REPORT

JUNE 2023

ENERGY OPTIONS ANALYSIS FOR GREATER LINCOLNSHIRE

FINAL REPORT

Rider Levett Bucknall

Rider Levett Bucknall

TABLE OF CONTENTS

VERSION

Version	Authorised	Date
V1	HE	14 March 2023
V2	HE	15 March 2023
V3	HE	30 May 2023
V4	HE	30 June 2023

AUTHORISATION

This report has been prepared by:

Verity Topham

Barry Malone

and authorised for issue by:

Heather Evans
Partner, National Head of Sustainability

1.0 EXECUTIVE SUMMARY

This report aims to support Greater Lincolnshire Local Authorities and the Greater Lincolnshire Infrastructure Group by providing a regional energy options analysis to identify where to target investment to meet net zero targets and enable economic growth, whilst addressing the below Key Lines of Enquiry (KLOE).

The KLOE are detailed below:

- To challenge whether the provision of energy genuinely affects viability of development and economic growth, differentiating between the levels of National Grid, Local Distribution Network Operator (DNO) and local energy operators – and whether implementing local innovative solutions could deliver necessary local requirements.
- To identify how authorities could work together to build the scale to make an alternative energy offer attractive to the private sector.
- To strengthen the connection between energy and other utility provision, notably digital infrastructure, and the Internet of Things (IoT).
- To provide a forum for the private and public sectors to collaborate on specific schemes, creating the environment for a strong dialogue that leads to investment in priority sites.

This paper outlines the KLOE alongside analysis of the demand from growth in the immediate term, and any further energy requirements to deal with the growth over the next 20 years.

To deliver the KLOE assessment, this report is enhanced by in-depth but highly accessible informational review and analysis of the UK energy system, key technologies and a range of other topics essential to regional net zero and the energy system's role in regional economic growth, all aligned as far as possible to specific data and evidence from the Lincolnshire region. This review covers pages 13 to 61 and includes topics like:

- The UK national energy system
- Local energy context
- Energy management topics
- Alternative and emerging technologies
- Future Energy Scenarios analysis
- Energy investment analysis
- Sector discussion for residential, industrial, ports and logistics, health, agriculture, and energy
- Future demand analysis and energy shortfall analysis

This study, managed by Lincolnshire County Council, on behalf of the Greater Lincolnshire Infrastructure Group, and completed by Rider Levett Bucknall (RLB), looks at current and proposed developments in the Greater Lincolnshire area to estimate future electricity demand, which will be key for delivering net zero. These demands have been mapped onto the electricity network to see where infrastructure investment could be targeted, including sub-stations and power lines which may have limited capacity in future. The local distribution network operators have been consulted on the information and various options for providing additional capacity investigated and outlined in this report.

As noted above, we have analysed energy issues and demand for strategic sectors to determine future opportunities, constraints and innovations. Digital transformation and the green transition have been considered as key strategic elements to the future energy demand and supply across Greater Lincolnshire. Building on the region’s unique position and attributes, the following actions have been recommended:

Table 1 Recommendations

Theme	Recommendation	Detail	Timeframe	Investment	Location
Collaboration	Open Networks Insights Forum	Quarterly online forum	Short term	Capacity of appropriate resource	Page 18
Energy transformation	Align strategic sectors energy strategies. Geothermal energy and biomass project collaboration and lesson learned sharing.	Integrate geothermal and biomass energy projects into GLLEP Energy forum or other appropriate forum.	Short term	Capacity of appropriate resource	Section 4
	Develop an outline strategy for integrating geothermal into the region’s long-term energy landscape. Biomass strategies and investment should be closely linked to CCS, with a regional strategy considering socio-economic factors.	Strategies should be integrated into LAEPs with an overarching GL wide strategy.	Medium Term	Internal or external funding to facilitate strategy development	

Theme	Recommendation	Detail	Timeframe	Investment	Location
Energy transformation	Mapping of high intensity users in urban areas, linking together organisations such as the NHS trusts with local industrial businesses to power residential heating.	Heat network study to be undertaken. Applications to Heat Network Transformation Programme (HNTP) to be submitted.	Medium term (funding applications to be sent prior to closure of scheme in 2025)	Internal or external funding to undertake mapping exercise. Capacity of appropriate resource for funding applications.	Page 30
Collaboration	Alignment of DNO strategy across GL to ensure LAEPs are consistent	Energy management including ANM Identify targeted areas of improvement / upgrades to infrastructure to understand if potential case studies for energy mgmt.	Short term	Capacity of appropriate resource to engage with both DNOs	Page 41
Collaboration	Integrate aquaculture into agri-food sector energy analysis. Consider wider sector collaboration where there are known synergies e.g. logistics and transport, logistics and agri-food.	Due to the anticipated increase in transport related to agri-food and aquaculture, collaborate on transport strategies where there is anticipated increase in EV demand across combined sectors.	Medium term	Capacity of local resource Internal or external funding to work with GLLEP to integrate energy demand from both sectors	Page 88
Innovation	Undertake LAEP for all areas within GL	Determine appropriate areas (noting the DNO boundaries) for	Short term	Short term resource from each relevant area (district, county etc) to	Page 41

Theme	Recommendation	Detail	Timeframe	Investment	Location
		LAEPs to be undertaken. LAEP to identify short and medium term actions / projects, with prioritised investment. Scope should include electricity, heat, gas, future innovations inc. hydrogen, generation and storage as well as changing built environment demands.	Medium term	confirm boundaries. Funding to be sourced for each LAEP whether funded centrally or on a local basis.	
Innovation / Collaboration	Integration with Regional System Planners (RSPs) when / if put in place	GL local authorities engage with the new RSPs to determine accountability for regional energy systems planning.	Medium – Long term	Capacity of dedicated resource internally to engage with RSPs, Ofgem and DNOs. Potential for further investment if RSPs scope is determined to be closely integrated with local authorities.	Page 75
Innovation	Smart Energy Skills programme	Enhance existing skills in energy sector supporting the accelerated delivery of Smart Energy Systems, and attract resource into the sector through presenting the opportunity to help	Medium – long term	Pooled resource from GL, consider funding sources such as LCSF (Low Carbon Skills Fund) or other grants from organisations such as the DNOs	Page 80

Theme	Recommendation	Detail	Timeframe	Investment	Location
		shape the future of energy in an innovative way.			
Energy transformation	Shortfall feasibility studies	Identify the most suitable solution to the primary substation demand headroom restrictions, a feasibility study should be carried out for each area identified as a priority 1 shortfall. This feasibility study would need to be carried out with the relevant Local Plan for that particular area and in conjunction with the net zero strategy.	Short term	Resource and funding to deliver feasibility studies	Section 7
Energy transformation	Energy PPP viability study	Study to determine if an Energy PPP would be viable for GL. A key area to explore would be Energy Performance Contracts	Medium – long term	Resource to fund study, subsequent investment if deemed viable.	Page 88

This study has clearly demonstrated that the need for an integrated regional strategy on energy and net zero involving key players like DNOs and all LAs to deal with the increasing complexity and emerging options for linking regional net zero with future economic growth.

For Greater Lincolnshire, the focus of a regional approach should be on energy capacity and generation innovation, promoting the regions unique characteristics such as the strong agri-food sector and strong links to energy, industry and CCS to drive forward investment and growth into ensuring the key economic sectors can secure sustainable growth.

1.1 KLOE REPORT REFERENCES

Due to the scale of the research completed within this study, the below table signposts and summarises the KLOE reference points.

Table 22

Key Lines of Enquiry	Section	Detail
To challenge whether the provision of energy genuinely affects viability of development and economic growth, differentiating between the levels of National Grid, Local Distribution Network Operator (DNO) and local energy operators – and whether implementing local innovative solutions could deliver necessary local requirements.	Section 4, 8, throughout report	Content throughout the report demonstrates the qualitative and quantitative research undertaken as part of this study. Inclusion of National Grid, DNO and other energy context has been provided to address this KLOE, with proposed potential solutions summarised in Section 9.
To identify how authorities could work together to build the scale to make an alternative energy offer attractive to the private sector.	Section 8, throughout report	Within the context of the local energy market, supply and demand alongside local strategic sectors, alternative energies have been researched with identification of case studies where progress or live projects are in motion. The KLOE section identifies the critical requirement to be collaborative between public and private sector – enhancing the DNOs strategy for improving energy infrastructure whilst being cognisant of the local demands. This study recommends that authorities have a critical role to play in facilitating collaboration to build scale.
To strengthen the connection between energy and other utility provision, notably digital infrastructure, and the Internet of Things (IoT).	Section 4.1, 8, throughout report	Digital infrastructure and IoT context has been provided in section 4.1, with recommendations and research overview included in Section 8. Anecdotal evidence provided during study demonstrates a weak relationship between utilities provision, with little indication of this being set to change. The key area where this is likely to differ is the gas network,

Key Lines of Enquiry	Section	Detail
		which is likely to transform into a hydrogen network. This however is a long term development and therefore deemed of small impact in the short term. To ensure this KLOE was addressed in as much detail as possible, focus was given more to smart technologies, digital management and IoT.
To provide a forum for the private and public sectors to collaborate on specific schemes, creating the environment for a strong dialogue that leads to investment in priority sites.	Section 8, throughout report	During the research as part of this study, it was clear that multiple forums exist across GLA. To remove the potential that a forum creation would be a reinvention of an existing forum, we recommend that the existing larger forum is reconsidered in terms of representation and focus. DNOs are keen to engage, and we recommend that the forum takes the format of allowing that direct engagement in a controlled way, streamlining communications and providing a direct link between private organisations and DNOs to facilitate a clearer view of the constraints and demand.

2.0 PROJECT SCOPE

The project scope was to deliver a fully coordinated, intelligence-led and targeted report into an Energy Options Analysis for Greater Lincolnshire that incorporates the outputs below and shows implications of current legislation.

The key project objective was to develop a report that will support the Greater Lincolnshire Local Authorities and the Greater Lincolnshire Infrastructure Group through providing an energy option analysis of the area, and to identify where investment may be required, to meet not only net zero targets but to enable economic growth.

RLB have addressed the KLOEs and the ability of the identified energy approach to meet the demand from growth in the immediate term, and any further energy requirements to deal with the growth over the next 20 years.

2.1 PROJECT OUTPUTS

A report detailing the key lines of enquiry below:

- Challenge whether the provision of energy genuinely affects viability of development and economic growth, differentiating between the levels of National Grid, Local Distribution Network Operators (DNO) and local energy operators – and whether a decision to implement local innovative solutions could deliver necessary local requirements.
- Identify how authorities could work together to build the scale to make an alternative energy offer attractive to the private sector.
- Insight into strengthening the connection between energy and other utility provision, notably digital infrastructure, and the internet of things.
- Investigate providing a forum for the private and public sectors to collaborate on specific schemes, creating the environment for a strong dialogue that leads to investment in priority sites.

Study outputs include:

- Engagement with key economic sectors to gain insight into how vital is energy supply to ensure investment and development.
- Exploration of opportunities within present/future energy networks including alternative and low carbon energy.
- Analysis of requirements for key employment sectors including future impact of growth e.g., food chain carbon reduction.
- Identification of two pilot Residential Development Scheme case studies.
- Energy supply and demand mapping across the region - National Grid: Energy Distribution and Northern PowerGrid.

2.2 STAKEHOLDERS

This report has been commissioned by Greater Lincolnshire authorities, with the main stakeholder for the Project being the Greater Lincolnshire Infrastructure Group (IG). Management and key decision making are led by the Infrastructure Reference Group (IG Reference Group).

2.3 APPROACH

This study has used projected growth plans from each local authority and developed a trajectory of energy usage to enable analysis of requirements for energy patterns. Within this study, area-wide transport plans, such as the Freeport on the Humber and other infrastructure requirements which would contribute to the overall energy demands have been considered.

Throughout this study it has been clear there is a shortfall in electricity capacity within the Greater Lincolnshire area, and this has been determined through anecdotal responses from developers across key economic sectors, and through mapping the energy demand across the region. RLB have engaged with the licenced distribution network operators (DNOs, National Grid ED & Northern Powergrid) with a view of aligning the need for additional capacity and generation. As part of this study, we considered how the private sector could assist the long-term objective of growing and investing in the local areas.

3.0 ENERGY OPTIONS ANALYSIS

3.1 NATIONAL ENERGY CONTEXT

Energy is critical to maintaining a strong economy, from heating homes to powering the industrial sector. The energy landscape at present is volatile, driven through a range of global and local factors. As the UK is part of a global market, gas prices are set internationally. European gas prices soared by more than 200% in 2022[1] and coal prices increased by more than 100%. A significant factor in the rising energy prices has been Russia's invasion of Ukraine, which resulted in reduced supply to Europe in response to sanctions. This record rise in global energy prices has led to an increase in the cost of living in the UK.

It was expected that the UK Chancellor would announce a £20bn investment[2] in technology to reduce Britain's carbon emissions at the March 2023 budget. The investment was spread over the next two decades into Carbon Capture Storage (CCS) and low carbon energy projects. However, this was not reflected in the spring budget and anticipated investment will not appear before the next election in 2024, with additional uncertainty over funding from taxes or levies.[3]

The UK Government released several strategies in recent years to drive investment and improve energy security. These include the Ten-point plan for a green industrial revolution, the Net Zero Strategy, Powering Up Britain and the Energy Strategy, among others.

In the last quarter of 2022, energy production was stable overall with a range between different energy sources. 2022 saw a record low for both oil and coal generation, with natural gas recovering to pre-pandemic levels, nuclear energy production higher than 2021 despite plant closures, and all renewable technologies have increasing, including a 29% growth in wind, solar and hydro compared to 2021.[4] The growing proportion of UK electricity coming from renewables, reduces exposure to volatile fossil fuel markets, and strengthens energy security.

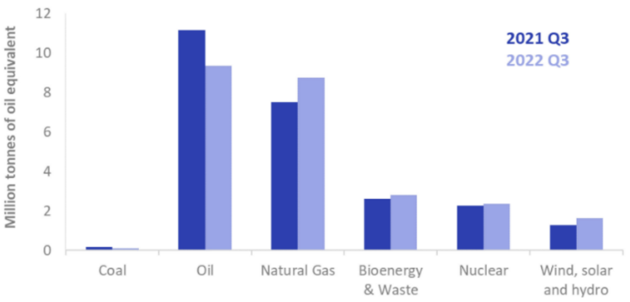


Figure 1 UK Energy Production, UK Government 2022

DECARBONISATION

The UK has set a legal target to reach net zero carbon emissions by 2050. As part of the green transition, by 2030 95% of British electricity could be low-carbon and by 2035[5] the electricity system

[1] The Guardian, October 2022
[2] The Guardian, March 2023
[3] https://www.gov.uk/government/publications/spring-budget-2023/spring-budget-2023-html#growing-the-economy-1
[4] UK Government, Energy Trends December 2022
[5] UK Government, British Energy Security Strategy

should be decarbonised, subject to security of supply. This is a transition which reduces dependence on imported oil and gas, and delivers a long-term shift in energy supply, intended to provide cleaner, cheaper power, lower energy bills, and deliver thousands of high-wage, high-skilled new jobs.

Energy-intensive sectors like heavy industry, transport and domestic and commercial buildings must transition to being predominantly electric-powered in order to decarbonise. This will require major investments into new electricity generation (e.g., wind, solar and nuclear), new and upgrades to existing electricity grids, as well as energy efficiency programmes (e.g. domestic thermal insulation).

This transition will require new ways of managing the energy system beyond current mechanisms, particularly as the removal of large coal and gas plants changes the buffers of fuel available to the electricity grid and therefore its stability. The introduction of large amounts of renewable generation increases the variability of available electricity, and therefore creates a need for energy generation balancing and energy storage at a greater scale.

3.2 LOCAL CONTEXT

The Greater Lincolnshire area covers three tier-one local authority areas of Lincolnshire County Council, North Lincolnshire Council and North East Lincolnshire Council. The Lincolnshire County Council area comprises seven tier two districts each serviced by a district or borough council: City of Lincoln, North Kesteven, South Kesteven, South Holland, Boston Borough, East Lindsey and West Lindsey. The Greater Lincolnshire Local Enterprise Partnership (LEP) covers the Greater Lincolnshire area included in this study.

Greater Lincolnshire has seen significant population growth, with the 2021 Census data showing a 10% increase in some areas, with Lincoln's population rising to over 100,000.

Following the Covid-19 pandemic, Greater

Figure 2 Greater Lincolnshire Map, GLLEP Plan for Growth

District	Population	Growth since 2011
Boston Borough	70,500	9.1%
East Lindsey	142,300	4.3%
City of Lincoln	103,900	11.1%
North Kesteven	118,000	9.5%
South Holland	95,100	7.7%
South Kesteven	143,400	7.2%
West Lindsey	95,200	6.7%
North Lincolnshire	169,700	1.3%
North East Lincolnshire	156,900	-1.7%
Source: Census 2021		

Table 2 Population growth in Greater Lincolnshire since 2011, Census 2021

Lincolnshire has experienced significant economic impacts. The Greater Lincolnshire LEP (Local Enterprise Partnership) has released a strategy "Protecting, Progressing, Prospering: Greater

Lincolnshire Plan for Growth”. The intent to grow the local economy will drive a different requirement for energy demand and supply requirements, particularly in the context of a rising population with a key goal to improve economic equality across the wider region.

Greater Lincolnshire (inc. Rutland) is a £23.2bn economy with significant opportunities for growth. Since 2010, the economy in Greater Lincolnshire has grown by £4.6bn. Average annual growth has been 3.1% in the decade up to 2019 (pre-pandemic).

However, productivity (as measured by economic output per hour worked) is 18.5% lower than the UK average, and the gap has generally been widening. This means that in 2020, the average job in Greater Lincolnshire had an output of £32.56 per hour, compared to the UK average of £39.94; a difference of £7.38 per hour worked. If the Greater Lincolnshire economy was performing at the national average in terms of productivity, output would be £5.2bn higher than current levels.

Manufacturing is the largest sector at £4.6bn GVA and is the third highest employer in the region. There are significant clusters across Greater Lincolnshire, including agrifood clusters in both the south and the north of Greater Lincolnshire, oil refineries and renewables cluster on the south bank of the Humber, and turbo machinery around Lincoln. Over the past 5 years, the number of jobs in manufacturing in England has fallen by 2% whilst in Greater Lincolnshire it has grown by 3%.

Greater Lincolnshire has significant potential, not only for local growth, but growth as part of the Midlands Engine Partnership (MEP). The MEP is the largest regional economy in the UK outside London.

4.0 ELECTRICITY SYSTEM

This section of the report provides context for the electricity system at a national level, intended to provide context of its structure, processes and key organisations. Please note that throughout this study, electricity has been the main focus due to increasing electrification and decarbonisation of energy, heat and travel and the central role it plays in net zero ambitions.

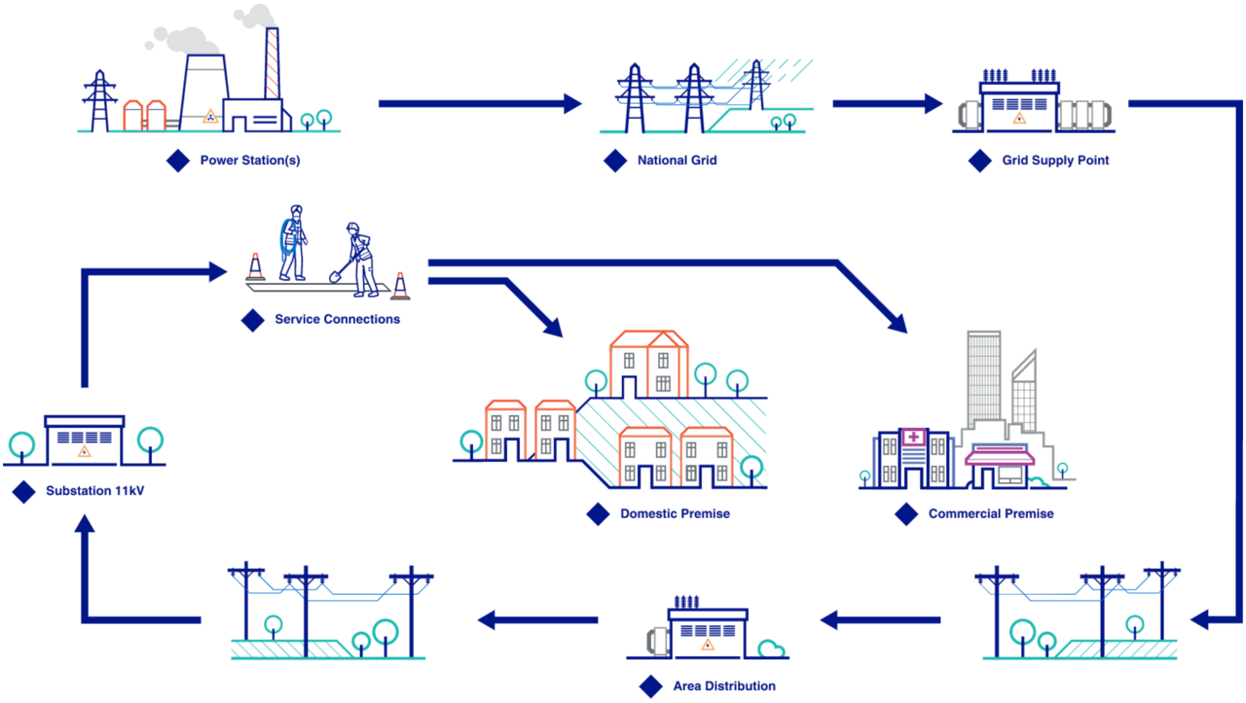


Figure 3 Energy provision structure, National Grid

NATIONAL GRID

The National Grid is the system operator of UK electricity and gas supply. It is the company that manages the network and transmission of electricity and gas to properties nationally. The National Grid network is made of high-voltage power lines, gas pipelines, interconnectors and storage facilities that together enable the transmission of electricity. The grid ensures that all areas of the UK have power supply. Within the network, there are many electricity distribution companies called Distribution Network Operators (DNO).

LOCAL DISTRIBUTION NETWORK OPERATOR

DNOs manage the electric power distribution system which delivers electricity to end users. There are 14 licensed DNOs owned by six different groups that cover specific geographically defined regions across the UK all regulated by Ofgem, and the two covering Greater Lincolnshire are Northern Powergrid and National Grid ED (previously Western Power Distribution). All DNOs are licensed companies that own and operate the network of towers, transformers, cables and meters that carry electricity from the national transmission system and distribute it throughout Britain. DNOs manage distribution networks from 240V to 400 kV through underground and overhead power lines, this covers commercial, industrial, and residential properties.

The Greater Lincolnshire Area is served by two separate DNOs, Northern Powergrid (NPg) and National Grid Electricity Distribution (NGED). NPg serves the northern part of the area, covering the whole of North Lincolnshire and North East Lincolnshire, while covering part of West and East Lindsey. In the south, NGED covers the whole of South Holland, Boston, City of Lincoln, South Kesteven, North Kesteven, with West and East Lindsey covered partially. Figure 4 below shows the dividing line between the two DNOs in within the Greater Lincolnshire Area.

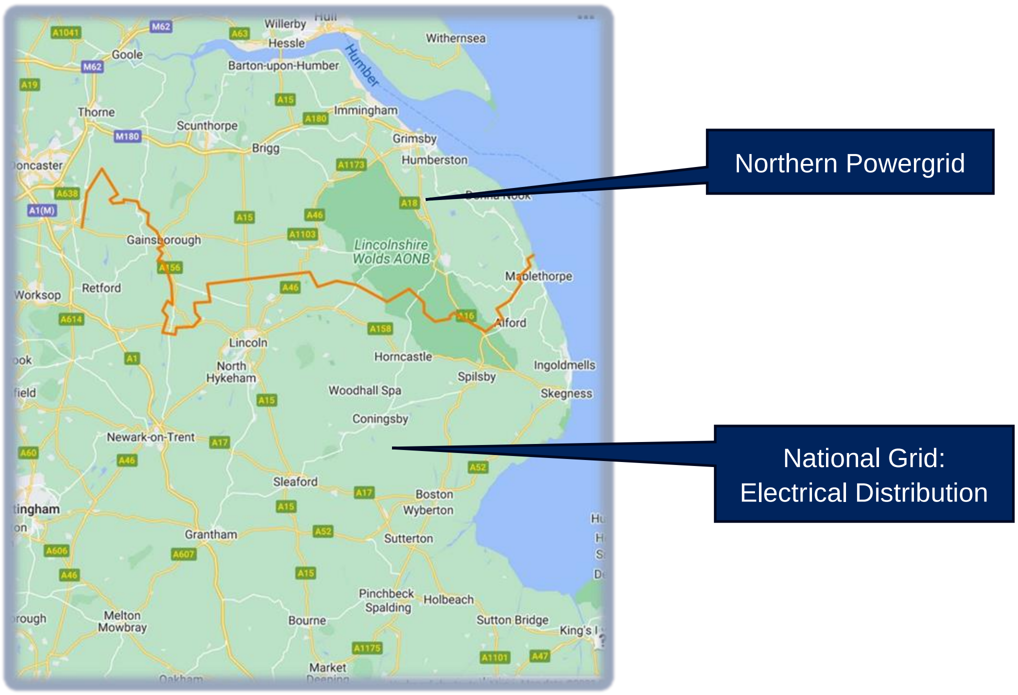


Figure 4 DNO boundary line within Greater Lincolnshire

Northern Powergrid (NPg) – Transports electricity across the North East, Yorkshire and northern Lincolnshire to provide electricity supply to 3.9million homes and businesses across the regions. NPg are part of Berkshire Hathaway Energy. NPg business plan for 2023-2028 states:

“Our plan positions us to take a leading role in enabling decarbonisation in our region and support future uptake in low carbon technologies such as electric vehicles and heat pumps. Our network will be instrumental in efficiently facilitating this transition, sitting at the heart of a decentralised, low carbon energy system that enables customers to be increasingly flexible with their energy use.”

National Grid Electricity Distribution (NGED, previously Western Power Distribution) – Transports electricity across Midlands, South West and Wales. NGED business plan (RIIO-ED2) for 2023 – 2028 states that investment proposals are circa £6bn (increase of £1bn compared to present) with a goal towards net zero.

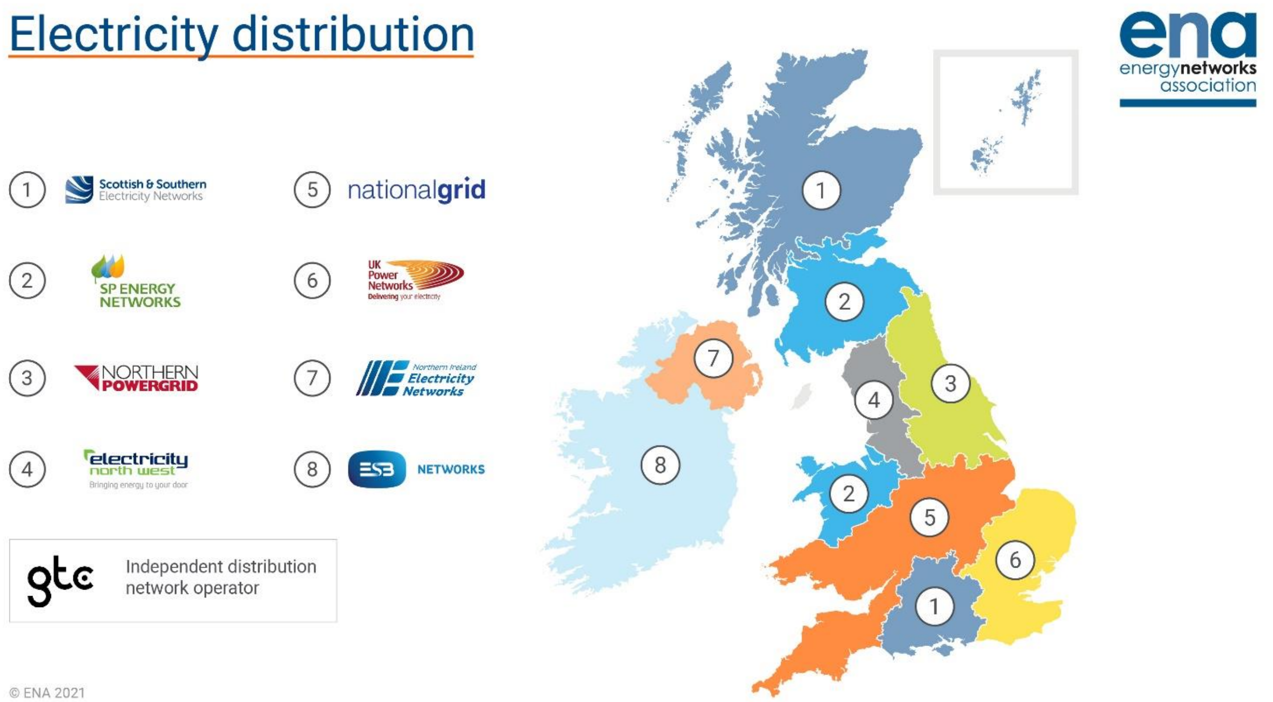


Figure 5 UK DNO regions, ENA

TRANSITION OF DNOS TO DISTRIBUTION SYSTEM OPERATORS (DSOS)

DNOs globally are challenged with of transitioning from being Network Operators to broadening the scope of their roles and expanding their operational reach to become DSOs. This has been driven by the transition to a lower carbon energy system and the increase in distributed generation. The current network was designed to have electricity flowing from large-centralised power stations to customers. Now, the system needs to evolve to include distributed sources of energy generation, for example large commercial and community owned renewable sources, as well as domestic scale generation.

This requires electricity to flow back and forth, which it was not designed for, and this is an engineering challenge. As part of their transition to DSOs, DNOs are responding to these challenges. New smart technologies will allow DSOs to have more visibility of what is happening on the network in real time, allowing the operation of the network to be optimised.

INDEPENDENT DISTRIBUTION NETWORK OPERATORS (IDNOS)

IDNOs provide an alternative route for businesses that want to connect to the electricity grid in the UK. Both distributors have many similarities, starting from the main concept - they own, run and maintain electrical infrastructure. The main difference is that IDNOs operate nationwide, without regional restrictions, to manage local networks. They are also regulated by Ofgem.

DNOs distribute electricity from the transmission grid for a large geographical area, whereas IDNOs distribute electricity from either DNOs, or the transmission network, to smaller local areas. Both DNOs and IDNOs are responsible for connection line faults and maintenance.

IDNOs working in partnership with local authorities, can look at innovative solutions to solve the issues around integrating private networks, including batteries, renewables, and EV charging. An example of this is Vattenfall,[6] who partner with Housing Associations and local authority developers to provide a long-term energy supply partner with capital repayment for assets. IDNOs cover investment costs of site infrastructure, which they manage and operate including maintenance and fault repairs. Developers receive an Asset Adoption Value which releases capital, and developers then pay an annual operational fee for the supply contract.

SUBSTATIONS

A substation is a part of an electrical generation, transmission, and distribution system. Substations transform voltage from high to low, or the reverse. Substations contain equipment that help keep our electricity transmission and distribution systems running as smoothly as possible, without repeated failure or downtime. Specialist equipment within the substation site can help prevent local network failures and power cuts.

There are two main types of substation: transmission and distribution. Transmission substations are where the electricity enters the power grid and convert it to a level that can be transmitted. Increasing or decreasing the voltage as it is transmitted ensures it meets the local distribution networks safely, whilst minimising energy loss. Distribution substations then lower the voltage so it can be used in buildings safely.

National Grid owns more than 300 large substations, where 275kV and 400kV overhead power lines or underground cables are switched and where electricity is transformed for distribution to surrounding areas. Smaller substations are owned and maintained by local distribution networks such as NGED and NPg.

4.1 ENERGY MANAGEMENT

WHOLE ENERGY SYSTEM APPROACH

A whole energy system approach refers to the development of a range of options for clean energy including electricity, transport, and gas, and fitting them together in the best combinations to deliver value for business and consumers, as well as keeping the energy flowing.

Energy Networks Association (ENA) represents the owners and operators of licenses for the transmission and/or distribution of energy in the UK and Ireland, those who control and maintain the critical national energy infrastructure. This includes NPg and NGED. Energy Networks Innovation Process (ENIP) relates to network innovation, the end-to-end industry led process for reporting,

---

[6] Low carbon housing - Vattenfall IDNO - Independent Distribution Network Operator

collaboration, and dissemination of Ofgem funded Network Innovation Allowance (NIA) projects in the UK, which NPg and NGED have engaged with.

ENA has an initiative called Open Networks,[7] which is looking to shape Local Area Energy Planning (LAEP) by co-ordinating input from gas and electricity networks into Ofgem, Department for Energy Security and Net Zero (formerly BEIS) and Energy Systems Catapult initiatives in the development of frameworks and tools. As part of this, a service is being developed which is aimed at providing Local Authorities with whole system solutions, where capacity constraints present barriers to new developments. For example, where a Local Authority has plans for a large number of new homes, there may be an electricity network capacity constraint if conventional solutions are deployed. A whole system solution could explore alternatives such as District Heating and Combined Heat and Power or freeing up capacity by moving existing electrical loads to alternative energy sources.

If the Greater Lincolnshire representatives are not already engaged with this initiative, then participating in the Open Networks Insights Forum is recommended, which would provide an avenue to determine the value it could bring to the region. This forum is an online event that is run quarterly. It would allow the Greater Lincolnshire representatives to engage with Open Networks as well as provide input and stay up to date on latest developments. This forms part of the works and remit of the recommendations detailed in the conclusion of this report.

Local Area Energy Plans

A Local Area Energy Planning (LAEP) is a data driven and whole energy system, evidence-based approach with the aim of identifying the most effective route for a local area to contribute towards meeting the national and local net zero target.

