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Green Energy International: Lincolnshire Solar Project – Independent Policy Report

30 April 2024

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HELPING YOU MAKE SENSE
OF THE ENERGY SECTOR

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Our independent experts work across the energy market and provide high quality and actionable insights on which to base your business decisions. We look to facilitate positive market and policy change, whilst also advising customers on how to navigate and comply with energy market dynamics, rules and regulations.

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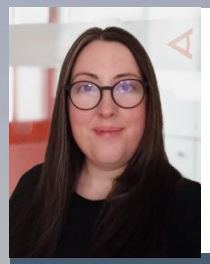
Our experts in-depth working knowledge of energy market design, including policy and regulatory changes, means we are perfectly placed to advise on changes to the future market design and help businesses achieve their net zero goals.



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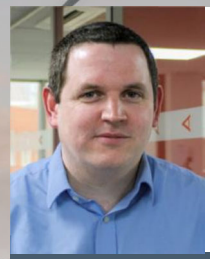

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- Our research creates new knowledge and insight in markets that are rapidly changing, leveraging Cornwall Insight's in-depth knowledge and expertise in the energy sector.
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Introduction & Disclaimer

- This report has been prepared by Cornwall Insight Ltd ("Cornwall") specifically for the client named in this report, Green Energy International Ltd ("GEI"), for the sole purpose of providing expertise to all interested parties in relation in the Caudwell Farm development.
- This report aims to provide independent expertise about a potential 49.9MW solar PV development at Caudwell Farm, Lincolnshire, suitable for communication with a wide range of non-energy industry stakeholders.
- This report does not constitute a recommendation for any specific action, nor does it consider the unique investment objectives, financial situations, or needs of individual investors regarding a development. It should not be viewed as advocating for or against any specific decision. This report does not contain exhaustive information necessary for decision-making. We are not liable for any errors or omissions in this report, which is based on publicly available industry data and information provided by others.
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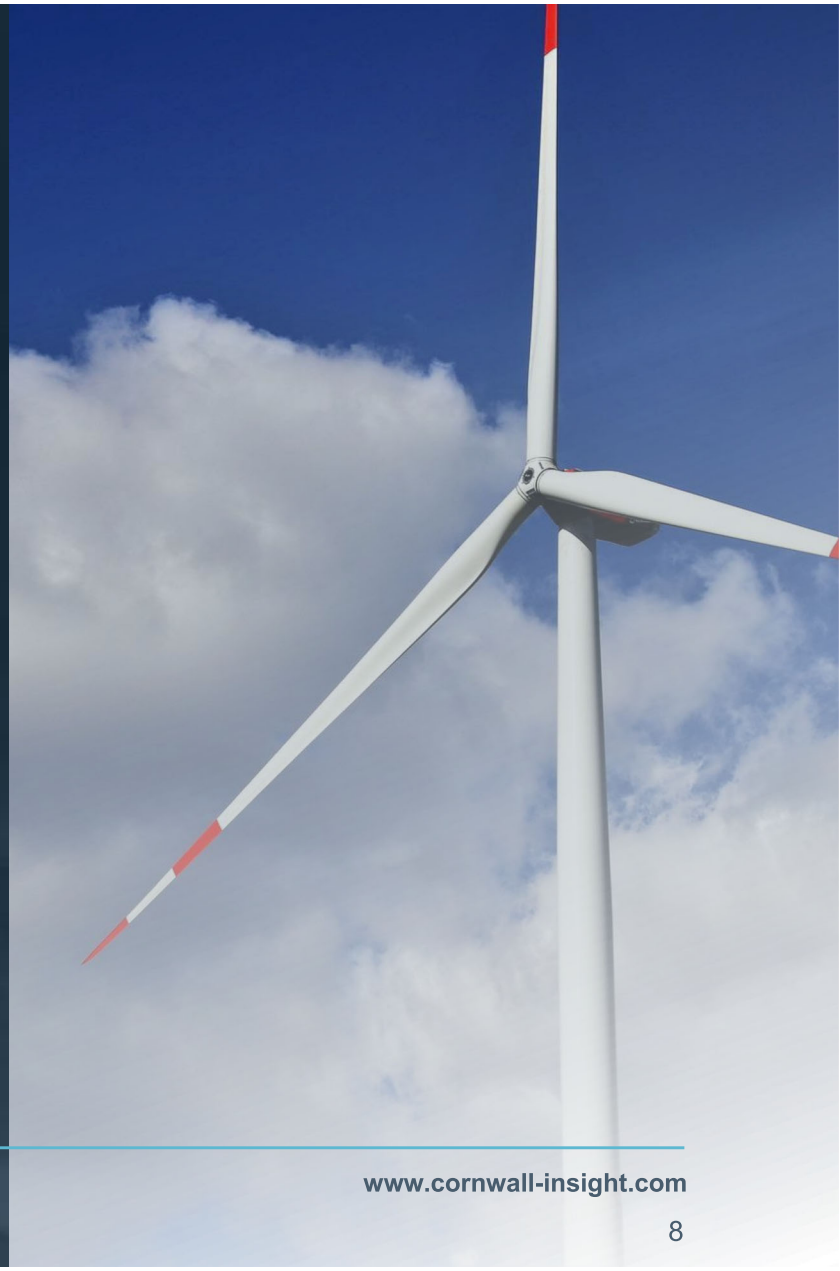
- Numbers may not add up due to rounding

About this report

- The report provides an overview of several relevant aspects of the Solar PV development proposed by GEI at the Caudwell Farm site (the 'asset')
  - Cornwall Insight is an independent consultancy and do not make any qualitative judgements or recommendations about the proposed development at Caudwell Farm
- The sections are summarised as follows:
  - **Overview of the GB Electricity Grid** – a high level description of the networks which transport electricity throughout Great Britain (GB), explaining the roles of Transmission and Distribution networks and where generation assets connect to the grid
  - **Generation Assets & Network Connection** – an explanation of how different generation assets face restrictions on where they can be installed in GB, how small, distribution connected renewable generation may be beneficial, and the current distribution of solar generation assets in GB
  - **Caudwell Farm Site & Development** – An evaluation of Caudwell Farm proposed solar development within the context of the wider Lincolnshire area and the future of solar developments in that region
  - **Renewables & UK Energy Policy** – A summary of recent energy policy with respect to the need for decarbonisation, balanced against the need for energy security and affordability for billpayers, particularly in the light of the recent energy crisis and the signposted potential for developing renewable generation assets going forward

Overview of the GB Electricity Grid



Electricity moves around the country via the transmission and distribution networks

Overview:

Great Britain's Electricity Grid is split into **Transmission** and **Distribution** networks which work together but have different roles and structures

Management and Responsibilities:

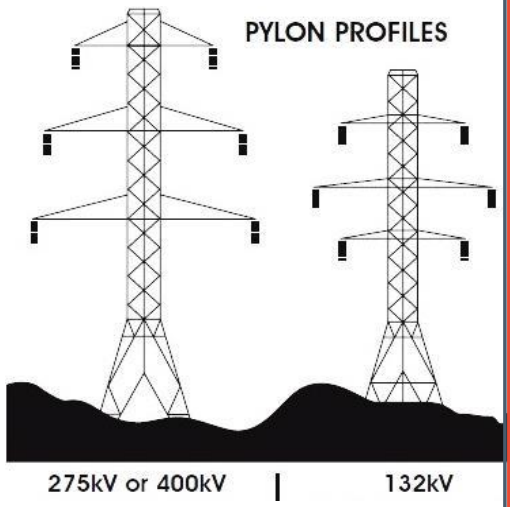
The Transmission system spans the whole of GB. Operated by National Grid Electricity System Operator (NGESO), electricity is transported from generators (power stations) to the 14 regional networks where Distribution Network Operators (DNOs) carry electricity to local consumers.

