

Worcester City Industrial Cluster Decarbonisation Study (WICD)

Final Report

A Place-based Energy Review of Worcester City's Industrial Estates

Researched and produced for Worcester City Council and Midlands Net Zero Hub by

Pro Enviro Ltd.

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Executive Summary

Worcester's industrial estates are central to the city's economic fabric and a material contributor to its carbon footprint. This study, commissioned by Worcester City Council and the Midlands Net Zero Hub, examines whether and how a place-based industrial cluster decarbonisation programme could be developed in Worcester. It draws on site assessments, case studies, benchmarking analysis, questionnaire responses and two stakeholder workshops.

At a glance

~140 GWh	160+	17 MWp
Combined annual energy use across the three estates	Businesses across Berkeley & Shire, Blackpole and Diglis	Shared rooftop solar PV potential identified on distribution and warehouse buildings

Key findings

Energy demand is highly concentrated. Across all three estates assessed, a small number of manufacturing sites account for the majority of total energy consumption. At Diglis, manufacturing represents 50% of businesses but ~94% of energy use; at Berkeley & Shire, manufacturing represents 25% of businesses but ~65% of energy use. This concentration shapes where cluster-level interventions can deliver the greatest impact.

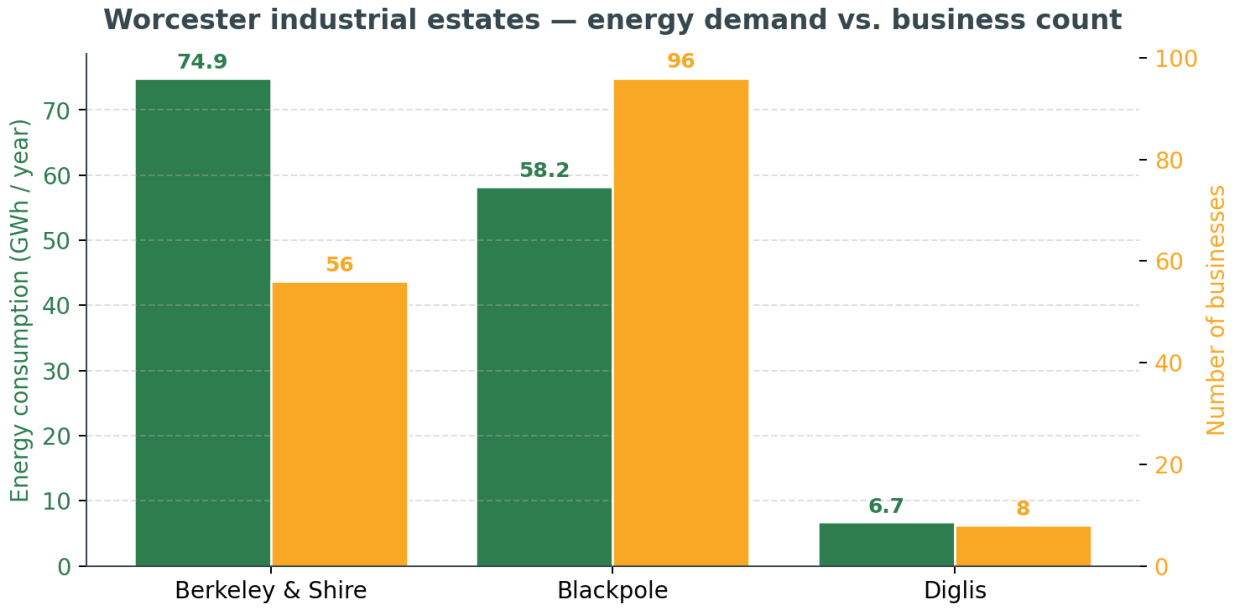


Figure 1 - Estimated annual energy consumption compared to business count for each estate.

Collective renewable generation is the headline near-term opportunity. Rooftop solar PV across distribution and warehouse roofs could deliver a 12.11 MWp array at Berkeley & Shire and a 4.8 MWp array at Blackpole, generating an estimated 14.2 GWh per annum combined and delivering payback within ~4–5 years on the PV component alone (excluding private wire infrastructure).

