BHESCo

Clean Energy for People Not for Profit

Local Area Energy Plan

Prepared for The Marches Local Enterprise Partnership

Brighton & Hove Energy Services Co-operative Limited
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Society registered with the FCA in England no. IP32097R

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Executive Summary

This local area energy plan was commissioned by the Marches Local Enterprise Partnership to recommend the steps and actions to be taken by Herefordshire, Shropshire, and Telford and Wrekin to cut carbon emissions to meet their ambition to be Carbon Neutral by 2030. Our conclusion from the analysis undertaken is that this ambition is impossible to achieve given the significant barriers presented in labour shortages, underinvestment in the electricity grid and lack of visionary leadership from Central Government. As such, no scenarios are presented in this plan. Instead, we present a clear pathway to how the Marches region can meet a Net Zero 2050 target by following the pathway recommended in this report, with an emphasis on economic prosperity, security of supply and improved well-being for the people in the region. The investment required is estimated at £4.4 Billion. This investment would start producing payback through regional GVA improvement in 14 years.

One of the most challenging barriers to connecting clean electricity generation assets will be the availability of headroom on the grid. In 2021, grid operators curtailed 7TWh or about 4% of the nation's wind power generation due to congestion[i]. Although OFGEM has released its Connections Action Plan[ii] to address grid constraints, it will take time to implement its recommendations.

A fundamental route to decarbonisation includes upskilling the labour force to focus on improved energy efficiency, installation of low carbon heating and rapid renewable energy deployment. The virtual ban imposed by Central Government on onshore wind from 2016 - present has created a significant shortage of skills and materials needed to develop the very projects that will help to meet the Net Zero 2050 target. Building these skills will take a war like effort in training and entrepreneurial skill to build a pipeline of clean home grown, affordable electricity generation.

The tables below summarise the growth in clean electricity generation capacity that will be required:

Table 1 - Cumulative deployment of onshore wind across the Marches

	2030	2035	2040	2045	2050
No. Windparks	2	9	22	40	58
Capacity (MW)	50	225	550	1,000	1,450
Generation (GWh)	142	639	1,561	2,838	4,115
Investment required (£M)	35	164	421	804	1,226

Table 2 – Solar Deployment across the Marches

		2030	2035	2040	2045	2050
Cumulative Generation (GWh)	Rooftop - domestic	35	72	108	145	181
	Rooftop - non-domestic	111	225	340	454	568
	Ground mounted	75	153	231	309	387
	TOTAL	221	450	679	908	1137
Total cumulative investment (£M)		£228	£432	£610	£765	£901

A committee tasked with overseeing the delivery of the target should be formed, consisting of stakeholders from commercial businesses and social enterprise, research, educational institutions, and trade organisations, each contributing their respective knowledge and experience, to ensure that the route to Net Zero is distributed through their areas of expertise, efficiently executed, holistic and as economically beneficial as possible. Just this joined up approach alone, would be a game changer for the region, presenting a way forward for other local authorities tasked to meet their targets with diminishing resources. All participants must be informed about the importance of this collaborative working, each one accountable for delivering their contribution to achieving their assigned target. To progress, it is essential that local authorities assume responsibility to deliver the national Net Zero 2050 target with the utmost urgency and priority, overseeing achievement in the areas within their jurisdiction, not just the housing stock, buildings, and transport fleets that they own.

Unfortunately, without a legislative framework mandating carbon emission reduction in energy and transport by industry over a timeline, there is no incentive for businesses to invest their resources. For most businesses, energy is not a core activity, it is an operating cost that they perceive to be set by contractual arrangement with an energy supplier. Well-designed investment in onsite renewable energy generation and energy efficiency drives down the cost of doing business. An example of this is the Lyreco solar array in Telford, that delivered savings of £50,000 in the first year of operation, while the array was financed through a Power Purchase Agreement, defraying the upfront cash flow implications for the business[iii]

We recommend utilising the significant resource available in the region to create biomethane to gas grid capacity, converting livestock waste from farms to grid quality biogas. This will provide affordable heating for properties on the gas grid. The high calorific value of this waste means that with the right chemistry, this waste can prolong the life of the existing grid, bringing the highest value to the region as a net exporter of biogas. Table 3 below outlines our plans for the construction of Anaerobic Digestion plants. As we consider biomethane to be an interim fuel, we do not recommend building any more plants after 2030.

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Table 3 - Anaerobic Digestion plant rollout

Years	No. plants	Capacity (Million Nm3)	Properties served ('000s)	CAPEX (£M)
2024 - 2030	95	600	651	2,280

Table 4 below displays the total cost of the renewable energy generation proposed in this report.

Table 4 - Total investment required.

Technology	CAPEX (£M)
Anaerobic digestion	2,280
Onshore wind	1,226
Rooftop solar PV (domestic)	277
Rooftop solar PV (non-domestic)	455
Ground mounted Solar PV	169
TOTAL	***4407***

Our full proposal for rollout of measures to 2050 are displayed in Table 5 below.

Table 5 - Full recommendations of measures to be implemented across the Marches.

		2023	2030	2035	2040	2045	2050
Grid carbon intensity (kilo tonnes/GWh)		0.183	0.104	0.050	0.010	0.001	-0.010
Forecasted change in electricity demand (GWh)		3,253	3,735	4,464	5,002	5,185	5,146
Energy efficiency improvements	Reduction in annual heat demnand (TWh)	7.70	6.90	6.01	5.67	5.40	5.27
Heat Pump Rollout	Heat Pump Uptake (% of fossil fuel heating systems swapped to heat pumps	-	10%	30%	50%	70%	90%
	Cumulative No. Heat Pumps Installed (thousands)	-	33	100	167	233	300
Energy efficiency improvements + heat pump rollout	Total annual C02 emissions (kilo tonnes)	1572	1257	854	560	316	87
	Increase in annual grid demand (GWh)	-	153	428	709	970	1243
EV Rollout	Cumulative no. EVs (thousands)	11	165	377	466	466	437
	C02 emissions from transport (kilo tonnes)	1,456	1,089	524	280	179	95
	Annual grid demand from EVs (GWh)	43	506	1,206	1,750	1,983	2,033
Deployment of Renewable Energy Generation (cumulative GWh)	Onshore wind	-	142	639	1561	2838	4115
	Rooftop solar PV (domestic)	-	35	72	108	145	181
	Rooftop solar PV (non-domestic)	-	111	225	340	454	568
	Ground mounted solar PV	-	75	153	231	309	387
	TOTAL	**-**	**363**	**1089**	**2240**	**3746**	**5252**

Implementing the recommendations in this report will add an estimated £100M in GVA per year to the region as it becomes a powerhouse for the clean energy economy. Total GVA to be contributed from the recommendations in this plan is estimated at over £60 Billion for the period to 2050.

Meeting carbon reduction targets requires a paradigm shift in our economic thinking. It is important to move away from discussion around the **Cost** of the transition to a low carbon economy to an **Investment** in the future wellbeing of our communities. This pivot in thinking will drive the economic shift by realising the full extent of the GVA growth potential offered by the low carbon economy.

The following figure shows carbon emissions by sector. Industry, commercial, domestic and transport sectors are addressed in this report. Although some emissions from Agriculture are addressed, they are outside the scope of this Local Area Energy Plan.

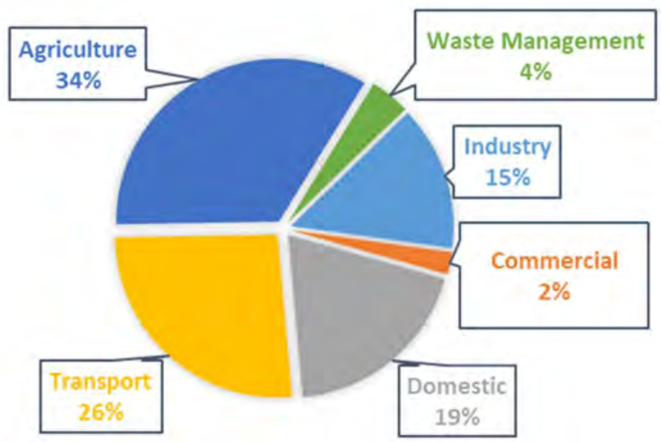

Figure 1 - Marches carbon emissions by sector[iv]

The primarily rural character of the region has a significant influence on the source of carbon emissions, informing the actions to be taken to structurally reduce carbon emissions. The Marches region has an opportunity to meet a carbon neutral 2050 target, not by relying on National Government policy, as funding programmes are short term, misguided and lacking in consistency as political priorities change, instead by tackling the challenge in a structural way by following this plan. The Marches 2030 Vision report[v] recognises that significant economic prosperity is associated with investment in a carbon neutral future, as millions are diverted away from oil and gas investments into a balanced, enriching, clean energy economy.

We would like to thank the contributors to this report and the reports that have informed our work, produced by the local authorities in the region, Marches Energy Agency and Marches Local Enterprise Partnership.

1 Scope

Three local authorities (Herefordshire, Shropshire and Telford & Wrekin) in the Marches Region declared climate emergencies in 2019, each actively working towards achieving carbon neutrality by 2030. Due to budgetary limitations, this report does not present a local area energy plan that replicates the methodology prescribed by the Energy Systems Catapult. We have engaged with various participants from the public sector, businesses, utilities, voluntary organisations and the wider community.

Equity in the energy transition is achieved through the provision of an affordable, secure, clean energy supply. Our report has been prepared with this in mind. Actions to reduce Scope 3 emissions associated with goods consumed is not included in this report. Because of the deterioration of manufacturing capacity in the UK due to globalisation, there are very few products that are produced here. One can question the wisdom of relinquishing the skills and economic power that this activity brings for the temporary fulfilment of cheap goods from overseas, as well as the national security threat of transferring wealth to other less democratic, more volatile and threatening nations. However, there is little use to lamenting past decisions, it is a question of the wise investment of national Gross Value Added into restoring the economic robustness of the region. The clean economy provides another opportunity to build back these skills. We have been in touch with many of these entrepreneurs during the course of preparing this report.

After consulting scientific experts in applications for hydrogen, we have determined that hydrogen technology would not be addressed in this report, due to its lack of relevance on a distribution network level and the lack of heavy industry in the region that would be off-takers of the hydrogen produced. We don't predict that any more than 20% of hydrogen, if any, will be added to existing gas networks because the expense of making it for this purpose will be cost prohibitive. We also share safety concerns associated with residential use. It is highly likely that hydrogen will be used for the following applications:

- Energy storage for transmission networks,
- Hydrogen production for heavy industrial applications, like steel,
- Shipping,
- Aviation.

For example, if hydrogen from electrolysis were to almost replace diesel fuel use by 2030, extrapolating on the figures used by Shropshire, 1300 GWh of electricity production (40% of current total) would be required to meet this need across the region[vi]. As DAF, Renault and Mercedes-Benz already have electric powered HGVs on the market, we don't project that hydrogen HGVs will ever be economically viable.

We have not determined any areas within the region that would make hydropower an attractive source of electric power. The only potential for productive use would be a river source heat pump system in Hereford, as mentioned later in this report.

We have not identified all of the areas where EV charging points can be installed. We note that Herefordshire, Shropshire and Telford and Wrekin have been allocated £293,000, £362,000 and £354,000, respectively through the Local Electric Vehicle Infrastructure fund distributed by Central Government over a three-year period to 2025. We note that no mention of EV charging infrastructure was included in Shropshire's Strategic Infrastructure and Investment plan 2022. Shropshire plans to bring the number of EV charge points to 320 from 50 with its strategic partner Connected Kerb. This partnership presents an opportunity to prepare a business model for the rollout of more charge points than the 320 planned. Given the estimate that 41% of all motor vehicles will be electric by 2030, this translates to 78,000 electric vehicles on the road in Shropshire.

Herefordshire Council are part of the Midlands Connect consortium, we have noted no specific location strategy or target for installation of EV charging points in Herefordshire. Telford and Wrekin are the only local authority in the region that have developed an EV charging infrastructure strategy. Their strategy is highly dependent on the availability of UK government funding. This is a dependency that must be addressed, as there are likely commercial options working with their implementation partner Wenea to support them, as landowner in many of the more densely occupied areas, to meet their EV charging point infrastructure ambitions.

We have not calculated the specific level of job creation in each of the relevant areas of this report.

We have also not addressed diesel emissions from the rail network in detail. We have made a recommendation in the biofuels section.

It is important to note that we have omitted potential solutions that would be contentious, controversial, costly and highly unlikely to be implemented, such as any potential developments in areas of Special Scientific Interest or Areas of Outstanding Natural Beauty.

2 Economic Metrics

The Marches region currently represents about 2.5% of National GVA. The energy transition presents an opportunity for growth in the economic output of the region. It also presents an economic challenge, especially with regards to labour productivity.

The table below[vii] highlights the economic challenge to the region in relation to the national economic strength.

Table 6 - Gross Value Added (GVA) across the Marches

Per capita GVA	1998	2003	2008	2013	2018	20 year change	20 year CAGR	Rank
UK	£15,531	£18,892	£23,265	£24,812	£28,725	+85%	+3.3%	
UK ex London	£14,049	£17,243	£20,549	£21,894	£25,346	+80%	+3.0%	
Worcestershire	£12,450	£14,799	£17,482	£20,041	£22,766	+83%	+3.1%	86/232
Shropshire	£12,218	£14,203	£16,574	£17,374	£19,333	+58%	+2.2%	218/232
Telford + Wrekin	£16,331	£18,705	£21,251	£20,582	£27,505	+68%	+2.6%	183/232
Herefordshire	**£13,326**	**£15,491**	**£16,956**	**£18,311**	**£20,463**	**+54%**	**+2.2%**	**218/232**
Gap - UK average	**13%**	**18%**	**29%**	**26%**	**29%**			
Gap- UK ex London average	**5%**	**11%**	**18%**	**17%**	**19%**			

Source: ONS. GVA = Gross Value Added (measure of economic productivity). CAGR = Compound Annual Growth Rate

More recent economic data for the region is as follows:

Table 7 - Recent GVA statistics for the Marches

	2021 population	GVA[1] value	GVA per capita
Telford and Wrekin	185,600	£ 4.665	£ 25,135
Shropshire	323,600	£ 6.236	£ 19,271
Herefordshire	187,100	£ 4.141	£ 22,133
Total Marches region	696,300	£ 15.042	£ 66,538

[1] Data provided by Office for National Statistics | GVA is for 2020

Although GVA for Shropshire is highest, Shropshire has the lowest GVA per capita as the working age population in the county is in decline with about 25% of residents over the age of 65. Telford and Wrekin has the fastest population growth rate of the region and as such, indicates the greatest potential for GVA growth. It is important that this growth is associated with a low carbon economy.

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77% of the land in the Marches Region is farmed land, representing one of the strongest agricultural centres of the country. The agricultural nature of the region means that the climate may have a greater impact on agricultural yields. Although farming is not in the scope of our report, we anticipate that more food production will need to occur in indoor controlled environments. This change in farming will increase local energy demand. The impact of this change has not been included in this report.

Harper Adams University, located in Shropshire, is considering the impacts that climate change will have on growing food in the region. In 2024, they are planning to launch a specialised course on Environment and Sustainability that will educate students on the threats that a changing climate has on crops, yields and farming. They are already taking action to investigate the economics of biomethane production on campus to transition their current fossil fuel driven combined heat and power (CHP) facilities to biomethane.

The launch of the Herefordshire Low Carbon Technology Centre at Holmes Lacy Campus will support the growth required in the supply chain to fulfil the demand created by investment to meet the nation's carbon emission reduction targets.

The Marches 2021 report identifies 500 – 1,000 new jobs associated with the transition to a low carbon economy. Based on the recommendations in this report[1], the ambition must be to create jobs growth at 15% per year associated with areas of the energy transition identified as follows:

- Upskilling trades for improving the energy efficiency of properties,
- Increasing employment for onshore wind development and construction,
- Increasing employment for energy infrastructure planning and construction,
- Employment for heat pump installers,
- Employment for solar PV installers on homes, commercial premises, and ground mounted systems,
- Project developers and managers,
- Procurement and manufacturing,
- EV charging installations,
- Alternative fuel production (biofuels and biomethane).