Balancing Supply & Demand:

The GB grid must be able to provide electricity to any consumer as and when they need it, and conversely take all electricity that has been supplied by generators and deliver or store it so it is not wasted. Therefore, 'balancing' the grid is an important concern for network operation. The responsibility for balancing electricity supply and demand falls under the purview of the transmission operator NGESO. See **appendix** for more detail

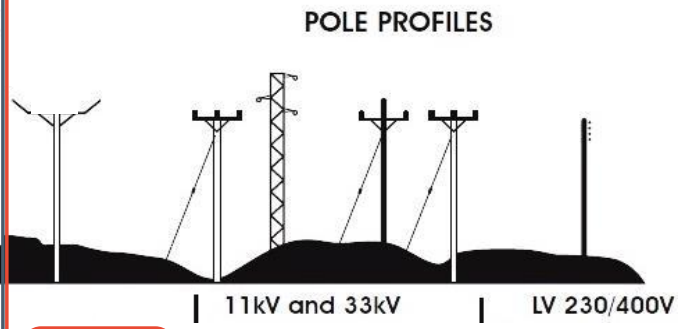
Transmission: **Pylons** form "spine" are used to transport electricity at high voltage to keep losses minimal over long distances from power stations to the distribution network

- High voltage: 400kV-275kV (132kV for smaller pylons in Scotland)
- NGESO responsible for always ensuring supply matches demand across GB, to avoid blackouts and outages



Distribution: **Poles** transport electricity to end-users (homes, commercial buildings etc) with a series of substations reducing the voltage of electricity from the transmission network to usable voltages

- Lower voltage – 33kV (132kV large poles in England and Wales) – 230V UK mains socket
- DNOs responsible for maintenance and service of electricity to GB energy consumers



Generation assets provide the electricity which flows through the networks to households and businesses

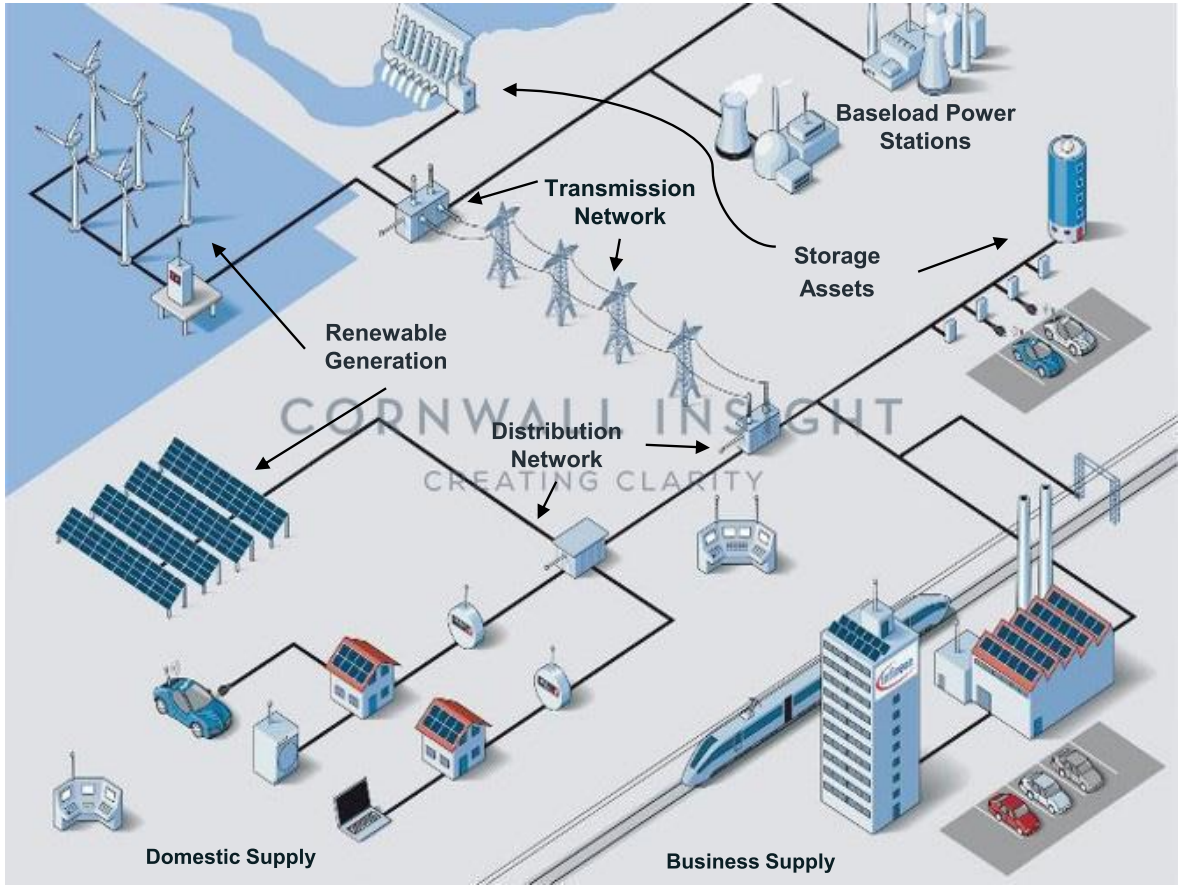
Electricity generation: Electricity generation assets produce power, exporting it to the grid, with the main sources of electricity as follows:

- **Baseload Power** – Also known as "Centralised Generation", these are large gas or nuclear power stations, which provide a stable 'baseload' of electricity and are connected directly to the transmission network
- **Renewable Generation** – These are numerous, and can be smaller. Generation can be variable, sometimes weather dependent, power stations fueled by natural phenomena e.g. wind, solar, hydro, which is most often connected to distribution networks
    - **Storage Assets** – Batteries and Pumped Hydro can be used to store electricity when supply is high due to renewables generating due to weather, for discharge during higher demand periods later