As a case study of local energy strategies being implemented, Greater Manchester Combined Authority is developing ten LAEPs across the city. The ten LAEPs will explore the unique local characteristics of each borough, including the types of buildings, transport systems, local industry, local energy generation, storage, and distribution assets, to help better understand how energy could be generated, distributed, and used in the future.

The insights will inform the creation of the Local Energy Market across Greater Manchester, helping to guide investment in measures like electric vehicle (EV) charging, energy storage capacity, decarbonisation of heating including introducing hydrogen where appropriate, home retrofit requirements for existing building stock and the development of local solar PV and hydropower generation.

Within the Greater Lincolnshire Area, the Greater Lincolnshire Local Enterprise Partnership (GLLEP), working with the University of Lincoln, has co-commissioned a LEAP for the UK Food Valley (UKFV). The project will undertake a “Deep Dive” into the energy requirements of the UK food valley and its transition to net-zero. Its overarching aim is to provide a series of recommendations for the short/near-term practical interventions that businesses in the agri-food sector could make to improve

[7] Open Networks: developing the smart grid - Energy Networks Association

energy efficiency and transition to low/zero carbon forms of energy. In addition, it aims to provide an evidence base to inform the requirement for the longer-term infrastructure changes. The project commenced in August 2022 and will reach its conclusion in October 2023.

It is noted that both NGED and NPg have identified support within their business plans for local authorities to develop local area energy plans.

DEMAND MANAGEMENT

Demand for electricity can fluctuate due to weather, economic growth, line damage and other causes, with the potential to cause blackouts. The transition to renewable energy plays a role in these fluctuations too, because power demand may peak at a time when the unpredictable supply of renewable energy is low. The new energy scenario calls for an increasingly flexible energy grid.

Demand Side Management (DSM) is a strategy used by electricity utilities to control demand by encouraging consumers to modify volume and pattern of electricity consumption. A DSM approach includes monetary incentives to encourage consumers to buy energy-efficient equipment, or lower prices if they agree to reduce usage during peak times of demand. This results in reduction in peak demand when prices are highest which evens out the demand and in turn, evens the prices.

DSM can result in reduced electricity prices through removing the requirement for back-up generators that have to be utilised to cope with peak demand, reduces grid management costs, and creates a more dependable and efficient network.

NPg have now rolled out the option of limited grid connections in terms of the amount and timing of peak demands from prospective developments as a cost-effective means of facilitating major new development across its area. There are similar examples across the UK, including in London – a region that has areas of highly constrained energy supply and high demand. For example, rather than developments paying for an unregulated connection that would need to pay for infrastructure that caters for the ‘worst case’ scenario in terms of peak demands on the network, it would pay for a limited connection that would prohibit demands over a certain level from development during the network peaks, thus ‘flattening’ those peaks and limiting the amount (and cost) of infrastructure required to cater for them.

Demand management can be part of the solution to accommodating future demands on the network, flattening the curve of those areas within Greater Lincolnshire that are experiencing constraints in the near future, when network infrastructure investment may lag behind demand. This will require customer behavioural change, alongside digital and process investment from DNOs to progress this. Greater Lincolnshire authorities can play a role in driving this investment into areas that are undergoing the greatest constraints, and the areas that require the most inward investment via development and economic growth; i.e. utilising the flexible demand approach to defer network reinforcement whilst enabling development in the short term.

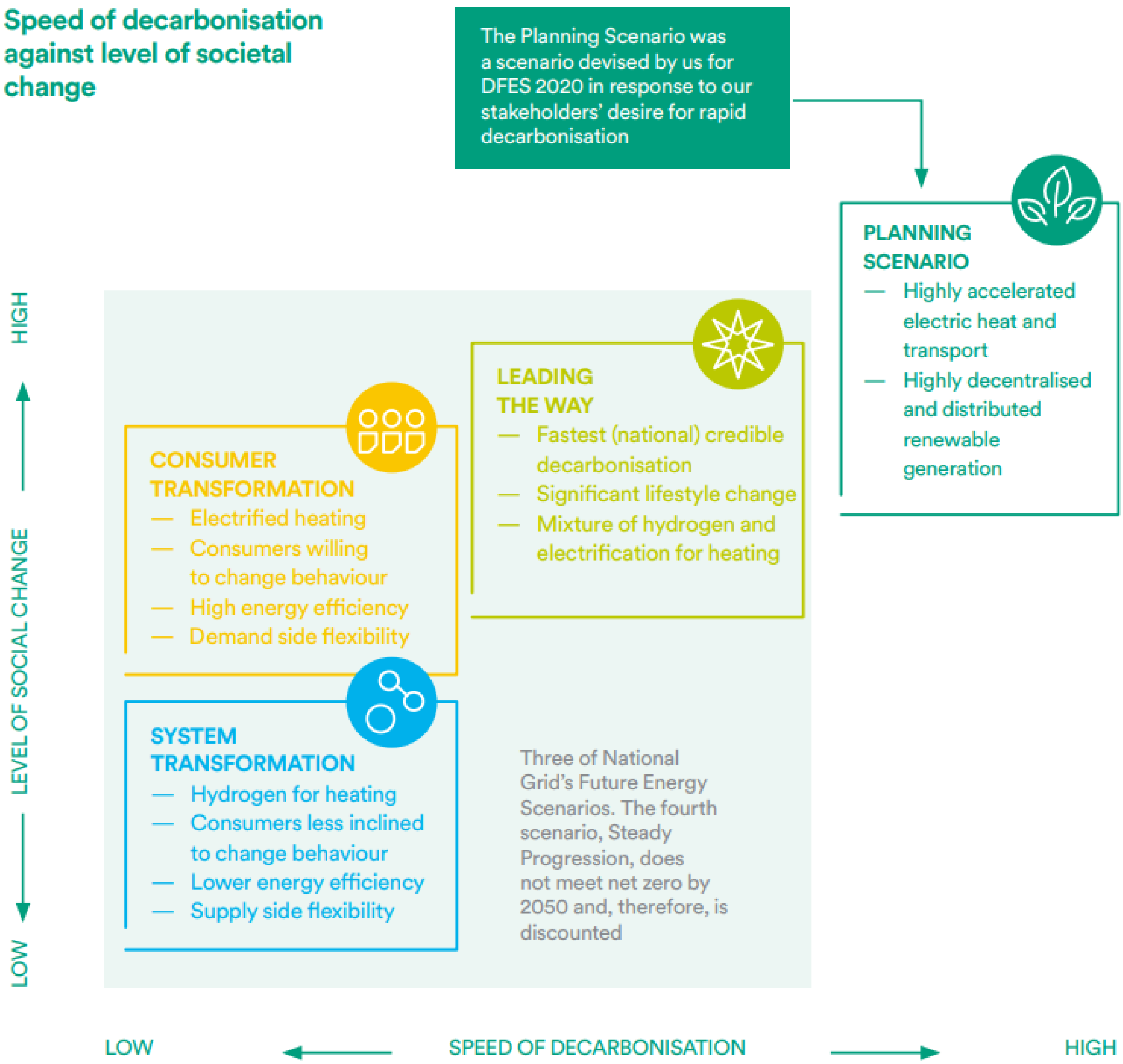


Figure 6 [Planning transformation pathways NPg]

For future energy supply, solutions to increasing demand are not solely infrastructure based. Smart solutions integrating digital advancement with enhanced management driven by data will be part of the overall solution. These can be based on fixed limitations on a connection, or intelligent connections that make use of 'base loads' on the network or cheaper tariffs, such as charging EVs at night.

SMART ENERGY

Through the Smart Meter Based Internet of Things Applications Programme, the UK Government announced £200,000 in funding for five projects that aim to bring smart technology to energy monitoring and management.[8] The funding is to facilitate better energy usage control, and therefore manage the green energy transition, whilst noting rising energy bills. This plays into the UK government approach to energy management, considering scaling up demand flexibility services. Both NPg and NGED have invited customers to take part in their flexibility services. This would benefit the network through changing the customers use habits. Energy strategies nationally are moving towards intelligent energy consumption; increasing renewable generation whilst actively managing supply and demand to smooth peaks and troughs.

Through integrating digital links, this approach can drive down costs, enhance efficiency, and reduce carbon emissions. The approach creates data through the increased monitoring of its electrical, gas, heat, and transport systems. The data empowers consumers and businesses to deliver greater efficiency, unlock cost benefits, and enhance flexibility; as large energy sectors begin to rapidly decarbonise, the electrification of these systems becomes critical – for example, major parts of heating and transport demand, and the deployment of greater volumes of low carbon generation, are opportunities to deploy smart solutions at the same time as new technologies.

A Smart Energy System is an approach which utilises new and emerging digital technologies, artificial intelligence, and machine learning, to actively monitor and balance energy needs across connected energy networks by making real-time autonomous interventions. This can provide transparency on energy consumption to enable cost savings are achieved, as well as improving energy network resilience.

The key benefits that digitalisation in energy can provide include:

- Access to data to drive evidence-based decision making and ability to automate energy interventions where possible.
- Modernising existing energy systems and moves towards the green energy transition.
- Improved resilience of energy networks through artificial intelligence and machine learning.
- Smart devices and systems allow energy to be used when prices are lower.
- Management of energy usage to align with energy generation variation (wind and solar).

The switch from analogue to digital systems combined with high performance computing capability enables huge volumes of data to be processed; this ability creates opportunities for innovation by energy providers. This includes tariffs that are sensitive to market price variations, such as Agile Octopus.[9] Digital advancement within energy is not yet widespread, such as real-time disaggregated domestic and non-domestic renewable electricity generation.

Smart energy solutions include:

- **Smart grids**: coordinate the needs and capabilities of all generators, grid operators, end users, and electricity market stakeholders, to operate all parts of the system as efficiently as possible, minimising costs and environmental impacts while maximising system reliability, resilience,

[8] Smart_Grid_Vision_and_RoutemapFINAL.pdf (publishing.service.gov.uk)

[9] Agile Octopus | Octopus Energy

flexibility and stability for transporting electricity from generators to homes, businesses and industry. A smart grid involves using the existing hardware of the national grid but in a smarter way. This means using data and communications technology to monitor and actively control generation and demand in near real-time. In practice, the smart grid can help network operators spot problems earlier and re-route power helping to ensure a more reliable and secure supply.[10] A smart grid cannot be considered as one single item, it is a combination of technology and innovation working together as one system. Examples of these include smart meters, Internet of Things, Vehicle to Grid and smart local energy systems. Both NPg and NGED consider the development of smart grids as part of their networks an essential aspect of preparing their networks to meet future demand.

Within the Greater Lincolnshire region, the use of smart grids can be a way for the two DNOs to manage the peak demand in areas, such as the north-east and city of Lincoln, where there is predicted to be significant constraint on demand headroom availability of the primary substations.

- **Smart meters**: Smart meters are a key enabler of the smart grid. The provide information to assist in improving network management as well as facilitating demand shifting and supporting distributed and renewable energy generation. The UK Government intends for all energy suppliers to offer a smart meter to every home in England, Wales and Scotland by mid-2025, covering over 26million homes.
    - Enables live data updates to energy providers, for example during a power cut
    - Enables improved network management
    - Enables data driven investment decisions

- **Vehicle to grid**: technology that enables energy to be pushed back to the power grid from the battery of an electric car, effectively utilising EVs as batteries to manage local demand.
    - Renewable energy production is inconsistent and volatile, resulting in a need to either utilise the energy when generated or find storage solutions.
    - As EV usage increases as transport decarbonisations, EV batteries provide a new method to balance and store energy in a cost-effective way through utilising existing hardware.
    - Estimated 140-240 million electric vehicles globally by 2030, therefore 140m vehicle batteries with an aggregated storage capacity of 7TWh.
    - Northern PowerGrid have invested in Vehicle 2 Grid (V2G) studies in the last five years

[10] Smart_Grid_Vision_and_RoutemapFINAL.pdf (publishing.service.gov.uk)

Figure 7 Virta, Vehicle to Grid process map[11]

- **Smart local energy systems:** A smart local energy system brings together energy generation, storage, demand and infrastructure and connects them in a smart way, at a local or regional level. This allows for a more tailored, dynamic approach to the energy transition, recognising that different places and communities have different needs and ambitions.[12]
  - A major innovation programme focused on smart local energy systems: Prospering from the Energy Revolution. This programme was delivered by Innovate UK and the Engineering and Physical Sciences Research Council (EPSRC) while being funded by Innovate UK. The aim was to work with businesses, communities and academics to explore intelligently joining up energy supply, storage and use at a local and regional level.
  - As part of the programme there were three demonstrator projects Project LEO (Local Energy Oxfordshire), Energy Superhub Oxford and ReFLEX Orkney.[13] Each of these projects showed that by using a combination of technology such as battery storage, electric vehicles, smart chargers and smart meters can build a local energy system that is flexible and meets the need of the local community. These systems can take away the technical and financial pain of energy transition by making the technology choices very simple for people.

---

[11] Vehicle-to-Grid (V2G): Everything you need to know (virta.global)

[12] Enabling smart local energy systems - Innovate UK KTN (ktn-uk.org)

[13] UKRI-250122-SmartLocalEnergySystemsEnergyRevolutionTakesShape.pdf

Smart local energy systems can be adopted in Greater Lincolnshire in urban areas. The type of system will depend on the requirements and wants of the local community.

- **Internet of Things Electricity Management:** The Internet of Things (IoT) can be described as a network of physical objects, "things", that are embedded with sensors, software, and other technologies. The purpose of connecting these "things" over the internet with outer devices and systems to exchange data. These devices range from ordinary household objects to sophisticated industrial tools.
  - This connectivity means that electrical devices can be turned on and off remotely, charging an electric vehicle at night or a heating system in an office. On a national grid level, it means that these devices can contribute to demand response where they are switched on at times of least demand. This means that National Grid can better control peak demand which provides flexibility and additional resilience to the grid.
  - The IoT is part of the smart grid that is referenced above, it is one piece in a complex system. The UK Governments Smart Meter Based Internet of Things Applications Programme[14] there are five projects that are trialling how best to utilise the IoT within a smart grid system. National Grid have made reference the IoT in their Future Energy Scenarios document[15], however there is no strategy currently in place on how best to utilise the IoT and integrate it into the national grid. NPg consider the IoT one of the technologies that they will be deploying and using in the future once mass data collection becomes cheaper.[16]
- **Private Wire Networks:** Private wire networks are a form of distributed generation separate from the national grid. This involves a privately-owned electrical generation plant which is connected to a local electricity grid that supplies electricity to those connected to it. The benefits of using private wire electricity are that organisations can reduce their energy costs, improve their energy security and reliability, and contribute to a more sustainable energy future. Private wire electricity can be generated from a variety of renewable energy sources, including solar, wind, and biomass. Private wire networks can be small scale between a number of organisations or large scale involving an entire city.

An example of a large-scale private wire network is in Cowley, Oxford where, as part of Energy Superhub Oxford (ESO) project, the UK's first grid-scale battery storage system that is directly connected to the transmission-network has been set up. The government-backed project, integrates energy storage, electric vehicle (EV) charging, low carbon heating and smart energy management technologies to decarbonise Oxford by 2040.[17] The system uses a 8km private wire network to connect the battery system to public and commercial EV charging locations across the city. It is hoped that this project can become a blueprint to other towns and cities in the UK to follow to achieve net-zero.

---

[14] Smart Meter Based Internet of Things Applications: Phase 1 projects - GOV.UK (www.gov.uk)

[15] download (nationalgrid.com)

[16] Innovation_strategy.pdf (northernpowergrid.com)

[17] Powersystems awarded EBoP works contract for the Energy Superhub Oxford - Powersystems (powersystemsuk.co.uk)

In the Greater Lincolnshire region, private wire networks are a way to manage connection to the grid and to achieve net-zero. Both small and large scale projects are feasible through the region. Small scale would be suited to rural setting where grid connection costs are large and in the north-east of the region where there may be significant constraint on the primary substations demand headroom. Setting up of a private wire network is not carried out through the DNOs.

4.2 ALTERNATIVE TECHNOLOGIES

Geothermal

Geothermal energy is the heat generated and stored in the ground and is a source of low-carbon, renewable energy. In the UK, it can be generated at depths from a few metres to several kilometres and can provide heat or power annually as it is not dependent on weather conditions. This means that it is able to deliver baseload energy for balancing more intermittent power generation from renewable sources, like solar or wind.

Geothermal technologies currently deliver less than 0.3%[18] of the UK's annual heat demand, using only a fraction of the estimated available geothermal heat resource. There is the potential to increase this proportion significantly and contribute to the UK's net zero targets. However, a lack of information about the application of the technology in the UK has meant that deep geothermal is not currently factored into the UK's carbon budget or government strategies. It is expected that widespread adoption of geothermal technologies will require long-term government support to develop demonstration projects and expand the industry.

Geothermal projects are occurring across Greater Lincolnshire, ranging from geothermal heat pump, drilling of boreholes in Lincolnshire, to Scunthorpe General becoming the first NHS Hospital in England to use renewable geothermal power for heating and hot water.

Without a clear route to market, hampered by unclear regulatory landscape, geothermal has the potential for economic growth across Greater Lincolnshire, but is unlikely to form a significant proportion of the regions energy strategy in the short or medium term. Added to this, there is often high upfront capital costs and geological risks of not being able to achieve required temperatures. It is recommended that engagement with the on-going projects across the region occurs to share lessons learnt and develop an outline strategy for integrating geothermal into the region's long-term energy landscape.

Biomass

Biomass is a renewable energy source, generated from burning wood, plants and other organic matter, such as manure or household waste. It releases carbon dioxide (CO_2) when burned but considerably less than fossil fuels. Biomass can be used to produce bioenergy in the form of electricity, heat, biogas or transport fuels, or to produce materials and chemicals. The Climate Change Committee recommend dedicated energy crops and forest residues as future sources of

---

[18] https://post.parliament.uk/research-briefings/post-pb-0046/

domestic biomass. Bioenergy is currently the second largest source of renewable energy in the UK, generating 12.9%[19] of the total UK electricity supply in 2021. When combined with carbon capture and storage (BECCS), bioenergy may deliver negative emissions, which could contribute towards the UK's legal commitment to reach net zero carbon emissions by 2050. At present, approximately one third of UK biomass feedstocks are imported, predominantly wood pellets from North America, showing an existing demand in the UK market for biomass fuels.

Bioenergy with carbon capture and storage (BECCS) is the process of capturing and permanently storing CO_2 from biomass energy generation. There are currently no commercial scale BECCS operations within the UK, but several are under development. Interestingly, all National Grid's Net Zero Future Energy Scenarios (FES) deploy BECCS by 2028 with rapid increase in capacity by the 2030s.[20] Biomass is only considered renewable if it comes from a sustainable source, where new plants are grown to replace those used for fuel. There are environmental risks associated with biomass fuel production including negative ecosystem impacts if improperly managed.

Across Greater Lincolnshire there is little evidence of widespread domestic or commercial biomass energy generation. There are however clear signs that there is increasing interest in the alternative technology.

The Brigg Biomass Power Plant is a 40MW straw-fired power station near Brigg, North Lincolnshire. The waste to energy biomass power project was developed by BWSC, a joint venture who purchased the project from UK based Eco2 in 2013, and the scheme was completed in 2016. The site claims to generate sufficient energy for more than 70,000 UK households a year, but feeds back into the national grid which offsets up to 300,000t of CO_2 emissions annually. The straw-fuelled plant uses more than 240,000t of wheat straw feedstock annually, which should be sourced from producers within a 50-mile radius.

The Sleaford Renewable Energy Plant has a generation capacity of 38MW and commenced operations in 2014. It generates electricity using sustainable fuel sources, the plant is designed for the clean and efficient combustion of straw, the by-product of wheat production, sourced from farms within a 50-mile radius of Sleaford. Ash produced by the plant will be recycled as crop fertiliser. The surplus heat generated from the plant is used to provide heating free of charge to Sleaford's public swimming pool, Sleaford Bowling Centre, Sleaford Town Football, William Alvey Primary School, and North Kesteven District Council's office in the town.

Drax Power Station in Yorkshire is the largest biomass plant in the UK, having converted three of its six generators from coal but has been heavily criticised. Back in 2016 it was burning more than the UK's entire wood production, and critics argue that the demand and subsequent emissions were too significant to be deemed sustainable. To address their fuels sustainability performance, Drax have been investing in BECCS. C-Capture (spin off from University of Leeds) is involved in a collaborative project funded by Department of Business, Energy and Industrial Strategy (BEIS) to scale up and

[19] Biomass for UK energy - POST (parliament.uk)
[20] https://www.nationalgrid.com/stories/journey-to-net-zero-stories/eso-why-we-need-negative-emissions-net-zero

deploy its technology at Drax power station in North Yorkshire. The project will see CO_2 captured from biomass used in power generation, and show how C-Capture's technology can be used as part of a process to remove existing CO_2 from the atmosphere (BECCS).

With Greater Lincolnshire's unique position in the agriculture sector and the East Coast Cluster, there is potential for huge opportunity to attract investment into biomass in the region. The wealth of agricultural land can provide not only waste product but explore the potential for dedicated energy crops beyond current position. It is recommended that biomass strategies and investment should be closely linked to CCS. This however should be reviewed with social, economic and environmental factors integrated to ensure long term sustainability of energy generation.

The use of Biomass as an energy source has to be balanced with the importance of food production to the Greater Lincolnshire Region. Currently, 30% of country's vegetables are grown in the region and currently there are plans to double the contributions of the agri-food sector.[21] Any reduction in agricultural production to allow for Biomass would have to consider these factors, can production be met elsewhere and would be economically viable for the Greater Lincolnshire region to make the shift.

Whilst this study is providing a measured view of alternative and renewable energy across the region, it is worth noting that Biomass is extremely controversial and unpopular. Recently Drax has been criticised for repeatedly exceeding air pollution limits, and reports in recent years show pellets for biomass in Europe coming from old growth forests which is not deemed to be a sustainable approach. With this in mind, Greater Lincolnshire should undertake a review of biomass across the region, integrating wider sustainability impacts such as air quality and biodiversity, as well as socio-economic impacts from an agriculture perspective. It would be of benefit to have a clear strategy and guidance for the region on the Greater Lincolnshire stance on biomass as an alternative energy source.

Energy From Waste

Energy from Waste (EfW) forms part of the circular economy, recovering benefits from resources when they are no longer in use or fixable. Generating energy (electricity or heat) from waste is part of the waste hierarchy, see diagram. Energy generation from waste (recovery) is below the preferred options of reducing waste, re-use, recycling and composting but is preferable to landfill.

Historically in the UK, many of the early incinerators were disposal-only plants, which simply burned waste to reduce its volume. Focus should be on reducing waste volumes, however there will always be a proportion of waste that cannot be prevented or recycled. Therefore, EfW is likely to remain important.

EfW facilities burn non-recyclable waste, with the resulting steam powering a turbine, which generates electricity. Some EfW plants are

Figure 8 Energy Saving Trust, waste hierarchy

[21] Agri-food Sector | Greater Lincolnshire LEP

able to provide direct heating for local properties. The waste going to an EfW would otherwise have been disposed of in a landfill site.

The EfW plant in Lincolnshire at North Hykeham has been in operation since 2014 and treats up to 190,000 tonnes of residual waste, diverting it from landfill and exporting 105,000 MWh of electricity in the process. The waste arrives on 10 and 25 tonne collection vehicles from the local Lincoln area and 5 waste transfer stations based at Boston, Gainsborough, Grantham, Louth and Sleaford.

The proposed Boston Alternative Energy Facility will be a state-of-the-art power-generation facility located south of Boston, Lincolnshire on the Riverside Industrial Estate. This facility will be capable of generating 102 MW of renewable energy, of this amount, 80MW will be exported directly to the National Grid for distribution by National Grid ED. The facility is currently moving through the planning process with a decision expected in July 2023.

There are generally two types of outputs, solid waste which includes metals and ash from the incinerator. At Lincolnshire the metals are collected and recycled, and the incinerator bottom ash (IBA) is used as aggregate in the construction industry. The air pollution control residue (APCR) goes to a waste treatment facility for further treatment. The steam powers the turbine and is then cooled before being fed back into the boiler.

There are concerns around EfW from a sustainability perspective, however there is no denying the role EfW can play in energy generation. Based on the above, it is unlikely that EfW will experience widespread growth across the region but will remain a part of the energy strategy across Greater Lincolnshire. It is suggested that feasibility studies should be considered for landfill sites across the region to determine if the waste is suitable for use in EfW, however it is critical that these are seen to complement recycling and waste reduction schemes, rather than compete with.

There is an opportunity to integrate a district heating system into the Lincoln EfW plant to utilise the excess heat from the plant to provide heating to homes in the region. An example of a successful EfW plant providing heat to homes through a district heating system is Sysav Power Plant in Malmo, Sweden. This plant process 600,000 tons of waste annually while providing 60% of the heating requirements of Malmo.[22] The plant in Lincolnshire has been designed and constructed to allow for the integration of a district heating system but to date this has not been implemented. According to the Lincolnshire County Council this is because they have not been able to secure necessary off-takers for the heat.[23]

Anaerobic digestion (AD)

Anaerobic digestion can be used to generate energy from organic waste like food and animal products. In an oxygen-free tank, this material is broken down to biogas and fertiliser. The Energy Saving Trust estimates that if the UK treated 5.5 million tonnes of food waste this way, the energy

---

[22] Welcome to Sysav | Sysav – tar hand om och återvinner avfall

[23] Energy from Waste – Lincolnshire County Council

generated would serve around 164,000 households while saving between 0.22 and 0.35 million tonnes of CO_2, in comparison to composting.[24]

Lincolnshire Wildlife Trust (LWT)[25] and Lincolnshire County Council have been trialling road verge biomass harvesting with a tractor-powered suction flail, where the vegetation was then used to generate energy through nearby farms on-site anaerobic digestion plants. This scheme has had challenges as verge vegetation does not align to waste codes therefore cannot be used in anaerobic digestion plants; this is an example of where collaborative efforts could overcome regulatory barriers for new energy generation innovations.

As part of the wider energy strategy across the Greater Lincolnshire region, it is worth considering how feasible and beneficial it could be to expand this initiative across the wider region.

Nuclear

Nuclear energy is a form of energy released from the nucleus, the core of atoms, made up of protons and neutrons. This source of energy can be produced in two ways: fission – when nuclei of atoms split into several parts – or fusion – when nuclei fuse together. The nuclear energy harnessed around the world today to produce electricity is through nuclear fission, while technology to generate electricity from fusion is at the R&D phase. Nuclear power contributes 15% of UK electricity[26] from 6.5GW of nuclear capacity. The UK government predict that up to 24GW of new nuclear capacity will be required by 2050 to provide 25% of electricity.[27] At a large scale, nuclear is low carbon provided from a relatively small land area. Hinkley Point C, located in Somerset, will power 6 million homes from a quarter square mile.

The UK government has confirmed that the West Burton Power station site in North Nottinghamshire on the Lincolnshire border will home the STEP (Spherical Tokamak for Energy Production) prototype fusion energy plant. The plant is intended to be operational by the early 2040's, with £220million pledged by the government. The scheme will be led by the UK Atomic Energy Authority.[28]

District Heating Systems

Heat networks (also known as district heating systems) supply heat from a central source to consumers, via a network of underground pipes carrying hot water. Heat networks can cover a large area or even an entire city or be fairly local supplying a small cluster of buildings. This avoids the need for individual boilers or electric heaters in every building. Heat networks are sometimes described as "central heating for cities".[29] There are many possible technologies that can provide the input to a heat network including power stations, energy from waste (EfW) facilities, industrial

---

[24] https://energysavingtrust.org.uk/generating-energy-waste-how-it-works/
[25] DEV_CASE_Roadside Verge Management Lincs1_2019.12.13.pdf (wildlifetrusts.org)
[26] Nuclear Power in the United Kingdom |UK Nuclear Energy - World Nuclear Association (world-nuclear.org)
[27] Nuclear energy: What you need to know - GOV.UK (www.gov.uk)
[28] Nuclear energy: What you need to know - GOV.UK (www.gov.uk)
[29] Energy Bill [HL] 2022-23, parts 7-10: heat networks, smart appliances, load control and energy performance of buildings - House of Commons Library (parliament.uk)

processes, biomass and biogas fuelled boilers and Combined Heat and Power (CHP) plants, gas-fired CHP units, fuel cells, heat pumps, geothermal sources, electric boilers and solar thermal arrays.

Heat networks have the most potential to reduce carbon emissions and costs when implemented for the benefit of existing building stock, rather than for thermally efficient new buildings, which have a much lower heat demand.[30]

A key focus on heat networks should be in conservation areas, where maintenance of the building character makes additional insulation hard and in off-gas grid areas where heating fuels are more expensive and produce higher carbon emissions than natural gas. In rural areas across Greater Lincolnshire, there are areas which are off-gas grid that may benefit; please note that the lowest costs are experienced in high density urban areas as they offer a communal solution as the pipe infrastructure is expensive. Therefore, further feasibility studies should be undertaken to progress DHS viability. Where renewable heat is already available nearby to new development then heat networks should be considered. Examples of available renewable heat sources situated nearby to proposed new development are the energy from waste plant in Lincoln and the biomass power station at Sleaford.

As heat networks work best across high density urban areas, heat networks are unlikely to be suitable as a widespread solution across Greater Lincolnshire. It is recommended that high intensity users in urban areas consider this approach as part of a combined energy forum; linking together organisations such as the NHS trusts with local industrial businesses to power residential heating.

For Central Lincolnshire, a study into heat networks has been undertaken, identifying ‘heat dense’ areas that would be most suitable for heat networks. The areas of highest heat density tend to be the historic centres which are often conservation areas, which makes retrofitting options that would impact their visual appearance difficult such as external insulation/cladding, energy-efficient glazing, and interior wall insulation. Additionally, ground or air source heat pumps in such locations can also be challenging due to space constraints and visual impact. As such, HNs with a low carbon heat source can be the optimal route to the decarbonisation in the absence of many other alternatives.

Local Authority Name	Estimated number of heat networks
North Kesteven	5
Lincoln	25
West Lindsey	7
Total	48
Estimate of single building communal heating systems	41
Estimate multi-building heat networks	7

Figure 9 Catapult, heat network requirements

Through the Heat Network Transformation Programme (HNTP) the government is working with industry and local authorities and investing over half a billion pounds in funds and programmes, to develop new heat networks and improve existing ones. Capital grant

[30] Decentralised energy: powering a sustainable future | The Carbon Trust

support is available for the development of new and existing low and zero-carbon heat networks, in a series of quarterly application rounds until the scheme closes in 2025.[31]

Battery storage

Across the UK, electricity storage technologies are deploying at different scales, from domestic batteries to larger grid-connected facilities, and are providing a wide range of benefits. It is highly likely that the need for electricity storage will rise as the UK increases the volume of variable, non-dispatchable renewables on the system, and increase peak demand through the electrification of heat and transport. There are a range of technologies that can provide electricity storage such as Chemical, Electrical, Mechanical and Thermal, from grid scale through to domestic level. It is estimated that approximately 30GW of capacity will be needed in 2030 and 60GW in 2050[32], to maintain energy security and cost-effectively integrate high levels of renewable generation.

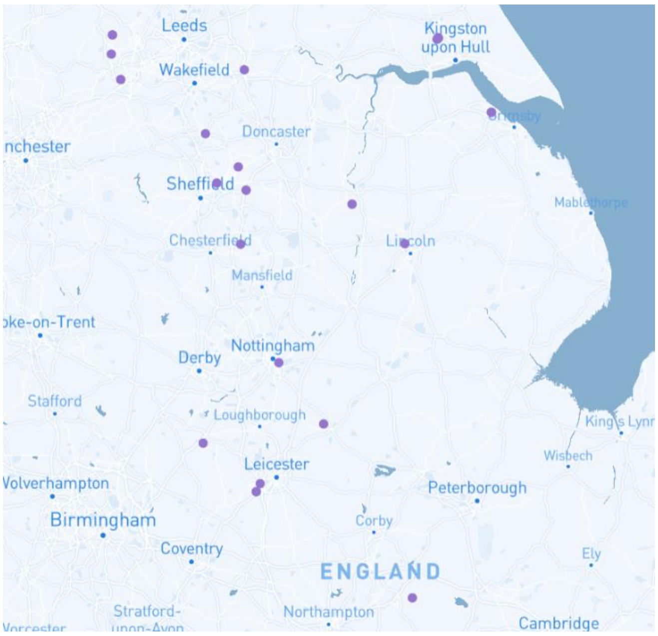


Figure 10 BEIS, battery storage projects

BEIS tracks renewable/alternative energy solutions that are either planned or in operation, which includes battery storage. Figure 9 demonstrates battery storage is far from widespread across Greater Lincolnshire, with only ca. current 19 projects that could be identified; the capacity for energy generation appears to outstrip battery storage capacity significantly. To address this, and allow for management of energy supply and demand, investigating new approaches such as Vehicle to Grid strategies and understanding what barriers are preventing a greater increase in battery storage would be beneficial. It is worth noting that skills and certification scaling up to respond to demand is critical to the success of battery storage UK wide.

Offshore Wind

Whilst offshore wind has been excluded from this study for the energy options analysis and future demand mapping, as it connects at National Grid level above the DNOs 132 kVA level, it has been referenced as a key part of the regions overarching energy strategy.

The are currently eight wind farms situated off the Lincolnshire coast, of which the largest is Hornsea 2. Hornsea 2 Wind Farm is located approximately 89km off the Lincolnshire coast in the North Sea.

---

[31] Green Heat Network Fund (GHNF): guidance on how to apply - GOV.UK (www.gov.uk)
[32] Energy Storage Landscape - Energy Systems Catapult

The farm has 165 Siemens Gamesa 8MW turbines generating 1.3GW of electricity,[33] making it the largest offshore wind farm in the world.