This will add an average of £100M in GVA to the Marches region per year in the first five years of its execution as it becomes a powerhouse for the clean energy economy. Total GVA to be contributed from the recommendations in this plan is estimated at over £60 Billion to 2050.

[1] Based on data supplied by kMatrix in their 2021 report "Low Carbon Environmental Goods and Services, p.86

3 Energy Efficiency

Although action to reduce energy consumption in our homes, public buildings and businesses can result in a 50% reduction in energy demand for heating[viii], little is being done nationally to promote action on energy efficiency[ix]. Clearly, any initiative by government to encourage the uptake of energy efficiency measures needs to be market-driven, incentivised by legislation and with guidelines and subsidies that encourage people to invest in improving the energy efficiency of their homes with a simple, easy-to-administer, quality-controlled incentive. Market-driven implies leadership in supporting communities to invest in improving the energy performance of their properties. This would be overseen by a trusted authority, working in co-operation with local energy groups and backed by national policy (refer to Policy recommendations Section 13).

From the Energy Performance Certificate (EPC) data across the Marches Region, we note that the distribution of properties with poor thermal efficiency is worse than the national average. In addition, Shropshire and Herefordshire fall below the national average in terms of percentage of homes with valid EPCs, i.e., carried out within the last 10 years. Of the domestic properties included in the Marches region, an average of 50% have EPCs. For the purposes of our report, we have assumed that homes without EPCs are owner occupied, acquired before the Energy Performance Certificate was required for the purchase or sale of a domestic property. Like the assumptions previously made by BEIS, we have assumed these properties have an average EPC rating of 55, the lowest rating in band D. In reality, many of these properties would likely be in bands E-G.

Table 8 - Overview of domestic EPC coverage across the Marches

County	No. Homes	With EPCs			Without EPCs		
		No. homes	% homes	Average SAP	No. homes	% homes	Assumed SAP
Shropshire	148,745	73,316	49%	62.2 (D)	75,429	51%	55 (D)
Herefordshire	88,665	41,460	47%	60.8 (D)	47,205	53%	55 (D)
T&W	79,370	43,026	54%	68.6 (D)	36,344	46%	55 (D)
England	-	-	*50%*	*67 (D)*	-	*50%*	-

Recently, the (BUS) Grant has been increased to £7,500 to support households to replace their fossil fuel boilers with an air source heat pump (ASHP). This grant will in many cases make the cost of installing a heat pump similar to that for replacing an oil or gas boiler, although not necessarily funding radiator upgrades required to deliver a high efficiency system with low running costs. With current oil and gas prices, a heat pump achieving a Coefficient of Performance (CoP) of 3.3[x] (3.3 units of heat for each unit of electricity used) is likely to have lower operating costs compared to older, low efficiency boilers. The BUS grant will balance the cost of replacing fossil fuel boilers with properly sized heat pumps.

Well insulated homes offer potentially large savings for households, particularly if they are also fitted with solar PV and efficient heat pumps.

Central government funded Affordable Warmth schemes operate as part of the ECO4 programme and the Great British Insulation Scheme for qualifying households. Local Authorities can participate in the delivery of ECO4 through a system called LA Flex. This involves resources to be spent by the local authority to support a claim for grant funding support by confirming that the claimant meets the eligibility criteria, primarily that household income is less than £30,000. Some local authorities work together to reduce the administrative burden of LA Flex. Unfortunately, these programmes still fund the replacement of gas boilers instead of focusing on funding work to help homes improve their efficiency so they can cost effectively run a heat pump. Our migration plan, increasing the use of biomethane on the grid, will address this oversight in legislation to protect vulnerable people who have had new gas boilers installed under this programme until their homes are made "heat pump ready".

To reach Net Zero, it is crucial that a long-term, reliable energy efficiency programme is rolled out to residents by the relevant local authorities, setting the eligibility criteria while reducing the administrative burden as much as possible by streamlining processes. This programme would boost the economy, by putting more money back in people's pockets, while reducing the carbon footprint of domestic properties. This is especially pertinent for those homes burning oil and solid fuels for heating, as 30% of households across the Marches are off the gas grid. The Home Upgrade Grant is a useful tool for helping these households upgrade to an ASHP.

The Minimum Energy Efficiency Standard (MEES) scheme requiring privately rented homes and non-domestic properties to achieve an EPC E with a planned increase to D was scrapped in September 2023. Increasing this rating has been much discussed but there are currently no confirmed dates in legislation for increasing EPC ratings. Government consultation on the target EPC levels gained strong support for an EPC B target by 2030[xi]. Deadlines need to be set for increased MEES standards as it has a direct impact on both carbon emissions and the cost of energy for many households. There have been many proposals for similar standards in social housing, but no limits or deadlines have been set with consultation ongoing. Some funding is available under the Social Housing Decarbonisation fund to improve social housing to an EPC C (or D for homes which are currently very poor).

3.1 Modelling Energy Efficiency Measures at Scale

Data from a UK Energy Research Centre (UKERC) project[xii] was used to model the implementation of energy efficiency measures and their concomitant impact on decreased heat demand across the three counties. In this study, appropriate energy efficiency measures were modelled based on raising the current EPC ratings to their potential EPC – an average of EPC B (SAP=81) for the Marches, as listed on EPC certificates.

In 2020, the UK Government, in its 'Energy White Paper', set out minimum energy efficiency standards (MEES) for all non-domestic properties[xiii]. The agreed regulation was for all non-domestic properties to reach EPC B by 2030 (SAP>81).

Table 9 - Impact of energy efficiency improvements on heat demand

		2023	2030	2035	2040	2045	2050
% Implementation of energy efficiency measures required to reach potential EPC rating		0%	33%	67%	80%	90%	95%
Annual heat demand across The Marches (GWh)	Domestic	6096	5420	4724	4458	4253	4151
	Non-Domestic	1674	1482	1284	1208	1150	1121
	Total	*7770*	*6902*	*6008*	*5666*	*5403*	*5272*

Combining the data from the UKERC study and available non-domestic EPC data, we have modelled a realistic rollout of energy efficiency improvements based on current rates of uptake, by which 95% of properties will reach EPC B by 2050. Our predicted rollout and estimations on the decrease in heat demand with energy efficiency improvements are included in *Table 7* above. Furthermore, aggregated data on a local authority level is displayed in *Figure 2* below.

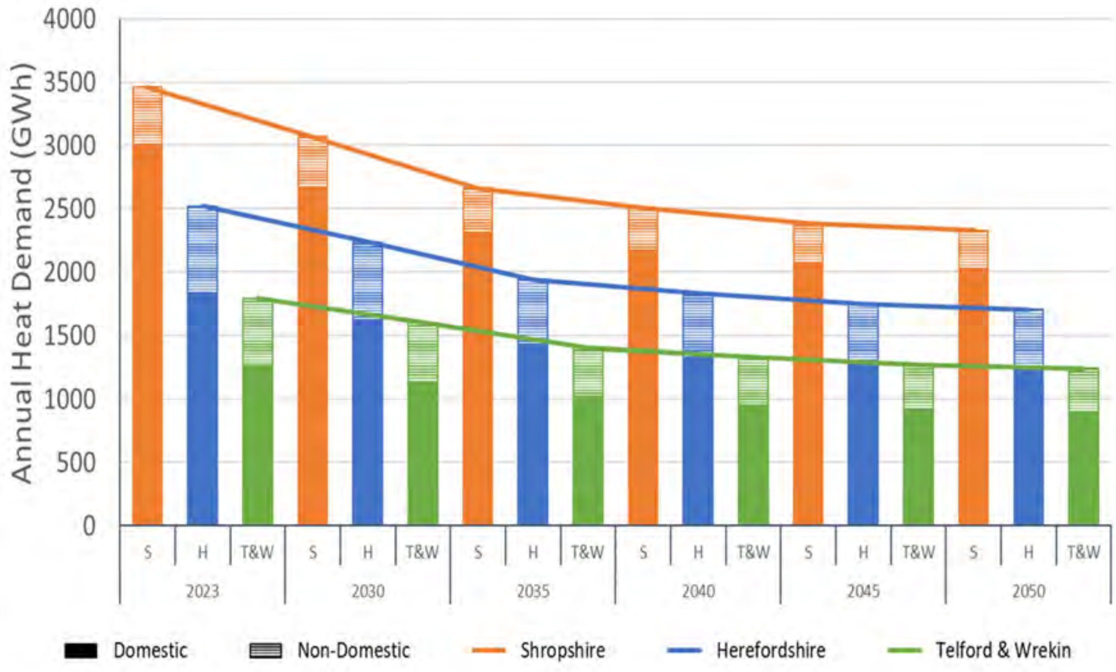

Figure 2 - Installation of energy efficiency measures and resultant decrease in annual heat demand

To estimate the costs associated with implementing energy efficiency measures on domestic properties, we utilised research from a 2020 study by Savills[xiv]. This research article lists the typical costs required to transition between EPC categories. By applying these costs to the number of houses per EPC category in each local authority, we determined the total retrofit costs required to bring domestic properties up to EPC B by 2050. For non-domestic properties, we estimated costs based on the domestic values, adjusting these estimates according to the larger average floor area and the higher average energy efficiency rating of non-domestic properties compared to domestic homes. Our cost estimations are outlined in Table 10.

Table 10 - Cost of energy efficiency improvements.

		Marches	Shropshire	Herefordshire	Telford & Wrekin
Domestic	per home (£)	£17,780	£18,145	£18,492	£16,220
	Total (£bn)	£5.24 bn	£2.53 bn	£1.56 bn	£1.15 bn
Non-Domestic	per property (£)	£29,041	£17,061	£31,770	£59,933
	Total (£bn)	£0.42 bn	£0.12 bn	£0.15 bn	£0.16 bn
TOTAL		***£5.66 bn***	***£2.65 bn***	***£1.71 bn***	***£1.31 bn***

3.2 Case Study: Rolling out energy efficiency improvements at scale.

In 2022-23, BHESCo trialled an approach to working with a defined community to encourage action on retrofits at scale. The total cost was £21.1k, £11.6k from the MCS Foundation, £4k from Kestleman Trust with BHESCo funding the remaining balance. The campaign started with a competition to identify the enthusiastic community lead by a local champion. BHESCo created a database of EPC ratings for the area. We then categorised each property by archetype based on age, wall type (solid or cavity), detached, terraced or semi-detached, solid floor or suspended timber, pitched or flat roof and window glazing. We performed a targeted energy survey to verify the EPC rating for 2 properties in each of the archetype areas.

To engage the community, the launch event took the form of a workshop to communicate the project aims and our plan to achieve these with residents, inspiring their participation by providing live examples based on their property information stored in our database. We soon observed that taking a whole house approach to the energy efficiency makeover felt overwhelming for homeowners, creating disinterest in participating in the project.

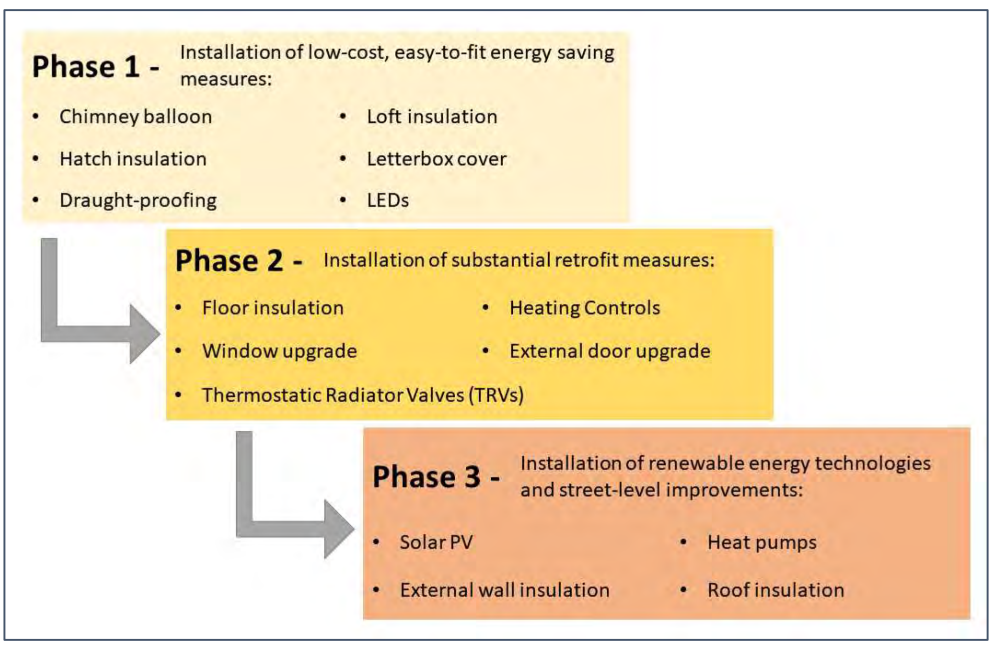

Figure 3 - BHESCo's Three-Phased Approach to Retrofits

To remedy this, we split the measures into three groups matching individual's approach to retrofits, moving from the easier to treat measures to the most time consuming and disruptive measures. This three-phase approach introduces people to the benefits of having energy efficiency measures installed, while softening the urgency of action and building trust in BHESCo, the project manager. A direct communication channel was established for the group where residents could express their concerns in a public forum. It is important to address negative comments as they arise, so the project manager must be included in the communication channels.

Local contractors were engaged to provide quotes for the works that BHESCo recommended for each home. These were managed into a timeline for rollout. Quality control is assured through a Retrofit Co-ordinator who works with the project manager and the systems installer or contractor. The contractor also supported the project manager to help the homeowner receive funding available through ECO and Local Authority Delivery schemes.

This approach to rolling out retrofits at scale is expected to drive down costs by about 10%, as acquisition cost is reduced for the contractor and more trade is guaranteed. All sources of funding are combined, including the Affordable Warmth scheme or funding available through the local authority. Finally, finance was offered to support the programme via partnership with a local community bank through a special agreement with BHESCo to offer lower interest rates.

Another similar project is being conducted by Rossendale Valley Energy[xv] and Carbon Co-op based in Manchester[xvi].

4 Low-Carbon Heating

Heating is responsible for approximately 30% of carbon emissions across the Marches. This section describes our recommendations for the decarbonisation of heat in a social context, where tackling fuel poverty is an important outcome. In developing these projects, our experience shows that decarbonising heat can be done in an economically sound way that is socially responsibly.

As illustrated in Energy Efficiency, *Section 4*, total heat demand for the Marches region is currently estimated to be around 7.8 TWh. By 2050, if the recommended rollout of energy efficiency improvements is adopted, this total could be reduced by 32%, to 5.3 TWh.

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Eventually, all properties in the region must transition from fossil fuel heating systems to electric heating. Heating will be delivered through a variety of renewably powered systems, namely: air source heat pumps (ASHPs), ground or water source heat pumps (G(W)SHPs); and where appropriate, electric resistive heating. This inevitable transition is recognised by DNOs such as NGED, which aims to have its network ready to support at least 600,000 heat pumps by 2028.

It should be noted that, in comparison to ASHPs, GSHPs generally provide larger incremental savings over their lifespan. This is due to their higher coefficient of performance (CoP), meaning that they deliver the same amount of heat while using less electricity. In comparison to GSHPs, ASHPs are easier, quicker, cheaper, and less disruptive to install. In addition, ASHPs do not have the same outdoor space requirements as GSHPs, making them more suitable for most urban environments. ASHP technology is also evolving rapidly. Previous concerns surrounding their noise levels are reducing with the development of increasingly quiet models such as the Bosch 7400i, which boasts a sound power level of just 50 db(A), the equivalent of a quiet refrigerator.

