Lancashire
Independent Economic Review

Final Report:

State of the Environment: Renewable Technology Input

A Technical Report on Renewable Energy Deployment Opportunities Across Lancashire to 2030

Jacobs

State of Environment Report - Renewable Technology Input

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Executive Summary

In 2021 the installed capacity of renewable energy assets across Lancashire is 544MW, which isalmost three and a half times higher than it was in 2011. This growth has largely been driven by external factors such as the introduction of legislation from the UK Government and the development of technology changing the energy market. Despite this growth, renewable energy generation still accounts for only 13% of power and 8% of heat demand for the region. As the county council and 14 local authorities look to 2030 and beyond to decarbonise Lancashire's energy system a more radical approach will be required to achieve such targets.

In the coming decade, the energy landscape will continue to change. The banning of gas boilers in new homes from 2025 and the sale of internal combustion engine cars from 2030 will shift more energy demand onto the electricity network. Furthermore, future technologies will have a more direct impact on how people live their lives. Therefore, there is likely to be more inertia to change than experienced by the transition of power to low carbon sources. Based on current policies and expected trends in the market, Table 1.1 displays the current trajectory for renewable energy capacity in Lancashire in 2030.

Table 1.1: A Table Displaying the Current Likely Capacity of Renewable Energy in Lancashire in 2030(Note this Excludes Biomass Options)

Technology	Current Capacity (MW)	2030 Forecasted Capacity (MW)
Wind	211	300
Solar	67	170
Solar (Micro generation)	93	127
Hydro	2	2
Tidal	0	Trajectory unclear[1]
Energy from Waste	0	80 MW
Anaerobic Digestion	7	7
Heat Pumps	15	247

While it is expected that the sector will grow, there exists a range of barriers which may constrain the trajectory for future deployments. Additionally, these issues will likely be exacerbated if the council wishes to reach a net zero target by 2030. This report outlines in further detail the impact these barriers may have on the region. Though some of these barriers are either fixed or beyond the council's sphere of influence, there are a number of areas that the county council and the 14 local authorities can impact to allow for more capacity to be installed across Lancashire. The following outline the areas where the council should consider focussing its efforts to overcome these barriers:

- Prioritising Renewable Energy – Councils need to ensure adequate prioritisation of renewable energy requirements across all its functions. This can be facilitated through the creation of dedicated teams or

[1] The growth trajectory for tidal is very unclear, while the 120MW Wyre Tidal Barrage Project presents an excellent opportunity for the region. The time frame for the development of large-scale tidal energy in the UK is unclear. Therefore, this report has not been able to determine if such a project will be commissioned and generating electricity by 2030.

working groups responsible for this area. Furthermore, due to competing priorities it may be challenging for staff to appreciate why climate change or renewable energy falls into their areas of responsibility. Councils should consider organisation wide internal training to help staff understand the overarching implications of climate change and renewable energy within their responsibilities.

- Local Area Energy Planning – The complexity of our energy system means that a fragmented approach to decarbonising energy will likely increase the cost of the transition and result in additional constraints to growth. To avoid such outcomes, Councils need a local area energy plan to enable effective whole system level change of the region's energy planning.

- Demonstrating Leadership – Councils need to lead by example if they are to encourage businesses and residents to install low carbon assets. Councils need to ensure their own energy consumption and supply chain is decarbonising. Where possible this should be achieved by installing low carbon assets on all council owned buildings and land.

- Capital – Currently the UK is going through a number of transitions all competing for capital. The net zero transition will require large amounts of capital and although there is funding available, councils will need to leverage connections with local stakeholders to ensure that adequate capital flows into the region. There are a number of routes for funding and until more funding is available, increasing deployment will be a challenge.

- Local Energy Markets – The wholesale electricity market currently does not allow generators of <1MW to participate which excludes smaller generators unless they make use of an aggregator. This means that the business case for most assets favours larger capacity projects. Small scale assets have an important role to play in future energy scenarios. If councils want to encourage further growth of local small-scale generation and storage assets, they should look to pilot local energy markets (LEMs). These markets would create the platform for small generation and storge assets to sell services at more competitive prices, improving the business case for such projects. Furthermore, the distribution network operator would have the ability to balance supply and demand more effectively on the network, reducing the requirement for future expensive upgrades or reinforcements. LEMs are still in a development phase and so they need to be piloted if they are to be an effective tool in improving deployment.

- Collaboration with Social Housing Providers – The single largest challenge to the UK's net zero target is the decarbonisation of heat. One option for enabling this transition is by councils collaborating with social housing providers to enable a large-scale change out to low-carbon heat sources. The share of properties that are owned by registered social housing providers or directly by local authorities, is roughly 17% of the total stock in Lancashire. Such a share of the housing stock would create a large demand for low carbon assets, driving down the cost of installations. Unlike the private sector, providers and councils have access to these buildings to facilitate the transition. Such large development projects could provide a whole host of additional benefits to the region and possibly create the market conditions to kick start the heat transition in the region.

- Planning Guidance and Signposting – The planning process for new developments is often complex and costly. While the process ensures quality and HSE standards are maintained to protect residents, businesses and the environment, this step can significantly lengthen project timelines. If councils would like to enable more renewable energy deployment, the region should consider providing open guidance or signposting to support developments. The focus of such materiel would be to support all projects to reach a planning application stage, not just the largest developers who have resources to do so.

- Piloting Innovative Projects – Alongside the deployment of existing technology, the region should look to maximise the opportunity to pilot new technology. Project's such at the Wyre Tidal Barrage not only increases capacity, but would support local business, creating jobs and provide a host of additional opportunities. If Lancashire can continue to demonstrate itself as a centre for energy innovation, the region can attract further investment, with the subsequent economic and social benefits being wide reaching.

- Local Skills Generation – Growth in the renewable energy sector will require a regional skills base to commission, operate and maintain assets. To date, the sector growth has been in largely power assets. Such technology can be managed, operated and serviced by nationally based organisations. However, as assets such as heat pumps start to enter residents' homes and business, a local contractor base will be required to instal and service such technology. For example, if an elderly resident loses heat in the middle of winter, there are multiple risks if a local contractor isn't available to fix the heat pump. This example demonstrates an extreme case. However, if issues with new technology can't be resolved easily and quickly, then uptake will be slow. However, considering there is a lag between upskilling and having a competent local skills base, the council should collaborate with businesses and local education institutions to start the process early if a 2030 target is to be met.

- Community Energy Projects – Community energy projects are an invaluable route to raising funding for renewable energy assets, as well as ensuring engagement with the community and providing alternative routes to increasing deployment. The local community are best placed to understand their own needs and by focussing on a collective approach to leadership and control, such projects have a real opportunity to tackle complex challenges while placing residents at the heart of the solution. The council should look to foster more growth from such projects.

- Community Energy Champions – Much of the coming transition of the energy system will require individuals to change their behaviour around energy use. Councils will need to further engage residents to actively participate in shaping the energy system of the future. One route to overcoming this challenge is to work with local representatives of the different communities of Lancashire to develop local energy action plans. These action plans would ensure adequate engagement of priorities from the diverse communities of the region, as well as providing a forum to help communities understand the transition.

- Maximising Renewable Technology in Large-Scale Future Developments – Councils need to take the opportunity to future proof new large-scale developments, such as Lancashire's Enterprise Zones. Such developments should consider low carbon power, heat and transport assets now to avoid costly retrofits in the future, while also showcasing the renewable energy potential of the region.

Whilst installation of renewable energy projects through to 2020 against projected levels has been higher than originally estimated, there is still further opportunity for growth in uptake through to 2030. Barriers have been identified and where appropriate solutions proposed, with recommendations for monitoring of the levels of deployment.

1. Introduction

In 2011 Lancashire County Council (LCC) commissioned research into the potential for renewable energy deployment across the county. The Lancashire Sustainable Energy Study (SQW, Maslen Environmental & CO2Sense, 2011) report outlined how based on the availability of land and the capability of technology, the county could deploy up to 10.6 GW of installed capacity. This would primarily be achieved through wind and heat pumps, with a small share from roof mounted solar.

In the decade since the publication of that report the energy market has experienced major changes, accelerating the deployment of renewable technology. Power output and system efficiencies have improved significantly, while manufacturing and operating costs continue to fall. As a result, the total energy supply from renewable sources in the UK doubled in just ten years, with almost 40% of electricity supply being met by renewable sources by 2020 (BEIS, National Statistics, 2020).

As Lancashire looks to 2030, the landscape for renewable asset deployment is different to that forecasted in 2011. The findings within this report map the progress of deployment since 2011, analysing the successes and failures of past projects. By understanding the lessons learned of the past decade, the outcomes from this study provide Local Authorities in Lancashire a new vision for renewable development towards 2030. Mapping the realistic deployment of both power and heat generation assets across the region and providing the framework to ensure that local authorities and their populations fully benefit from the renewable potential of the region.

1.1 Aims and Scope

To achieve the aims of providing an evidence-based update of progress since the 2011 study and to present an outline strategy for deployment to 2030, the research presented in this report achieves the following:

- Outlines what renewable sources have been exploited since 2011;
- Provides an understanding of what barriers or challenges restricted deployment during the last decade and why deployment has not been greater;
- Forecasts what capacity can reasonably be deployed in the next decade;
- Defines what barriers needs to be overcome to enable increased growth in renewable generation to support the decarbonisation of energy in Lancashire;
- Presents a strategic vision to deliver deployment, which;
- Describes the role local authorities can play in bringing about deployment of renewable energy generation;
- Highlights other key stakeholders who should be involved;
- Updates the policy context in which this will be achieved;
- Outlines how progress can be monitored to ensure deployment meets expectation by 2030.

The geographic area for this study is the boundaries of jurisdiction for Lancashire County Council, constituting 12 district councils known as the Lancashire-12, together with the unitary authorities of Blackpool and Blackburn with Darwen Councils which make up the Lancashire-14.

2. A Context for Future Growth: Current and Past Trends

The focus of this report is to provide development pathways for renewable energy technology towards 2030. To be able to accurately forecast future deployment it is necessary to understand the overarching approach and trajectory of the preceding decade. The following chapter outlines the historic and current policy and technology landscape, creating a context for what deployment may look like in the future.

2.1 Policy Context and Strategic Drivers

Over the past years the UK's energy policy has developed quite substantially as the government has committed to reaching net zero targets in the coming decades through increasing the deployment of renewable energy.

The chapter will explore the key legislations and policy's in the UK and within different local authorities in Lancashire which will mitigate climate change.

2.1.1 UK Strategies and Legislation

The UK has introduced much legislation and policies to drive the deployment of low-carbon energy. The prime driver for the update of these with respect to energy deployment in the UK is the Climate Change Act 2008. This Act has been the root in the shift towards decarbonising the UK as it sets a greenhouse gas (GHG) emission reduction target of at least 80% by 2050 compared to 1990 levels by 2050. An amendment was added to the Climate Change Act in 2019, increasing the target to 100% and effectively introducing a net-zero target. With the UK receiving the presidency for the 26th UN Climate Change Conference of the Parties (COP 26), in 2020 the UK government released its Ten Point Plan (listed below) outlining the areas of focus that will allow for a net zero target to be reached, laying the foundations for a green industrial revolution through investments in clean technologies.

- Point 1 – Advancing offshore wind
- Point 2 – Driving the growth of low carbon hydrogen
- Point 3 – Delivering new and advanced nuclear power
- Point 4 – Accelerating the shift to zero emissions vehicles
- Point 5 – Green public transport, cycling and walking
- Point 6 – Jet zero and green ships
- Point 7 – Greener buildings
- Point 8 – Investing in carbon capture usage and storage (CCUS)
- Point 9 – Protecting our natural environment
- Point 10 – Green finance and innovation

2.1.1.1 UK Government Future Energy Commitments

At the end of 2020, following up the Ten Point Plan, the Government released an Energy White paper which made the following commitments that are likely to shape energy across Lancashire:

- we will target 40GW of offshore wind by 2030, including 1GW floating wind, alongside the expansion of other low-cost renewable technologies

- we will support the deployment of at least one power CCUS project, to be operational by 2030, and put in place the commercial frameworks required to help stimulate the market to deliver a future pipeline of power CCUS projects
- by 2022, we will establish the role which bioenergy with carbon capture and storage (BECCS) can play in reducing carbon emissions across the economy and, as part of a wider biomass strategy, set out how the technology could be deployed
- we will support the delivery of the sector's target of 60% UK content in offshore wind projects by 2030, through more stringent requirements for the Contracts for Difference supply chain plan process
- a £160 million scheme and launched a competitive process in early December 2020 to support the development of offshore wind manufacturing infrastructure

2.1.1.2 Other Key Strategies

- **Industrial Decarbonisation Strategy** – The UK Government produced this strategy to drive the green industrial revolution, setting out how industry can reach a net zero target. This strategy looks to grow UK businesses and encourage them to expand into new and growing markets in low carbon alternatives.
- **The Sixth Carbon Budget** – The committee on climate change released a report detailing pathways for achieving a cut in emissions to 78% of 1990 levels by 2035. The report, which is intended to provide advice to UK ministers, contains a detailed breakdown of policy recommendations to drive change across the UK economy.
- **The Clean Growth Strategy** – this strategy, which was published in 2017, outlined proposals for the decarbonisation of different sectors of the UK economy and detailed the benefits that could be created by a transition to a low carbon economy.

2.1.1.3 Funding

The UK Government, specifically the Department for Business Energy and Industrial Strategy (BEIS), has made available large amounts of funding to support the development of renewable energy technology and to increase the installed capacity of assets throughout the UK. The following are flagship examples of such funds:

- the £505 million BEIS Energy Innovation Programme (EIP) (2015 to 2021)
- the £1 billion Net Zero Innovation Portfolio (2021 to 2025)

The Net Zero Innovation Portfolio was announced alongside the UK Prime Minister's ten-point plan as a leading funding programme to decarbonise energy following the closure of the EIP. The BEIS Innovation Programme aimed to drive the commercialisation of innovative clean energy technologies and processes into the 2020s and 2030s. The total programme had a budget of £505 million with 6 different areas to invest in between 2015-2021:

- £70 million in smart systems
- £90 million in the built environment (energy efficiency & heating)
- £100 million in industrial decarbonisation and carbon capture, use, and storage (CCUS)
- £180 million in nuclear innovation
- £15 million in renewables innovation
- £50 million in support for energy entrepreneurs and green financing

Other funds that may benefit Lancashire include:

- £160 million will be made available to upgrade ports and infrastructure across communities in Northern England,

- Joint funding of a £40million venture capital fund that is available to support green start-up companies across the UK to help support the development of future clean, low-carbon technologies. This fund could continue to grow as it is to be matched through private sector funding.

2.1.1.4 Local Policy, Commitments, and Legislations

As of 2021, Lancashire County Council and all 14 local authorities that constitute the Lancashire-14 have declared climate emergencies. In 2019 Lancashire County Council declared a climate emergency putting on record their commitment to support the uptake of emergency action to reduce the effects of global warming. Through this declaration LCC commits itself to the following:

- Declares a 'Climate Emergency' and commits to making the operations and activities of Lancashire County Council Carbon Neutral by 2030.

- Recognises that answering the challenge of climate change is not work that can be done individually and therefore commits to working in partnership with councils, businesses, organisations and residents across the county to meet this challenge.

- Establishes a scrutiny task group to review the council's operations and identify the changes that need making so that appropriate measures can be included in next year's budget, and recommendations for action short of budget proposals can be taken as soon as possible.

- Calls upon the UK Government to provide councils across the country with the powers, resources and funding to enable the work that must be done.

- Ensure that senior staff are fully aware of this commitment and Cabinet reports to Full Council every six months with the actions undertaken and planned to address this emergency

Lancashire Enterprise Partnership

The Lancashire Enterprise Partnership (LEP) is a collaboration of businesses, universities and local councils that look to drive economic growth and introduce new jobs through focusing on sustainable expansion. The partnership has a £1billion growth plan which they have used to bring forward 50 growth initiatives. The LEP produced an Lancashire Energy and Low Carbon Sector plan where the LEP has recognised new ways to develop and promote the energy sector throughout the county and ensuring the county takes a leading role in contributing to the UK's Net Zero target through utilising their existing low carbon ecosystem and capabilities in designing and manufacturing low carbon technologies.

Local Authority Planning Policy

Many of the local authorities in Lancashire have similar planning policies with many renewable energy projects only being granted permission when the development poses no damaging impact to the environment or local area. The Central Lancashire Core Strategy Policy 28 covers Renewable and Low Carbon Energy schemes setting out the requirements for proposals under this bracket and setting out the criteria needed to be met in order to successfully receive planning permission for a project.

Most renewable technology installations such as wind turbines, hydroelectric generators and anaerobic digesters will require planning permission. However renewable technology that can be installed on existing buildings will depend on the size of the installation, the building type and its location. The planning practice guidance states there are no set rules for how suitable areas for renewable energy should be identified. Most local councils have their own policies for determining land suitability for renewable assets, allowing for a county or district to assess the likely landscape and visual impacts of each proposal. Local planning authorities are required to use the contents of the National Planning Policy Framework issued by the UK Government, as the foundation for their local plans. This framework outlines an uptake of supply and use of renewable and low carbon energy through the introduction of policies to maximise renewable and low carbon energy development.

The 2 unitary and 12 district councils within Lancashire have released their local plans summarising their key local renewable energy plans. These plans have been summarised in the table below:

Table 2.1 : Lancashire Local Authorities Key Renewable Energy Plans

District	Key Policies
Blackpool	One of Blackpool's core policies is around sustainable design, renewable and low carbon energy where the focus is: - Mitigating the impact of climate change and minimising carbon emissions through ensuring developments are energy efficient. - Develop renewable, low carbon or decentralised energy schemes. This does not include wind projects that could cause an impact to the local environment or landscape or could cause any impacts to the environment or the local amenity. - Wind turbine projects will only gain planning permission when the proposal has local communities backing and the area is deemed suitable for wind energy deployment. Increase the amount of renewable energy generation to meet the 15% target, through the development of a renewable energy programme to deploy technologies such as roof top and ground based solar PV, wind, biomass, heat pumps and tidal.
Burnley	Proposals for renewable and low carbon energy developments that adhere to relevant planning policies will be supported by Burnley Council where they satisfy the requirements of other relevant planning policies. Burnley Council have put a focus around supporting renewable energy proposals that are community-led or directly benefit the community by being involved. Currently Burnley are working with local authorities in Lancashire to help households to gain access to funding to support energy-related improvements to their homes. This includes the Governments 'Green Homes Grant' which allowed Burnley residents up to £10,000 per property to get a renewable energy generator.
Blackburn with Darwen	Blackburn with Darwen Council has a Climate Impacts Framework that developers would have to follow to understand expectations surrounding development contributing to mitigating climate change and helping meet carbon dioxide reduction targets. The council uses an energy hierarchy approach to consider new development: - energy saving and energy efficiency measures for projects will be a priority - then the focus will be on renewably energy production - then finally on low impact energy measures In relation to wind energy the local council has already identified areas which are suitable for wind energy development.
Chorley	Chorley's Core Strategy Objectives relating to renewable energy are as follows: - SO21: To reduce energy use and carbon dioxide emissions in new development. - SO22: To encourage the generation and use of energy from renewable and low carbon sources. - SO23: To manage flood risk and the impacts of flooding, especially at Croston. - SO24: To reduce water usage, protect and enhance Central Lancashire's water resources and minimise the pollution of water, air and soil.

Fylde	Fylde has been identified has having potential to produce around 61 MW of renewable power by 2030. Fylde Council encourages and supports the installation of renewable and low carbon generation with policies available to provide a criteria-based framework to determine applications. The policy applies to most types of renewable and low carbon energy generation including, but not restricted to solar, biomass generation, hydropower and micro-generation. Fylde Council is currently interested in community-led new development schemes, especially around decentralised energy networks and district heating systems for small scale decentralised energy schemes in new developments.
Hyndburn	Hyndburn Council's policy around sustainable development and climate change states that renewable energy developments or low carbon technology is to provide at least 10% of predicted energy demand where feasible. Its policy around renewable energy stipulates that for the council to support new renewable developments, the following criteria should be met: a) measures are taken to avoid and where appropriate mitigate any negative impacts of the effects on local amenities b) the visual impact can be accommodated within the landscape and the development c) measures are taken to avoid and where appropriate mitigate any negative effect of the development on nature conservation d) the site is accessible, and the development of supporting infrastructure does not itself result in unacceptable adverse impacts e) developers have engaged with the community and local authority at an early stage prior to the formal submission of any proposals f) large scale renewable energy developments make provision for direct community benefits over the period of the development
Lancaster	Lancaster Council is searching for opportunities to explore any economic potential in the district within the clean energy sector. The council is in support of future expansion opportunities around the Port of Heysham and is also looking to diversify the use of the port, for example using the port as a base for serving the offshore wind farms in Morecambe Bay There are potentially opportunities for future planning proposals that might allow for renewable generation to be incorporated at the port as on-site generation, as well as facilitating operations for offshore wind turbines. Early last year, the UK Government announced that onshore wind and solar projects will be allowed to compete for government-backed contracts alongside other renewable technologies from 2021 and Lancaster Council is considering supporting the growth of renewable technology in their district.
Pendle	Pendle Council has no generic restrictions coveringrenewable and low carbon technologies in the area as they want to encourage the uptake ofthe technologies and explore all the potential constraints. There are some conservation areas such as the Forest of Bowland where less intrusive technologies such as ground or air source heat pumps would be more favourable compared to other options available. The Council appreciates the potential that small-scale technologies have in helping isolated 'off grid' properties especially to provide a greener and cheaper source of energy whilst also reducing fuel poverty. There are some areas where planning policy will not allow renewable energy developments due to the importance around conserving the area, however, for proposals that take into account the scale of the setting the council will consider the proposal. Future local and neighbourhood plans will consider the need to define suitable areas for wind energy development.
Preston	The council conducted a study which showed that Preston has a potential renewable capacity of about 661 MW. As the city is quite urban the council recognises that there is high potential for renewable energy generation from micro generation as well as from wind generation. The

	core strategic objectives Preston council follow around renewable energy and climate mitigation are as follows: - To reduce energy use and carbon dioxide emissions in new developments - To encourage the generation and use of energy from renewable and low carbon sources - To manage flood risk and the impacts of flooding - To reduce water usage, protect and enhance Preston's water resources and minimise pollution of water, air and soil
Ribble Valley	All developments will need to show Ribble Valley Council how it will help reduce the district's carbon footprint. The council is open to new renewable energy generation projects inclusive of onshore wind turbines and the need to reduce the carbon footprint will be assessed together with the proposal's potential impacts on the land. Large developments will need to fulfil the following requirements in order to gain planning permission: - Must deliver a proportion of renewable or low carbon energy on site based on targets elaborated within the relevant development management policy - Must incorporate recycled or reclaimed materials or minimise the use of energy by using energy efficiency solutions and technologies
Rossendale	Rossendale's developments keep in line with the policy that new developments are required to be energy efficient, water efficient and have low carbon design and layout whilst also keeping up with regional and national standards.
South Ribble	South Ribble's core strategy objectives are as follows: - To reduce energy use and carbon dioxide emissions in new developments. - To encourage the use and generation of energy from renewable and low carbon sources. - To manage flood risk and the impacts of flooding especially adjoining the River Ribble. - To reduce water usage, protect and enhance water resources and minimise pollution of water, air and soil.
West Lancashire	West Lancashire Council aims to deliver climate change mitigation and energy security by: - Requiring all major developments to explore the potential for district heating or a decentralised energy network - Using funds to support carbon saving projects - Support community-led proposals focusing around renewable, low carbon or decentralised energy schemes
Wyre	Wyre Council is open to the development of renewable energy schemes and has policies in place to support these schemes as long as they do not impact existing or planned developments. The Council is keen to support the development of a tidal energy scheme across the River Wyre at Fleetwood if it adheres to the local development policies. The whole of Wyre is designated as an area suitable for wind energy development, proposals just have to meet the set policy requirements as well as ensuring other key aspects such as agreeing a scheme for the removal of the wind farm at the end of its design life and restoring the site. Solar energy proposals are also similar to wind and tidal, in that Wyre is open to them on

	agricultural land as long as it meets development policies and there are no other plans for the agricultural land.

There are a number of keyindustrial partners in the area, who's own energy strategies will have an important part to play in shaping the energy landscape in the region, a selection are highlighted in the table below:

Table 2.2 : Key Industrial Strategies in Lancashire

Company	Key Strategies
BAE	Energy is oneof BAE's core targets in their business where they are required to set reduction targets as part of their environmental sustainability objectives. These objectives focus on improving the efficiency of their manufacturing processes and ensuring where possible renewable energy or low emission sources are used to provide energy to the site.BAE has committed itself to setting science-based targets to align with the Paris agreement. It has set a target to achieve net zero greenhouse gas emissions across its operations by 2030 and then across its value chain by 2050. The company will do this through investing in low/ zero carbon products and renewable energy use. The BAE site within the Lancashire County has installed around 16,000 solar panels which are currently active and cover around 25% of the site's current electricity needs.
EDF	EDF has committed to reaching carbon neutrality by 2050 through ensuring their work and projects are either able to reach net zero or close to zero carbon emissions, reduce their indirect carbon emissions and offset any residual emissions through the implementation of negative emission projects. EDF invests in the decarbonisation of electricity through renewable and nuclear assets. EDF introduced solar and wind projects across the UK to help power local communities whilst also preserving local habitats.
Veolia	Veolia is part of the ETL Net Zero Carbon Delivery Framework which is designed to help the public sector achieve carbon targets. This programme has allowed Veolia to deliver a wide range of carbon savings to the public sector allowing areas to meet their targets. Veolia support clients to reduce emissions through the circular economy and using renewable energy to produce heat. Veolia's Energy Recovery Facilities utilise energy recovery, helping to meet recovery and carbon emission targets.
United Utilities	United Utilities has made several commitments in order to help achieve net zero by 2030, one being to use 100% renewable electricity by 2021. Currently, up to 30 per cent of the electricity used by United Utilities is generated on its own sites through renewable schemes such as solar farms, wind turbines and the production of biomethane from sewage treatment. The company is alsoat the forefront of new innovative renewable technologies such as floating solar arrays which have been installed at Lancaster. By 2030 the company has also pledged to improve its land holdings by planting more than 1 million new trees and restoring 1,000 hectares of peat bog.
Electricity North West	Electricity North West plans to invest a significant amount into driving down their own carbon emissions to reach a net zero carbon target. As part of this they are also developing a new programme of initiatives to support carbon reduction activities in local communities. It is also enabling its customers to connect low carbon technologies to its network to facilitate moving towards a low carbon economy. Electricity Northwest is also aware of the importance around evolving technology and operational management to secure a constant supply of renewable energy, reducing the impact of intermittency from current technologies.
Cadent	Cadent is looking to introduce green fuels into their network by working with industries to introduce new sources of gas into the existing gas networks or by exploring ways to

	decarbonise further current options, allowing Cadent to focus on improving the reliability of their energy infrastructure in the UK. Cadent is looking to meet emission reduction and energy efficiency targets though the supply of renewable gas. It has currently connected 35 biomethane sites to its network, which have the potential to heat up to 218,690 homes annually. It is also keen to utilise new technologies to help make its systems more flexible to allow them to meet domestic peak heat demand and reduce pressure on the electricity grid. It is looking into new hybrid appliances powered by renewable electricity to transfe r to gas at peak times, or at other times when there is not enough renewable electricity. Other developments include smart technologies that can switch from electricity to gas depending on changes in the price of electricity, and smart appliances that can choose the cheapest or lowest-carbon fuel.
National Grid	National Grid has its Future Energy Scenarios (FES) which demonstrate various ways to decarbonise its energy system so that it can achieve its 2050 target. Its key focus is to transition towards a zero-carbon electricity system. National Grid is focusing on flexibility as it believes it is crucial to achieve a net-zero economy. Flexibility is a focus for National Grid in order to overcome the peaks and troughs created by a renewables-dominated generation mix. It also believes that the future energy market will revolve around low demand and high renewable generation resulting in very volatile wholesale and balancing markets, with negative prices and high bid to offer spreads. It also realises the importance of stepping up renewable storage capability in order to support Government plans for 40GW of offshore wind by 2030. National Grid is looking to make improvements in short -term renewable generation forecasting, in particular solar, through innovation projects incorporating artificial intelligence , machine learning, and big data techniques.
NHS	The NHS is committed to ensuring its medicines and supply chain are able to meet its commitment to reach net zero em issions by the end 2030. NHS is looking to increase its renewable energy usage throughout its buildings by better utilising roofs and adjacent ground space for on-site renewable energy and heat generation across the estate. The NHS has also committed to purchasing 100% renewable energy from April 2021.

2.2 Technology

2.2.1 Development since 2011

Since 2011 there has been a strong decline in the use of coal for energy; this reduction has been supported through the increase of renewable energy sources, specifically wind and solar. UK Government schemes drove the increase of renewable technology uptake across the UK. Wind and solar supply significantly contributed to this increase due to significant technical advances, increased installed capacity and generation capacity increasing each year over the past 10 years. However, since the first-generation technologies were established the main improvements to the technologies have predominantly been around efficiency improvements, but they have also levelled out. There are advances being made to improve efficiencies for certain technologies, however they are still not cost effective and will take some time before they are rolled out at scale. Application of these technologies within Lancashire is presented in Section 2.4.

2.2.2 Solar – Building and Ground Mounted

Solar has made substantial advances over the past decade as solar technology experienced large drops in cost, which then drove demand across the whole supply chain. This uptake was largely unexpected as, at the beginning of the decade, there was no expectation that solar would have such an uptake due to grid scale solar not yet being available. Solar uptake increased suddenly especially with the uptake of ground mounted solar which, although not as popular as rooftop solar, had quite a significantly higher uptake over the decade than originally forecasted.

The decade of investment has resulted in consumers paying 90% less for solar energy than they would have in 2010 and the installed capacity of off -grid solar PV increasing more than tenfold from approximately 0.25 GW in 2008 to almost 3 GW in 2018. This uptake was mainly driven by government schemes such as Feed in Tariffs (FiTs). This scheme came to an end in 2019, which caused the uptake of solar projects to stagnate causing the number of installations to drop by 43% in 2020.

Due to its modular design solar PV has been adopted across a range of off-grid and small-scale applications. The key improvement in solar panel technology since the early 2010s is a large improvement in sunlight conversion efficiency from circa 17.8% in 2012, quickly progressing to 44.5% by 2017 (Energy Sage, 2021). However, these higher efficiencies are due to the use of multi-junction technologies[2] which presently have relatively high incremental costs of around £50k per square metre. This technology is not yet viable for commercial use, however, with government support and economies of scale this could see a greater uptake near the end of the next decade.