Table 3 Offshore wind farms Greater Lincolnshire

Name	Turbines	Operational	Capacity (MW)	Developer
Lynn & Inner Dowsing	54	2008	194	Centrica
Lincs	75	2013	270	Centrica
Humber Gateway	73	2015	219	E.on
Westermost Rough	35	2015	210	Ørsted
Race Bank	91	2018	573	Ørsted
Hornsea One	174	2020	1218	Ørsted
Triton Knoll	90	2022	857	RWE
Hornsea Two	165	2022	1400	Ørsted
Hornsea Three	300	2025	2400	Ørsted
Hornsea Four	180	2027	1800	Ørsted
Race Bank Extension	TBA	TBA	573	Ørsted
Outer Dowsing	TBA	2030	1500	Total Energies and Corio Generation

Currently, there are four more wind farms proposed to be built off the Lincolnshire coast in the next 10 years. These additional wind farms will bring the total generating capacity of Greater Lincolnshire offshore wind to 11.2GW of electricity.

As well as providing renewable energy for the Greater Lincolnshire region and the UK, the offshore wind industry has been a major boost for the port town of Grimsby in North East Lincolnshire. The Port of Grimsby has seen a transformation with the world's foremost developers and manufacturers of wind turbines locating themselves there. In 2019 Ørsted, a Danish renewable energy company, opened the East Coast Hub at the port of Grimsby, the world's largest offshore wind operations and maintenance centre.[34]

Onshore Wind

Electricity from onshore wind can be used to generate electricity at both a national grid level, where the electricity generated is fed directly into the national grid, and at a distributed level, where the electricity generated is used directly by those generating it. Currently in the UK, there are more than 2,500 onshore wind farms in operation, generating 14.5 GW of electricity which makes up 11% of the UK's electrical needs.[35] In 2015, using the National Planning Policy Framework, planning restrictions on onshore wind farms were tightened effectively placing a ban on them. However, the government has recently indicated that it will relax the planning regulations.

[33] Hornsea Two offshore wind farm (hornseaprojects.co.uk)

[34] World's Largest Offshore Wind Operations Centre | Ørsted (orsted.co.uk)

[35] Onshore vs offshore wind energy: what's the difference? | National Grid Group

The Greater Lincolnshire Region provides good conditions for locating onshore turbines and wind Farms with large areas of flat open land and proximity to the coast. Average wind speed in the region range from 8-10 knots inland to 10-15 knots in coastal regions.[36] Despite this there is internal resistance to the use of onshore wind as a form of generating renewable electricity within the region.

Since 2005, there have been planning application for 40 onshore wind projects.[37] Of these, 11 are Operational generating 17.8MW of electricity. The last project that was granted planning permission was in March 2015.

The Green Masterplan published by Lincolnshire County Council in 2019 makes no mention of the use of onshore wind to meet the county's net-zero emissions targets.[38] Currently there are no planning permission for onshore wind projects being sought within the region. However, through the Central Lincolnshire Local Plan, the councils of North Kesteven, West Lindsey and City of Lincoln have identified suitable locations for small, medium and large wind energy development throughout the region. Any wind developments identified for these locations will be supported through the planning process. All three districts see onshore wind as necessary for their goal of net zero carbon by 2050 or before. Also, the East Lindsey District Council have teamed up with Norwegian company Ventum Dynamics to run a trial using vertical turbines to generate electricity to be used at source.[39]

Onshore wind is another tool to allow the region to reduce its emissions and achieve the net-zero targets. Currently it is underutilised across the region for a number of factors. Onshore wind projects in particular shows how internal politics and market drivers can cause conflict in trying to achieve a common goal.

Hydrogen

Hydrogen can be a low carbon energy source that the UK government is intending to form a key part of the roadmap towards decarbonised energy.

There are very few natural abundant sources of hydrogen, which means that it needs to be created. This is commonly through steam methane reformation, where natural gas is reacted with steam to form hydrogen. This is carbon intensive – made low carbon from CCS which produces 'blue hydrogen'. Hydrogen can be produced by electrolysis where electricity splits water into hydrogen and oxygen, which produces 'green carbon' or zero carbon hydrogen when the electricity used is renewably sourced. The majority of hydrogen produced globally at present is carbon intensive, therefore hydrogen only forms part of the net zero solution if it is manufactured in a low carbon way.

BEIS priorities include industrial fuel switching, transport, market interventions, hydrogen for heating and gas blending and storage. At present, hydrogen supply is a key challenge for both quantity and stability of supply. Current UK hydrogen production and use is heavily concentrated in chemicals and

---

36 Where are the windiest parts of the UK? - Met Office

37 Renewable Energy Planning Database: quarterly extract - GOV.UK (www.gov.uk)

38 Initial Action Plan 2020-2025 – Lincolnshire County Council

39 Skegness wind turbine trial to light up pier in UK first - BBC News

refineries and is produced form natural gas without CCS therefore high carbon intensity. Hydrogen is also used in the transport sector to a smaller degree, as hydrogen cars, trucks, buses and marine vessels are already operating and supported by a network of refuelling stations, with plans for hydrogen trains and aircraft underway.

For residential use, there is a trial scheme where hydrogen and natural gas as blend will be supplied to over 650 homes in the north-east of England. Across Greater Lincolnshire, hydrogen is not yet widely used as an energy source. However, there are many projects upcoming where hydrogen will be created or required. Hydrogen Valley (Cadent) incorporates Greater Lincs and could be an opportunity to demonstrate cluster users and producers. GLLEP have been engaging with national and regional hydrogen experts to determine the opportunities within hydrogen.

For future energy landscapes, there is a national hydrogen strategy with a roadmap to market development. This details that small scale production with on site use and trial projects will occur in 2023, with certification schemes not being rolled out to market until 2027. Alongside the market development, there is government funding including £240m Net Zero Hydrogen Fund (NZHF) to provide capital expenditure support for low carbon H2 production projects.

Across the midlands there is a new programme to support the creation of a new hydrogen economy. HyDEX includes universities, large businesses and SMEs as well as other partners to accelerate hydrogen market growth whilst providing skills to support the growth. The £4.99m programme, funded via the RED Fund scheme run by Research England, which is part of UK Research and Innovation (UKRI), will see the ERA university partners making available their £111m worth of hydrogen facilities, large-scale demonstration programmes, and research capabilities to regional businesses.

In wider industry, JCB have developed an internal combustion engine (ICE) that runs on hydrogen. This is more appropriate for larger vehicles as fuel cells proved too expensive and not robust enough, therefore smaller vehicles are converting to EV. Hydrogen supply is a key challenge and is currently limited widespread development.

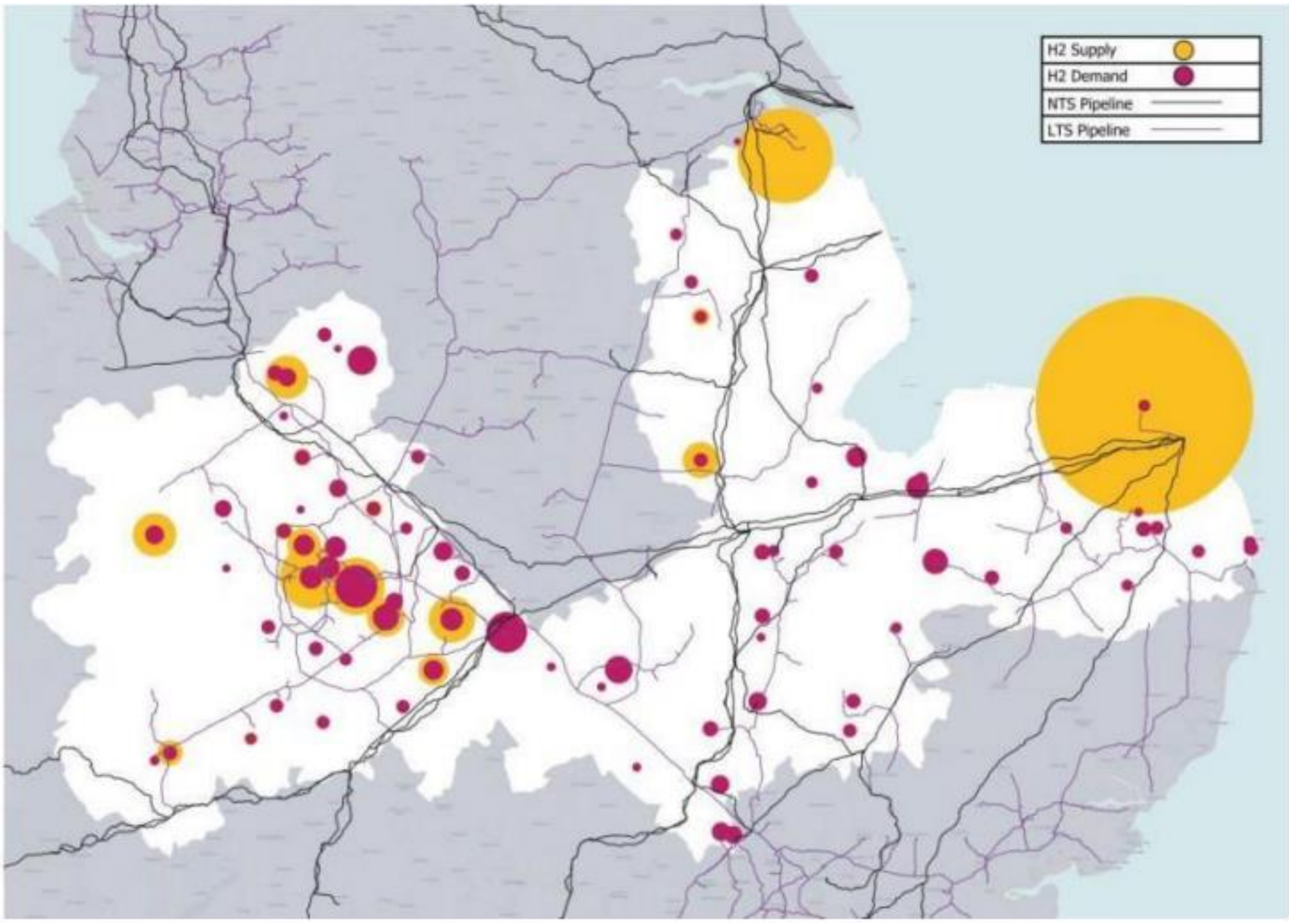


Figure 11 Hydrogen valley supply and demand

Power generator VPI and the world's largest hydrogen producer, Air Products, have signed an agreement to jointly develop a flagship 800MW low-carbon hydrogen production facility in Immingham. The majority of hydrogen produced by the 'Humber Hydrogen Hub' or 'H3' would be used to decarbonize VPI Immingham's existing power production. The H3 project looks to capture up to two million tonnes of CO_2 per annum and contribute to achieving Net Zero in the wider Humber industrial region by 2040. The H3 project has submitted an application for 'Strand 1' funding as part of the Net Zero Hydrogen Fund (NZHF). Administered by UK Research and Innovation (UKRI), the fund has the objective of enhancing hydrogen production at scale. It will contribute towards the UK Government’s ambition of realizing 10GW of low-carbon hydrogen production by 2030.

Greater Lincolnshire has been chosen as the area for one of the worlds first low carbon hydrogen towns within the next decade as Cadent and Equinor have joined forces to develop the technical assessments and concepts for hydrogen production, storage, demand and distribution of heat. Greater Lincolnshire has been chosen as the Humber is an ideal location for a pilot study due to the number of proposed low carbon hydrogen production projects including H2H Saltend. Cadent is the gas network operator for the Greater Lincolnshire area, therefore it will be exploring the conversion of its distribution infrastructure for hydrogen rather than natural gas. The research project is initially aimed at a pilot study, with the intent to extend out to the North of England and East Midlands.

Please note that as the majority of hydrogen projects are at early stages of planning, and there are no operational large scale hydrogen projects either supplying or using hydrogen as the main energy source across the region at present. Therefore, whilst it is likely to transform the energy landscape across the region, it is difficult to predict with any certainty when hydrogen will be widely utilised. It is anticipated that this is to form a key part of the energy supply, and energy sector industry, in mid 2030s.

Solar

Solar panels, also known as photovoltaics, capture the sun's energy and convert it into electricity. Residential solar energy is the world's fastest growing renewable energy solution.[40] At a domestic level, Solar PV systems are made up of several panels with each panel generating around 355W of energy in strong sunlight. Typical systems contain around 10 panels and generate direct current (DC) electricity. As electricity used for household appliances is alternating current (AC), an inverter is installed along with the system to convert DC electricity to AC. Electricity is generally used on site, or exported back to the grid.

After the UK Government's Feed-in Tariff renewables incentive scheme closed in March 2019, the Smart Export Guarantee was brought in which provides support to small-scale renewable energy generators for exporting electricity back to the grid.

There are numerous solar Nationally Significant Infrastructure Projects (NSIP) proposed across the Greater Lincolnshire area, these are detailed in the table below. A solar project is classified as NSIP if its generating capacity is more than 50MW. In addition to these major developments, there are seventy-nine developments under 50MW registered on the Renewable Energy Planning Database for development in the area.

Details	Developer	Capacity (MW)	District
Springwell Solar Farm	EDF Renewables UK and Luminous Energy	800	North Kesteven
Mallard Pass Solar Farm	Canadian Solar and Windel Energy	350	South Kesteven
Gate Burton Energy Park	Low Carbon	500	West Lindsey
Cottam Solar Project	Island Green Power	600	West Lindsey
West Burton Solar Project	Island Green Power	480	West Lindsey

[40] Solar Photovoltaic Panels | How Solar PV Works | E.ON (eonenergy.com)

Tillbridge Solar Project	Tribus Clean Energy and Canadian Solar	500	West Lindsey
Temple Oaks Renewable Energy Park	Ridge Clean Energy	250	North Kesteven
Heckington Fen Solar Park	Ecotricity	500	North Kesteven
Beacon Fen Energy Park	Low Carbon	600	North Kesteven

Table 4: Greater Lincolnshire Area Solar Nationally Significant Infrastructure Projects

Large solar projects are contentious across Greater Lincolnshire, due to many of the proposals being on valuable farmland. From research during this project, whilst solar will undoubtably form a major proportion of future energy generation, there is likely to be more benefit from a collaborative approach to small scale domestic energy generation to reduce residents' energy costs, easing the cost of living crisis and developing energy resiliency across the region. This approach should be linked closely with NPg and NGED to ensure that connections back to the grid are not prohibitive.

5.0 FUTURE ENERGY SCENARIOS

Building on National Grid's four national scenarios, NPg have modelled five scenarios[41] demonstrating how energy use might change up to 2050. They set out a range of decarbonisation pathways, titled 'Leading the Way'; 'Consumer Transformation'; 'System Transformation'; 'Steady Progression'; plus 'Net Zero Early' allowing for a scenario where the region decarbonises faster than the national average.

NGED have developed Distribution Future Energy Scenarios[42] (DFES) which outline the range of credible futures for the growth of the distribution network. Broadly aligning with the National Grid Future Energy Scenarios, these encompass the growth of demand, storage and distributed generation, also low carbon technologies such as Electric Vehicles and Heat Pumps. Of the four scenarios, three are compliant with the UK's target to reduce carbon emissions by 100%, achieving 'net zero' by 2050. A fourth non-compliant scenario is also modelled. For the East Midlands, NGED have estimated that in 2022 only 1% of homes have heat pumps, with 3% of vehicles being EV. However, the recent energy crisis has seen renewed interest in on-site electricity generation across homes and businesses with uptake of both of these low carbon technologies accelerating. New policies and support have emerged to encourage decarbonisation of heat and transport across the UK.

5.1 FUTURE ENERGY: INVESTMENT

Increased electrification of heat and transport, combined with renewable energy generation, require significant investment in energy infrastructure. It is anticipated that moving towards net zero, low carbon technologies, energy generation and energy efficiency will require a series of network intervention costs to address network needs.

Whilst the structure of the business plans and the investments differ between the two DNOs that cover Greater Lincolnshire, they both feature net zero / decarbonisation as high priority areas. Both plans show methodology to determine the predicted future energy scenarios aligned to government policy. For NPg[43], "Optioneering around solving network constraints by a mix of price-driven and DNO-contracted customer flexibility, network flexibility and conventional network reinforcement, to determine network investment required in 2023-28". Their investment plan is focused on a process driven approach: optimising network monitoring to identify constraints, utilising load reinforcement and maximising decarbonisation. During 2023-28 planned investment spend is £3.3bn, an annual spend of £661.3m. This is split into:

- Asset Resilience – 34%
- Decarbonisation – 26%

---

41 Northern Powergrid Future Energy Scenarios 2022 (odileeds.github.io)
42 National Grid - Distribution Future Energy Scenarios Application
43 NPg_Our_business_plan_for_2023_28.pdf (northernpowergrid.com)

- Reliability and Availability – 23%
- Connections – 6%

Increase in spend compared to the previous period (2015-2023) has been driven by decarbonisation, which 96% of the increase is attributable to. Decarbonisation requires capacity for heat pumps, EVs as well as digitalisation and smart grid technology.

The most significant change in network management is anticipated to be the increased data analysis enabled through sensors, storage and analysis tools, that active network management requires. In areas where energy demand outstrips capacity, there are methods of managing energy demand which are driven by monitoring limits on networks and allocating maximum capacity to customers in that area, typically based on connection application dates.

This method is called Active Network Management (ANM). This Last In, First Out (LIFO) hierarchy prioritises the oldest connections when issuing capacity, but is scalable so that new entrants will get access to the capacity when it becomes available. Where constraints are driven by DNO limits they may be referred to as Distribution Active Network Management (DANM) and for National Grid constraints Transmission Active Network Management (TANM). This includes customer price driven flexibility. This investment appears to form the bulk of the next phase of investment until circa 2030, when increased investment into management of low carbon electrification into the network will occur.

NGED have published their business plan for 2023 – 2028, with investments focusing on the journey to net zero and cyber security. The planned investment is £6.7bn, an increase of £1.4bn with an average annual expenditure of £1.34bn. It is noted that East Midlands is attributed 30% of shared costs.

Similarly to the NPg plan, the drivers are cited as decarbonisation and low carbon technologies. Whilst NPg doesn't cite local development plans, NGED state this to be a driver behind enhanced loads requirements. NGEDs approach includes flexibility services to manage demand in real time to remove need for reinforcement. Flexibility services includes local management of generation output, load and power flows, with predicted savings of £94m.

Load related reinforcement

Load related reinforcement investment relates to providing additional capacity on the network to facilitate new connections as well as load growth, for both demand and generation, covering connections, general reinforcement, fault level reinforcement and new transmission capacity charges.

EHV (33kV and 66kV) level

NPG

- Load growth based on scenario planning
- Options analysis for network areas

NGED

- EHV forecasts are expected to be low volume and high cost
  - Majority of asset replacement requirements anticipated for EHV

Load related reinforcement at HV/LV level

NPg

- Techno-economic modelling of network impacts and solutions
- Constraints anticipated to be higher on LV circuits, driven by electrification of heat and transport

NGED

- LV and HV forecasts are expected to be high volume and low cost

Fault level related reinforcement

The number of generators and large induction motors connected to the network can cause the fault current to exceed the rating of the circuit breakers, overhead line and cables. Temporary operational limitations are used as interim solutions until equipment is replaced, which can affect network performance and constrain network capacity. Distributed generation connections can also increase fault levels, which is expected in the future.

NPg

- Traditional approach was operational routines/alternative running arrangements to manage constraints
- Future approach to remove operational restrictions to increase fault level headroom and flexibility
  - Intended to remove barriers for low carbon generation

NGED

- NGED have identified sites that are higher risk alongside growth projections for investment or alternative network running arrangements.

Looped services

NPg

- Low voltage services to properties that are shared between customers are known as looped services
- Can be a barrier of low carbon technologies due to limited capacity on shared cables
- Solution is to de-loop services with new cables, which can be disruptive. NPg intend to do this as a reactive service when customers request low carbon technology connections.

NGED

- NGED are intending to proactively unbundle the looped service cables to address the growing demand for low carbon technologies to remove constraints and demands for customers, unlike NPg who will be reactive to customer demand.

NGED[44] predict an additional 1.5 million electric vehicles and 600,000 extra heat pumps across their area coverage, with adaptive plans that can flex to meet greater demand if change happens at a greater pace than predicted. For NPg, predictions are for 941,000 electric vehicles, 309,000 heat pumps whilst delivering a 20% reduction in connection lead time.

---

[44] NGED Business Plan

Active network management (ANM) appears to be relatively early on in maturity across the two DNOs, but with a clear trajectory to increase ANM over the next phase of the business plan. For NPg, four ANM zones in operation by 2023 with an estimated 540MW of flexibility. NGED rolled out ANM systems in 2014 but these are not widespread.

There are clear synergies between the two DNO business plans. However, where the plans differ, particularly regarding looped system approach and Local Area Energy Plans (LAEP), it is recommended that engagement with the DNOs is undertaken to understand the following:

- Possibility of aligning approaches between the DNOs further to gain consistency of energy management across Greater Lincolnshire, including ANM
- Whether generation of LAEPs across Greater Lincolnshire with two differing DNO approaches will result in significant changes across the region in energy approach
- Where there are targeted areas of improvement / upgrades to the infrastructure, if these areas can be used as pilot studies to drive energy efficiency and resilience of energy supply i.e. integrating connections for renewable and low carbon technologies.
- Greater Lincolnshire LA’s to input collaboratively in terms of upcoming development, demand and economic growth areas to allow DNOs to accurately model for the DFES approach

6.0 SECTOR FOCUS

Within Greater Lincolnshire there are significant sectors where energy demand and supply is critical to development. Greater Lincolnshire LEP (GLLEP) have identified sectors which are key to the economic development of the region which are Agri-Food, Manufacturing, Visitor Economy, Energy, Health and Care, Ports and Logistics. This study has aligned to those key economic sectors, focusing on the sectors where there is either significant energy demand or opportunity. Additionally, residential sector has been deemed as a sector where energy is critical to ensure ongoing investment.

Key sectors that have significant energy demand, either current or predicted, have been engaged with, to understand the current situation and gain an insight into predicted development and significant changes.

6.1 RESIDENTIAL

The residential sector is influenced by existing demand, predicted growth through direct population growth and through attracting those from other regions. Housing and the economy in Greater Lincolnshire are inextricably linked, contributing significantly to the local economy by creating two jobs for every house built.[45]

Greater Lincolnshire is committed to housing growth, with Local Plans working towards the delivery of 100,000 new dwellings by 2031.[46] The right mix of housing helps to attract and retain the workforce needed to enable growth, whilst new development generates employment opportunities and encourages spending in the local economy. Planned new developments will provide major growth opportunities along nationally important investment corridors. Our study has tracked all developments given to us by local authorities and planning portals.

Across the residential sector, decarbonisation of building stock is anticipated to be achieved through energy efficiency retrofit, low carbon heating (heat pumps), smart tariffs and demand side management. The impact of the above measures on domestic energy demand is key to enabling accurate energy forecasting; with increased efficiencies of domestic building stock, future demand may be over-estimated. At present, forecasted energy consumption has predicted a rapid increase in domestic demand driven through widescale adoption of heat pumps and EV charging requirements. NGED have commissioned a study to "*Develop an understanding of the electricity demand profile of UK domestic building stock pre- and post-retrofits to building fabric. Produce a methodology for integrating pre- and post-retrofit domestic demand profiles into network forecasting. Assess the potential savings on network reinforcement and flexibility from accounting for energy efficiency in demand forecasting. Perform an economic assessment of the potential benefits to networks from increased penetration of domestic retrofit interventions.*"[47] This project is expected to complete in July 2023, and consideration should be given to how Greater Lincolnshire can learn from the outcomes of

45 Priorities and Plans | Greater Lincolnshire LEP
46 National Grid - Demand Forecasting Encapsulating Domestic Efficiency Retrofits (DEFENDER)
47 National Grid - Demand Forecasting Encapsulating Domestic Efficiency Retrofits (DEFENDER)

the study and implement retrofit programmes across the region accordingly, (this may be an enhancement of existing schemes rather than new initiatives).

Sustainable urban extensions (SUEs) will accommodate the vast majority of the UK's new homes over the next few decades as the supply of brownfield and city centre sites depletes. SUEs have significant scope to incorporate green energy into the design. Large-scale renewable, locally sourced energy such as combined heat and power can be considered and incorporated into the environmental design. This has been considered on Queen Elizabeth Road, Lincoln.

RESIDENTIAL DEVELOPMENT CASE STUDY SELECTION

An outcome required from this study was the identification of opportunities in Greater Lincolnshire where a more collaborative energy approach can deliver commercially viable net zero carbon development and achieve the wider objectives of this energy options analysis.

For this study, all residential housing developments have been categorised into the following planning priorities:

- Short term, 1-3 years
- Medium term, 3-10 years
- Long term, 11+ year

In order to establish the two housing sites a short list of twelve housing sites was formed based on the following criteria:

- Greater than 50 units by 2025
- Planning permission granted
- Construction has not begun and will begin in the next two years.

Following review between RLB and the IG it was confirmed that the two development schemes to be used as case studies for wider application of learned issues across the Greater Lincolnshire area are the **Lincoln Western Growth Corridor** and **Boston Toot Lane**.

Rider Levett Bucknall

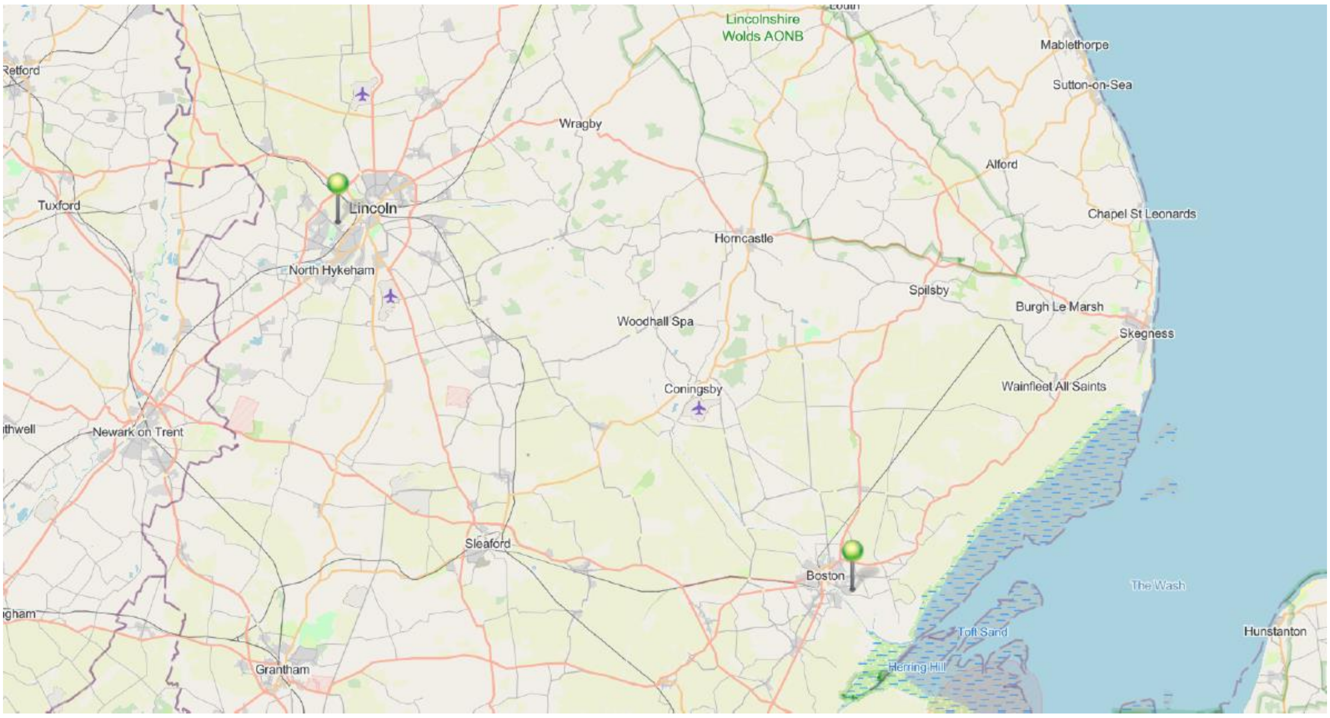


Figure 12 Location of chosen housing sites

These sites were selected based on the following factors:

- Ability for learning from the sites to add value to the overall commission / study
- Ability for this learning to be replicated through Greater Lincolnshire
- One Brownfield and one Greenfield site
- One Sustainable Urban Extension and one edge of town / semi-rural site
- Predicted housing values close to the Lincolnshire average
- Substation availability
- Scale and nature of development

Although the two sites do not reflect the full range of housing units, the combination of both provides a large site with great diversity and a smaller less diverse development. The main driver for the two sites selected is to capture as many aspects of housing developments as possible to have the greatest breadth of potential learning that can be applied to all new developments across the whole of Greater Lincolnshire – including future developments that are not yet scheduled, confirmed, or granted planning consent. This is intended to provide Greater Lincolnshire with the necessary tools and institutional capacity for future actions without the same level of need for external assistance. This has necessarily required some optimisation, being restricted to two case studies.

Further rationale is provided below for the site selections:

Boston Toot Lane - 200 units

- Low sub-station availability
- The development consists of greater than 50 units built by 2025
- Obtained full planning permission

  - Construction has not yet commenced
  - The area is representative of the average Lincolnshire housing price.
  - The development is located in an area that can provide access to affordable housing

Beaver Street (Lincoln Western Growth Corridor) 3,200 units

  - 4.679 MVA estimated demand, 5.2kW/unit
  - Residential and commercial demand, challenges and constraints
  - Planning consent granted
  - Brownfield city site
- A Sustainable Urban Extension site, the findings/opportunities from the study could be replicated across GL, including at 7 SUEs in Central Lincs
- Outline planning permission awarded with start on site for phase 1 and infrastructure (spine road and new rail bridge) expected before 2025
- The largest site on the shortlist, 3200 homes
- An urban brownfield and greenfield site with a range of infrastructure challenges/opportunities.
- Utility strategy report available to provide energy requirement for the site
- Substation demand headroom 7.14 MVA and residential site will require 27MVA. Additional demand from surrounding commercial, residential and leisure developments threaten to stagnate development in this area in the medium/long term phases
- An agreed commitment between the 2 major landowners (City Council and Lindum) to deliver a commercially viable net zero carbon development.
- Large areas of land that is not suitable for housing has the potential for renewable energy generation/heat network

PILOT STUDY

The identified sites are deemed to be representative of Greater Lincolnshire's residential developments, with capacity to provide a pilot scheme to drive forward energy efficiency and resiliency across the region. A detailed feasibility study should be undertaken in conjunction with the relevant development stakeholders. This feasibility study should include consideration of:

- All properties to be installed with low carbon technologies including but not limited to:
  - Air source or ground source heat pumps (ASHP, GSHP)
  - Electric vehicle charge points
  - High level of energy efficiency in fabric performance
- Small scale energy generation across the sites to supplement the additional load driven by electrification of heat (ASHP, GSHP) and transport (EV)
- Detailed modelling of energy demand with the above included to understand implications of sub-station capacity and required infrastructure upgrades, if necessary
- Active network management including flexibility contracts to enable quicker connections without significant reinforcement. Consideration to be given to Enterprise ANM systems or similar, both DNO's are increasing ANM zones therefore these case studies could be test bed projects. This can enable customers to access network information to understand factors impacting connectivity.

6.2 INDUSTRIAL

RLB held engagement workshops with a range of commercial / industrial organisations across the region. The key outcomes are detailed below.

ABLE HUMBER PORT

Able Logistics Park has now changed to Able Energy Park (AEP), with Able Marine Energy Park being Able Humber Port (AHP). It is situated on the south bank of the Humber Estuary, which has been described as the Energy Estuary and in recent years it has been one of the UK's fastest growing port and logistics centres. AHP is potentially Europe's largest new port development as part of the growing marine renewable energy sector; this includes Able Energy Park[48] (AEP) providing an additional circa 1,000 acres of hinterland development to support a wide variety of port centric logistics functions.

The UK Government has identified AHP as a strategic location in the National Renewable Infrastructure Plan and HMG UK Treasury has confirmed AHP as the UK's largest Enterprise Zone, attracting 100% enhanced capital allowances.

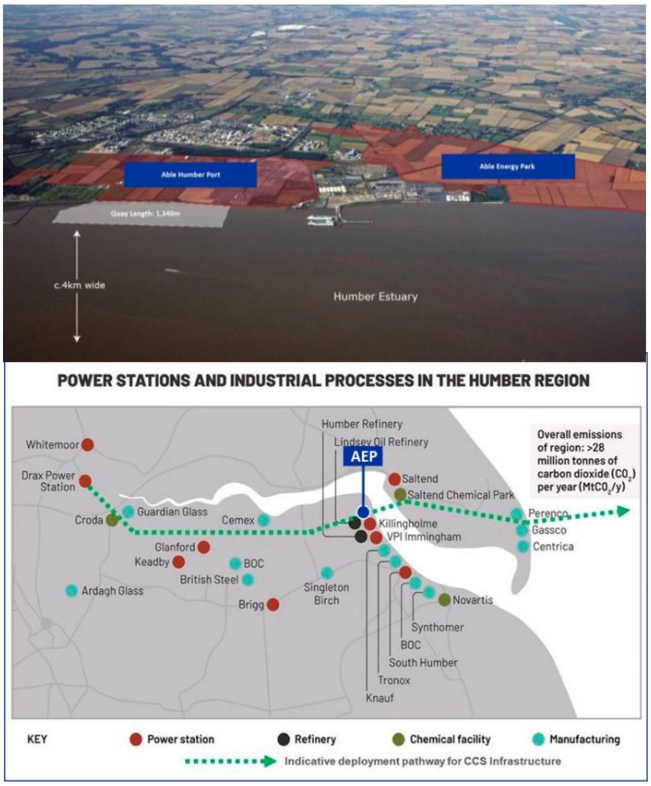


Figure 13 Able Humber Port / Humber Region

ABLE ENERGY PARK

Able Energy Park (AEP) is located at the top of the proposed Humber Low Carbon Pipeline (as shown in Figure 6) close to the nearby Humber Ports.