Replacing an oil or gas boiler with a heat pump will give an immediate, large reduction in CO_2 emissions. Homeowners are currently unlikely to see a significant reduction in heating costs due to the high price of electricity compared to gas or oil, mostly due to imbalance in levies imposed by central government. Heat pumps are extremely efficient and will deliver much more heat energy than the electrical energy they consume. The delivery of heat compared to electricity consumption is termed the coefficient of performance (CoP) with GSHPs often achieving COPs of 4.0, i.e. 4 kWh of heat for every 1 kWh of electricity used.

ASHPs usually have lower CoPs, typically around 3.0, which with electricity unit costs around 4x those for gas makes them more expensive to operate. Given that fossil fuel boilers are, at best, only around 90% efficient, a price ratio of 3.3 would give parity in operating costs for a COP of 3.0.

To incentivise consumers to make the switch to a heat pump, this price difference must be addressed. Government has signalled its intention rebalance energy prices from 2024[xvii].

The CoP for ASHPs can also be improved substantially from levels seen historically in the UK[xviii] by ensuring good installation practices. We would like to see the MCS requiring installation for high efficiency including proper consideration of all system design such as heat emitters (usually radiators), flow rates and control systems which maximise efficiency followed by correct implementation of these elements.

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The selection and suitability of low-carbon heating solutions are context dependent. The following sections outline our approach for the decarbonisation of heat across the Marches, including:

- Rural areas off the gas grid (30% of homes across the Marches)
- Communities where district heating can be implemented economically, like new developments and densely populated urban areas,
- Less densely populated urban communities.

4.1 Rural Areas

Across the Marches, 30% of homes are off the gas grid. Most rural communities have either electric storage heating or hot water heating systems powered by heating oil, solid fuels, like biomass or coal, or LPG. We recommend transitioning such properties to air source heat pumps (ASHP) as an efficient way to reduce carbon emissions, based on our own experience that GSHP's higher upfront cost cannot be recouped by the incremental savings achieved through their running costs in the long-term. This transition is in line with government strategy which proposed in 2021 to phase out installation of new oil and LPG boilers from 2026 [xix].

Replacing fossil fuel boilers with ASHPs will bring an immediate large reduction in carbon emissions and will be lower cost to operate for many homes if installed correctly and particularly if combined with solar PV and/or replacing an older, low efficiency boiler.

Fabric improvements to reduce heat losses should be made first as these will reduce operating costs, radiator upgrade requirements and heat pump installation costs. The BUS grant requires loft insulation and cavity wall insulation where feasible. Other improvements such as improvements to glazing can be difficult in older homes, particularly if they are in AONB areas or listed properties. We would like to see other authorities following the example of Kensington and Chelsea[xx] where secondary glazing is permitted in all grade II listed dwellings without seeking prior approval.

High temperature heat pumps are now available which can be installed into existing heating systems without replacing radiators or hot water cylinders. These will be more expensive to operate but allow for progressive improvements after installation and will suit some homeowners better as they can retain period radiators, for example.

Some of the economic challenges associated with transitioning rural areas to heat pumps are exemplified by recent efforts to develop rural heat networks. For example, the heat network project in Swaffham Prior, built by the Cambridgeshire Combined Authority where over £12M was reported to be spent to provide 300 homes with clean, renewable heat. Locally to the Marches, Sharenergy are in the early phase of developing their Bishops Castle project. However, we expect their conclusion to be that retrofitting a heat network in a village is not economically attractive. Although Sharenergy realise that these projects are not viable without local generation to power it, they will have to secure a lower tariff for electricity from the wind turbine they plan to install to deliver affordable heating to residents while also ensuring that the project is financially sustainable through the heat price offered.

To keep the price of running heat pumps to a minimum, local communities should consider areas where they will tolerate the installation of wind turbines or solar power and long-term battery storage. This will improve energy security while driving down the cost of the electricity supply. It will also help to reduce the cost of grid reinforcement as the increased demand associated with running a heat pump is an average of 50% of a household's annual electricity consumption. We suggest that a significant share of this infrastructural development is funded through community ownership. More information on Community Ownership is discussed in Section 11.

4.2 Heat Networks

The Committee on Climate Change projects that 18% of heat demand will be met by heat networks by 2050[xxi]. Below, we outline some of the barriers associated with heat network development in rural communities and potential opportunities for their successful implementation across the Marches.

4.2.1 Barriers to Heat Network Development

A key issue for rural communities is land ownership. Ideally, a heat network would be designed such that the network would run through land that was owned by one landowner, a local authority or family, to minimise the negotiations for the rights to use the land. Negotiating rights to land is complicated when multiple landowners exist.

Heat network projects to date have only been undertaken where the local authority owns the highway. Until a statutory undertaking is legislated, i.e., simplified, and standardised procedures put in place that make it easier to negotiate rights to the land, like the legislation that exists for electricity or gas networks, the negotiation of land rights will be complex and time consuming.

This will add cost to the development stage of the process when margins are likely to be low. Therefore, we recommend that local authorities work proactively to identify areas of dense habitation where a heat network may be attractive. These are blocks of flats and multi-occupancy buildings, or terraced streets with higher heat demand that are currently off the gas grid. Identification of potential heat networks, especially where on site electricity generation is also possible should be shared with a developer, preferably a local community energy organisation, who would take over the project management to its delivery and operations. Local authorities can be a facilitation partner, also by assisting the developer to obtain external funding and to manage funding deadlines.

In addition, agreement must be made with the relevant local authority to account for the cost of the residual value of the heat network after the heat supply agreement period. Most people who connect to the network will be unwilling to commit to a period longer than 25 years. Even contemplating a 25-year agreement will be difficult for many people. This must be overcome by focusing on the infrastructural elements of the heat network and the long-term nature of local energy generation. Studies confirm that people are willing to accept wind and solar farms if there is a level of community ownership involved[xxii].

There is also the emotional barrier, that residents are used to running their own heating systems. They are not connected to the gas grid, so this cannot be used as an example of shared network heat delivery systems. Creating a shift in people's values and a change in their relationship to their energy provision, transitioning away from fossil fuels, is a daunting challenge. This is best tackled by engaging champions, people who are respected within the community to endorse the project and its aims.

4.2.2 Communally Heated Urban Areas & New Housing Developments

Heat networks are the lowest cost option in urban areas where many buildings of multiple occupancy have communal heating systems, whereby heat and hot water is generated by a centralised boiler. These generate the density of heat consumption required for heat networks to be economically viable. An inspiring example of an urban heat network in development is the Bristol Heat Network, which is being driven by a 3MW water source heat pump. This was developed with Vitali Energy, presenting an excellent source of low-carbon heating.

In 2019, Graham Wynn, Marches LEP chairman announced their ambition to create 54,400 new homes in the region. Heat networks are a natural solution to providing low-cost renewable heating for new housing developments. Kensa Utilities are a UK based installer that work with developers to fund, own, and operate heat networks. They will fund the infrastructure while the customer pays for the heat pump. This is one way to ensure that low-cost, low-carbon heating infrastructure is installed in new housing developments.

In Hereford, 305MW has been identified from the river Wye as a potential source of heat[xxiii]. As new housing developments are submitted for planning, heat networks should be an essential component of building affordable housing. This can be incorporated into planning requirements by all local authorities in the Marches region.

4.2.3 Funding Sources

Funding for heat networks is available until November 2024 under the Green Heat Network Fund. Other funds available to local authorities are: BHIVE – a service that will allow public sector owners and developers to procure funding and funding related services for their heat network services. Both of these programmes are administered by Triple Point Heat Networks. The Heat Networks Delivery Unit (HNDU) provides grant funding and guidance to local authorities for heat network project development.

Central government is planning to release heat zones to local authorities by February 2024. These heat zones are designed to support local authorities to plan and develop their heat networks by designating the areas where these can be developed at lowest cost.

In the next section, we outline our proposal for the rollout of heat pumps.

4.3 Heat Pump Rollout

For our modelling of heat pump rollout, we computed baseline carbon emissions from heating in both domestic and non-domestic properties. The methodology varied somewhat between the two property types according to the availability of relevant data and existing studies. For the purposes of our analysis, it was assumed that all heat pumps were air source. A CoP of 3.1 was adopted as a conservative measure, as a well installed ASHP can achieve a CoP of close to 4. Currently, ground source heat pumps have a CoP of around 4, slightly higher than air source, resulting in reduced grid electricity consumption, demonstrating our conservative approach to the modelling analysis.

Domestic and non-domestic electricity and gas consumption was obtained for each county from the latest DESNZ 'Sub-National Consumption' datasets.

Table 11 - Baseline carbon emissions from heating and total electricity consumption

		Marches	Shropshire	Herefordshire	Telford & Wrekin
Annual C02 emissions from heating (kilo tonnes)	Domestic	1,264	631	390	243
	Non-Domestic	308	308	128	846
	Total	**1,572**	**759**	**474**	**339**
Total annual electricity consumption (GWh)	Domestic	1189	574	359	256
	Non-Domestic	2064	861	607	596
	Total	**3253**	**1435**	**966**	**852**

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4.3.1 Domestic Heat Demand - Methodology

- Data on domestic heat demand was taken from the UKERC project referenced earlier in the energy efficiency section.
- This project used EPC data and supplementary datasets and research articles to estimate the annual domestic heat demand across England at Lower Layer Super Output Area (LSOA) level.
- Heat demands were split by household type and heating fuel, i.e., Biomass, Gas, Oil and Electric. This allowed the heat demands of the different heating system types to be calculated and then aggregated at a local authority level. From this data, separate carbon emission contributions were calculated based on most recent government conversion factors[xxiv].

4.3.2 Non-Domestic Heat Demand - Methodology

- BEIS' 2016 Building Energy Efficiency Study lists the national proportion of electricity and gas used for space heating purposes in non-domestic properties. This national average was applied across the three counties in the Marches for the purposes of this analysis.
- EPC data was used to disaggregate non-domestic properties' heating type by fuel, such as properties with direct electric heating and those with A/C units or other heat pumps. Together with the BEIS consumption data, the non-domestic heat demands were estimated for each county, separated into heating from gas and from electricity. The total heat demands across The Marches are illustrated below in *Table 12*.

Table 12 - Heat demand across the Marches

	Heat Demand (GWh)			
	Marches	**Shropshire**	**Herefordshire**	**Telford & Wrekin**
Domestic	6096	3002	1824	1270
Non-Domestic	1674	694	458	521
Total	**7770**	**3696**	**2282**	**1791**

4.3.3 Modelling Heat Pump Rollout and Carbon Emissions Reductions

- By introducing heat pumps, gas boilers and other fossil fuel heating systems, as well as direct electric heating units, will gradually be replaced. This will result in a decrease in carbon emissions from fossil fuel heating systems, while increasing electricity demand on the grid.

- The carbon intensity of the electricity grid is projected up to 2050 in National Grid's DFES scenario. For our modelling, we used the 'Falling Short' scenario which forecasts the tonnes of CO_2 per MWh of grid electricity to fall to zero by 2044.
- For the purposes of our forecasting analysis, we modelled a heat pump rollout that would result in 90% of existing fossil fuel heating systems being replaced by 2050.
- Table 13 below outlines our rollout from 2023-2050, including concomitant decreases in CO_2 emissions and increasing electricity consumption.

The results displayed below in Table 13 illustrate a **92%** drop in carbon emissions from heating and a **50%** increase in electricity demand.

As we recommend a fabric-first approach to implementing retrofit, we have also accounted for the impact of installing energy efficiency measures alongside heat pumps.

Table 13 - Heat pump rollout across the Marches and its effects on increasing electricity consumption and decreasing CO2 emissions.

			2023	2030	2035	2040	2045	2050
Heat Pump Uptake (% of heating systems)			2%	10%	30%	50%	70%	90%
Grid carbon intensity (kilo tonnes/GWh)			0.183	0.104	0.050	0.010	0.001	-0.010
Cumulative No. Heat Pumps Installed (thousands)	**Shropshire**	**Domestic**	3.0	14.9	44.6	74.4	104.1	133.9
		Non-Domestic	0.2	0.8	2.4	4.0	5.5	7.1
		TOTAL	*3.1*	*15.7*	*47.0*	*78.3*	*109.7*	*141.0*
	Herefordshire	**Domestic**	1.8	8.9	26.6	44.3	62.1	79.8
		Non-Domestic	0.1	0.5	1.6	2.6	3.6	4.7
		TOTAL	*1.9*	*9.4*	*28.2*	*46.9*	*65.7*	*84.5*
	Telford & Wrekin	**Domestic**	1.6	7.9	23.8	39.7	55.6	71.4
		Non-Domestic	0.1	0.3	1.0	1.6	2.3	2.9
		TOTAL	*1.7*	*8.3*	*24.8*	*41.3*	*57.8*	*74.3*
Electricity Consumption (GWh)			3,253	3,433	3,794	4,155	4,516	4,877
C02 Emissions from heating (kilo tonnes)			1,572	1,417	1,106	769	454	128

4.3.4 Heat Pump Rollout + Installation of Energy Efficiency Measures

The final stage of this forecast analysis involved an interpolation exercise, modelling simultaneously a heat pump rollout alongside the installation of energy efficiency measures. The results of this analysis are displayed below in Figure 4.

From this analysis, the added benefit of carrying out domestic and non-domestic energy efficiency improvements alongside heat pump installations is evident. For example, by improving energy efficiency in line with the strategy highlighted earlier in section 3, the transition to zero carbon emissions from heating is accelerated significantly and grid electricity demand is reduced by over 750 GWh by 2050 – a 15% decrease in comparison to the without measures scenario (see Table 13). Moreover, decreased grid consumption brings benefits to the consumer in terms of reduced energy bills whilst easing pressure on the network operator to upgrade grid capacity across The Marches.

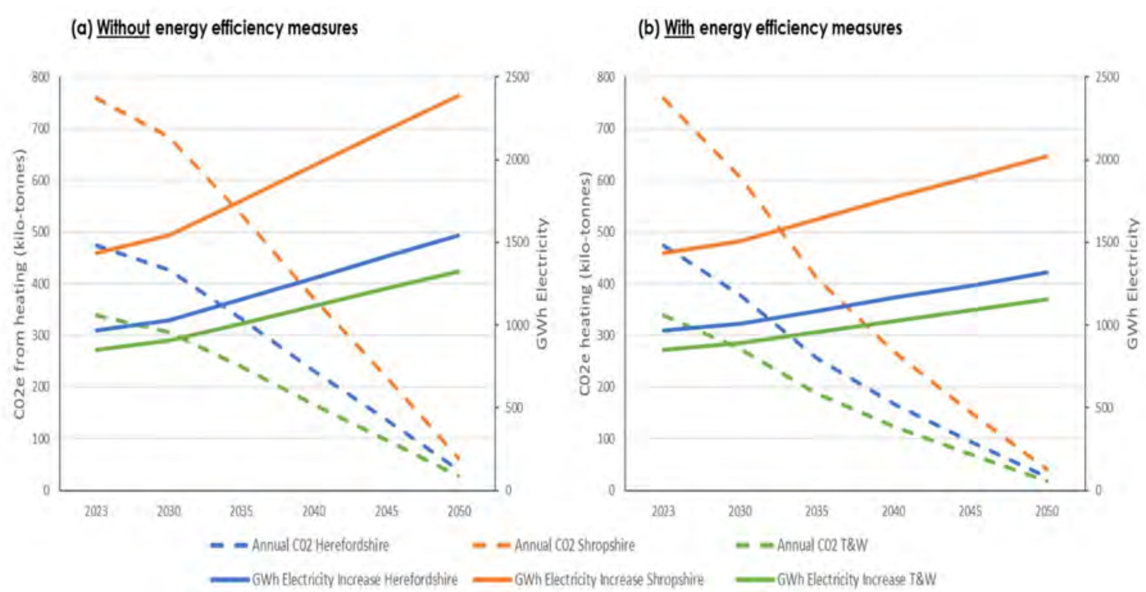

Figure 4 - Transition to heat pumps and its effect on increasing grid electricity demand (GWh) and decreasing carbon emissions from heat, with (b) and without (b) energy efficiency improvements.