2.2.3 Wind (On-shore and Off-shore)

Within the UK wind uptake has increased significantly over the past 10 years due to substantial reductions in the cost of constructing and operating wind power facilities. Turbines have increased in size, obtained cheaper finance and achieved more efficiency in construction and operations that have helped drive down the cost. Wind power's key focus is around improving performance and reliability of the technology whilst reducing the cost of wind energy. Total wind generating capacity in the UK increased by 19 GW from 5.4 GW in 2010 to 24 GW in 2019. This is due to a 10GW increase in onshore capacity and an 8.5GW increase in offshore capacity (UK Government, n.d.). This increase in capacity has resulted in wind generators becoming the UK's second largest source of electricity.

This capacity increase has been largely possible due to government funding and initiatives. Onshore wind saw a large increase at the start of the last decade due to the Contracts for Difference (CfD) scheme, which brought down the levelised cost of the technology resulting in its uptake. However, as policy and funding will be a key aspect affecting the future growth of wind technology, without new government initiatives growth in this sector is expected to become static. Onshore wind is expected to grow in the next decade due to its inclusion back into the CfD scheme and advances in technology. However, growth may still be limited due to national planning policy that makes it challenging to construct new wind developments. An example of such a barrier is due to Written Ministerial Statement HCWS421 issued by the then Secretary of State Secretary for Housing, Communities and Local Government in 2015 (Department for Communities and Local Government, 2015). This amendment to national planning policy states that local planning authorities should only grant planning permission for wind energy development if:

- The development site is in an area identified as suitable for wind energy development in a Local or Neighbourhood Plan.
- Following consultation, it can be demonstrated that the planning impacts identified by affected local communities have been fully addressed and therefore the proposal has their backing.

While not banning new developments, it creates considerable barriers. If the UK Government wish to increase the deployment of onshore wind, a review of national planning policy may be required. During the last decade the offshore market, experienced strong growth in the UK primarily due to the Government's CfD scheme. Successive auctions saw dramatic reductions in the strike price for offshore wind.

2.2.4 Anaerobic Digestion

There are currently around 500 anaerobic digestion (AD) plants in the UK. The uptake of this renewable energy source has predominantly been due to the FiT scheme and Renewable Heat Incentives (RHI). Advances in the

[2] Multi-junction solar cells have multiple semiconductor junctions made of differing materials. Each type of junction produces electrical current in response to different wavelengths of light. This allows the absorbance of a broader range of wavelengths improving the cell's sunlight to electrical energy conversion efficiency.

technology meant that by 2016 there were about 540 plants across the UK. The increase in AD capacity growth over the years in the UK has predominantly been due to growth in farm applications, and this growth is expected to continue into the coming decade (WRAP, 2021). There are still issues that need to be overcome with this renewable source especially around the nutrient rich digestate product of AD. Issues such as this hidered the uptake of the technology as it does not have the same supply chain maturity as other renewable technologies and it is still quite a risky technology. Since 2016 there has been a decline in AD especially as other renewable sources became cheaperand more appealing to implement. Even with the incentives to drive the uptake of ADs there was not a huge uptake due to the complex economics surrounding the technology.

2.2.5 Water – Hydro and Tidal

On a global scale hydroelectric capacity has significantly increased over the past decade, however, in the UK the potential for new large-scale hydropower is limited, which has resulted in only a small growth in hydro and pumped storage over the last decade. There is potential for tidal and pumped storage energy generation to increase over the coming decade, however, it is a slow-moving market with pioneering projects such as the UK's first tidal lagoon struggling to get government approval. However, as the key UK sites which can undertake tidal or hydro energy production already have, there has been a slow projected increase with future potential stemming around innovation.

Lancashire has a number of large estuaries in the area which does provide an opportunity for tidal; however, many come with environmental barriers which make it unfavourable to implement. Many of the districts have considered their bays and ports for other renewable technologies, though there has not been much discussion noted around utilising local rivers for tidal technology. Many districts wanted community-led initiatives to be supported in their area which provides an opportunity for micro generation hydro projects on a community scale, and this was successfully adopted in The Green Valleys, Wales (BHA, 2018).

2.2.6 Heat – Pumps (Ground, Water and Air) and Networks

In general, heat pumps take low-temperature heat energy from the environment and convert it to higher-temperature heat using electrical energy. There are mainly three different types of heat pumps:

- Air source heat pumps that use the ambient air temperature to produce usable heat for heating purposes. The heat extracted from the ambient air is renewed naturally.
- Water source heat pumps extract heat from a body of water and convert it to useful heating purposes.
- Ground source heat (GSH) pumps use the natural steady temperature of the ground to heat radiators, underfloor heating systems and hot water. The ground stays at a relatively constant temperature, and so GSH pumps can be used throughout the year. GSH pumps can be closed or open loop; however, an open loop does require the presence of an aquifer.

Heat pumps have historically come with high costs as well as slow deployment due to the lengthy time to achieve an economical return on investment (IEA, 2020). However, material technology advancements and deployment lessons learnt have allowed heat pumps to become one of the most common energy technologies in new builds. Over time heat pumps will start to drop in price due to the learning curve in the technology. Improved technological advancements in heat pumps will enable an increase in efficiencies and deployment.

Heat pumps are predominantly used as part of the commercial heat market with the vast majority of their use being in residential properties. The UK Government is keen to drive the uptake of heat pumps, however, currently uptake is very low sitting at about 5% of its target.

2.2.7 Energy from Waste

In 2017, bioenergy accounted for roughly two thirds of renewable energy sources used in the UK. Between the 2010-2018 period bioenergy usage in the UK rose from 2.7% to 7% and this continued with it reaching as high as 11% in 2019. Anaerobic digestion is a key contender in this category along with incineration and advanced thermal conversion technologies such as gasification. Mass burn incineration is the most common type of technology used to recover energy from waste. Thethermal energy from incineration is used to generate steam in a boiler for driving a steam turbine for electrical power generation, with up to circa 27% o verall power efficiency (CEWEP, 2013) Gasification is dependent on the suitability of the feedstock and can either use the same steam power cycle or produce a syngas that is combustible in a gas turbine/engine to generate electricity, with up to circa 30% overall efficiency. It has been noted that over the past decade there have been technical issues with the implementation of some of the advanced conversion technologies that have resulted in reduced plant availability. The coming decade may see fiscal incentives for the development of advanced conversion technologies such as gasification of municipal waste (UK Government, 2018).

Overall, the capacity in the UK is quite low for this technology, however it does help the UK solve the issue around available landfill space being consumed and producing a negative impact on the environment. Energy from waste helps reduce some of this landfill and produces useful energy. In the long-term energy from waste is looking to implement circular economy through reusing the materials in the supply chain from which they arise instead of combusting the waste and producing emissions. A short-term way to negate the combustion emissions is through carbon capture, utilisation and storage (CCUS)

2.3 Regional Demand for Power and Heat 2011 to 2020

This chapter and Section 2.4 outline the current renewable energy deployment and demand for Lancashire to help define the roadmap for further deployment to 2030. This focuses on the present renewable capacity and how it has developed since the Lancashire Sustainable Energy Study was published, including any barriers to implementation. Data is provided at a county, unitary and district council level.

2.3.1 Regional Level

As of 2018 the total energy demand, including transport for Lancashire was 32.8TWh. 2019 Figures show that the county-wide electricity consumption was 6.1TWh and gas consumption totalled 13.4TWh. 2019 figures have been used for electricity and gas data and not for totals due to differences in the most recent figures available from BEIS. For reference, the 2018 figures for county-wide electricity and gas figures were 6.2TWh and 13.0TWh respectively. Energy demand for Lancashire in 2018 made up approximately 2% of the UK total energy demand of 1548TWh. The per capita energy demand in Lancashire for 2018 was 21,931kWh per person. For comparison, Merseyside a county with a similar population to Lancashire (both circa 1.4 million) contributed 1.7% to the UK total energy demand with a per capita demand of 18,500kWh per person. The greater demand figure for the Lancashire-14 is likely due to the increased levels of industry in the region compared to Merseyside.

The split between domestic and non-domestic gas and electricity and heat demand is shown in the table below. Heat demand from electricity has not been captured within the heat demand figure but rather is accounted for within the electricity demand figure. To estimate heat demand, it has been assumed that 98% of domestic gas use is for heating purposes. For non-domestic use it has been estimated using historic data from 2013 that the split of non-domestic gas use between commercial and industrial operations is 51% and 49% respectively. Of this, it has been assumed that 70% of commercial gas use and 72% of industrial use is for heating purposes. An overall heating from gas efficiency of 80% has been used to calculate the final heat demand figure seen in the table below.

Table 2.3 : Lancashire Districts Total Electricity and Heat Demand 2019 (BEIS- 1, 2020) (BEIS- 2, 2021)

Region	Domestic Electricity Demand (TWh)	Non-Domestic Electricity Demand (TWh)	Domestic Gas Demand (TWh)	Non-Domestic Gas Demand (TWh)	Domestic Heating Demand (TWh)	Commercial Heating Demand (TWh)	Industrial Heating Demand (TWh)	Total Heating Demand (TWh)
Lancashire 14	2.32	3.78	8.58	4.84	6,73	1.38	1.37	9.71

From the period 2011 – 2019 regional electricity demand has reduced by 1.7% and heating by 1.2%. The charts below show the trend over the period.

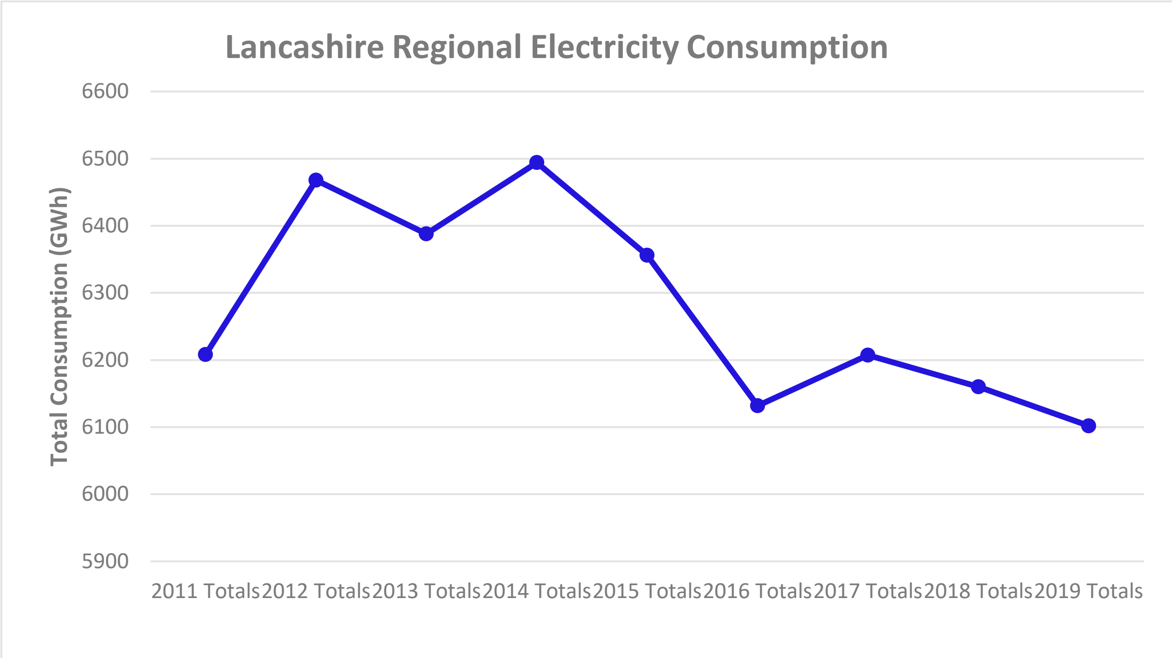

Figure 2.1: Lancashire's Total Electricity Consumption

The 1.7% reduction in electricity demand compares with a UK reduction in the same period of 7.7%.

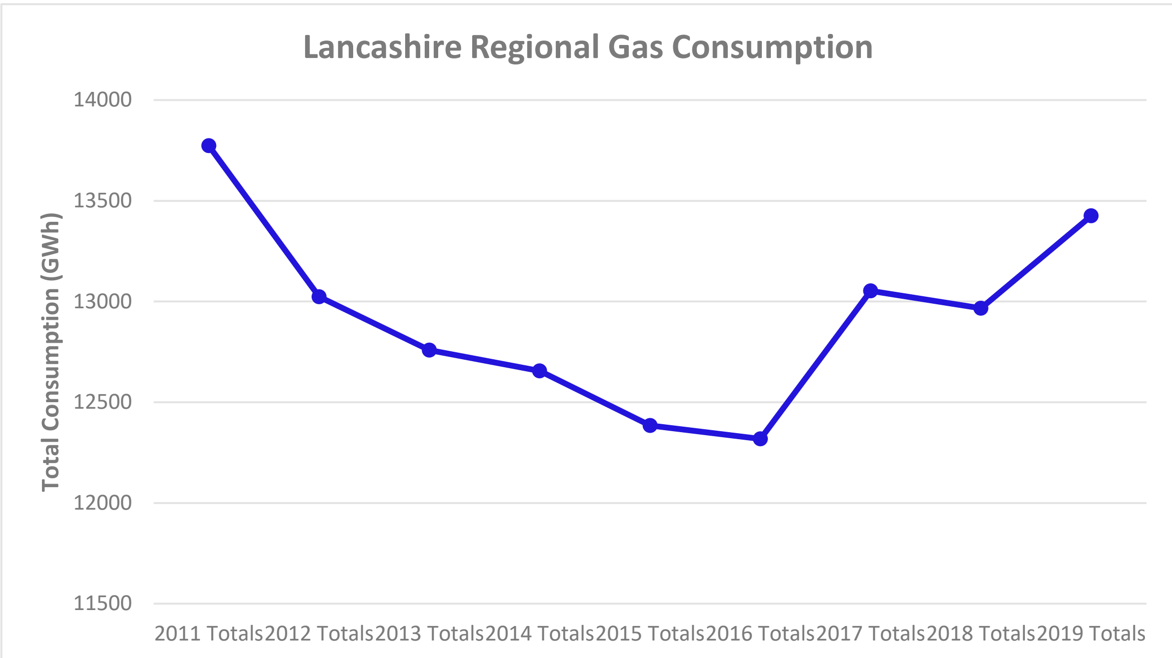

Figure 2.2: Lancashire's Total Gas Consumption

The 2.5% reduction in gas demand compares with a UK reduction in the same period of 3.6%.

At a per capita level, electricity and heat demand follow much the same pattern as the tables above. Both electricity and heat demand per capita have seen an overall reduction since 2011 with electricity demand dropping from 4,249kWh to 4,044kWh per person. Heat demand has reduced from 6,648kWh to 6,282kWh per person but has increased since its lowest point of 5,926kWh per person in 2016. The charts below show the year on year trends.

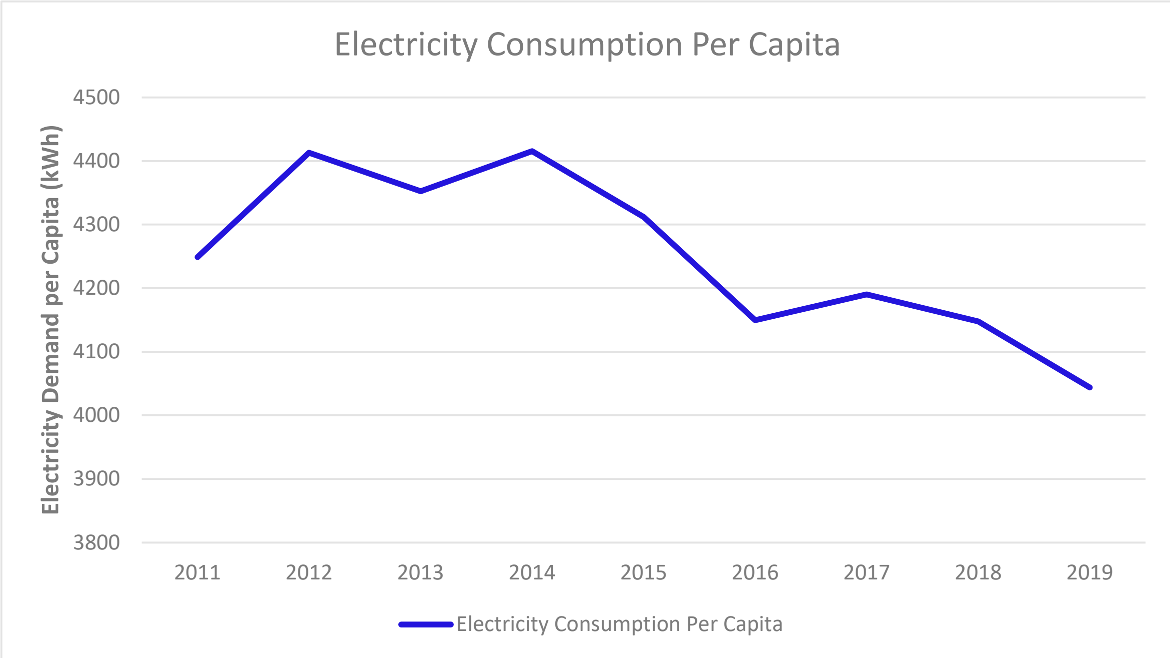

Figure 2.3: Lancashire's per Capita Electricity Consumption

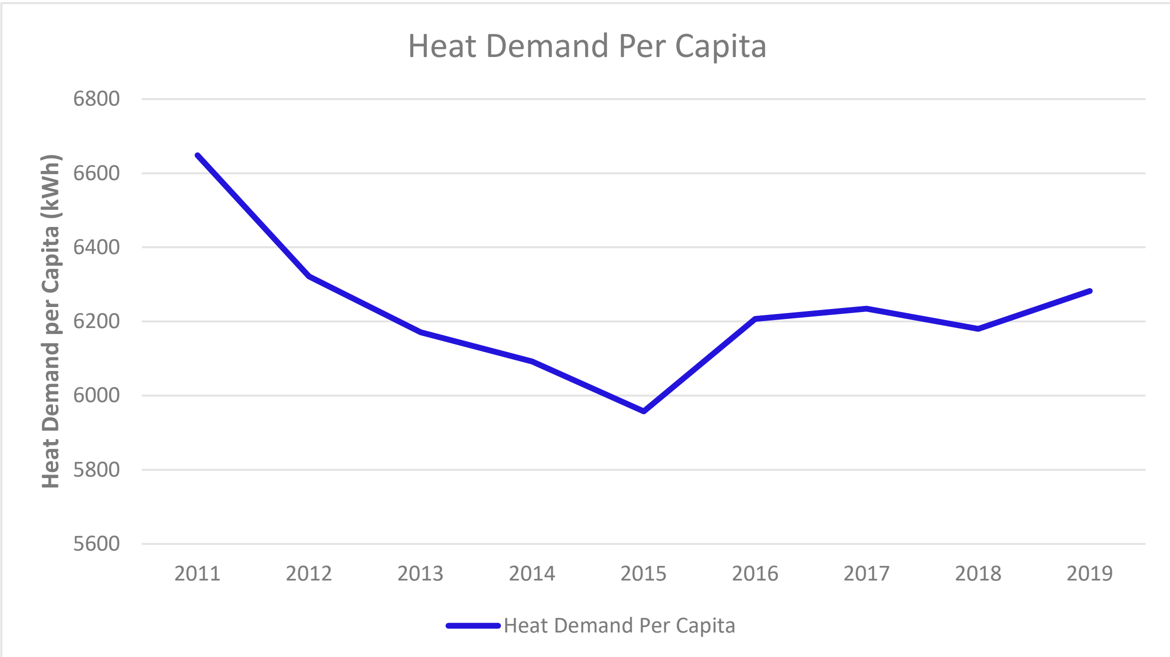

Figure 2.4: Lancashire's per Capita Heat Demand

2.3.2 Unitary and District Council Level

This section examines demand further at a district level. Electricity, gas and heating demand are broken down for each district and unitary council within Lancashire looking at local trends and changes in use.

Electricity and gas consumption for each of the 2 unitary councils and the 12 district councils is shown in the table below.

Table 2.4 : Lancashire Local Authorities Electricity and Gas Demand 2019

Local Authority	Domestic Electricity Demand (GWh)	Non-Domestic Electricity Demand (GWh)	Total Electricity Demand (GWh)	Domestic Gas Demand (GWh)	Non-Domestic Gas Demand (GWh)	Total Gas Demand (GWh)
Burnley	130	211	341	535	357	892
Chorley	179	196	375	653	303	956
Fylde	145	217	362	506	191	697
Hyndburn	114	170	284	480	276	756
Lancaster	219	310	529	730	451	1181
Pendle	130	222	352	554	227	781
Preston	209	322	531	762	374	1,136
Ribble Valley	111	319	430	349	241	590
Rossendale	113	182	295	459	247	706
South Ribble	170	280	450	631	291	922
West Lancashire	184	376	560	625	651	1,276
Wyre	184	308	492	644	400	1,044
Blackburn with Darwen	202	381	583	842	464	1,306
Blackpool	228	290	518	814	369	1,183

Lancaster, Preston, West Lancashire and Blackburn with Darwen are the highest demand hotspots in the county, in large part due to their higher populations and having most of the region's major employers located there. This is especially the case with Blackburn.

Heating demand for the fourteen local authorities has been estimated using the same method detailed in Section 2.3.1 and is detailed below.

Table 2.5 : LancashireLocal Authorities Heat Demand 2019

Local Authority	Domestic Heat Demand (GWh)	Commercial Heat Demand (GWh)	Industrial Heat Demand (GWh)	Total Heat Demand (GWh)
Burnley	419	101	101	622
Chorley	512	86	86	684
Fylde	397	54	54	505
Hyndburn	376	78	78	533
Lancaster	572	128	128	828
Pendle	434	65	64	563
Preston	597	106	106	810
Ribble Valley	274	68	68	410
Rossendale	360	70	70	500
South Ribble	495	83	83	660
West Lancashire	490	185	185	860
Wyre	505	114	113	732
Blackburn with Darwen	660	132	132	924
Blackpool	638	105	105	848

From this it can be seen that domestic heat demand is significantly higher than non-domestic for all regions, even those with greater presence of large industrial sites, with non-domestic heat being split roughly evenly between industrial and commercial use.

Change in demand for each of the local authorities from the period 2011-2019 is shown below.

Table 2.6 : Lancashire Local Authorities Change in Electricity and Heat Demand in Period 2011 to 2019

Local Authority	Change in Electricity Demand	Change in heat Demand
Burnley	2.40%	-1.42%
Chorley	2.46%	0.42%
Fylde	-5.97%	0.29%
Hyndburn	-3.40%	-2.68%
Lancaster	-3.29%	-1.33%

Pendle	-1.12%	-1.63%
Preston	-15.98%	0.70%
Ribble Valley	0.70%	1.54%
Rossendale	-12.20%	-2.20%
South Ribble	5.63%	-2.11%
West Lancashire	18.14%	-0.46%
Wyre	11.82%	-1.13%
Blackburn with Darwen	-8.04%	-1.94%
Blackpool	-7.17%	-4.03%

It can be seen that, at a district and unitary level, changes in demand differ more greatly than at a county-wide level, especially with regard to electricity demand. West Lancashire and Wyre have seen the greatest increase in electricity demand whilst Preston and Rossendale have experienced a significant decrease in electricity demand. Changes in heat demand have stayed relatively consistent withmost councils seeing a decrease of between 1 and 2% since 2011. There does not seem to be any correlation between change in electricity and heat demand for any of the councils within Lancashire. Charts showing the year on year change for electricity and gas demand are provided below.

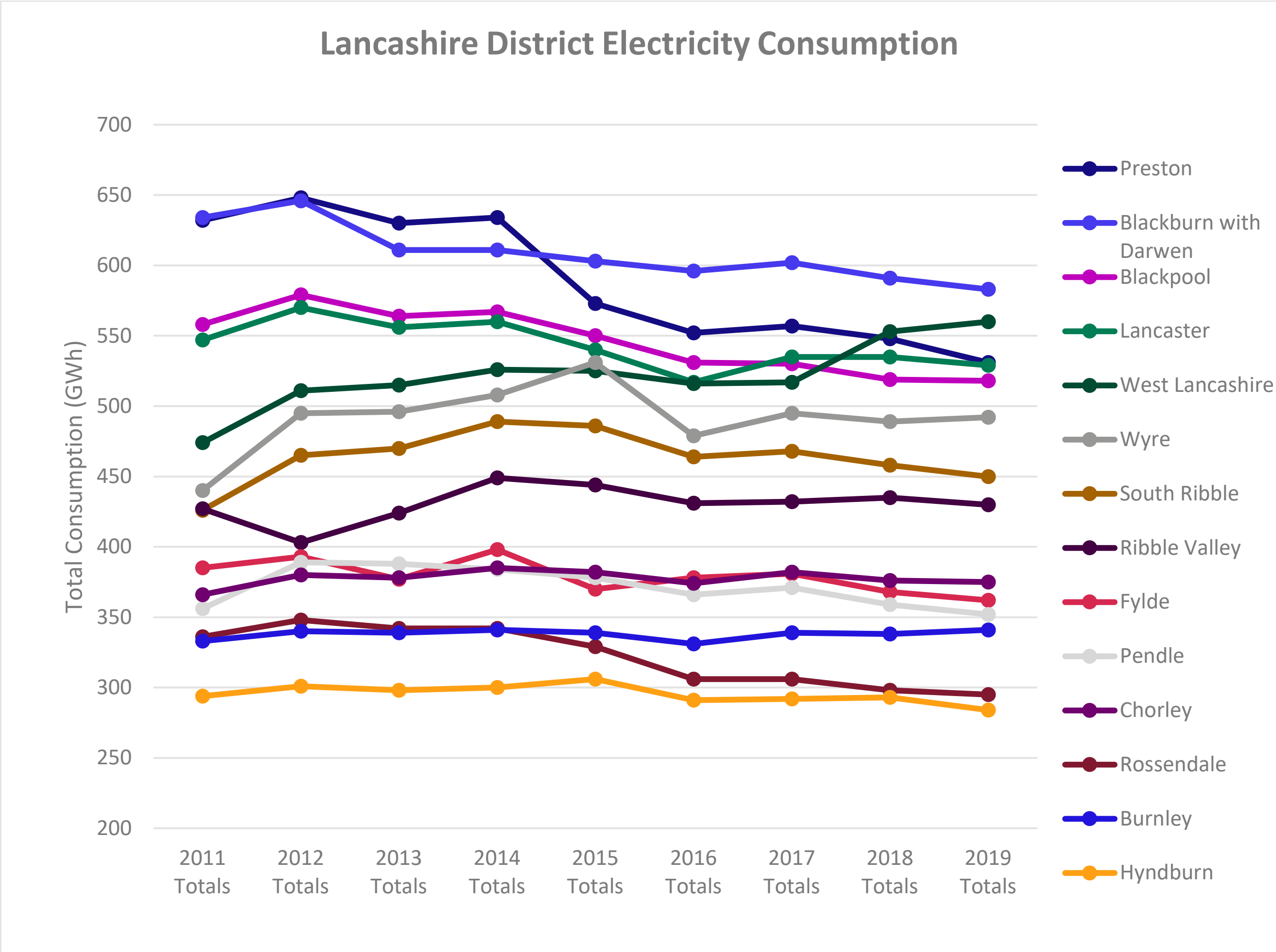

Figure 2.5: LancashireLocal Authorities Electricity Demand Trend in Period 2011 to 2019 (BEIS- 3, 2021)

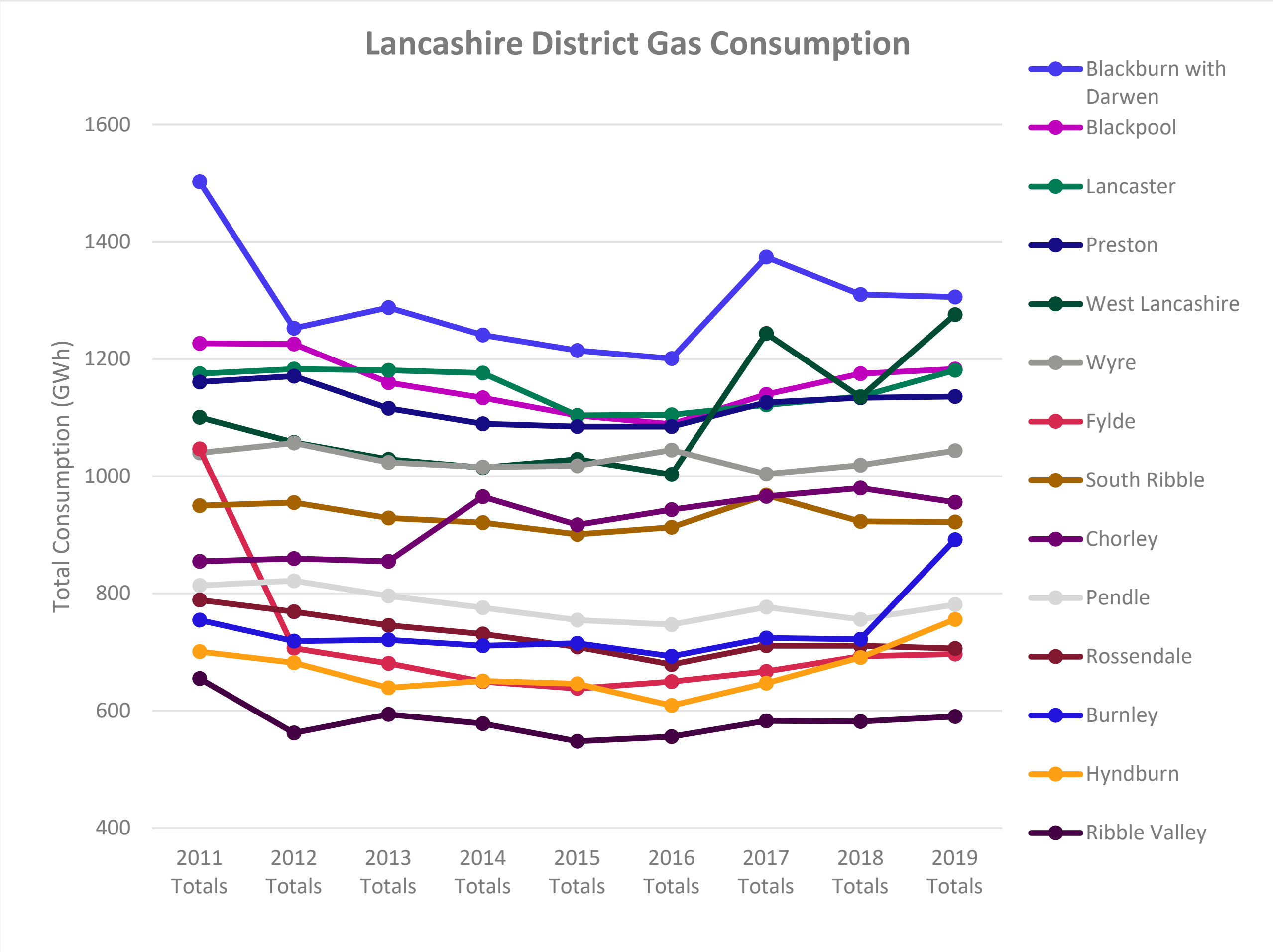

Figure 2.6: LancashireLocal Authorities Gas Demand Trend in Period 2011 to 2019

Changes in domestic electricity gas consumption per household have also been examined for each of the fourteen councils to provide insight into how demand is changing with the population for each local authority. It can be seen from these charts that per household energy use has largely followed the same trend as district level consumption with a gradual decrease in electricity usage since 2011 and a redudion in gas usage until 2016 that has slowly been climbing again up to 2019.

