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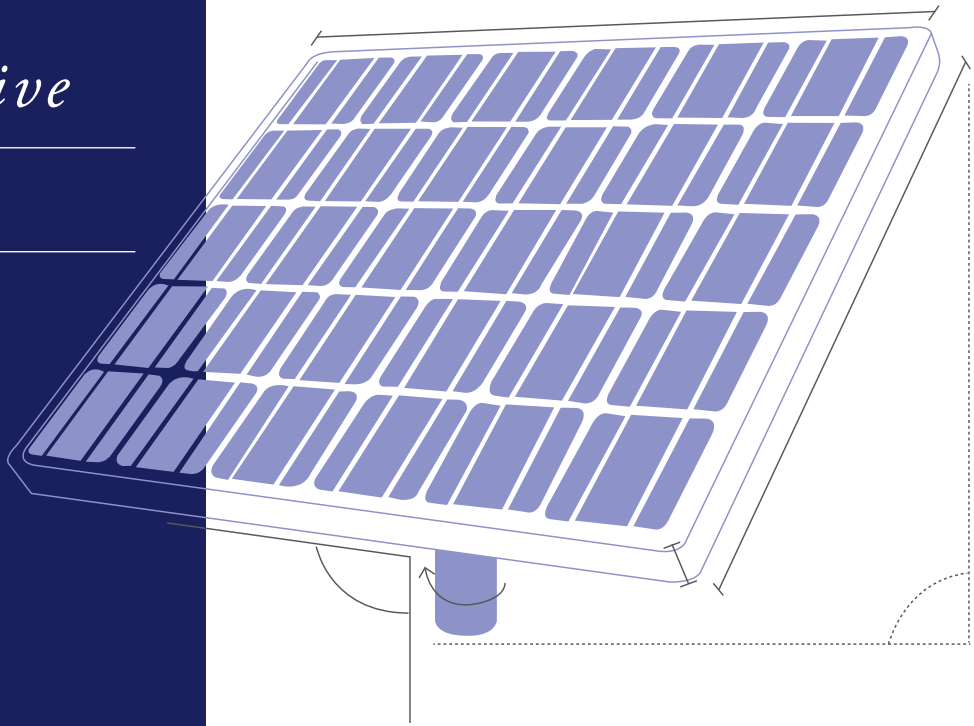
An ETI Perspective

Can you base a UK transition to low carbon on solar PV?



INTRODUCTION

2015's UK Government 'Reset' on energy policy focussed on keeping the lights on. Subsequently, subsidies for renewables and bioenergy have been reduced and the Carbon Capture and Storage (CCS) competition cancelled. The future of large nuclear through Hinkley Point C remains uncertain, creating an environment where new investment in large scale power plants looks increasingly difficult. Without major new policy developments, it could be that by 2030 the only new low carbon generation built through contracts for difference (CfDs) will be "up to 10GW of new offshore wind"[1] and solar PV. Both are intermittent, but to an extent predictable. Here we look at what the UK power system might be like without new nuclear or CCS in the 2020s.

[1]A new direction for UK energy policy, Amber Rudd, 18th November 2015

A ROLE FOR SOLAR

Could solar PV really form the basis for transitioning the UK's energy system to low carbon or is it likely to be a niche but contributing technology?

The cost of solar panels has fallen dramatically in recent years and the capacity installed in the UK has now reached 10GW. Feed-in-Tariff's (FITs) were cut again in January 2016 and the Renewables Obligation shut in April 2016 but let's assume that CfDs materialise and ground mounted solar farms, being substantially cheaper than rooftop solar[2], remain a viable investment.

Unfortunately the sun doesn't shine when demand is highest (winter evenings) and when it does shine in winter it is low in the sky meaning solar panels are less effective. For solar to function effectively the country would need significant back-up generation or energy storage. Today this is held as 'spinning reserve' gas-fired powerplants running at low load and pumped hydro storage facilities in Wales and Scotland.

[2]IEA Solar PV Roadmap (2014) suggests it is 50% more expensive to utilise rooftop installations for solar power generation compared to ground mounted arrays

WHAT ABOUT INTERCONNECTORS?

There could be up to 8GW of new electricity interconnector capacity by 2030 but will these keep the lights on? The actual power delivered is based on circumstances outside of the UK's direct control. European countries with significant wind capacity – Ireland, Denmark – see similar weather patterns to the UK and are unlikely to have excess electricity to export when the wind is not blowing. France has excess nuclear power today but has plans to introduce more renewables so its ability to export power in the future is uncertain. The UK would therefore still need back-ups or storage capacity.

Batteries have shown significant cost reduction potential so could solar PV generation with battery storage form the basis for transitioning our energy system, and what would the UK electricity system look like by 2030 if the country was relying heavily on solar PV?