4.4 Availability of Skilled Labour

One of the significant barriers to meeting a Net Zero 2050 target is the availability of skilled labour to carry out the extent of the specialist work required. Unfortunately, the inconsistent application of policy and prohibitive costs of compliance, as well as the ever-changing regulation from central government, have had a detrimental impact on the supply of skilled labour. The PAS 2035 requirements, although a well-intended attempt to improve the quality of installations, is confusing and costly. Supply chain availability has made it difficult to start a business, manage the prohibitive costs of running the business, while ensuring that the business complies with the massive layers of regulation on retrofit.

The following table demonstrates the impact that poor, inconsistent policymaking has had on the trades. The Microgeneration Certification Scheme (MCS) was launched in 2010 when the Feed in Tariff was put into place for smaller renewable energy generation systems. The rebound in demand resulted from the launch of the Covid 19 Economic Recovery Plan, which funded the Social Housing Decarbonisation fund, as the cost of solar PV installations fell significantly during the period from 2016 to 2020.

Figure 5 below shows the small increase in MCS certified installers, at about half of the level in 2010. It is very challenging to find an installer for most domestic properties as most of the larger companies won't install these smaller, on average 4kW installations. It is also virtually impossible to find an installer for solar thermal technologies as these have been eliminated by solar PV immersion heating systems.

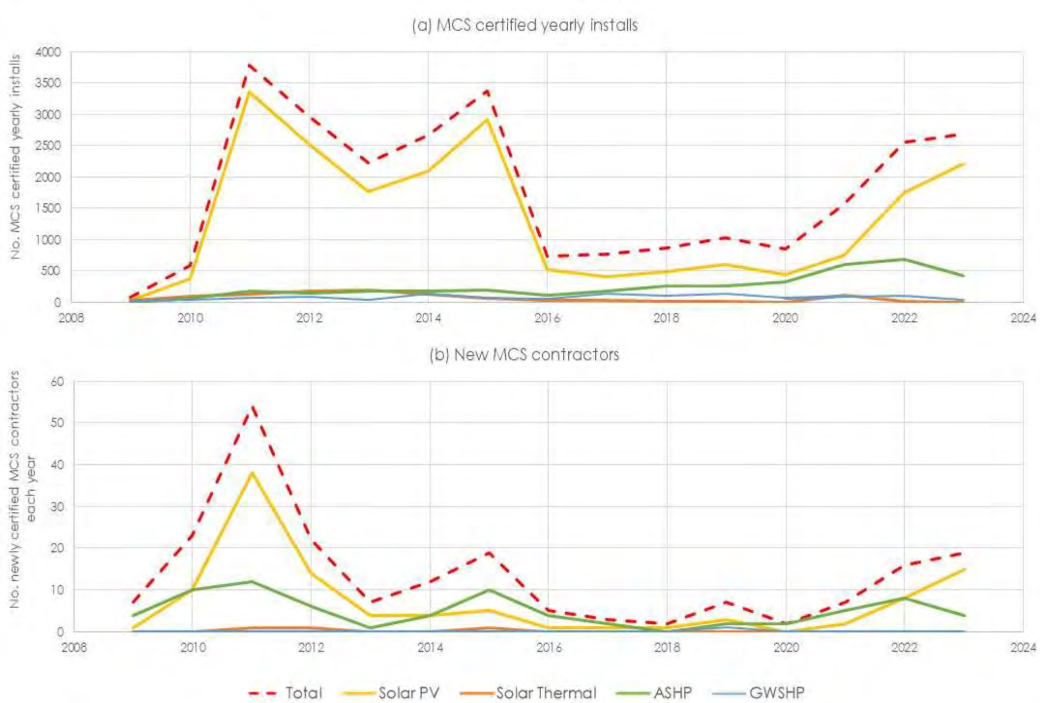

Figure 5 – (a) MCS certified yearly installs and (b) newly certified MCS contractors each year since 2009.

The Herefordshire Low Carbon Technology Centre at the Holme Lacy campus aims to support 750 new learners in its first three years, providing training in low carbon and renewable technologies. It's a good start to develop the skills required to grow the supply chain needed to support the timelines for achieving Net Zero in this report.

The skills gap is more than just training and qualifications, it is also about the creation of consumer demand needed to provide these newly skilled labourers with gainful employment. Without leadership by example and through policy (refer to our recommendations in Section 14, to encourage consumers to take the action necessary to replace their fossil fuel powered heating systems or to improve their property's ability to retain heat, graduates will struggle to find employment, which will lead to problems attracting students to the Centre.

It is important that local authorities, trade associations and industry participants promote the successful installation of heat pumps, including the financial, environmental, and social improvements that result from a low carbon economy.

For the purposes of this report, we have assumed that the supply chain will become significantly more robust each year, with capacity to build solar and wind capacity growing at an unprecedented peacetime rate, to increase at 20% per year. Should development of projects be pursued at the rate required, these employment opportunities will drive enrolment in the Herefordshire Low Carbon Technology centre.

5 Transport

Transport is the UK's largest carbon emitting sector with road transport representing 91% of its total emissions[xxv]. In the Marches, the transport sector accounts for 26% of the region's carbon emissions, second only to agriculture (34%) (refer to Figure 1 in the Executive Summary).

The uptake of electric vehicles (EVs) will depend on how public funding is allocated to address the two main barriers to the accelerated uptake of EVs:

1. the higher cost to acquire an EV; and
2. the prohibitive impact of range anxiety, the fear that an EV won't have sufficient battery charge to reach the intended destination, leaving the motorist stranded.

Figure 6 below shows the carbon emissions contributions by transport type:

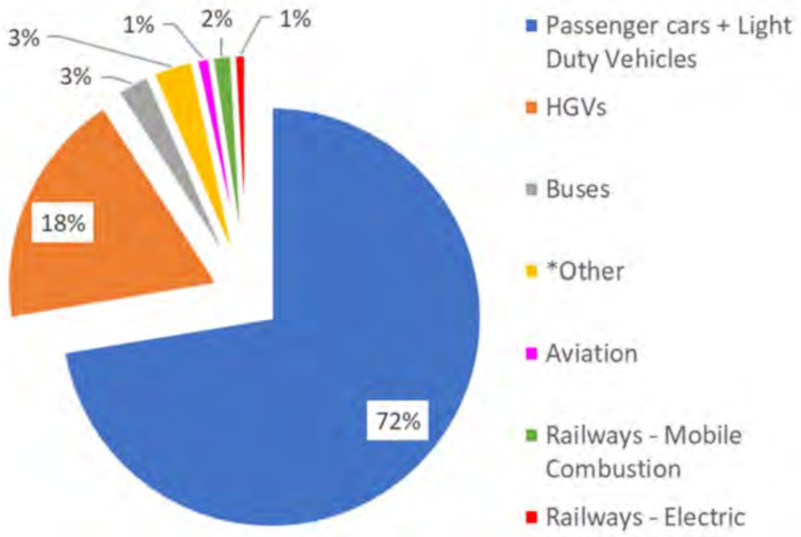

Figure 6 - Carbon emissions contributions by transport type (national average)

NGED aims to have its network ready to support at least an additional 1.5 million electric vehicles by 2028, leading to 400,000 new connections every year in its region. This will be required as rapid charge points are installed at every motorway service area. Although it is expected that the majority of EV motorists will charge their cars at home, there is still a requirement for a reliable, plentiful, and fairly priced public charging network.

Across the region, we observe a shortfall in EV charging points, despite the essential role cars play in the daily lives of the people living there. For instance, a consultation of ZapMap reveals a lack of EV charge points in the centre of Shrewsbury, including the train station. In Telford, despite the proliferation of commercial facilities, there are very few charge points in its carparks. There is also a dearth of charge points along the motorways. Hereford only has 14 EV charge points. This inadequate infrastructure will only exacerbate people's unwillingness to buy an EV.

A £950 million Rapid Charging, alongside £300 million from OFGEM's Green Recovery Programme, is available to support the electrical capacity required at motorway and A-Road service areas. We are pleased to note that all councils in the Marches region secured funding through the Local Electric Vehicle Infrastructure scheme to install charge points between 2025 and 2029, totalling £3 million. Shropshire Council is working with Connected Kerb on their charge points, while Herefordshire Council is working with Wenea. Notably, Telford and Wrekin is the only council with a dedicated public EV charging infrastructure strategy. In their strategy document, they identify 1.5% of cars as EV. Nationally, 12.5% of all new car acquisitions are electric vehicles.

In November 2020, the government announced that all new cars and vans sold would be electric from 2030. However, in September 2023, Prime Minister Rishi Sunak pushed back the deadline for the end of petrol and diesel vehicle sales from 2030 to 2035, with no mention of the intent for 100% zero emissions at the tailpipe by 2035. This change in ambition creates the impression that the government may struggle to support its decarbonisation goals regarding the transport sector, portraying a counterproductive stance and a lack of leadership in supporting consumers' best interests. According to a 2020 study by Direct Line insurance company, an electric vehicle's lifetime ownership cost is £52,133 compared to £53,625 for an equivalent ICE car[xxvi]. EVs also incur approximately 50% less in maintenance costs each year and 60% less in fuel costs annually.

Local authorities should work with DNOs to strategically plan capacity reinforcement in key areas, effectively integrating these plans into their EV infrastructure strategies.

The installation and maintenance of EV charging points are expected to generate jobs in the region, with a forecast of 42,000 related roles in the Midlands by the end of 2032, including an anticipated 4,000 in the Marches region[xxvii].

Various automotive companies, including DAF, Renault, Tesla, and Mercedes-Benz, have introduced electric heavy goods vehicles (HGVs) that could replace diesel HGVs for local deliveries. Tevva has launched the first high-volume electric lorry production plant in Tilbury, Essex. The company aims to sell 1,000 units in 2023 and plans to start production of hydrogen lorries in 2024.

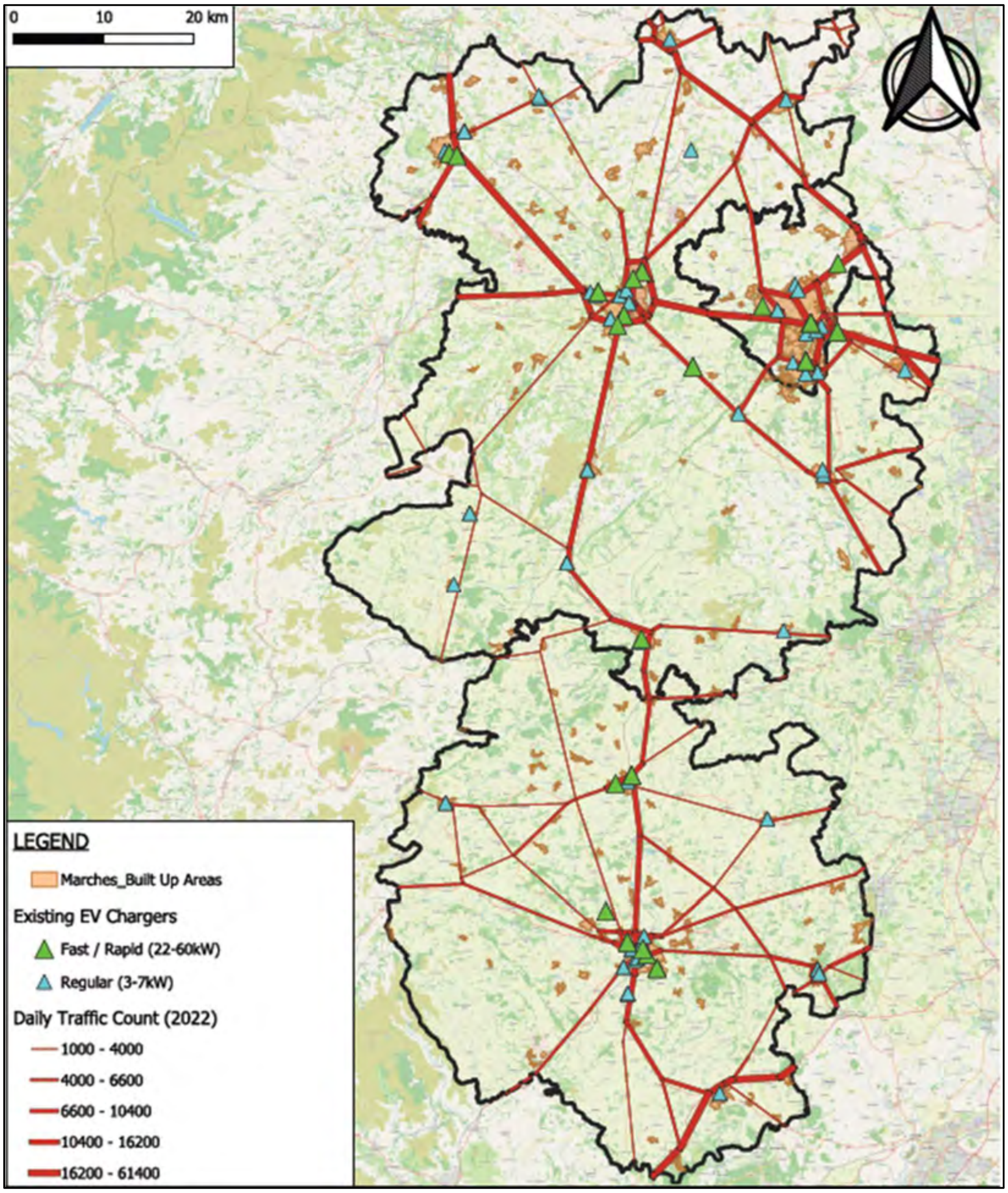

Figure 7 - Existing EV Charging Infrastructure

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5.1 EV Rollout

Table 14 - Electrification of vehicles across the Marches

Vehicle Type	Proportion of vehicles electrified						Reference
	2023	**2030**	**2035**	**2040**	**2045**	**2050**	
Passenger cars & LDVs	2%	37%	83%	100%	100%	100%	NGED DFES
HGVs & Buses	0%	10%	25%	50%	80%	100%	BHESCo estimate

For the modelling of Electric Vehicle (EV) rollout across the Marches up to 2050, we have used forecast uptake rates taken from NGED's "Consumer Transformation" distribution future energy scenario[xxviii]. This dataset also included the predicted increase in grid demand associated with a transition to EVs. It should be noted that in NGED's forecasting analysis, only passenger cars and LDVs were included. These vehicle types account for over 70% of the transport sector's total carbon emissions as shown above in Figure 6[xxix].

Next to passenger cars and LDVs, HGVs and buses stand as the second and third-largest CO_2 contributors to the transport sector, accounting for 18% and 3%, respectively, as depicted in Figure 6. In our modelling, we chose to incorporate the electrification of HGVs and buses, albeit with a more conservative forecast compared to passenger cars and LDVs (see Table 14). The actual transition to electrification for HGVs is by no means certain but the potential for low operating costs compared to other low carbon options makes this an attractive option[xxx].

The precise number of HGVs operating in the Marches is unknown, given that many traverse in and out of the region. Consequently, the impact of electrifying HGVs and buses relies solely on baseline carbon emissions across the Marches region, assuming current vehicles are diesel powered, not on the specific number of vehicles. To determine the baseline carbon emissions from fossil fuel vehicles in the Marches region, we applied the national averages, illustrated in Figure 6, to the most recent government data related to carbon emissions within each county's transportation sector[xxxi].

In our analysis, we assumed that for every EV adoption, an equivalent fossil fuel vehicle would be taken off the road. With this assumption, we modelled the reduction in carbon emissions resulting from the increasing number of EVs and the concurrent decrease in fossil fuel vehicles. The results of this analysis are presented below in Table 15 and illustrated graphically in Figure 8.