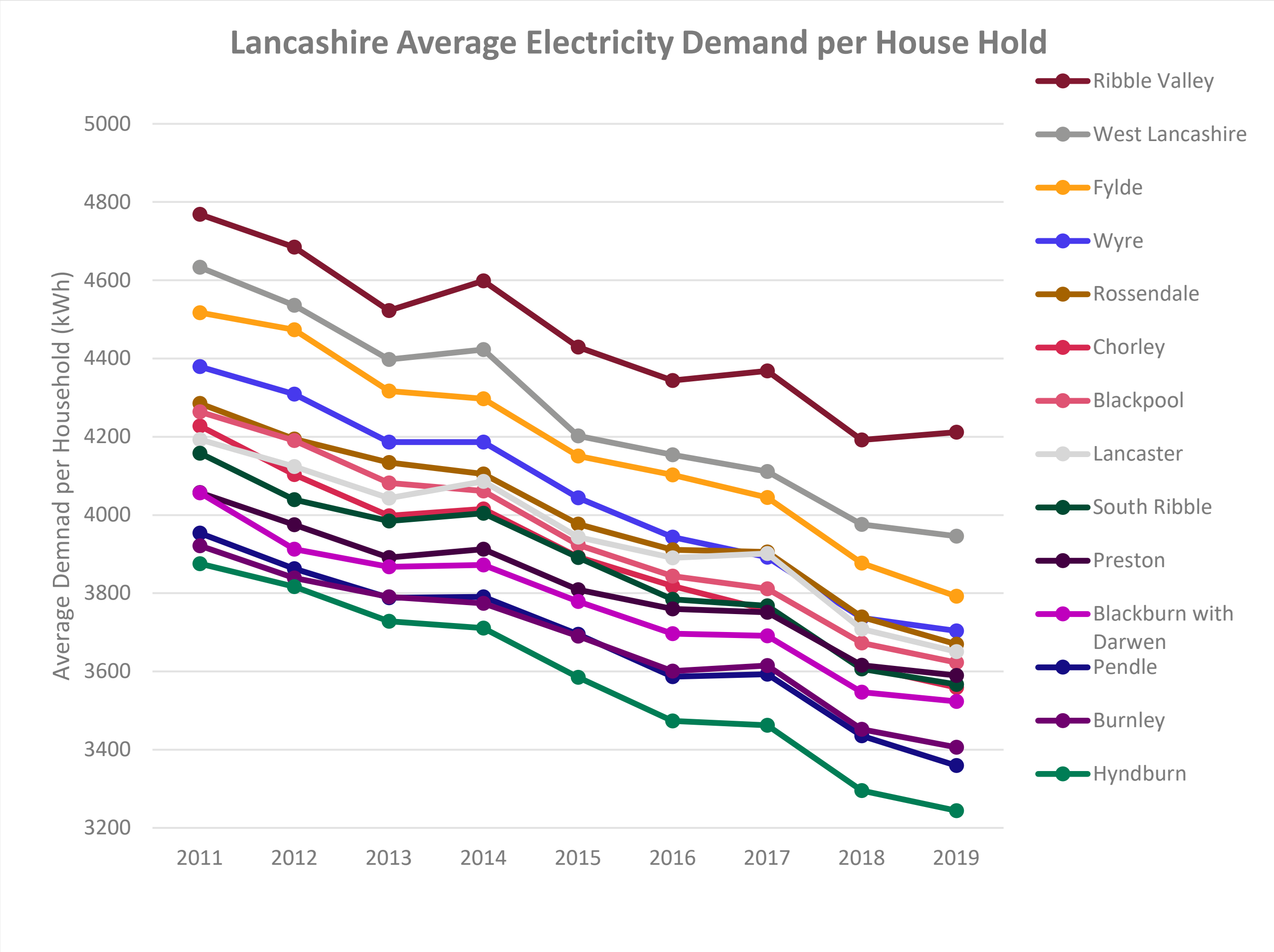

Figure 2.7: Lancashire local authorities per household electricity demand trend in period 2011 to 2019

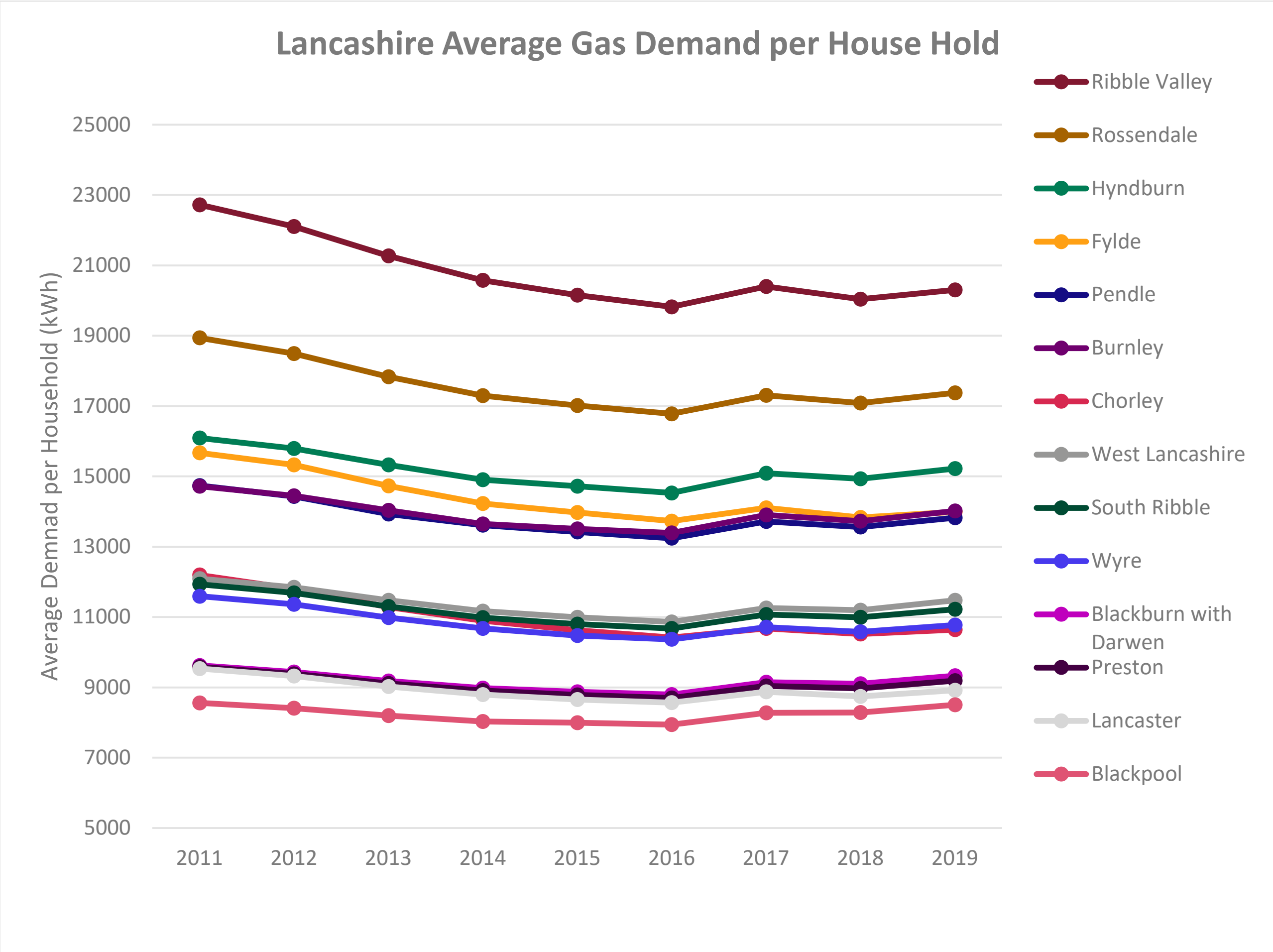

Figure 2.8: LancashireLocal Authorities per Household Gas Demand Trend in Period 2011 to 2019

The percentage of electricity and heat demand currently met by renewables in Lancashire has been estimated. District annual consumption figures for both electricity and heating were converted into an average annual demand in MW. Renewable output was estimated using installed capacity figures and load factors from BEIS. As of 2019, an estimated 12.9% of Lancashire's electricity demand and 8.3% of heat was met by renewables. It should be noted that these are annualised aggregated figures and do not account for the time dependent nature of supply/demand and therefore the proportion of renewable generation to demand fluctuat es during the year. For electricity, the proportion met by renewable sources is considerably lower than the UK total of 33.1% being met through renewables. Heat demand does not meet the UK's indicative 2020 target of 12% in Lancashire but is greater than latest estimates from 2016 of 5.64%, suggesting that Lancashire may be on par with, or outperforming the UK average in terms of uptake of renewable heating technologies.

A summary of demand met by renewables for each of the local authorities within Lancashire is shown in the table below.

Table 2.7 : LancashireLocal Authorities Proportion of Electricity and Heat Demand Met by Renewables 2019

Local Authority	Electricity			Heat		
	Demand (MW)	Renewable Output (MW)	% Met	Demand (MW)	Renewable Output (MW)	% Met
Burnley	39	8.86	22.8%	101	2.78	2.8%
Chorley	43	5.56	13.0%	108	11.38	10.6%
Fylde	41	5.04	12.2%	78	11.39	14.5%
Hyndburn	32	9.74	30.0%	85	7.05	8.3%
Lancaster	60	11.58	19.2%	133	18.39	13.8%
Pendle	40	1.07	2.7%	88	2.34	2.7%
Preston	61	2.05	3.4%	128	5.22	4.1%
Ribble Valley	49	1.70	3.5%	67	10.64	16.0%
Rossendale	34	30.87	91.7%	80	2.35	3.0%
South Ribble	51	1.77	3.4%	104	10.77	10.4%
West Lancashire	64	2.17	3.4%	144	19.92	13.8%
Wyre	56	6.54	11.6%	118	16.70	14.2%
Blackburn with Darwen	67	2.53	3.8%	147	4.49	3.1%
Blackpool	59	0.48	0.8%	133	1.82	1.4%

2.3.3 Industry and Major Employers

Lancashire is home to a number of major employers within the aviation, manufacturing and chemicals sectors. Of these BAE systems is the largest private sector employer with various offices and large industrial sites located in Preston, Chorley and Blackburn. Aviation and aviation related manufacturing is anticipated to grow within Lancashire with the introduction of three new enterprise zones housing the offices and manufacturing plants of a number of aviation companies in Blackburn, Preston and Blackpool. An additional enterprise zone is also planned for Wyre which will house a large number of chemical sites. Hanson Cement is based in Ribble Valley at the Ribblesdale cement works. Lancashire is also home to a number of large bakeries. Warburtons, FOX's and Burton's biscuits have bakeries located in Burnley Blackpool and Preston. Blackburn and Preston house the majority of major employers within the region. The most dominant sector within the region is manufacturing.

At present, manufacturing sites use a large amount of natural gas to provide low and high level heat for various process and space heating. By 2050, as part of the UK's net-zero road map, it is anticipated that this heat will be produced through electricity and hydrogen making use of technologies such as electric arc furnaces and hydrogen boilers.

By 2030, the Climate Change Committee (CCC) does not anticipate any major uptake of hydrogen technologies within manufacturing but does predict increasing electrification of heat. It can therefore be reasonably anticipated that Lancashire will see an overall increase in its electricity demand in 2030 despite the anticipated decrease in overall energy consumption.

Decarbonising industry presents a unique set of challenges for Lancashire County Council and the 14 local authorities. Many large organisations play a major role in the local economy and until technologies such as CCUS come through, efforts to decarbonise industrial processes could damage the economic output of the region. It is therefore imperative that councils continue to foster strong links with industrial partners to leverage the benefits such organisations can provide to decarbonise the region. This includes increasing the deployment of renewable assets on company buildings or land and providing new jobs to support a more sustainable sector. However, ensuring that these organisations do meet their commitments to reach net zero and focus on mitigative strategies to decarbonisation, rather than taking a risk on adaptive technologies of the future.

2.3.4 Off Gas Grid Properties and Fuel Poverty in the Region

Fuel poverty exists when a household is unable to afford adequate energy services in the home on their present income. There are various influences or fuel poverty such as the age and attributes of the household such as the occupancy type the insulation of the property and the location. The table below shows the number of properties in Lancashire that are currently in fuel poverty.

Table 2.8 : Properties in Lancashire's Councils that are Currently in Fuel Poverty (The Non Gas Map, n.d.)

Local Authorities	Number of Properties	Fuel Poverty (%)	Fuel Poverty properties	Non-gas properties (%)	Non-gas properties
Pendle	39,792	15.7%	6,247	13.6%	5,412
Burnley	40,844	14.2%	5,800	11.9%	4,860
Blackpool	73,927	14.1%	10,424	26.4%	19,517
Hyndburn	37,123	14.0%	5,197	13.1%	4,863
Blackburn with Darwen	61,083	13.6%	8,307	13.4%	8,185
Preston	60,401	12.9%	7,792	18.6%	11,235
Lancaster	68,682	11.6%	7,967	31.1%	21,360
Rossendale	32,088	10.3%	3,305	16.9%	5,423
Ribbie Valley	26,554	9.4%	2,496	31.7%	8,418
Wyre	52,207	9.0%	4,699	22.7%	11,851
West Lancashire	51,149	8.6%	4,399	24.8%	12,685
Chorley	48,751	8.2%	3,998	15.4%	7,508
Fylde	40,294	8.1%	3,264	33.0%	13,297
South Ribble	49,513	7.9%	3,912	13.7%	6,783

Although Lancashire experienced a reduction in fuel poor households back in 2018 as confirmed in the table above there is a significant number of properties still living in fuel poverty. Whether this is people living in rented flats, low income houses or rural locations an investment in renewable technology provides an opportunity for Lancashire to reduce this number. Many of the issues may lie with proximity to the gas network as many of the properties are well over 500m away from the nearest gas grid. There are some properties across Lancashire which are still off the gas grid, meaning that systems-based solutions will not be applicable across the county. There are some local authorities such as Fylde where 33% of the properties are non-gas properties paired with 8% fuel poverty in the district, which indicates that gas grid connection in this area might be too expensive to consider. This would result in part of that district being unable to benefit from renewable technologies such as hydrogen or biogas. These properties could be fitted with heat pumps especially those without grid connection. These properties probably use expensive systems using oil or wood fires which produce carbon emissions.

Flats face the issue of being quite costly to update to put in a gas system if they do not already have one. These properties tend to be old, poorly insulated properties. There are several councils with non-gas properties that also have high fuel poverty rates such as Blackpool and Lancaster. Councils could investigate retrofitting and insulation, however this would require around £10-20k investment per property and if councils decided to update these properties to have heat pumps that would cost another £20-30k resulting in a significant investment needed for each.

The socio-economic aspects would need to be evaluated by councils as people left in these properties throughout winter could result in people most in need ending up sick; however, the updates necessary for these sites require significant investments. Low indoor temperatures encourage the development of damp and mould further contributing to unsafe properties. To prevent this from occurring will be a challenging and costly task for councils and would need investment from social housing providers to help drive this change enabling care for this vulnerable group.

2.4 Understanding Renewable Energy Deployment from 2011 to 2020

This section outlines the current renewable energy capacity deployment across Lancashire at a regional and local level. Lancashire's renewable energy capacity has increased significantly since 2011, estimated as a 240% increase, from 160 MW to 544 MW excluding offshore wind. Current renewables capacity is compared to the Sustainable Energy 2011/2012 report predictions. An analysis is also made of planning applications for current, in progress, and submitted renewable energy projects. Data has been gathered from BEIS's and OFGEM databases.

2.4.1 Regional Level

Lancashire currently has 1,871 MW of renewable capacity (power electricity and heat). The table below outlines the total renewable capacity by technology including the total number of projects (for the electricity data) and accredited applications (for the heat data). The heat data is acquired from the renewable heat incentive dataset (from BEIS), where accredited applications represent the number of approved technology acquisitions through the RHI scheme. Precise data of heat capacity per technology is not available, hence the data is grouped into domestic and non-domestic uses.

Table 2.9 : Lancashire Renewable Energy Capacity by Technology (BEIS, 2020)(BEIS, 2021)

Number of projects / accredited applications and total capacity by technology type, Lancashire			
Energy Type	**Technology Type**	**Number Projects / Accredited Applications**	**MW**
Heat Non-Domestic	Biomass boilers, heat pumps, solar thermal, CHP, and Biogas	397	111

Heat Domestic	Heat pumps, biomass systems, and solar thermal	1,070	14
Power Electricity (Domestic and Non-Domestic)	Onshore wind	202	211
	Offshore wind	6	1,327
	Wave and tidal	0	0
	Solar PV	18,389	160
	Hydro	9	2
	AD	10	7
	Energy from Waste and Biomass	21	38

Offshore wind, having 1,327 MW of capacity, represents 70% of the total renewable capacity and 76% of renewable power electricity capacity and is by far the largest supplier of renewable energy in Lancashire. Total renewable capacity without offshore wind is 544 MW, of which 70% comprises solar PV and onshore wind, and 23% heat energy. The chart below provides a breakdown of each technology's contribution (without offshore wind).

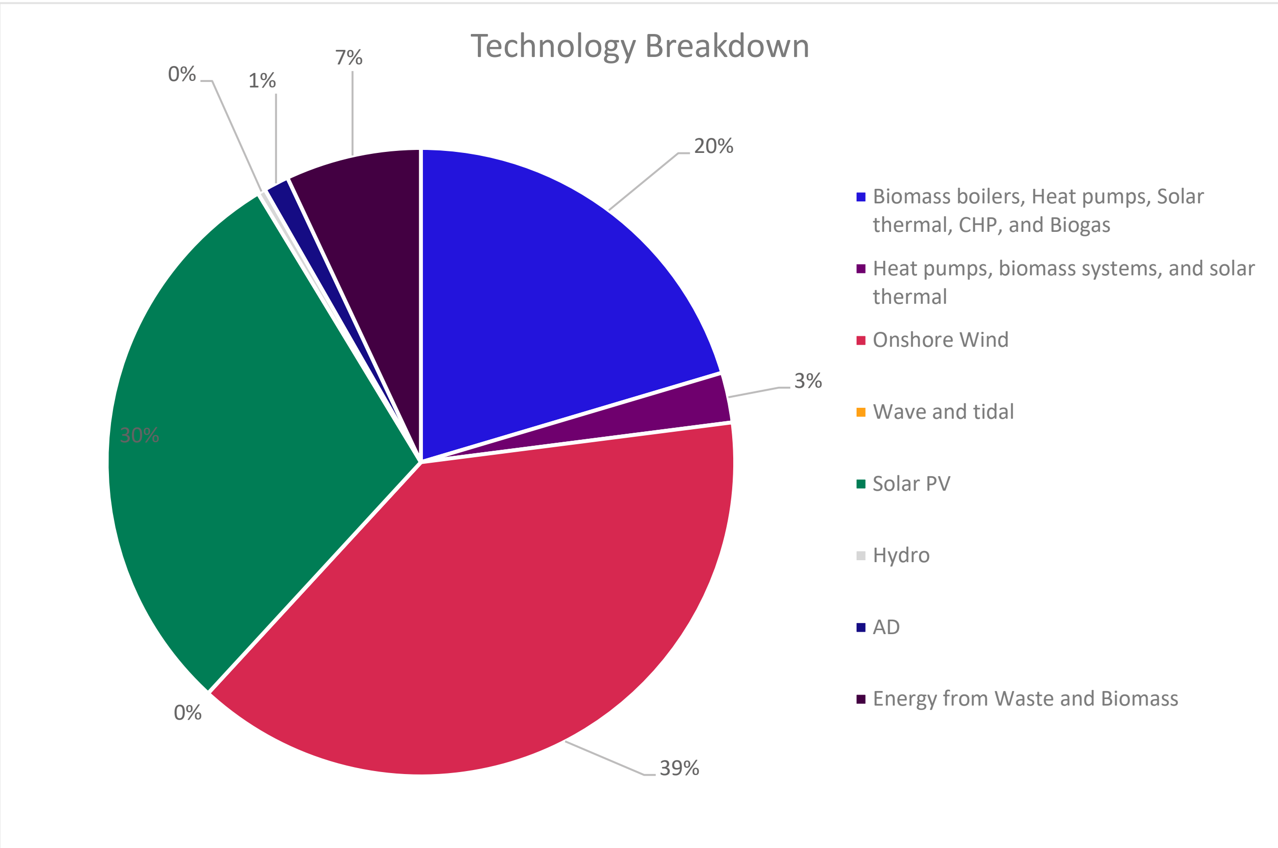

Figure 2.9: Technology Breakdown (without Offshore Wind)

In terms of overall renewable energy breakdown:

- 77% comes from electricity and 23% from heat, excluding offshore wind.

- With offshore wind included: 93% is renewable electricity and 7% is heat.

The chart below visually displays renewable energy capacity per technology; onshore wind representing 50% and solar 38% of this total.

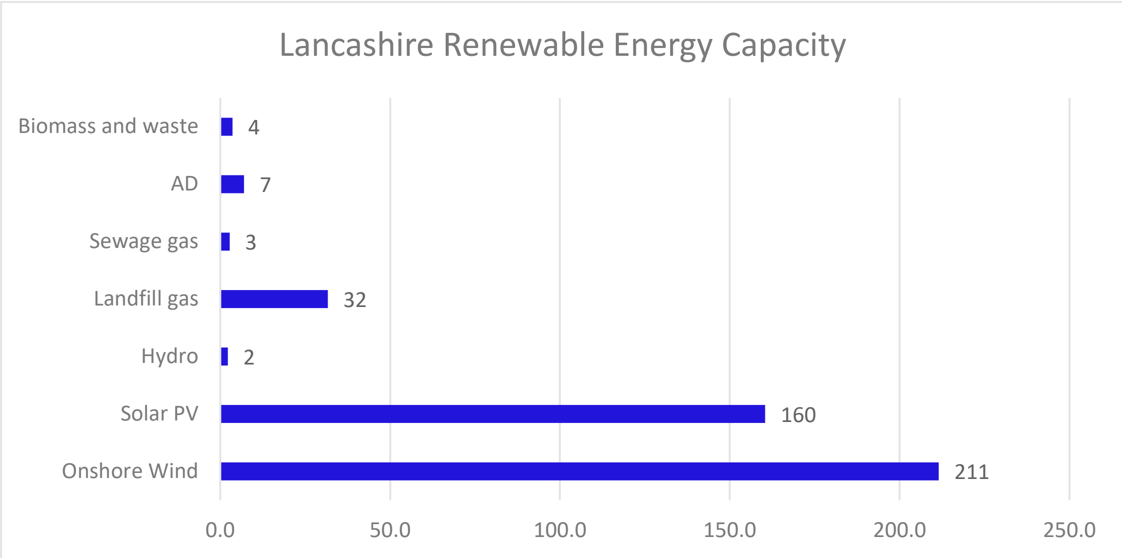

Figure 2.10: Lancashire Renewable Electricity Capacity per Technology (MWe) (BEIS, 2020)

Three charts are presented below:

- Solar and offshore wind development since 2011
- Renewable heat technologies (non-domestic and domestic) development since 2011
- Other renewable electricity technologies development since 2015

For electricity, the data is accurately available from 2014 for Lancashire. From 2011 to 2013, the data has been extrapolated. Offshore wind is a dominant proportion of the overall capacity, though it is excluded from the analysis as the expansion of offshore wind capacity is managed by the crown commercial services, not local authorities. For reference, the chart below illustrates offshore wind development from 2011 to 2019. Due to the large available area and high capacity for offshore wind farms, this has been a growing dominant technology. Government subsidies and 'contracts for difference' have benefitted the growth of offshore wind.

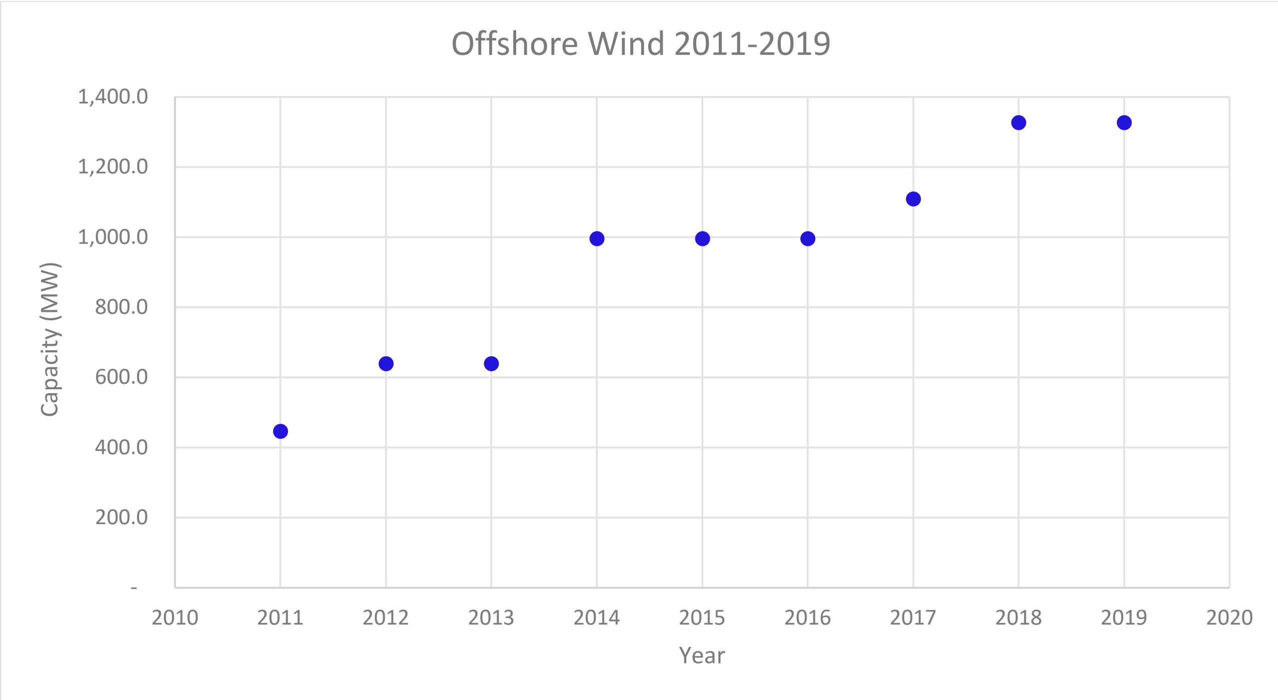

Figure 2.11: Annual Development of Offshore Wind Capacity in Lancashire (BEIS, 2020)

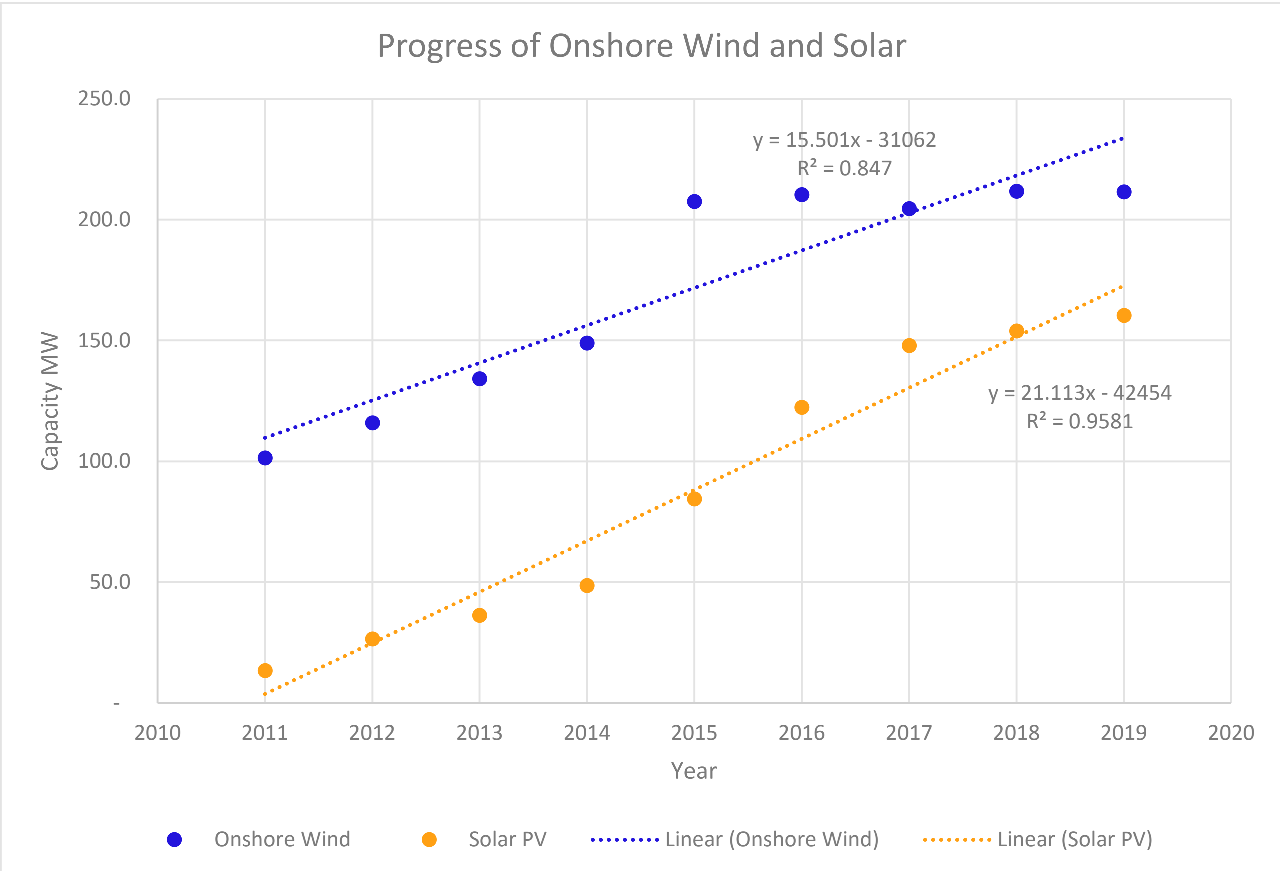

Figure 2.12: Annual Development of Solar and Onshore Wind Capacity in Lancashire (BEIS, 2020)

