Briefing

Why a 'vaccine task force' approach is needed for clean flexible power

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green alliance...

Summary

As the UK power sector expands and transforms to be dominated by variable cheap renewables like wind and solar, more flexible generation capacity and demand side flexibility will be necessary.

Current market arrangements favour new, polluting gas power stations, which are more expensive than cleaner alternatives.

Speed is of the essence to bring down energy costs, increase energy security and tackle climate change. Sticking with unabated gas power rather than building cheaper, cleaner alternatives now could mean consumers pay twice as much as necessary for power at times of peak demand.

To avoid this, the government should act now to ensure investment flows into cheaper, cleaner power options through a new 'clean flexibility task force'. The approach should emulate the vaccine task force during the Covid-19 pandemic: procuring multiple technologies now to guarantee sufficient capacity to maintain energy supply and bring down emissions. The technology trajectory could be refined later, to optimise for the cheapest, cleanest solutions already tested via the task force push.

Because the government has not significantly reformed the capacity market, through which it procures flexible power, for a decade, a new task force leading early deployment of clean flexible power technologies is likely to be the cheapest way to meet the UK's energy goals.

Introduction

Both the government and the opposition have committed to reaching a zero carbon power system by or before 2035. The cheapest way to meet this goal – at lower cost than today – will be if 80-90 per cent of electricity is supplied by renewables, like wind and solar.[1]

The remaining ten to 20 per cent will need to be clean flexible power, providing 50 to 150GW of capacity.

What is 'clean flexible power'?

Clean flexible power comes from sources that can be turned up or down to meet energy demand, technologies that can store electricity for later use, or 'demand response', where energy consumers can adjust how much energy they use to help maintain a balanced grid.

Batteries and short term demand response are capable of balancing variable supply and demand within the power system for short periods of up to eight hours. But new clean flexible power and demand reduction is needed over longer periods, including to deal with variation in demand from season to season, and to supply electricity during wind droughts. These can last from a couple of days once or twice a year to, in the most extreme cases, up to four weeks once a decade.[2]

Clean flexible power is cheaper than gas

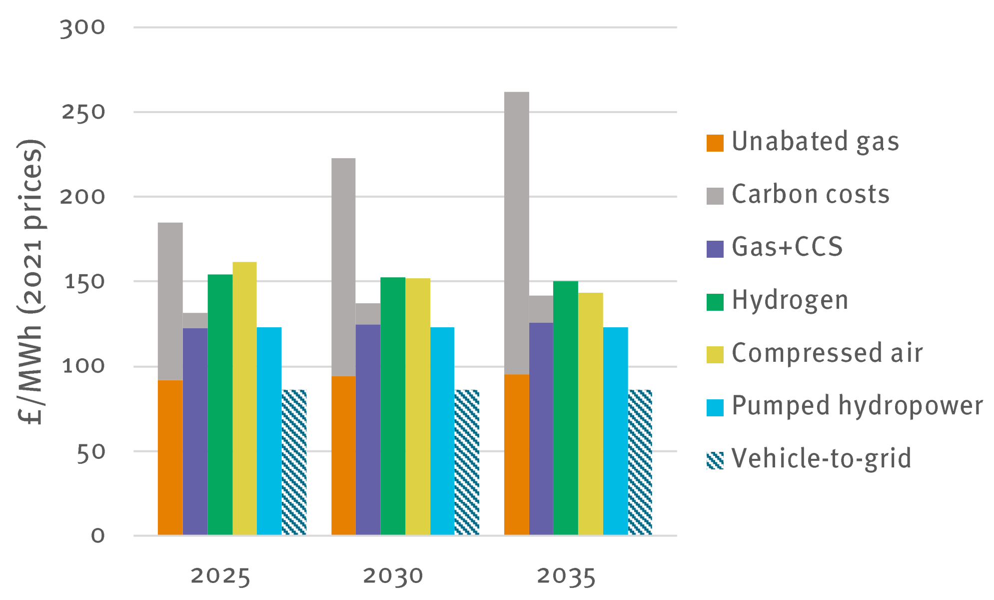
A decade ago, the capacity market (CM) was introduced through the government's 'electricity market reform' package to help provide secure, flexible power. It has successfully procured short term energy storage: 1.2GW of new battery capacity was contracted in the latest auction.[3]

But flexible power supply for over eight hours is primarily provided by unabated gas power plants, with smaller amounts coming from biomass plants and existing pumped hydropower. The government's refusal to reform the CM over the past decade means that new medium and long duration flexibility, built under the CM, has been overwhelmingly fossil fuel based, rather than coming from zero carbon sources, long duration energy storage, demand flexibility or demand reduction.[4,5]

Demand side response could provide extremely low cost flexibility but needs support to scale up. Otherwise, there is a risk that high cost supply side solutions like gas will continue to be prioritised.