The slight decrease in the cumulative number of EVs observed in Table 15 is derived from the forecasted data included in NGED's consumer transformation FES, which was utilised in this analysis. Nevertheless, we acknowledge that this trend may not be applicable to the Marches region; currently, the region heavily relies on individual vehicles for transportation across the three counties.

Notable omissions from our modelling include, but are not limited to, the embodied carbon of electric vehicles, the electrification of railways and motorbikes, and the decarbonisation of aviation.

Regarding the remaining 7% of the transport sector's CO_2 emissions in the Marches, decarbonisation will be facilitated through the electrification of other transportation types such as Railways and aviation.

Table 15 - EV rollout, CO_2 emissions from transport, and increasing grid demand.

		2023	2030	2035	2040	2045	2050
Cumulative No. EVs (thousands)	Shropshire	5	78	178	220	220	206
	Herefordshire	4	51	117	145	145	136
	Telford & Wrekin	2	36	82	102	102	96
	TOTAL	*11*	*165*	*377*	*466*	*466*	*437*
C02 emissions from transport (kilo tonnes)	Shropshire	743	555	253	137	85	48
	Herefordshire	407	298	140	76	47	26
	Telford & Wrekin	306	235	131	67	46	21
	TOTAL	*1456*	*1089*	*524*	*280*	*179*	*95*
Annual grid demand from EVs (GWh)	Shropshire	19	241	574	837	953	982
	Herefordshire	15	156	372	537	604	617
	Telford & Wrekin	9	109	260	376	425	435
	TOTAL	*43*	*506*	*1206*	*1750*	*1983*	*2033*

From this analysis, by 2050 all fossil fuel cars will be replaced by EVs, resulting in zero carbon emissions.

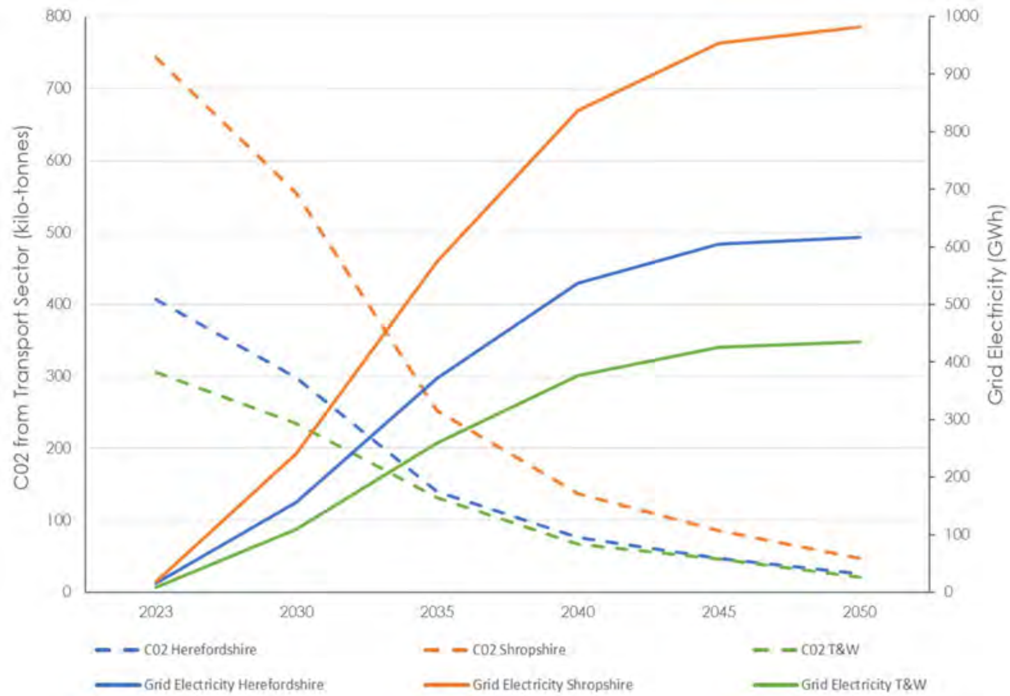

Figure 8 - EV rollout: decrease in C02 emissions from the transport sector and increase in grid consumption (GWh)

The decarbonisation of passenger cars and LDVs, the most common vehicle types, is projected to result in a 73% decrease in the Marches' overall transport sector carbon emissions from 2023 to 2050. Further, the modelled electrification of HGVs and buses is expected to contribute an additional 20% reduction. Collectively, this envisioned electrification of the transport sector would lead to an estimated 93% decrease in associated carbon emissions. We propose for the remaining 7% to be offset through Carbon Sequestration activities in the region (refer to Section 12).

5.2 Biofuels

Only first-generation biofuels, the fuels that are produced from food or animal feed crops, are addressed here, given the maturity of the biofuel industry in the UK. Biofuels can contribute to the accelerated decarbonisation of transport during the interim period, especially for heavy goods vehicles, while the government devises a subsidy programme to support the uptake of electric vehicles for transport. Refer to policy changes section of this report for more details (Section 14). One source of biofuel, oilseed rape, boasts a particularly high calorific value, nearly equal to that of fossil fuels, making it an attractive component for diesel fuel blends.

The production of biofuels necessitates careful land-use management to prevent any alterations in land-use that could result in increased greenhouse gas emissions or land, water resource, and ecosystem degradation. It is evident that land currently dedicated to food production should not be repurposed for biofuel production. However, the production of oilseed rape, an important soil enhancer for crop rotation, can improve land yield, following crops such as wheat. Furthermore, oilseed rape production reduces the nitrogen requirements of subsequent crops, whilst improving soil structure and spreading out labour peaks[xxxii].

To bolster the rural economy, it would be beneficial to gauge the interest in establishing a working group in collaboration with local farmers, with the primary objective of assessing the economic advantages of coordinating crop rotations, including oilseed rape. This is especially relevant considering the potential profitability associated with selling oilseed rape to the likely customer, the Cargill seed crushing facility in Brocklebank, Liverpool.

Elevated oil prices should incentivise farmers to collaborate in implementing effective regional crop rotations. Utilising oilseed rape in these rotations may help mitigate the impact of the cabbage stem flea beetle on yields. Additionally, oilseed rape can serve as a valuable feedstock for the growing bio-aviation fuel market, simultaneously contributing to significant gains in soil carbon sequestration, while contributing to GVA.

The introduction of biofuels in machinery and HGVs can contribute to a reduction in GHG emissions. Biofuels are also pertinent in the shift away from diesel-powered systems in the rail network and other public transport. We believe that biofuels can play a significant part in decarbonising HGVs and buses. These are likely to take longer to transition due to the significant financial investment required by the transport industry as well as technological challenges associated with HGVs.

In conjunction with biomethane (which will be discussed in-depth later in section 6.4 of this report), biofuels play a critical role as transition fuels, demanding a closer exploration of the economic, social, and environmental advantages they provide.

6 Renewable Electricity

Standing out prominently in our analysis from the preceding sections is the remarkable surge in grid electricity consumption expected with the transition to heat pumps and EVs across the Marches.

It is evident that to match this rising electricity consumption and reach net-zero carbon emissions by 2050, a rapid transition to renewable energy is required alongside the continual upgrading of grid infrastructure. In the following sections, we outline our actionable recommendations for implementing renewable energy solutions across the Marches.

In this LAEP, we focused on solar PV and onshore wind as they represent the most cost-effective forms of electricity. Our preference for producing home-grown electricity stems from an aim to enhance affordability for residents and ensure security of supply. In terms of land use efficiency, onshore wind surpasses solar PV, generating nearly 9 times the electricity per hectare. Regarding costs, solar PV costs are projected to decrease by 73% by 2050, driven by improvements in module capacity and declining production costs[xxxiii]. Historically, these two technologies have complemented each other effectively; wind tends to blow more intensely in winter, while solar PV produces more electricity in summer. In the National Grid FES, local distributed energy is underscored as an important component of the nation's future heat and power supply.

The transformation scenario used in our analysis is based on the 'Consumer Transformation' scenario, listed in the National Grid DNO's Future Energy Scenarios[xxxiv]. Key details of this scenario include:

- Reaching net zero by 2050
- Electrification of heating
- Consumers willing to change behaviour.
- High energy efficiency
- Electrification of transport
- High demand side flexibility

This transformation scenario estimates a 58% increase in electricity demand by 2050 for the Marches region. Individual forecasts for each local authority are displayed below in Table 16.

Table 16 - Forecasted change in electricity demand (Source: National Grid DFES)

	Electricity Demand (GWh)					
	2023	**2030**	**2035**	**2040**	**2045**	**2050**
Herefordshire	966	1077	1263	1430	1484	1465
Shropshire	1435	1697	2069	2316	2415	2415
Telford & Wrekin	852	961	1133	1256	1286	1266
Marches	3253	3735	4464	5002	5185	5146

The following sections outline our recommendations for renewable energy generation rollout across the Marches, facilitating a net zero 2050 transition.

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6.1 Renewable Energy Case Study

There are few precedents for 100% renewable energy generation as we are proposing for the Marches region in this report. Two locations where this target has been successfully achieved are Iceland, with its vast reserves of geothermal power and Orkney Islands, an island significantly smaller than the Marches region. There are lessons to be learned from the achievements of the Orkney Renewable Energy Forum that are referenced in this report.

Orkney Islands have become a net exporter of wind generated electricity to the Scottish mainland, despite grid constraints, due to the implementation of Active Network Management (ANM) with the grid operator Scottish and Southern Energy Networks and its partner Smarter Grid Solutions Ltd. This system applies live monitoring at critical points on three networks operating over five zones. A 2MW lithium-ion battery storage system is integrated into the ANM system helping to balance the variable energy output from the renewable energy sources. The ANM system controls the curtailment of electricity generation across the three networks.

6.2 Onshore Wind

Table 17 – Onshore Wind: GIS maps for reference (see Appendix B)

Map No.	***Description***
OW1	Marches Onshore Wind Potential
OW2	Shropshire Onshore Wind Potential
OW3	Herefordshire Onshore Wind Potential
OW4	Oswestry Case Study - Wide View
OW5	Oswestry Case Study - Zoomed View

According to Renewables UK, 77% of the UK population support building our national capacity in onshore wind energy. We suggest that all counties in the Marches region take an assertive approach to onshore wind development in areas where it is economically and socially logical by including these sites in their development plans.

Onshore wind is the cheapest form of electricity[xxxv]. Where counties have a higher rate of fuel poverty than the national average, this important source of power is a major contributor to combatting the climate crisis and the cost-of-living crisis. It makes sense that local electricity generation will keep the costs of food production down as the cost-of-living crisis was triggered in part due to the cost of fossil fuels on global markets.

This section addresses the locations where onshore wind power plants can be installed and how to get communities on board through leadership and good communications concerning the benefits of onshore wind power. Central government has provided guidance on this issue in their report "Community Engagement and Benefits from Onshore Wind Developments"[xxxvi].

Figure 9 below displays our recommendations for where these onshore wind power plants should be developed. We have cross referenced these locations with the availability of grid connection to demonstrate the connection availability in these areas to facilitate notifying the DNO for headroom planning.

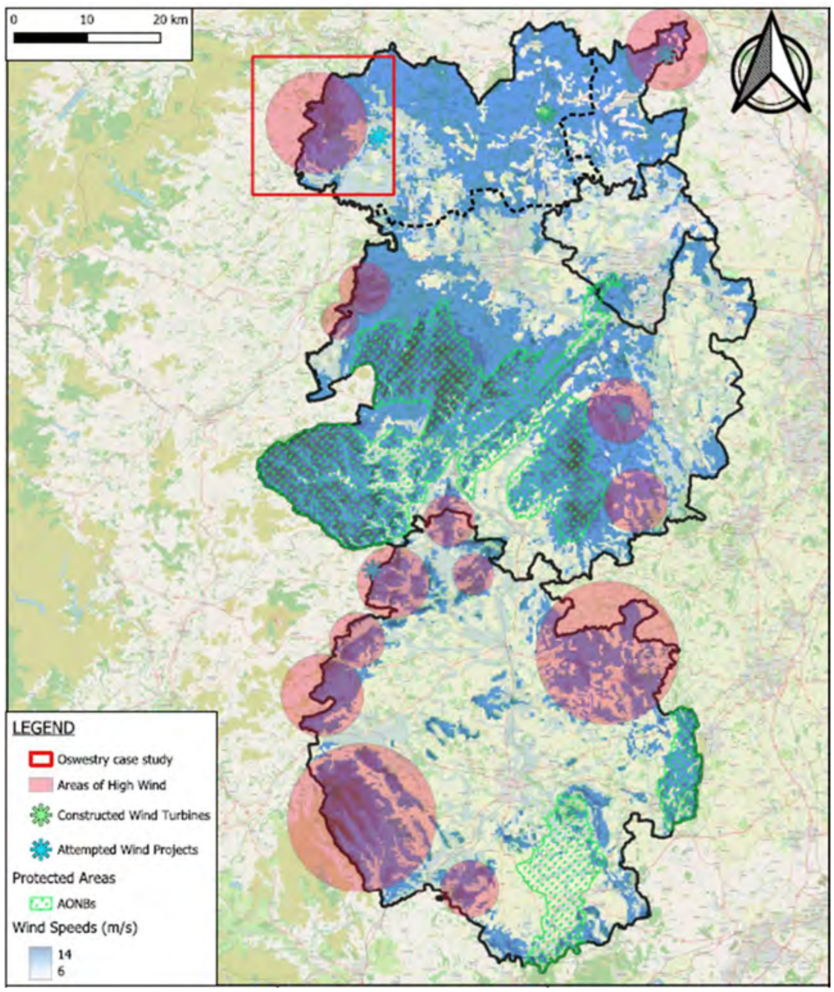


Figure 9 - Onshore wind across the Marches: Areas of high potential

These locations can be identified early in the local plans to raise awareness of the onshore wind potential in each area. There are many possibilities for local authorities to work with developers to realise this local generation potential.

1. Community energy groups, like the Sharenergy/Marches Energy Agency partnership, is a good way to develop onshore wind projects. As onshore wind planning approval requires the consent of local residents, these groups are connected to trusted and respected leaders in the community who endorse the project. Development approval can be achieved through the offer of community ownership and community benefit, as people respond more positively when they obtain some benefit from the development. This is achieved by allocating a share of the annual profits from the generator to a Community Benefit Fund. In 2022, community owned onshore wind contributed 113MW of a national total of 14,8GW. This very small percentage is due to the virtual ban of onshore wind development since 2015.

2. Energy suppliers like Ripple Energy and their deployment partner Octopus Energy. These developers also offer community benefit that is attractive to residents, bringing people together in a positive way. Their engagement methods differ as they currently require participating customers to use one particular energy supplier, which may discourage participation and support. We would like to see the energy market opened up more to peer to peer trading so that residents local to renewable energy systems can benefit directly from low-cost electricity generation at the site. This could emerge from a regulatory requirement that all licensed energy suppliers facilitate these types of arrangements.

3. Commercial developers are a means to encourage development to fund the projects. As the requirement for onshore wind is very high, it will be important to engage all potential developers, to determine the more affordable and effective methodology for deploying cheap, onshore wind generated electricity. Community benefit can be embedded as a requirement for planning permission.

Total wind capacity for the Marches region was identified as 17.5GW by Encraft in their 2018 report. This capacity is not deployable within the region as the time it would take and the area it would cover is prohibitive. Considering that only 2.6MW of wind capacity (Norton Fields Farm, Sandy Lane and The Haven) has been deployed in the region since 2005, it is going to take a monumental effort to obtain the targets recommended below.

Table 18 below shows the criteria that we applied for the selection of wind power generation for the region.

Table 18 - selection criteria for potential wind farm/ turbine sites.

