to 20% to 40% of the wholesale energy price and the off-grid developments will only need a standby connection to the grid for dark days and low wind episodes. This will reduce the need for the saturation of the countryside with pylons.

National Grid is planning to extend the grid and needs to hasten up the connections to offshore wind. However, solar PV should be on the rooves of new off grid developments, not on agricultural land, with onshore wind nearby.

Subject: New housing

There is no reason why new houses can't be off-grid, with solar PV and a battery. Instead of a grant of £7500 for heat pump exchange - why not add a battery to a new house with solar PV?

Also, all new houses should start with solar PV, an air-to-air heat pump with air internal circulation, with inlet/outlet air exchanged. No new estate gas mains should be installed and no gas boilers.

Conclusions

The hiatus in making grid connections can be avoided by an alternative of new developments being initiated off grid and net zero.

The Northern and Scottish offshore wind will not be able to be fully connected to England and Wales in the foreseeable future, so should be held in favour of off grid and net zero developments in the whole of the UK.

As Sizewell C is unlikely to be built or be fuelled, the £ssex/Suffolk/Norfolk 400 kV transmission line will not be necessary

Also, although NG is proposing to add batteries, they would be better deployed with the off grid developments for net zero operation.

As the proposed 24GW of nuclear power can't be fuelled, these factors together should stem the march of the pylons, which will not be needed.

John Busby 4 April 2024 (Revised 22 July 2024)

WNA fuel report plot of potential natural uranium supplies