Building gas power plants is already costing consumers a lot of money. To illustrate this, we have compared the government's cost projections for unabated gas power plants (which top up the grid when there is high demand or low levels of renewable generation, eg open cycle gas turbines running for 2,000 hours per year) to the estimated costs of new hydrogen and gas carbon capture and storage (CCS) plants, and to medium and long duration energy storage technologies, compressed air energy storage and pumped hydropower.[6,7,8,9,10,11] We have also included a conservative, ie high, estimate of the potential cost of vehicle-to-grid energy storage as an example of demand side flexibility.[12] The results are summarised in the graph below.

All clean flexible power technologies may soon be cheaper than unabated gas, and will become even cheaper in future



We find that new unabated gas may already cost more than cleaner alternatives, and is expected to become even more expensive over time. By 2035, flexibility provided by clean technologies could cost about half that of unabated gas.

Going slowly only benefits gas companies

The short timeframe available to decarbonise the UK's power system to meet climate targets and the fact that alternatives to unabated gas are cheaper today is a compelling case for more rapid change. While it is not possible to predict exactly which combination of technologies will be optimal for the UK's power system in the 2030s, building clean flexibility would be better than the status quo on grounds of the cost to consumers, energy security and carbon reduction.

An optimal approach would be to procure clean flexibility immediately, rather than wait for market based price discovery to show exactly which and how much of each technology should be built. Waiting means costly polluting gas plants will continue to be built, locking in further climate impacts.

Invest for early results

When the government launched its vaccine taskforce to find an effective route to immunity from the Covid-19 virus, it did not focus on cost reduction to seek the cheapest, long term 'best' vaccine. The urgency warranted investment in a portfolio of options using different techniques, to give the UK the best chance of developing a safe and effective vaccine as soon as possible.[13]

In this case, the government acted more like a hands on venture capital investor, working in partnership and helping to shore up any weaknesses in the supply chain. If it had simply waited for an optimal vaccine to gradually develop, the Oxford AstraZeneca vaccine may never have been produced. This protected the most vulnerable in society until the later, more effective mRNA alternatives were developed, and it was cheaper and easier to store. This enabled more people to be vaccinated more quickly, especially during the winter of 2020-21.

A similar approach to clean flexible power would deliver results quickly. A task force, focused on the urgent need for clean, flexible power, would ensure it is deployed, and should help identify and clear any barriers. Unlike most government procurement, there should not be an overwhelming focus on compliance, but rather a collaborative effort to achieve quick results, in the style of venture capital investment and the vaccine task force. This task force should oversee deployment to ensure lessons are learned from developments, and make adjustments as necessary from 2030 onwards, as power demand rises and more flexible capacity is required.

A 'build it all' approach to clean flexible technologies would also boost jobs and economic activity through the domestic supply chain. It would allow the UK to compete internationally, as well as solidify demand for clean hydrogen from new UK producers.[14]

Various support regimes proposed by the government could be used by a task force to accelerate deployment, including a Dispatchable Power Agreement for gas power with CCS and hydrogen power, a 'cap and floor' mechanism for long duration storage, and a reformed CM. Contracts for difference (CfD) or cap and floor mechanisms (similar in effect to CfDs) may be appropriate for hydrogen, gas with carbon capture and compressed air energy storage, whereas state ownership or state investment, in return for part ownership, could be more suitable for pumped hydropower.

However, none of these support frameworks are yet in place, and existing CfD auctions come with a capped budget, limiting the capacity that can be contracted. The failure of the fifth auction round for renewables CfDs in 2023 demonstrated that the existence of a support mechanism does not guarantee that capacity will be built. A clean flexible power task force would ensure that contracts are signed quickly.