The site has local sources of electricity, including power supplied from renewable sources, most notably the Hornsea offshore wind farms, with a potential of a new carbon capture pipeline adjacent to the site. AEP states; "the Energy Estuary is pursuing the option to deliver the UK's first zero carbon cluster and help position the North of England at the heart of the global energy revolution".[49]

AEP has a significant predicted demand with an investigative exercise being undertaken to determine if the local infrastructure can provide green supply from the substation or if there is an existing agreement to feed green energy back to the grid. There is an intent that green hydrogen will be produced; this is dependent on there being sufficient renewable energy supply. If hydrogen is not

---

48 www.ableuk.com/sites/port-sites/humber-port/able-logistics-park/
49 Home - Zero Carbon Humber

generated using renewable energy then it is referred to as blue or grey which will not align with net zero aspirations, however it will provide energy supply to the region. Additionally, there are numerous solar proposals surrounding both sites, many of which are seeking battery storage sites.

At present, the quoted dates required will be at the earliest 2.5 years before demand kicks in, with AEP clients requiring energy from 2026 of circa 200MW with the remaining anticipated energy demand within the next 5 years. AEP has had planning permissions for a Bio-Ethanol Plant and Urea Manufacturing Facilities at present.

There are challenges not only for energy supply to the site, but water supply too on a clean, industrial scale. As Greater Lincolnshire moves towards attracting industry, it is likely that resource intensive industrial developments will require linked utility management supply and demand.

From the engagement with Able, there is potential for both significant energy demand and energy supply. However, until the developments progress further it is difficult to accurately predict either demand or supply. A key item from engagement is that Able have been in discussions with IDNO management companies for both energy and water supply rather than the DNOs (NGED and NPg).

BRITISH STEEL

British Steel's headquarters are in Scunthorpe, Lincolnshire employing the majority of their 4,000 employees within North Lincolnshire. There is a period of significant investment ahead, aligned to their overarching decarbonisation strategy; committing British Steel to deliver net zero steel by 2050 and significantly reduce CO_2 intensity by 2030 – 2035. This includes a £14.6million investment to enhance energy operations including projects to improve electricity and process gas usage. Due to soaring energy prices, the steel manufacturing industry has been hit hard.

The Scunthorpe manufacturing site imports 500M kWh of gas per year. The site has 2 CHP and a central power station to generate steam for the site which produces 19MW baseload, with 35MW generated internally. British Steel confirmed that grid connection is key to maintain the manufacturing plant, with a key risk being any issues with grid transmission connection. Relocation of the British Steel plant would need to be considered in respect of energy supply and energy cost, alongside their decarbonisation strategy. At present, they are reliant on market prices for low carbon energy. It is likely that hydrogen technologies will be adopted early for steel manufacturing, although at this stage it is unclear as to when hydrogen will form a significant proportion of manufacturing energy consumption.

Electrical requirements are anticipated to be 220MW electrical supply, which has been calculated to be the new upgraded supply requirements with a need to upgrade the connections. This will likely be a transmission connection via National Grid.

National Grid Electricity Transmission (NGET) and British Steel have held informal discussions for the last five years. National Grid engagement is intended to restart after further feasibility studies for equipment requirements and private wire network assessments.

In February 2023 British Steels owners, Jingye Group, announced the closure of the coking ovens at the Scunthorpe plant as coking coal will now be imported. Initially it was announced that the closure would result in the loss of 300 jobs, however it has now been made clear that those affected by the closure will be offered positions within the company.[50] Furthermore, British Steel faces an uncertain future with the need for them to become net zero in the near future. They are currently in discussion with the UK Government to adopt policies and frameworks to allow them to secure their future as a low-carbon company.[51]

6.3 HEALTH AND CARE

NHS Lincolnshire is responsible for the health services in Lincolnshire while the Northern Lincolnshire and Goole NHS Foundation Trust is responsible for health services in North Lincolnshire and North East Lincolnshire. The member organisations of NHS Lincolnshire consist of NHS Lincolnshire Integrated Care Board (ICS) (Formerly Clinical Commissioning Group), United Lincolnshire Hospitals NHS Trust (ULHT), Lincolnshire Community Health Services NHS Trust (LCHS) and Lincolnshire Partnership NHS Foundation Trust (LPFT). Through the ULHT, NHS Lincolnshire is responsible for the services in Lincoln County Hospital, Pilgrim Hospital, Boston and Grantham and District Hospital. Northern Lincolnshire and Goole NHS Foundation Trust is responsible for Scunthorpe General Hospital and Dian, Princess of Wales Hospital in Grimsby.

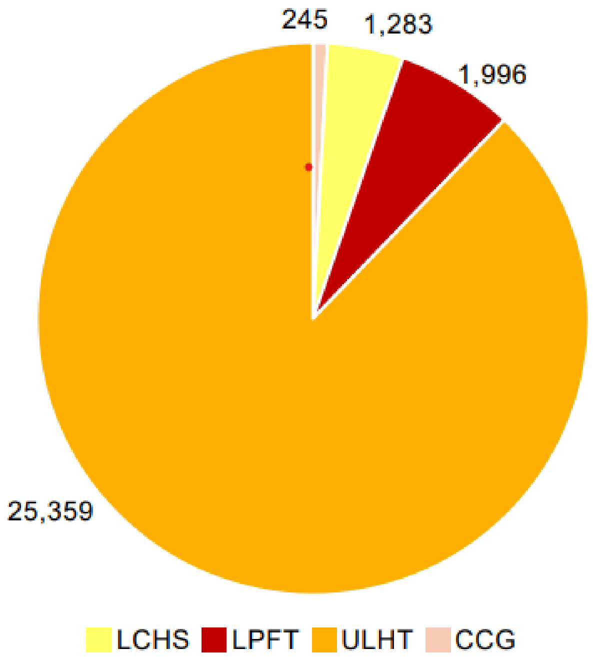


Figure 14: Building Energy Emissions from NHS Lincolnshire Member Organisations 2019 (tCO_2e) [1]

---

[50] [Threatened Scunthorpe steel workers to be offered new jobs - BBC News]
[51] [Secretary of State visits British Steel as level playing field policy sought on energy and carbon costs - Business Live (business-live.co.uk)]
[Slide 1 (icb.nhs.uk)]

It is the hospital facilities that are responsible for the significant quantity of electricity consumption within the NHS.[52] All acute hospitals and many other NHS buildings are required to run continuously with rigorous backup energy strategies. For UHLT the aim is to reduce energy consumption by over 2,771,437 kWh per year to achieve the emissions reduction target of 14,802 tCO_2e in 2024/25 and to for the system to be net-zero by 2040. To achieve these goals, NHS Lincolnshire and Northern Lincolnshire and Goole NHS Foundation Trust are following the four-step approach set out within the NHS' 'Estates 'Net Zero' Carbon Delivery Plan'[53]:

1. Making every kWh count: Investing in no-regrets energy saving measures.
2. Preparing buildings for electricity-led heating: Upgrading building fabric.
3. Switching to non-fossil fuel heating: Investing in innovative new energy sources.
4. Increasing on-site renewables: Investing in on-site generation.

The immediate priority for the trusts is to introduce energy efficiency measures throughout their estates to avoid waste energy and reduce consumption. To move away from the use of fossil fuel as a heating source, the use of district heat networks is being explored in both existing and new building. Electrically powered heating systems, heat pumps, and infrared heating are other options available to the trusts, the decision which system to chose will depend on building surveys. To further decarbonise the system, on-site renewable energy systems, such as solar PV and battery storage will be implemented. As well as decarbonising, these systems will provide additional resilience to the estate in case of power outages and reduce the reliance on diesel generators.

In new capital projects, embodied carbon emissions are a concern that needs to be addressed. Both Trusts will look to explore options to reduce these emissions through collaboration with partners and their supply chain.

From our study it is clear that NHS Trusts in the region (and nationally) are exploring extensive on-site renewable energy systems, such as solar photovoltaics and integrated large battery storage technologies. This is intended to reduce the impact of switching to electricity and the associated costs, as well as providing additional resilience to power outages, with the potential to negate using back-up diesel generators. Additionally, District Heating Systems are being considered, which can be integrated with a wider set of beneficiaries beyond NHS Trusts to transform energy supply across urban areas of Greater Lincolnshire.

6.4 AGRI-FOOD

As part of the Greater Lincolnshire LEP Growth Strategy, agrifood/agriculture is a key sector for economic growth with an ambition to deliver sustainable, healthy food from land and sea by championing supply chain efficiency, the delivery of a Net Zero food chain and food which is naturally

[52] ULHT-Green-Plan-Final-.pdf
[53] Estates-Net-Zero-Carbon-Delivery-Plan.pdf (jpaget.nhs.uk)

healthy. This is intended to reinforce the position as the UK Food Valley and an internationally competitive food cluster.

Greater Lincolnshire is responsible for growing 30% of the nation's vegetables and producing 18% of the poultry, with a total agricultural output of over £2bn in 2019, representing 12% of England's total production. In total the food chain provides 24% of jobs throughout Greater Lincolnshire (as compared with just 13% nationally) and 21% of its economic output (7% nationally). The future of the food chain is therefore absolutely vital to Lincolnshire and its population, with the region being strategically important to national food security.[54]

Greater Lincolnshire combines large-scale production, processing, cold storage and logistics capacities with cold chain and Food Industry 4.0 technologies[55] and expertise. The food supply chain accounts for circa 75,000 jobs within the region, therefore a significant sector for both employment and energy consumption. This sector is experiencing growth, with high levels of predicted investment. There are three key factors behind the sectors growth:

1. Brexit: increased costs to import food results in preference for local
2. Covid: global food supply chain impacted by disrupted labour supply
3. Low carbon supply chain: local food reduces carbon miles, reducing food wastage.

As part of the growth and investment in the agricultural sector, new facilities such as large-scale greenhouses will be required. This can be to the scale of 150 hectare greenhouse, which would consume 150 MW.

As the transport sector looks to decarbonise, this will result in increased demand for EV facilities and hydrogen fuelled transportation. This will therefore increase energy demand. This will not be a wholescale switch to EV, as it is deemed inefficient in larger trucks due to weight and recharge times; with EV preferred option for small vehicles and machinery.

As there is more Grade 1 agricultural land than in any other LEP area in England, the Greater Lincolnshire agri-food sector is anticipated to double its contribution to the economy by 2030 through an ambitious programme of investment in productive capacity. This increase in productive capacity will have an impact on energy requirements, as technology investment grows.

Circular economy is likely to be a large driver of growth across the region, as Greater Lincolnshire presents significant opportunities for investing businesses specialising in food waste recycling and the manufacture of recycled food packaging. This includes businesses such as Clean Tech (rPET manufacturing) and BioteCH4 (Anaerobic Digestion).

The strategy for the sector includes building an economic case for investment in the strategic transport infrastructure to support agri-food sector growth, with a particular focus on road freight. From engagement with the sector, there is a large data gathering exercise occurring to determine the

---

[54] Agri-food Sector | Greater Lincolnshire LEP
[55] UK Food Valley | Greater Lincolnshire LEP

size of the challenge, which is covering red diesel through to off grid generation through AD, solar and wind. A current debate in the sector is whether to increase electrical connection capability or if the constraints that are present are prohibitive, with wait times of 10 years in some cases.

The agrifood industry has a range of challenges, notably energy costs. Unlike domestic energy bills, commercial energy costs are free to move with market prices. This has led to some production ceasing e.g. greenhouses fuelled by gas with heating costs spiking to levels up to 8 times the level seen in 2021.[56] More generally food chain companies have seen their electricity prices rise by 300-600%, particularly when tariffs fixed during the pandemic end. For example, a Lincolnshire farm has reported its energy bill rising from £164,000 to £636,000 per year for cold stores and grain storage. Many businesses report that at current energy prices their production is uneconomic and unless energy costs fall or food prices rise, production of food will reduce and many food chain businesses, especially SMEs, will close or cease production.

Cool chain or cold chain is a significant element of the agrifood energy demand and uses circa 11% of energy supply nationally. An established cold store cluster is located in Scunthorpe and an emerging cold store cluster situated in Grantham. Cool chain has numerous challenges at present, including workforce constraints, decarbonisation targets and supply chain resilience. There are significant cost pressures, considered to be an impact of Brexit, as imports have risen by circa 10%. To navigate, and mitigate the impacts investment in technology solutions is key – this will reduce energy consumption whilst improving data robustness.

Another major part of the agrifood sector in Lincolnshire is seafood. The UK is one of the top five EU aquaculture nations.[57] The Global Aquaculture Alliance (2019) has predicted that global aquaculture is likely to double from 47 million tonnes in 2006 to 94 million tonnes in 2030. Technological investment from industry and government is key to develop better management, reduce energy consumption and a sustainable fishing industry.

To progress this, it’s clear to see that the region has pockets of research and development, including Grimsby’s Food Refrigeration and Process Engineering Research Centre (FRPERC). There is significant capacity for cold storage in Grimsby. These and other regional centres of excellence partner with businesses in key areas including low carbon energy, sustainable refrigeration, digitalisation, automation, and intelligent transportation - to deliver improvements in sustainability, traceability and productivity.

A recommendation from this study is to integrate energy demand from the sector into Agricultural sectors strategy and collaborating on transport strategies where there is anticipated increase in EV demand.

56 https://committees.parliament.uk/writtenevidence/111840/pdf/
57 Country fact sheets (europa.eu)

Alternative technologies for energy generation such as Energy from Waste and Biofuels could be of significant benefit to the region; reducing grid energy demands for producers and allowing income through exporting back to the grid.

6.5 PORTS AND LOGISTICS

Greater Lincolnshire is expected to experience projected population growth, alongside economic growth across key sectors. To facilitate this, transport infrastructure requires investment. This impacts energy in two ways:

- Switching to lower carbon transport resulting in increased demand for EV charge points, particularly for strategic transport hubs
- Economic growth particularly across low carbon energy generation / carbon capture which requires operations and maintenance, and across agriculture, chemicals, ports and logistics increasing transport demand and improvements. The economic growth results in increased energy requirements, and net zero aspirations changes this requirement to increased green energy requirements.

From analysis of Transport for the North and Local Authority transport strategies, it is clear that the move towards sustainability and enhancing active travel in urban areas are key for the next decade. Increasing the opportunities for sustainable modes of transport such as public transport, cycling and walking for commuting, leisure and recreation is intended to reduce private car demand.

For rail, 25% of UK rail freight passes through Greater Lincolnshire, presenting businesses with the opportunity to transport more goods by rail, which reduces carbon emissions by 75%. Midlands Connect has a Stronger, Greener, Fairer strategy[58] which encompasses:

- Fairer: levelling up and strengthening the region and the UK
- Greener: decarbonising transport and adapting to climate change
- Stronger: driving resilient economic growth

There are various initiatives driving investment into the three strategic areas. Greater Lincolnshire should feed into these collaboratively, utilising the ports and others significant industry to drive investment into modern transport systems. Initiatives of note include:

- Midlands Net Zero Hub to understand how hydrogen and other alternative fuels can be used to power the fleet of freight vehicles and HGVs within the Greater Lincolnshire Region.
- H2GVMids is a feasibility study on the transition to hydrogen powered HGVs. This has been developed by the Energy Research Accelerator (ERA) on behalf of the Department for Transport's Zero Emission Road Freight programme.[59]

[58] Summary Document (Midlands Connect) Final
[59] H2GVMids - a feasbility study for hydrogen freight - ERA Energy Research Accelerator

- Establishing industry 'centres of excellence' where partners come together to share knowledge, collaborate and work together on new emerging technology areas or topics such as decarbonisation, freight and alternative fuels.
- Delivering a regional decarbonisation policy toolkit that will provide evidence to partners on the decarbonisation potential of various interventions and policies that could be used in their local sustainability plans.
- Creating a network resilience map to understand how transport, technology and energy generation interventions can work together to address climate change.

When considering road networks and private transportation, there are developments both current and scheduled for EV charging networks across the wider region. An example of this is the rapid charging fund (RCF), which is a £950 million fund to future-proof electrical capacity at motorway and major road service areas to prepare the network for 100% zero emissions vehicles (ZEV) uptake. A local case study is the LEVI scheme (Local EV Infrastructure) pilot – Lincolnshire County Council advised that as part of this successful bid 109 EV charging points will be installed across the Lincolnshire area, site locations are being reviewed, subject to approval. Locations have been selected primarily due to their proximity to areas highly reliant on on-street parking and with a lack of current charge point provision. The charge points themselves will include slow and fast charging. Lincolnshire County Council is the lead partner for the LEVI pilot, with circa £310,000 invested directly in the county.[60]

For large employers across Greater Lincolnshire, a large proportion of those researched have either installed, or intend to install EV charge points for their employees. An example of this is ULHT where a EV charging point project is being undertaken with a potential of fifteen charging points across the Trust being installed for staff and visitor use.

It is worth considering that the additional wider infrastructure for EV is likely to increase the attractiveness of private EV ownership, which can then result in additional demand both at a local residential unit level and across the wider infrastructure network. From discussions held with NPg, there is a predicted growth of EVs across the region they cover to total circa941,000 by 2028[61] while NGED have not yet released their EV Strategy which details future growth, this is expected in Summer 2023.

6.6 ENERGY

Greater Lincolnshire has significant ambitions in the energy sector - the acceleration of clean growth and the potential to be a global leader in the transition to net zero carbon emissions in line with the ambition of the Green Industrial Revolution presents a significant opportunity. In more rural parts of Greater Lincolnshire there remains huge potential to provide an innovation test bed for clean energy and whole system technologies.

[60] Lincolnshire County Council, LEVI
[61] NPg Business Plan 2023 – 2028

This study has considered the below energy initiatives; these have the potential to significantly impact the energy landscape across Greater Lincolnshire over the next decade. A note of caution should be applied to predicted growth of energy industry where there is non-confirmed funding, planning or agreements in place.

It is clear to see that the region has the potential for huge growth due to the abundance of natural resources, location and proximity to energy developments, but is not maximising partnerships across the region to the fullest possible extent.

Greater Lincolnshire has multiple location advantages including tri-modal freight connectivity (road, rail and sea), whilst the Humber energy strategy and the agrifood sector impacts multiple areas of energy growth and opportunity, including the established Refuse Derived Fuel (RDF) feedstock supply chains, based on Immingham's status as a major port for RDF exports. The GLLEP has released a report on Low Carbon Investment Opportunity across the region, focusing on the Humber region as a key investment area for energy generation and carbon capture.

Figure 15 Greater Lincolnshire Industrial areas, GLLEP

The wider Humber Energy Estuary's Offshore Renewables ecosystem includes the UK's only wind turbine blade manufacturing facility (Siemens), specialised logistics infrastructure and sector-focused skills providers. Whilst Offshore Renewable Energy hasn't been included as a key part of this study as it is above grid level, it is worth noting that it is a key pillar of Greater Lincolnshire's low carbon capability, presenting significant opportunities for expanding businesses across operation & maintenance, manufacturing, technology, and logistics supply chains.

Along with offshore wind, another key renewable energy source for the region is solar PV. Currently in the Greater Lincolnshire Area there are seventy-nine solar PV developments either in operation, under construction or have received planning permission to proceed with a generation capacity of 840.51MW.[62] In addition to these developments, there are nine solar PV Nationally Significant

[62] Renewable Energy Planning Database: quarterly extract - GOV.UK (www.gov.uk)

Infrastructure Projects (NSIPs) proposed over the next seven years with a generation capacity of 4580MW[63] (See Appendix A).

In terms of hydrogen energy, The Gigastack,[64] the UK's flagship renewable hydrogen project, aims to demonstrate that renewable hydrogen is essential to achieving the UK's 2050 net-zero emissions target. By producing green hydrogen through electrolysis utilising renewable electricity generated by the Hornsea 2 offshore wind farm. Initially renewable hydrogen will be supplied to the Phillips 66 Humber Refinery, the project will also facilitate the wider industrial cluster's decarbonisation and '2040 Net Zero' target.

The GLLEP figure above demonstrates that the concentration of energy sector industry is focused in North and North East Lincolnshire.

EAST COAST CLUSTER

The East Coast Cluster (ECC) is a collaboration between Zero Carbon Humber, Net Zero Teesside and Northern Endurance Partnership.

The ECC is enabled by the Northern Endurance Partnership (NEP) comprising BP, Equinor, National Grid Ventures, Shell and Total Energies. Together the partnership will develop the infrastructure needed to transport CO_2 from across the Humber and Teesside to the Endurance Carbon Store, located 145km offshore in the Southern North Sea.

Survey works have commenced, which will inform engineering plans for pipelines connecting the onshore CO_2 transportation and storage network with the offshore Endurance Carbon Store. The ECC is intending to deliver the following which will impact Greater Lincolnshire:

- Decarbonise industry: potential to tackle almost 50% of the UK's total industrial cluster CO_2 emissions – *significant area of North Lincolnshire*
- Support levelling-up: creating and supporting an average of 25,000 jobs per year to 2050 and underpinning new low carbon industries in the north of England – *significant area of job creation in Greater Lincolnshire*
- Kick-start a hydrogen economy: supporting the creation of low-carbon hydrogen projects to deliver 70% of the UK's hydrogen target for 2030 – *job creation and energy generation across the region*

The work being conducted by each group in the East Coast Cluster can be tied together in The Humber Industrial Cluster Plan (HICP). This is an initiative by UK Research and Innovation (UKRI) that sets out a strategic roadmap for the East Coast Cluster to achieve net zero carbon emissions by 2040.[65] Figure 16 gives an overview of the projects and companies that are working together to achieve net zero in the Humber Cluster.

---

[63] Renewable Energy Planning Database: quarterly extract - GOV.UK (www.gov.uk)
[64] Gigastack - Demonstrating renewable hydrogen for a net zero future
[65] Humber Industrial Cluster Plan – UKRI

Figure 16 The Humber Industrial Cluster Plan[66]

ZERO CARBON HUMBER

Zero Carbon Humber is a collection of international energy producers, major regional industries, leading infrastructure and logistics operators, global engineering firms and academic institutions. The group are working to deliver low carbon hydrogen production facilities and essential carbon capture usage and storage (CCUS), together with region-wide infrastructure that will enable large-scale decarbonisation across the country's most carbon intensive region.

Hydrogen to Humber (H2H) Saltend is intended to be the world's largest hydrogen production plant with carbon capture at Saltend Chemical Park. It will be the starting point for a CO_2 and hydrogen pipeline network developed by National Grid Ventures, connecting energy-intensive industrial sites throughout the region, offering businesses options to directly capture emissions or fuel switch to hydrogen. All captured CO_2 will be compressed at Centrica Storage's Easington site and stored under the southern North Sea using offshore infrastructure shared with the East Coast Cluster. It is expected that this will be available to organisations in Greater Lincolnshire.

Hydrogen production requires significant energy supply to produce either blue or green hydrogen – the wider benefits of energy supply and economic generation will be particularly relevant to this study.

CARBON CAPTURE AND STORAGE (CCS)

CCS is the process of capturing CO_2 emissions from industrial activity such as steel and cement production, transporting it, and then locking it into underground storage sites. CCS has the potential to capture over 90% of the CO_2 emissions produced from the use of fossil fuels in electricity generation and industrial processes, preventing the CO_2 from entering the atmosphere. The CCS chain consists of three parts; capturing the CO_2, transporting the CO_2, and securely storing the CO_2 emissions underground, in depleted oil and gas fields or deep saline aquifer formations.

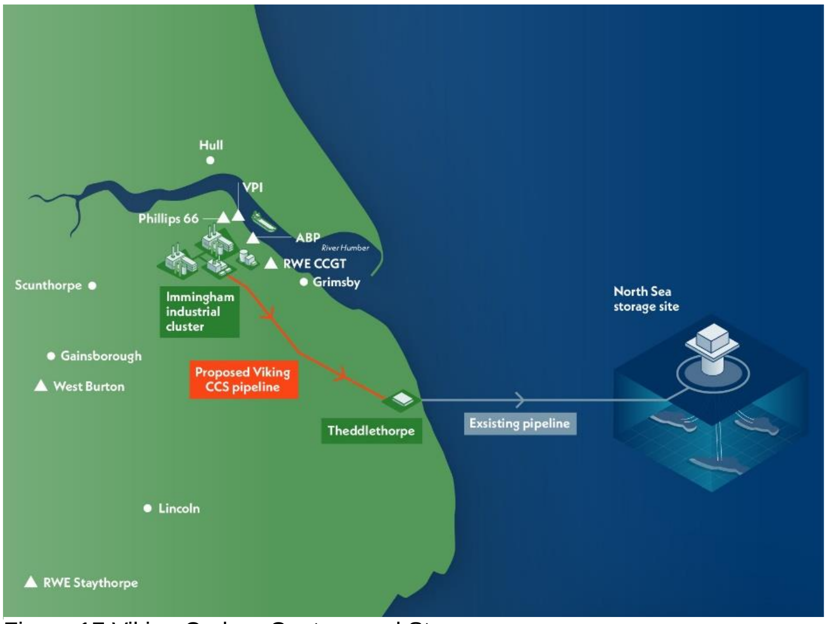


Figure 17 Viking Carbon Capture and Storage

The government hopes to store 20-30m tonnes of CO_2 a year by 2030, equal to the emissions from 10-15m cars. The UK Governments March 2023 budget commits to investing £20 million to scale-up CCS projects across the UK. The new funding will be rolled out over a period of twenty years and will support the development of CCS initiatives. Across the UK, CCS projects have been developed which have been awaiting government approval. These include the Acorn CCS project designed to support the decarbonisation of two St Fergus gas terminals in Aberdeenshire, and Viking CCS, a 34-mile pipeline that will take carbon from industrial sites on Humberside and lock it under the North Sea.[66]

The UK's largest industrial cluster, the Humber, is responsible for producing 12.4 million tonnes of CO_2 emissions per year. It's home to a high concentration of fossil-fuel power stations and large industrial plants that release millions of tonnes of CO_2 every year. This makes it an ideal and important location for clean growth projects using CCS and hydrogen. The Humber Low Carbon Pipelines project is a significant part of the Zero Carbon Humber vision, to become the UK's first net zero carbon cluster by 2040. The project aims to deliver new onshore pipeline infrastructure to transport the captured carbon emissions from the regions industrial emitters for safe storage in the North Sea, and enable industries to fuel-switch from fossil fuels to low-carbon hydrogen. Humber Low Carbon Pipelines intends to support the UK to transition to a low-carbon economy and reach its ambitious net zero targets by 2050.

In North Lincolnshire, Keadby Carbon Capture Power Station has been proposed as a 910MW power station fitted with carbon capture technology to remove CO_2 from its emissions. Keadby 3 will connect to the shared infrastructure being developed by the East Coast Cluster to transport the captured CO_2 and store it safely offshore. The installation of CCS into a power station utilises a significant amount of energy to run therefore has the potential to significantly reduce the efficiency of the power station.

Whilst CCS does not generate energy, it is a key part of this study as it will enable decarbonisation of energy across the region which has been a theme throughout all stakeholder engagement. It is likely that CCS will be required to decarbonise the energy consumed by heavy industry such as steel within the region, where demand is consistently high and renewables will not provide sufficient supply and continuity in the short term. It is likely that CCS projects will benefit from the March 2023 budget and should be considered within the Greater Lincolnshire energy landscape as a step to achieve the ambitious decarbonisation goals across the region.

ELECTRICITY INTERCONNECTORS

Electricity interconnectors are a way of connecting the electrical systems of two countries together to trade and share surplus electricity. They allow for a more competition in the market for costs, a more secure electrical system and a reliable source of electricity. Electricity interconnectors can run on land via overhead cabling, under the sea or underground. In the UK there are five interconnectors, linking the UK with France, Belgium, Norway and the Netherlands. Interconnectors are also important in the transition of the national electrical system away from fossil fuels generation to renewable energy sources, this is the case with the latest interconnector project, the Viking Link. This interconnector will link the British and Danish transmission systems and is due to be completed at the end of 2023.[67] The link will supply 100% renewable energy generated in Denmark. The link is a two-way system, as

[66] Consultation - Viking CCS
[67] Viking Link Interconnector (viking-link.com)

well as importing electricity from Denmark, it can also be exported. This means that any excess renewable energy generated in the UK will not go to waste.

From a Greater Lincolnshire perspective, the link lands on the coast and will be connected to the UK national grid at Bicker Fen substation, where work is progressing on the new convertor station. The link allows for security in the local grid, supporting the region to meet its renewable energy targets and should reduce the electricity bills for customers in the region.

7.0 FUTURE DEMAND ANALYSIS

This analysis was carried out to assist in meeting the key lines of enquiry of the report. The aim is this analysis was to Identify any significant barriers and/or opportunities relating to the underlying energy provision infrastructure within Greater Lincolnshire area. An analysis of the information gathered provides a picture of the energy demand and availability in the Greater Lincolnshire regions over the next twenty years.

The intent behind the GIS mapping exercise is to enable the ability to develop key/targeted decisions based on the need to secure significant inward investment, where this is needed from National Grid/DNOs based on what we know as the region's growth areas.

Methodology

Data Gathering: A large quantity of data on the future developments was obtained from the seven district and two unitary authorities in the Greater Lincolnshire area. The data collected was via documents submitted from the seven districts, two unitary authorities and additional investigation by the RLB team. Circa 250 documents were gathered in the data analysis phase. Alongside document analysis, additional research and engagement via email and virtual meetings was undertaken in search of further information that was not contained in the submitted documents.

The bulk of the information was gathered from the Local Plans, which have been adopted by the various councils and each district into each council. The local plans contained planning data on residential, commercial, and industrial developments. There was also information on projected future energy demand. Based on this information, further research was carried out by the RLB team to obtain details on the developments in the plans and other relevant developments. Further consultation was sought with each district on any developments relevant to the project.

There were consultations with third party stakeholders that were considered large energy users in the council areas about upcoming projects, and existing asset future energy use. This type of data was not available to the districts councils and required a direct approach.

Data Input: The data was compiled into a spreadsheet where each district was divided into separate tabs. To determine the connected load of each development, the BSRIA General Rules of Thumb and industry standards load assumptions were used. An example if this is for the residential units, where an assumption of 4.5kVA maximum demand per general domestic unit has been used in this study. This assumption is based on the load estimation values in the *BSRIA Rules of Thumb guidelines for building services*. To take into consideration the move towards a low carbon economy the figure was revised upwards to 7.2kVA per unit. This is to account for the use of increased electrical demand with low carbon heating technologies such as air source heat pumps and the use of domestic charge points for electric vehicles. A list of the other assumptions can be found in the spreadsheet.

When a development was entered into the spreadsheet, it was allocated a classified based on its use, e.g., residential or office space. By doing this an electrical load assumption was applied to the development. A diversity factor was added to each development to calculate the After demand maximum demand (ADMD) figure that is used in the design of electricity distribution networks. The diversity factor was based on consultation with both Northern Powergrid and National Grid:ED. This ADMD value was adjusted to include for the use of electrical vehicle charge points in domestic housing.

To allow for time sequencing, each development was grouped in terms of priority based on the below classification:

Priority number	Justification
1	High priority – GLA Development with live requirement - 1 - 3 years
2	High priority - confirmed 3rd party demand, GLA sites requiring future proofing, 4 - 10 Years
3	Consented development - status unknown, unconsented but highly likely to come forward, 11+ years
4	Potential future generation

Three separate priority levels are used in this study. Each priority level has a different time frame, this allows for the separation of the future developments into specific categories. By grouping the developments in this way this provides stakeholders within the region insight on how to proceed. Developments that are in Priority 1 require immediate attention as they will require connection to the grid the soonest. Those in Priority 2 will require planning. Consultations can take place with the DNOs to determine the availability of substation headroom. Investment can take place to ensure that there will be adequate electrical infrastructure available to meet the demands of future developments. Priority 3 allows for long-term planning.

Data Analysis: This data was analysed for information relating to energy demand from future developments. The connected load for each development was allocated by district and then broken down further into location. Each development was assigned to a primary substation based on the area data of the two Distribution Network Operators (DNOs). Once this was carried out it allowed for a total demand value to be determined for each primary substation.