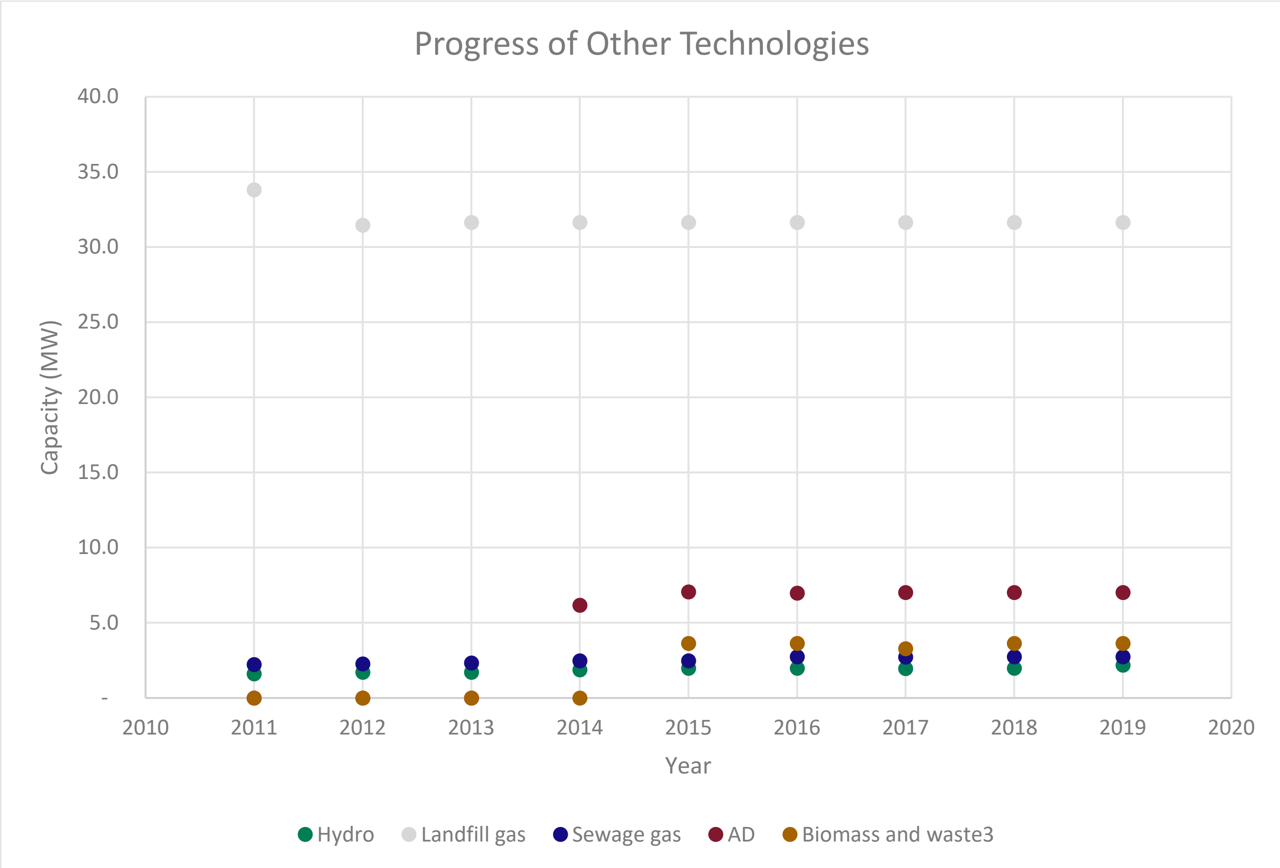

Figure 2.13: Annual Development of Other Renewable Technologies Capacity in Lancashire

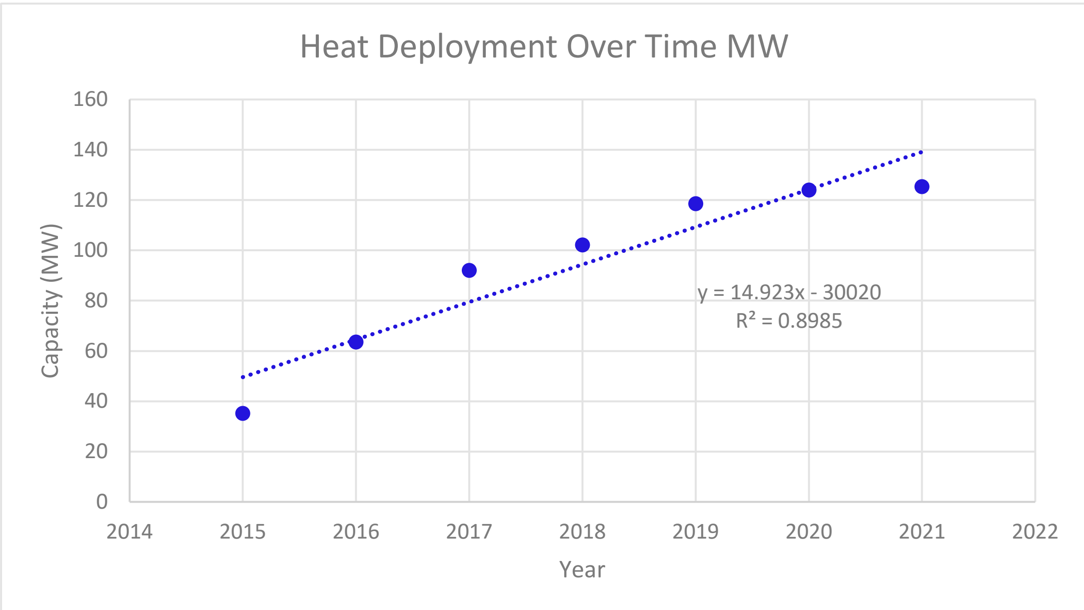

Figure 2.14: Annual Development of Renewable Heat Technologies Capacity in Lancashire

Conclusions drawn from the data are: -

- Solar PV is the only technology with a substantial and constant linear capacity increase year by year. Two main reasons explain this trend; a) the feed-in-tariff introduction in 2010, accelerated the deployment of solar increase year by yearand b) the fast decline in the price of solar technologies boosted its profitability and therefore deployment.

- While onshore wind also displays a linear trend over time, there has not been a constant increase year by year. In general, this is expected as wind energy is heavily dependent on large wind farm projects that require extended time for planning, and construction. This explains the step increase from 2014 to 2015. Note that 2010 to 2013 show more of a linear increase due to necessary calculation assumptions mentioned above. From 2015 to 2019, there has been a slow progress in onshore wind. This is explained by the removal of government subsidies from onshore wind in 2015, which heavily slowed its development from 2015 onwards.

- Hydro has had a minor increase over the study period. This is expected as significant development concerning larger scale hydro had already been implemented, leaving only small-scale hydro to be developed.

- For anaerobic digestion, there is no data before 2014. There has been only a minor capacity increase from 2014 to 2015; from 2015 the AD capacity has been constant.

- Energy from waste (EfW) and biomass energy capacities have both been relatively constant over the years. Because waste sent to landfill has been constant in the county of Lancashire over the years, it has not been a factor for higher waste energy capacity deployment. This has recently changed as two EfW incinerators have received planning approval with a total capacity of 80 MW.

- The relatively small annual increase in deployment of heat pump technology is discussed at Sections 2.2.6 and 4.1.

Apart from solar PV, heat pumps and wind, the other technologies have achieved only minor capacity increases in the past ten years.

2.4.2 Unitary and District Level

The table below provides data for renewable electricity and heat deployment by council in Lancashire (with and without offshore wind).

Table 2.10 : RenewableEnergy Capacity byCouncil (BEIS, 2020)

Local Authority	Total Renewable Electricity Capacity MW (2019)	Renewable Electricity Capacity MW (without Offshore, 2019)	Renewable Heat Capacity MW (2021)	Total Renewable Capacity (MW)	Total Renewable Capacity Onshore (MW)	% of total (without Offshore)
Burnley	35.6	35.6	2.8	38.4	38.38	7%
Chorley	21.3	21.3	11.4	32.7	32.68	6%
Fylde	37.5	37.5	11.4	48.9	48.92	9%
Hyndburn	36.4	36.4	7.1	43.5	43.47	8%
Lancaster	1,381.3	54.3	18.4	1,396.6	72.65	13%
Pendle	5.9	5.9	2.3	8.3	8.26	2%

Preston	15.4	15.4	5.2	20.6	20.64	4%
Ribble Valley	14.5	14.5	10.6	25.1	25.14	5%
Rossendale	119.6	119.6	2.4	121.9	121.90	22%
South Ribble	12.7	12.7	10.8	23.5	23.46	4%
West Lancashire	15.5	15.5	19.9	35.4	35.38	7%
Wyre	34.2	34.2	16.7	50.9	50.86	9%
Blackburn with Darwen	11.5	11.5	4.5	16.0	16.02	3%
Blackpool	4.4	4.4	1.8	6.2	6.22	1%
Total	**1,746**	**418.8**	**125.2**	**1,871.0**	**544.00**	**100%**

Lancaster has thehighest proportion of renewable energy due to the high predominance of offshore wind. When excluding offshore wind, Rossendale has the highest proportion at 22%, due to its dominance in onshore wind. Precise data for capacity per district per technology is only available for renewable power electricity.

2.5 Lancashire Renewables Capacity Compared to other Regions in England

Compared to other counties in England, Lancashire is heavily influenced by offshore wind deployment. With offshore wind, Lancashire ranks 4th compared to the 48 counties selected. When offshore wind is excluded from the analysis, then Lancashire, with a capacity of 419 MW, is 20th ranked, within the average of 433 MW. The charts below show the respective counties' comparisons with and without offshore wind, respectively.

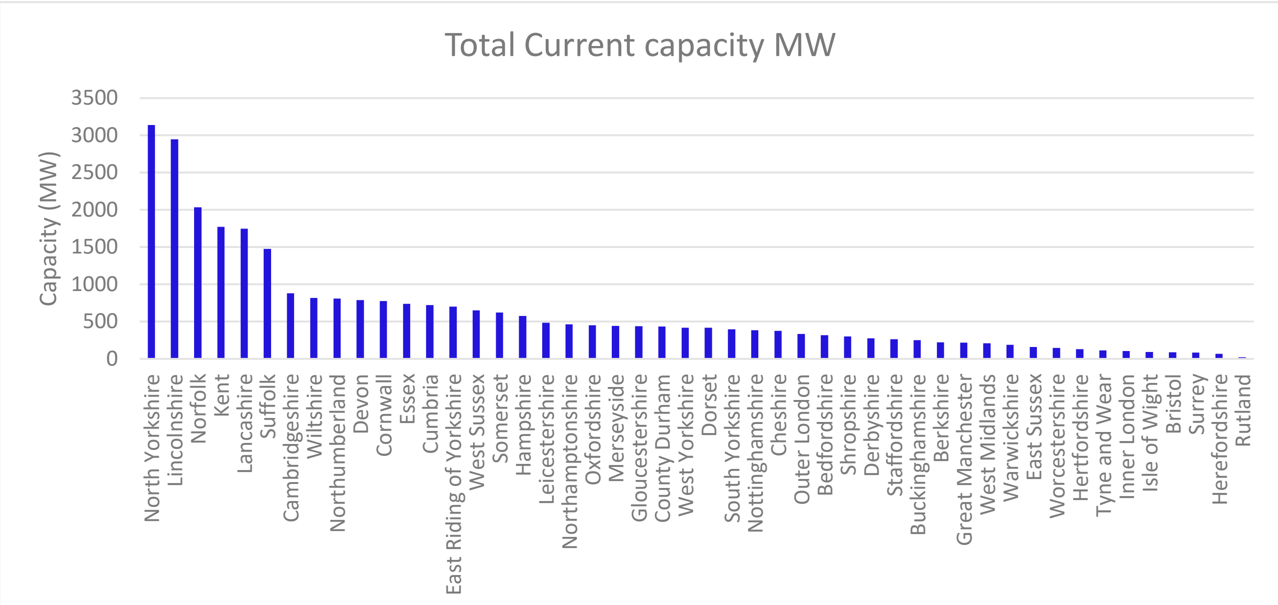

Figure 2.15: English Counties Renewables Capacity (including Offshore Wind) (BEIS, 2020)

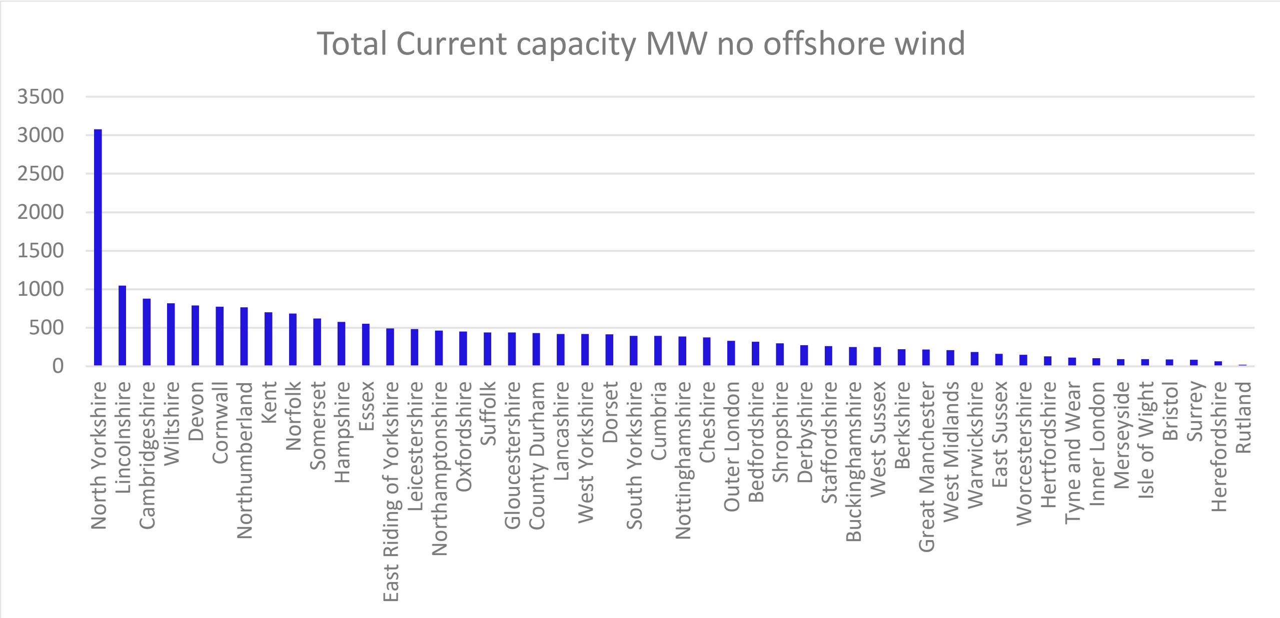

Figure 2.16: English Counties Renewables Capacity (excluding Offshore Wind) (BEIS, 2020)

2.6 Comparison of Current Renewables Capacity to the Sustainable Energy 2011/2012 Report

Two key questions that arise from studying the current and past renewables capacity deployment are:

- By looking at current deployment, how does it compare to the Sustainable Energy Study 2011/2012? (SQW, Maslen Environmental & CO2Sense, 2011) (SQW, Maslen Environmental & CO2Sense, 2012)
- How can this data be interpreted looking ahead to 2030?

This subsection focuses on how the current renewables capacity compares to the 2011/2012 report (both county and district levels) and understand some of the reasons for the differences.

2.6.1 Comparison with Lancashire Sustainable Energy Study 2011 and 2012

The Lancashire Sustainable Energy studies conducted in 2010-2012 deliver three main results in terms of renewable energy:

- The renewable energy technical potential in Lancashire in 2020 and 2030 (both for Lancashire and each district). The technical potential refers to the "maximum" technical capacity of renewable energy in the county (within the report's methodology). The 2020 and 2030 values can differ because the biomass feedstock and roof area available for solar changes overtime.
- The deployable potential in 2020 and 2030. Deployable potential means: "translating technical potential into more realistic deployable potential by identifying the baseline, in terms of currently installed capacity and projecting this forward to 2020 with growth rates constrained by transmission, economic viability, supply chain and planning factors" (2011/2012 report, page 21).
- The calculated renewable capacity in 2011; as total MW value at county level.

The following subsections compare current deployment data with the Lancashire Sustainable Energy report data outlined above.

2.6.1.1 Regional Level

The chart below compares, at a county level, renewable energy capacity in terms of 2011 deployment, current deployment, and the Lancashire Sustainable Energy Study's 2020 and 2030 deployable and technical potential. The Lancashire Sustainable Energy Study's existing 2011 value has been included for reference.

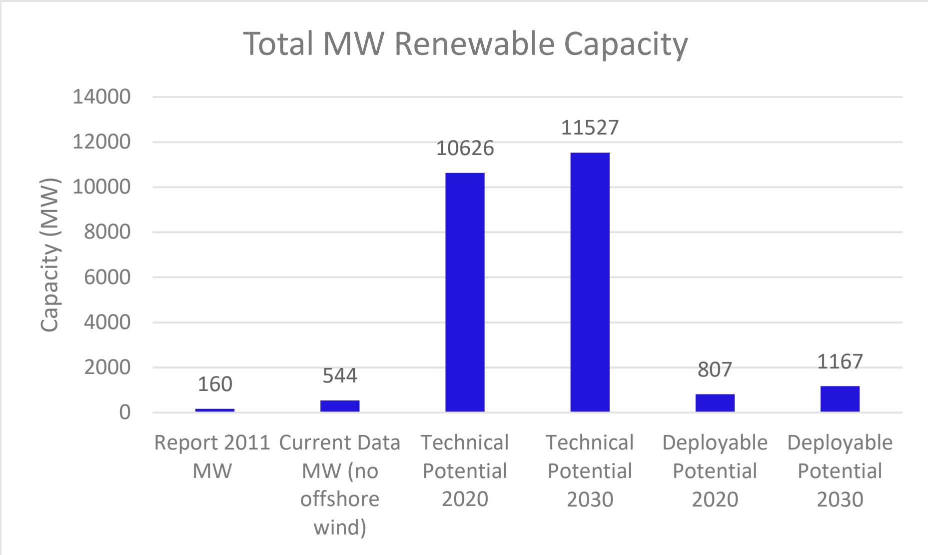

Figure 2.17 : Lancashire Total Renewable Energy Capacity Comparison

Current renewable energy capacity is underperforming compared to the 2020 deployable potential calculated by the Sustainable Energy 2011/2012 report . This report predict ed a deployable potential of 807 MW in 2020 compared to an actual deployment of 544 MW.

The table below compares the current capacity renewable energy per technology versus the Lancashire Sustainable Energy Study2020 technical capacity and deployable potential per technology. It should be noted that compared to Table 2.10, Table 2.12 groups technology slightly differently so that data can be better compared:

- Energy from waste in Table 2.12 includes landfill gas, sewage gas, and other waste energy from Table 2.10
- Table 2.12 further breaks down plant and animal biomass separately.

Table 2.11 : Renewable Energy Capacity by Technology

Technology	Current MW	Technical Capacity 2020 (MW)	Technical Capacity 2030 (MW)	Total Deploy able Potential 2020 (MW)	Total Deploy able Potential 2030 (MW)
Commercial Wind	211.2	6889	6889	634.5	849.4
Plant Biomass	2.6	46	49	10.4	11
Animal Biomass	0	53	53	7.8	9.4
Energy from Waste	35.4	117	136	34.7	17
Small scale hydro	2.2	21	21	1.9	2.3

Microgeneration - Solar	160.4	642	697	73.2	181.4
Microgeneration - Heat pumps	14[3]	2844	3667	44.5	96.8
Anaerobic Digestion	7	-	-	-	-

It should be noted that the Sustainable Energy 2011/2012 report analysed the base biomass feedstock without considering whether it could be converted by anaerobic digestion. Thus, because the 2011/2012 report does not give a capacity figure for AD, it cannot be compared. Current AD deployment is included in Table 2.12 for reference purposes.

Comparisons to the predicted 2020 deployable potential for each technology are as follows: -

- Solar has exceeded expectations; 160 MW compared to a predicted 73.2 MW. This difference is mainly due to:
  - The Sustainable Energy report study did not consider grounded solar as an option, only calculating and analysing roof solar. 67 MW of the current 160 MW corresponds to scale likely to be ground mounted solar; therefore, 92 MW represents small-scale solar, which is still higher than 73 MW from the 2011/2012 study.
  - As aforementioned, feed-in-tariffs have had a positive boost in the deployment of solar energy. Because feed-in-tariffs were introduced in 2010 and the report was written in 2011/2012, deployment predictions would probably have been conservative at the time.
  - Solar PV prices have fallen in the last ten years. This further explains a lower prediction compared to the current solar capacity.
- Small scale hydro current capacity is similar to the report's deployable prediction: 2.2 MW compared to 1.9 MW, respectively. This is further discussed at Section 2.4.1 above.
- Energy from waste is also in line with the report's expectations; the report expected it to decrease marginally (due to an expected reducing landfill gas/waste over time).
- The technologies that have not achieved predicted levels are:
  - Wind – 33 % of predicted deployment in 2020. Withdrawal of government subsidies in 2015 has considerably retarded onshore wind deployment.
  - Plant biomass – 25% of predicted deployment in 2020.
  - Animal biomass – 0% of predicted deployment in 2020. It is important to note that part of animal biomass is used in the current AD deployment (which accounts for 7 MW of current capacity). Nevertheless, it still underperforms compared to the predicted value from the Report.
  - Heat pumps – 32% of predicted deployment in 2020. Difficulties in achieving an economical return on investment have slowed deployment, which is further discussed at Section 2.2.6.

[3] Heat pumps MW has been extrapolated (not precise value).

As aforesaid, wind energy has the most significant proportion of energy in Lancashire; thus, of all of the technologies, wind energy has the greatest impact on the overall gap between current capacity renewable energy and the Lancashire Sustainable Energy Study 2020 deployable potential .

2.6.1.2 Unitary and District Level

The chart below compares, at a unitary and district level, renewable energy capacity in terms of current deployment, and the Sustainable Energy report's 2020 and 2030 technical potential. This chart is provided to indicate the extent of the theoretical potential (though not all of it is realistically deployable, refer Section 2.6.1 above).

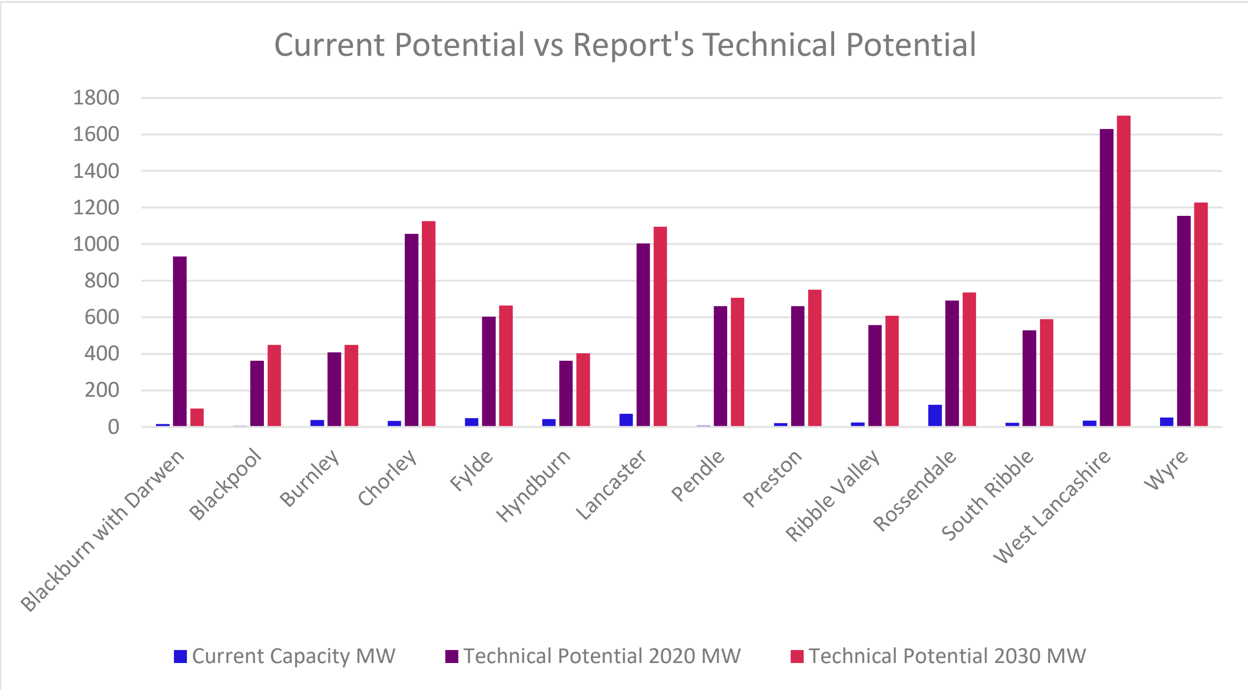

Figure 2.18: Lancashire Unitary and District Council Renewable Energy Capacity Comparison to 2011 Sustainable Energy Report Technical Potential

The chart below compares, at a council level, renewable energy capacity in terms of current deployment, and the Sustainable Energy 2011/2012 report's 2020 and 2030 deployable potential.

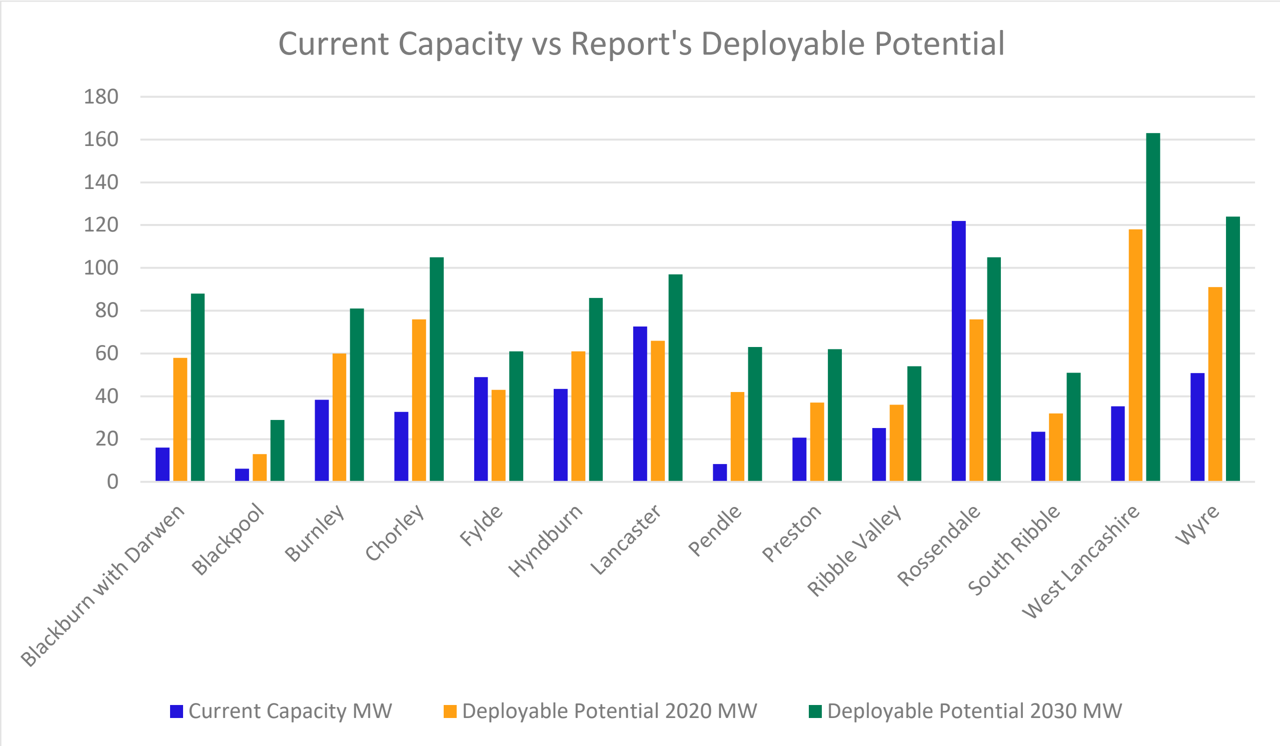

Figure 2.19: Lancashire Unitary and Districts Council Renewable Energy Capacity Comparison to the Sustainable Energy 2011 Report Deployable Potential

Comparisons to the predicted 2020 deployable potential for the various districts are as follows:-

- Fylde, Rossendale, and Lancaster all exceed predictions. Solar dominance in Lancaster and Fylde exceeded the report's predictions for solar in the area. For Rossendale, on the other hand, its wind energy was underpredicted in the report 114 MW vs. 68 MW.

Figure 2.20 and Figure 2.21 below display onshore wind and solar contributions per district, respectively. The other technologies do not have a strong influence on the overall renewable capacity.