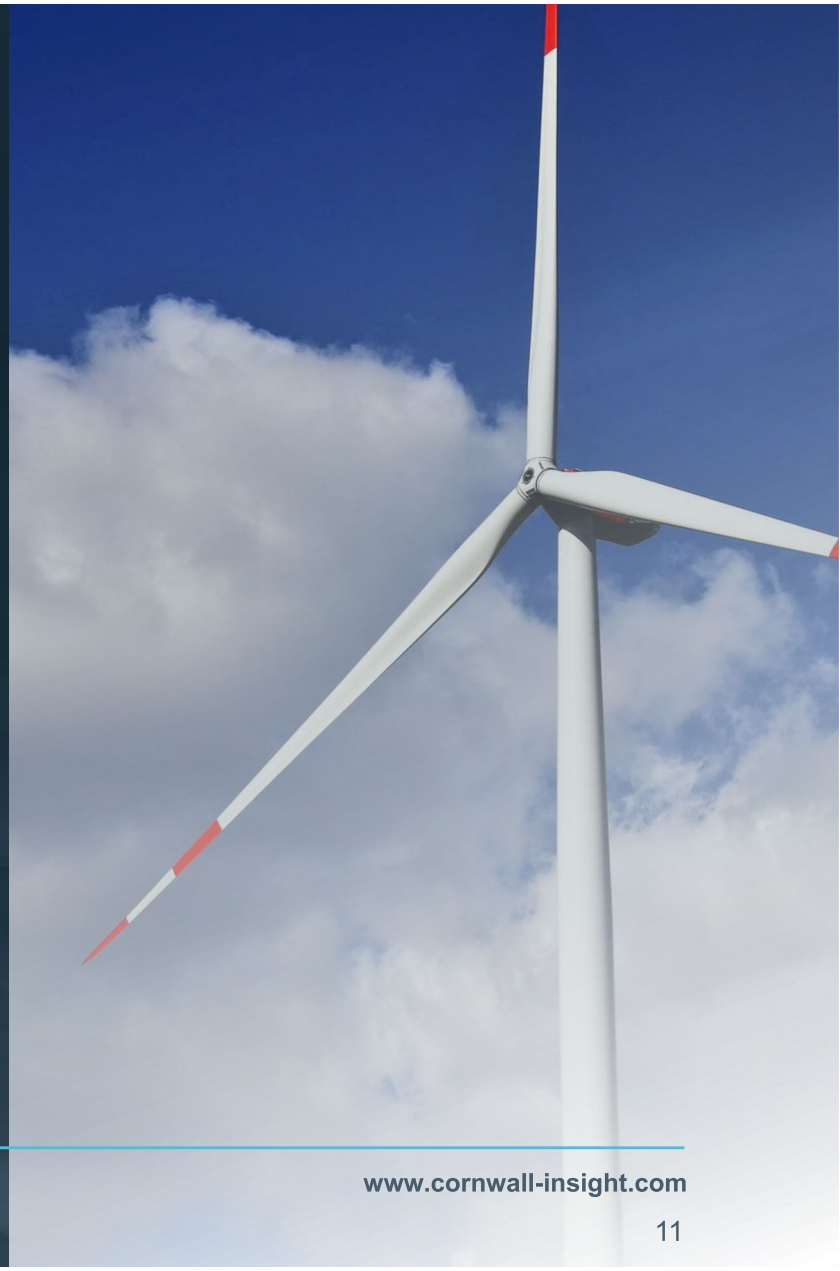
Embedded Generation: Distribution-connected generation is also called Embedded Generation and can be helpful because they provide electricity directly to the local network, taking load away from the transmission network and transporting electricity over smaller distances.

The government is looking to increase the amount renewable generation connected to the GB grid, both to shore up energy security and as part of the legally binding target to reach net zero by 2050. Getting a connection to the network can be an issue, with distribution network often constrained. Policy and regulatory reform will aim to:

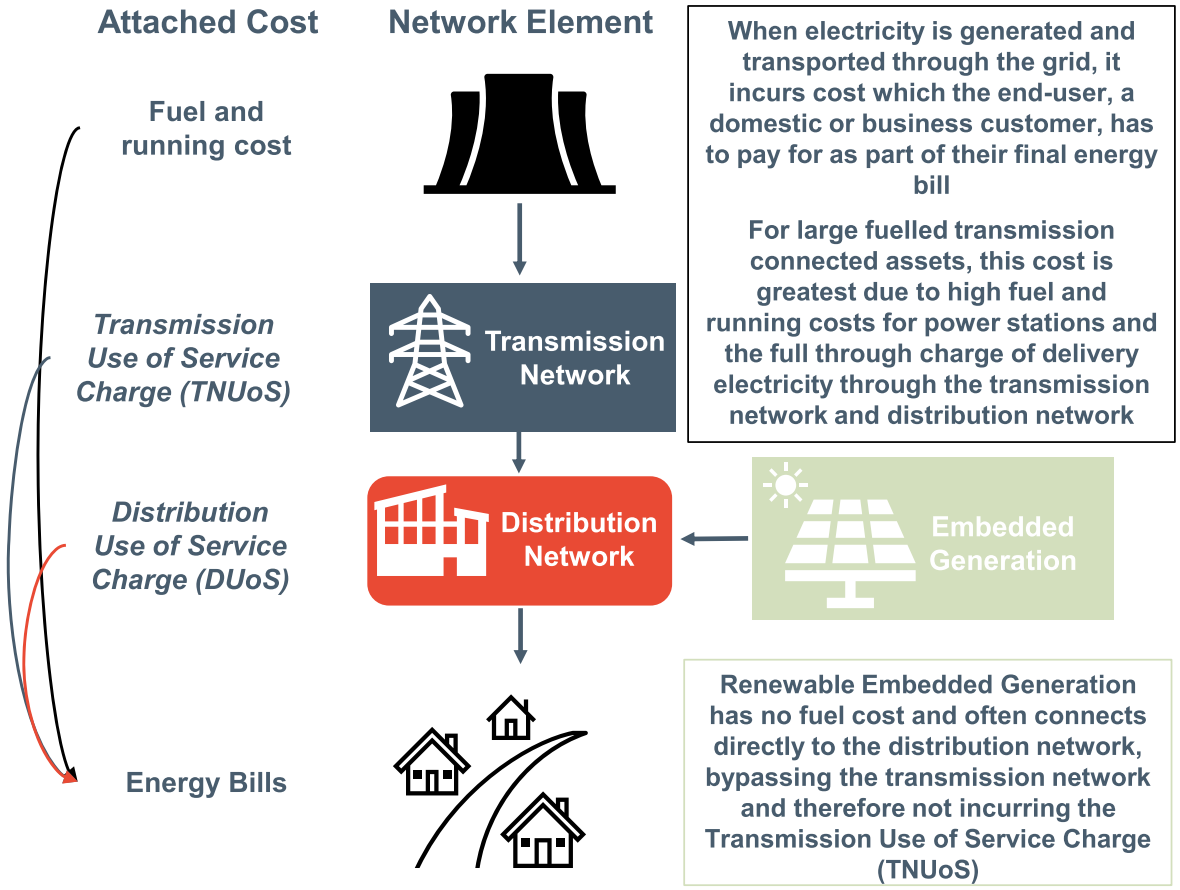
- Ensure strong incentives for network companies to speed up the process of securing a network connection
- Implement a new process from January 2025 so that projects that are ready first get connected to the grid first



Generation assets and network connection



Local generation can help to lower costs for the network and help reduce overall energy bills



When electricity is generated and transported through the grid, it incurs cost which the end-user, a domestic or business customer, has to pay for as part of their final energy bill

For large fuelled transmission connected assets, this cost is greatest due to high fuel and running costs for power stations and the full through charge of delivery electricity through the transmission network and distribution network

Renewable Embedded Generation has no fuel cost and often connects directly to the distribution network, bypassing the transmission network and therefore not incurring the Transmission Use of Service Charge (TNUoS)

Network Connection:

- When a generation asset (power station) is developed, it needs to be connected the transmission or distribution network to be able to export the electricity it generates to the grid for use
- Gaining a connection is long-standing issue. Distribution network is often constrained meaning developers have to pay large amounts and/ or wait many years for a connection
  - Distribution networks can offer 'non-firm' connections – where connection may be made more quickly, but the generator will not be guaranteed to flow power onto network at all times
- As mentioned, the government, specifically the Department for Energy Security and Net Zero (DESNZ) are seeking to increase low carbon Embedded Generation capacity to support national targets to decarbonise electricity, but embedded generation also has benefits for the regions they service