Concurrently, data was gathered from the two DNOs, Northern PowerGrid and National Grid ED on the Demand Headroom availability for each primary substation in the Greater Lincolnshire area. The Demand Headroom of a primary substation is the gap between its rating and the actual demand being placed upon it, essentially the spare capacity of the substation. The connected load data for the developments and the headroom availability of the primary substations were overlayed on top of each other to determine the amount of demand headroom that would be available in each primary substation with the introduction of the future developments. The information for the DNOs can be found here;

- Northern PowerGrid demand availability: Demand Availability Map | Northern Powergrid
- National Grid: Energy Distribution network capacity: National Grid - Network Capacity Map Application

Limitations:

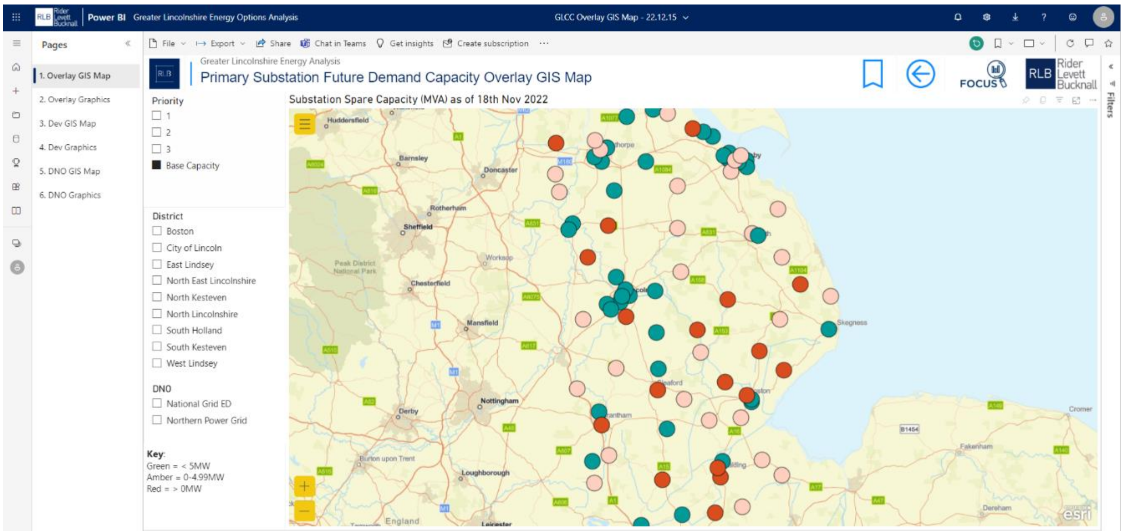
Whilst every effort was made to collect data from all the relevant stakeholders, they were certain organisations that did not respond to enquiries from the project team. To allow for this certain load assumptions were made.

One aspect that has been identified as an important factor on future demand headroom availability in the primary substations is supply capacity. This study focused on the demand capacity of the primary substations. Supply capacity has been identified as an issue by the DNOs. This is an issue that they are aware of, and they are working on options to resolve it. Supply capacity restriction is an issue for the Greater Lincolnshire area as it limits the amount of electricity that can be imported back into the grid through local substations. This is particularly relevant to renewable energy systems, such as wind and solar. New renewable energy developments in the area face long wait time to secure a supply connection to the DNOs infrastructure. This can have an impact on the area achieving low carbon targets as well as low carbon investment and business growth.

Further discussion is required with the two DNOs in the area to establish the extent of the issue and to discuss options for moving forward and resolving the issues. To establish how much the substations in the Greater Lincolnshire area are affected, further analysis would need to be conducted where the focus is on supply headroom availability.

Mapping

To provide a visual representation of the data, Microsoft Power BI was used to create a GIS map with a red, amber, green representation that allowed the client a clear visual of where there will be a shortage of demand in the future. A substation is classified as Red if the demand headroom is equal to or less than 0 MVA, Amber if the value is greater than zero and less than 2.5 MVA and Green if the value is equal to or greater than 2.5 MVA. By using this application, it allows for greater interaction between the user and data. The two figures below give demonstrate the visuals that are being used in the application.



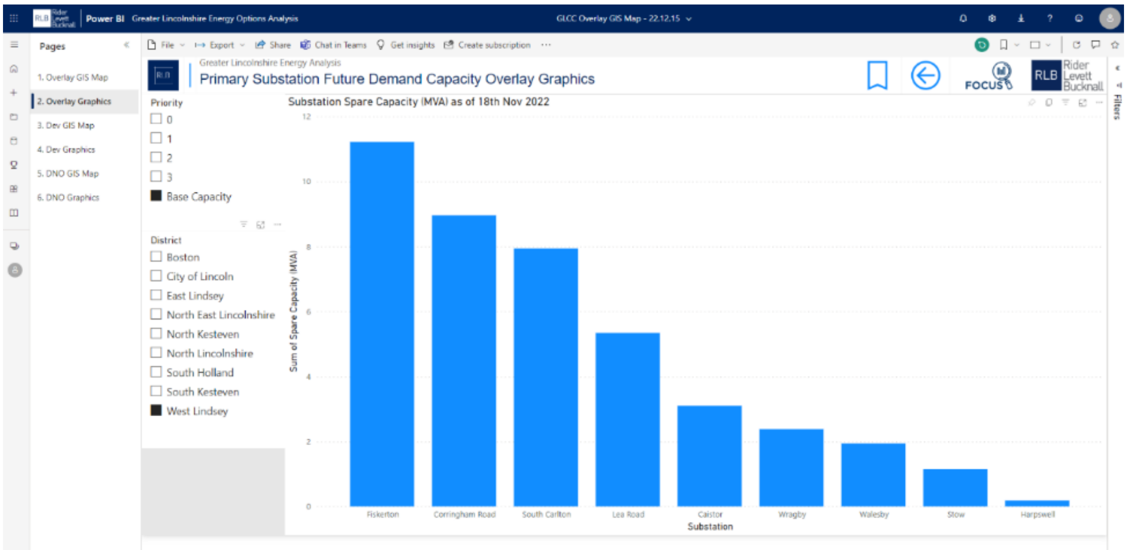


Figure 18 Future Demand Capacity

Each primary substation was mapped showing the demand headroom availability for each over a twenty-year period, split using the three priority options, with 'Base Capacity' being the current value of demand headroom. To allow for accuracy demand headroom values for each primary substation is linked to the DNOs live values. The map can be filtered to a specific priority, district, or DNO.

7.1 ANALYSIS OF THE AREAS OF SHORTFALL

An analysis of the information gathered provides a picture of the energy demand and availability in the Greater Lincolnshire region over the next twenty years.

Regional Analysis

Within the nine council areas of the Greater Lincolnshire Area there are one hundred primary substations that distribute electricity from the national grid to local developments. From our analysis we have concluded that there will be a significant constraint on demand headroom in these primary substations over a twenty year period. Without investment in infrastructure or the introduction of innovative measures to rectify these constraints, there will be difficulty in the supply of electricity to future developments.

Table 5: Number of Primary substation demand headroom RAG for the Greater Lincolnshire Area.

	Baseline	Priority 1 (1-3 Years)	Priority 2 (4-10 Years)	Priority 3 (11+ Years)
Red	15	40	66	77
Orange	20	20	13	9
Green	65	40	21	14

Table 5 gives an indication of the movement of demand headroom of each primary substation in the region. At this moment in time, the substations that are classified as red account for 15% of the total. This moves to 40% in the first three-year period and further moves to 77% by the end of the time frame for the analysis. On a regional level, over the first 3 years of the analysis, the north of the region, North Lincolnshire and North East Lincolnshire, see the highest constraints on demand headroom. As the time frame moves forward, the south and west of the region begin to experience significant constraints. Boston and West Lindsey experience 100% negative demand headroom during the second period of the analysis. How this breaks down into each area is discussed in the following section.

Table 6 Number of Primary substation Demand headroom RAG by District

		North Lincolnshire	North East Lincolnshire	City of Lincoln	North Kesteven	West Lindsey	East Lindsey	Boston	South Holland	South Kesteven
Baseline	**Red**	3	0	0	4	0	2	1	3	2
	Amber	3	1	0	2	4	4	2	1	3
	Green	13	11	6	6	4	10	3	4	8
Priority 1 (1-3 Years)	**Red**	5	5	3	6	5	4	2	5	6
	Amber	5	0	0	3	1	5	2	2	2
	Green	9	7	3	3	2	7	2	1	5
Priority 2 (4-10 Years)	**Red**	12	6	4	8	8	11	6	6	7
	Amber	1	1	1	3	0	2	0	1	3
	Green	6	5	1	1	0	3	0	1	3

		North Lincolnshire	North East Lincolnshire	City of Lincoln	North Kesteven	West Lindsey	East Lindsey	Boston	South Holland	South Kesteven
Priority 3 (11+ Years)	**Red**	13	7	5	10	8	13	6	7	9
	Amber	2	1	0	1	0	1	0	0	2
	Green	4	4	1	1	0	2	0	1	2

Distribution Network Operators

For the DNOs, of the one hundred primary substations active across the region NPg are responsible for forty-three of the primary substations in the region while NGED are responsible for fifty-seven. At baseline NPg have 72% in green classification while NGED have 60%. In the short-term NPg will see 35% of their primary substations with negative demand headroom, while NGED will have 44%. For NPg this will increase to 63% in the medium-term and 70% in the long-term. NGED will have 68% with negative demand headroom in the medium-term and 82% in the long-term.

Table 7 District network operators primary substation demand headroom RAG connected load

	Baseline			**Priority 1 (1-3 Years)**			**Priority 2 (4-10 Years)**			**Priority 3 (11+ Years)**		
	Red	Amber	Green	Red	Amber	Green	Red	Amber	Green	Red	Amber	Green
Northern Powergrid	7%	21%	72%	35%	19%	47%	63%	7%	30%	70%	9%	21%
National Grid ED	21%	19%	60%	44%	21%	35%	68%	18%	14%	82%	9%	9%

Council Area Analysis

Boston

Currently the primary substations in the district are in reasonable health with one of the six having negative demand headroom capacity. In the district, residential will account for the majority of demand headroom, at 64%. The majority of this is planned to be in the town of Boston, with two Sustainable Urban Extensions planned for the west and north of the city. The town of Boston also dominates the share of employment and office land in use, with a major development planned for The Quadrant and a redevelopment of the port area. Residential developments are also planned for the villages of Kirton, Sutterton, Swineshead and Fishtoft. By the end of the study, all of the district's six primary substations will have negative demand headroom availability, however only one has major constraints, Sleaford Road, Boston.

Table 8 Primary substation constraint - Boston

Substation	Demand Headroom Availability (MVA)			
	Baseline	Priority 1 (1-3 Years)	Priority 2 (4-10 Years)	Priority 3 (11+ Years)
Kirton	4.39	3.14	1.49	-3.64
Langrick	1.33	0.77	-0.73	-7.40
Marsh Lane	9.76	6.56	-0.70	-9.95
Mount Bridge, Boston	9.68	7.91	3.93	0.30
Sleaford Road, Boston	0.00	-1.40	-4.80	-15.97
Wrangle	0.38	0.37	-0.15	-0.43

City of Lincoln

Currently the primary substations in the district are in good health with all having positive demand headroom capacity. Residential developments plan to be the dominate source of electrical use over the course of the study. There are a large number of residential developments planned for the future with the Sustainable Urban Extension, Lincoln Western Growth Corridor, being the largest. There is a number of employment and light industrial developments planned in the east of the city beside the River Witham along with the expansion of existing companies such as Wyman Gordon and Bifrangi. The city will also benefit from planned expansion of the two universities located there as well as the NHS Trust situated in the city. The planned developments place constraints on the primary substations in the district with five of the six in negative demand headroom by the end of the study.

Table 9 Primary substation constraint - City of Lincoln

Substation	Demand Headroom Availability (MVA)			
	Baseline	Priority 1 (1-3 Years)	Priority 2 (4-10 Years)	Priority 3 (11+ Years)
Anderson Lane	5.70	4.88	0.25	-3.02
Beevor Street	5.95	-0.66	-4.92	-7.23
Doddington Park	11.60	-1.51	-11.21	-33.66
Lincoln No 2	7.14	-0.04	-25.03	-65.64
Rookery Lane	16.25	5.83	-1.58	-3.52
Ruston and Hornsby	5.70	15.12	15.07	14.96

East Lindsey

Currently the primary substations in the district are in reasonable health with two of the sixteen having negative demand headroom capacity. The majority of future electrical demand in the district is planned to be residential use, 44%. Developments in Louth and Skegness will account for the largest growth, with the Skegness Gateway Project being a major development. There is also planned residential growth in the smaller towns in the district, with Horton-le-Clay, Horncastle, Spilsby, Stickney and Tetney all marked for planned residential growth. With the districts proximity to the coastline there is growth in the tourism sector and a planned increase in the provision of Static Caravans as holiday homes. This district is expected an increase in the agri-food sector with an increase in commercial greenhouse provision. By the end of the study thirteen of the district's sixteen primary substations will have negative demand headroom availability.

Table 10 Primary substation constraint - East Lindsey

Substation	Demand Headroom Availability (MVA)			
	Baseline	Priority 1 (1-3 Years)	Priority 2 (4-10 Years)	Priority 3 (11+ Years)
Alford	1.22	0.66	-0.57	-1.77
Belmont Covert	4.38	4.35	4.24	4.13
Chapel St Leonards	3.16	2.72	-4.09	-4.26
Grainthorpe	2.30	2.10	1.58	1.12
Horncastle	0.00	-1.03	-11.91	-17.55
Ingoldmells	5.79	5.47	4.39	4.18
Keddington Road	5.21	2.60	-0.50	-8.08
Louth	3.13	-1.64	-12.97	-14.52
North Thoresby	3.79	1.71	-0.67	-5.01
South Reston	4.25	3.59	2.92	-0.25
Spilsby	3.75	3.40	-0.33	-9.77
Stickney	0.00	-2.65	-3.70	-9.22
Trusthorpe	4.98	1.11	0.38	-0.23
Warth Lane	14.57	3.00	-14.83	-38.02
Woodhall Spa	0.61	-0.41	-2.15	-5.57
Wragby	1.22	1.06	-0.91	-4.72

North East Lincolnshire

Currently the primary substations in the area are in good health with all having positive demand headroom capacity. Over the time frame of the study, employment is planned to be the largest requirement of electricity in this area, accounting for 47% of the total demand. As with North Lincolnshire, there is significant demand in the Killingholme and Immingham areas from industrial and employment use. The primary substations in this region show significant constraint as the timeframe move forwards and more developments come online. In the urban areas of Grimsby and Cleethorpes there is significant redevelopment of the city centre planned as well as new residential developments to the west. Despite these, the primary substations in the Grimsby and Cleethorpes vicinity remain healthy for the duration of the study.

Table 11 Primary substation constraint – North East Lincolnshire

Substation	Demand Headroom Availability (MVA)			
	Baseline	Priority 1 (1-3 Years)	Priority 2 (4-10 Years)	Priority 3 (11+ Years)
Binbrook	5.65	5.57	5.23	4.46
BTP	5.43	5.43	5.43	5.43
Convamore Road	9.69	8.66	5.93	1.99
Conyard Road	14.30	12.45	8.58	3.98
Doughty Road	3.40	-5.42	-8.31	-21.04
Great Coates	4.99	-8.55	-70.83	-192.41
Grimsby Docks	20.75	20.26	16.77	11.38
Marsden Road	1.49	-5.65	-6.76	-9.28
Queens Road	15.57	-69.77	-313.63	-617.38
Scartho	3.41	-2.29	-13.82	-37.72
Wesley Crescent	9.84	5.08	-2.53	-13.00
Yarborough Road	9.64	8.03	2.20	-9.00

North Kesteven

Currently the situation with the primary substations in the district is downbeat with four having negative demand headroom capacity. There is mix of residential, office and employment use planned for the district that place equal demand on electrical infrastructure. The district's close proximity to the City of Lincoln increases the demand for housing in the district, there are also two Sustainable Urban Extensions planned for the Sleaford area that will increase demand. By the end of the study the districts will see eight primary substations with negative demand headroom availability, while two further substations, Cranwell and RAF Cranwell, are lacking data to make an analysis.

Table 12 Primary substation constraint – North Kesteven

Substation	Demand Headroom Availability (MVA)			
	Baseline	Priority 1 (1-3 Years)	Priority 2 (4-10 Years)	Priority 3 (11+ Years)
Billingborough	6.00	5.88	5.68	5.38
Cranwell	0.00	0.00	0.00	0.00
Great Hale	1.56	0.38	-0.31	-1.77
Leadenham	2.09	0.95	0.03	-2.04
Metheringham	6.59	2.88	0.71	-1.12

Substation	Demand Headroom Availability (MVA)			
	Baseline	Priority 1 (1-3 Years)	Priority 2 (4-10 Years)	Priority 3 (11+ Years)
North Hykeham	5.18	-21.06	-93.78	-171.31
RAF Cranwell	0.00	0.00	0.00	0.00
Ruskington	5.34	3.88	0.95	0.09
Sleaford	0.00	-22.61	-45.57	-61.39
Swinderby	4.80	-2.50	-7.14	-7.65
Tattershall	3.50	2.17	-2.77	-6.34
Waddington	0.00	-8.93	-15.06	-17.94

North Lincolnshire

91% of the future electricity demand for North Lincolnshire will be required by employment and heavy industry usage. In the town of Scunthorpe, the future of British Steel is still to be determined as it transitions to a net-zero operation. This transition will require a significant increase in electrical use which will put strain on the primary substation in the immediate vicinity, especially Station Road Substation. To the west of Scunthorpe, the Lincolnshire Lakes development will also place a demand for electricity in the area. In the east of the area, the industrial heartland in the vicinity of Killingholme and Immingham, with the ABLE Humber Port and ABLE Energy Park being major developments in the area. Initially these developments will place increase demand pressures on the primary substations in the area. However, it is planned that once the generational capacity of the developments come online this pressure will decrease. As the time frame increase there is significant constraint on the primary substations in the area to meet the demand in increased industrial capacity being introduced. This area sees the most significant constraints on demand headroom of the region.

Table 13 Primary substation constraint – North Lincolnshire

Substation	Demand Headroom Availability (MVA)			
	Baseline	Priority 1 (1-3 Years)	Priority 2 (4-10 Years)	Priority 3 (11+ Years)
Barrow	4.33	0.92	-10.59	-22.22
Billet Lane	8.61	8.07	6.52	6.52
Bottesford	10.57	9.61	6.44	-14.56
Bridges Road	8.37	8.14	7.45	7.45
Caistor	3.10	1.96	-0.48	-1.88
Clough Lane	-0.98	-1.19	-109.15	-1079.89
Crowle	-0.95	-1.67	-6.30	-7.52
Eastfield Road	0.47	-17.97	-47.71	-86.61
Epworth	1.94	1.50	-15.92	-33.34
Firth Brown	11.93	11.27	10.73	10.25

Substation	Demand Headroom Availability (MVA)			
	Baseline	Priority 1 (1-3 Years)	Priority 2 (4-10 Years)	Priority 3 (11+ Years)
Flixborough	-2.39	-11.04	-30.07	-45.97
Foxhills	2.16	2.02	-14.54	-29.13
Haxey	2.66	1.72	0.84	0.06
Hibaldstow	5.54	3.72	-1.54	-5.43
Humber Road	11.81	11.65	-338.35	-338.35
Pasture Road South	10.37	9.17	5.41	0.91
South Ferriby	5.75	5.53	4.39	3.27
Station Road	3.67	-2.77	-307.06	-321.88
Wrawby	10.90	9.76	-1.23	-8.13

South Holland

Currently, the outlook for the primary substations in the district is mixed with three having negative demand headroom capacity. Employment use is planned to be the largest requirement for electrical demand in the future, 53%. Residential use will be second with 31%. The South Lincolnshire Food Enterprise Zone at Holbeach is a major employment development that will require a large electrical demand. Spalding is the other area that is the focus for future planned employment development. Spalding and Holbeach are the two centres that dominated the residential use, with Holland Park development in Spalding and the Peppermint Park Project in Holbeach being the largest developments planned. This district is at the heart of the UK Food Valley and is also expected to see an increase in the use of land for the agri-food sector, particularly cold storage and transport. By the end of the study seven of the district's eight primary substations will have negative demand headroom availability with Spalding experiencing the most significant constraints.

Table 14 Primary substation constraint - South Holland

Substation	Demand Headroom Availability (MVA)			
	Baseline	Priority 1 (1-3 Years)	Priority 2 (4-10 Years)	Priority 3 (11+ Years)
Crowland	0.00	-3.03	-7.36	-15.04
Donington	3.22	0.40	-5.33	-11.87
Holbeach	2.40	-5.87	-18.20	-32.92
Long Sutton	4.14	-11.44	-34.90	-71.32
Spalding Clay Lake	0.00	-3.61	-10.75	-20.66
Spalding Park Road	0.00	-4.93	-18.74	-45.61
Wardentree Park	8.99	4.35	3.14	-1.78
Whaplode Drove	2.68	2.34	1.57	1.37

South Kesteven

Currently the primary substations in the district are in reasonable health with two of the thirteen having negative demand headroom capacity. It is planned that residential,46%, and employment, 42%, will account for the majority of future electrical demand in the district. Grantham and Stamford areas see the largest planned residential developments, with three major developments planned for Grantham, Southern Quadrant, Rectory Farm, Prince William of Gloucester and Prince William Barracks. The employment developments are spread across the district, with the most significant one planned for Gonerby Moor. The region has carried out a survey to identify land that is suitable for future office and employment use, this has given the district a clear picture of the future demand objectives. Part of the district falls within the UK Food Valley and will benefit from growth in this sector. By the end of the study nine of the district's thirteen primary substations will have negative demand headroom availability with those in Grantham experiencing the most significant constraints.

Table 15 Primary substation constraint – South Kesteven

Substation	Demand Headroom Availability (MVA)			
	Baseline	Priority 1 (1-3 Years)	Priority 2 (4-10 Years)	Priority 3 (11+ Years)
Bourne	0.00	-0.95	-9.36	-13.33
Dowsby Fen	1.77	1.77	1.77	1.77
Easton	3.26	-1.16	-1.67	-5.85
Grantham North	24.80	22.42	14.22	-9.17
Grantham South	0.00	-3.93	-11.39	-40.41
Market Deeping	10.21	6.05	-4.44	-21.85
Market Overton	1.69	1.22	1.08	0.28
New Beacon Road, Grantham	8.94	-11.99	-37.18	-70.55
Skillington	10.18	10.18	9.56	9.39
Stamford	6.68	-0.49	-14.65	-29.15
Tunnel Bank, Bourne	13.60	11.08	7.84	6.50
West Deeping	0.86	-1.32	-2.02	-2.33
Westborough	4.69	4.32	0.84	-3.27

West Lindsey

Currently the primary substations in the district are in good health with all having positive demand headroom capacity. Future electrical demand in this district is split between residential and employment use. The district's proximity to the City of Lincoln increases the number of residential units planned for development as overspill from the city is expected. There are also two Sustainable Urban Extensions planned for the Gainsborough area that contributed to the residential use planned for the town. Employment land is mainly focused in the Gainsborough area, with the Hemswell Cliff Business Park requiring significant demand. Part of the district falls within the UK Food Valley, the agri-food sector is expected to grow and this will affect the district through an increase in planned industrial greenhouses. An allowance has been allowed for expansion in this sector, however the exact demand of this in the future is an unknown quantity. By the end of the study all of the district's primary substations will have negative demand headroom availability, this is the only district in the region that this occurs.

Table 16 Primary substation constraint – West Lindsey

Substation	Demand Headroom Availability (MVA)			
	Baseline	Priority 1 (1-3 Years)	Priority 2 (4-10 Years)	Priority 3 (11+ Years)
Corringham Road	8.96	5.24	-8.86	-24.73
Fiskerton	11.22	-0.16	-37.70	-62.65
Harpswell	0.18	-5.54	-22.37	-23.28
Lea Road	5.34	-7.83	-24.94	-32.63
Normanby	1.71	1.25	-4.08	-5.25
South Carlton	7.94	3.34	-28.29	-33.23
Stow	1.15	-0.08	-4.75	-5.89
Walesby	1.94	-1.25	-9.49	-11.33

Shortfall Solutions

From the analysis carried out during this study a number of areas have been identified that require attention due to demand headroom restrictions. Resolving these restrictions required discussion with the relevant DNO to identify the reason for these restrictions and the most beneficial solution(s). In section 4.0 of this report, alternative solutions have been identified that can provide solutions for the Greater Lincolnshire area. Each council area is different, with different demands, needs and goals.

It is because of this that a recommendation of this report would be that to best identify the most suitable solution to the primary substation demand headroom restrictions, a feasibility study should be carried out for each area identified as a priority 1 shortfall. This feasibility study would need to be carried out with the relevant Local Plan for that particular area and in conjunction with the net zero strategy.

8.0 KEY LINES OF ENQUIRY

Both nationally and across Greater Lincolnshire, the energy landscape is undergoing a period of change; from increasing development across regions, transitioning to net zero with the subsequent increases of low carbon technologies, putting further demand on the network for connections. Ofgem notes that there are three main areas of change occurring across the energy market in the UK which will all require enhanced organisational competence, skillsets and incentives:

- Energy system planning
- Market facilitation of flexible resources
- Real time operations

Whilst these areas are not yet translated to local or regional level, it will be critical that local government shapes the response and facilitates energy improvements. This report is intended to provide an overview of the current market landscape, coupled with a regional insight into the current and predicted energy demand and supply.

Throughout this study, the sources of information from various stakeholders are ever changing as the developments are in a constant state of flux. Regarding energy networks, the main challenge has been to provide a robust and up to date analysis of the capacity in the networks. As network operators are constantly under scrutiny by the regulator, they are tasked with exploring innovation to provide a flexible network and alleviate, where possible, reinforcements. However, this is not always possible especially where networks have been underfunded and not maintained due to license constraints.

RLB have reviewed local energy networks alongside how national transmission could benefit the county and local areas, with the intent of understanding how new opportunities for generation and distribution could promote private investment. The below KLOEs are summaries building on from the main body of this report and are derived from the research completed during this study with recommendations stemming from each area of focus.

KLOE: Energy generation, viability, key energy operators, local innovative solutions

RLB have engaged with the Local DNOs to determine the extent of innovation and investment either existing or planned across the region. It has been acknowledged that there is a shortfall in electrical capacity within the Greater Lincolnshire area of power capacity and this has been determined by several developments providing anecdotal evidence to that effect. Our study into future demand mapping has confirmed this as a concern in the short, medium and long term. RLB have engaged with NGED and NPg, with a view of aligning the need for additional capacity and generation.

As part of this study, consideration has been given to how private generating companies could assist the long-term objective of growing and investing in the local areas. Engagement with IDNOs has been sparse and requires further investigation as to why there is perceived lack of interest in local government engagement. Private investment into the energy sector is significant, as is the predicted government investment into projects to progress low carbon generation in the northern part of Greater Lincolnshire. Viability is more likely to be an issue across the other districts in the region; those which do not have large energy sectors or benefit from strong transport links. However, the UK Food Valley poses a critical opportunity for growth and investment, not only as a sector providing employment, but to attract investment through research and development and generate energy.

NGED and NPg both have future growth strategies in place, which not only outline physical infrastructure, but innovations in digital advancement and smart management. From engagement with both DNOs, there is little concern regarding capacity for developments, or large scale switches from gas to electricity supply. This does contrast the experiences of those developers who have experienced electrical capacity shortfall, as well as the published headroom (see Section 6.0 Future Demand Analysis). RLB have conducted a demand and supply mapping exercise, utilising the published headroom capacity from both DNOs against planned development across the region. This has been supplemented by data provided by large energy consuming organisations across the region to provide as accurate an analysis as possible.

For both DNOs, the key challenge appears to be new connections to facilitate renewable energy generation as well as low carbon technologies such as EVs and heat pumps. This has been outlined by both DNOs as a focus area for future investment, which will facilitate moving to a decentralised, low carbon energy supply. It is worth noting here that predictions are currently modelling heat pump demand to accelerate post 2030, after gas boilers begin to be phased out.

NPg and NGED both engage with LEPs and councils and run programmes of engagement. Through this study, it has been recognised that wider engagement is needed with a variety of stakeholders, but principally greater local authority engagement is needed, combined with enhanced engagement with installers across the region. Installers in this case refers to all renewables and low carbon technologies, ranging from heat pumps through to AD systems.

For viability constraints stalling development, it is has not been a clear indication that energy provision has prevented development across the region. However, it has been clear that there are real constraints in generation of energy. Small scale energy generation is a critical element in decarbonising the UK. The time frames for connection to grid are prohibitive in areas, with concern being present both from DNO perspective and those wishing to generate energy. From analysing the shortfall areas, it is believed that energy supply will be increasingly constrained, and this has the potential to therefore constrain development in two ways. Firstly, prevention of development at all due to difficulties in connecting to the electricity grid. Secondly, prevention of small scale renewables being installed at scale.

To enable targeted investment and a clearer picture of the viability constraints across Greater Lincolnshire, it is recommended that Local Area Energy Plans are undertaken. These should be considered at a strategic level; considering phasing of LAEPs, and where there may be local areas that intersect both DNO coverage. The report has previously covered the recommendation for alignment between the DNOs to mitigate any differing approaches that may mean that LAEPs for neighbouring areas are not consistent.

The benefit of a LAEP will be a fully costed spatial plan that identifies the local energy system changes including energy use and net zero transition with programmed targets. It is worth noting that a LAEP does not provide ‘oven ready’ projects, but provides detail required for outline design or masterplan, identifying projects to then progress through to delivery. For Greater Lincolnshire, all LAEPs should have similar overarching long term visions, with detailed strategies that reflect the local requirements. Variances here should include potential for renewable energy generation, and areas of constrained supply identified within the demand/supply mapping exercise and summarised within this report.

A real benefit of a LAEP is to provide staged investment and identify clear areas for improvement which require targeted investment. The risk of not undertaking an LAEP is that a strategic view of energy demand and supply across the local area can get lost amongst smaller standalone projects, removing the forward planning and context of the wider policy and market environment.

A holistic, whole system approach to engagement is recommended to ensure that strategies consider the following:

- Availability of electricity supply
- Stakeholder engagement
- Capture of socio-economic drivers
- Mapping of future scenarios and pathways including to net zero
- Decarbonisation targets
- Changing demand
  - Increased demand through electrification to facilitate decarbonisation
  - Reduced demand through efficiencies
  - Spatial analysis
- Technology trends at domestic, commercial, and industrial levels
- Local renewable schemes and low carbon technologies to boost energy resilience and reduce the impacts of high energy costs
- Governance and delivery

As part of Ofgem’s recommendations for transforming UK energy, an area of reform is likely to be energy system planning where new Regional System Planners (RSP) would be introduced to ensure accountability for regional energy system planning. When, or if, this comes into place, it will be a key recommendation that Greater Lincolnshire local government engage with the new RSPs.

Local innovative solutions have been referenced throughout the study, notably in the sector and future energy sections. A recommendation from this study is to align strategic sectors to collaborating on strategies. An example of this could be agrifood with logistics, where agrifood can provide alternative fuels but also plans to decarbonise food related transport. Alternative technologies for energy generation such as Energy from Waste and Biofuels could be of significant benefit to the region; reducing grid energy demands for producers and allowing income through exporting back to the grid. A forum as suggested will allow for DNOs and IDNOs to schedule, plan and strategize to allow for connections and capacity which in turn should reduce wait times and energy capacity issues.

KLOE: Collaborative authorities, alternative energy solutions, forum for private and public sectors, focused investment

Through this study, sector analysis has been carried out to understand current risks and constraints that may be preventing private and public sector development. The opportunity for alternative energy supply at scale within the region is significant – from a review of economic activity across the region, the energy sector has held steady during the recent turbulence caused by the pandemic. This bodes well, particularly when paired with the investment (private and publicly funded) into the Humber region to generate energy supply and industrial economic market increase; this will not only impact the region's energy supply and demand, but the wider economy through employment, infrastructure requirements and innovation.

To provide further context as to the current position of renewable technologies and alternative technologies, planned and operational projects across the region using data from BEIS have been included as an appendix.

Ofgem have raised concerns that there is insufficient, or ineffective, coordination between actors across the energy system at a sub-national level, and that confusion and regional variance in approaches to delivering functions could delay the transition to net zero. For Greater Lincolnshire, these risks are present due to there being two DNOs across the region; equally, proactive collaboration and alignment in approach can drive greater opportunities. GL local government can provide the in-depth understanding of place-based development, including local phased EVs, LCT including power generation.

As a key recommendation of this study, it is suggested that to prepare for the energy market changes, investment to enable required resources and support is sought. The Local Government Association (LPA) has stated that councils will need to play an increasingly predominant role in energy systems planning. Greater Lincolnshire should consider if the existing resources and technical skills for energy planning to enable a holistic partnership approach are present.

From stakeholder engagement there have been two key focus areas – residential demand through the region, and industrial development across the north. Considering districts like Boston and the wider agricultural areas where alternative energy production could be utilised should be prioritised. These could be Energy from Waste, biomass and biomethane; both options can be linked to the thriving agrifood industry. The growth in agrifood presents a challenge of finding net zero/carbon negative networks by providing a secure, reliable, and affordable energy systems. Creating an attractive environment for innovation and investment in this area will address this challenge and further, the ability to export energy (heat and/or power). This could be facilitated through engagement with farms, installers, and potential investors – a focused engagement programme drawing together best practice, lessons learnt and practical experiences to enable information sharing and expert advice.

There are many options for alternative energy generation. Through a focused, strategic approach per sector opportunities can be generated to collaboratively provide a holistic approach to energy generation and distribution; and offering opportunities for end-user cost savings as well as income generation. Each sector has differing constraints, and differing opportunities. Through developing an energy strategy per strategic sector across Greater Lincolnshire, targeted investment, collaboration opportunities and critically, identification of trends and risks can be enabled. This process should occur in conjunction with the GLLEP, to build on the wealth of regional knowledge, contacts and research already undertaken.

To progress the energy analysis of the region, it is suggested that utilising local authority leadership and central government relationships to drive insight, funnel investment and create an attractive, local centric environment for energy generation and investment would be of benefit. This could be driven through GLLEP, ensuring links to central government are integrated to create insight into funding, future strategies and policy. This streamlined approach of generating a forum of collaborative, shared knowledge can facilitate a centre of excellence and innovation, to attract private investment into the region and strengthen the robustness of energy supply in the future.

Prior to deregulation of the utility market, developers and investors could only engage with the monopolistic incumbent statutory utility providers. These organisations still exist today but are all now in private ownership. However, the obligation to provide a connection to a customer remains. It is suggested that any forum/committee reviewing the energy market going forward should appraise different models available since de-regularisation to determine which have the potential to attract private investment and innovation; this has been demonstrated by commercial organisations reaching out for information beyond DNOs to explore other options.

