How can the delivery of national infrastructure meet the national need to decarbonise and ensure climate resilience for communities and the environment?

Introduction

The urgency of climate change necessitates the rapid decarbonisation of energy production to limit global warming and carbon emissions and the UK has set a target to reduce its greenhouse gas (GHG) emissions by at least 100% compared to 1990 levels by 2050.

This paper takes a broader approach to the need for decarbonisation and climate resilience, beyond that which can be provided by national infrastructure alone. The low carbon transition presents opportunities to rethink not just how energy is produced but how it is governed and delivered. Without reconsideration, it risks reinforcing existing energy injustices and entrenching corporate market actor oligopolies.

It proposes to reconcile the speed and scale of Nationally Significant Infrastructure Projects (NSIPs) with the energy resilience and community benefits of micro-grids; through their co-delivery alongside NSIPs as a mitigative response to development.

The model integrates centralised and distributed systems that in policy and regulatory terms are considered separately but are equally essential to the renewable energy transition. It uses solar energy as an example however, the principles are transferrable to other renewable energy sources such as wind and hydroelectric power, where existing communities are impacted by large-scale energy projects.

Solar NSIP Contestation

Intrinsically modular, solar technology is relatively fast to install, low cost and can be placed on buildings or ground-mounted at scale. Solar deployment is considered critical for the UK to diversify its energy mix, with central government setting a goal to increase solar capacity to 45-47 GW by 2030, more than double existing provision (DESNZ, 2024).

Increasingly, solar farms and parks are being promoted through the NSIPs regime to help meet these targets. However, at ~4-5.6 acres of land required per Megawatt (MW) for a ground-mounted system, utility scale projects require extensive parcels of land (Spry, 2024).

Predominantly in rural areas where land is more abundant, communities are under pressure to accommodate the national need for low carbon electricity generation. This has caused ‘green on green’ conflicts between food production and energy land uses (Warren *et al*, 2005) as well as other concerns such as supply chains and upstream environmental damage (Morton, 2022). This results in a growing discontent towards the cumulative effects from multiple developments which are compounded by energy transition acceleration. Agrivoltaics is an emerging application of solar technology that may assuage food security concerns. It advances new solar layouts that are either raised above the land for crops and grazing or sited vertically to provide space between (Neesham-McTiernan et al, 2025).

Rural areas experience weaker labour markets and reduced levels of investment compared to core urban locations (Lee, Fransham and Bukowski, 2024). Utility-scale solar projects are in danger of reinforcing these spatial inequalities, by concentrating national scale infrastructure in peripheral areas while extracting and exporting the benefits in the name of national need.

Efforts to mitigate public concerns including Community Benefit Funds and ‘co-ownership’ opportunities provide little agency and assumes resources are available for communities to invest (Strachan *et al*, 2015). Worse still, proposed financial incentives to affected communities (DESNZ, 2025a) presume self-interest as motivators for resistance and fails to acknowledge deeper held concerns of place (Devine-Wright, 2009).

Centralised Infrastructure

The NSIP regime provides a ‘streamlined’ path for consenting large-scale energy infrastructure when compared to the Town and Country Planning process, through stricter timescales and centralised decision-making that intends to facilitate rapid implementation (Whiteley, 2024). By way of example, Heckington Fen Solar Park in North Kesteven, once online, will have over twice the electrical capacity of all non-NSIP solar farms consented in the authority’s area since 2012 combined (Hunt, 2024).

NSIPs are not without controversy, being decried by some for limiting opportunities for deliberative participation (Esposito, Felicetti and Terlizzi, 2023) and not resulting in the substantive reductions in project delivery as was originally intended by the statute that enables them (Marshall and Cowell, 2016).

Nevertheless, installed solar capacity has grown by 2.5GW in the last 12 months alone (Lynas, 2026). Solar is not immune to political cycles, with previous public subsidy withdrawal accounting for a collapse in solar deployment between 2016 and 2024 (Rankl, 2024). So too, the pace of landscape change from so-called ‘green industrialisation’ has provided oxygen to political actors seeking to capitalise on marginalised rural community sentiment (Heffron and Carter-Brookes, 2025).