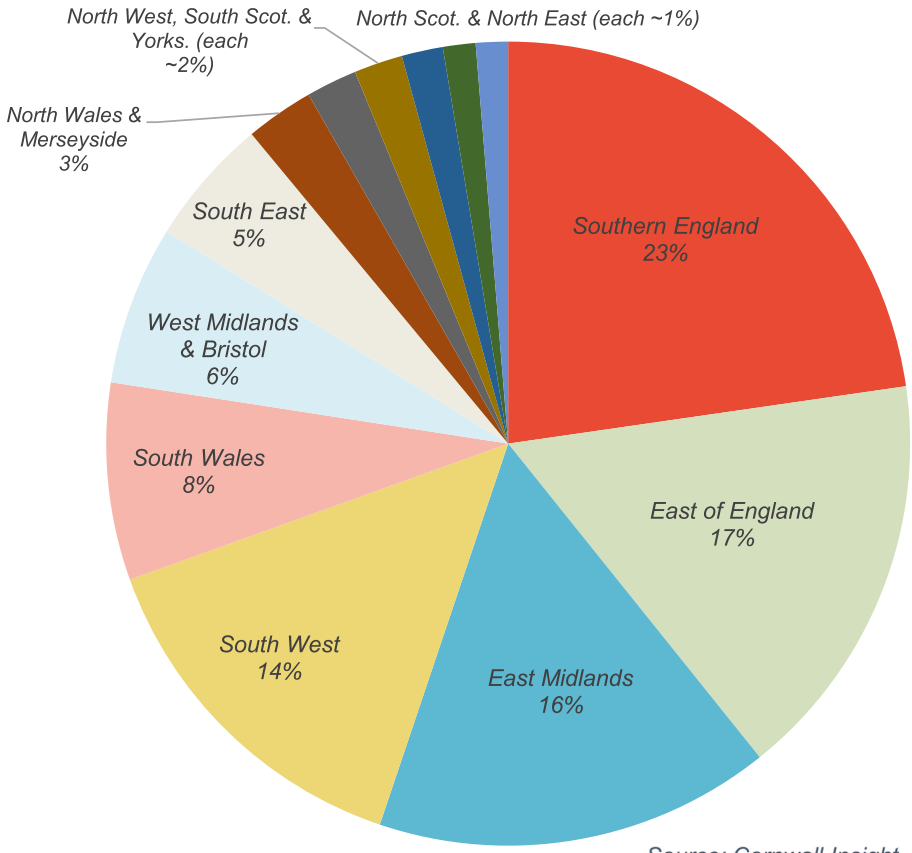
Different technologies are suited to different places, and this affects how they connect to the electricity network

- Electricity generation assets will ideally build in locations that best help ensure affordability and security of energy supply. Different generators of power are dispersed across GB, and are often situated near to their fuel source or where it is most operationally appropriate.
- This map highlights that power stations are usually located near their fuel source and technical requirements are met.
    - Nuclear: Coastal (access to water/ shipping to get fuel in/ out); requires a large plot of land and generally not be located near towns and cities for safety reasons (and so have to move the power long distances, requiring additional networks to be built)
    - Gas: Similar to nuclear but with less requirement on access to water, so often are located relatively close to demand
    - Offshore wind: Usually requires shallow coastal areas, albeit floating turbines are under development for deeper waters, and site in areas of high wind. Typically require long network cables back to shore and then to demand
    - Onshore Wind: Onshore wind can be found around the country, but ideal areas are often far from built up demand centres (North Scotland & Western coast)
    - Solar: Very flexible, can be installed on buildings in demand centres; slightly better in the South due to more sunshine
- The system is imperfect, and electricity cannot always be transported to areas of demand due to network constraints. The system operator has to take actions to manage these constraints
    - Physical network capacity is the most significant. Cost of managing these constraints has risen significantly recently – over £1bn for past two years
    - Equally, building new network connection infrastructure can be disruptive and expensive, with transmission connections being larger than distribution connections for embedded generation assets

Solar generation is a key resource for energy production

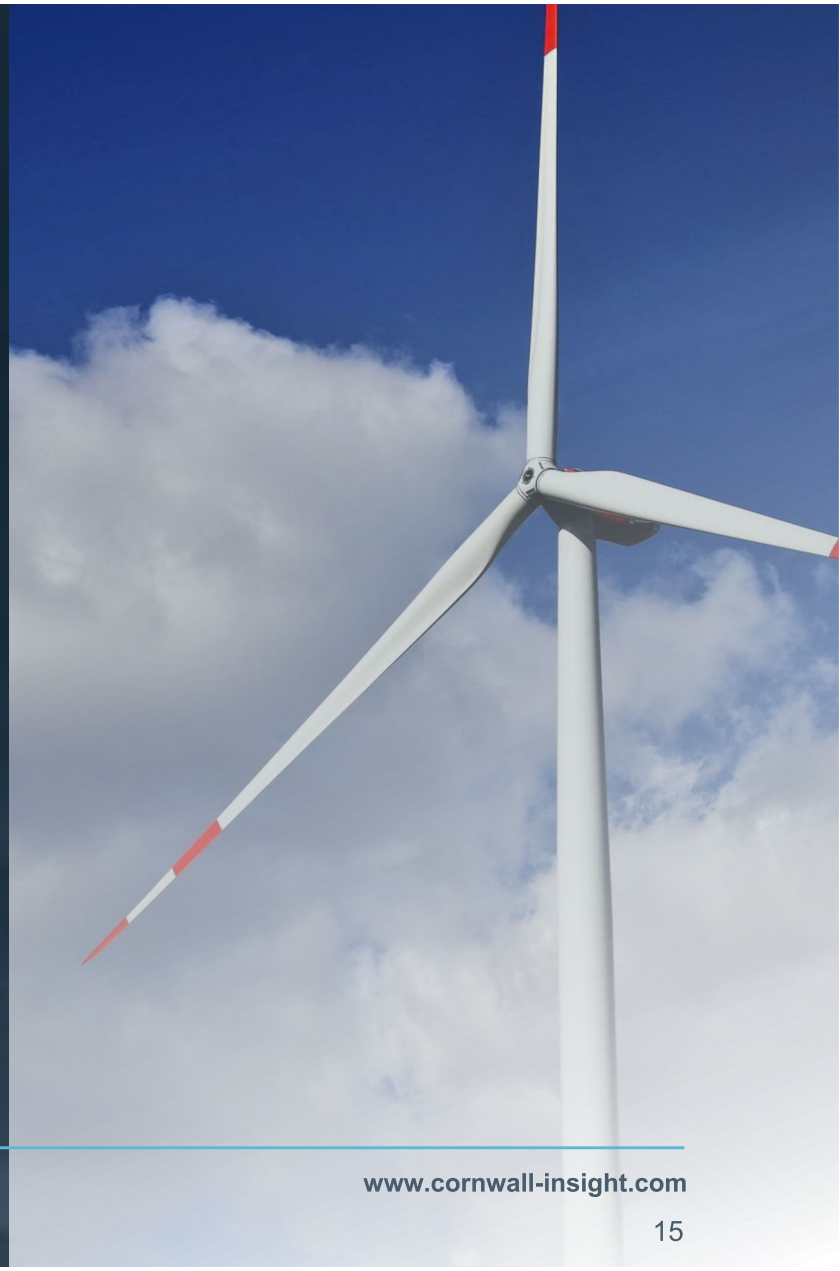
- Since 2010, Solar generation has increased its contribution to meeting total GB power demand with the average annual amount rising from close to zero to just under 5%
- There is approximately 9GW of Solar PV capacity currently operational in GB, which could provide electricity for more than 3 million homes. Around 14GW of additional solar is currently close to or under or construction
  - Around 38GW more of solar capacity is in development across the country
- Figure 1 shows the how each region of Great Britain contributes to the current capacity. The top four regions don't correlate exactly to Counties, but roughly encompass the following:
  - Southern England: Oxfordshire, Wiltshire, Berkshire, Dorset and Hampshire 23%
  - East of England: Norfolk, Suffolk, Essex, Cambridgeshire, Bedfordshire, and Hertfordshire 17%
  - East Midlands: Derbyshire, Nottinghamshire, Lincolnshire, Northamptonshire, and Buckinghamshire 16%
  - South West: Bristol, Somerset, Devon, and Cornwall 14%
- There is an established history of deployment of solar generation in these regions in particular due to generally more sunlight and the availability of non-built-up land which can be developed into arrays which are far more powerful than personal installations e.g. panels on household roofs
  - Large demand centres like cities can lack space to host generation assets - the entirety of Greater London contributes almost no solar generation largely due to availability of suitable land