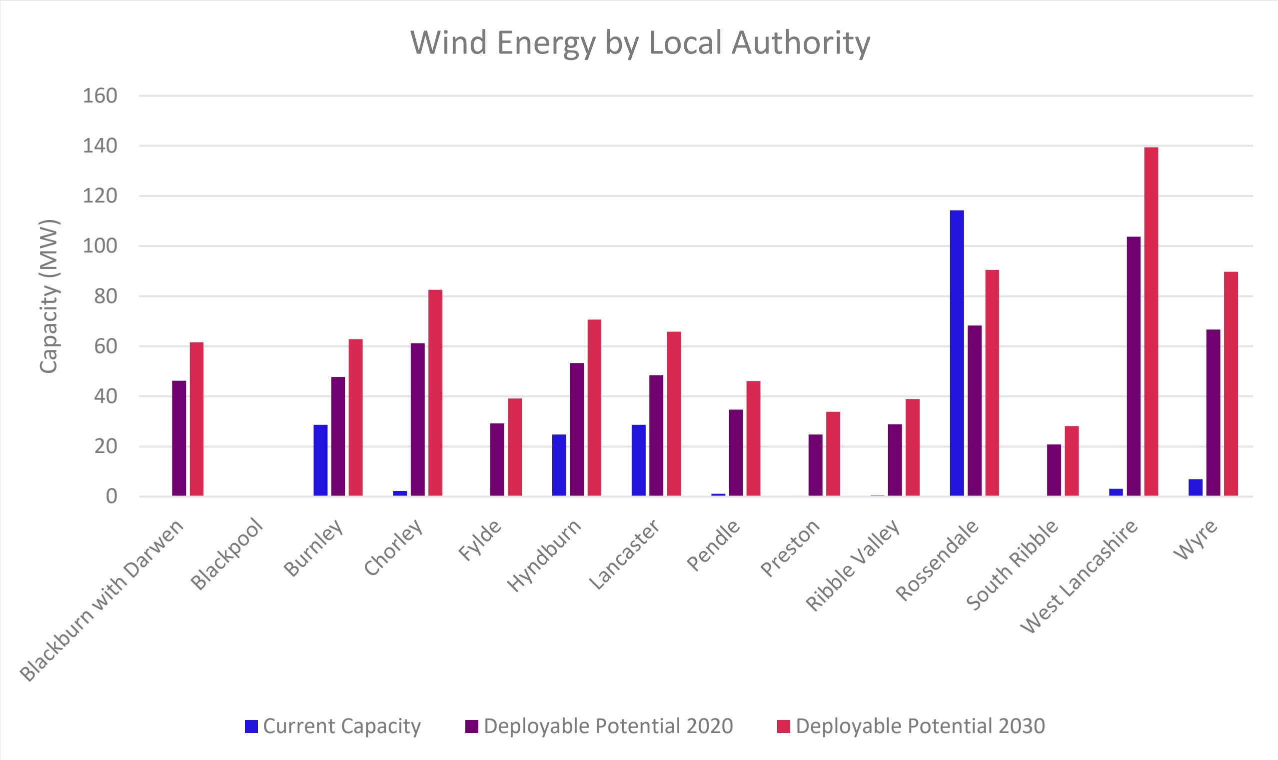

Figure 2.20 : Lancashire Councils Onshore Wind Energy Capacity Comparison to the Sustainable Energy 2011 report Deployable Potential

Observations of onshore wind energy data by dstrict are:

1. Rossendale is the only district that is exceeding predictions.

2. Chorley, Fylde, Pendle, Preston, Ribble Valley, South Ribble, West Lancashire, and Wyre need to considerably increase their wind capacity to achieve predictions.

3. Burnley, Hyndburn and Lancaster are achieving circa 50 to 60% of the predicted wind energy levels.

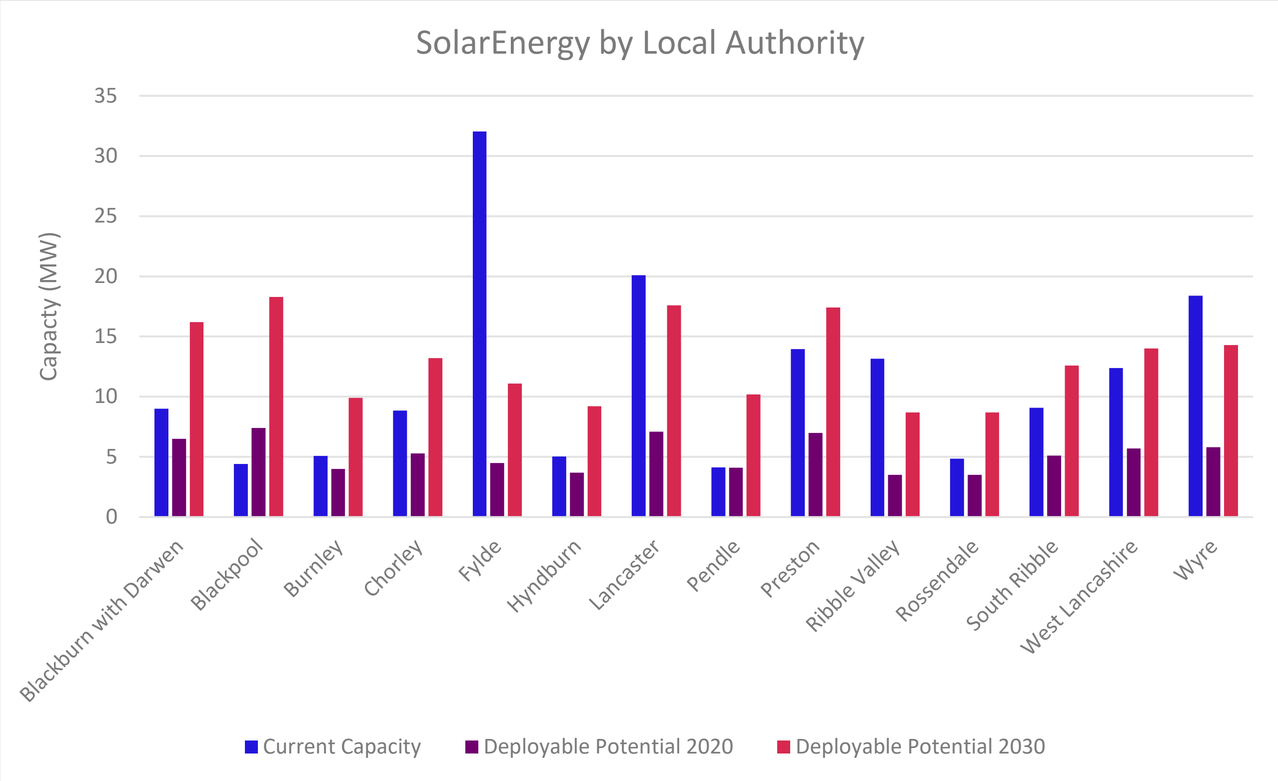

Figure 2.21 : LancashireDistricts Solar Energy Capacity Comparison to 2011 Sustainable EnergyReport Deployable Potential

Comparisons to the predicted 2020 deployable potential for the various districts are as follows:-

- For solar, current capacity, in most cases, considerably exceeds report's expectations for the reasons discussed in previous sections.

To conclude this section and looking ahead, there is still room for improvement in renewable energy capacity to be made for Lancashire in general and for each district. While there has been a significant increase over the last ten years, it has not come close to its full potential. Moreover, thanks to technological advancement and economies of scale, it is likely that 2030 deployment potential is now higher than Lancashire Sustainable Energy report calculations, and if recalculated today, the 2030 deployable potential would be higher.

2.7 Lancashire Renewable Energy Planning

This section discusses Lancashire renewable energy planning projects that have been accepted and awaiting construction and submitted application pending approval. The data is collected from: The Renewable Energy Planning Database ('REPD') and Heat Networks Planning Database ('HNPD'). This does not include domestic renewable energy or small-scale projects that don't require planning permission.

The chart below provides the total capacity per technology for projects that have been granted permission and are awaiting construction. It should be noted that newer types of renewable technologies, such as battery, are now being included in the planning data.

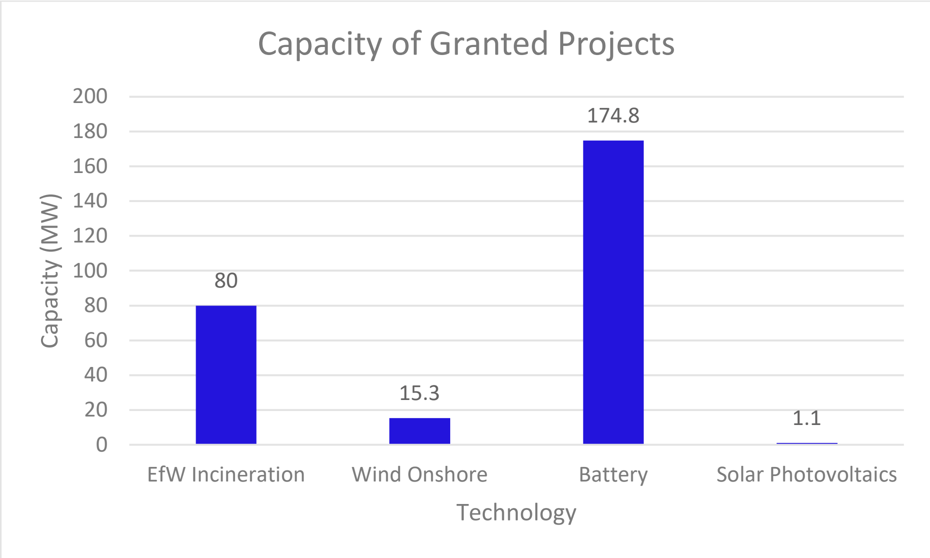

Figure 2.22: Lancashire Renewable Energy Projects Granted Permissions Total Capacity (BEIS- Planning, 2021)

If all projects complete, wind will increase capacity by 15 MW, waste by 80 MW and solar by 1 MW for a total of 96 MW (without counting battery). As a result, it will further improve the gap to the total predicted deployable capacity to be installed by 2030. Moreover, a few projects have been submitted but have not yet received approval for construction (as shown in the figure below). Therefore, the capacity could potentially increase by a further 35 MW, summing to a potential of 131 MW in the project pipeline.

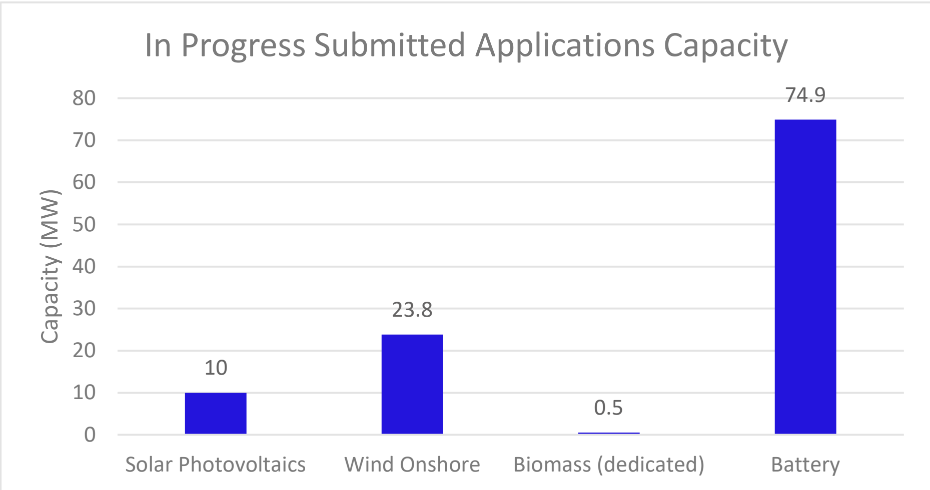

Figure 2.23: Lancashire Renewable Energy Projects Awaiting Permissions Total Capacity (BEIS- Planning, 2021)

In term of heating network there is only one Gas Boiler for the Royal Lancaster Infirmary - Energy Centre and it is under construction (capacity unknown).

2.8 Industries and Major Employers

This section highlights the capacity employed by the industry and major employers. Section 2.3.3 above outlines the industries and major employers in Lancashire. Unfortunately, in terms of installed renewable capacity, little reliable data has been discovered. Two employers with solar capacity installation have been identified:

- BAE Systems – 9,000 solar panels in the area of Samlesbury that provides a capacity of 2-2.6 MW. "This reduces the site's electricity bill by nearly £400,000 annually, while cutting CO_2 emissions by 1,500 tonnes". (BAE Systems, 2016)

- United Utilities – 8 MW of solar capacity.

- NHS - Lancashire Care had renewable energy equipment installed at 3 sites; The Harbour Biomass Boiler, Guild Park, and Sceptre Point Solar Panels. Capacity is unknown. (NHS, 2019)

Non-domestic heat data, covered in Section 2.4, also falls under this section. As Table 2.10 depicts, 111 MW comes from renewable heat technologies in the non-domestic sector.

3. Barriers and Constraints to Deployment

The following chapter examines the barriers and constraints that have hindered the deployment of renewable assets across Lancashire in the previous ten years. While the region has experienced positive growth in the sector, the capacity deployed still falls below the potential opportunity presented in the Sustainable Energy 2011/2012 report. There are a range of reasons why renewable assets have not been deployed at a faster rate, which include, environmental, administrative, and socioeconomic barriers. While some of these may be static constraints, which are unlikely to be overcome or change, many barriers can be avoided through adequate planning and design. This chapter is intended to provide councils, developers and other stakeholders involved in the deployment of renewable assets an overview of potential factors that could incumber the progression of their project. Furthermore, a suite of tools and approaches are discussed to help mitigate and avoid these issues and accelerate deployment across the county. Finally, an analysis of rejected planning proposals for energy projects in the county region provides further insight into why projects have failed in the past ten years.

3.1 Rejected Projects

The table below provides a high-level summary of the projects that have had their planning proposals rejected by different local authorities. While the analysis of the reasons as to why projects have been rejected is incomplete, the information available provides a general trend as to the primary reasons why increased deployment has not occurred. While the reasons for a number of sites were not established, it can be seen that the overwhelming reasons for rejection across the county were for environmental and ecological reasons.

Many renewable energy project applications have been refused or withdrawn over the past twenty years. This represents a substantial loss of capacity.

Table 3.1 : Capacity of Refused Renewable Energy Planning Applications

Technology Type	Installed Capacity (MWelec)
Anaerobic Digestion	2
Solar Photovoltaics	105.4
Onshore Wind[4]	271.4

This table suggests quite a significant amount of MW has been refused by the local authorities.

The table below summarises the main reasons of refusal for each project.

Table 3.2 : Reasons for Refusal of Renewable Energy Planning Applications

Record Last Updated	Site Name	Technology Type	Reasons for Planning rejection
26/09/2003	Black Scout Wind Farm	Onshore Wind	*Reliable data not attained*
10/12/2003	White Hill	Onshore Wind	*Reliable data not attained*

[4] Claughton Moor Wind Farm project has been resubmitted twice- first 39 MW second 23 MW– total 271.4 MW is counting both.

02/09/2004	Warcock Hill 1MW Project	Onshore Wind	*Reliable data not attained*
07/11/2007	The Stables (Edgeworth)	Onshore Wind	*Reliable data not attained*
02/10/2012	Cross House Farm Turbine	Onshore Wind	Radar Interference
07/12/2012	Claughton Moor (Re-Submission)	Onshore Wind	The development is of an inappropriate scale given its location within an Area of Outstanding Natural Beauty + residential amenity + ecological and biodiversity
10/07/2013	Claughton Moor (Re-Submission 2)	Onshore Wind	The development is of an inappropriate scale given its location within an Area of Outstanding Natural Beauty + residential amenity + ecological and biodiversity
08/10/2013	Reaps Moss Wind Farm	Onshore Wind	Visual Impact
08/10/2013	Hogshead Wind Farm	Onshore Wind	Visual Impact and Ecological Impact
08/10/2013	Tooter Hill and Hogshead Hill	Onshore Wind	Visual Impact and Ecological Impact
24/01/2014	Tithe Barn Lane	Solar Photovoltaics	Unsuitable for green belt land policy + visual amenity of the area
17/07/2014	Fletcher Bank Quarry (Waste AD)	Anaerobic Digestion	Inappropriate development on protected land and have a 'detrimental impact' on residents living nearby: cause noise, smell, traffic and pollution
23/11/2014	Bilsborrow Solar Farm	Solar Photovoltaics	Visual impact, the loss of agricultural land and impact on wildlife
20/02/2015	Land off Tithe Barn lane	Solar Photovoltaics	Green belt; visual impact; fails to protect local amenity; environmental
09/03/2015	Land off Moss Side Lane	Solar Photovoltaics	*Reliable data not attained*
28/05/2015	Hoddlesden Moss	Onshore Wind	Visual Impact - Environmental
05/11/2015	Cask Farm	Solar Photovoltaics	*Reliable data not attained*
04/01/2016	Rooley Moor	Onshore Wind	Unacceptable impact on the landscape and on heritage assets

06/01/2016	Lower House Farm	Solar Photovoltaics	*Reliable data not attained*
05/02/2016	Gerard Hall Solar Farm	Solar Photovoltaics	Unsuitable for green belt land policy -+ visual amenity of the area
30/05/2016	Wanes Blades Road Solar Farm	Solar Photovoltaics	Impact on environment and visual amenity of the area; not compliant with green belt land policy
30/01/2017	Clifton Marsh Wwtw	Solar Photovoltaics	*Reliable data not attained*
01/02/2017	Little Snodworth Solar Farm	Solar Photovoltaics	Green belt; visual impact
04/04/2017	Lower Alt Wind Farm	Onshore Wind	Green belt land; + harm to the historic setting of a number of local heritage sites
28/07/2017	Scout Moor Windfarm (extension)	Onshore Wind	Significant adverse effect on the landscape character and visual amenity; result in significant adverse visual effects and would harm the appearance of the area for local receptors
30/08/2018	Back Lane Solar Farm (resubmission)	Solar Photovoltaics	Environmental concern on Green belt land
10/06/201 9	Claughton Moor Community Wind Farm	Onshore Wind	Landscape and visual amenity + ecological and biodiversity + highways and access + highway safety + residential amenity + radar
26/03/2020	Fromby Lane Solar Farm (resubmission)	Solar Photovoltaics	Environmental - Green belt

To summarise the main reasons for refusal were:

- Green belt policy: most of the refused applications go against the green belt policy, with green belt affecting all technologies. The green belt being a policy for controlling urban growth and so protecting agriculture, forestry, outside leisure, and openness of area.
- Effect on the landscape and visual amenity of the area: alongside with the green belt many projects have been refused (and protested by local areas) because it was believed that it would harm the landscape and visual amenity of an area.
- Effect on the residential amenity of the area: noise, visual, traffic, smell, and discomfort caused to the residentials.
- Ecological and biodiversity harm: impact on protected species and nature.

Among the list special cases for refusal included: radar interference cause by the wind farm (Cross House Farm Turbine), detrimental impact to residents living due to noise, smell, traffic and pollution caused by Anaerobic digestion and highways and access and safety (Claughton Moor).

3.1.1 Withdrawn, Abandoned, or Expired Applications

A few project applications instead of being refused were either withdrawn, abandoned, or expired. The table below gives total capacity for the technology involved per category:

Table 3.3 : Capacity of Withdrawn, Abandoned and Expired Planning Applications

Technology Type	Abandoned Installed Capacity (MWelec)	Withdrawn Installed Capacity (MWelec)	Expired Installed Capacity (MWelec)
Biomass (dedicated)	2.2	0	0
Anaerobic Digestion	2	0	0
Wind Onshore	4	0	14.1
Solar Photovoltaics	12.2	7.5	15

Withdrawn applications follow similar reasons as refusal applications. Because of lengthy discussions around different concerns, some applications tend to become too difficult to proceed with. For one withdrawal two new concerns/barriers were noted: 1) impacts on designated heritage assets. 2) Potential safety risks associated with the proximity of the developme nt of Nuclear Power Station. These were found for the Heysham Wind Farm the application which was withdrawn because of 4 fundamental concerns:

1) Impacts on ornithology and potential adverse effects on Morecambe Bay SPA/RAMSAR site
2) Impacts on the setting of designated heritage assets (St Patricks Chapel and Heysham Head)
3) Impacts on residential amenity (visual impacts); and
4) Potential safety risks associated with the proximity of the development of Heysham Nuclear Power Station (concerned raised by EDF Energy). (lancaster.go.uk)

In some cases, the operator or applicant have abandoned the project or let it expire without the reason being made clear. The reasons for these could be commercial or economic.

3.2 General Barriers and Constraints

3.2.1 Environmental and Ecological Barriers

The key issue with some of the renewable technologies is their requirement for a large amount of land space. The majority of these technologies need a large investment to get the land ready for the technology and connection required or the introduction of new facilities can end up interfering with existing land uses. Therefore, councils could look to establish designated areas to make developers aware as to where, provided the land is suitable, they can propose projects. These designated areas can also work in a recycle based scheme where developers can work to either recycle the materials to carry on the same type of project or can reuse the land for other projects as technology advances are made over the course of the technology's installation period.

The introduction of many of these technologies would lead to habitat loss and potentially the use of hazardous materials in manufacturing, which will need to be considered during the proposal stage. Proposals that cannot show that they have limited any potential damaging effects to the environment are highly likely to be rejected. For example, wind turbine projects would need to take into consideration their potential impact on birds as many turbine projects need to be located and designed to minimise collisions with bird populations, therefore avoiding having turbines located in or close to major habitat or migration pathways.

3.2.2 Technical Constraints

There are several technical constraints that may impact renewable technology deployment over the coming decade. The key constraints that will come from trying to significantly increase the current capacity will be electrical grid capacity needed by 2030, as it would need to be able to withstand the extra capacity expected from the renewable technology. There are other constraints such as transmission constraints, economic viability constraints, supply chain constraints and planning constraints. These constraints will play a key role in the capacity role out that is able to be achieved by 2030.

For solar the key technical constraints stem from the efficiencies they are able to achieve. Currently solar panels are able to process around 15-20% of solar energy into usable energy, dependant on where the panels are located, their orientation and local weather. There are solar panels which can now reach an efficiency of 40-45%, however they are quite new to market so come with high costs per square metre. A key driver to support the uptake of these higher efficiency solar panels would be access to capital, and support from local policies and housing associations. Solar irradiance is also a limitation as Lancashire only receives an annual average of circa 1,000kWh/m^2 compared to southern UK counties with circa 1,150kWh/m^2 (Green Business Watch, 2018). In Lancashire there is more of an opportunity for ground mounted solar as there are areas of land that could potentially be used compared to roof mounted solar, which have limitations on structural integrity of buildings and lack of available space.

For wind technology the limiting factor is the Betz limit, 59.3%, that is the theoretical maximum that could be reached by spin and generate energy however in reality turbines are only able to reach about 35-45% range. There are many advances in wind power technology with newer bigger turbines able to operate at lower wind speeds. However, there are other limitations that come with these advances in technology such as the limited number of turbines per kilometre that are allowed due to the turbulence that is shed from the turbine. This can be avoided through the use of vertical turbines however they have a lower power output and they are not as developed supply chain wise so are riskier as an investment. Wind turbines can avoid visual impact issues through avoiding implementation in sensitive landscapes, especially as there could be an issue with a flickering effect, which can also pose a limitation to where wind turbines can be located. The flickering affect is caused when the sun shines through the blades on the turbine and the moving shadow causes flickering. The government guidance states that only houses that are located within 130 degrees either side of north relative to a turbine with a 10-rotor diameter can be affected by this. This can be avoided if turbines are appropriately located or set to automatically stop if the potential for shadow flicker occurs.

Large scale hydroelectric projects face a huge concern around their impact on wildlife and local habitats, as they require water reservoirs, which unless already existing, would need to be artificial. There is also an issue with the effect on wildlife during construction due to the noise and construction impact. A similar issue also affects tidal especially due to large area that the project needs to be to economically generate the power required.

For anaerobic digestion and energy from waste the barriers shift more towards odour reduction as well as the visual and land impacts the other technologies face. For AD there is an issue with the output of the process (digestate), which would need to go through other processes to enable it to become a useful material, otherwise the digestate itself becomes a waste. Another hindrance to AD technology is the fact that as this is a biological process, where correct conditions are required in order for this process to work optimally. If these processes are disturbed the digestion process would not function efficiently. There is also the odour problem with the feed into the anaerobic digestor which requires either measures to be taken to ensure the system as a whole is closed off or not located near dwellings. The supply chain for AD is not as developed compared to solar and wind so it can have relatively large capital costs.

The key barrier to heat pump technology is the high investment and building retrofitting costs that come with the technology. In the next decade an increase in heat pumps can be foreseen however, there are high costs that come with the technology as well as introducing the new technology to consumers that might not want to get on board especially with no incentive. There are a number of potential issues with heat pumps as follows:

- ground source heat pumps requiring boreholes, which could have an impact to the local environment.
- There may not be a servicing infrastructure available to the same extent as the current non-renewable alternative.
- Many of the dwellings that might want to install this technology may not have sufficient space available to install the equipment.

- As heat pumps are taken up by more households there may emerge capacity issues on the local electrical grids.
- This technology requires a low temperature heat distribution system in order to be at optimal performance which is an extra cost that consumers may not be willing to install.

Although energy from waste significantly helps the UK conduct waste management at landfill sites the key barrier is that the process itself still produces CO_2. Left untreated the waste will have a greater impact on the local environment and there is also the issue with landfill gas that can be burned to produce CO_2 but can result in some of the methane from the landfill being released into the environment. The process for EfW production is well established and can be deployed across Lancashire with the technical barriers being well understood. The main barriers would be acceptance across local communities due to perceived waste odour issues. Overall, with EfW the aim is to move towards a circular economy which will reduce the need for this route of energy production.

3.2.3 Legal Barriers

In the UK the Renewable Energy Directive supported a drive in renewable energy requiring that at least 15% of total energy produced needed to be renewable by 2020. Policies and legislation can act as a key driver for uptake in the coming decade, however they can also cause limitation to the uptake especially if appropriate support is not given for a long enough period. The Office of Gas and Electricity Markets (Ofgem) is one of the key authorities that regulates the renewable energy sector, as it grants licenses and ensures the electricity market remains competitive. The Energy Act (2013) is a key piece of legislation relating to renewables, as it has a legal framework that aims to secure affordable and low-carbon electricity. This act introduced the Contracts for Difference framework which was a key driver for the uptake of renewable technology over the past decade. The main barrier that renewable technology deployment will face legally will be the uncertainty around policies and incentives relating to renewable energy as much of the uptake and investments into these projects is heavily reliant on schemes such as CfD and FiTs.

There are several legal barriers when it comes to renewable energy implementation within an area. The key limitation for many renewable energy projects comes from planning policy with planning authorities only approving projects that are able to sufficiently show that they have minimal impact to the development land and that the visual and noise impacts are minimal. Even if the developer owns or has rented the land suitable for renewable energy deployment, they still would not be able to proceed with any build without the appropriate planning permissions. Many developers may also face supply licensing issues, which is a requirement prior to being able to supply renewable energy directly to consumers.

Compared to wind, solar does not face as much scrutiny when applying for planning permission as the projects do not significantly change the outside appearance of a building and they make no noise. However, wind has more considerations that need to be assessed by the local authority prior to permissions being granted. The planning authority needs to weigh up the effect the construction could have on the local environment against the reduction to climate change effect the introduction of the proposal could have.

3.2.4 Grid Constraints

Connection of generation load to the electricity grid has the potential to trigger costly reinforcement works. Reinforcements due to insufficient current carrying capacity on particular parts of the network or an increase in potential fault currents. Synchronous generation technologies such as wind turbines generate larger fault currents than inverter-based generators such as solar PV and therefore less headroom will be available on the network for generators of this type. The larger the connection of either generation or demand is, the greater the likelihood of triggering reinforcement.

Reinforcement works can add significant costs to a renewable development project as well as cause longer lead times and significant reinforcement works could damage the commercial viability of some projects or cause them to fail entirely. This is especially true for medium sized developments where developers may not have sufficient amounts of available finance to afford the costs posed by required reinforcement but whose installations may be sufficiently large enough to trigger reinforcements. It is therefore important that developers engage early with Distribution Network Operators (DNOs) to understand the work required to accommodate any potential development and the impact this may have on the project. Early engagement can give developers longer times to plan and maybe shift the location of the development in order to avoid reinforcements. Developers may also work with DNOs to understand areas of the network where capacity constraints may be eased by the location of renewable generation.

Electricity North West (ENW) provides an online heatmap free for public use. This displays all of ENW's substations and gives an indication of the available demand and generation headroom. Developers can make use of this tool to give an idea of the available capacity there may be for generation on that part of the network. This can provide an early warning if generation is constrained in the proposed development area. Local authorities can support developers by signposting them to these tools to help them understand some of the considerations they will need to take regarding connection to the grid. It should be noted that this tool does not serve as a replacement to engagement and conversation with the DNO and should only be used as a high-level indicator or an initial tool to get the conversation with the DNO started. In-depth discussion and feasibility studies will be required to understand the true impact of connecting any generation onto the network.

Energy storage systems (ESS) such as batteries, can provide greater flexibility to electricity networks. They are able to function as both a generator or demand by either storing or discharging energy, and network operators can use this feature to balance the network and alleviate constraints caused by insufficient or surplus supply and demand. This allows network operators much tighter control of the network and can allow additional generation demand capacity on the network without triggering reinforcements. For developers this can mean they are less likely to run into prohibitive reinforcement costs or lead times.

Local councils can support further penetration of ESS onto the electricity grid by looking to engage with and support trials for novel storage technologies. This can enable further penetration of ESS onto the grid, improving overall flexibility of the network and keeping required reinforcement works to a minimum.

3.3 Planning and Public Opposition

The planning process for renewable energy projects is a crucial step towards deployment. The planning process involves two main steps: a pre-application and later the main planning application. The pre-application requires consultation with the local communities to improve the efficiency and effectiveness of the planning application system for all parties. As stated in the National Planning Policy Framework, "*pre-application discussions should enable early consideration of all the fundamental issues relating to whether a particular development will be acceptable in principle, even where other consents relating to how a development is built or operated are needed at a later stage.*" and "*the more issues that can be resolved at the pre-application stage, the greater the benefits*". The main planning application needs more substantial work to be compliant with policies, clearly making sure that the area chosen is appropriate for the project (considering all environmental and community concerns), and outlining the benefits and drawbacks. The planning authority will need to consider both national and local authorities' policies. For more information around specifics of the planning application process, the National Planning Policy Framework should be consulted. Applications normally take "*13 weeks for major development and 8 weeks for other development, or any period agreed in writing between the developer and the local authority*". Major development is defined as development carried out on a site having an area of 1 hectare or more. It is crucial to carefully highlight all aspects of the planning application to avoid delays.

The following two sub-sections analyse barriers and constraints concerning planning and public opposition.

3.3.1 Planning

Strictly speaking, planning process itself is not a barrier or a constraint to deployment of renewable energy projects. The planning application is important so that critical aspects where a project could negatively impact the community, environmental impacts, and other potential issues can be considered. This is an important step towards the proper implementation of projects. National and local planning policies are there to both protect communities and the environment as well as promote the deployment of sustainable and renewable energy.

Thus, the planning process isn't a negative step towards renewable deployment. However, because many applications are rejected or delayed during the planning process, in some cases, if not managed well, the planning process can cause barriers and constraints toward deployment. For instance, in some cases, the way the whole planning application is conducted is a barrier for many developers. Some examples of where the planning process is not operated efficiently are:

- Selecting an unsuitable location for the project
- Poor communication between council/planning officers and developers
- Poor research by developers
- Poor interaction with local communities

These four aspects are analysed in more detail by presenting case studies and discussing solutions. Poor local community interaction will be covered in the public opposition section as it is directly connected.