The GLLEP predicts that the low carbon and energy economy, already worth “£1.2bn per annum to Greater Lincolnshire, holds exceptional potential offering an unprecedented level of private investment of £60bn over the next fifteen years.” This demonstrates that alongside ensuring viability of developments across the region, there is a critical opportunity to expand the energy sector to grow the local economy, to develop an offering that could be of national importance through enhancing existing skillsets, leveraging locational benefits, and providing an attractive environment for investment. Developing a forum, or task force, that proactively engages with the energy sector with the focus of driving strategic investment from both private sector and central government will be key to appearing as an attractive investment opportunity.

Existing groups and forums do not currently have consistent structured engagement with NPg and NGED. A key recommendation from this study is to integrate local DNOs into energy forums and committees to improve information sharing, collaboration and continuous improvement. There are NGED Local Investment Workshops, one of which covers Lincolnshire. At present, this appears to be the main opportunity to provide feedback on local investment. It is clear that a coordinated approach between Greater Lincolnshire and local DNOs would be of significant benefit.

When considering the transition to net zero, it is clear that local councils will play a pivotal role in shaping energy landscape, and shaping the route through local leadership. Ofgem held a consultation in May 2023[68] regarding the future of local energy institutions and governance; focusing on accelerated decarbonisation and decentralisation of generation and demand.

Energy generation and network capacity should be planned and coordinated to achieve net zero deadlines, whilst mitigating the consumer borne impacts of fossil fuel price fluctuations. Local network planning needs to be in alignment to drive system wide benefits as well as flexibilities nationally.

For this KLOE, the key recommendation is to develop the following;

- Enhanced capability and capacity at a regional level with local expertise to drive energy transformation
  - Investigation into appropriate sourcing of expertise, which could be driven via internal upskilling, external recruitment or direct placements from DNOs
- Facilitation of a forum

KLOE: energy and utilities connectivity, digital infrastructure, and the internet of things.
Connectivity between energy and other utilities provision is mixed. Local DNOs have identified that they work closely with the gas networks to understand future planning, including conversions to hydrogen. Water supply has been noticeably less concerning for developments across most sectors. However, with the increasing investment in industrial hubs across Greater Lincolnshire and the Humber, the focus of water supply to industry is becoming critical. Engagement held during this study has shown developers reaching out to IDNOs for both energy and water supply.

The National Grid is commencing with the next stage of a new Government-backed project to explore how satellite imagery and data analytics can improve the resiliency of the UK's gas and electricity infrastructure, potentially helping to reduce blackouts while cutting emissions.

Digitalisation is disrupting and bringing benefits to diverse sectors, including energy. A Smart Energy System is an approach in which smart electricity, thermal, and gas grids are aligned to identify synergies to achieve a solution whether at building, region, or system level. This links to the whole energy system approach. Through integrating digital links, this approach can drive down costs, enhance efficiency and reduce carbon emissions.

Across the wider Midlands region there are multiple projects progressing digital integration into energy systems. These include:

- Smart Energy Network Demonstrator (SEND) project is the largest of its kind in Europe. The University of Keele is working in partnership with Siemens and Engie/ EQUANS to create a smart energy network of energy generation, distribution and storage across different energy sources at the university campus
- The Trent Basin project in Nottingham is a housing development focused on local smart energy systems
- The Regional Energy Systems Operator project in Coventry has examined new ways of managing energy at a local level

[68] Ofgem Consultation

- Plans for the University of Birmingham and Siemens to create a smart campus with 38,000 sensors linking to a smart energy system.

There are projects across Greater Lincolnshire progressing digital advancement in energy:

- Smart Energy Project in North Lincolnshire is focused on boosting renewable energy use in small and medium-sized enterprises (SMEs), council and other public sector owned buildings in the area by providing a one stop shop of energy and low carbon services to SMEs as well as facilitating large scale investment in public infrastructure
- University of Lincoln SEP (Sustainable Energy and Power) research group leads systems thinking and applied research to develop new energy delivery approaches for heat and electricity. The group focuses on combined demand profiles, integrating technologies and AI.
- University of Lincoln: Stabilising the National Grid research, applying Internet of Things technologies to stabilise industrial energy demand (Demand Side Response)
- SMARTGREEN project is a research collaboration between nine research institutions and three commercial companies internationally, including University of Lincoln and Lincoln Institute for Agri-Food technology. The project analyses big data on climate and production with practical SME level demonstration to show how agri-food industry can improve energy efficiency, for example through sensors, measurement and controls in greenhouses.

Beyond the financial benefits, Smart Energy Systems are crucial for energy security. Small-scale and local low-carbon energy generation combined with proper energy management and distribution would allow for the region to become more self-sufficient in managing its energy demand and supply. The region would become less reliant on outside energy sources, thus becoming more resilient against the volatility of global energy prices. The implementation of various Smart Energy interventions for monitoring and optimisation would be able to better address the energy flows, further helping to match energy needs of different areas.

At Midlands level, there has been a recent study which has recommended a regional coordination body for Local Area Energy Planning[69], to provide a focus for data sharing on Smart Energy Systems and their deployment, including microgrids.[70] This would involve local and combined authorities through to energy companies and consumer organisations. It is recommended that GL engage with the MEP initiative and replicate a similar forum. As a critical player in the MEP for energy generation, particularly with the Humber energy investment and offshore wind, GL have the potential to rapidly enhance the smart energy approach. This could be facilitated through an energy forum, as recommended within the report conclusion.

Energy systems can be improved by targeting greater levels of resource toward low-carbon electricity generation such as solar, wind and nuclear and a focussed programme on developing a Smart Energy Systems industry. Greater Lincolnshire would benefit from a combined resource pooled from all councils, and engagement with the wider regions forums and initiatives. Across Greater

---

[69] Home | Midlands Engine
[70] Local Area Energy Planning - Energy Systems Catapult

Lincolnshire there is a strategic goal to improve highly skilled employment; smart energy systems can facilitate this. This could be developing a Smart Energy skills programme to (re-)train those in the energy sector supporting the accelerated delivery of Smart Energy Systems, and attract resource into the sector through presenting the opportunity to help shape the future of energy in an innovative way.

KLOE: private and public sectors collaboration, targeted investment in priority sites

There are various forums across Greater Lincolnshire and neighbouring regions that consider the energy sector either as the main, or one of the key areas of focus. Of the forums reviewed, none appear to be focused solely on investment collaboration to drive schemes forward.

GLLEP has created an Energy Council, to focus on the progression of the current and long-term outcomes and opportunities to a whole-system approach for the Greater Lincolnshire area; and for the transformation of energy, particularly the opportunities around developing a rural innovation test bed for energy and water (and waste). The Energy Council is a Strategy Advisory Board, with a remit to provide high-level strategic guidance to implement the Enabling Framework for Greater Lincolnshire, make strategic recommendations for long-term energy goals, support the active engagement of businesses, and potentially suggest funding opportunities as needed to implement the Enabling Framework.

The Energy Council is intended to be predominantly private with public representation, however the board does not have representation across all councils. The current format of the board as of March 2023 include representation from:

- Global Smart Transformations
- Lincolnshire County Council
- Lincolnshire STP NHS
- Cadent Gas
- Singleton Birch
- South Kesteven District Council
- North Lincolnshire Council
- Sustainable Direction
- National Grid
- N4 Energy Solutions Ltd
- Siemens Energy
- HCF CATCH Ltd
- Branston Ltd
- Offshore Renewable Energy Catapult

There are two potential avenues to enable the forum for private and public sectors to collaborate on driving investment and energy strategy:

Develop a new forum focused on attracting investment into priority sites

- Strategic oversight board focused on development viability and energy demand / supply
- Focus groups to be developed for each major investment site

Enhance an existing forum such as the Energy Council

- Investigate if a sub-group solely focused on investment would be a viable option through discussion with the committee board
- Sub-group to be formed of local district/authority, DNOs, private sector, and installers
- Engagement to be focused on Greater Lincolnshire, whilst maximising links to central government and wider Midlands region.

For this forum, the purpose should be focused on the future of energy demand and unlocking regional potential. As explored throughout this study, Greater Lincolnshire holds significant potential for not only renewable energy generation, but also to showcase the benefits of collaboration between key energy organisations. For example, the two DNOs across the region, National Grid ED and Northern Powergrid, both of which are keen to promote engagement and collaboration to ease the challenges ahead.

9.0 SUMMARY

Greater Lincolnshire is in a unique position to drive energy solutions and attract investment, through key strategic sectors that are predicted to experience sustained growth, to the locational positioning with strong, rail, road and port links. The low carbon and energy economy holds potential for £60bn private investment.

A key part of this potential, the Humber Estuary is connected with at least 25% of the UK's energy production, while the south bank of the Humber lies at the centre of an emerging offshore wind market. There are significant differences across Greater Lincolnshire, notably the shift of industrial activity in the north to rural areas. One theme has been clear throughout analysis of all sectors and regions, that there is a clear shift towards innovation and alternative energy sources across the region to swiftly progress towards net zero, and the need to accommodate electrification in virtually all sectors.

Net zero is a common theme across all sectors, echoed by the shift in energy providers and increase in private investment. At a domestic scale, there are four key areas impacting future energy demand, all supporting a focus on electrification:

- Heat pumps
- Electric vehicles
- Retrofit and energy efficiency measures
- Domestic scale renewables

Across other sectors, alternative technology investment appear to be focused either in the Humber region (including CCS) or linked to the agrifood sector, e.g., biomass and AD.

Initiatives to support SME's have been successful in the region; a collaborative approach could foster increased uptake of local energy solutions to enhance energy resilience, and reduce energy costs.

All sectors have been impacted by the cost of living crisis to some degree, with energy intensive organisations being hit hardest. Reducing energy consumption eases financial pressures and can facilitate sustainable growth and employment.

Providing access to information, expert advice and options could be critical to long term energy sustainability across Greater Lincolnshire, which could take the form of an Energy Hub.

It appears that across Greater Lincolnshire there is inconsistent collaboration in regards to energy, whether that is in relation to supply and demand, or through exploring alternative solutions.

There are pockets of exceptional collaboration, innovation and best practice that should be shared with private and public organisations across Greater Lincolnshire, with the overarching goal of attracting investment into the region, alongside decarbonisation, reducing financial pressures, and improving energy resilience. Smart energy solutions should sit alongside physical infrastructure investment, with local stakeholders regularly engaging with DNOs to align DNO/DSO investment with local requirements.

The below is a detailed summary of the recommendations from this comprehensive study, aligned with the KLOEs brief:

Theme	Recommendation	Detail	Timeframe	Investment	Location
Collaboration	Open Networks Insights Forum	Quarterly online forum	Short term	Capacity of appropriate resource	Page 18
Energy transformation	Align strategic sectors energy strategies. Geothermal energy and biomass project collaboration and lesson learned sharing.	Integrate geothermal and biomass energy projects into GLLEP Energy forum or other appropriate forum.	Short term	Capacity of appropriate resource	Section 4
	Develop an outline strategy for integrating geothermal into the region's long-term energy landscape. Biomass strategies and investment should be closely linked to CCS, with a regional strategy considering socio-economic factors.	Strategies should be integrated into LAEPs with an overarching GL wide strategy.	Medium Term	Internal or external funding to facilitate strategy development	
Energy transformation	Mapping of high intensity users in urban areas, linking together organisations such	Heat network study to be undertaken. Applications to Heat Network Transformation	Medium term (funding applications to be sent	Internal or external funding to undertake mapping exercise.	Page 30

Theme	Recommendation	Detail	Timeframe	Investment	Location
	as the NHS trusts with local industrial businesses to power residential heating.	Programme (HNTP) to be submitted.	prior to closure of scheme in 2025)	Capacity of appropriate resource for funding applications.	
Collaboration	Alignment of DNO strategy across GL to ensure LAEPs are consistent	Energy management including ANM Identify targeted areas of improvement / upgrades to infrastructure to understand if potential case studies for energy mgmt.	Short term	Capacity of appropriate resource to engage with both DNOs	Page 41
Collaboration	Integrate aquaculture into agri-food sector energy analysis. Consider wider sector collaboration where there are known synergies e.g. logistics and transport, logistics and agri-food.	Due to the anticipated increase in transport related to agri-food and aquaculture, collaborate on transport strategies where there is anticipated increase in EV demand across combined sectors.	Medium term	Capacity of local resource Internal or external funding to work with GLLEP to integrate energy demand from both sectors	Page 88
Innovation	Undertake LAEP for all areas within GL	Determine appropriate areas (noting the DNO boundaries) for LAEPs to be undertaken. LAEP to identify short and medium term actions / projects, with	Short term	Short term resource from each relevant area (district, county etc) to confirm boundaries.	Page 41

Theme	Recommendation	Detail	Timeframe	Investment	Location
		prioritised investment. Scope should include electricity, heat, gas, future innovations inc. hydrogen, generation and storage as well as changing built environment demands.	Medium term	Funding to be sourced for each LAEP whether funded centrally or on a local basis.	
Innovation / Collaboration	Integration with Regional System Planners (RSPs) when / if put in place	GL local authorities engage with the new RSPs to determine accountability for regional energy systems planning.	Medium – Long term	Capacity of dedicated resource internally to engage with RSPs, Ofgem and DNOs. Potential for further investment if RSPs scope is determined to be closely integrated with local authorities.	Page 75
Innovation	Smart Energy Skills programme	Enhance existing skills in energy sector supporting the accelerated delivery of Smart Energy Systems, and attract resource into the sector through presenting the opportunity to help shape the future of energy in an innovative way.	Medium – long term	Pooled resource from GL, consider funding sources such as LCSF (Low Carbon Skills Fund) or other grants from organisations such as the DNOs	Page 80

Theme	Recommendation	Detail	Timeframe	Investment	Location
Energy transformation	Shortfall feasibility studies	Identify the most suitable solution to the primary substation demand headroom restrictions, a feasibility study should be carried out for each area identified as a priority 1 shortfall. This feasibility study would need to be carried out with the relevant Local Plan for that particular area and in conjunction with the net zero strategy.	Short term	Resource and funding to deliver feasibility studies	Section 7
Energy transformation	Energy PPP viability study	Study to determine if an Energy PPP would be viable for GL. A key area to explore would be Energy Performance Contracts	Medium – long term	Resource to fund study, subsequent investment if deemed viable.	Page 88

Building on the above, a wider set of overarching suggested recommendations from this study are detailed below:

CREATE A REGIONAL FUTURE ENERGY FORUM

Throughout this study, it is clear that the energy landscape and market is undergoing a period of rapid change and innovation whilst experiencing constraints on demand and supply. For Greater Lincolnshire to capitalise on the opportunity of shaping the energy market in the region, we recommend developing a private and public future energy forum / committee, focused on demand vs supply.

Throughout the data analysis we found that significant developments often hadn't engaged with the local DNOs. This lack of engagement with a key stakeholder impacts the viability of future development, the robustness of predicted future demand, and slows down the process of enabling new developments through lack of early engagement.

As part of this forum, we recommend that beyond energy demand and supply management, consideration of energy reduction initiatives are included alongside efficient resource management.

The management of resources such as electricity will benefit society and reduce costs as well. The more energy efficiency and resource management that is undertaken at scale, the greater benefit that will transpire. Reducing of existing demand and improving efficiencies whilst identifying new energy infrastructure requirements to promote growth will be critical to robust, resilience energy for the region. Working at scale across several LAs to a unified strategy will also help position the region for the emerging green economy and bring enough local demand to protect the competitiveness of the region for the future by creating stable incentives to grow local green skills and business capacity.

Energy supply is critical to commercial developments, therefore engagement with Greater Lincolnshire energy stakeholders (private and public) will be key to enabling development.

Organisations such as British Steel are engaged with UK government, as UK wide policy driving decarbonisation is integral to achieving targets. Smaller-scale organisations and regional players will also require not only access to support, but a forum to understand capacity across all levels of energy infrastructure in the area, and are less likely to have existing relationships.

We recommend that a Greater Lincolnshire Energy Committee/Forum is created. Our recommendation is to consider the following to participate:

- Key relevant and influential members of each local authority
  - This should include those involved directly in energy, infrastructure and development
- Representatives of each DNO
  - This should include those who can advise on the following:
    - Transformation projects
    - Local initiatives
    - Knowledge sharing from other regions
    - Funnel queries to the relevant parties
    - Progress against business plans
- Representatives of significant future demand / development including but not limited to
  - Able Energy Park
  - Zero Carbon Humber
  - Significant residential developments
  - Significant industrial developments

It is worth noting that there are existing forums which may be a preferred route rather than creating a new entity. This should be a joint decision formed by all councils across the region.

EXPLORE ENERGY FOCUSSED PUBLIC / PRIVATE PARTNERSHIP

Whilst public-private partnerships (PPPs) can be challenging to deliver and not without controversy, robust and well-coordinated partnerships present opportunities to bring together the resources, expertise, and powers available in ways that cannot be achieved by either sector in isolation. As such, councils across the UK are now exploring how this investment could unlock a range of social, environmental, and economic benefits aligned to local and national priorities.

When considering PPPs from a collaborative angle, there are two impacts that the energy sector can have. These are net zero and energy security/fuel poverty. "The cost of achieving net zero is calculated to be at least £200 billion. If we can find the right financing models we can turn this cost into an investment opportunity, and a 'skills and jobs dividend'. Local and national government need to work together with the investment community to realise this massive dividend."[71]

An example of this is Energetik, an energy company that was established by Enfield Council and has wide ambitions to service residents across the borough with low carbon energy, with surpluses reinvested into infrastructure and education programmes. Energetik highlighted that councils are well placed to deliver more affordable energy solutions for residents. Where the private sector would seek to return a margin, the public sector can elect to reinvest surpluses to deliver low and transparent tariffs.

There have been success stories across the region of public funding facilitating take up of energy efficiency measures, such as the Smart Energy Project in North Lincolnshire. Addressing SMEs across the region and linking together expertise with installers, providers and funding streams is a valuable resource for SMEs that are unlikely to have resource in house or access to expert advice. It is recommended that as an outcome of this report, a study should be undertaken to determine if an Energy PPP would be viable for Greater Lincolnshire. A key area to explore would be Energy Performance Contracts, which is an agreement to deliver energy savings and / or energy generation whilst providing a guaranteed energy saving plus cost reduction.

As private investment has focused upon large scale renewable and alternative technologies, there appears to be a gap to address existing organisations rapidly decarbonise through energy efficiency retrofit measures, local energy generation, community energy generation linked to the agrifood industry, and exploring innovations such as Vehicle to Grid technologies.

For Greater Lincolnshire, the following areas are deemed to demonstrate value in progressing feasibility of PPPs:

- District Heat Networks: these should focus on urban areas, and link together industrial and heavy energy use sectors with residential / commercial to gain maximum benefit.
- Agri-food / aquaculture: determining the scope of the opportunity to enhance the energy generation abilities of both sectors when combined with the significant on-going investment into alternative energy generation and carbon capture in the north of Greater Lincolnshire. This can provide much

[71] LGA, Public-Private Partnerships

needed investment into the agricultural sector, whilst providing assurance of socio-economic factors across the region.

- Vehicle to grid and EV charging: there is a significant opportunity for local authorities to take a leading role in shaping the EV infrastructure network across the region. This will include ensuring accessibility for those not within dense urban areas, and enabling long term investment for Greater Lincolnshire. Energy companies are increasingly seeking opportunities to install or own EV assets, which gives local authorities the potential to utilise existing land or go into partnership for charging stations.
- Renewable energy projects: there's an opportunity to capitalise on private sector ESG ambitions through accessing funding for projects that provide public benefits. An example of this can be entering Power Purchase Agreements with energy providers; allowing authorities to support renewable infrastructure without taking on the complex demands of developing on authority assets. For Greater Lincolnshire, the study has shown that there's varying interest in renewable energy projects across the region. For coastal areas, on-shore wind should be considered. Solar energy projects should be considered across both rural and urban areas; utilising the often underutilised roof spaces across built up areas, enhancing car park structures (shading or roof spaces), providing on site small scale renewables as part of a larger strategy can all be beneficial.
- Energy efficiency of built environment: a critical piece of addressing energy demand and supply is to address the demand driven from the built environment, which aligns to net zero aspirations. To facilitate this, there are various schemes that local authorities can access to drive efficiencies. An example of a partnership is Energiesprong, which is a whole house approach to retrofit, which guarantees energy performance of homes and shows real life performance – enabling housing associations and other organisations to benefit from reduced operating costs. As a case study, Nottingham City Council and Nottingham City Homes delivered Destination Zero, which was funded by BEIS.

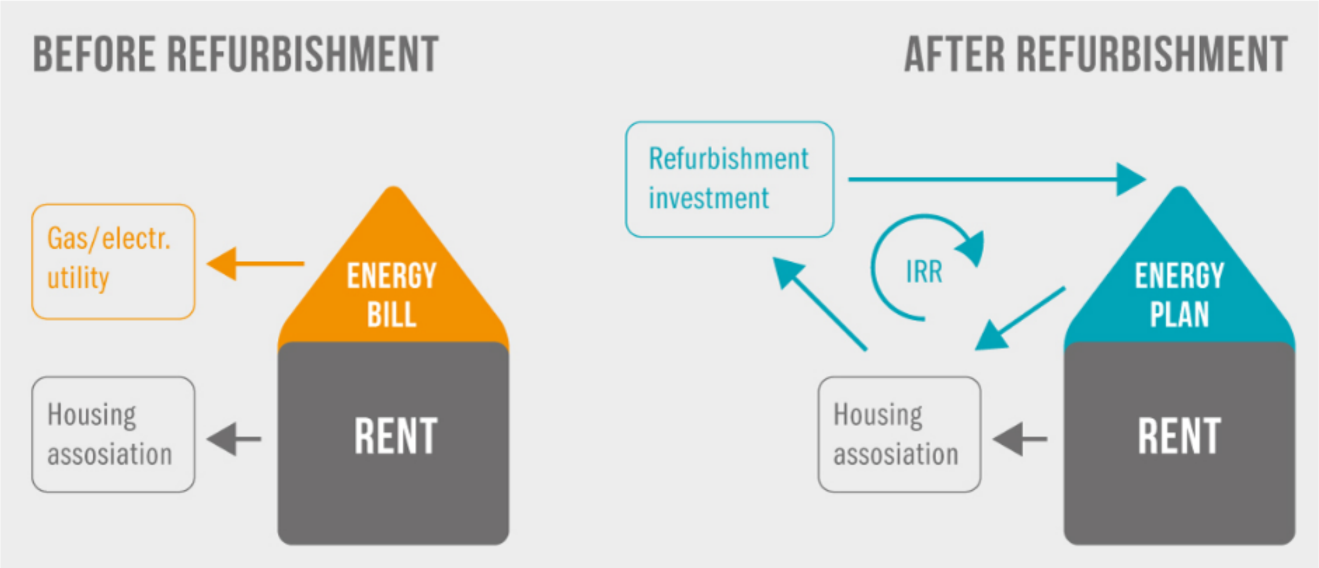


Figure 19 Energiesprong, 'How does it work'

To facilitate a PPP, the LGA recommend the below structure be followed:

- Defining the vision and outcomes
  - For Greater Lincolnshire, consideration should be given to what outcomes a successful energy strategy and related partnerships would result in.
    - Energy resilience and security
    - Addressing energy poverty
    - Transition to net zero
      - Focused approach to alternative energy
    - Utilising energy as a driver for investment
      - Two approaches: energy supply to facilitate development, or through inward investment into the energy sector directly
- Scoping
  - Establishing the roles for public and private sectors i.e. who sets the strategy, who delivers the strategy, who is responsible for outcome delivery, who is responsible for assurance and governance
  - Investigating if Greater Lincolnshire have sufficient resources including financial to enable a successful partnership
- Reviewing partnership options
  - Significant specialist resource will be required to:
    - Undertake market engagement to gauge interest
    - Undertake legal and commercial review
    - Stress test forecasts and budgets
- Identifying right route to market
  - Greater Lincolnshire local authorities are in a strong position to determine best route to market. It is advisable that the GLLEP are integrated into this stage, to enable market insight, provide resources and support and demonstrate market confidence.
- Preparation
  - Governance, oversight and delivery control will be critical. For PPPs, it would be unlikely that partnerships would cover the entirety of the region, but in the case that multiple districts/authorities are involved, clear governance procedures will be required.
- Managing
  - The critical element here is that a PPP requires investment from the public sector bodies involved on an ongoing basis throughout the contract/partnership length. Securing committed resources will enable financial and risk management as well as monitoring value creation.
- Evaluation and handover
  - Integration an evaluation of the whole life of the project into the deliverables at an early stage is advisable. As the energy market is evolving, so should PPPs which Greater Lincolnshire should be flexible and adaptable in their approach.

CONCLUSION: THE NEED FOR A REGIONAL STRATEGY

This study has clearly demonstrated that the need for an integrated regional strategy on energy and net zero involving key players like DNOs and all LAs to deal with the increasing complexity and emerging options for linking regional net zero with future economic growth.

Energy investment was previously focused on cost and risk, whereas in the context of national and regional policy and strategies, sustainability / green energy is viewed as investment and opportunity.

Building on the work that GLLEP has undertaken to position Greater Lincolnshire as open to business investment, driving forward clean energy growth will impact the key strategic sectors. This takes seven key forms:

- Providing a test bed for innovations building upon well-established industries such as agrifood
- Enhancing existing skillsets in the energy sector and positioning the region at the forefront of smart and green energy systems
- Engage with national government to attract funding and investment across the region
- Improving communication and engagement from DNOs and developers to address concerns of capacity stalling development
- Develop a clean energy strategy that strategically focuses upon the areas with limited capacity as identified through the future demand mapping exercise
- Regional Energy Parks could provide large communities with a stable local supply of low carbon heat and electricity, maximising local resource and enabling local pricing structures
- Humber region will likely play a critical role in this approach. Smaller regional energy parks should be considered across Greater Lincolnshire, building on larger parks to align with and complement energy production and management.

For Greater Lincolnshire, the focus of a regional approach should be on energy capacity and generation innovation, promoting the region's unique characteristics such as the strong agri-food sector and strong links to energy, industry and CCS to drive forward investment and growth into ensuring the key economic sectors can secure sustainable growth.

APPENDIX A

PROPOSED RENEWABLE ENERGY SCHEMES

North Lincolnshire

Name	Location	Type of Generation	Generation Start Date	Generation Capacity (MW)
Green Energy Park	Flixborough Wharf, Flixborough Industrial Estate, Scunthorpe	EFW Incineration	2025/2026	95.00
Little Crow Solar Park	Land located 0.6km to the east of the British Steel site at Scunthorpe,	Solar		150.00
Little Crow Solar Park	Land located 0.6km to the east of the British Steel site at Scunthorpe,	Battery	2022	90.00
Winterton Landfill Site - Ground Mounted Solar PV Arrays	Land on the restored part of Winterton Landfill site, access roads to landfill site, Winterton	Solar	2023	5.00
Winterton Road - Battery Energy Storage	N/O Gala Bingo, Winterton Road, Scunthorpe	Battery	N/A	95.00
Sweet Briar Farm - Solar Farm	Sweet Briar Farm, Carr Road, Ulceby	Solar	N/A	39.00
Scawby Brook, Brigg - Battery Storage	Power Station Access Roads To Power Station, Scawby Brook Brigg	Battery	N/A	99.00
WM Morrison Supermarkets - Solar Photovoltaics	WM Morrison Supermarkets Plc, Access road to Morrisons Superstore, Scunthorpe	Solar	N/A	0.62
Elsham Wold Industrial Estate - Solar Panels	GFP Agriculture, Office, Warehouse, Pegasus Road, Elsham Wold Industrial Estate, Elsham,	Solar	N/A	0.29

Name	Location	Type of Generation	Generation Start Date	Generation Capacity (MW)
Elsham Wold Industrial Estate, Pegasus Road - Solar Panels	GFP Agriculture, Office, Warehouse, Pegasus Road, Elsham Wold Industrial Estate, Elsham,	Solar	N/A	0.31
Atherton Way - Solar Panels	Rocal Limited, Atherton Way, Brigg,	Solar	N/A	0.24
Frederick Gough School, Grange Lane South - Solar Panels	Frederick Gough School, Grange Lane South, Scunthorpe	Solar	N/A	0.21
Green Energy Park	Flixborough Wharf, Flixborough Industrial Estate, Scunthorpe	Battery	2025/2026	30.00
Green Energy Park	Flixborough Wharf, Flixborough Industrial Estate, Scunthorpe	Hydrogen	2025/2026	10.00

North East Lincolnshire

Name	Location	Type of Generation	Generation Start Date	Generation Capacity (MW)
North East Lincolnshire Energy Park	South East of Immingham, North East Lincolnshire	Solar	N/A	50.00
Grimsby Solar Farm	Grimsby, North East Lincolnshire	Solar	2024	50

West Lindsey

Name	Location	Type of Generation	Generation Start Date	Generation Capacity (MW)
Gate Burton Energy Park	Gate Burton, West Lindsey	Solar	2028	500.00
Cottam Solar Project	Cottam, West Lindsey	Solar	2024	600.00
West Burton Solar Project	West Burton, West Lindsey	Solar	2024	480.00
Tillbridge Solar Project	Tillbridge, West Lindsey	Solar	2025	500.00
Welton Gathering Centre, Sudbrooke - Battery Storage	Welton Gathering Centre, Sudbrooke	Battery	N/A	3.00
Hemswell Biogas, Hemswell Cliff Industrial Estate - Anaerobic Digestion	West of Hemswell Biogas Ltd, Hemswell Cliff Industrial Estate, Hemswell Cliff	Anaerobic Digestion	N/A	17.00
The Old Airfield Solar Farm	The Old Airfield, West Lindsey	Solar	N/A	49.80
Barff Lane - Farm Anaerobic Digestion Plant	Barff Lane, Glentham, Market Rasen	Anaerobic Digestion	N/A	6.8 (a year)
River Cottage, Scampton - Solar Panels	River Cottage, Tillbridge Lane, Scampton	Solar	N/A	0.19

East Lindsey

Name	Location	Type of Generation	Generation Start Date	Generation Capacity (MW)
Low Farm (Anesco)	Wainfleet, East Lindsey	Solar	N/A	50.00
Hatton Solar Farm	Sotby Woods, in turton Road, Hatton, East Lindsey	Solar	N/A	50.00
Campney Grange, Bucknall - Solar Panel	Campney Grange, Campney Lane, Bucknall, Woodhall Spa	Solar	N/A	0.17
Mallows Lane - Solar Farm & Battery Storage	W/O Mallows Lane & N/O Pymoor Lane, Sibsey, Boston	Solar	N/A	10.00
Mallows Lane - Solar Farm & Battery Storage	W/O Mallows Lane & N/O Pymoor Lane, Sibsey, Boston	Battery	N/A	5.30

North Kesteven

Name	Location	Type of Generation	Generation Start Date	Generation Capacity (MW)
Springwell Solar Farm	North Kesteven - Between Lincoln and Sleaford	Solar	2030	800.00
Heckington Fen Solar Park	Between Sleaford and Boston. North Kesteven	Solar	N/A	500.00
Barn Farm, Navenby - Solar Panels	Barn Farm Lowfields Navenby	Solar	N/A	3.00

Name	Location	Type of Generation	Generation Start Date	Generation Capacity (MW)
Boothby Graffoe - Solar photovoltaics panels	Lowfields Farm Castle Lane Boothby Graffoe Lincoln	Solar	N/A	0.22
Barn Farm Lowfields, Navenby - Biomass boiler	Barn Farm Lowfields Navenby	Biomass (dedicated)	N/A	1.60
Skinnand Manor Farm, Parsons Lane - Biomass Boiler	Skinnand Manor Farm Parsons Lane Navenby	Biomass (dedicated)	N/A	1.60
Poplar Farm, Lowfields - Biomass Boiler	Poplar Farm Lowfields Navenby Lincoln	Biomass (dedicated)	N/A	1.60
Castle Farm, Castle Lane - Biomass Boiler & Agricultural Building	Castle Farm, Castle Lane, Lowfields, Navenby, Lincoln	Biomass (dedicated)	N/A	1.60
Noble Foods, Hives Lane - Solar Panels	Noble Foods Limited, Hives Lane, North Scarle	Solar	N/A	0.37

South Kesteven

Name	Location	Type of Generation	Generation Start Date	Generation Capacity (MW)
Mallard Pass Solar Farm	East Coast Mainline near Essentine, South Kesteven	Solar	2026	350.00
Belvoir Estate - Solar farm	Land To The South West Of Easthorpe Lane Muston	Solar	N/A	50.00
Environcom - Thermal Treatment Plant	Environcom Limited, Great North Road, Grantham	EfW Incineration	N/A	N/A
Mid UK Recycling, Caythorpe Heath Lane - Solar Photovoltaic Panels	Mid Uk Recycling Limited, Caythorpe Heath Lane, Caythorpe, Grantham	Solar	N/A	0.97
Bypass Solar Farm	S/O The A1, Foston By-Pass, Foston, Grantham	Solar	N/A	50.00
Gonerby Moor, Great Gonerby - Solar Farm	Gonerby Moor, Great Gonerby	Solar	N/A	50.00
Morrison - Roof mounted solar panels	W Morrison Supermarkets Ltd Uffington Road Stamford	Solar	N/A	0.68
BGB Engineering Limited - Solar Panels Scheme	357 Dysart Road, Grantham	Solar	N/A	0.21
Openfield, Colsterworth - Solar PV System	Openfield Honey Pot Lane Colsterworth Grantham	Solar	N/A	0.38

Name	Location	Type of Generation	Generation Start Date	Generation Capacity (MW)
Cherryholt Road - Solar Panels	Cherryholt House Cherryholt Road	Solar	N/A	0.17
Gonerby Moor - Battery Storage	South Of Cliff Lane Gonerby Moor	Battery	N/A	N/A
Heathland House, High Dike - Biomass Boiler	Heathland House High Dike Ancaster	Biomass (dedicated)	N/A	0.25
New Earth Solutions West, High Dike - Solar Panels & Battery Srorage	New Earth Solutions (West) Ltd, Copper Hill Industrial Estate, High Dike, Wilsford	Solar	N/A	4.80
New Earth Solutions West, High Dike - Solar Panels & Battery Srorage	New Earth Solutions (West) Ltd, Copper Hill Industrial Estate, High Dike, Wilsford	Battery	N/A	Co-located with above

Boston Borough

Name	Location	Type of Generation	Generation Start Date	Generation Capacity (MW)
Vicarage Drove Solar Farm & Battery Stoarge	Boston, Bicker Drove	Solar	2023	50.00
Vicarage Drove Solar Farm & Battery Stoarge	Boston, Bicker Drove	Battery	2023	20.00

Name	Location	Type of Generation	Generation Start Date	Generation Capacity (MW)
Boston Landfill, Wyberton - Solar PV Array	Boston Landfill, Slippery Gowt Lane, Wyberton, Boston	Solar	N/A	9.70
Boston Alternative Energy Facility (BAEF)	Riverside Industrial Estate, Boston	EfW Incineration	N/A	80
Station Road, Swineshead - Solar PV System	Reflex Labels, North End Business Park, Station Road, Swineshead, Boston	Solar	N/A	0.25
Riverside Industrial Estate - Solar PV Panels	Howard Tenens, Riverside Industrial Estate, Marsh Lane, Boston	Solar	N/A	0.89
Marsh Lane - Solar PV Panels	Howard Tenens, 1 Tenens Way, Boston,	Solar	N/A	0.89
TB Containers Limited, Brenton Villa - Solar Panels	Brenton Villa, Broadgate, Boston	Solar	N/A	0.38

South Holland

Name	Location	Type of Generation	Generation Start Date	Generation Capacity (MW)
Sutton Bridge Solar Farm	Land to the South of Centenary Way Sutton Bridge Spalding	Solar	N/A	50.00
Caudwell Solar Farm	Hamlet of Holbeach St Matthews	Solar	2022	50.00

Name	Location	Type of Generation	Generation Start Date	Generation Capacity (MW)
Bowman Stores Marsh Road	Bowman Stores Ltd, Marsh Road, Spalding, Lincolnshire	Solar	N/A	1.00
Worldwide Fruit - Solar Panels	Worldwide Fruit Limited, Apple Way, Pinchbeck, Spalding	Solar	N/A	0.36
Spalding Energy Park - Battery Storage	Spalding Power Station West Marsh Road Spalding	Battery	2026	550.00
Cowbridge Road, Bicker Fen - Solar Array	W/O Cowbridge Road, Bicker Fen, Boston	Solar	N/A	50.00
Cowbridge Road, Bicker Fen - Battery Storage	W/O Cowbridge Road, Bicker Fen, Boston	Battery	N/A	Co-located with above
J O Sims, Pudding Lane - Solar Panels	J O Sims Ltd. Pudding Lane Pinchbeck	Solar	N/A	0.30

APPENDIX B

GLOSSARY

GLOSSARY

Air Pollution Control Residue (APCR): This is typically a mix of ash, carbon, and lime. It is a hazardous waste which is currently disposed of at a hazardous waste landfill or undergoes further processing such as washing or stabilisation to send to a non-hazardous landfill.