ETI analysis suggests that by 2030, alongside the government's desired additional 10GW of offshore wind and 8GW interconnectors, the UK would need 188GW of solar PV capacity - more than double today's total power generation capacity with solar PV delivering 163TWh annually (just over half of current total demand). These solar farms would require land area equal to all four national parks[3] in the south and south west of England – incidentally the sunniest part of the UK.

Assuming no reduction in planned wind and legacy nuclear generation, less than half (47%) of this PV generation could be used at the time of production, the majority of this daytime power generation would be surplus.

This is the opportunity for electricity storage – storing electricity produced in the middle of the day for use in the evenings and early morning, avoiding the need to 'turn off' PV in summer. But what about meeting our winter peak demands – currently most effectively delivered by unabated gas-fired power plants.

There could be up to

8GW

of new electricity interconnector capacity

by 2030

[3] Dartmoor, Exmoor, New Forest, South Downs

COULD WINTER DEMAND IN 2030 BE MET WITH ELECTRICITY STORAGE?

In theory yes – if we think the UK can build another 80GW of solar (above the 188GW already assumed) and provide around 60TWhs of storage, equating to a 40ft shipping container battery pack for every person in the UK. In reality, converting most of the excess electricity to hydrogen, storing it in salt caverns until winter and then using it in gas turbines to produce electricity is likely to be a simpler, cheaper and more robust option, but this will require even more solar to be built due to conversion losses in going from PV electricity to stored hydrogen.

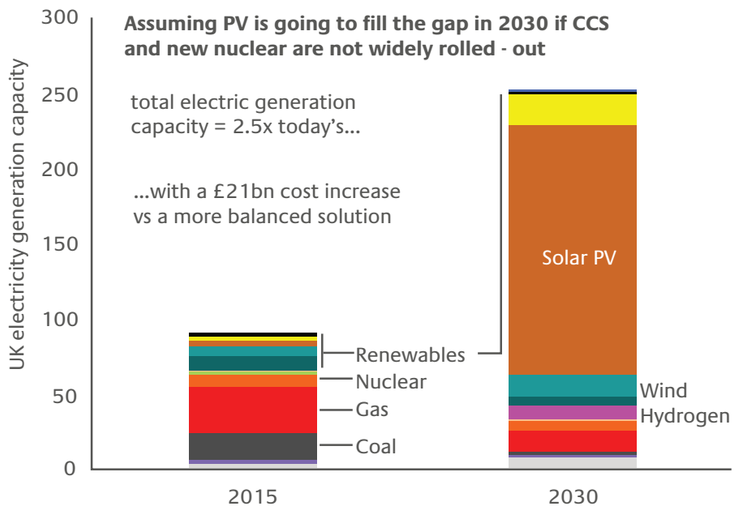
And then there is the issue of the electricity grid. Both the transmission and distribution systems have limited capacity and solar farms tend to be clustered where there are land, sun and grid connections. There are a host of grid management issues to consider – including stability, voltage control, and frequency response – and although batteries can contribute towards some of these, large fossil fuel and nuclear plants provide necessary power quality and security benefits (through 'mechanical inertia') that solar PV with batteries cannot deliver.

System costs for this scenario would be expected to rise further beyond 2030 to support increasing electricity demand from vehicles and heating.

WHAT WOULD A SOLAR STORAGE SYSTEM DRIVEN SOLUTION COST?

Assuming solar PV costs continue to fall as predicted by the Solar Trade Association and storage costs fall by 2030 to one fifth of the price announced by Elon Musk of Tesla Motors last year and legacy gas plants are still used in winter, then UK national abatement costs might be held at about £30bn per year.

ETI modelled UK energy scenarios for 2030 with electricity generated in roughly equal proportions from renewables, nuclear and CCS typically show abatement costs of just £9bn per year.



WHAT WOULD A SOLAR PV STORAGE SYSTEM MEAN FOR THE UK?

Significant electrification of cars and home heating will be needed to meet UK 2050 targets so the country would need to further increase winter generation and overall system flexibility. The UK needs to reduce emissions from industry as well as power and without bioenergy and CCS creating negative emissions then you need to take a further 50-100MTe CO_2 pa out of vehicles, homes and industry to meet targets. These are expensive steps and in part drive the £21bn cost increase from a balanced power system to a solar and storage dominated system. The recently agreed UN goal of achieving nett zero emissions would remain a pipe dream for the UK.

Over the next decade the UK needs to replace its coal plants and aging nuclear plants with a mix of renewables, low carbon firm generation (new nuclear, fossil fuel or biomass with CCS), flexible, controllable secure generation (gas and hydrogen powered) whilst developing smart solutions across the entire energy system, not just in electricity. Solar with batteries will contribute, and is important in raising public awareness of the low carbon possibilities, but the UK's needs indicate that a much more diverse approach to power delivery will deliver a low carbon transition more efficiently and cost-effectively.

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