3.3.1.1 Selecting an Unsuitable Location

While an important aspect of the planning process is to determine whether an area/land is suitable to be used or not, it is not the only objective. In many cases, projects have been refused due to selecting an unsuitable location. The planning process could be greatly optimised if suitable land areas were, to some extent, already determined. Thus, if a project is in a land area where it is already known to be suitable for use, the planning process could focus on other essential aspects such as community, environmental protection preventions, and planning demands. For instance, in many cases, projects in areas of clear objections, such as within the green belt, were submitted by developers, thus, "wasting" both planning officers' and developers' time and money.

Solutions to reduce the number of applications refused for unsuitable land area include:

- Conduct new geographic information system (GIS) studies or models to determine all plausible areas that are most likely to be suitable for renewable energy deployment in Lancashire. The more precise the analysis is, the better the result, of course. However, the study does not have to be absolutely definitive, but rather underlining which areas are strictly forbidden, and which areas could potentially be exploited, which would benefit developers enormously,
- If a study of the whole Lancashire region is not feasible, only understanding which lands within the green belt area can be utilised would benefit all stakeholders involved. As aforesaid, many of the projects are refused because of being inside the green belt area. In some cases, it is possible that because of "very special" circumstances, renewable energy projects can be approved within the green belt regions. It would be beneficial to clearly state areas within the green belt that can't be utilised, so avoiding applications being refused immediately.

Case studies 1, 2, and 3 below serve as examples.

3.3.1.2 Poor Communication between Council/Planning Officers and Developers

While a pre-application is a mandatory step, in some cases, it does not achieve its intended purpose. As case studies demonstrate, there are occasions when poor communication leads to unnecessary extra time on projects. Communication is vital for projects to be implemented; councils and developers should work together to understand the pro and cons when implementing a project.

Solutions to improve communication include:

- Having in place a good framework that obligates a certain level of communication would highly benefit future projects submissions
- Having a checklist that both planning officer or council and developers need to review together.

3.3.1.3 Poor Research by Developers

As case studies 2 and 3 below show, there are occasions where developers do not perform an adequate level of research needed for the application. Local authorities can't control quality of the level of research or how well a developer follows the project guidelines, nevertheless, actions can be performed to prevent them. Possible solutions include:

- As aforementioned, a better communication framework is the first step.
- Create a checklist for developers to complete when submitting an application, specifically for each different district.

Other solutions for planning authorities: Within the planning team, more specialisation in renewable energy planning policy or a dedicated resource at the upper LA level providing technical support for lower level planning teams.

3.3.1.4 Case Studies

Case Study 1- Little Snodworth Solar Farm (Dept for Communities and Local Government, 2016)

Mulbrick Clean Energy ltd put forward a planning application for Little Snodworth Solar Farm in Ribble Valley area. The project had been refused when first submitted. The developers of the project then presented an appeal that resulted in a refusal by the Secretary of State. Little Snodworth Solar Farm was refused for three reasons:

1. Inappropriate development in the Green Belt.
2. "*Harmful to the visual amenities and character of the locality by reason of the size, scale, incongruous appearance and inappropriate nature of the proposals; particularly with regards to the proximity of the development to adopted highways and the lack of any proposed natural screen planting/landscaping to mitigate the detrimental effects upon visual amenity*".
3. "*Proposal would result in moderate landscape character and visual impact harm when seen from local vantage points*"; contrary to Policy DMG1 of the Ribble Valley Core Strategy(Adopted Version).

The case study highlights three important aspects:

- No appropriate communication with the developer – the developer highlighted in the appeal that: "*It was understood that the application would be assessed versus the policies regarding development within the Green Belt, however, there was no prior communication that there was concern regarding the landscape and visual impact, impact on local roads or the potential to impact on the experience of the local footpath network.*" The appeal suggests poor communication between the planning officer, the council, and the developer,
- As stated by the Secretary of State in response to the appeal - the reason for refusal highlights how this project would have substantial harm to the Green Belt and that no exceptional circumstances needed to justify the proposal do not exist.
- Local policies, such as DMG1, do have important influence in the projects outcome.

Conclusions: - developer choosing a Green Belt area that had no prospect for constructing a solar farm, poor communication leading to an appeal, and importance of local district policies.

Case Study 2 - Appeal by Peel Energy LTD: Land at Common Lane (Dept for Communities and Local Government -1, 2016)

Peel Energy LTD appealed to the council's decision to refuse the construction of a 5 MW solar farm in the Land off Common Lane, Frodsham, Cheshire, WA6 0JS. The appeal was also refused, the main reason being: "proposal represents inappropriate development in the Green Belt and that this would be, by definition, harmful to the

Green Belt". In addition, the "loss of openness and visual impact would run counter to the aim of safeguarding the countryside from encroachment".

Further, the following statement was noted in the response of the appeal: "The Secretary of State notes that the agricultural land classification is 3b (which is not the best and most versatile land) and agrees with the Inspector that no compelling evidence has been submitted to undermine the appellant's consideration of potential alternative sites (IR75)." This highlights how the developers could have presented more evidence regarding land alternative.

Conclusions:- developer choosing a Green Belt area that had no prospect for constructing a solar farm and did not provide compelling evidence on land type and alternatives. Overall, this demonstrates how a study highlighting potential suitable area would be highly benefit to all stakeholders involved.

Case Study 3- Appeal by Green Switch Developments (Dept for Communities and Local Government -2, 2016)

Green Switch Development appealed to the West Lancashire Borough Council's decision to refuse the construction of a 16 MW solar farm (Wanes Blades Road Solar Farm) in Tawdside Farm, Lathom, Ormskirk, Lancashire, L40 4BL. The appeal was also refused. The main reasons being:

1. "*the proposal is in conflict with national policy as it relates to the Green Belt, and would therefore cause definitional harm, additional harm to openness and harm to one of the purposes of designation*".
2. "*the proposal would result in significant visual harm when viewed from local vantage points*".
3. "*Secretary of State notes that the Inspector did not have sufficient information to assess if alternative, non-agricultural sites in the wider Lancashire / North West England region would be suitable for a development of the size proposed*".

Concerning the third point, in the first refusal, the project was rejected because the applicant had failed to justify the loss of 39 hectares of best and most versatile (BMV) agricultural land. On the appeal, it was learned that "67% of the site is of Grade 3b agricultural land, which is below BMV quality". Nevertheless, this was still not adequate for the Secretary of State to draw a conclusion.

Conclusions:- developer choosing a Green Belt area that would cause harm to the area and not conducting the right level of research needed to highlight the quality for the land used and to justify the loss of agricultural land area. Moreover, in this case study the Secretary of State could not make a decision as it did not have sufficient information around "if alternative, non-agricultural sites in the wider Lancashire / North West England region would be suitable for a development of the size proposed". Understanding these alternative sites would greatly benefit deployment for all stakeholders involved.

3.3.2 Public Opposition

The planning process and public opposition come basically hand in hand. As the following case study show, many applications get turned down to public opposition. Public opposition mainly comes from local communities or "organised communities". The public has the right to express their concerns on large energy projects that happen near their communities, so it is critical to have a good interaction with all parties involved. In almost all refused applications, residents have gathered to oppose the projects being put forward. For instance, onshore wind, energy from waste, and solar projects (as highlighted in Table 3-2). Case study 4 below is just an example of what happens most of the time.

Solutions to reduce public opposition and understand the public concern involve:

- Make sure there is good communication between the public and the developers. Create mandatory meetings or some agenda developers must follow.
- Educate the public on the benefits of renewable energy projects.

- Understand public concerns, usually around visual amenity and environmental protection, and understand if there are any steps that can be taken to proceed with the project.

3.3.2.1 Case Study

Case Study 4 – Stop Hoscar Farms (Stop Hoscar Solar Farm, 2016)

This case study also concerns the refused solar farm in the Land off Common Lane, Frodsham (ref. Case Study 2). In this case a group of residents from Hoscar, Lathom, Bispham Newburgh, Hilldale and Parbold came together to continue objections to the plans for a 90 Acre solar farm on Greenbelt land in Hoscar. As stated on their website, they wished to "*keep Hoscar Moss safe for future generations who can now look forward to enjoying its openness and take pleasure in the variety of wildlife that it plays host to*."

Residents do gather to oppose projects that, from their point of view, are not beneficial towards the landscape amenity and environment. In many cases, education with locals could help find a solution that benefits the construction of the project and achieve residents' approval. For instance, agreeing to operate the solar farm for an agreed timeframe (such as 25 years). Educating the communities on the importance and benefits of some renewable projects can facilitate both the communities and developers.

3.3.3 Aviation and MOD Constraints

Some renewable generation technologies can negatively impact aviation and defence operations, which is especially true in the case of wind. Wind turbines above a certain height can present physical obstruction to the flight path of aircraft, this is increasingly important at night often requiring high visibility equipment such as lights and high visibility painting or sheaths for guy wires. Wind turbine blades can also interfere with radar and communications, navigation and surveillance systems for air traffic management (CNS) equipment. Wind turbine blades, if sufficiently large, can throw up false readings to nearby radar systems causing them to be detected as aircraft. The chance of this increases with more turbines and denser spacing. Wind turbines also generate turbulence which can disturb the flight of aircraft if flying too close.

It is important that wind developers engage early with aviation authorities to understand whether their planned project will cause any disruption. Many of these potential issues have workarounds such as altering flight paths, increasing visibility of turbines or switching to alternative radar systems, however this all requires prior planning and therefore early engagement is key.

Both the MOD and the NATS make various provisions for developers to identify and mitigate any potential disruptions that may be caused by planned development. NATS have an online self-assessment form that developers can fill out to understand if their development may impact on NATS activity. They also provide a google maps layer for developers, to showcase any parts of the country that may potentially impact upon their operations should wind developments be built.

The MOD have a wind energy team that will consult with local planning authorities to help both parties identify and understand any impacts the development may have. Developers can access these consultations by submitting an application form. The minimum information developers will require when filling out these application forms is:

- Maximum hub height above ground
- Rotor diameter
- Grid reference for the planned development
- Generation capacity

The below table provides and overview of consultation considerations.

Table 3.4 : MOD Consultation Considerations for Wind Turbine Planning Applications

Location	CNS Facilities	Obstacle Considerations
Aerodrome (consultation required with aerodrome licensee/manager)	• Safeguard PSR and SSR • Safeguard Approach Aids • Safeguard Navigation Beacons • Safeguard VHS	• OLS • Impact on procedures • Need for lighting to aid night time conspicuity • Anemometer masts
En Route (consultation required with MoD and NERL	• Safeguard PSR and SSR • Safeguard Navigation Beacons • Safeguard VHS	• >300 ft/91m chart and entry to AIP • >150m (492 ft) Lighting in accordance with article 219 of ANO 2009 • Marking of turbine upper 2/3rd in white in accordance with ICAO guidance • Potential for additional lighting requirements where turbines may be considered as a significant hazard
Offshore (consultation required with MoD, NERL and MCA)	• Safeguard PSR and SSR • Safeguard Navigation Beacons • Safeguard VHS	• Offshore lighting in accordance with article 220 of ANO and CAP 764) • HMR • Operations around oil and gas platforms • Anemometer masts • Search and rescue requirements

The MOD recommends that if a turbine is eleven metres blade to tip or taller or has a rotor diameter of two metres or more, then developers and local planning authorities should consult with their wind energy team.

The Civil Aviation Authority in their CAP76 document provide the following guidance for wind developers to consider whether their installations may interfere with aerodrome activities.

- Unless otherwise specified by the aerodrome or indicated on the aerodrome's published wind turbine consultation map, within 30km of an aerodrome with a surveillance radar facility. The distance can be far greater than 30km depending upon a number of factors including the type and coverage of the radar and the particular operation at the aerodrome.
- Within airspace coincidental with any published Instrument Flight Procedure (IFP) to take into account the aerodrome's requirement to protect its IFPs.
- Within 17km of a non-radar equipped licensed34 aerodrome with a runway of 1,100m or more.
- Within 5km of a non-radar equipped licensed aerodrome with a runway of less than 1,100m.
- Within 4km of a non-radar equipped unlicensed aerodrome with a runway of more than 800m.
- Within 3km of a non-radar equipped unlicensed aerodrome with a runway of less than 800m.

The CAA can provide the following input to formal planning submissions for wind turbine developments:

- Identification of aviation stakeholders that would potentially be affected.
- Reviewing the aviation section of the Environmental Statement for accuracy and completeness.
- Consideration of regulatory requirements.
- Consideration of whether all other aviation issues known to the CAA have been taken into account (including other potential developments).

It should be noted that the CAA is currently only a statutory consultee for onshore developments in excess of 50MW and for offshore developments in excess of 100MW. Responses to other planning submissions can be made, resource permitting.

Solar PV can also negatively impact upon aviation activities. Physically PV can impact on safety clearances around aerodromes. Any cranes used in the construction of the array could pose a potential safety hazard if they are within the vacinity of an aerodrome. Developers should consult with the aerdrome or airfield manager a minimum of 6-8 weeks prior to development taking place to gain a permit to work if the crane is within 6km of the aerodrome and its height exceeds 10m or the the height of surrounding structures or trees.

PV installations can also attract birds which like to roost underneath the panels. Birdlife can be incredibly dangerous to aircraft activities, obstructing flight paths and being drawn into plane engines. Developments which may have the potential to attract birdlife, such as PV, within 13km of an aerodrome may need a Bird Hazard Management Plan (BHMP) to be agreed with the aerodrome to detail how the development will be managed with regards to birdlife.

Solar PV can also produce glare which can cause visiblity issues for aircraft pilots. Developers can use solar glare analysis tools such as National Laboratory's Sandia to predict the likelihood of glare for aircraft paths and fixed points such as air traffic control towers.

PV can also interfere with Communication Navigation Systems (CNS). To understand the impact of this, it is recommended that developers consult with the aerdrome operator and Air Navigation Service Provider.

Biogas plants can produce thermal plume turbulence which can affect the manouvreability of aircraft as well vapour plumes which can provide visual obstruction. If sufficiently large enough the plant may also impact on radar systems used by aviation authorities. As with the above two technologies early consultation with the aerdromes to understand the impact of any planned development should be prioritised.

Whilst most of the responsibility for mitigating the potential risks posed by renewable development to aviation activities lies with the developer, local authorities can support developers by promoting awareness of the relevant considerations. Local authorities can signpost developers to the relevant websites, documents and tools provided by aviation authorities on their own websites. This will help by provding developers with all the relevant information and processess they need to understand in order to avoid potential risks posed by the development to aviation activities.

3.4 Capital Constraints

Among the constraints that will be the hardest to overcome is the availability of capital to fund new projects. The UK is in a position post Brexit and post COVID-19 where it is looking to recover and grow in a new direction. The issue is that the roadmap post both these economic and social shock events also requires capital to enable new opportunities. New clean energy projects in the UK will therefore find itself competing even more fiercely for capital. Furthermore, globally despite an increase in the investment of green technologies and assets, the level of investment is still far short of what is required to limit global temperature rises to below 2 degC (The Economist, 2021).

3.5 Green Tariffs

As the UK electricity grid transitions to a zero-emissions energy mix, a frequent question being raised is why anyone should consider installing costly renewable assets when it is possible to purchase green tariffs from an increasing number of energy suppliers. While such a perspective raises valid concerns, especially when considering the scale of capital costs, there are a number of risks associated with this question. Green tariffs are a major procurement route to meeting a large proportion of the region's electricity demand, though their use must also be matched with a supply of renewable energy to meet the demand. The rationale which underlines this question presents a serious barrier to the deployment of renewable assets, the following sections dissects these problems and considers how councils can begin to overcome them.

The nature of renewable energy sources is that they are variable with time and geography and, as a result, the supply needs to be met by a with a large variety of different assets utilising different resources across the country. This differs from the conventional model of generation, where large power stations were strategically positioned to provide power to population centres and the electricity network was designed around this unidirectional centralised structure. Utility scale renewable assets have made considerable gains in increasing renewable supply, but the cost of transmitting and distributing this electricity is expensive and increasing. One of the advantages of renewable technology is that the assets can be integrated into urban areas and, with over 80% of the population living in such areas, the need to pay for an increasingly large and complex network only serves to disadvantage consumers through increases to energy prices (UK Government, 2020).

To countenance the intermittency of decentralised renewable assets and maintain a security of supply to consumers, the network requires back up generation which currently is made up of a large number of combined cycle gas power stations. As a larger share of renewables is added to the grid, these plants are idle for longer periods of time and so when they are fired up to meet demand, the cost of electricity is high as they are not operating in an efficient regime.

The issue is that if domestic and commercial consumers as well as public institutions increasingly choose to buy green tariffs as opposed to investing in local renewable assets, the risk is that the price of energy continues to increase while also risking the security of supply. This is more of a risk considering the rate of transition required to net zero. By not exploiting the resources proximate to population centres, larger assets will be built further away, requiring a larger more complex network, which increases costs. With more renewable capacity the cost of maintaining reserve energy assets will also increase. Eventually with fossil fuel power stations becoming economically unviable or are decommissioned like the UKs aging nuclear assets, there isn't the reserve power to balance the grid which risks the security of supply. This may all be compounded by future increases to the price of carbon.

Finally, green tariffs are certified as zero carbon as they are backed by a renewable energy guarantee of origin (REGO) certificates. REGO's are issued by the UK regulator the Office of Gas and Electricity Markets (Ofgem) to generators for every 1 MWh of renewable electricity they produce. These certificates are then used by licenced suppliers as part of their fuel mix disclosures, demonstrating the proportion of electricity they supply that is generated from a renewable source. Consumers can then select their green tariff from the licenced supplier of choice and understand the proportion of electricity they consume which has zero emissions. While REGO's ensure that renewable electricity generation is being supplied into the grid, the certificates can be unbundled from the energy being supplied to customers and be traded as a financial instrument. This means that a licenced supplier can source their electricity from fossil fuel sources and purchase REGOs to cover their output, therefore still certifying that their electricity is from 100% renewable sources and produces zero emissions. If consumers require green tariffs a low carbon supply is required to meet this demand. As more consumers switch to green tariffs instead of installing their own assets and supply doesn't match demand, the price of REGO certificates is likely to also increase with the cost being passed onto the consumers. Coupled with all of the possible outcomes mentioned in this section, a possible future trajectory for energy is a risk from increasing costs and security of supply.

To prevent this trend occurring in the energy system it is imperative that local authorities utilise the space proximate to urban areas or within urban areas themselves with renewable generation assets. This barrier is complex as it's a function of the current structures and mechanisms of the energy market and is linked with the barriers associated with the location of end users and the viability of opportunity in the region compared with elsewhere in the country. This section has tried to establish why it is important for the population of Lancashire that local authorities encourage investment in renewable asset deployment within their own boundaries and close to consumers. However, currently the market conditions necessary to enable this transition do not exist. The accelerated period of growth in renewable generation in the UK occurred at a period where grant's, subsidies and other incentives made the business case for small to medium scale assets viable alongside utility scale projects. It should be noted that the performance and payback of renewable assets increasingly benefits from scale. As funding for new projects has slowly been removed new mechanisms are necessary to encourage the growth of small and medium renewable assets, so encouraging investors to choose Lancashire as a region to install new capacity.

3.6 Viability of Opportunity in the Region Compared with Elsewhere

As has been discussed in the sections on green tariffs, the UK's energy mix will need to take advantage of all of its resources. While some locations may be more economically viable than other locations, renewable energy resources are distributed across the UK. Inevitably as certain locations are utilised, developers will look to other not yet harnessed energy resources. Lancashire is a large region with a diverse topography making it suited to a range of renewable technologies.

3.7 Location of End Users

The population of Lancashire is roughly 1.5 million, a similar size to Merseyside and triple the size of Cumbia. The region has a large population base to provide energy for. Generally, the electricity network is extensive and so the location of end users to the sources of power generation is less of a barrier to the deployment of renewable energy. It is favourable and advantageous to have power connected to the grid as opposed to off grid as long as the DNO is sufficiently engaged to manage new constraint additions to the distribution network. Even if there are points of excess power generation in the region which exceeds demand, the region would become a net exporter of energy which is generally beneficial to the local economy, generating growth in the region and ensuring jobs are created locally, especially around the maintenance and operation of assets.

However, the concern for this barrier changes when considering heat. While a majority of the population is connected to the gas grid and the expectation is that a combination of either low carbon bio-fuels or hydrogen will serve this share of the population, the timeframe for deployment is as yet uncertain and unlikely to occur in the short term. The barriers to deployment are exacerbated with the share of the housing stock that is off the gas grid. The proportion of this share of the total housing stock across Lancashire varies between 11.9% of the housing stock to 33% in some areas. It is understood that in many instances the connection of these houses to the gas grid will be costly. At their current cost heat pumps are prohibitively expensive for many households, especially with the closure of the renewable heat incentive and the green homes grant in Q1 2022. Furthermore, the location of many of these properties means they are unlikely to be suitable for heat networks. The generally rural location of many of these end users will mean that decarbonising heat will be very challenging.

3.8 Supply Chain

In the coming decades the renewable energy supply chain is likely to experience varying bottlenecks as global efforts to deploy more low carbon generation assets intensifies. While many of these bottlenecks will occur outside the control of councils, they may still serve as serious constraints for deployment in Lancashire. Renewable technologies require a range of materials, many of which are abundant, but there are a few rare earth and critical metals which are to some extent in short supply, either because there are only small volumes available on the surface of the earth’s crust or they can only be mined in very specific parts of the world. Demand is forecast to increasingly outpace supply and the likely trajectory for these materials is that their price will increase and lead times for their delivery will be extended. Similar trends are also forecasted for more commonly used materials such as concrete and steel, as the growth in renewable assets competes for supply with other infrastructure projects such as roads and buildings. This global demand glut for materials is also occurring alongside a growing demand for material alternatives which use new processes to reduce the embedded carbon of projects. While there is growing investment in research and development to replace the reliance on scarce materials and to reduce the carbon footprint of structural materials, there are no indicators that suggest major shifts away from current material demands. While it is difficult to determine exactly how these macro market events will impact specific projects, this issue is likely to intensify towards 2050 as new mines can take decades to establish and geopolitical activity continues to complicate the matter.

Looking further down the supply chain, the renewables market has expanded rapidly in the UK in the last decade. As a result, there is a healthy availability of companies to design, build, operate and maintain power generation assets. The market for low carbon heat is a little more complex. An example of some of these barriers was demonstrated through the roll out of the green homes grant, a £2 billion scheme designed to boost the decarbonisation of the UKs housing stock. Among a range of challenges homeowners faced with the scheme, there was a reported shortage of quality accredited contractors. As the market is still undecided on a direction for low carbon heat technology, the labour and skills market is not mature, which is an issue found across the UK. A rapid upskilling is required to meet the demands of a growing clean heat market. While nationally located, geographically mobile contractors may be able to install assets, what is required is a local skills base for the operation and maintenance of heat assets. With power, if a fault occurs in an asset, most buildings are still likely to be connected to the distribution network who will guarantee the security of supply or have a robust operation and maintenance supply chain to fix faults. However, with heat they are islanded assets, which means that for example, if a heat pump breaks in the middle of winter, there is unlikely to be an alternative supply. Unless Lancashire has a healthy availability of contactors who are skilled enough and have the experience of fixing common problems, as well as having available vendors to supply spare parts, the region might find itself lagging behind in clean heat deployment. Understandably, if early adopters find issues with installing and running heat pumps, hydrogen boilers or heat networks, this is only going to inhibit further uptake.

4. Mapping Renewable Energy Deployment to 2030

4.1 Regional Demand Trends to 2030

High level estimations have been made for both electricity and heat demand into 2030 for the 2 unitary councils and the 12 district councils in in Lancashire. Electricity has been estimated by extrapolating the 2011-2019 trend of a 1.7% decrease in overall demand out to 2030 to account for improvements in energy efficiency. It is also highly likely that transport and heating will be become increasingly electrified in the run up to 2030. It is therefore anticipated that overall electricity usage will increase in 2030. Electricity North West has considered a range of scenarios in which energy demand increases by between 10 and 20%. An average increase of 15% has been assumed and applied to the 2019 demand factor whilst also accounting for the regional trend of a 1.7% decrease, which results in an overall estimated 2030 energy demand of 6.99TWh, an increase of 14.6% from 2019.

2030 heat demand has been estimated by extrapolating the 2011-2019 trend of a 1.2% decrease in heat demand out to 2030, resulting in an annual heat demand figure of 9.25TWh. As mentioned previously, increasing electrification of heat is anticipated to take place in the run up to 2050. In 2025 all new homes in the UK will be required to be fitted with low carbon heating technologies. An estimation of the electricity demand for heating has been made for 2030. It has been assumed that 75% of new built properties will be fitted with electric heat pumps after 2025; this, combined with the trend of increasing numbers of heat pumps seen between 2011 and 2019 from the domestic and non-domestic RHI schemes, gives an estimated 20,100 heat pumps for Lancashire-14 by 2030. Given the current economics around heat pumps it has been assumed that minimal conversion of existing gas based wet heating systems to heat pumps will take place by 2030. Electricity North West has provided aggregated demand figures for heat pumps which have been used to estimate their overall electricity demand in 2030. This results in an energy demand of 123GWh electricity and 369GWh heat, making up an overall 4% of 2030 heating demand. Note that this demand does not include industrial heating technologies and so the actual demand could be even higher.

4.2 Technology

4.2.1 Trends Towards 2030

Solar PV is emerging as one of the most competitive sources of new power generation capacity after a decade of dramatic cost declines and development of innovations within the area such as multi-junction technologies and floating PVs[5]. The steady growth seen in solar is expected to continue through to 2050, especially as new innovations within the solar PV industry drive further uptake. New types of solar cells and modules are currently under development; however the current market is still dominated by first generation solar panels (IRENA, 2019). Among the different solar applications being explored are building integrated PV solar panels, which can be adapted to a variety of surfaces and are cost effective by allowing savings on aspects such as roofing material, refurbishment costs and construction labour as well as for allowing versatility and design flexibility in size, shape and colour. As these innovations start to come to market, Lancashire can continue their uptake of solar technology throughout their district especially in new builds and as part of renovation projects. Lancashire could also explore the combination of solar technology with other renewable sources to overcome power supply intermittency. This would include power systems that combine technologies e.g. solar systems with other sources such as onshore and offshore wind, hydro or storage technologies, or emerging technologies such as hydrogen.

Councils should consider onshore wind over the coming years as ongoing technology innovations and enhancements start allowing for larger capacity turbines. Future projections of wind power indicate much expansion is yet to occur in the total installed capacity for onshore wind. Onshore turbines are expected to increase in size from an average of 2.6MW to around 4-5MW for turbines commissioned in 2025. These larger assets would require more space to produce energy, however, as some wind farms created in the last decade

[5] Solar cells mounted on structures that float on a body of water.

come to the end of their cycle these new turbines can be easily installed into the existing land without the need for planning permission if the developer is able to show that taller turbines will have no effect on the local environment.

Wind power could also facilitate the shift towards a hydrogen economy in the future as projects such as Hynet could utilise surplus electricity generation as capacity increases over time to produce hydrogen that could be used as a natural gas alternative across the district(Hynet, n.d.). Lancashire has many councils that are willing to increase their wind uptake as planning policy requirements are met in each local authority. There are also some councils that are willing to utilise their local rivers and ports t o increase their renewable offshore uptake. In the UK there is currently a large operational capacity for both onshore and offshore as seen however for councils in Lancashire specifically the opportunity lies more within onshore wind as offshore projects are implemented at national level.

Innovations in offshore wind technology predict a size increase from circa 9.5MW today to circa 12MW in 2025. These innovations include new floating foundation designs which would enable their installation in deeper waters. Innovations around onshore wind can be adapted to start utilising these deep-water resources with floating offshore technology.

The UK government, has already announced a £60million investment in upgrading the country's offshore wind capacity, increasing the target production from 30GW to 40GW by 2030. This increase would produce enough electricity from offshore wind to power every home in the UK. There are also currently tests undergoing to develop different turbine designs that can operate in extremely high and very low wind speeds, which would expand the potential areas in which wind turbines can be introduced (The Renewable Energy Hub UK, n.d.)

The growth in farm applications for AD is expected to continue into the coming decade. There are still issues that need to be overcome as mentioned above. For anaerobic digestion uptake to increase over the coming decade there is potential for around 6.4 million homes to be heated by 2030; however supportive government policy is crucial to make the technology more worthwhile to drive this (ADBA, 2020). There are plans for in excess of 400 plants currently in the planning process, with a potential aggregate capacity of over 500MW across the UK(Natwest, 2020).

Though the RHI, which is applicable to various sized digestors, is due to come to an end in the early 2020s there may be FiTs available for small scale digestors.

Local authorities in Lancashire currently have some heat pumps producing energy and could explore further adoption through the support of renewable heat incentive and other funding to help make the heat pumps more efficient and less costly. The key driver for this uptake will be around new incentivesas currently the technology is still too expensive with current incentives. However off-gas properties could consider heat pumps as it would be better suited for them.

Energy from waste could see increase development over the coming years through innovations within this area. There are currently new technologies that are being developed such as hydrothermal liquefaction (thermochemical conversion of biomass into oils which can then be refined into petroleum derived fuels), hydrothermal carbonisation (fast -tracks the slow process of geothermal conversion of wet waste with an acid catalyst) and dendro liquid energy (processing mixed waste from plastics to wood logs), producing clean fuels for electricity generation such as carbon monoxide and hydrogen (William Foster, 2021) (Precouster, 2017) (World Energy Council, 2016).

4.3 Realistic Deployment up to 2030

Section 2.4 discusses past and current capacity deployment of the different renewable technologies. This section looks at how the different technologies will evolve towards 2030.

4.3.1 Onshore Wind

As discussed in Sections 2.2.3 and 2.4.1, onshore wind represents a large proportion of the current renewable capacity in Lancashire. As aforementioned, due to withdrawal of government subsidies, onshore wind has had a flat uptake from 2015. Looking to the future, according to research done by Renewable UK, by 2030 the United Kingdom will have an onshore wind capacity of 30 GW (Renewables UK, 2020). The current proportion of onshore wind in the North West, is circa 4% (data from Renewable UK report). The Lancashire proportion of the North West is circa 28% (obtained using the renewable energy technical capacity potential of the Lancashire 2011/2012 Sustainable Energy report). The expected capacity in 2030 of onshore wind is therefore calculated as:

- 30 GW x 4% x 28% ~ 300 MW capacity in 2030

The table below shows onshore wind: current capacity, granted projects awaiting construction, submitted project awaiting approval, and future expected capacity (to bring the total to 300 MW).