Demand Flexibility Service: This is a service run by the electricity suppliers and aggregators to manage the demand flow of electricity on the national grid. By reducing demand through rewarding participating customers to turn down their usage when we demand is high.

Distribution Network Operator (DNO): A DNO is a company licences to distribute electricity in the UK. These companies operate the system of cables and towers that bring electricity from the national transmission network to homes and businesses.

Distribution System Operators (DSOs): DSOs are the operating managers/owners of energy distribution networks. They are responsible for distributing and managing energy from the generation sources to the customers.

EHV (33kV and 66kV) Level: Extra high voltage networks are circuits or substations with a voltage of 33,000V (33kV) or above. There are several advantages of higher voltage networks, such as reduced power loss through transmission lines, greater network reach and improved efficiency and operational savings.

Energy Systems Catapult Initiatives: This provides technical, commercial and policy expertise to drive innovation across the whole energy system.

Incinerator Bottom Ash (IBA): This is a form of ash produced in incinerator facilities. It is discharged from the moving grate of municipal solid waste generators. Once IBA is processed by removing contaminants, it can be used as an aggregate.

Independent Distribution Network Operators (IDNOs): IDNOs develop, operate and maintain local electricity distribution networks in the UK. IDNOs connect to the local distribution network or to the transmission network to serve new housing and commercial developments. They are responsible for managing and operating their local networks, including all future maintenance and fault repairs. The main difference is that IDNOs operate nationwide, without regional restrictions, to manage local networks. They are also regulated by Ofgem.

Midlands Engine Partnership (MEP): This is a pan-regional partnership with the aim to provide the region with a single, unified voice to speak to government in order to drive pan-regional economic prosperity and boost productivity through concerted investment and long-term commitment. It is the largest regional economy in the UK outside London.

Network Innovation Allowance (NIA): This is an allowance provided to the network licencees that allows them to carry out projects to consumer vulnerability and/or deliver longer–term financial and environmental benefits for consumers.

Refuse Derived Fuel: This fuel is produced from combustible components that the industry calls Municipal Solid Waste – MSW for short. This waste, usually Ftaken from industrial or commercial sites, is shred, dried, baled and then finally burned to produce electricity. Refuse Derived Fuel is a renewable energy source that ensures waste simply isn't thrown into a landfill and instead, put to good use.

Sustainable Urban Extensions (SUEs): Sustainable urban extensions present an opportunity to deliver sustainable development whereby residential development is served by the necessary services, facilities, infrastructure, and employment opportunities to sustain a community.

Transport for the North: A partnership that brings the North's local transport authorities and business leaders together with Network Rail, Highways England, and HS2 Ltd, while working closely with Central Government. Their aim is to represent the North on transport infrastructure investment required to drive transformational growth and rebalance the UK economy.

UK Government Powering Up Britain: This paper sets out how the UK government will enhance the country's energy security, seize the economic opportunities of the transition, and deliver on the net zero commitments by powering the UK through affordable, home-grown, clean energy by ensuring Britain has among the cheapest wholesale electricity prices in Europe by 2035 and moving towards energy independence through a potential doubling of Britain's electricity generation capacity by the late 2030s.