NSIP solar schemes represent a traditional energy pathway that favours centralised provision (Mercante Thierauf, 2025), with electricity exported in bulk to the National Grid. Centralised systems provide advantages, such as economies of scale, efficiency and reliability of transmission. They also have the benefit of plugging into a pre-existing infrastructural and regulatory environment that favours centralised systems (Judson *et al*, 2020).

Yet, centralisation is vulnerable to disruptive events (Bouffard, 2008), such as the 2019 power outage, which affected over 1m people and suggested that the rapid decarbonisation of the grid may actually be reducing resilience (Bialek, 2020).

Decentralisation: Micro-Grids

Distributed network models assume dispersed and smaller-scale energy ownership, controlled by a new class of 'prosumers'; that is, individuals and collectives who both consume and produce energy, with excess supply exported peer-to-peer or back into a centralised grid (Judson *et al*, 2020).

A minority but growing number of communities are promoting their own co-ownership models, giving rural localities democratic control over energy production and usage. The UK lags comparable economies in this regard and successive commitments to support local production have been forwarded (Lockwood, 2023). Despite their advantages, the greatest barrier to delivery is funding, followed by uncertain investment return, capacity and technical expertise (DESNZ, 2025b).

Ray Valley Solar is a community-owned solar park in Arncott, which supplies electricity back to the national grid and generates 19.5 GWh of electricity annually (Low Carbon Hub, 2026). Nonetheless, energy is exported out of the locality and is subject to centralised energy market dynamics (Horton, 2024).

Peer to peer (P2P) trading between prosumers in the UK is regulated, requiring an intermediary 'supplier' to facilitate the system. Full democratic control is thus difficult in the current regulatory environment and suppliers act as gatekeepers, determining the entry rules for joining trading pools (Judson *et al*, 2020).

Micro-grids are a form of autonomous network with the ability to 'island' and maintain supply when the central grid fails, making them more resilient to disruption (Aoun *et al*, 2024). Micro-grids aren't necessarily synonymous with renewable energy, and studies have shown that resilience and self-sufficiency are greater drivers of adoption than environmental concern (Warda, 2019).

Nevertheless, micro-grids have the potential to provide remote and peripheral communities clean energy without reliance on centralised distribution models and macro price fluctuations in the wider market. In addition, agency over production has shown to translate into reduced demand through a raised awareness of energy use amongst cooperative members (Yildiz *et al*, 2015).

Synthesising Centralised and Distributed Systems

To reconcile the advantages and disadvantages of both infrastructure models, a hybrid approach is proposed that synthesises centralised NSIPs with decentralised micro-grids.

NSIPs benefit from regulatory and economic advantages by virtue of scale; an integrated approach shares these with the local communities which host them. Where feasible, national scale solar farms should provide micro-grid nodes powered by solar and battery storage to serve hosting communities, with the larger development acting as an energy hub. Excess supply from the micro-grids would be traded back upstream, generating income and having the ability to island during times of disruption. Local grids may be owned and governed by co-operatives such as Community Benefit Societies (CBSs).

Suppliers under Contracts for Difference (CfD) subsidy can act as facilitators for local trading on the micro-grid and 'nest' equivalent tariff mechanisms between community prosumers and the supplier, maintaining a stake in the community. This stabilises income for both and de-risks capital exposure. Tariffs can be agreed between supplier and community within the examination stage as can governance structures.

Profits from micro-grids can be re-invested into the communities they serve, and energy cost savings frees up capital for local businesses to invest, which enhances local economies and labour markets.

Meaningful stakes in local energy may galvanise support for NSIPs in rural locations and reduce the level of contestation evident in the current transition pathway, limiting project delay and increasing political legitimacy.

Conclusion

NSIPs have the potential to act as vehicles for national infrastructure evolution. Reforms to existing mitigative responses to their introduction in host communities is urgently needed - The integrated approach suggested incorporates the strengths of both central and distributed systems, to create a new fractal electrical network that delivers community benefit, local resilience and economic efficiency while supporting the wider need for energy transition.

Further refinement and reform of regulatory and planning frameworks are required, and it is proposed a hybrid approach to electrical network provision allows a realistic and effective way to decarbonise.

Underlying this pathway is a commitment to policy-alignment across energy infrastructure design, that enables the energy transition to combine climate goals with energy justice, democratisation and systemic resilience at national and local levels.

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