Table 4.1 : LancashireOnshore Wind Projected Capacity 2030

Current Wind Capacity (MW)	Awaiting Construction Capacity (MW)	Awaiting Approval Capacity (MW)	Future Projects Capacity (MW)	2030 Total Capacity (MW)
211	21	24	44	300

The increase expected in the next ten years is similar to the increase seen in the past ten years. Onshore wind is now a mature technology and there is no evidence to suggest a faster uptake for 2030.

4.3.2 Solar Energy

After onshore wind, solar energy represents the highest proportion of renewable energy in the county of Lancashire. Due to the substantial decrease in solar PV cost and the use of feed-in-tariffs, solar capacity has substantially increased over the past ten years. As for onshore wind, solar PV is a well-established and mature technology. Having achieved a mature state, the growth rate in the next ten years is expected to be lower compared to 2010-2020.

To calculate the expected capacity towards 2030, a linear trend starting from 2016 has been adopted. Starting the linear trend in 2016 is more accurate compared to 2011 as the solar annual growth rate has a more constant and more reasonable value looking forward to 2030.

Consequently, 2030 solar capacity in the county of Lancashire is based on the linear trend of the past 5 years. To better contextualise, the linear trends have been split for solar projects that do require and projects that do not require planning permission (using available data). The chart below indicates the solar development expected to 2030 for planning and non-planning requirement (small scale) projects.

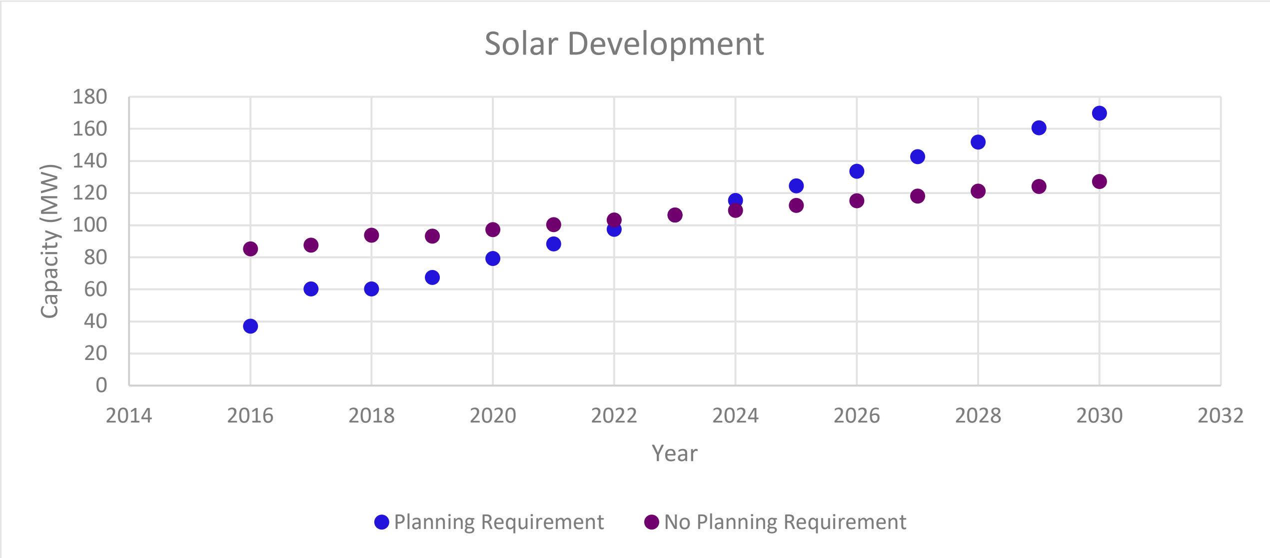

Figure 4.1: LancashireSolar Projected Capacity 2030

The expected solar capacity for 2030 is:

- 170 MW for solar projects requiring planning and 127 MW for small scale solar projects, a total of 297 MW. It should be noted that commercial deployment will include projects both that require planning and those that do not.

The table below summarises current capacity, granted projects awaiting construction, submitted projects awaiting approval, and future expected capacity (allocated to the relevant category and to bring the total to 297 MW).

Table 4.2 : Lancashire Onshore Solar Projected Capacity 2030

Category	Current Capacity (MW)	Granted Projects Capacity (MW)	Submitted Projects Awaiting Approval Capacity (MW)	Future Projects Capacity (MW)	2030 Total (MW)
Planning Required	67	1	10	92	170
Small scale	93	N/A	N/A	34	127

4.3.3 Hydro Energy

As discussed in Section 2.4.1, hydro has had only minor development over the past ten years as major hydro projects have already been implemented, as reported by the Lancashire 2011/2012 report. Large capacity projects are not expected to be installed over the next ten years both for reasons of environmental issues and lack of economic incentives. In addition, there are no new technologies in prospect that would suggest a significant capacity ramp-up. Only small-scale capacity is expected for Hydro, which should not significantly increase the current capacity. As a result, a maintained total capacity of 2.3 MW is expected for 2030.

4.3.4 Tidal Energy

Currently, tidal energy provides zero MW capacity in the county of Lancashire. There is currently no evidence to suggest that the technology will reach a level of maturity to enable a substantial introduction of capacity during the next ten years and only pilot projects are expected. There have been proposals for implementing a tidal barrage of 100-120 MW in the Wyre river (Natural Energy Wyre, n.d.), However, no particular advancement for the pilot project has occurred in recent years. Thus, it is currently expected that tidal will remain at zero MW capacity in 2030, excluding pilot projects.

4.3.5 Energy from Waste

EfW is separated here into two types of technology:

- EfW from incineration or landfill gas
- Anaerobic Digestion

As discussed in section 2.4.1, for both types of technology the trend over the years has been flat. Looking ahead to 2030 the amount of waste feedstock is expected to stay relatively constant over the years. To predict a capacity for EfW for 2030 the following tasks have been performed:

- Maximum capacity from waste feedstock has been calculated
- Analysis of projects in the pipeline and past trends to qualitatively estimate a capacity for 2030.

4.3.5.1 Incinerator or Landfill Gas

As the total municipal and commercial waste generated in the county, especially waste to landfill, has been relatively constant over the years, the average annual tonnage of the past six years has been used for the 2030 estimation. The following assumption to calculate the energy capacity from waste for incineration technology in 2030 has been used: Average of 385,309 tonnes of landfill waste produced per year, 550 kWh electrical power generation per ton and a load factor of 35%. Thus, the maximum expected incineration capacity from the available feedstock is 70 MW.

The table below provides the historical landfill waste data for Lancashire.

Table 4.3 : Lancashire Landfill Waste Arisings 2015 to 2020 (DEFRA, 2021)

Year	Total Landfill Waste (tonnes)	Sent to Incineration with EfW (tonnes)	Sent to Incineration without EfW (tonnes)
2020	379,507	153,909	235
2019	382,415	121,998	1,049
2018	430,731	38,131	58,869
2017	432,441	43,554	28,390
2016	324,264	80,704	18,020
2015	362,497	40,489	22,230

Two EfW incinerators have received planning approval and are awaiting construction: amounting to a total capacity of 80 MW (BEIS - Planning 1, 2021). The trend in the past years has been flat (no increase or decrease) for EfW. Considering the already existing 35 MW (produced by sewage gas and landfill gas), and the 80 MW in the project pipeline, there is no evidence to suggest further projects or capacity increases. This assessment is supported by EfW incineration having a negative environmental impact and there being an increasing trend towards more recycling and a circular economy.

The table below provides current capacity, granted projects awaiting construction, and future expected capacity.

Table 4.4 : LancashireEnergy from Waste Projected Capacity 2030

Technology	Current Capacity (MW)	Awaiting Construction Capacity (MW)	Awaiting Approval Capacity (MW)	Total (MW)
Landfill Gas +Sewage Gas	32-39	0	0	35
EfW Incineration	0*	80	0	80
Total				115

* It should be noted that no data has been found on waste tonnages presently incinerated within the area of Lancashire. It is presumed that the 153,909 tonnes for 2020 in Table 4-3 was sent for incineration outside the area of Lancashire.

4.3.5.2 Anaerobic Digestion

To calculate the maximum technical capacity from anaerobic digestion (AD), the calculated feedstock from the Lancashire 2011/2012 report has been used (note that this report converted tonnes of feedstock into MW): ~100 MW. A 60% gas conversion to power output from the feedstock has been used for AD, so an estimated theoretical maximum energy output of 60 MW has been calculated. However, considering the flat development over the years in AD, at the present time there is no evidence to suggest that there will be an increase in capacity up to 2030. As a result, the existing capacity of 7 MW is maintained as an estimate for 2030. There is, however, substantial additional capacity that could be exploited by AD.

Table 4.5 : Lancashire Anaerobic Digester Projected Capacity 2030

Technology	Current Capacity (MW)	Awaiting Construction Capacity (MW)	Awaiting Approval Capacity (MW)	Total (MW)
Anaerobic Digestion	7	0	0	7

4.3.6 Heat Pumps

In general heat pump technology capacity has had a slow linear increase in the past years, refer Sections 2.2.6 and 4.1.

The estimated (due to their being no precise RHI data available) past deployment (from 2015) for both domestic and non-domestic is shown in the chart below.

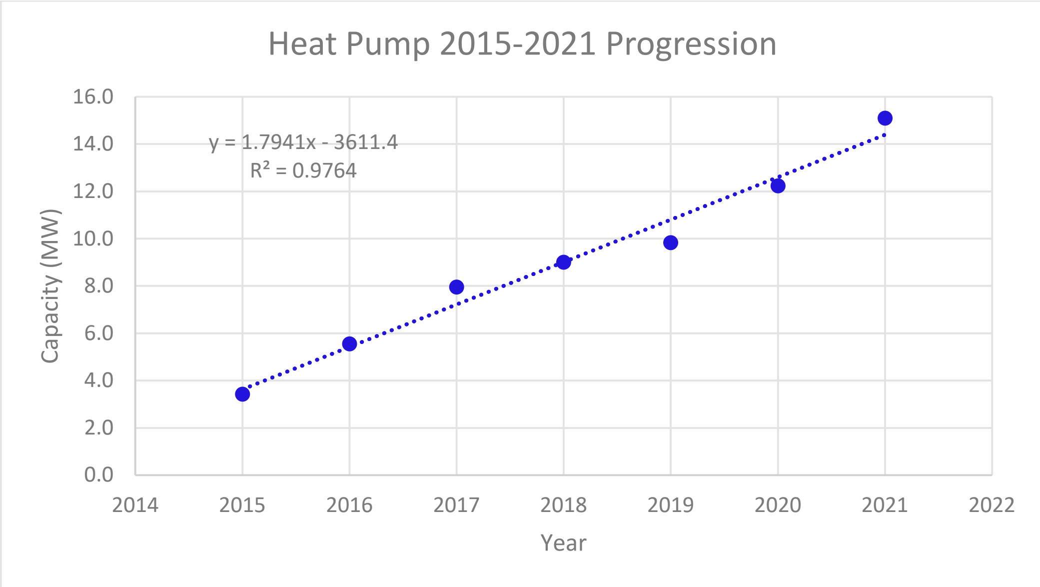

Figure 4.2: LancashireHeat Pump Capacity Trend 2015 to 2021

The UK government has announced a policy that will ban the use of gas and oil boilers for new homes from 2025 and these will instead be heated by low-carbon alternatives. These are likely to include heat pump technologies. Therefore, to calculate 2030 deployment the following process has been adopted:

- Use the linear trend in the chart above and forecast out to 2030.
- On top of the linear trend, add the expected number of new heat pumps starting from 2025. The number of new dwellings per year for Lancashire has been estimated for 2025-2030.

Taking the linear trend and forecasting to 2030 delivers a value of: 30 MW (2,100 domestic and non-domestic heat pumps).

When calculating the number for new heat pumps starting 2025 the following calculation are made:

- First the total number of new dwellings is calculated. Looking at past data in Lancashire-14 the average of new private dwellings per year (from 2015-2020) is 4,000 (Ministry of Housing, Communities & Local Government, 2021). Thus, a total of 24,000 new homes from 2025-2030.
- Heat pumps are not the only alternative to boilers when it comes to heating. A study was on behalf of the CCC that outlined district heating, storage heating, resistive heating, and resistive heating plus solar thermal as alternatives to heat pumps (Climate Change Committee, 2021). Using this study, it has been estimated that about 75% will be composed of heat pumps from 2025-2030. It is noted that while this study predicted a higher share of district heating, that is likely only to be true for high population density areas. Thus, for Lancashire a higher proportion of heat pumps have been assumed compared to district heating. As a result, the total number of heat pumps is calculated by: 20,000 x 75% equating to 18,000.
- A capacity of 12 kW per heat pump is assumed, equating to a total capacity of 216 MW from new homes starting 2025.
- A total capacity of 247 MW generated from heat pumps is expected by 2030

Based on these assumptions, the chart below shows the estimated heat pumps uptake over the next 10 years.

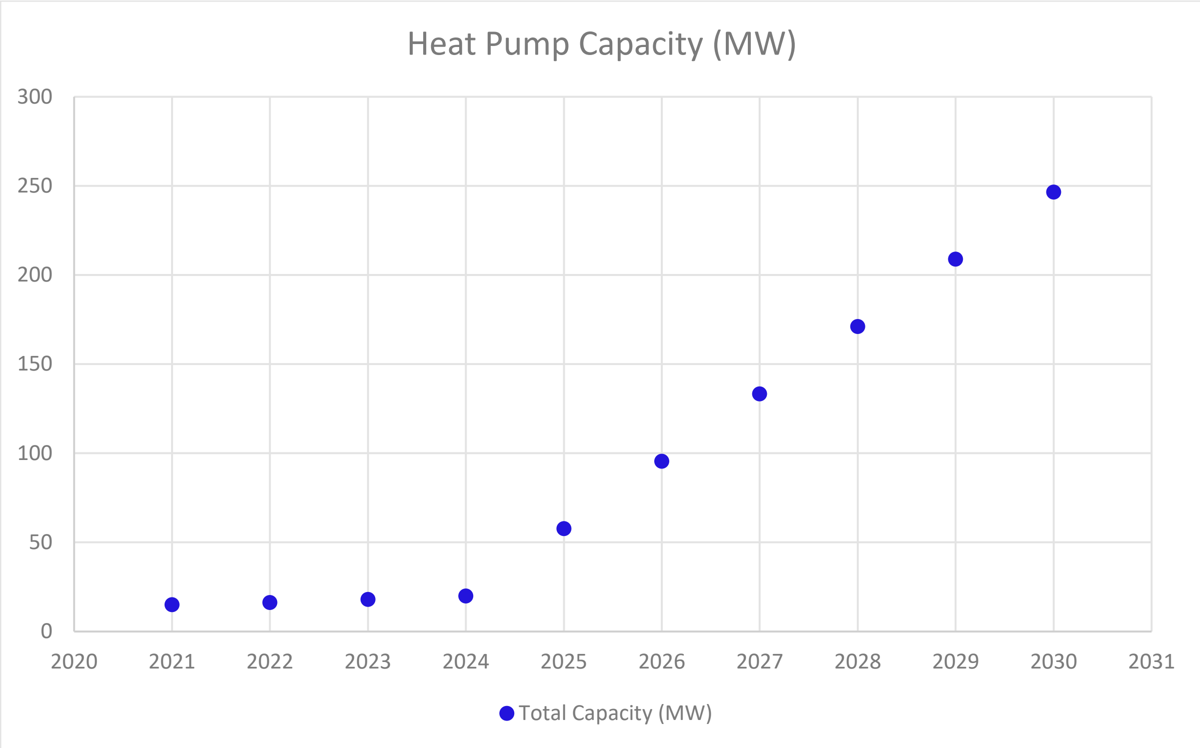

Figure 4.3: LancashireHeat Pump Capacity Trend to 2030

4.3.7 Heat Networks

As major increases in the uptake of heat pumps are not forecasted to occur before 2025, heat networks are likely to dominate the decarbonisation of heat in the short term. Heat networks are not a generation source, but the delivery mechanism for a heat source. The generation source or energy centre can be from any of the following sources:

- Combined heat and power (CHP) plants
- Bioenergy boilers
- EfW facilities
- Fuel cells
- Heat pumps
- Geothermal sources
- Electric boilers
- Solar thermal arrays
- Power stations
- Industrial processes

While system efficiency gains allow for lower per capita GHG emissions, for a heat network to be low or zero carbon, they must be supplied by such a generation source. The North West has some of the highest generation capacity supplied through heat networks in the UK, with parts of Lancashire supplying the most heat through heat networks in the North West (BEIS Research and Analysis, 2018). In 2019, the Heat Networks Delivery Unit (HNDU) utilised BEIS funding to conduct a study titled 'HNDU Heat Mapping and Master Planning' to investigate heat network opportunities. The study identified sites across Lancashire including the Blackpool Airport Enterprise Zone, NHS hospitals and various town centres. The programme stalled for a number of reasons which included resource allocation. The CCC forecast that heat networks will constitute a proportion of the technology mix for heat generation, especially until technologies such a heat pumps and hydrogen become more economically competitive. Considering the challenges associated with the decarbonisation of heat it is recommended that councils look to continue investigating this technolo gy option. The UK Government publishes a project pipeline for heat networks online (BEIS Heat Networks, 2021)

4.3.8 Hydrogen

It is crucial to mention hydrogen as it will be a technology with significant attention in the next ten years. It will surely play an important role, but it would be too speculative at the present time to estimate the capacity or role that hydrogen will play in the county of Lancashire. It is expected that for hydrogen both as a heat source or storage source there will be pilot projects in the next ten years in Lancashire. Currently the market is undecided in which direction hydrogen use will proceed.

4.3.9 Other Technologies for Consideration

In additional to hydrogen there are a number of technologies that have not been explored in this report. Many of these options are well established in other parts of the world. Though, in the UK their potential is still being explored or their installed capacity is low. Water source heat pumps (WSHPs) are one such option, with Lancashire having an extensive network of canals and rivers which could be utilised. While capital costs can be high due to the design and construction of WSHPs, the relatively constant temperature and higher density of water compared to the air enables higher heat exchanger efficiencies to be achieved. Similarly, the large number of reservoirs and lakes also present opportunities for WSHPs. It should be noted that a barrier for WSHPs from some water sources is that the buildings being heated will need to be proximate to the water source to prevent transmission heat loss.

The UK Coal Authority is investigating opportunities for mine water heat recovery. In December 2020 the British Geological Survey (BGS) and the Coal Authority released maps displaying key locations in the UK for mine water heat recovery (British Geological Survey , 2020). Unsurprisingly, with coal mining being historically a large industry in Lancashire, the map demonstrates a number of sites in the region that could be utilised as a source of renewable heat. While more conventional geothermal in the region, especially in West Lancashire has been considered since the 1970s. To date, the business case for geothermal has limited the utilisation of this resource, but as technology advances there may be opportunities to harness such resources in the future.

5. The Role of Lancashire County Council in Enabling Future Deployment

5.1 Spheres of Influence

5.1.1 Responsibilities

The National Planning Policy Framework explains that all communities have a responsibility to help increase the use and supply of green energy.

Local planning authorities are responsible for renewable and low carbon energy development of 50 MW or less installed capacity (under the Town and Country Planning Act 1990). Renewable and low carbon development over 50 MW capacity are currently considered by the Secretary of State for Energy under the Planning Act 2008, and the local planning authority is a statutory consultee. It is the government's intention to amend legislation so that all applications for onshore wind energy development are handled by local planning authorities. Microgeneration is often permitted development and may not require an application for planning permission (Ministry of Housing, 2019).

In general, local authorities can help influence the adoption of renewable energy in an abundance of ways, from direct control over council owned property and travel to partnerships with leading local organisations that encourage renewable energy investment.

The diagram below is taken from the UK's 6th carbon budget report and provides an excellent visual interpretation of how local authorities control and influence emissions (Evans, 2020).

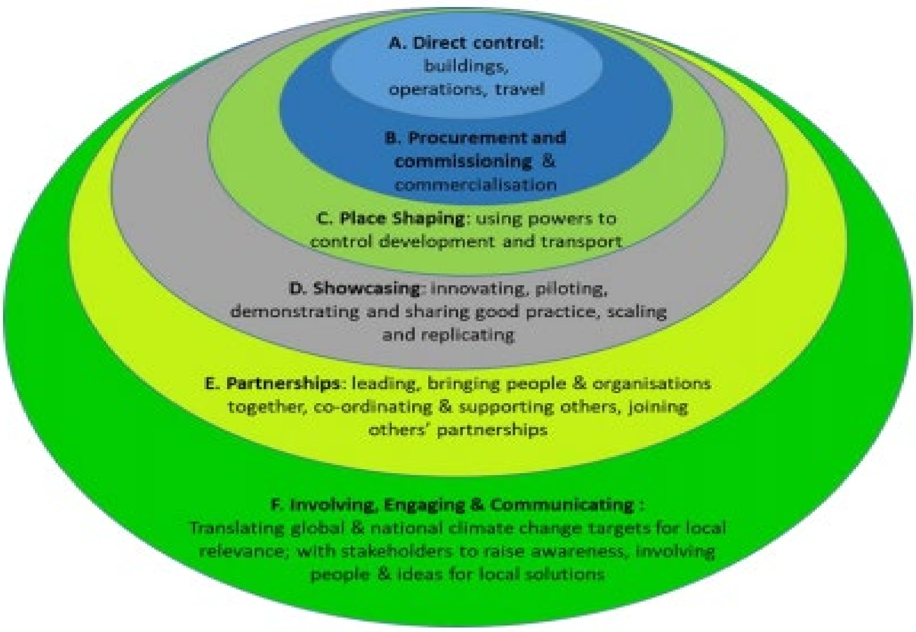

Figure 5.1: Local Authorities Sphere of Influence

5.1.2 Planning

There are no hard and fast rules about how suitable areas for renewable energy should be identified, but in considering locations, local planning authorities will need to ensure they take into account the requirements of the technology and, critically, the potential impacts on the local environment, including from cumulative impacts. The views of local communities likely to be affected should be listened to (Ministry of Housing, 2019).

In shaping local criteria for inclusion in Local Plans and considering planning applications in the meantime, it is important to be clear that (Ministry of Housing, 2019):

- the need for renewable or low carbon energy does not automatically override environmental protections
- cumulative impacts require particular attention, especially the increasing impact that wind turbines and large-scale solar farms can have on landscape and local amenity as the number of turbines and solar arrays in an area increases
- local topography is an important factor in assessing whether wind turbines and large-scale solar farms could have a damaging effect on landscape and recognise that the impact can be as great in predominately flat landscapes as in hilly or mountainous areas
- great care should be taken to ensure heritage assets are conserved in a manner appropriate to their significance, including the impact of proposals on views important to their setting
- proposals in National Parks and Areas of Outstanding Natural Beauty, and in areas close to them where there could be an adverse impact on the protected area, will need careful consideration
- protecting local amenity is an important consideration which should be given proper weight in planning decisions.

5.1.3 Strategy

Local authorities don't have a statutory duty to reduce emissions in line with the Climate Change Act, but they do need to produce plans that have a big bearing on emissions (e.g. transport, local plans, minerals plans, procurement).

As of 2021, Lancashire county council do not have a climate strategy in place, despite declaring a climate emergency in 2019 (Lancashire County Council, 2021).

Development of a carbon reduction is certainly possible given the existence of the Climate Change Act, scientific warning and public concern. Indeed, a number of local authorities have developed a climate strategy. For example, Bristol, Leeds, Manchester, and London.

Below are some individual actions that local authorities can take in the context of renewable energy:

Table 5.1: A Table Outlining Actions Taken by Councils to Decarbonise the Energy System

Cost Category	Local authority renewable opportunities	
Low Cost	Identify areas suitable for renewable energy in the local plan.	NPPF states that new onshore wind cannot be approved outside an area "identified as suitable for wind energy" unless it is a community-led scheme (Ministry of Housing, 2019). Therefore, local councils could undertake surveys to identify such areas.
Low Cost	Divest from fossil fuels and invest in renewable energy projects.	Many local authorities have now chosen to divest their investments from fossil fuels. Campaigners in Waltham Forest, Southwark, Haringey, Hackney, South Yorkshire and Merseyside have all persuaded their councils to move money out of the coal, oil and gas companies whose actions are fuelling climate change (Friends of the Earth, 2019).

Low Cost	Commit to opposing fracking and other fossil fuel extraction	Both on council owned lands but also more widely. Note: - In November 2019, the UK government launched a moratorium halting fracking and exploration with immediate effect, and also warned shale gas firms they would not support future fracking projects. This directly affected the only active fracking site in the UK, operated by the energy firm Cuadrilla, near Blackpool. Cuadrilla has now relinquished its permission to test drill in Lancashire.
Low Cost	Buy green energy	Procure renewable energy through a Power Purchase Agreement (PPA). A PPA is a long-term purchasing contract with a developer which gives the developer the necessary confidence to build the renewable power plant. PPAs could also be used to support the development of community-owned energy schemes. Sheffield City Council has recently committed to only buying green electricity which it says will not cost much more than its existing source (Big Stamp of Approval, 2019).
Low Cost	Support local people and community energy organisations to install renewable generation for on-site local use	Solar Together is increasingly popular as a way to form buying clubs for local communities to install affordable solar PV. While compared to offshore wind, small scale solar is expensive, it brings the benefit of supporting jobs locally and opening the conversation for heat pumps and other measures in people's homes (Evans, 2020). Development of local energy markets.
High Cost	Produce biogas	In the waste contract, require the production of biogas from non-recyclable biodegradable waste. Biogas is an important contribution to decarbonising the gas grid. Heating of homes and commerce using gas is one of the largest sources of greenhouse gases in the UK.
High Cost	Develop district heating	Map out and develop district heating, as long as it's from low carbon sources. Enfield Council has formed a company that aims to provide lower carbon heat and hot water to around 15,000 residents with an explicit aim to reduce greenhouse gas emissions (Enfield Counci, 2017).
High Cost	Explore forming a non-profit green energy company	Bristol City Council has formed an Energy Company (Bristol Energy) which aims to be in profit in 2021 with those profits invested in the city for energy efficiency (BBC, 2017).

5.1.4 Relationship with District Councils and Other Organisations

What local authorities can and can't do varies depending on the type of local authority.

There are two-tier local authorities (e.g. county councils, district councils), unitary authorities, metropolitan authorities, and combined local authorities. Some combined local authorities may have a Mayor who has a strategic overview and powers (GOV.UK, n.d.).

The following sections outline the responsibilities of the different Local Authorities that make up Lancashire. While this report does not investigate how different governance structures across the region could improve renewable energy deployment, this may be an area for future consideration by councils. In the context of this report, there are three tiers that we are interested in as follows.

5.1.4.1 Lancashire County Council (LCC)

LCC is responsible for services across the whole of the county, such as:

- education
- transport
- planning

LCC is able to set out the vision and framework for the future development of an area through local plans, including policies on new retail parks and housing developments. It can also determine detailed decisions on planning applications and change of use.

Local plans are prepared by one or more district planning authorities (local planning authorities responsible for district matters). They set out a framework for the future development of an area on a 15-year horizon. They define: the priorities for an area, strategic policies, the framework for neighbourhood plans, land allocations, infrastructure requirements, housing needs, requirements for safeguarding the environment, measures for adapting to climate change, and so on. These policies should be illustrated geographically on a policies map (GOV.UK, n.d.)Typically policies cover areas such as:

- fire and public safety
- social care
- libraries
- waste management
- trading standards

These concern enforcing consumer protection legislation. For example, Trading Standards also work with DEFRA to ensure disease controls are in place protecting residents and agriculture in the UK.

5.1.4.2 District Councils

There are 12 district councils within the jurisdiction of LCC's authority.

These cover a smaller area than county councils. They're usually responsible for services such as:

- rubbish collection
- recycling
- Council Tax collections
- housing
- planning applications

Planning permission is the granting of permission to proceed with a proposed development. Responsibility for granting permission generally lies with local planning authorities (usually the planning department of the district or borough council). All developments require planning permission, other than 'permitted developments', which are considered to have insignificant impact (GOV.UK, n.d.).

5.1.4.3 Unitary Authorities

Finally, there are also the two unitary authorities of Blackpool and Blackburn with Darwen.

Unitary authorities provid e all of the local services listed above.

5.1.4.4 Relationship with Lancashire Enterprise Partnership

Lancashire Enterprise Partnership (LEP), is a strategic collaboration between business, universities and local councils which directs economic growth and drives job creation, established by LCC which still acts as the partnership's accountable body (Lancashire Enterprise Partnership, 2021). Similar partnerships include Blackpool's climate action partnership.

The LEP was formed in 2011 to make Lancashire the location for business growth and inward investment. LEP work with government to bid for public funds, focussing on opportunities that maximise job creation and growth to spread the benefits right across the county. All funding which is awarded is subject to a competitive process engaging with a wide range of local stakeholders.

Their strong strategic focus has enabled securing a £1 billion growth plan and bring forward over 50 major growth initiatives. This includes a £6.2m funding for the Lancashire Energy HQ in Blackpool, a national centre of training for the energy sector.

Lancashire Energy HQ (LEHQ) aims to deliver the next generation of engineers and technicians through renewable and low-carbon energy generation as well as traditional oil and gas training and skills (LEHG, n.d.). LEHQ provides essential training to facilitate careers within the renewable energy sector, a field of expertise that it acknowledges is currently experiencing a skills shortage.

LEP have also provided funding for Lancashire Advanced Manufacturing and Enterprise Cluster (LAMEC), capable of supporting 10,000 new jobs in the energy and engineering sectors (LAMEC, n.d.). Sector focus is on offshore wind and the huge potential for tidal energy generation from the Morecombe Bay.

The Lancashire Enterprise Partnership Board comprises of the expertise of senior leaders from the private, public and higher education sectors. In addition, a new Local Government Scrutiny Committee is being formed, through the Lancashire Leaders' Forum. This will be inclusive and draw membership from across all fifteen local authorities.

This is an excellent example of local authorities can influence uptake of renewables via partnerships in Figure 5.1.

5.2 Funding

5.2.1 Raising Funds

Local authority funding is restrictive after many years of cuts to budgets and continues to tighten with no end in sight. This has significantly impacted on local authorities spending power. Indeed, unlike many places on the continent, local authorities in the UK have very few powers to raise money.

While austerity continues in practice (even if not in name) local authorities will need to be imaginative in securing money for delivering low carbon projects, particularly for money that can fund on-going costs, such as employing staff (revenue costs).

Local authorities can raise some funds themselves (e.g. through car parking fees, bonds or, to a limited extent, raising council tax) but, unlike in many parts of the continent, their powers to raise funds are very limited.