Land classification:	**Grades 3, 4 and 5 only**
Areas eliminated from scope:	**- Areas of Outstanding Natural Beauty and other protected areas e.g., local nature reserves**
	- Wind speeds less than 6 m/s
	- Flood risk areas

We assume that the most efficiently managed process would take 5 years from planning to operating a wind farm. We apply an average of 10 x 2.5MW wind turbines to generate 25MW capacity. Applying a minimum average wind speed across the region of 6.0 meters per second, each wind farm would generate approximately 71GWh per year. We would look to commissioning 2 x 25MW windfarms per year, starting in 2029. The production of wind power would take tremendous effort and determination to reach the target that would involve the development of up to 100MW each year for the next 26 years to meet the target of 1.3GW of installed capacity by 2050.

Table 19 - Onshore wind deployment

Years	No. Wind Parks	Capacity (GW)	Generation (GWh)
2024 - 2030	4	0.10	284
2031 - 2040	24	0.60	1,703
2041 - 2050	38	0.95	2,696

There may be delays in grid connection due to the Transmission Entry Capacity queue and the Transmission Reinforcement Works demonstrating the scale of work that is needed to enable some grid connections. According to a recent report by Current ± News, there are 371GW of projects in the grid connection queue, around 114GW of these have listed their connection date before 2029[xxxvii]. We have taken this into consideration when looking at headroom in the areas we have recommended.

Onshore wind will contribute an estimated £59 billion to GVA in the region for the period when the first 50MW begins operating in 2029 to 2050 when 1.45GW of capacity is completed, generating community benefit of approximately £13 million by 2050. Total community benefit is anticipated to reach £118 million during the period from 2029 to 2050.

6.3 Solar PV

Our approach to investment in solar PV for the region is characterised by the landscape and land characteristics. This section considers domestic and non-domestic rooftop and ground mounted solar generation separately. Local Authorities must endorse, encourage, and promote the attractiveness of using roof top assets for electricity generation. Their level of involvement will depend on the resources available. The important element is the explicit support for action. Plymouth Energy Community is an outstanding example of a local authority that has taken action in this area, with 33 community owned solar arrays generating 6.2MW of power.

Table 20 below details the status of solar PV development at scale in the region.

Table 20 - Current Solar PV projects across the marches as listed in the Renewable Energy planning Database (REPD)

REPD Solar	Capacity (MW)
Ground	**710.1**
Appeal Granted	30.0
Operational	201.3
Planning Application Submitted	81.0
Planning Permission Granted	321.5
Under Construction	76.3
Rooftop	**11.7**
Operational	4.8
Planning Application Submitted	1.1
Planning Permission Granted	5.5
Under Construction	0.3
Grand Total	**721.8**

6.3.1 Ground Mounted Solar

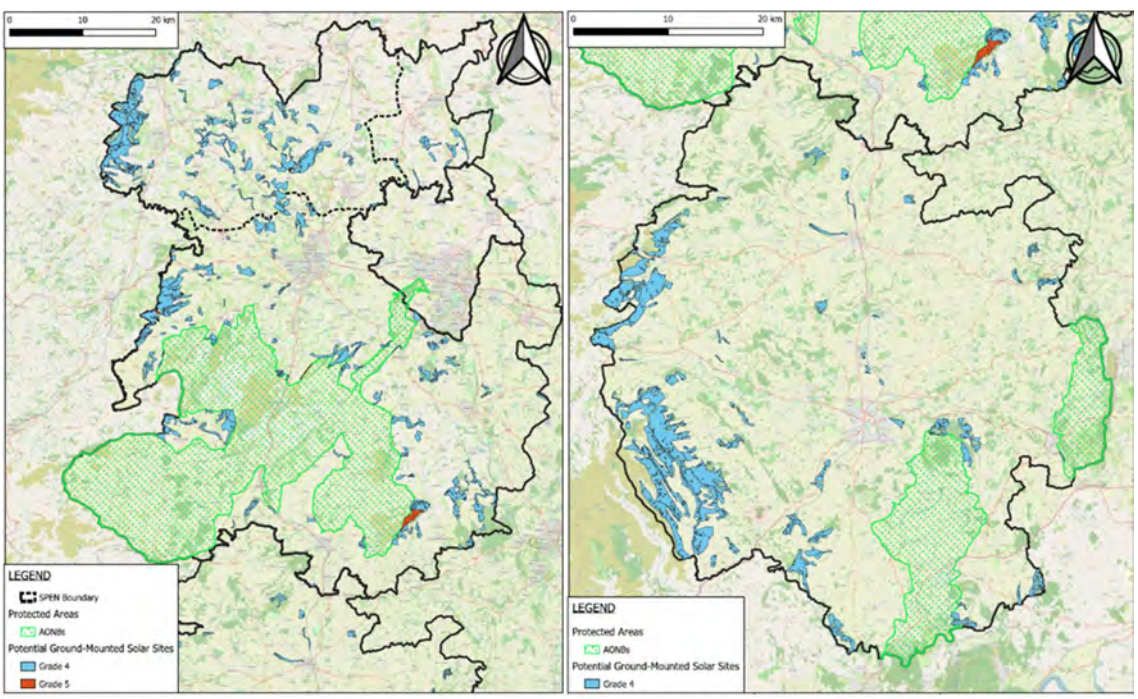
Table 21 - Ground-mounted Solar: GIS maps for reference (see Appendix B)

Map No.	***Description***
SG1	Marches Ground-Mount Solar Potential
SG2	Shropshire Ground-Mount Solar Potential
SG3	Herefordshire Ground-Mount Solar Potential

The criteria we used for determining the solar potential of the region is displayed below in Table 22. Identified areas for potential ground mounted solar are illustrated in Figure 10.

Table 22 - Selection criteria for potential ground mounted solar sites.

Land classification:	**Grades 4 and 5 only (not suitable for gowing crops)**
Areas eliminated from scope:	**Areas of Outstanding Natural Beauty and other protected areas e.g., local nature reserves, including:** **- Woodland** **- Flood risk areas** **-Areas of land less than 10 Hectares** **-Roads and rail networks (with 15m buffer)**



(a) Shropshire **(b) Herefordshire**

Figure 10 - Potential areas for ground mounted solar PV

Land area available for solar farms in each county is marked out in the Appendix. This can serve as a guideline to support community groups and commercial developers to take these potential projects further. The local authority could support these efforts by leading the way in supporting planning applications, liaising with private landowners, and negotiating market rates for the land rents over the estimated 25-year life of the solar farm.

Table 23 below summarises ground mounted solar PV capacity in the region. Telford and Wrekin had no areas within our criteria that were available for ground mounted solar. Therefore, we have focused their solar capacity on rooftop solar.

In total, we have identified 435GW of ground mounted solar capacity in Shropshire and Herefordshire, with an estimated average annual generation capacity of 415TWh.

From the schedule of projects in round 5 of the Contracts for Difference Allocation, we note that approximately 6GW of ground mounted solar capacity is being installed per year for the next three years. To meet the Net Zero generation requirement for Solar PV, a total of 16GW would need to be installed each year in the Marches region. Work needs to be started now to develop these projects and to train the teams of electrical technicians required to complete these installs. These are highly skilled jobs that are likely to attract significant public interest.

Assuming a ramp up of the capacity to install ground mounted solar, milestones for solar generation capacity are illustrated later in this report, in Table 31.

Table 23 - Ground mounted solar capacity across the Marches

Ground Mounted Solar Capacity per hectare		1.54	MW
	Land Classification	**Hectares**	**Capacity (GW)**
Marches	Grade 4	279,657	431
	Grade 5	2,712	4
	Total	**282,369**	**435**
Shropshire	Grade 4	160,749	248
	Grade 5	2,712	4
	Total	**163,461**	**252**
Herefordshire	Grade 4	118,908	183
	Grade 5	-	0
	Total	**118,908**	**183**
Telford & Wrekin		0	

6.3.2 Rooftop Solar - Industrial Estates

Table 24 - Rooftop Solar: GIS maps for reference (see Appendix B)

Map No.	***Description***
SR1	Telford & Wrekin - Non-Domestic Rooftop Solar Potential
SRA	Newport - Non-Domestic Rooftop Solar Potential
SRB	Hadley / Hortonwood / MOD Donnington - Non-Domestic Rooftop Solar Potential
SRC	Stafford Park - Non-Domestic Rooftop Solar Potential
SRD	Halesfield - Non-Domestic Rooftop Solar Potential

The large number of industrial parks in Telford and Wrekin lend themselves to rooftop solar generation. Encraft's 2018 report identified 39 MW of rooftop solar potential in Telford and Wrekin, the largest in the region. Some of the largest buildings in the area, including HM land registry and Thomas Telford School don't have any solar PV on their roofs.

To avoid delays associated with structural reinforcement of the buildings concerned, we have assumed an average system size of 175kW on industrial estates.
Older roof structures are not expected to be able to support the heavier loads of larger systems where 150kW= 9,487 kgs. We refer to the Lyreco project as an example of the effort required to install larger capacity solar PV on industrial roofs[xxxviii].

Systems larger than 175kW for one consumer reduces the availability of headroom on the grid, impacting other consumer's ability to connect. As we are pursuing an equitable, affordable, and ubiquitous access to the grid, we have restricted sizes of non-domestic rooftop solar PV systems for this report.

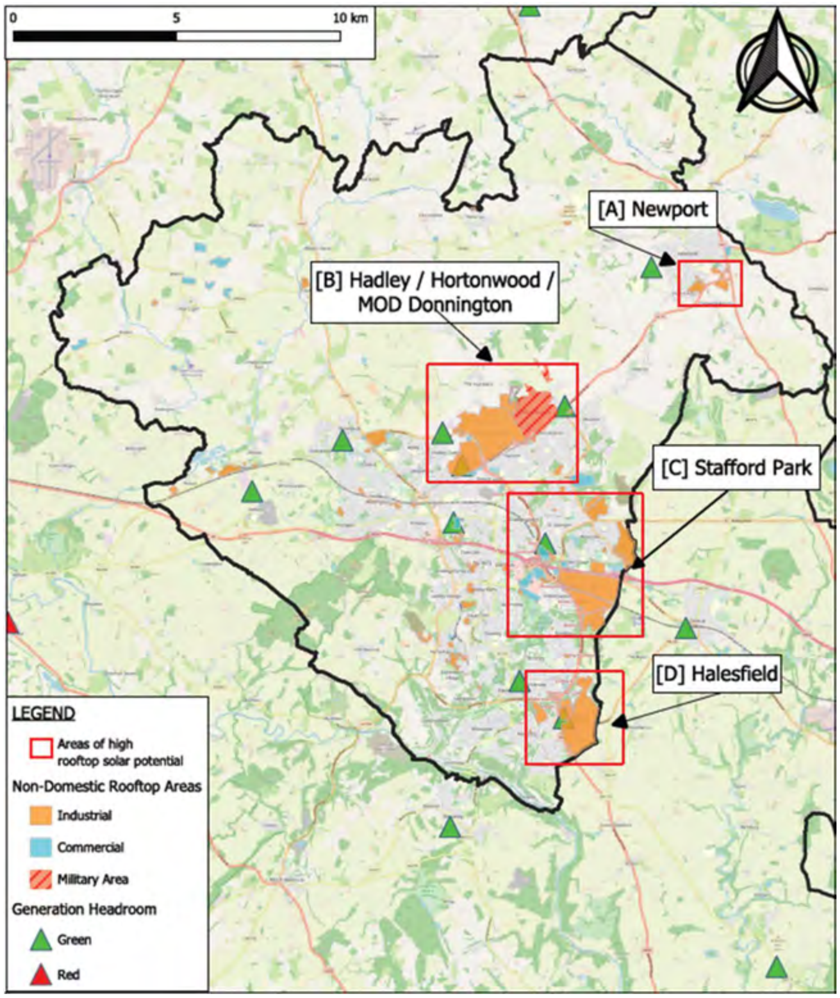


Figure 11 - Non-domestic rooftop solar potential in Telford and Wrekin.

There is headroom for connection to the grid in these areas, presenting an attractive opportunity to develop a strategy for engaging businesses in the region to commit to using their rooftop assets to generate clean, renewable electricity from solar.

To achieve a 2050 target, 126 solar installations must be installed on non-domestic buildings each year. This is an aggressive, yet achievable, target that requires effort to encourage the owners of industrial estates and other non-domestic buildings to prompt their tenants to install solar PV generation.

Converting rooftop assets to electricity generation platforms is advantageous because it uses available space to create value for the electricity consumer and for the community.

For example, the Skylon Enterprise Zone presents an exceptional opportunity to install solar power to support the provision of low-cost electricity for the businesses located there. Food manufacturers have high electricity demands that are well suited to solar power. Also, a local, renewable energy provision fits well with the Cyber Security Business and Research Quarter in partnership with Wolverhampton University. It is interesting to note that the other major business parks in the County, being Leominster Industrial Estate and Moreton Business Park already have a significant amount of solar PV generation installed.

6.3.3 Rooftop Solar – Domestic Properties

The Marches 2030 Vision report identified 3kW of solar generation for 300,000 households in the region. To achieve this vision by 2050 would require 44 solar installations per day. This is an ambitious target that we don't believe can be met with the current resources available. There are 19 MCS registered solar PV installers in the region, were these to be fully engaged on the installations, there would be insufficient qualified installers to do the job. For the purposes of our analysis, we have assumed that 8 domestic rooftop installations can be made per day. As part of the advocacy role that local authorities must assume, attracting candidates to retrain as solar PV installers will be an important task.

Domestic rooftop solar can be rolled out using three channels:

1. **Community Energy:** Existing community energy groups or interested champions can be recruited for each county to work directly with local installers. The Big Solar Co-op, a social enterprise incubated by Sharenergy, based in Shropshire, would be an attractive partner for the local authority to achieve its ambitions.
2. **Energy suppliers:** Octopus Energy offer a solar PV home installation service. The difference between the offerings will be the community benefits available as Octopus Energy is a commercial enterprise.
3. **Commercial contractors:** As ECO4 includes a grant payment for the installation of solar panels, some contractors have increased their capacity to install solar PV on domestic properties. It is expected that the average cost of the solar PV will be higher, but the cost to the consumer will be lower due to the grant support.

Local authorities may commit the resource required to establish an endorsement relationship with a domestic solar PV developer, similar to the Solar Together programme that has operated across the country with some success.

6.4 Biomethane

Table 25 - Anaerobic Digestion: GIS maps for reference (see Appendix B)

Map No.	Description
AD1	Marches - Anaerobic Digestion Plants, Cadent Gas Network & Total Manure Output
AD2	Shropshire - Anaerobic Digestion Plants, Cadent Gas Network & Total Manure Output
AD3	Herefordshire - Anaerobic Digestion Plants, Cadent Gas Network & Total Manure Output
AD4	Telford & Wrekin - Anaerobic Digestion Plants, Cadent Gas Network & Total Manure Output

Central government published its biomass strategy in August 2023, suggesting that Anaerobic digestion should be increased five to eightfold to reach net zero[xxxix]. Increasing biomethane to grid gas production has two advantages for the region. Firstly, the continued use of the gas network is an important asset that delivers significant value to the areas it serves. As heating is electrified, the utility of the gas network becomes increasingly redundant. A phased approach to decarbonising heat by introducing more biomethane at a suitable calorific value into the gas grid means that although the impairment of the gas grid will still occur overtime, more value could be extracted from the sunk investment in the grid to optimise the benefit derived over its useful life.

Secondly, production of biomethane from animal waste diverts a methane producing product into a revenue generating one. Capturing and processing all organic waste should be an immediate priority, according to the Anaerobic Digestion Bioresources Association[xl]. Cadent sponsored a study by Anthesis Consulting Group PLC and E4tech UK Ltd, looking at the potential scale of bioresources available within the UK to make low carbon gas. The study showed that the potential for renewable gas from waste and biomass feedstocks could be as high as 174TWh by 2050, with a central estimate of 108TWh, or 25% of the heat used for space and water heating in the UK.

There are 702 AD plants operational in the UK. From 2013 – 2015, 50 AD plants per year were built across the country. At its peak, in 2016, 100 biogas plants were constructed, while 17 have been built in the past two years. In the Marches region, 7 AD plants were made operational in the period from 2013 – 2022.