There's little danger of too much clean flexibility

It would be very difficult to deploy too much of any of the technologies we analysed by 2035, because the supply chains for all of them are constrained. By 2050, UK electricity demand is likely to be twice that of today, meaning more clean flexibility will be needed to maintain power supply. This could be procured following the lessons learned from a clean flexible power task force. The task force could recommend how the government should adjust its support over time. It is only by building the technologies now that price discovery will happen soon. We recommend that the task force should procure the following quantities of different technologies:

Pumped hydropower: A good example of the constraints which limit the risk of over procurement is pumped hydropower: only a few geographies suit new large scale development. Nevertheless, there are several projects in development that could double existing pumped hydropower capacity, but which cannot secure sufficient financial support through the current CM to go ahead.[15] **The task force should procure 3GW by 2030.**[16]

Compressed air: Compressed air energy storage is a form of long duration storage that is well established in other countries. Although not deployed at scale in the UK, it has great potential, with salt caverns capable of storing many times more energy than the UK will ever need.[17] A limit on the amount of compressed air energy storage development might be appropriate, which would drive down prices through competition for the capacity qualifying for government subsidy. **The task force should procure 2GW by 2030.**[18]

Hydrogen and gas CCS: There will be a limited supply of hydrogen, and limited access to CO_2 transport and storage infrastructure, which will constrain where these types of plants can be built. Care is required to ensure capacity is linked to adequate infrastructure and fuel supply, and the task force should be wary of locking in too much reliance on CCS or hydrogen. **The task force should procure 10-15GW by 2030.**[19]

These options are not exhaustive. The task force may need to consider other long duration energy storage technologies, and must ensure cheap demand side response and vehicle-to-grid options are also deployed. Vehicle-to-grid has a technical potential of at least 6GW and is likely to be so cheap that there is no obvious upper limit.[20]

The costs of most clean flexible power technologies are expected to fall but, even if some fall more sharply than others, there is unlikely to be any regret in deploying more of all of them, as they are all cheaper than building new unabated gas power plants.

Conclusion

The UK's electricity system is expanding fast as transport and heating electrify. This, coupled with the retirement of some existing gas power stations, means that investment is needed to maintain a stable grid.

The government's Review of Electricity Market Arrangements (REMA) should evolve the CM and start to address this problem, but the REMA process is slow. Meanwhile, every new unabated gas power plant built is leading to negative outcomes for bill payers and the climate.

Price discovery happens by building, not by waiting. The government should convene a clean flexible power task force. This would ensure the deployment of a range of available clean technologies to balance the electricity grid when renewables cannot meet demand or when demand is high, reducing costs for consumers and cutting carbon emissions, while increasing energy security.

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Endnotes

1 S Dossett and L Hardy, January 2023, Green Alliance briefing, 'The building blocks of a secure 2035 zero carbon power system'
2 The Royal Society, September 2023, 'Large scale energy storage'
3 Electricity Market Reform Delivery Body, March 2023, 'Final auction report; 2022 four year ahead Capacity Auction (T-4)', National Grid ESO

