One thing we have learnt this week – power outage

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A week ago today there was a major power outage. Large scale power cuts are very rare. There have only been three on the UK grid since 1990. The 2003 power outage was confined to parts of London. The cause was a transformer that had not been maintained properly. The 2008 outage as I remember it was confined largely to SE England. Sizewell B nuclear power station went down at almost the same time as Longannet coal fired power station in Fife, Scotland. (This latter plant has since closed.) In the most recent one a gas fired power station and an off shore wind farm went off line. There was widespread disruption in England especially to the transport networks. Of course once anyone hears that a wind farm is involved, you get the anti renewables mob coming out. The Hornsea wind farm didn't fail for lack of wind, there was some other reason. I note however it still seems to be under construction. This is a complicated area but I'll attempt to explain it as far as I can. The grids frequency is regarded as its heartbeat and has traditionally been set at the speed of rotation of generators. In the UK this is 50HZ±1%. When there is loads of power then the frequency rises as does the voltage (in crude terms this is the pressure). If there is too little in the way of capacity then the opposite happens. Too much capacity is slightly easier to deal with. You simply switch stuff off. (With the rider that if you shed too much you'll cause the other problems.*) With a lot of renewables on the grid taking stuff off line is an economic issue. Also as far as I can gather high voltages less damaging. This I assume is because the there is less current (P=IV). The opposite seems to be true for low voltages. Low frequency also apparently affects any motors since they run in synchronicity with the frequency. So what can learn from the last two power outages? One big challenge for the grid is that now there are millions of generation systems that are either not setting their frequency physically or are not in the same way as a gas or steam turbine. These systems such as my PV installation mimic exactly what is on the grid, within set limits. Outside these limits then then my inverter (DC to AC conversion device) shuts down. In 2004 when my system was installed this happened quite a lot. I complained and the installer made a special trip up to sort the problem out. My system was set up under embedded generation connection standard G59/2. (Embedded generation is small scale stuff that feeds in the low voltage distribution network. Not huge power stations that feed into the transmission network.) This meant that at times of high demand/low capacity when there was a low voltage my inverter shut down. The solution was simple, to set it to the new standard G83/1 using a powerline modem. This newer standard has wider ± voltage limits. In the 2008 power outage a lot of small generation systems tripped out because they had not yet been reprogrammed from an even older standard G59. This of course made the problem worse. They did this not because the voltage/frequency was low but because of the *rate* of drop of the frequency. What exactly happened in the recent power outage is unclear, but lots of embedded generation did shut down which of course is a positive feed back loop. This must again have been due to the rate of frequency drop, rather than the frequency itself which seems to be set at 47Hz.) National grid carried out load shedding. That is they cut power off to large users. This included hospitals (where at least one emergency generation system failed to start) and traffic lights and railway signalling systems. That's why you had the slightly bizarre situation where traffic lights were working and other things around them weren't. So what is to be done? The first thing to say is that managing the grid is more of a challenge with lots of renewables. Apart from variability in output thermal plant has some inertia i.e. when it goes down the turbines spin to a halt slowly. But clearly since the amount of renewable capacity has gone up about 3 fold since 2008 its far from impossible. As I write this almost 40% of the UK's electricity demand is coming from wind and everything is fine. There are two solutions that immediately come to mind. The first dynamic demand management. Not everything needs to be on all the time. One example has been in the news this week. A supermarket chain will switch its fridges and freezers off at time of high demand. The second obvious solution is to add more storage capacity. Batteries yes, but other technologies such as air or flywheels. In my opinion we need to revisit the Dartmoor pumped storage scheme as well and others. The last thing to do is to work why so much embedded generation shut down and perhaps set the rate of frequency change settings differently. There is

so much embedded generation on the grid now that it shutting down in tandem makes things far worse. Neil * This is a problem with lots of embedded generation of one type. The Germans have worried about this. They have so much PV output in summer, that in principle if the voltage and frequency went above limits then the whole lot could shut down leading to a power outage. Remember there is no central control over millions of domestic systems. They came up with a neat idea from the control point of view, though less good for individual PV owners. They decided to set voltage limits differently in different parts of the country. So in sunny parts with higher insolation the limits would be narrower and visa versa.

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