Figure 1: Regional share of currently installed Solar PV capacity in GB (%)



Source: Cornwall Insight

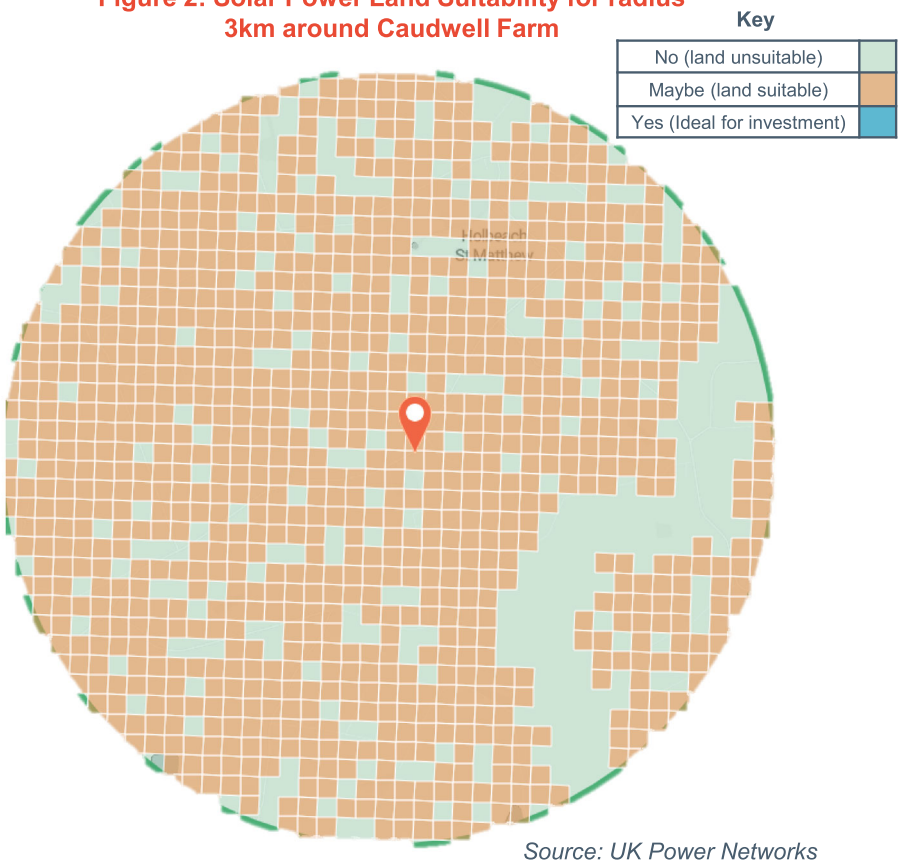
Caudwell Farm Site and Development



The Caudwell Farm area is suitable for building but the area is not likely to be overdeveloped

- The GEI solar development proposes to build a ground mounted solar photovoltaic (PV) array with a maximum export capacity of 49.9MW on an area of agricultural land covering approximately 114 hectares.
    - The Caudwell Farm site is located in Lincolnshire, east of the A17 and west of The Wash, approximately 3km off the coast, within the South Holland district of Lincolnshire, at postcode PE12 8EW.
- Figure 2 shows the Caudwell Farm site and the surrounding area to a 3km radius, with the orange squares representing sites deemed neither suitable or unsuitable and blank green land as unsuitable due to land features such as roads, residential areas, world heritage sites, agricultural land, and flood zones.
    - The site itself is rated “Maybe” (orange) by the tool, meaning it is not untenable but there is not notable potential for developers to earn revenue
    - As a result, it is unlikely that the area would be able to attract a large amount of interest from solar developers as the land is not particularly attractive
    - The Caudwell Farm site’s suitability for development is primarily derived from its pre-agreed network connection, of which there are no others identified in the area
    - From the perspective of the electricity grid, the connection will be made on the Walpole to Boston 132kV circuit 2, specifically between towers 48HW60 and 48HW59
- For this analysis we have used UK Power Networks’ Solar Power Land Suitability Tool to assess the site of the proposed development, accounting for factors that would make land suitable or unsuitable for solar farm developments. See appendix for more details

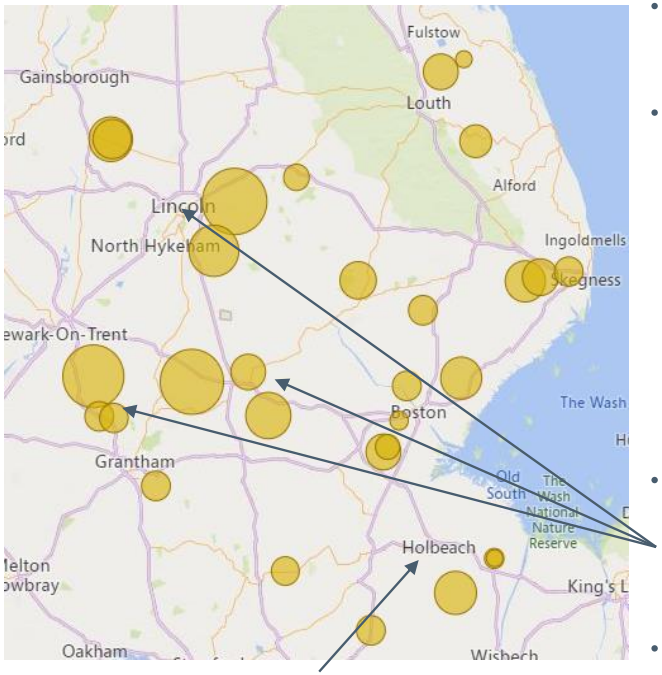
Figure 2: Solar Power Land Suitability for radius 3km around Caudwell Farm



Source: UK Power Networks

Lincolnshire as a region does not currently have a large installed solar capacity