[4] A Mount, E Coats and D Benton, 2016, 'Smart investment: valuing flexibility in the UK electricity market', Green Alliance
[5] Eighty six per cent of all new build generation contracted through the T-4 capacity market auctions in the past four years has been unabated gas power. The majority of the other 14 per cent has been short duration battery storage.
[6] All estimated costs are consistent with the values provided by the Climate Change Committee in its March 2023 report 'Delivering a reliable decarbonised power system'.
[7] We compare costs with unabated open cycle gas turbine (OCGT) plants because, without further policy changes, government modelling indicates that OCGTs will continue to be built to replace other ageing plants, at least until 2035 when emissions limits for the capacity market are expected to be tightened. See, for example, page 19 of the Department for Energy Security and Net Zero (DESNZ) report 'The need for government intervention to support hydrogen to power'. Carbon costs grow in line with the government's appraisal prices, also known as the carbon value. Unabated OCGT costs are for a 600MW plant running for 2,000 hours per year, taken directly from: DESNZ, August 2023, 'Electricity generation costs 2023'
[8] To estimate costs for gas plants with carbon capture and storage (CCS), we again imagine a 600MW OCGT plant running for 2,000 hours per year, but with added CCS costs. To estimate these, we use 2020 'Electricity generation costs' projections from the Department for Business, Energy and Industrial Strategy (BEIS), which include both combined cycle gas turbine (CCGT) plants and CCGT+CCS plants. We compared the fixed capex and variable opex costs from the BEIS modelling, and applied either a corresponding cost premium (for fixed costs) or a multiplier (for variable costs) to the 'Electricity generation costs 2023' modelling for OCGTs, adjusting for inflation from 2018 prices into 2021 prices using the Bank of England inflation calculator. We adjusted the residual carbon costs to match those shown in Annex A of 'Electricity generation costs 2023'.
[9] To estimate costs for hydrogen power plants, we used the DESNZ 'Electricity generation costs 2023' Annex B calculator and the Annex A technical and cost assumptions for a 1,200MW first of a kind hydrogen CCGT plant, running for 2,000 hours per year rather than as baseload.
[10] To estimate costs for compressed air energy storage, we use the Lifetime Cost calculator provided by: O Schmidt and I Staffell, 2023, 'Monetizing energy storage: a toolkit to assess future cost and value', Oxford University Press, available at energystorage.shinyapps.io. We use the default assumptions for frequency and duration of discharge under the 'Renewables Integration' application (eight hour discharge, 300 times a year), and an electricity purchase price of £40 per MWh. We assume that the power capex cost in £ per kW for compressed air energy storage declines gradually from 2025 to 2035, through the range of values estimated in: Climate Change Committee (CCC), 2023, *Delivering a reliable decarbonised power system*.
[11] To estimate costs for pumped hydropower, we again use the calculator at energystorage.shinyapps.io and the default assumptions under the 'Renewables Integration' application. We assume a steady capex cost of £1,440 per kW for pumped hydropower, which is higher than the default assumption but consistent with the CCC's in *Delivering a reliable decarbonised power system*. We do not expect costs for pumped hydropower to fall as this is already an established technology in the UK.
[12] To estimate costs for vehicle-to-grid energy storage, we again use the calculator at energystorage.shinyapps.io and default assumptions under the 'Renewables Integration' application. Here, we assume that capex costs (ie for the installation of two way EV charging technology) are ten per cent of the default capex costs of static grid scale lithium ion

batteries. This ten per cent estimate is a conservative rounding up of a six per cent figure reported in: Australian Renewable Energy Agency, June 2030, *V2X.au summary report – opportunities and challenges for bidirectional charging in Australia*. We then added a further 20 per cent premium on the resulting cost per MWh, to account for aggregation and operating costs for vehicle-to-grid behaviour, and an incentive for car owners to participate. The resulting estimated costs are at the low end but are consistent with those found in J Geng, et al, 2024, 'Assessment of vehicle-side costs and profits of providing vehicle-to-grid services', *eTransportation*, vol 19, pp 100,303.

[13] K Bingham, January 2021, 'The UK Government's Vaccine Taskforce: strategy for protecting the UK and the world', *The Lancet*, vol 397, pp 68-70

[14] C Murray, 26 October 2022, 'Construction starts on 1.4GWh compressed air energy storage unit in China', *Energy Storage News*

[15] For example, Coire Glas (1.5GW maximum output and 30GWh storage capacity) and Balliemeanoch (1.5GW maximum output and 45GWh storage capacity) are provisional projects in Scotland seeking a route to derisking investment. Pumped hydropower plants take longer than four years to build, and often take longer than 15 years to achieve payback, meaning the capacity market, which offers 15 year contracts, is unsuited to support their deployment.

[16] National Grid ESO's Future Energy Scenarios rely on up to 6GW of pumped hydropower (including the existing 2.7GW), as well as up to 10GW of compressed air and liquid air energy storage.

[17] The Royal Society, September 2023, op cit

[18] National Grid ESO, 2022, 'Potential electricity storage routes to 2050'. This paper notes that 1-2GW of other energy storage is needed to balance the system in ESO/Regen's 'Day in the Life' modelling. Research commissioned by BEIS, and conducted by AFRY in 2022 (*Benefits of long duration electricity storage*) found that 15-19GW of medium and long duration energy storage capacity (excluding hydrogen power) is likely to be optimal in 2050, and at least 3GW of this would be low regret.

[19] S Dossett and L Hardy, op cit. 8-20GW of gas with CCS or hydrogen power capacity is found in most models of a decarbonised power system in 2030 or 2035, often with some unabated gas capacity remaining on the system as backup. In the last four capacity market auctions, an average of 6.4GW of new build unabated gas power was contracted each year. There should be no regret in replacing this with clean flexible power.

[20] This is a very conservative estimate based on an assumption that there will be at least 5 million EVs on UK roads by 2030. Even if only a quarter of these are available to discharge at any one time, they could provide at least 40 GWh of power over extended periods.