Table 5.2: A Table Displaying Some of the Ways UK Local Authorities can Raise Funds for Action on Climate Change:

Local authority fund raising opportunities	
Bid for money	Local authorities can convene others to seek funds: • Seek government grants (UK's shared prosperity fund, Green Finance Strategy) • Collaborate with public sector organisations (NHS, Universities) to provide attractive investment propositions for investors.
Borrowing	Local authorities are well placed to access cheap debt finance: • Can be accessed through Public Works Loan Board and through the emerging Community Municipal Bond (CMB) market
Local taxes	Can create local tax levies to help finance renewable projects: • For example, Nottingham City Council has used powers to charge a levy for workplace parking. This encourages a greater use of public transport and provided the council with £44m over 5 years (Go awards, 2019).

At the launch of the UK Cities Climate Investment Commission a number of novel and well-established renewable energy specific funding sources were discussed, these are displayed in Table 5.3 below:

Table 5.3: A List of Funding Sources which could be used to Generate Capital for Renewable Energy Assets (Catapult: Connected Places, 2021) .

Fund Category	Funding Source
General	• Municipal community investment bonds • Council backed carbon offsetting schemes (savings from invest-to-save projects are reinvested) • Council carbon management funds
Commercial and Domestic Decarbonisation	• Local carbon offsetting by big emitters • Carbon offset fund (development sites that fail to achieve on-site net zero contribute) • Redesign of national fuel cost subsidies • Heat or energy as a service models • Energy efficiency council tax bands
Renewable Electricity Generation	• Green bonds • Crowdfunding

	• Community energy schemes and grants • Co-operative purchasing club
Transportation Decarbonisation	• Shared investment with EV charger companies • Costs shared with local business for consolidation centres • Workplace parking levy • Income generated from EV charging • Banded parking permit charges (by emissions)
Waste Decarbonisation	• Pay as you throw schemes • Funding to deliver fuel from waste • Collection charge for contaminated recycling

6. Overcoming the Barriers and Constraints to Further Deployment

As Lancashire County Council and the 14 local authorities within its boundaries look towards a net zero 2030 future, the challenge of this target cannot be understated. Achieving this will require a technological, socio-economic, and behavioural paradigm shift that is to date unprecedented. The pace of change will require a nimble and adaptive approach. As such, the following solutions and case studies provide a broad-brush perspective to overcoming this challenge. The intention is to leverage collective spheres of influence across society which accelerate the deployment of renewable energy at a rate that councils on their own may struggle to achieve due to the expedited time frame.

6.1 Prioritising Renewable Energy

If there is to be a concerted effort to increase the deployment of renewable energy assets across Lancashire, an appropriate level of priority needs to be given to this issue within councils. There is an increasing societal awareness of climate change which has led to councils across the UK announcing climate emergencies and 2030 net zero targets. While this is an important first step, what is required is action. There are many competing priorities within the local authority alongside the challenges this presents. If efforts are diluted across different teams and individuals it will be increasingly more challenging to affect meaningful change from a business as usual scenario. The solution to this is to create a working group or dedicated team to focus on renewable energy, their remit would include power, heat and transport. This team or working group could then give adequate focussed attention to tackling the problem. However, due to the intersection of this area with many other parts of the council's responsibilities, it would be prudent to raise the profile of renewable energy deployment and more widely climate change as a topic. Just a slight increase in the understanding of some technical aspects of the subject area could enable better, more collaborative decisions to be made, helping individuals throughout councils to understand the urgency of the coming decade and apply appropriate significance on action.

6.2 Local Area Energy Planning

The decarbonisation of energy in Lancashire will require a systems level approach to tackling this challenge. This is due to the complexity of change required across the whole of society and the nature of how energy permeates our lives, as well as the scale of individuals, businesses and assets that constitute modern energy networks. A fragmented approach to transitioning Lancashire's energy is unlikely to achieve a net zero target and will end up costing consumer's through higher capital and operational costs. The approach to overcoming these systemic challenges recommended by the UK regulator Ofgem is to create a Local Area Energy Plan (LAEP). A well-executed LAEP will support continuous local action to reducing greenhouse gas emissions, ensuring adequate intervention from relevant industry and community leaders. Furthermore, the plan will link wider local council priorities with initiatives to decarbonise the local energy network. LAEP as a process should be widely engaged with across all the local authorities in Lancashire. The methodology for local area planning commissioned by Ofgem outlines the following key elements that comprise an effective LAEP (Centre for Sustainable Energy and Energy Systems Catapult, 2020).

1. The use of robust technical evidence produced using analytical techniques which consider the whole energy system and make consistent use of available data, and whose strengths and weaknesses are well understood.
2. A comprehensive assessment of wider non-technical factors which need to be understood and addressed to secure change.
3. A well designed and involving social process which engages appropriate stakeholders effectively, uses the technical evidence appropriately, and manages vested interests effectively, thus ensuring the resulting plan can be seen as an informed and legitimate representation of local intent in relation to energy system decarbonisation.
4. A credible and sustained approach to governance and delivery

6.3 Demonstrating Leadership

Councils needs to demonstrate leadership and a commitment towards decarbonisation. In addition to creating LAEPs, setting up dedicated teams and engaging in further internal training, the council needs to show its commitment by reducing its own internal carbon emissions. This could be achieved by installing low carbon power and heat assets on its building and land, procuring energy from low carbon sources, enabling the use of low carbon transport on site and ensuring that its own supply chain is being transitioned to net zero. Taking such steps would signal to business and the community the importance the council is placing on decarbonisation and should encouraging wider engagement with the issue. But importantly, it would provide the council with a more nuanced understanding of the challenges in decarbonising energy in the region and could provide valuable learning for the council to overcome these barriers for future deployment.

6.4 Capital

Access to capital will always be a challenge for any development and there is very little the Council can do to reduce the competition in the current climate. The focus should be to ensure that local government, public institutions, businesses and the residents of Lancashire are aware of the capital available to them, providing them the opportunity to leverage funding if they so choose. The UK Government continues to direct large sums of its budget towards grants, subsidies, and loans for clean energy projects. While it is evident that the strategic focus from the 14 LA's to increase the deployment of renewable assets has incentivised investors and increased confidence in the market, however, to accelerate deployment to 2030, additional support for innovation in green technology that create more jobs and boost the local economy is required. More of this centrally available funding needs to be directed to the region. During the recent first phase of the Public Sector Decarbonisation Scheme, the North West received £134 million of the £1 billion fund. The whole of Lancashire received £21 million (BEIS Fund, 2021). By comparison Manchester Combine Authority received £78 million, which doesn't include all applications made from the Greater Manchester region, while Lancashire County Council received just £167k. Councils need to lead by example, ensuring that as funding becomes available, they continue to utilise their resources to access this capital and decarbonise their own buildings and assets. Additionally, efforts should be made to publicise these funds. Also, collaborating with private companies through organisations such as industrial clusters or with public institutions such as schools and universities ensuring that Lancashire maximises the direction of funds towards the region. Beyond applying for grants or subsidies, the region needs to continue to take advantage of different sources of capital or by generating its own funding such as through community energy schemes. The table below, displays a selection of these funds

Table 6.1 : Available Funding Schemes

Fund -Schemes	Description	Deadline
Energy Company Obligation (ECO)	This ECO policy will be entirely formed from one obligation, the Home Heating Cost Reduction Obligation (HHCRO). Under HHCRO, obligated suppliers must mainly promote measures which improve the ability of low income, fuel poor and vulnerable households to heat their homes. This includes actions that result in heating savings, such as the replacement of a broken heating system or the upgrade of an inefficient heating system.	On Going
Domestic Renewable Heat Incentive (RHI)	The Domestic Renewable Heat Incentive (Domestic RHI) is a government financial incentive to promote the use of renewable heat. Switching to heating systems that use eligible energy sources can help the UK reduce its carbon emissions and meet its renewable energy targets	April 2022
Clean Heat Grant	The domestic RHI should be replaced by the Clean Heat Grant which is in consultation to open from April 2022, providing grants of £4,000 to households and non-domestic properties (up to a capacity of 45kW) to enable the installation of heat pumps with some limited provisions for biomass.	To be determined

Energy Entrepreneurs Fund	The Energy Entrepreneurs Fund is a competitive funding scheme to support the development and demonstration of state-of-the-art technologies, products and processes in the areas of energy efficiency, power generation and heat and electricity storage. Last phase budget of £11 million.	On Going
Smart Export Guarantee (SEG)	The SEG enables small-scale low-carbon electricity generators to receive payments for the surplus energy they export back to the grid.	On Going
Reduced VAT for Energy-Saving Products	If you're eligible, you'll pay a reduced rate of VAT (5%) when certain energy-saving products are installed in your home. Your supplier will charge you the reduced rate on the installation and any extra work that's part of it.	On Going
Clean Growth Fund	In partnership with the private sector, the Clean Growth Fund aims to speed up the deployment of innovative clean technologies that reduce greenhouse gas emissions, by making direct investments in companies seeking to commercialise promising technologies. The new £40 million Fund combines a £20 million investment from BEIS alongside £20 million from a private sector investor CCLA, a UK institutional investor with an environmental social governance agenda. The Fund has ambitions to reach £100 million and CGIM is now seeking additional investment from other private sector investors.	2030
Electric Vehicle Homecharge Scheme	The Electric Vehicle Homecharge Scheme (EVHS) is a grant that provides a 75% contribution to the cost of one charge point and its installation. A grant cap is set at £350 (including VAT) per installation. The main requirement is that a person owns, leases, or has ordered a qualifying vehicle and has dedicated off-street parking at their property. A person may apply for 2 charge points at the same property if they have 2 qualifying vehicles.	On Going
Rural Community Energy Fund	The Rural Community Energy Fund (RCEF) is a scheme to support rural communities across England wanting to set up renewable energy projects in their area. RCEF is being run by five regional local energy hubs. Stage 1 grants – up to a maximum of £40,000 can be granted for Stage 1. Stage 2 grants – up to a maximum of £100,000 can be granted for Stage 2.	XX
Energy Industry Voluntary Redress Scheme	Energy Saving Trust has been appointed by Ofgem to distribute payments from energy companies who may have breached rules. Registered charities can apply for funds to deliver energy related projects that meet the scheme priorities and benefit people in England, Scotland and Wales. Energy Saving Trust will be administering the scheme until 2022. The Energy Redress Scheme is only open to registered charities in England, Scotland and Wales, and Housing Associations that are exempted charities. The minimum grant that can be requested is £20,000 and the maximum grant amount varies depending on the size of the fund available.	2022
Sustainable Warmth competition	The Sustainable Warmth Competition will award funding to Local Authorities to help them upgrade energy inefficient homes of low-income households in England. Projects that upgrade homes with an Energy Performance Certificate (EPC) rating of E, F or G will be prioritised. £300 million available budget for the scheme.	04-Aug-21

Decarbonisation Fund (SHDF)	The 2019 Conservative Manifesto committed to a £3.8 billion Social Housing Decarbonisation Fund (SHDF) over a 10-year period to improve the energy performance of social rented homes, on the pathway to Net Zero 2050. The Social Housing Decarbonisation Fund will upgrade a significant amount of social housing stock to an Energy Performance Certificate rating of C. Applications for the first wave of funding will open in autumn 2021. Registered providers of social housing will be able to apply.	Ongoing
Funding for innovation in renewable energy	Within the BEIS Energy Innovation Programme, BEIS expects to invest around £15 million in renewable technology innovation.	-
Energy storage innovation	£68 million will further the development of energy storage technologies to support a future renewable energy system. These new innovations will accelerate the commercialisation of a first-of-a-kind storage that can hold energy from wind turbines and solar panels, as well as heat, over long periods of time, including months and years, until it is needed by consumers.	2021
Floating offshore wind	£20 million funding will power innovation that unlocks the full potential of floating offshore wind technology around the UK coastline, allowing turbines to be situated in areas where it is too deep for them to be embedded on the seafloor. These tend to be locations where wind strengths are stronger and more consistent as they are further out to sea and further support the government's commitment to power every home in the country with wind by 2030.	2021
Sustainably sourced biomass	Biomass projects will benefit from £4 million government investment aimed at increasing the production of sustainably sourced biomass in the UK– supporting local economies and regional growth, as well as creating jobs in rural areas.	2021
Hydrogen for Heat	This project explores the potential use of hydrogen gas for heating UK homes and businesses. It aims to define a hydrogen quality standard, and to explore, develop and test domestic and commercial hydrogen appliances. BEIS has invested £25 million funding in the project. Following a competition, we appointed Arup+, a team of contractors led by Ove Arup to run the project.	2021

6.5 Local Energy Markets

A solution to many of the barriers and constraints is through the introduction of a local energy market (LEMs). LEMs in the UK are still in the early stages of development, but they are increasingly demonstrating their capacity to incentivise renewable energy uptake and ultimately abate emissions associated with energy use. They are geographically specific small-scale markets where smaller generators and consumers in a local area can trade directly between one another over the distribution network. Furthermore, the market provides a platform where energy demand, generation and storage providers can be incentivised to change their behaviour and provide services to the network. This in turn provides grid operators the flexibility to manage energy flows across the network, unlocking capacity in constrained areas with less need for costly grid extensions or reinforcement. The wholesale electricity market currently does not allow generators of <1MW to participate which excludes smaller generators unless they make use of an aggregator. LEMs can help overcome this barrier.

LEMs will therefore be key in enabling wide-spread use of distributed domestic and community scale renewables. Generators will have greater flexibility with how they sell electricity enabling potentially more favourable prices than feed in tariffs, for example, would offer. This can lead to overall improvements in the commercials associated with renewable projects. Consumers too will have greater control over where they get their energy from, being able to select between the prices offered by their normal electricity supplier from the wholesale market or being able to take advantage of attractive prices offered for a short period by local renewable generators.

As mentioned above, these local markets are in the early stages of their development and, as such, many exist only in the form of pilot schemes and have prioritised commercial business and community generation schemes. Some example trials that have taken place in the UK include the Piclo trial in Cornwall and Swanbarton's LEMDEx project in Dorset. Since LEMs currently carry an element of risk it is worth noting that another option for Lancashire could be to setup local trading platforms. Born from the Piclo trial in Cornwall, Selectricity is a platform developed by green electricity supplier Good Energy. Using the platform, participating businesses can choose to take their electricity directly from a number of nearby participating generators. While this might not allow for all the benefits of LEMs it provides lower risk alternatives to growing the region's installed capacity.

6.6 Collaboration with Social Housing Providers

The decarbonisation of heat is expected to be a much larger challenge to overcome than the transition has been for power, with the opportunity for council interventions currently being diminished. What is required is for technology to develop and market conditions to change which drive down costs, making technology affordable to more end users. While changes to policy at a national level such as banning oil and gas boilers in new homes from 2025 should facilitate change for new builds, for much of the existing building stock, retrofitting costs may remain prohibitively high. One option that councils should consider is collaborating with social housing providers to enable the large-scale deployment of local low-carbon heat assets. The share of properties that are owned by registered social housing providers or directly by local authorities, is roughly 17% of the total stock in Lancashire (Lancashire County Council, 2021). With such a large share of the housing stock, providers and local authorities have the demand and control of these properties to enable a large-scale deployment of clean heat assets in the region, and the added likelihood of being able to capitalise on large economies of scale to drive down costs. Such large development projects could provide a whole host of additional benefits to the region, which include, but are not limited to the following:

- Improving the health and wellbeing of residents by providing them adequate heating
- Reducing fuel poverty in the region by reducing fuel bills
- Decarbonising the regions heat demand
- Create wider consumer confidence in a technology, which encourages more residents to switch to low carbon heat alternatives
- Establish a local market for the selling of low carbon heat assets and creating jobs for installing and maintaining such assets
- Create a replicable model for low carbon heat deployment which enables the necessary technological and market conditions to drive down costs

To support this collaboration, the UK government has made available a range of different funds to enable the decarbonisation of social housing. The Social Housing Decarbonisation Fund Demonstrator was a £62million fund to "demonstrate innovative approaches to retrofitting social housing at scale, using a whole house approach" and was part of the Social Housing Decarbonisation Fund for which the Government had committed £3.8 billion (BEIS Notice, 2021). While the demonstrator fund is closed the Sustainable Warmth competition has opened, which should support a wider programme of social housing decarbonisation across the county (BEIS Form, 2021).

6.7 Planning Guidance and Signposting

The planning process can be a lengthy and costly stage in the overall development of renewable assets. This stage is crucial in ensuring quality and HSE standards that safeguard residents, businesses, and the environment, though good planning policy should enshrine or raise standards as opposed to inhibit needed developments. Emphasis should be made to maintain standards while streamlining bureaucratic processes. One way to achieve this is for LCC and the Lancashire14 to provide additional guidance and support packs specifically for renewable energy developments. While planning policy is continuously being developed, this process only occurs periodically. Additionally, too much regulatory change can discourage developers as it becomes costly to continuously adapt to new policy. By providing guidance and signposting it can help improve the planning process for developers, possibly reducing associated costs and motivating more developers to consider Lancashire as a region to focus on for future deployment. Guidance can come in multiple formats, for example the LCC website displays maps which show national and international designations for the Lancashire14 area, as well as agricultural land classifications. Such information could be bundled together with other similar information in digital or GIS format. The collated material would help developers to understand some environmental barriers with more ease; alternatively highlighting specific areas available for development such as council owned land, attracting developers to focus new assets in specific areas with fewer constraints. Regardless of the format, the information should be grouped in a specific area which is easy to find and access.

6.8 Piloting Innovative Projects

The pace of this energy revolution requires not just accelerated deployment, but the concurrent development of new technology. At the point of publication of this report a number of the solutions are still novel or in an early development stage and so it is important that Lancashire produces models and processes for new technologies that are suitable to the region. This will require the council to continue supporting pilot projects such as the Wyre tidal barrage, which should in turn provide further socio-economic benefits to the region. Through organisations such as the Local Enterprise Partnership, local universities and the newly created Lancashire Advanced Manufacturing and Energy Cluster there is an opportunity to boost knowledge sharing, pool capital to increase project budgets and generate new skills for a future job market. All of these could make Lancashire an innovation hub for clean technology, which in turn should provide additional capacity on top of the current deployment of clean energy assets.

6.9 Local Skills Generation

The Lancashire Skills and Employment Strategic Framework 2021 provides a long-term strategy to develop key competencies and skills across the region. The strategy highlights the need for collaboration between educational institutions and industry to map what skills will be required in the coming decades and establish the learning routes to meet these skills. If councils want to ensure they can meet or even exceed their deployment targets for renewable energy, they must ensure that some of the skills growth is in the renewable energy sector. Developing a local skills base takes time, so if local authorities wish to prevent supply chain constraints through a lack of skilled labour they must ensure that as local markets grow, there is an availability of competent and skilled employees to support a local market. The 2021 skills and employment framework outlines a specific focus to grow digital skills in the region and it may be a consideration to place priority for skills associated with the renewable energy sector. While it is understood that councils are juggling multiple priorities, there are multiple cross-cutting opportunities presented by the local renewable's sector and so if adequately planned, the positive externalities of a burgeoning renewables skills market could help achieve a range of different targets for different LA's.

6.10 Community Energy Projects

Community schemes will continue to be an invaluable tool in generating funds, bolstering local engagement, and providing alternative routes to growing the capacity of renewable assets in the region. The local community are best placed to understand their own needs and by focussing on a collective approach to leadership and control, such projects have a real opportunity to tackle complex challenges while placing residents at the heart of the solution. There are a myriad of additional socio-economic benefits that are associated with community projects which are fairly well understood, but there is a specific opportunity which relates to the energy transition that this report would like to highlight. The energy system is changing and with that behaviours need to adapt to how we collectively think about, understand, and consume energy. To date the changes to our electricity network have not really impacted how people live their lives, though for heat and transport, technology changes will require people's everyday lives to be different to how they are now. Such intrusions into people's home and lives will understandably often be met with opposition. The learning and understanding required for such behaviour change can be challenging due to budget constraints of private and often public projects. Though, with community schemes the engagement that is often fost ered and is at the heart of such energy projects can provide an ideal platform to enable lasting behavioural change across Lancashire, community energy projects are not a panacea as there are challenges in establishing successful schemes However, by 2019 nearly 265 MW of community energy capacity had been added to the UK, providing tens of thousands of business and homes with electricity (Community England, 2020). Table 6.2 provides a summary of case studies from within Lancashire and further afield in in the UK. Local authorities should look to support and grow these projects across the county, providing guidance and facilitating their capacity to boost deployment in the region.

Table 6.2: A Case Study List of Community Energy Projects in Lancashire and the North West (ENWL, n.d.) (Local Energy North West Hub, 2021)

Local Authority	Project Title	Notes
Burnley	Burnley Boys and Girls Club Eco Warriors	One of seven schemes in the North West given funding by Electricity North West as part of their Community Energy outlook. The scheme equips boys and girls of the club with the knowhow to reduce their carbon footprint and build the confidence in them to engage with others and share and spread their learning. The club revamped its facilities to become more eco-friendly such as installing LED lights and an energy efficient boiler.
Hyndburn	The Solar Meadow	North West Energy Hub have granted The PROSPECTS Foundation £15,600 to undertake a feasibility study for a 2MWp ground mounted solar array on a 3.5 hectare parcel of unused land in Oswaldtwistle. The scheme will generate 1,760,000 kilowatt hours (kWh) of renewable energy every year, the equivalent of 475 households' usage. It is expected to save around 408 tonnes of carbon emissions each year of operation by displacing fossil fuel electricity generation.
Lancaster	Zero Carbon Electric Homes	Lune Valley Community Land Trust is a volunteer group set up to build and manage energy efficient homes in Halton-with-Aughton. The scheme is to expand an existing solar and hydro powered cohousing development. A feasibility study has shown this to be practical and could increase the current local usage of the renewable energy from 15% to 32%
Lancaster	Lune Valley Electric Vehicle Charging Study	A study to investigate the methods to install EV charging at the above-mentioned housing development. The homes are driveway free hence the challenge presented by installing EV charging.
Ribble Valley	Chipping Low Carbon Project	North West Energy Hub have granted Chipping Community Land Trust a grant of £40,000 to undertake a feasibility for options to transition the village from oil based heating to low carbon alternatives with the aim to reduce its current heating emissions from 2,700 CO¬2 p.a.The feasibility will look at what 'fabric first' measures to reduce energy demand and individual heating solutions, such as air source and ground source heat pumps.

Eden	Community Energy Start-up	Cumbria action for sustainability have been given a grant to develop a solar calculator and carbon tool that can estimate available space for PV. The tool is focused on domestic and small businesses as they do not normally have the funds to carry out these studies themselves.
Flintshire	Bretton Hall Farm Community Solar	North West Energy Hub have granted the Community Benefit Society, Ynni Newyyd, £97,000 towards the development of a 30MW community owned solar array. If it succeeds at planning . It will be one of the largest community owned schemes to be developed in the UK.It will begin generating 24,500MWh of renewable energy in 2024, which is enough to supply around 7,500 households and save around 6,370 tonnes of carbon emissions each year of operation by displacing fossil fuel electricity generation.
South Lakeland	Energy Local Broughton-in-Furness	Energy local plans to set-up local co-operatives known as energy local clubs. The aim is to set up direct wire arrangements between these groups and local renewables owned by Octopus Energy in order to secure better prices for both parties. The first scheme is being set up in Broughton in Furness to take energy from Logan Gill Hydro Plant.
South Lakeland	Burneside Community Energy	Burneside Community Energy have a number of schemes to install community owned solar PV

6.11 Community Energy Champions

Lancashire, like much of the UK, has a socially and ethnically diverse population, all with differing aspirations and needs for their energy use. To enable the growth in energy deployment and, more specifically, the uptake of heat generation assets it will be important to engage with a plurality of these needs. With all the benefits of community energy projects their scope is unlikely to reach across the whole of Lancashire. Individuals want their voices heard and their needs met, but everyday life can inhibit engagement with such schemes. This can often lead to opposition to new developments. A way of overcoming this is to consider establishing “energy champions” from different communities who serve as local representatives for their area. These champions would work with the support of third sector organisations, energy expert’s, planners, and other public institutions to develop local energy action plans for their respective communities. An example of this is the Oldham Energy Futures project currently being run by Carbon Co-op (Carbon Coop, n.d.). These action plans would help create a two-way dialogue between councils and their communities. They would ensure that communities are heard and understood. They would serve as an effective forum for sharing specialist and technical knowledge through champions to their communities, with the added benefit of bolstering community connections with the councils and other public institutions. The end goal would be to develop a local energy system that can meet the economic, environmental, and social needs of the people of Lancashire.

6.12 Maximising Renewable Technology in Large-Scale Future Developments

With development such as Lancashire’s Enterprise Zone planned for the coming years, LA’s need to use such opportunities and other similarly large future developments to showcase their commitments towards decarbonising energy. Developments should consider maximising renewable power, heat and transport technology into design’s taking advantage of the benefits of installing both generation and storage assets. As well as showcasing Lancashire to future investors as a region that is attractive to develop renewable technology, it will also ensure new assets are future proofed to avoid costly retrofitting programmes as legislation changes to meet the UK's net-zero target.

7. Monitoring and Tracking Deployment

The regular monitoring and tracking of renewable energy capacity will be key in meeting local deployment targets towards 2030. As well as monitoring progress during a critical decade of abating greenhouse gas emissions, it will also provide periodic opportunities for intervention's to be reviewed and for corrective actions to be made if necessary. When establishing new performance metrics, it is desirable to operate within existing framework's assuming that current processes and procedures are effective. The intention is to avoid complication and undue burden through concurrent or overlapping systems. Lancashire County Council and the 14 Local Authorities need to review their own internal processes and determine whether there exists adequate monitoring and tracking of performance. If not, new structure and procedures will need to be established. Performance metrics should be more than just the reporting of data and should also include steps for feedback and continuous improvement of what is being monitored. An existing framework that could be tailored to incorporate renewable energy capacity monitoring is through the data collection for annual authority planning reports. It is beyond the scope of this report to evaluate the performance of any council's authority planning reports processes, but considering these reporting procedures should be well established, only small alterations may be required to incorporate new performance metrics. Irrespective of the process that may be used, the following outlines the key considerations that should be included in the structure and procedures to establish an effective monitoring and tracking process for renewable energy deployment.

Before establishing what data is being collected it must be clear who the data is being collected for and what is the purpose of this data is. This will help to determine the data to be collected, the format of the data and what it is used for. In addition to local authority planning officers, this data will likely serve beneficial to councillors and council cabinets as well as the public and potentially organisations such as the network operators. While it is self-evident this data is to support deployment in the region, it may have wider benefits and these need to be considered. From a local authority perspective there needs to be an understanding of the gated stages of deployment, therefore the data needs to be collected within the following categories.

- Planning applications submitted
- Planning applications approved
- Installed rated capacity of constructed assets
- Generation capacity annually.
- An action log on interventions

The rationale behind this is to identify where the constraints are occurring that are preventing the deployment of new assets. It is apparent how this may be facilitated by the first three metrics. However, the fourth metric is important and should not be discounted, as it would serve as a key performance indicator (KPI) to determine the effectiveness of the installed assets in the region. The aim for Lancashire should not be to just continue increasing the installed capacity but to ensure the maximum generation of renewable energy from that installed capacity. The aim is to decarbonise electricity. While large scale developers will ensure they maximise generation capacity to manage their revenue, as more capacity is integrated into our everyday lives the rate of generation may not increase at the same rate. There are many reasons why this might happen, which might include curtailment due to grid constraints. However, as discussed there is competition for capital and so the value of every pound spent needs to be maximised. If capacity is being added and there is no real additional generation being added to the region this could signify a number of problems, but may also result in stranded assets and a waste in funds. Finally, the action log will help to understand the trajectory of deployment based on different strategies and actions. For each metric the following categories should be used:

- Differentiate between power or heat
- Differentiate between generation or storage

- Breakdown by technology type

Consideration may want to be made to look at the data by district, though this depends on whether the data is monitored by LCC or one of the 14 Local Authorities in the region.

The following outlines specific indicators for each metric:

- Planning applications should consider the number of applications and the capacity in MW

- Installed capacity should be monitored in MW

- The magnitude of installed capacity will differ from the capacity of approved planning applications. If lower this may signify projects not proceeding to construction. Though the notable value to record is the installed capacity above the capacity of approved applications as this will be small scale installations that do not need planning approval. The capacity of small-scale installations should also be recorded.

- Generation capacity should be monitored in MWh

The categories and indicators that have been selected can all be found from publicly available data sources published by the Department for Business, Energy and Industrial Strategy. As such not only will it be possible to track future deployment as it occurs, but it will also be possible to benchmark against past deployment. Allowing for an analysis of how different strategies and interventions have affected deployment. Data on applications can be found in the UK Governments Renewable Energy Planning Database. Though in both cases alternative internal sources of data may be viable. The source can be whatever is deemed appropriate, especially if more granular local data is available. However, there needs to be consistency between the data to allow adequate comparison and analysis of the metrics. If the data is to be collected independently by the 14 councils, a more unform centralised data source is advised.

The intervals for monitoring will be limited by the availability of the datasets. The data on generation and installed capacity from BEIS is published on an annual basis. Though, annual monitoring may not be adequate for all the indicators being recorded. Planning proposal data is made available by the UK government on a quarterly basis. Ensuring regular intervals is key to enabling adequate interventions to improve deployment in the coming decade. If monitoring reports are too far apart, precious time can be lost between reporting intervals. Planning data can therefore serve as an early indicator for installed capacity while this data is being published. Allowing for interventions to increase applications or approvals. Since the construction of large-scale assets can take up to a year, reporting on a shorter time scale may not reveal any information at an analysis stage. The intervals should be as follows.

- Quarterly – Planning applications submitted and planning applications approved

- Annually – Installed rated capacity of assets being constructed and generation capacity.

This work should be conducted by the specialist working group or the team assigned to focus on renewable energy. Consideration should be made for individuals with a data processing or analytics background. Furthermore, efforts should be made innovate data collection, using new digital systems or software to monitor and conduct analysis of each performance metric. Some of the dataset formats may need a further understanding of energy systems to process into useable metrics. There needs to be accountability for this data and the deployment of renewable energy assets in the region. This can be conducted internally within planning teams, though reporting externally may maintain priority over the coming decade, especially when there are competing requirements on resources. One way of creating this accountability is reporting these metrics to councillors and council cabinets ensuring there is adequate context and reporting on these metrics. Finally, there needs to be a process of review and improvement based on the metrics. Periodic workshops should be organised to review metrics and create solutions and action plans to improve deployment. These workshops should consider engaging with wider stakeholders, such as industry experts or community leaders to maximise their success and guarantee more effective solutions are put in place.

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Lancashire
Independent Economic Review

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