Figure 3: Visualisation of operational solar capacity in Lincolnshire, bubble size proportionate to power (MW)



- The GEI proposed development is located in the South-East of the Lincolnshire area, where there is currently little installed capacity and, as demonstrated on page 16, there is unlikely to be a large amount of interest in this area of the county

- Lincolnshire is part in the East Midlands region, the third largest area for solar power generation.
- Figure 4 gives a more granular view of installed capacity in regions, showing 290MW of installed solar capacity, ranked 13th, with Lincolnshire the second largest county in the UK
  - This is disproportionately less than similar regions, such as Devon which is both smaller in area and more remote, yet it contributes 45% more solar power to the GB grid
- Figure 3 shows the currently installed solar sites in the county by installed capacity size, with the ten largest solar asset generators being located in the North and West of the county
- This lack of currently installed capacity may indicate that the area is ideal for planned development, the next page will explore this

Figure 4: Installed Solar Capacity by Area (MW)

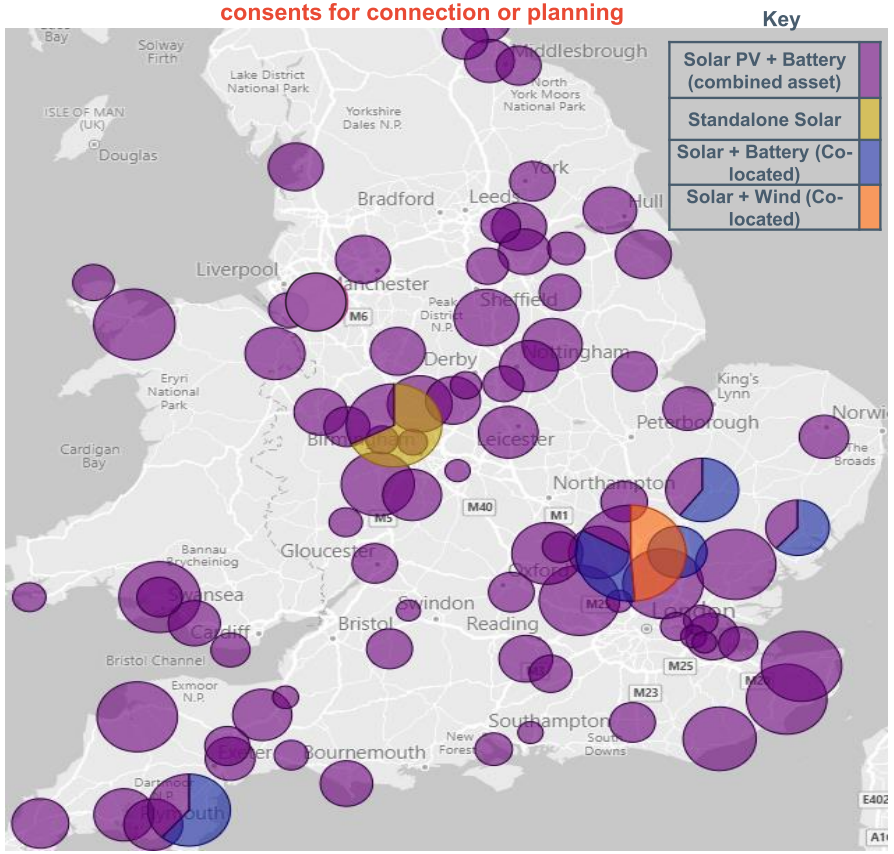
Position	Area	Installed Solar Capacity (MW)
1	Gloucestershire, Wiltshire and Bristol/Bath area	1,096
2	East Anglia	1,076
3	Dorset and Somerset	792
4	West Wales and The Valleys	538
5	Berkshire, Buckinghamshire and Oxfordshire	504
6	Derbyshire and Nottinghamshire	502
7	Hampshire and Isle of Wight	488
8	Cornwall and Isles of Scilly	480
9	Devon	421
10	Leicestershire, Rutland and Northamptonshire	416
11	Kent	355
12	East Wales	291
13	**Lincolnshire**	290
14	Shropshire and Staffordshire	277
15	Surrey, East and West Sussex	246
16	Essex	219
17	Northern Ireland	204
18	Herefordshire, Worcestershire and Warwickshire	189
19	Bedfordshire and Hertfordshire	146
20	Cheshire	111
21-35	Remaining areas	<100
	GB	**9,161**

Source: Cornwall Insight

Lincolnshire does not have a large pipeline of solar developments planned

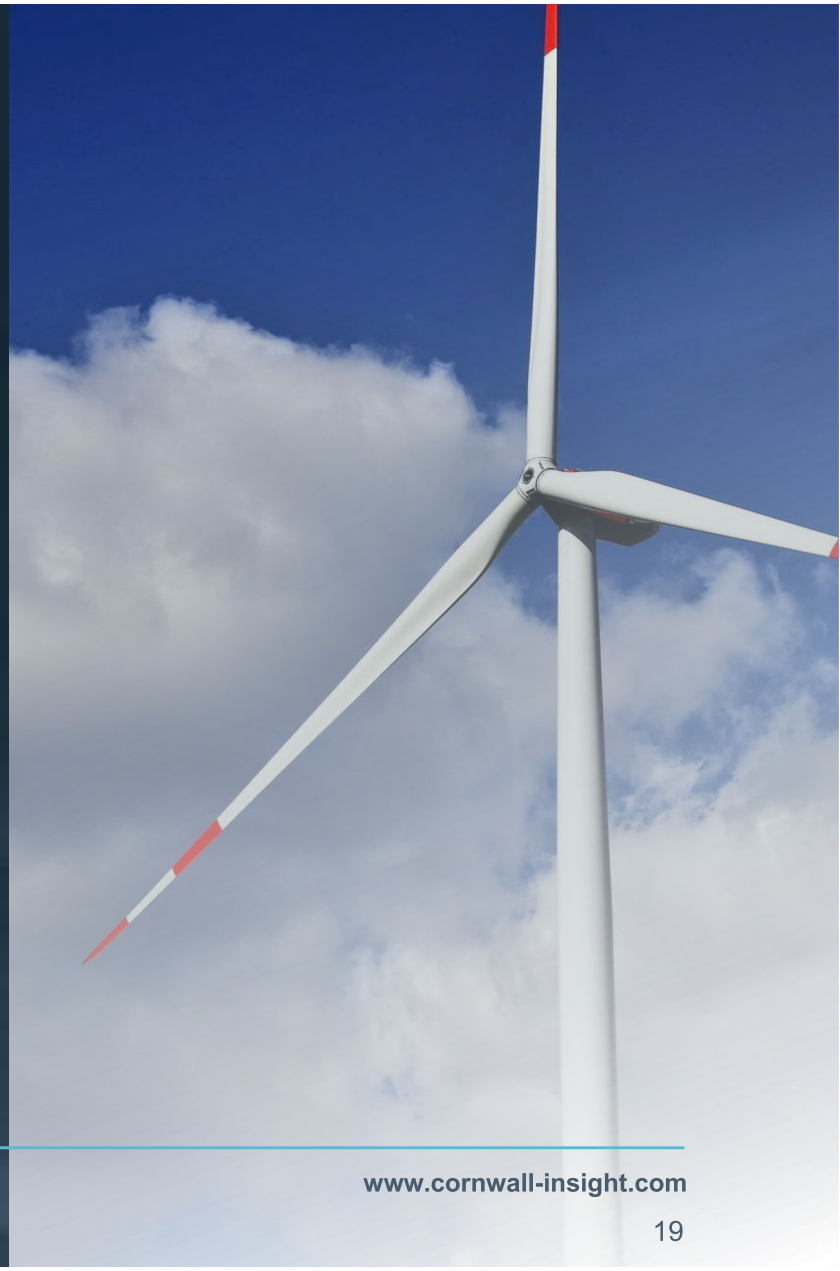
- Current levels of installed capacity in the Lincolnshire area, especially the South East are relatively low
  - Figure 2 (Page 16) showed that the area is not notably attractive for solar revenues but that the land was suitable for large solar arrays to be built
  - There is not a large pipeline of planned projects in this area (Figure 5)
- Figure 5 shows solar developments, some including battery storage, awaiting consent for network connection and/or formal planning permission spread across the country. North of Yorkshire and Lancashire is limited for solar development due to lower sunshine hours on average per year.
  - Figure 5 shows developments which will, in theory, start operating any year from 2025-2039, with 2033 as the year predicted to see most capacity (29GW) added to the grid
  - The majority of planned projects will be solar panel arrays combined with battery storage to provide flexible electricity supply to the grid
  - Key areas identified for larger solar projects in the pipeline are the areas directly north of London, (Essex, Hertfordshire, and Buckinghamshire), and the regions surrounding the West Midlands (between Birmingham, Leicester, and Derby), and the South-West coast
  - North and South Wales, Merseyside, and Yorkshire expect to see smaller, more numerous solar generation projects relatively speaking
- The Lincolnshire area has very few developments observed in the planning pipeline, suggesting it will be less likely there will be numerous solar arrays like the proposed Caudwell Farm development built and operating in the foreseeable future.