APPENDIX C

MAPPING OF SUBSTATION DEMAND HEADROOM RED/AMBER/GREEN

Greater Lincolnshire Area

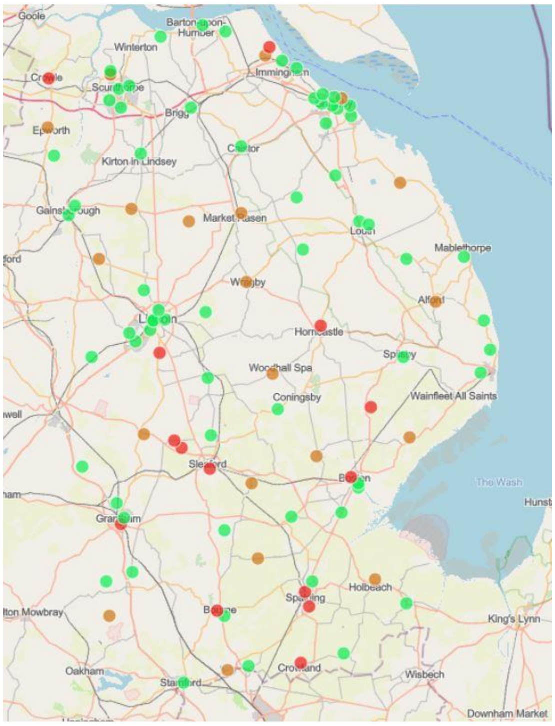


Figure 1: Baseline

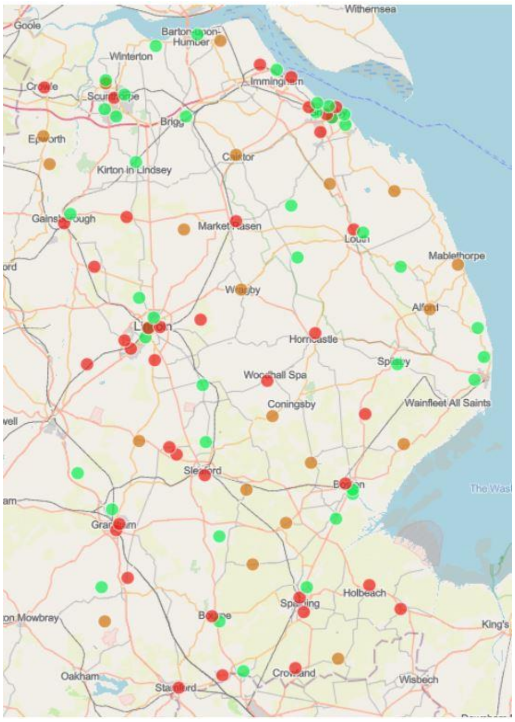


Figure 2: Priority 1

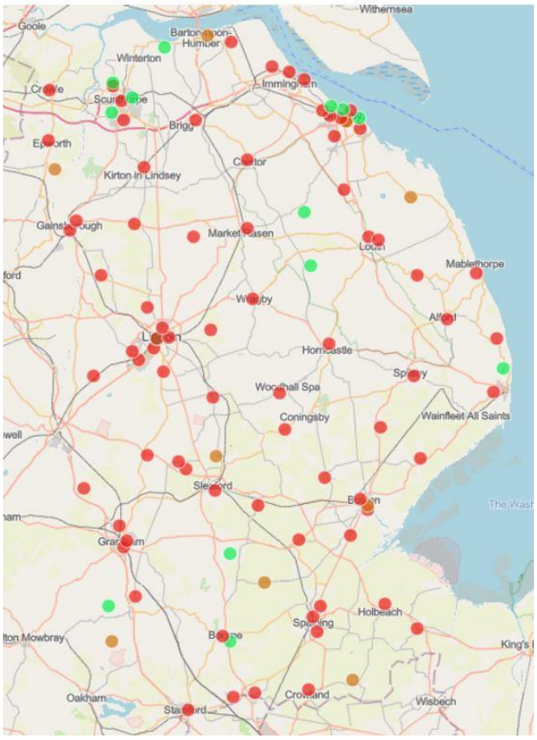


Figure 3: Priority 2

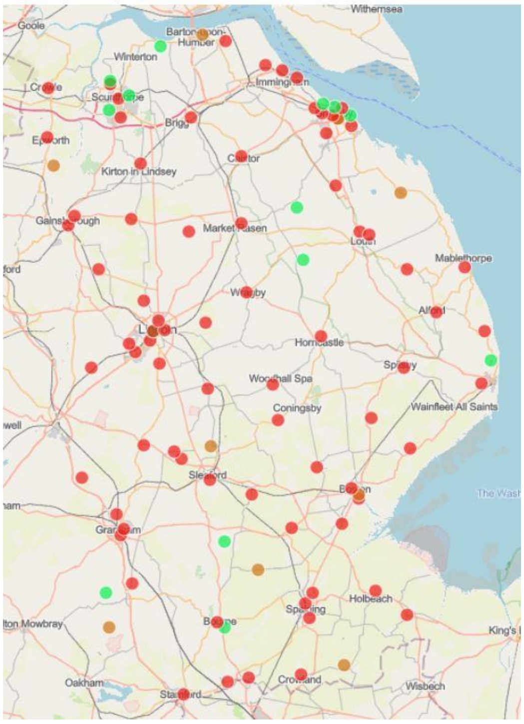


Figure 4: Priority 3

Boston District

Figure 1: Baseline

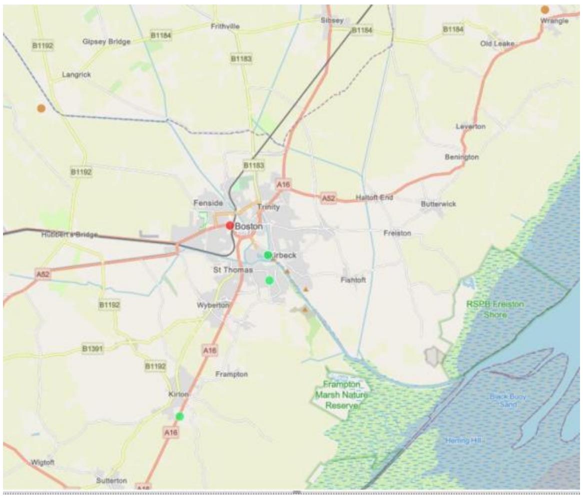


Figure 2 – Priority 1

Figure 3: Priority 2

Figure 4: Priority 3

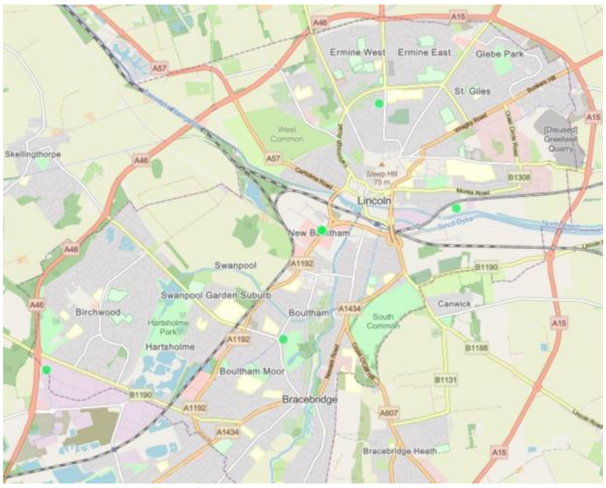


Figure 1: Baseline

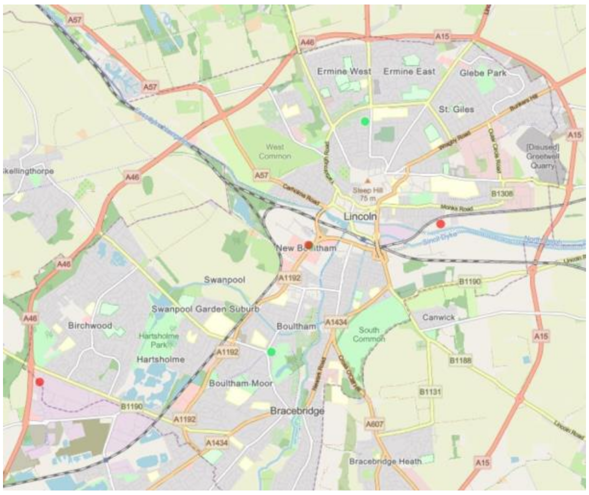


Figure 2 – Priority 1

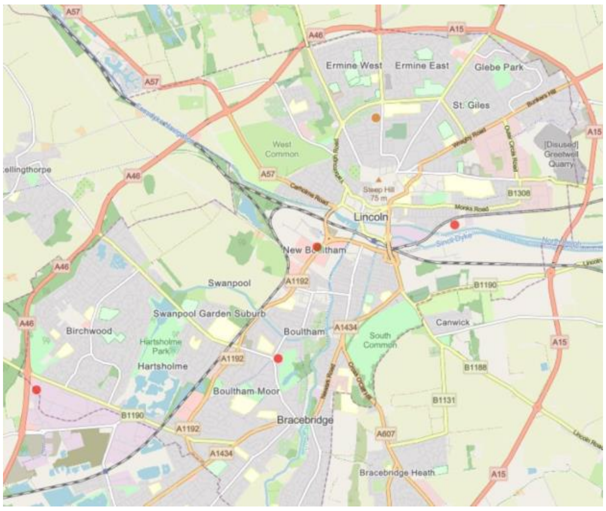


Figure 3: Priority 2

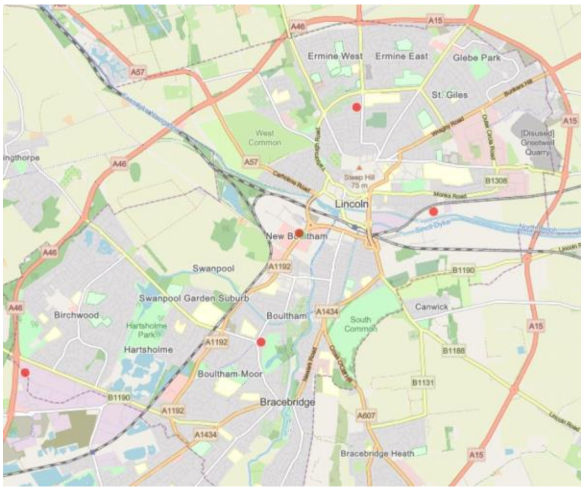


Figure 4: Priority 3

East Lindsey

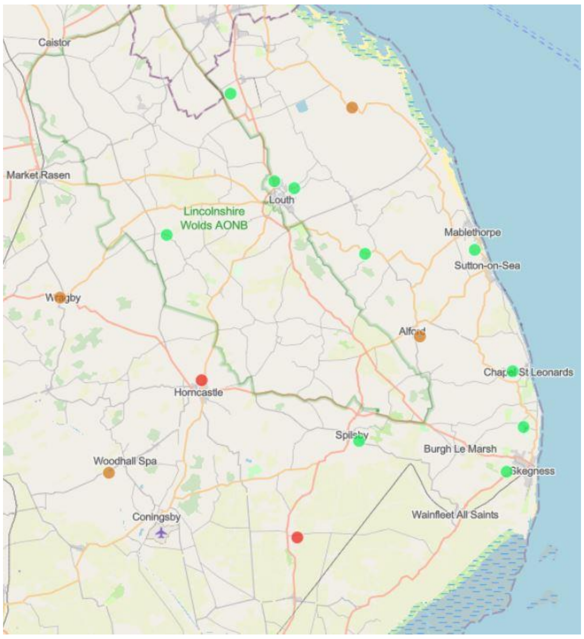


Figure 1: Baseline

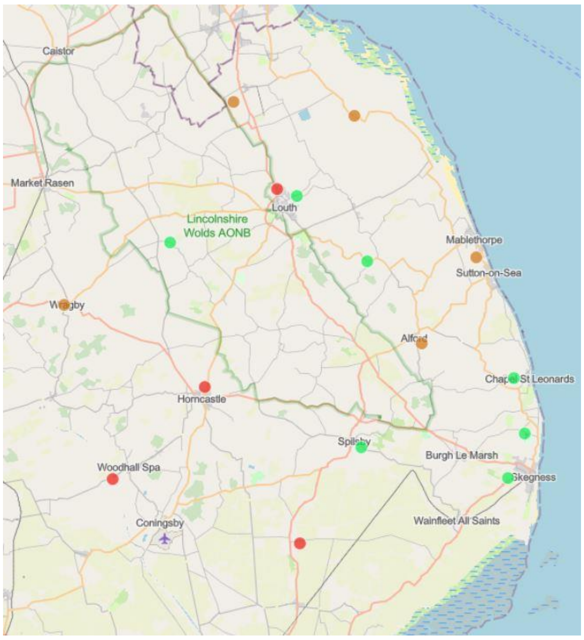


Figure 2 – Priority 1

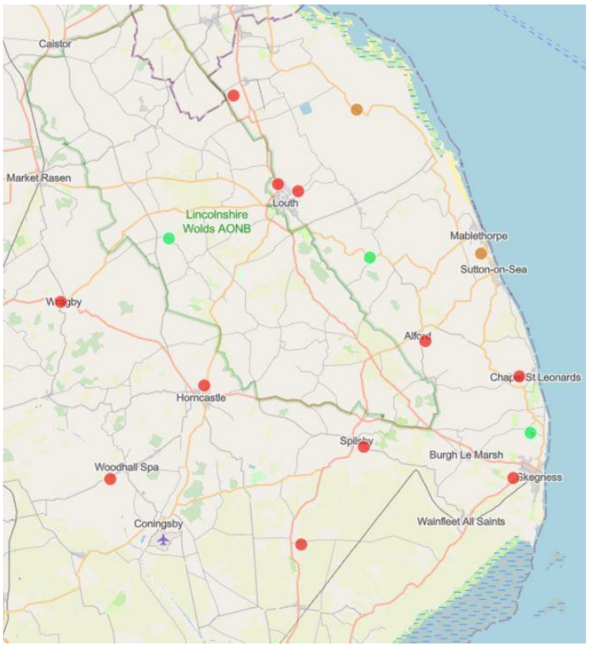


Figure 3: Priority 2

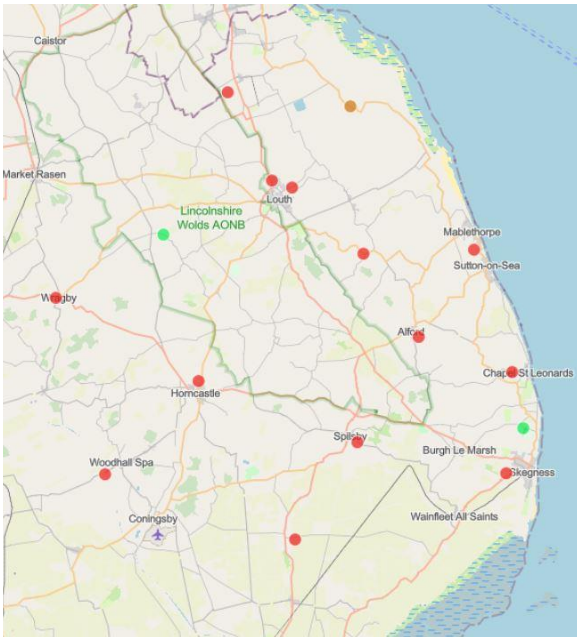


Figure 4: Priority 3

North East Lincolnshire

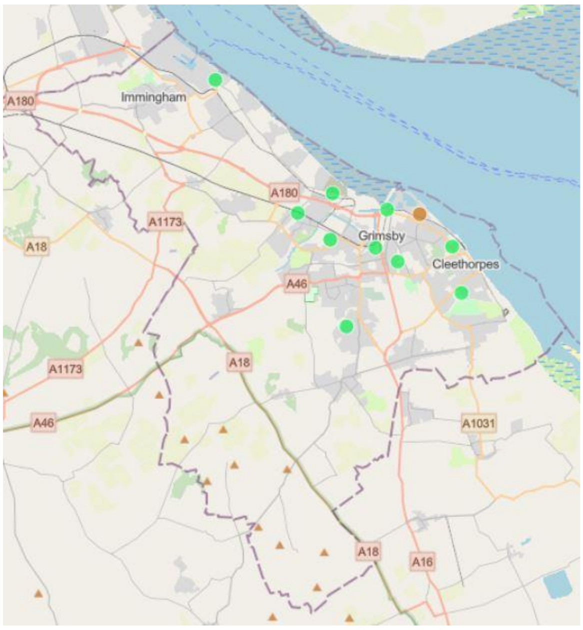


Figure 1: Baseline

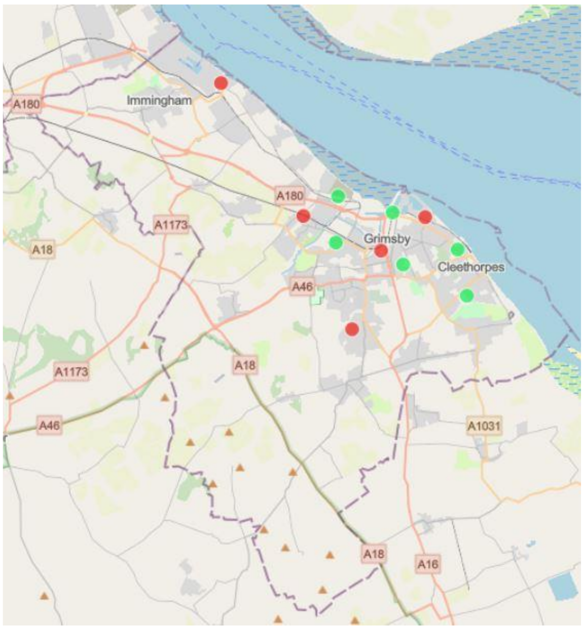


Figure 2 – Priority 1

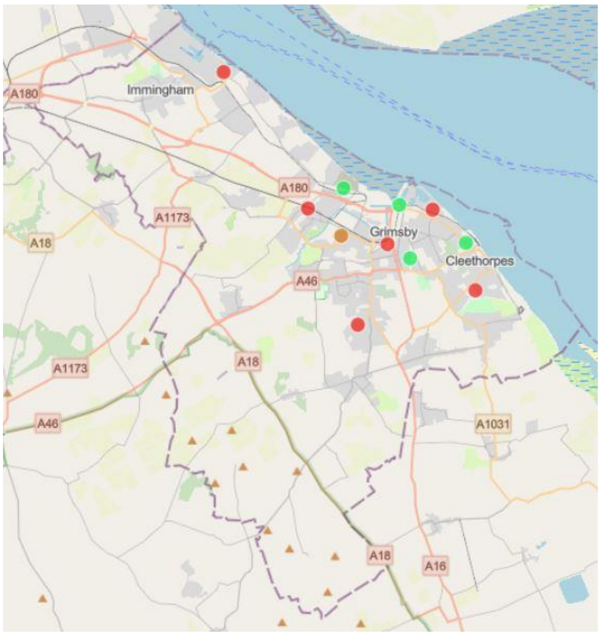


Figure 3: Priority 2

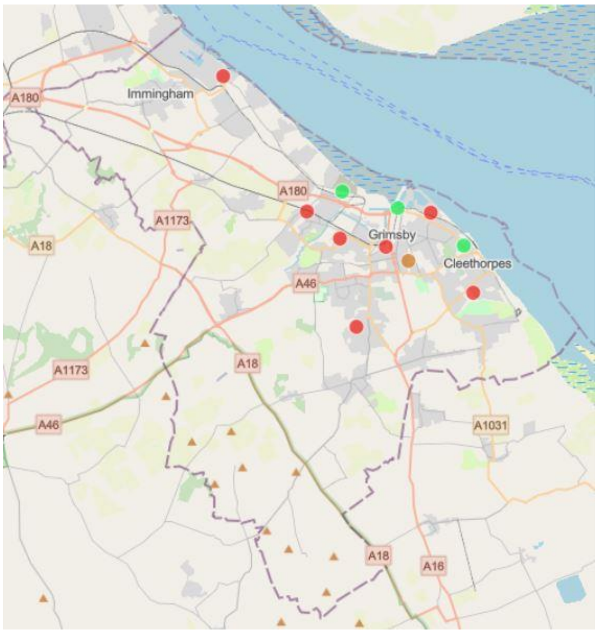


Figure 4: Priority 3

North Kesteven

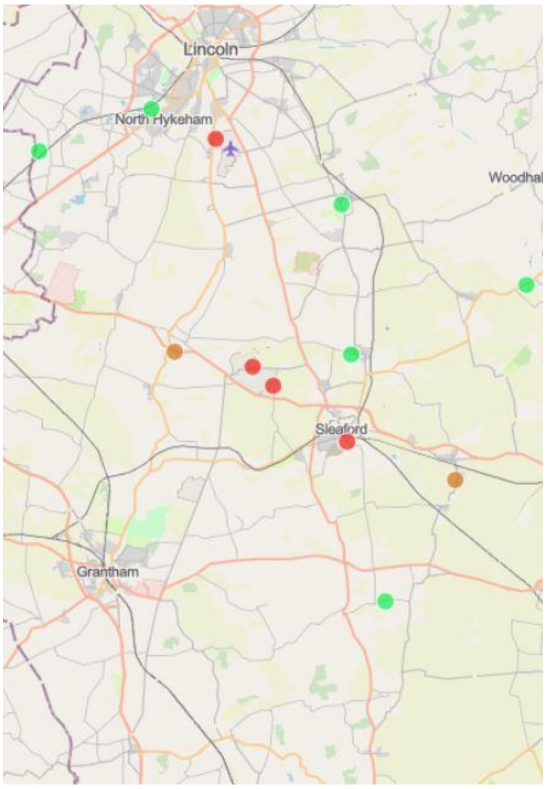


Figure 1: Baseline

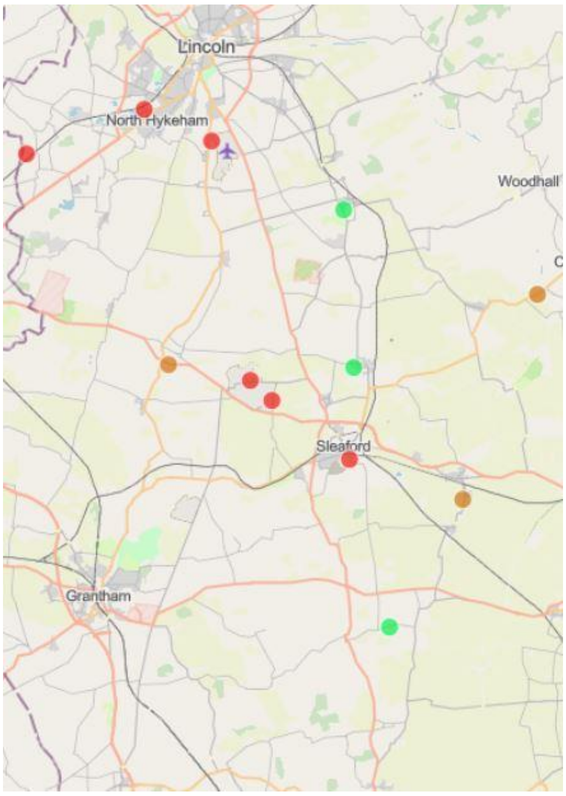


Figure 2 – Priority 1

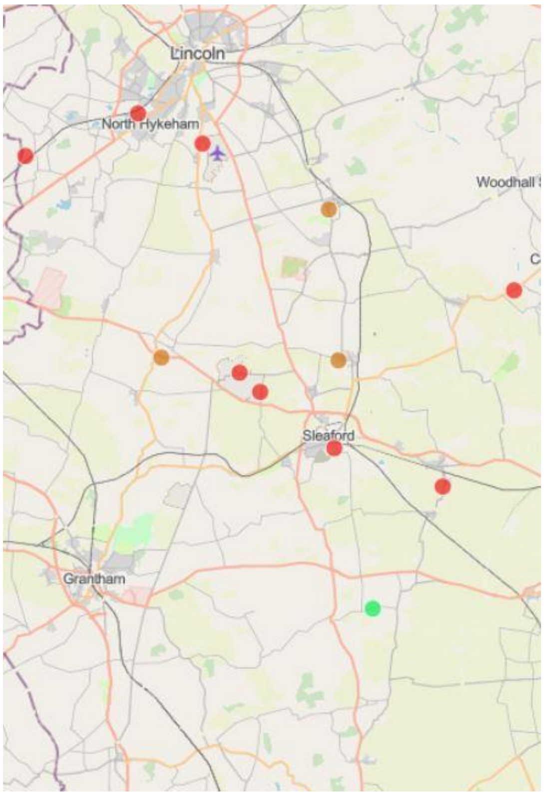


Figure 3: Priority 2

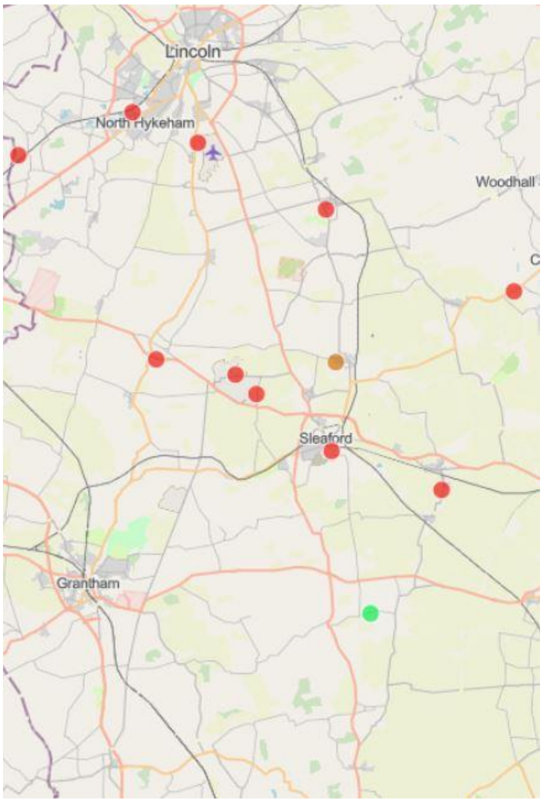


Figure 4: Priority 3

North Lincolnshire

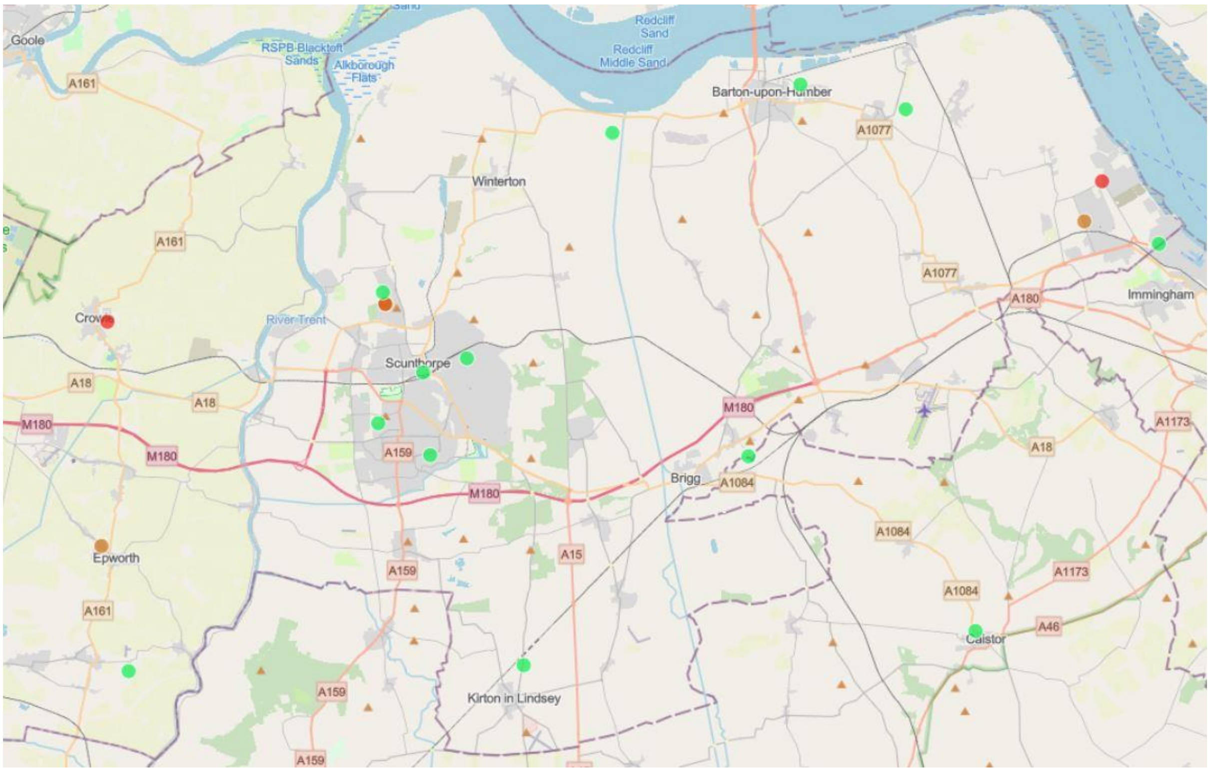


Figure 1 – Baseline

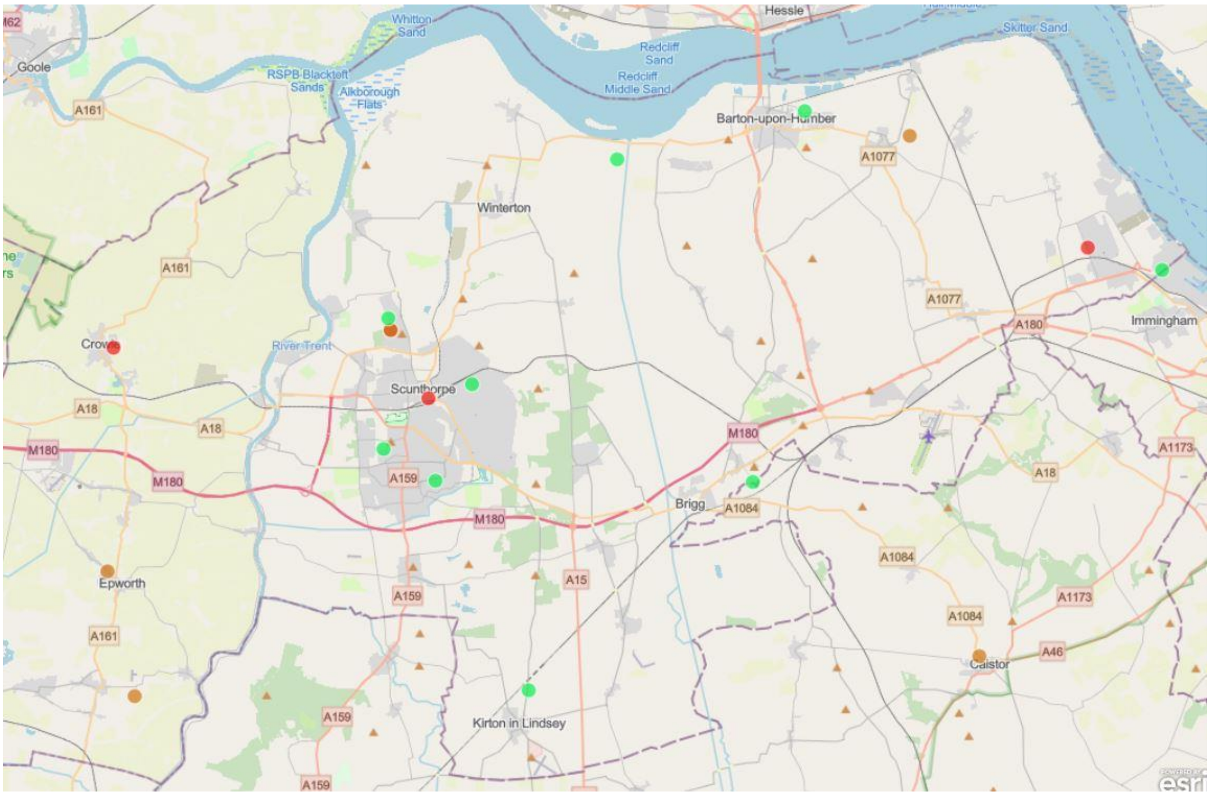


Figure 2 – Priority 1

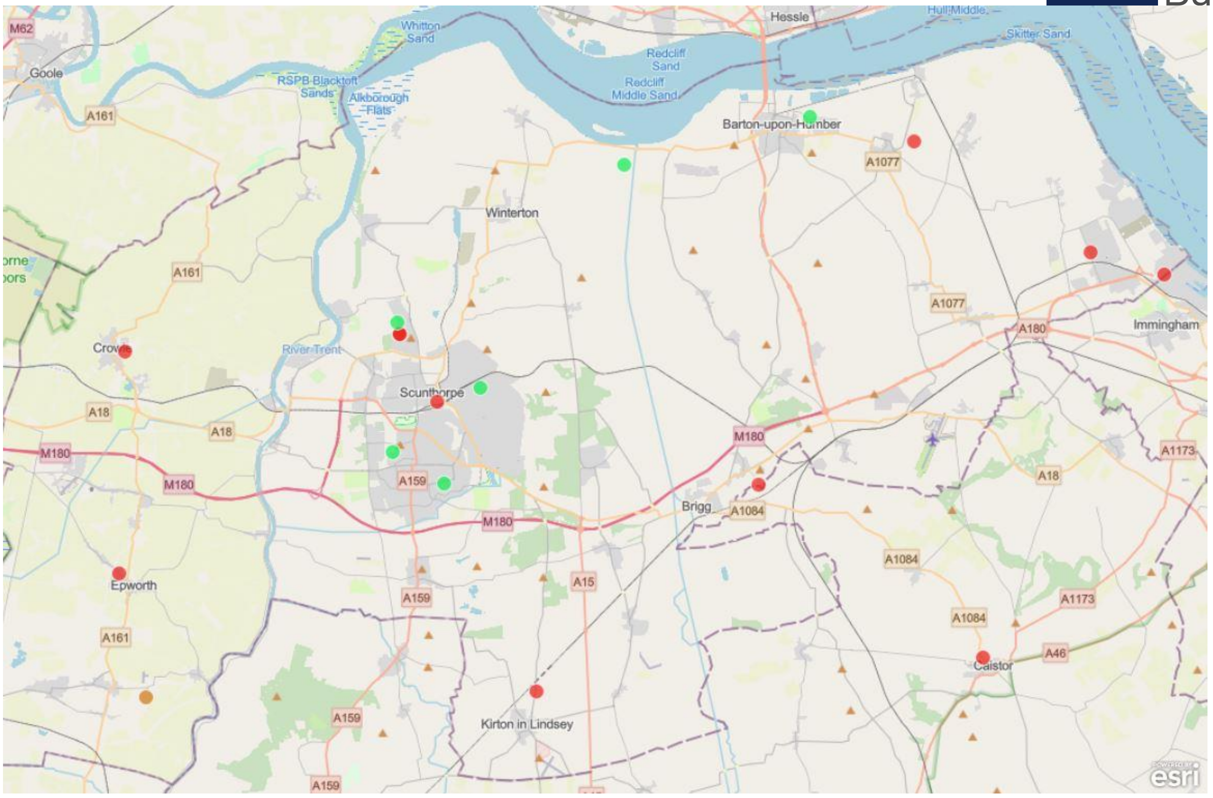


Figure 3 – Priority 2

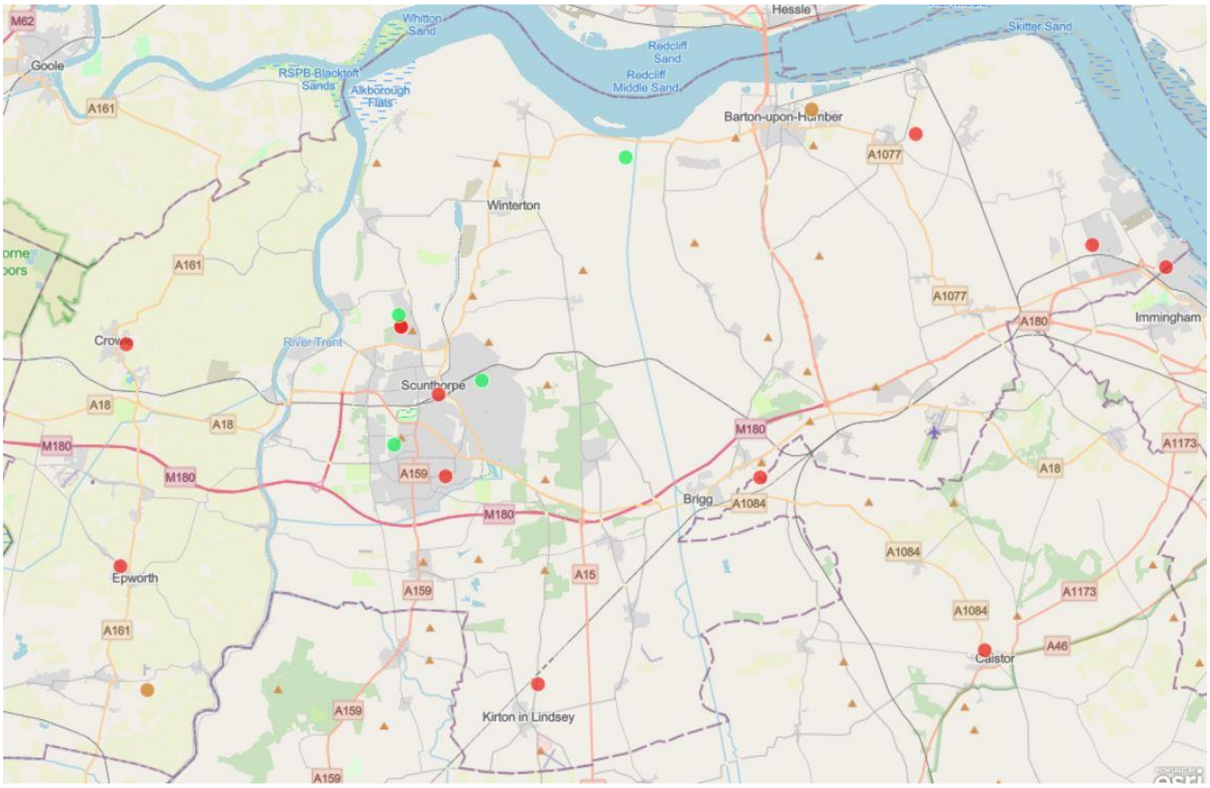


Figure 4 – Priority 3

South Holland

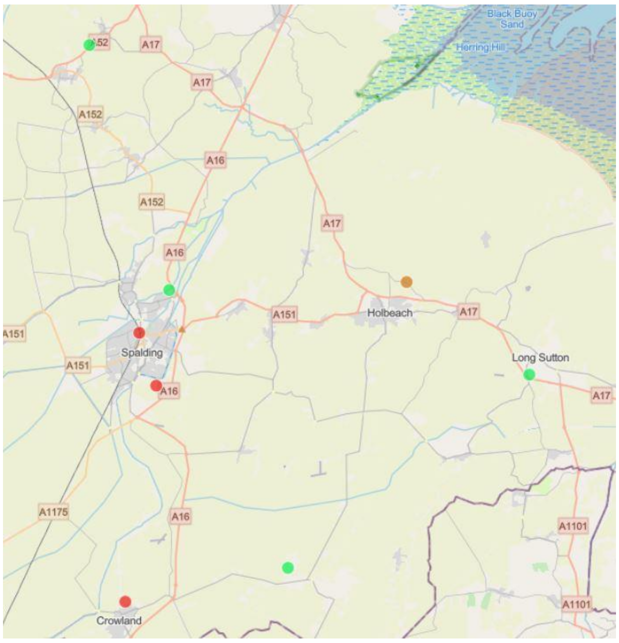


Figure 1: Baseline

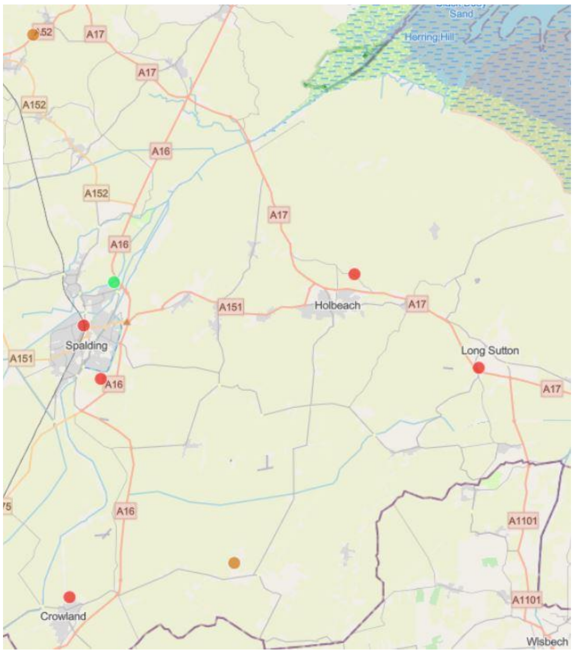


Figure 2 – Priority 1

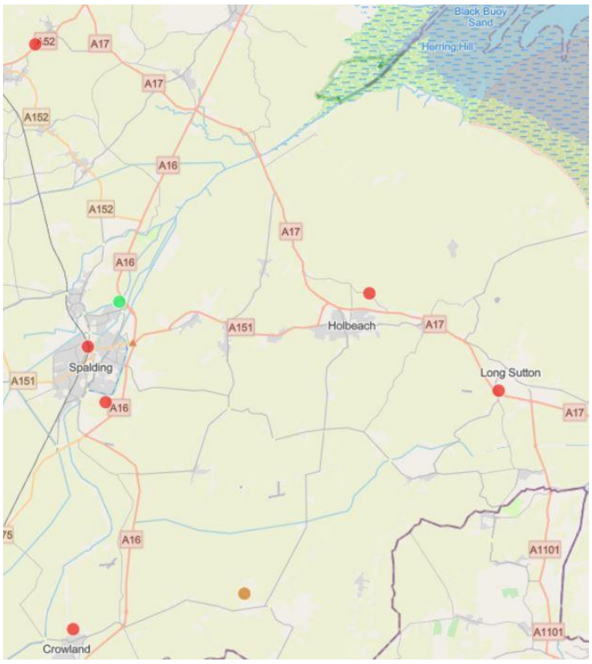


Figure 3: Priority 2

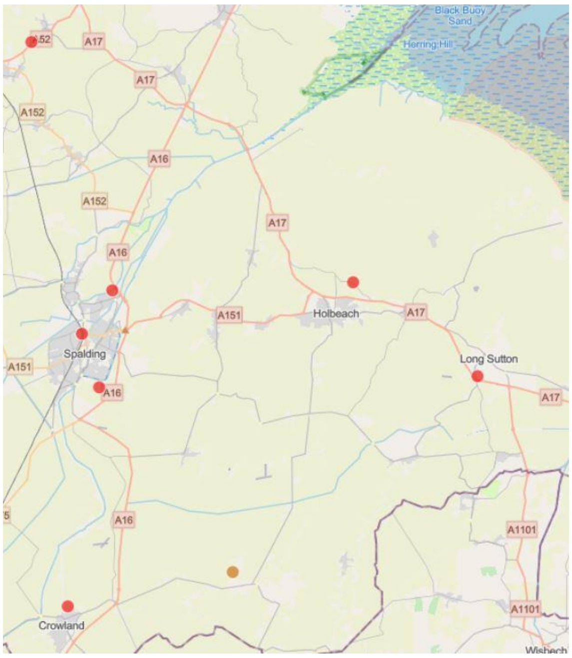


Figure 4: Priority 3

South Kesteven

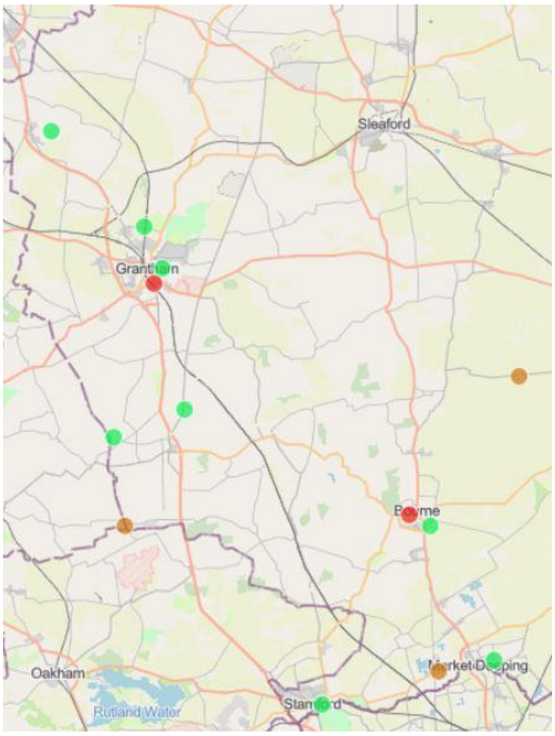


Figure 1: Baseline

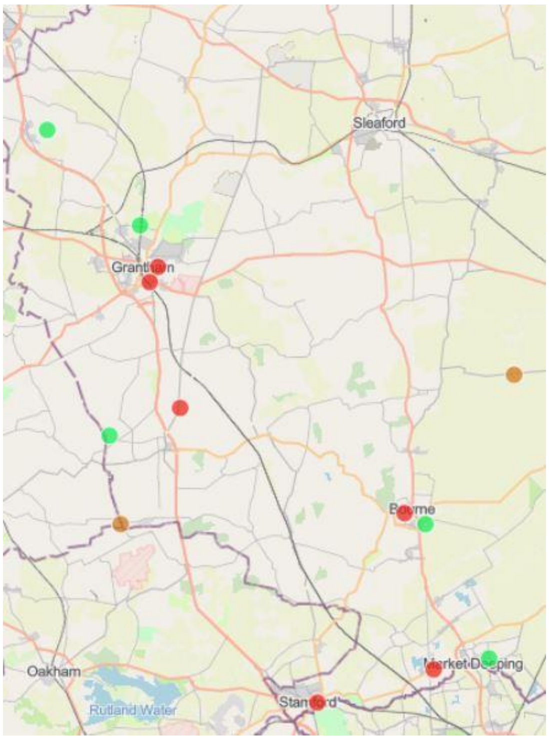


Figure 2 – Priority 1

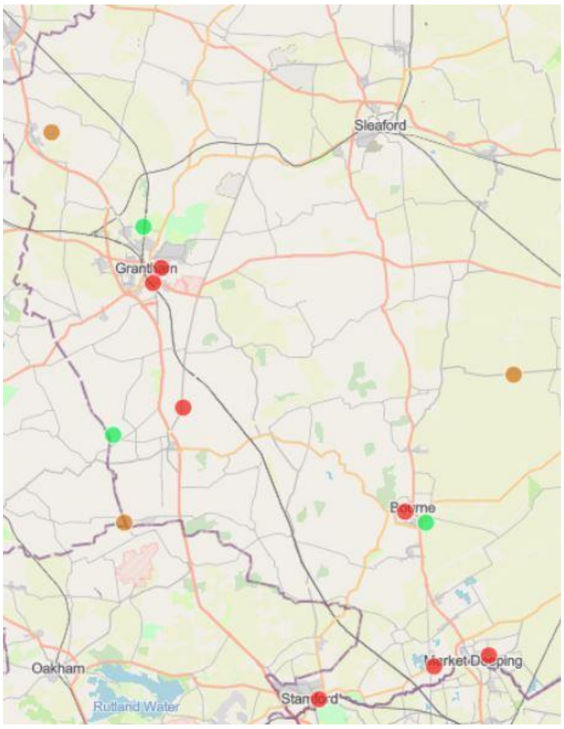


Figure 3: Priority 2

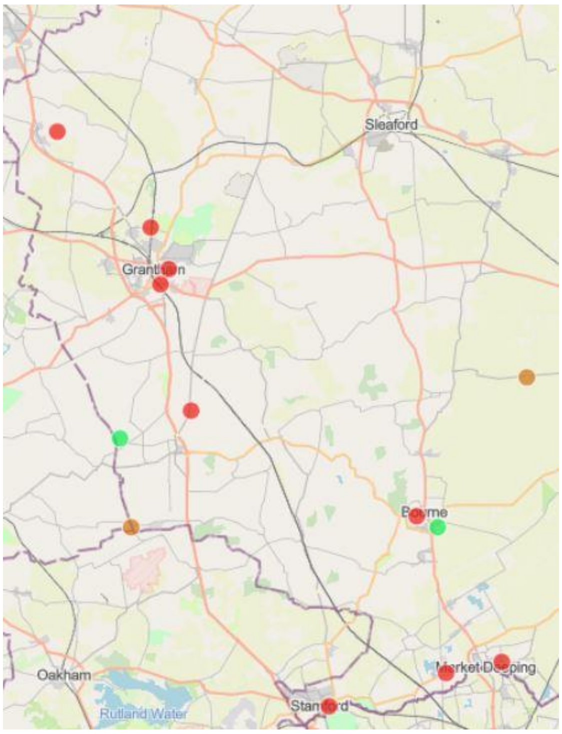


Figure 4: Priority 3

West Lindsey

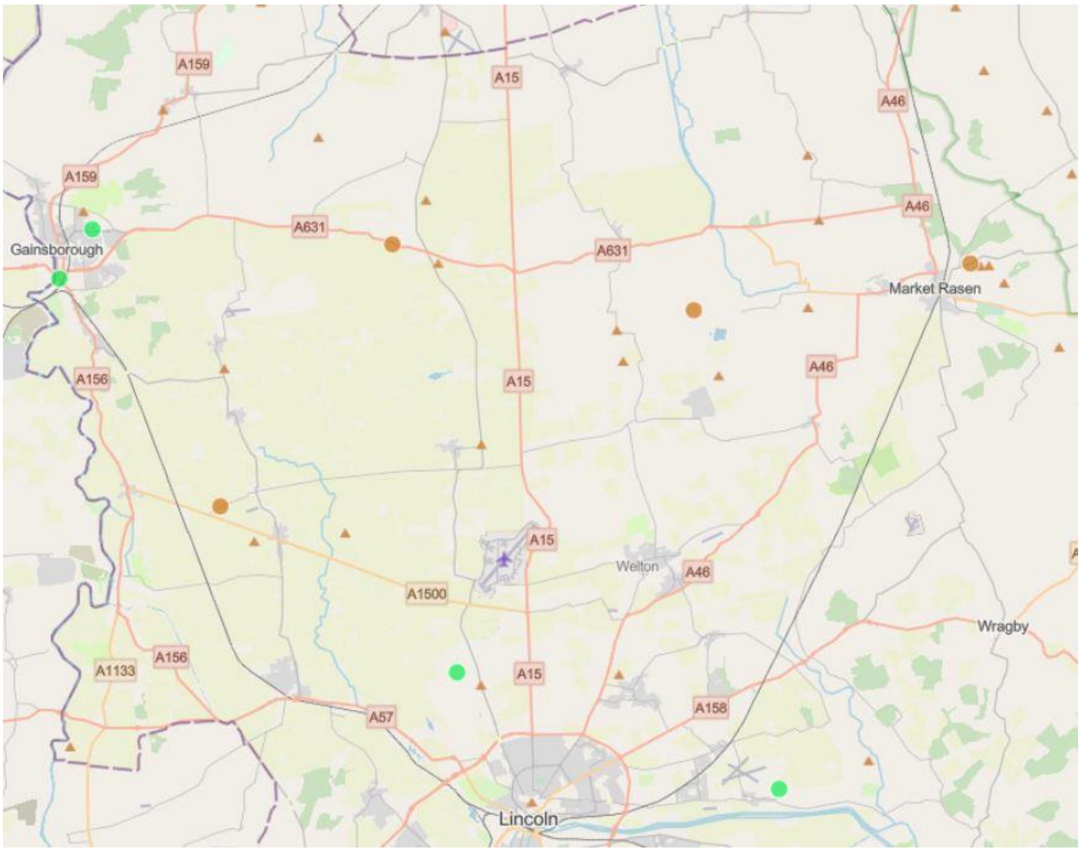


Figure 1 – Baseline

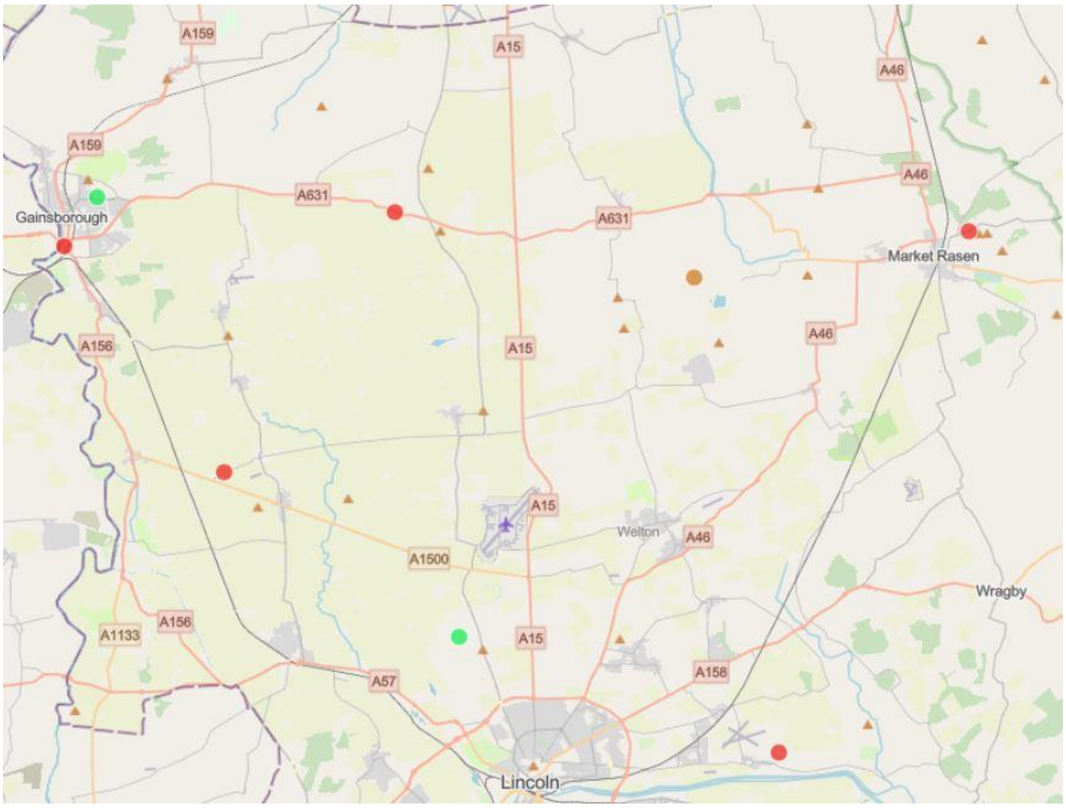


Figure 2 – Priority 1

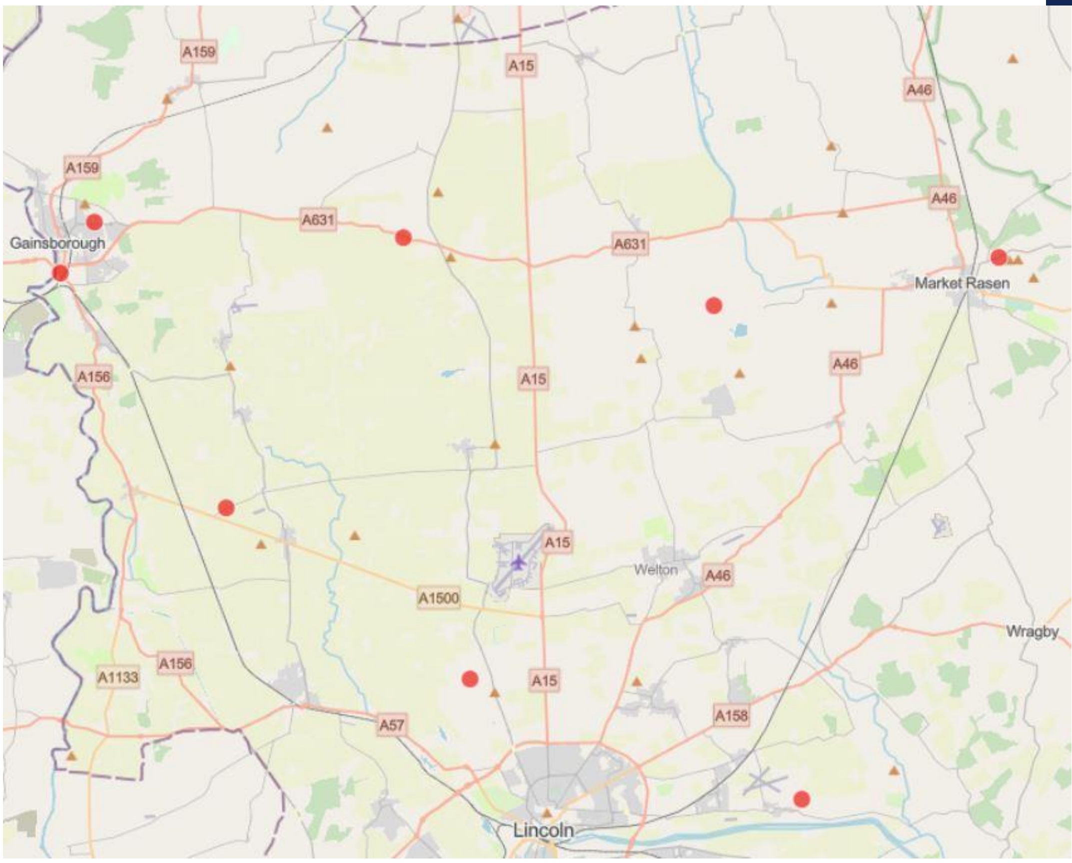


Figure 3 – Priority 2

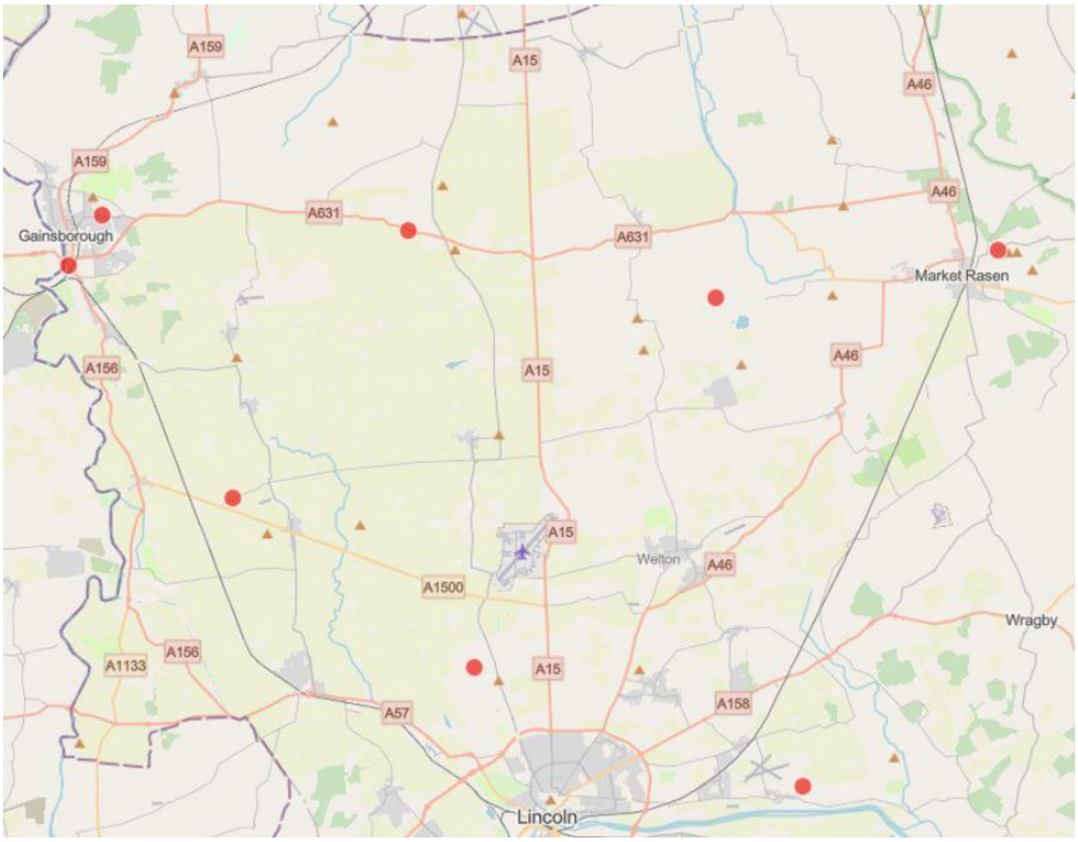


Figure 4 – Priority 3

This page is intentionally left blank