Based on our analysis of tonnes of manure produced by the region each year, we have estimated that if all of this was captured and treated, 67.7GWh of heat could be provided, serving 6 million homes on the gas grid, or 54% of Cadent's customers. The bioproducts of Anaerobic Digestion (AD), being a digestate slurry, is also useful for soil enrichment. This bioproduct would present an additional revenue stream for the plant.

Assuming there is insufficient capacity in the supply chain to support this level of construction, we estimate that the region will only be able to achieve 1% of its capacity for biogas production, building 95 x 80,000 tonne AD plants from 2024 – 2030, when an assessment should take place of the benefits of the biogas production programme. Total investment required is estimated at £2.28 Billion. As wholesale gas prices are projected to continue increasing to 2035[xli], the significant commercial opportunity of a home-grown source of biogas will bring an annual revenue potential of £393 million, based on an average wholesale gas price of 5.5p/kWh while diverting the methane emissions from animal manure.

Table 26 - Total forecasted AD capacity and properties served.

Years	No. plants	Capacity (Million Nm3)	Properties served ('000s)	CAPEX (£M)
2024 - 2030	95	600	651	2,280

Construction ramps up each year as follows:

Table 27 - Rollout of AD plants (2024-2030)

Year	2024	2025	2026	2027	2028	2029	2030
No. plants	-	10	10	15	20	20	20

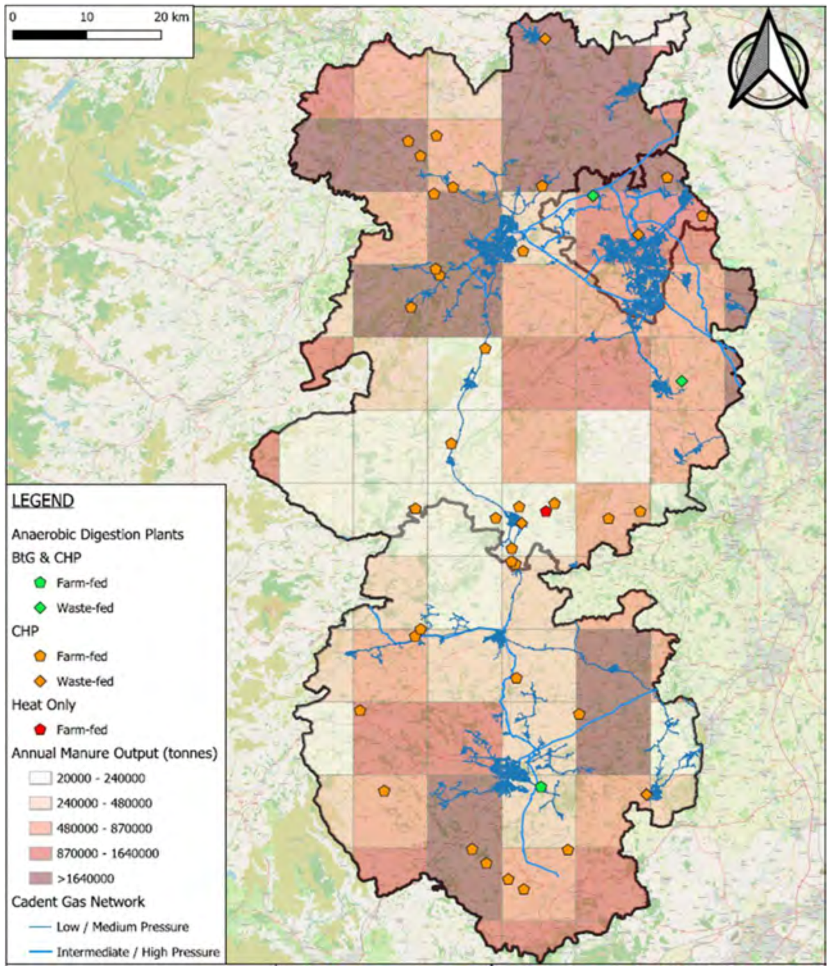


Figure 12 - Potential biomethane to grid locations across the Marches

The estimated reduction in GHG emissions is 2.4 million tonnes/annum. We are assuming that the AD plants will become obsolete after 30 years of operation.

This level of investment would bring in significant GVA per hectare of land compared to wind or solar power at £162 million per year at full capacity, based on current gas prices. The land required is 1% of the land that is required for onshore wind, delivering value to the communities where the plants are located. It will take 2 years from development to operation of an AD plant. The average simple payback on this investment is estimated at 17 years.

The areas served by the gas grid will decline over time, with city centres being served by local sources of biomethane. Shrewsbury, a city with an architectural heritage, and

Telford, where 91% of all homes are connected to the gas grid, are well suited to continue using biomethane while rural and some urban areas continue to electrify their heating systems.

Biomethane can be considered a transition fuel to support transport companies to reduce their carbon emissions while they implement their transport decarbonisation strategies. Each 100% biomethane-powered HGV typically saves up to 84% (typically 130-150 tonnes per year) of CO_2, compared to the same vehicle powered by Euro VI diesel[2]. Cadent are actively decarbonising their own fleet, converting their HGVs to bio-CNG, which will reduce greenhouse gas emissions by more than 500 tonnes/year. They are also operating some CNG vans in their West Midlands networks to understand how these will reduce the emissions associated with roadside working[3].

We estimate that 1,555 jobs will be created to construct the AD plants we have recommended. Many of the 350 annual construction jobs will be sourced from Germany and Austria, with a view towards transferring the knowledge and training to a contracting firm based in the UK. 855 jobs will be associated with operating and maintaining the plant. Estimated GVA contribution from biomethane to grid production is £33 million over the useful life of the plants.

7 Local Energy Supply

Generating energy locally is the best solution for achieving Net Zero targets and energy security amidst an environment of increasing dependency on rogue nations for fossil fuels. Community energy is a way to incorporate equity into the energy mix. In Appendix H of The Future of Energy in Herefordshire[xlii], community energy was mentioned as a means to boost the local economy and to gain acceptance of larger scale local energy generation. This is reinforced by the Local Government Association and other organisations that communities may be more willing to accept the visual impacts of local energy if they directly receive the benefits. We note that distributed, smart local energy systems are recognised by OFGEM[xliii], National Grid ESO, NGED and SPEN.

7.1 Direct investment vs Grant programmes

In 2019, the Marches region received £3.4million of funding from the European Regional Development Fund. A matching fund was provided by the Marches region such that the total expenditure was £7.5 million. The Marches Renewable Energy Grant Scheme, which ran from June 2019 to January 2023 provided grants totalling almost £950,000 supporting the installation of over 2.3 megawatts of new renewable energy generation capacity achieving an annual decrease of 563 tonnes of CO_2. Whilst the vast majority of projects installed were for solar panels, air-source heat pumps, battery storage and a river source heat pump were also installed.

The most important aspect of the energy transition is the economic case, as this is the primary driver of investment in low carbon technologies. Therefore, emphasis must be made on the change in expectations around investment returns by business decision makers. Investments in energy supply and infrastructure are by their nature longer term investments. When executed proficiently, most if not all of the technologies on the market today, with the exception of some heat pumps, will deliver a benefit compared to their fossil fuel equivalents.

There is a gap in the market for energy savings consultants that can support businesses to make the appropriate investment in their premises to reduce their energy usage, thereby delivering year-on-year reductions in their energy costs. A large share of the energy transition must be funded by businesses keen to improve the energy performance of their properties.

8 Energy Storage

The Marches region has the opportunity to lead the nation in the area of battery storage, given the commitment that each county has to meeting its Net Zero targets. Large scale battery storage appears to be dominated by private equity investment firms, like Gore Street Capital. There is an opportunity for local authorities to support community groups to develop battery storage sites in connection with the National Grid, to deliver community benefit.

We are looking to install energy storage in the areas where the grid is constrained, and we can use the local storage to achieve two aims:

1) to overcome grid constraints and mitigate the expense of grid reinforcement,
2) to provide flexibility on the distribution network.

8.1 Overcoming grid constraints

In Herefordshire, there is a 103MVA main supply substation - Bulk Supply Point (BSP) with no demand headroom. We understand that several applications to connect have been submitted that have been rejected. This has the impact of inhibiting the county's ability to decarbonise its electricity supply. There is a 19.5MW battery storage facility adjacent to the BSP owned and operated by Anesco, a commercial energy services provider. The battery is designed to provide frequency response services to the ESO. This storage does nothing to support the two main low voltage distribution networks that feed from this point because the cables travel longer distances serving higher demand.

We note that the grid is constrained by applications to connect battery storage and clean electricity generation assets that have not yet been developed. From our contacts at National Grid, we understand that this constraint is in place until 2033. An independent report has confirmed that there are 62GW of power projects in the queue being blocked by developers that may not even have land rights and have not filed for planning consents[xliv]. This queue must be addressed through legislation.

Battery storage at the distribution network level can be a way of storing generation supplied locally using a behind the meter business model, a straightforward way to avoid costly reinforcement associated with grid constraints. This means that the power generation is connected to the battery and not to the grid supply to ensure that the power does not impact the grid. By working collaboratively with battery storage companies, applicants looking to connect clean energy generation at their sites can determine the economic benefit of such a business model.

Depending on the storage capacity and if there is some headroom at grid level, batteries could be used to provide a source of flexibility at the distribution level, which is relevant to the Marches region and within the control of the respective counties. The transmission level is controlled by National Grid ESO at a national level and is financially more rewarding, incentivising the installation of large-capacity energy storage.

Maximising revenue at the distribution level is more difficult, as the compensation rates are inconsistent across the various substations, making investment in local energy storage less attractive. The compensation is per kWh, however, the capacity must be available to meet demand on the grid when needed. This may mean that the on-site capacity is secondary to the grid demand, which would reduce the value of the battery system to the customer. We have determined from our own experience that the financial benefits of participating in these flexibility markets at a smaller scale are not beneficial.

In our GIS maps produced for this report, we have referred to the generation headroom of substations. It's worth noting that this data source is only updated on an annual basis by the DNOs. Consequently, we acknowledge the dynamic nature of this information, which makes it challenging to produce a definitive grid constraints map. The ever-evolving situation necessitates ongoing collaboration between project developers and DNOs. NGED holds connection surgeries, during which developers can discuss future or potential projects.[xlv]. We recommend expanding these sessions across the Marches region to expedite the connections process for all parties involved.

9 Community Benefit

Community benefit is derived from a variety of sources: an increase in jobs will bring more prosperity to a region creating increased local spending power, increased local investment and improved economic conditions for residents, including more amenities and a better quality of life. Economic improvement can result from a multitude of activities stimulated by investment:

- Rebuilding manufacturing.
- Re-training people giving them new valuable skills.
- New training facilities brings more jobs and more students to educational institutions,
- Generating growth in industries and services
- An increase in council tax revenues for the local authority will allow them to improve the social services they provide to their community.
- Increases in personal income will lead to investment in homes and local infrastructure.

Given the extent of deployment of local energy generation recommended in this report, we estimate that approximately £6 million could be allocated to supporting local communities to invest in charitable activities like biodiversity improvements, support for people unable to pay their heating bills, youth or other community-based activities. Initiatives like tree planting could be funded to help the region meet with carbon sequestration goals.

Table 28 below presents our estimate of contributions from community owned projects.

Table 28 - Annual contribution (£k) from community-owned wind and solar.

Technology	Annual contribution (£K)
Onshore wind	5,364
Ground Mounted Solar PV	707

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10 Financing the local area energy plan

Funding the energy transition plans for the region will require investment from a myriad of sources, all focused on delivering the local area energy plan. Because decarbonisation requires investment, a change in the economic model of finance, shifting the investment from distant professional fund managers to the communities where the benefit is obtained from a social, environmental, and financial perspective, will help retain value in the region.

One route to transferring ownership to local communities is to work through the UK infrastructure Bank. They will lend a minimum of £5million to local authorities or community energy groups with an attractive business plan for building clean energy infrastructure. We suggest that this plan be used as the basis for preparing a fundable business plan to be submitted to the UK Infrastructure bank for finance.

Table 29 below shows the projected generation, investment, and cost per GWh for the renewable energy recommendations included in this report.

Table 29 - Renewable energy recommendations: investment and generation

Technology	Installation Lifetime	CAPEX (£M)	Lifetime Generation (GWh)	£k/GWh
Anaerobic digestion (heat delivered)	30	2,280	18,015	127
Renewable Energy Generation				
Onshore wind	25	1,226	102,886	12
Rooftop solar PV (domestic)		277	4,537	61
Rooftop solar PV (non-domestic)		455	14,210	32
Ground mounted Solar PV		169	9,667	17
Renewable Energy Total		*2,127*	*131,300*	

Table 30 and Table 31 below outline our proposed deployment timetable for onshore wind and solar PV respectively.

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Table 30 - Deployment of onshore wind

	2030	2035	2040	2045	2050
No. Windparks	2	9	22	40	58
Capacity (MW)	50	225	550	1,000	1,450
Generation (GWh)	142	639	1,561	2,838	4,115
Investment required (£M)	35	164	421	804	1,226

Table 31 - Deployment of solar PV (GWh)

		2030	2035	2040	2045	2050
Cumulative Generation (GWh)	**Rooftop - domestic**	35	72	108	145	181
	Rooftop - non-domestic	111	225	340	454	568
	Ground mounted	75	153	231	309	387
	TOTAL	221	450	679	908	1137
Total cumulative investment (£M)		£228	£432	£610	£765	£901

For the purposes of estimating cost, we refer to the BEIS 2020 report "Electricity Generation Costs". The cost assumptions that they have used are based on levelised costs, or the discounted lifetime cost of building and operating a generation asset, divided by the value of the electricity generated, whereas for the purposes of investment, only capital costs are required. Considering the high levels of investment required, the difference between these two measurements will be immaterial to the recommendations that we make, as essentially levelized cost = CAPEX x operating cost as a percentage of revenues. Because the government has assumed that the levelised costs will decrease over time, this factors out the extra margin that comprises the difference between our estimate and BEIS methodology. It is clear from the lack of participation of any offshore wind projects in the last Contracts for Difference Round 5 allocation, that the theory of decreasing costs or learning rate – the rate at which capital costs decrease as more plants are built, is not substantiated for wind power.

Looking at government projections of energy costs, one may conclude that their predictions of price increases have been consistently understated over the years. Therefore, we have included CAPEX investment increases at 1% each year for onshore wind and a decrease of 2.7%[xlvi] for solar PV. We have experienced significant declines in the cost of solar PV over the past 7 years which are expected to continue over time. As with any forecast or projection, predicting energy costs is challenging, presenting an inherent uncertainty around future costs.

Although onshore wind costs more per GWh of electricity generated, the technology creates more value by generating more power more quickly than solar PV. It also generates more electricity per hectare of land, so is a more productive use of land. It will be impossible to generate the clean electricity requirement locally without onshore wind.

Moving to a local generation model ensures equity and fairness in access to and benefits from renewable energy generation as demonstrated in the Community Benefit section above.

Because these generation projects will generate commercially attractive profits, local authorities can facilitate development of these projects by advertising the availability of the land for development. This would be released on an annual basis in tranches, in accordance with the schedule outlined in this report, to meet the electricity generation target. Social benefit would be made a condition of receiving planning permission for the sites, encouraging participation by and co-operation with community energy groups.

11 Carbon Sequestration

Creation, restoration, and improved management of natural habitats will contribute to offsetting carbon emissions in the region. This is especially relevant for the more challenging targets. Setting a deployable carbon capture and storage target can be helpful in creating some headroom, especially where action is constrained by factors out of the region's control. Carbon storage in natural habitats, including lowland raised bog, woodlands, hedges, heathland, healthy soils and grassland are all sources of carbon sinks that not only serve towards meeting the Net Zero target, but also improve the quality of life for people living in the region by encouraging and nurturing the natural environment. It presents a tangible means of bringing communities together in efforts that bring increased wellbeing.