Figure 5: Visualisation of all solar developments currently scoping and awaiting consents for connection or planning



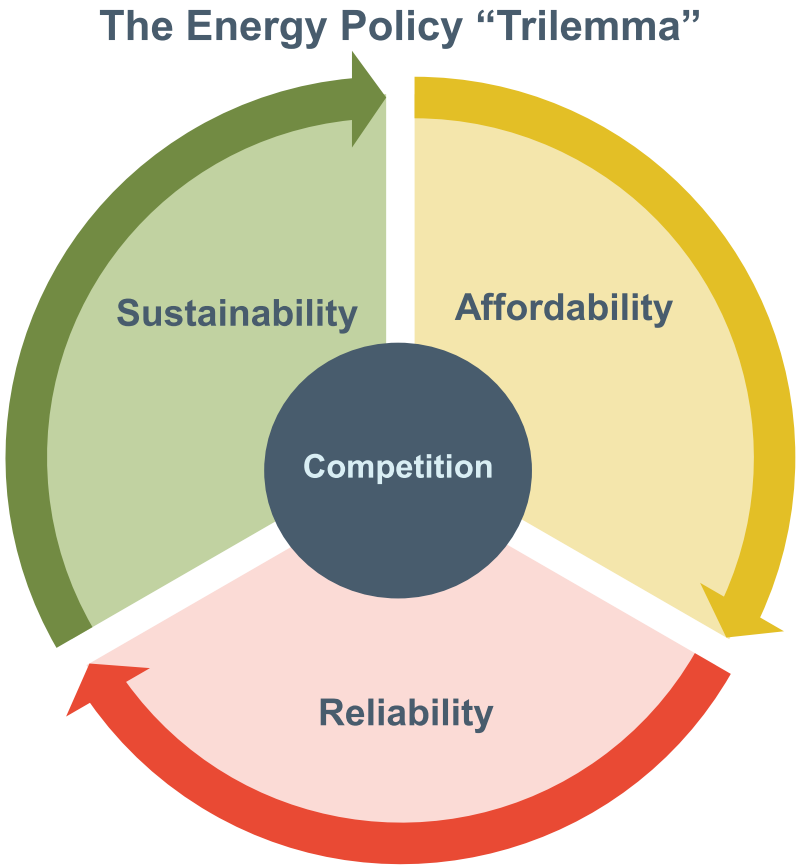
Source: Cornwall Insight

Renewables and UK Energy Policy



21st century Energy Policy has been focused on "Balancing the Trilemma"

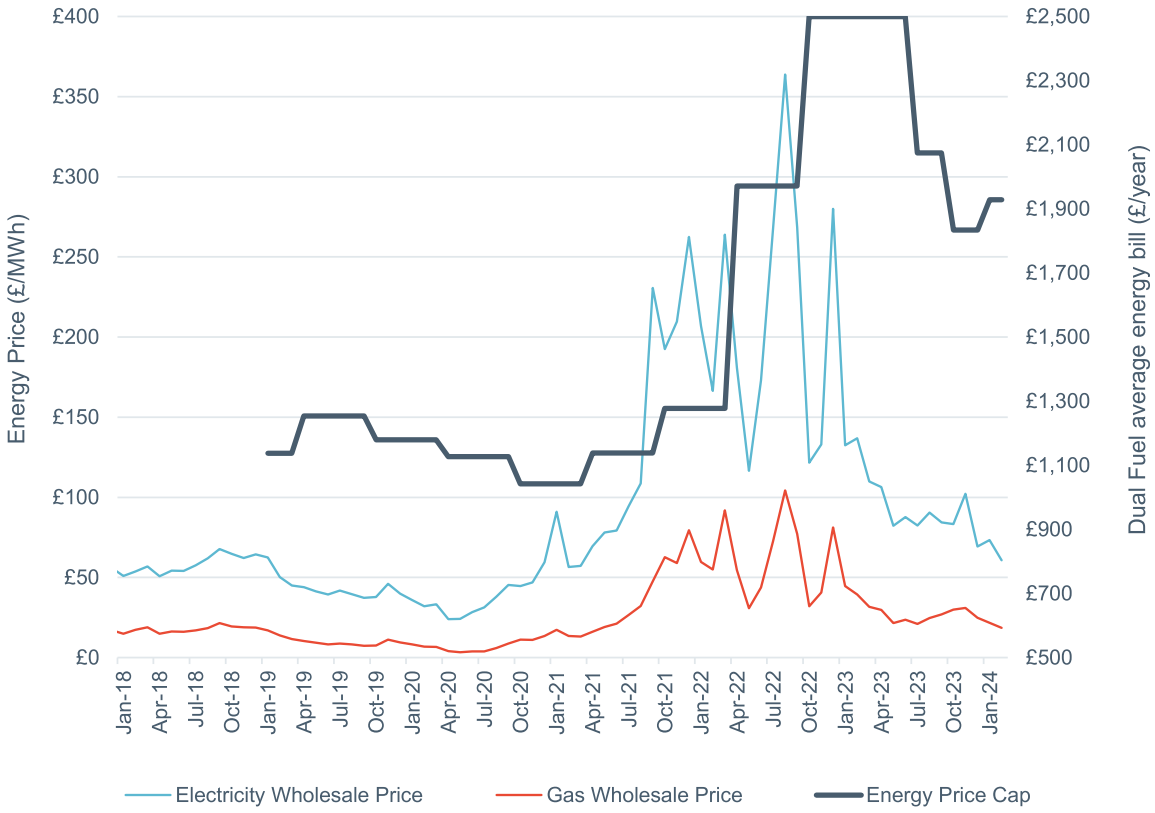
- UK energy policy has long been dominated by the need to balance the "trilemma" of energy which is sustainable, affordable, and reliable
- Historic policy has aimed to:
  - Ensure energy security – We do not experience power blackouts or have to take steps to limit energy usage at any time
  - Tackle affordability issues – Energy bills were lower for many before the Russian invasion of Ukraine, with geopolitical issues having the potential to cause price spikes in the future
  - Control emissions – We reduce our carbon output to protect the environment
- Many different policies have been introduced over the last couple of decades. The energy markets must deliver an energy market that's affordable, that can meet increased demand from a growing economy, and can support increased amounts of renewable generation to meet long term sustainability goals
- Throughout the 2020s, the increasing need to accelerate the reduction in carbon emissions to stay on track to meet the target of net zero by 2050 has been come up against market shocks which have raised more immediate threats to energy security and affordability



