Distributed energy

Commentary on Distributed Energy presentation.

Slide one

The UK's electricity grid was started in 1928 with the erection of 6,400 kilometres of mostly overhead cables, running at 132 kilovoltage and 50 Hz frequency and linking the then 122 most efficient power stations.

The 132 kV grid is now subsidiary to a 400 kV super grid run by National Grid's central control room with the task of maintaining stability of supply.

The introduction of renewable sources of electricity has created a distributed energy sector predominantly with solar PV on houses, industrial premises and large farm buildings. There are small and medium-sized wind turbines on farms and on some industrial sites. There is anaerobic digestion on farms, on sewage works and for food factories waste treatment.

Large, on- and off-shore wind farms augment central generation, but the stability of the national electricity supply is questioned by the introduction of the increased size of new nuclear power stations.

Stability of supply also relies on net imports/ exports of electricity from the EU.

Slide Two

The national grid consists of 400 kv, 132 kV overhead and intercontinental interconnectors.

Slide Three

Below the 400 kV and 132 kV power lines in the hierarchy are 33kV and 11 kV high voltage underground cables and overhead lines for town and rural distribution, followed by 415 V and 240 V for local distribution, to which solar PV, small wind and anaerobic digestion are connected as distributed energy, beyond the control of the national grid.

This makes better use of the existing power lines as self-generation reduces the input from the mains.

Slide Four

The national grid has to balance inputs with demand. If a major source of power drops out of action, such as a power station or offshore wind farm, other sources have to be brought on line to maintain voltage and frequency.

The bigger the size of the source dropping out, the speed of response in bringing in alternative sources is critical in avoiding a national blackout.

The loss of a big source may mean the assembly of several smaller sources. The distributed sources on the local distribution lines are not available to the grid controller.

Also the closure of big coal stations, together with the soon to be closed AGR nuclear power stations, has reduced and will reduce the ability of the controller to maintain stability.

Slide Five

Two power sources lost in quick succession led to the closure of a large part of Wales to avoid a complete national shutdown.

Also the contribution of the distributed sources in the isolated section was lost.

Slide Six

To maintain the generation of the renewables in an isolated section closed to maintain national supply poses a complex problem. The grid controller would need to isolate sections of the 400 kV and 132 kV lines to relieve the national load sufficiently in which there would be 33kV, 11kV, 415 and 240 V sections in which renewables are connected.

The question is whether it would be possible to maintain local supplies from renewables in the closed sections with standby generation for reference voltage and frequency? This would require too many control systems and is probably impractical.

The electronics in the dc/ ac inverters might be adapted to work when severed from the mains to supply a local need and to reconnect once central power is restored. If this is the case, then it would mean an immediate and total severance of all the renewables in an isolated section, which would otherwise give them an excessive load and they would be shut down.

Slide Seven

Of the list of nuclear power plants currently in operation only Sizewell B will remain until 2035.

Slide Eight

While still in operation the coal and the wood fired boilers can offer flexibility of output.

Slide Nine

The consumption of 385 TWh in 2010 fell by 88 TWh or 23% to 297 TWh in 2021

Central generation of 382 TWh in 2010 fell by 131 TWh or 34%, to 251 TWh in 2021, showing the move to distributed energy.

Slide Ten

The UK's central generation, i.e., without the distributed energy has declined from 2016 to 2020 by 11% to 251 TWh

The UK's consumption has declined from 2016 to 2020 by 7% to 297 TWh

The contribution of net imports/ exports and solar power of 23 TWh is significant.

Slide Eleven

The 2020 day GW averages are taken from the Gridwatch website.

At national minimum power of 17.151 GW, Hinkley Point C's transmission to the grid of 3.2 GW will provide 19% of the central load, which if it tripped with lightning would certainly be unrecoverable.

With SZB, HPC SZC and perhaps two Hualong 1 GW plants, nuclear would provide 55% of central generation.

These ratios will be more extreme with more distributed energy and the closure of the current nuclear plants, except SZB.

Slide Twelve

The owners of nuclear power plant have to run them 24/7 at 90% load factor to maximise revenue. If all those planned are in operation, unless considerable load is added, they will dominate 55% of the minimum load at night.

Just HPC's or SZC's transmission transfer of 3.2 GW would be 19% of minimum power. Either would not be available to fill the gap if one shut down. Both would need to run 24/7 for an even doubtful viability.

Slide Thirteen

The national electricity grid is soon to be not fit for the purpose.

It needs re-profiling to suit the increasing distributed energy and decreasing central generation. The potential new load for electrical vehicles might need a special grid extension for battery charging and part of the new nuclear could be diverted for this purpose, improving the stability of the current grid. The loss of a major nuclear power plant would then just stop vehicles being charged.

Slide Fourteen

Although small modular reactors are apparently more likely to fit into a distributed system, they are more likely to be uneconomical with the same technical staff costs and security. Also the automation and controls would be the same as for bigger plants.

As uranium supplies peaked in 2016, increased nuclear power fuel prices will rise and affect adversely the viability of SMRs.

Rivers in the UK are suffering low flow with water abstraction and SMRs would have to be sited on major estuaries. There would be concerns for radioactive outflows.

Otherwise, they would have to deploy fan air-cooled condensers, noisy and inefficient.

They would need to be sited in town industrial estates and there would be considerable local opposition.

Slide Fifteen

With central generation currently declining it is doubtful that Sizewell C is required. It is too big for grid stability and unacceptably expensive.

Domestic bills are rising and forward debiting for a future nuclear power station for over ten years will be unpopular, if not unaffordable.

SMRs are unacceptable to most communities and insecure.

Grid stability needs study, but major inputs are too big.

John Busby 26 August 2021