Herefordshire is best placed to enhance its position as the most rural county in the West Midlands. In 2021, Herefordshire Council, as its role as the responsible body, prepared an action plan for Farming and Land use called "Zero Carbon and Nature Rich[xlvii]", containing actions and timeframes for achievement. This is combined with its "Local Nature Recovery Strategy and Network Mapping Project". These activities set a precedent for Herefordshire to pursue its role as a carbon sink for the region. Shropshire and Telford and Wrekin are also working on a Local Nature Recovery Strategy, as responsible bodies. They are in the first stages of preparing a local habitat map of existing areas of particular importance for biodiversity. Progress has been delayed by DEFRA as they are still preparing guidance around offsite contributions.

Although each responsible authority has appointed members to their Steering groups, including the Shropshire Wildlife Trust, Herefordshire Wildlife Trust, Natural England, Environment Agency and National Farmers Union, there are important stakeholders that have not been included, such as Shropshire farmers group, Aqualite farmers group, landowners and local universities including Harper Adams University.

We recommend that the project management of delivery is transferred to one of the stakeholders for each region, preferably an organisation that is most invested in meeting the target, like a local nature group, with the local authority retaining oversight and ultimate responsibility for delivery. Funding the resources to be invested by the local authority should be transferred to the project management organisation. This way an efficient process that is driven by the people most invested in its success will ensure that the goals are met on a timely basis. The local authority would set targets, overseeing the delivery in a goal-oriented manner, utilising the skills, knowledge and experience that each of these organisations offer, to deliver significant value for the region, while contributing toward the Net Zero target for the particularly hard to tackle carbon emissions, for example the scope 2 and 3 emissions.

From our conversations with experts in the area, we understand that patches of low land peat have deteriorated quite significantly, although there is no complete dataset to address the current state of peat, a resource that is capable of storing about 2,000 tonnes of carbon per hectare[xlviii], so there is no conclusion as to whether this peat land can be rewetted, or recultivated.

The Marches Land Use Study identifies areas with significant opportunities for woodlands[xlix]. This action plan with measurable targets be prepared to introduce carbon sequestration into the region. Carbon sequestration must be included in the local authorities Net Zero portfolio as a central co-ordination point for the measurement of activities to measure investment in natural carbon sinks. As a co-ordination centre, the role is not full time, instead it is an oversight role that ensures that the targets are being addressed by the associated organisations. Between these groups, volunteers can be recruited and managed, perhaps with some funding from Natural England or DEFRA as it is in the national interest that such a programme is successful.

There may be financial benefits to the monetisation of carbon sinks for industry, to divert funds away from activities that don't generate any value, like investments in carbon capture and storage, to generate funding for investment in expanding and managing existing woodlands or preserving existing peatlands. This is a business case that should be worked out in the next steps for the Marches region.

12 New Technologies

Evolution in technology will impact the development of renewable energy generation projects in the region. This section reviews some of the emerging technologies not yet mentioned in our report, assessing their potential impact on the achievement of a carbon neutral target.

Perovskite is an emerging technology that could make a significant contribution to efficiency of solar electricity generation in the built environment. Oxford PV is a leader in the production of these solar cells. The technology can improve the efficiency of solar cells to 43%, in comparison to 29% for monocrystalline solar cells[l] This can increase the amount of solar electricity generated without using more land or rooftop area.

There are several noteworthy developments in the battery storage industry that merit attention. Pressures on global lithium resources and supply chains have led to a resurgence in alternative battery compositions. Increasing consumer demand for sodium-ion batteries, particularly in the automotive, electronics, and electrical industries, has driven the expansion of the global sodium-ion battery market. The transition to sodium battery cells is expected to be simpler for manufacturers, as handling sodium-based chemicals can be accomplished using the same equipment designed for lithium-ion components. Given the widespread availability of sodium metal, sodium-ion batteries are likely to be more durable, addressing the growing need for a reliable power source. The recognition of the role of sodium-ion batteries in our future renewable energy transition is evident in the growth of the global market, which is projected to increase from £0.24 billion in 2021 to an estimated £0.95 billion by 2031[li] ($1 = £0.79). In the UK, organisations such as Lancaster-based LiNa are demonstrating how low-cost, high-performance sodium-ion batteries have an important future role in the renewable energy storage market[lii].

Vanadium redox flow batteries (VRFBs) represent a cutting-edge advancement in battery technology, offering a promising alternative to traditional energy storage solutions. Among these, Invinity's VS3-022 stands out[liii]. Leveraging vanadium redox flow technology, this battery stores energy in an aqueous solution, showcasing remarkable resilience even under continuous cycling. With a focus on safety, Invinity's technology boasts a non-flammable nature, requiring minimal maintenance for optimal performance. The vanadium electrolyte's stable chemistry significantly reduces risk compared to other battery storage technologies. Furthermore, Invinity's VRFBs exhibit unparalleled longevity, operating for over 25 years with unlimited cycling and no capacity degradation. As the global demand for efficient and sustainable energy storage solutions grows, VRFBs emerge as a formidable player, exemplified by ongoing projects such as a 24-hour discharge duration battery test conducted by Pacific Northwest National Laboratory and Invinity, supported by the UK Department of Energy[liv]. This venture signifies a pivotal step towards wider commercial adoption of long-duration energy storage, emphasising the transformative potential of vanadium redox flow batteries.

13 Policy Recommendations

There are some fundamental shifts that must occur to achieve the targets defined in this report.

1) Local authorities must demonstrate leadership in the support, guidance, oversight, and direction of action. Leadership is important because meeting the target will be the result of collective action pursuing a shared vision. We support local authorities to implement the recommendations in this report by exercising their power to ensure that legislation and policy exists to encourage action by private industry and community social enterprise to invest in the infrastructural changes recommended.

2) Energy pricing must change to transfer the environmental levies on electricity to gas to make it more economically attractive to operate a heat pump. Reducing electricity prices relative to gas would make low carbon heating much more affordable and attractive helping property owners plan to replace their fossil fuel powered boilers. We understand that OFGEM is addressing this disparity in levies, albeit slower than needed to encourage the uptake of efficient heat pumps.

3) The energy infrastructure is a 'natural monopoly' at both the regional and national level that is controlled by the regulator, OFGEM. The customer pays for investment in the grid through their energy bill. In the Marches region, Scottish Power Electricity Network overspent on their RIIO-ED1 grid investment allowance whereas NGED (formerly WPD) underspent by £24M. The significant underspend in investment constrains the development of clean, affordable distributed power. This underinvestment in affordable power, combined with an increase in the standing charge in 2022-2023 and the energy crisis associated with global fossil fuel prices, has made access to heat and power more challenging for more people. Fuel poverty has increased from about 4 million people struggling to pay their energy bills in summer 2020 to an anticipated 7.5 million people in April 2023[lv].

   Significant investment is required in the electricity grid at both the transmission and distribution level. This should be done by raising private finance that provides a return on capital earned from trading activities as a whole, not solely funded at the expense of the energy consumer. The returns that grid operators earn are steady and reliable, presenting less of a risk to investors who would receive a lower, albeit more reliable social return on their capital over a longer period of time. Significant changes need to be made in legislation to facilitate more private investment to power the energy transition.

4) A subsidy programme to support car owners to upgrade to electric vehicles will not happen at scale until government addresses the infrastructural issues that cause range anxiety. We have two suggestions for improvement. First is a subsidy for installing a 7kW EV charging point in one's home. In office and industrial complexes charges at 7-22kW should be installed, depending on the anticipated usage, i.e., if employees will leave their automobiles to charge during working hours or if the site would like to accommodate visitors with faster charging. On motorways, we recommend 50 – 180kW supercharging points, that would fully charge within an hour to support people on their journeys. The transport strategy will need to take the uptake of electric vehicles into consideration as modelled in Transport Section 6.

5) HGV charging at service stations will need to be at least 250kW to avoid long haul drivers having to take excessively long rest periods during journeys. The transport strategy for the region needs to take this into consideration when planning connections with the Distribution Network Operator.

6) OFGEM must regulate to manage the logjam that has built up in connections to the National Grid. Developers must be required to have met key milestones in their project development trajectory to retain their consent by the ESO to connect to the grid. If they are shown to create delays in projects, their permission to connect should be transferred to a developer that is actively working on building clean generation or storage assets.

7) Local planning authorities have the ability to set planning policy[lvi]. They must be bold to:
   - include a requirement for all new homes to meet a net zero carbon emissions target through energy efficiency and installation of renewable generation over a period of time,
   - allow the improvements of an existing building's ability to retain heat, where these changes do not impact the appearance of the building. Today, many people cannot make the thermal improvements necessary to prevent draughts in their properties due to planning restrictions. These prohibitive and archaic rules must be adapted. This concerns secondary glazing of windows, underfloor insultation or heating systems and the siting of heat pumps on a premises.

8) Building regulations (Part L) should be modified to support attaining the Net Zero target by phasing out fossil fuel powered heating systems in new developments. Once the electricity tariff is modified to distribute social and environmental levies to gas tariffs, electric heating by efficient heat pumps will become more affordable to the consumer. The ban on installation of gas boilers in new build homes should come into effect in 2025. Government should

focus on making all homes "heat pump ready" to prepare them to install a heat pump when their gas boiler has come to the end of its life, or when fossil fuel boilers are banned completely by 2030[4]. This is essential to improve our independence from volatile nations for natural gas and to achieve the Net Zero 2050 target.

9) The energy market should be opened up to more to peer-to-peer trading so that residents local to renewable energy systems can benefit directly from low-cost electricity generation at the site. This could be created through a regulatory requirement that all licensed energy suppliers facilitate these types of arrangements. Licensed suppliers should be mandated to work closer with community energy groups to support the development of local energy generation.

14 Next Steps

This report addresses the energy challenges and opportunities associated with current and future technologies and trends. Each section has identified the way forward in the respective area. These are summarised here for future reference:

1) Development of a business plan to compensate local authorities for the creation of carbon sinks in their region. Local authorities must quantify the carbon removed from the atmosphere resulting from their biodiversity gains. This is a viable way forward as an alternative means to central government funding to the oil and gas industry for carbon capture and storage as these are deteriorating national GVA through temporary investment in assets that don't add value, because they don't generate positive outputs with the exception of carbon emission removals, taking away the risk to the taxpayer in financing unproven technologies so that fossil fuels can continue to be burned.

2) Finalise business plans and contractual relationships with partners to ensure that the installation of electric vehicle charging points will address the issues of range anxiety such that people will replace their petrol motor vehicles with electric vehicles. These plans should be prepared in cooperation with the DNOs to ensure connections can be made at important locations such as transport depots, motorway service areas, shopping malls, office parks and other centres identified as logistically important. This co-ordinated effort will instil confidence for the motorist that they can recharge their vehicle in ways that are convenient and reliable.

[4] We propose to move the date forward 5 years from the date central government proposes.

3) Timelines and carbon emission reduction goals should be broken down into annual targets and actions taken by area that can be monitored and reported on by local authorities.

4) A comprehensive engagement plan should be prepared that includes clear communications strategies with stakeholders, including businesses, universities, trade groups and energy groups.

5) An annual investment plan should be prepared for each region including CAPEX and OPEX expenditure required to grow the various areas of GVA identified in this report.

6) Scheduled meetings with grid operators should be arranged periodically to determine the timeline for rollout of the development of onshore wind according to headroom on the grid. The plan should match RIIO-ED2 investment plans. Once areas are identified, local authorities should communicate with developers to endorse their plans to communities promoting their benefits to obtain local consent to support planning applications.

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Appendix A1 - List of Consultees

We would like to thank the following people who made the time available to us to prepare this report:

Name	**Group/ Organisation**
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Richard Hooper	Harper Adams University
Richard Heath	Harper Adams University
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John Ogle	Zero Carbon Shropshire
Ian Wykes	Telford & Wrekin Council
Sharon McGuffie	National Grid DSO
Mohammed Jaffar	National Grid DSO
Fay Morris	Scottish Power Energy Networks
Adrian Cooper	Shropshire Council
Robert Saunders	Big Solar Co-op
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Will Tope	LINa Energy

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Appendix A2 – Glossary of Key Terms

£bn	Billion pounds (£1,000,000,000)
£M	Million pounds (£1,000,000)
AD	Anaerobic Digestion
AONB	Area of Outstanding Natural Beauty
ASHP	Air Source Heat Pump
BEIS	Department for Business, Energy & Industrial Strategy
BHESCo	Brighton and Hove Energy Services Co-operative
Bio-CNG	Bio-Compressed Natural Gas
BUS	Boiler Upgrade Scheme
C02	Carbon Dioxide
CAPEX	Capital Expenditure
CHP	Combined Heat and Power
CoP	Coefficient of Performance
DEFRA	Department for Environment Food and Rural Affairs
DESNZ	Department for Energy Security and Net Zero
DNO / DSO	Distribution Network Operation / Distribution System Operator
ECO4	Energy Company Obligation (scheme number 4)
EPC	Energy Performance Certificate
EV	Electric Vehicle
FES	Future Energy Scenarios
GHG	Greenhouse Gas
GSHP	Ground Source Heat Pump
GVA	Gross Value Added
GW	Gigawatt (1,000,000,000 watts)
GWh	A unit of energy that is equal to the energy provided by 1 Gigawatt in one hour
Hectare	Ten thousand square metres (10,000 m2)
HGV	Heavy Goods Vehicle
ICE	Internal Combustion Engine
Kt	Kilo-tonne (1,000,000 kg)
kW	Kilowatt (1,000 watts)
kWh	A unit of energy that is equal to the energy provided by a thousand watts in one hour
LA	Local Authority
LDV	Light Duty Vehicle
LEP	Local Enterprise Partnership
LPG	Liquid Petroleum Gas
LSOA	Lower Super Output Area

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m/s	Metres per second
m3	Cubic metres
MCS	Microgeneration Certification Scheme
MEES	Minimum Energy Efficiency Standards
MVA	Megavolt-amperes - the unit used to measure the apparent power in a circuit.
MW	Megawatt (1,000,000 watts)
MWh	A unit of energy that is equal to the energy provided by 1 Megawatt in one hour
NGED	National Grid Electricity Distribution
PV	Photovoltaic - solar electricity panels, which convert the sun's energy into electricity
REPD	Renewable Energy Planning Database
SAP	Standard Assessment Procedure
SPEN	Scottish Power Energy Networks
t	tonne
T&W	Telford and Wrekin
Tonne	1,000 kg
TW	Terawatt (1,000,000,000,000 watts)
TWh	A unit of energy that is equal to the energy provided by 1 Terawatt in one hour
UKERC	UK Energy Research Centre
VFRB	Vanadium Redox Flow Batteries
WPD	Wester Power Distribution

Appendix A3 – List of Assumptions

A full list of technical and financial assumptions utilised in the production of this report are shown below.

Energy Efficiency	
Assumed SAP of domestic homes without EPCs	55 (D)
Assumed SAP of non-domestic properties without EPCs	61 (D)
Heat pump modelling	
ASHP CoP	3.1
Number of domestic heat pumps currently installed	0
Biomass boiler efficiency	80%
Gas boiler efficiency	90%
Oil boiler efficiency	90%
Electric boiler efficiency	100%
Electric vehicle modelling	
Number of electric HGVs active in the Marches	0
Typical diesel engine C02 emissions	680 g/kWh[lvii]
Loss of energy in charging/recovery	80%[lviii]
Solar PV	
Irradiation factor (kWh/kWp)	954.74
Onshore Wind	
Wind availability	90%
Mast height (m)	90
Average wind speed (meters per second)	6
Wholesale price of electricity (in pence)	10.24
Electricity generation per hectare (kWh/annum)	13,723
Anaerobic Digestion	
Wholesale price of gas (in pence)	5.5
Average gas consumption per household (kWh)	11,000
Biogas yield per hour (Nm^3)	744

Appendix B – GIS Maps

Please see supplementary document "Appendix B_GIS Maps" for all GIS maps referenced in this LAEP.

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