The 2022 gas crisis increased energy bills to all-time highs

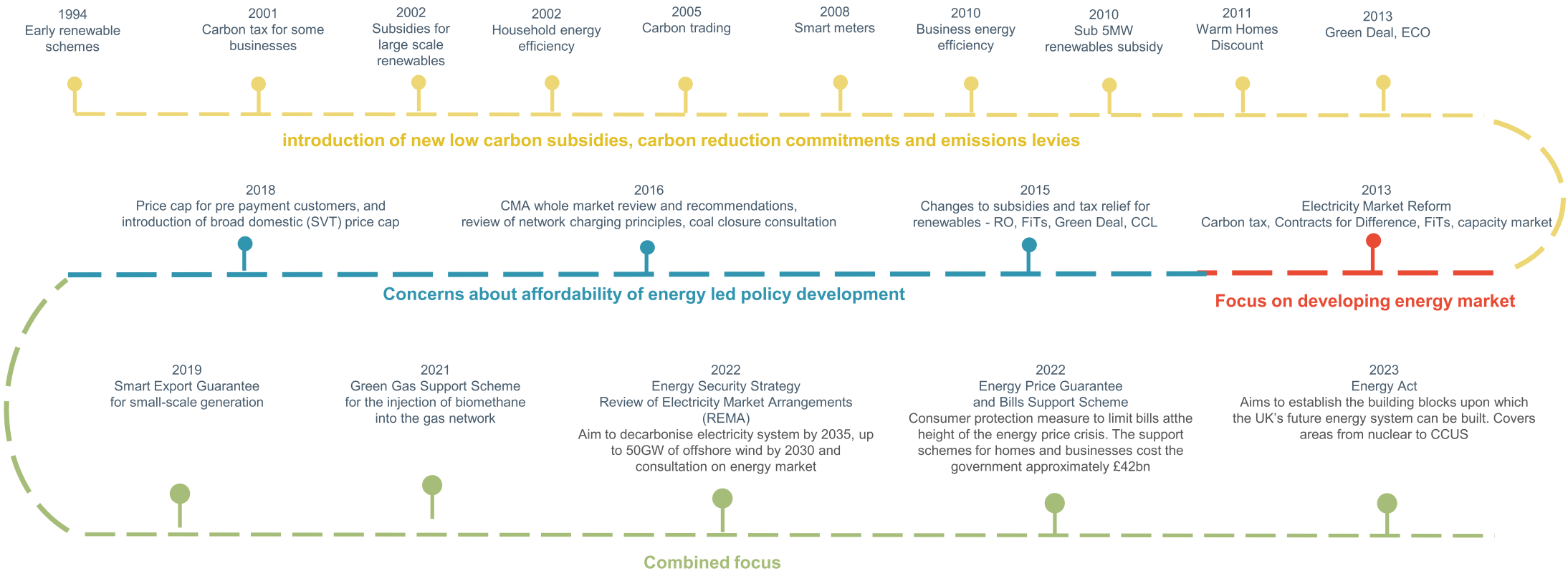
- Great Britain's energy is reliant on natural gas, both for direct use and in generating electricity through gas power stations
  - Natural gas for heating is at a rate higher than any other European country with over 80% of households using gas for their central heating
  - Electricity generated from gas power stations is the most expensive way to generate one unit of electricity due to the cost of the gas as fuel and the cost of running the power station to produce it, but this sets the market price for "power" (electricity bought from the grid as a unit of energy)
- Figure 6 shows the how electricity price correlated to international gas market prices, and how Ofgem's (the energy regulator) price cap has increased significantly since the beginning of 2022
- The Russian invasion of Ukraine resulted in Russia greatly limiting the flow of gas into Europe in the first half of 2022. The resulting international shortage increased the price of natural gas
  - Many major European countries looked to fill their gas stocks in response to this uncertainty in preparation for the winter, driving prices to unprecedented highs and creating huge market volatility due to the uncertainty created in 2022
  - Prices and volatility was greatly reduced as the supply of gas was brought under control due to a mild 2022-23 winter, but the effects of 2022 are still felt with the energy price cap not yet returning to pre-crisis levels despite energy prices returning to previous levels

Figure 6: Energy wholesale prices with Ofgem price cap level from 2018-present



Source: Ofgem

Government policy has developed over time, with the energy price crisis directing recent focus



Increased roll out of renewables will be crucial to address energy concerns going forward

- The government's energy policy points toward the need for increased renewable capacity in the UK to address all points of the energy trilemma. Projects like the solar array proposed for Caudwell Farm could help decarbonise the electricity grid and reduce reliance on natural gas for producing electricity.
- Recent geopolitical events have demonstrated the wide-reaching impact gas supply shortages can have on bills and the wider economy. Gas will continue to play an important role in the GB energy system, although its use will be refocused to support the grid during periods of high demand using smaller, flexible gas assets to 'top up' supply as needed

Net Zero Strategy (*Oct 21*)

- Set out policies and proposals for decarbonising all sectors of the UK economy
- Mainly focused on the consumer side, looked at: ensuring the largest emitters will pay the most for the net zero transition and that vulnerable people will be protected
- Ensuring Working with businesses to reduce cost in low carbon technologies: by 2035 the electricity grid will be fully renewable (subject to security of supply)
- Introduced a new integrated regime for onshore and offshore electricity networks – aiming to create efficiencies and therefore drive more deployment of further capacity

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Updated April 2022 after High Court ruled it was not able to deliver the necessary emissions reductions to meet carbon budgets

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Energy Security Strategy & REMA (*Apr 22*)

- Set out ambition for 'up to' 50GW of offshore wind by 2030 including up to 5GW of floating wind and firming up approach towards more anticipatory network investment
- Doubling ambition to 10GW of hydrogen production by 2030
- Review of Electricity Market Arrangements (REMA) will deliver a step change in the rate of deployment of low carbon technologies and reduce dependency on fossil fuels

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Looking forward with a more radical and step-change approach to diversifying electricity generation and targeting decarbonisation in wider economic sectors such as heat and transport

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Energy Act (Oct 23)

- Licensing framework for CO2 transportation and storage & hydrogen pipeline projects
- Government support for ideas about how fossil fuels could be decarbonised
- New measures to aid the transition to smart appliances
- Establishing the FSO
- Ofgem's authority expanded to include heat networks and must now consider net-zero targets in its decisions

Additional Information

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