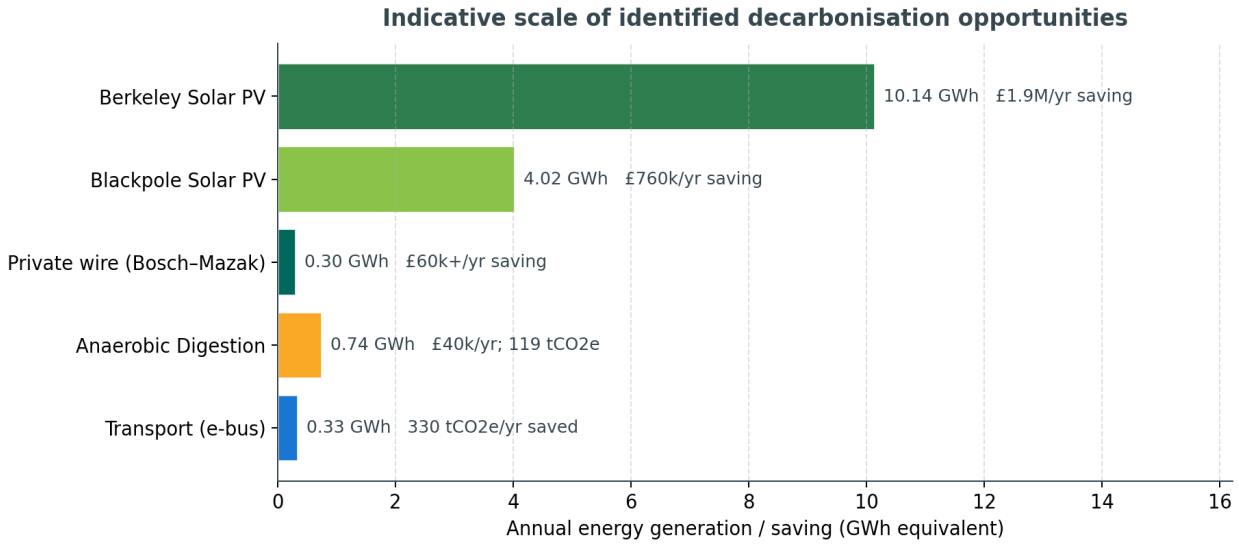


Figure 2 - Indicative scale of identified decarbonisation opportunities across Worcester.

Curtailed generation represents an immediate, recoverable loss. Worcester Bosch already operates a 1.064 MWp PV array but operates under a zero-export connection agreement, resulting in an estimated 30% of generation (~300,000 kWh/year) being curtailed. A private wire link to neighbouring Yamazaki Mazak could recover this surplus and deliver indicative annual savings exceeding £60,000.

Appetite is genuine but conditional. Workshop engagement showed interest in shared solar PV, collective procurement (PPAs/VPPAs) and shared energy management. Willingness to commit depends on clarity of benefit, manageable governance, and confidence that early participants will not bear disproportionate risk on behalf of the wider group.

Structural conditions will shape what is achievable. Grid capacity, planning and land-rights arrangements, lease structures (notably at Diglis), and the evolving regulatory framework for shared energy will determine the pace and scale of any future cluster activity.

Priority opportunities

Five interventions warrant early development

• Shared rooftop solar PV across Berkeley & Shire and Blackpole - the single largest near-term opportunity identified.

• A private wire network between Worcester Bosch and Yamazaki Mazak. Deliverability depends primarily on NGED engagement around connection linking, supported by a Section 50 highway crossing of Ebrington Drive and appropriate supply-licensing structure; most realistically delivered as a funded demonstrator project rather than a self-funded bilateral arrangement.

• Collective procurement of HVO and exploration of cluster-level PPAs - accessible to SMEs that lack bargaining power individually.

• Low-cost industrial data analytics (LCIDA) deployed across willing sites - to underpin all subsequent investment decisions with credible consumption data.

• Shared energy management and social-value support models - using larger employers' in-house expertise to support SMEs on the same estate.

Recommendation

The technical evidence supports moving from study to scoping. We recommend that Worcester City Council and the Midlands Net Zero Hub work with the businesses engaged through this study to develop a phased delivery plan.

Sustained coordination beyond this study phase is the single most important success factor identified from comparator programmes.

1. Introduction

Worcester's industrial estates are a key component of the city's economic fabric, supporting manufacturing, engineering, logistics and a wide range of small and medium-sized enterprises. These activities are typically energy-intensive and therefore contribute materially to the city's overall carbon footprint. As national and regional policy increasingly emphasises energy efficiency, productivity and decarbonisation, there is a growing need to understand how industrial activity can reduce energy consumption while remaining competitive and resilient.

This study examines the potential for industrial cluster decarbonisation in Worcester. It draws together evidence from site assessments, case studies, benchmarking analysis, questionnaire responses and stakeholder engagement to develop an initial picture of energy use, sectoral composition and structural characteristics across the city's main industrial areas. The work is intended to support Worcester City Council and the Midlands Net Zero Hub by providing an evidence-based review of place-based industrial decarbonisation opportunities to inform future policy, planning and decision-making.

The analysis focuses on Berkeley & Shire Business Park, and Blackpole and Diglis Industrial Estates. These locations reflect a range of industrial activities and scales, and together illustrate patterns observed across Worcester, including the concentration of energy demand within a limited number of manufacturing sites alongside a larger number of lower-intensity occupiers. Case studies are used to provide practical context and to demonstrate how energy consumption is driven by industrial processes and sectoral activity rather than business size alone.

Structure of this report

The report is structured to move from national and regional context through to the legal, regulatory and energy infrastructure framework that shapes what is feasible in Worcester, before presenting local evidence from businesses and sites. Early sections set out relevant literature, skills considerations, participation challenges, and the statutory and infrastructure context. This is followed by questionnaire findings, detailed site assessments, sectoral and energy analysis, and case studies, which together form the core evidence base. Later sections explore a range of potential decarbonisation solutions, assessed for relevance and feasibility rather than presented as recommendations. The report closes with reflections from the second stakeholder workshop, which marked the conclusion of the study.

2. Existing Evidence

UK industrial decarbonisation schemes

This literature review critically analyses industrial decarbonisation schemes throughout the UK, identifying key successes and weaknesses of each. By utilising the information from previous case studies, the Worcester City Industrial Cluster Decarbonisation Study (WICD) can have a direct and effective pathway to achieving decarbonisation informed by previous experience.

Place-based decarbonisation schemes have been part of UK-wide industrial strategies since 2019 [1], with the goal of establishing the world's first net-zero carbon industrial cluster by 2040. Worcester is a compact city with multiple industrial estates and, despite their relatively modest scale, industrial activity contributes materially to the city's carbon emissions.

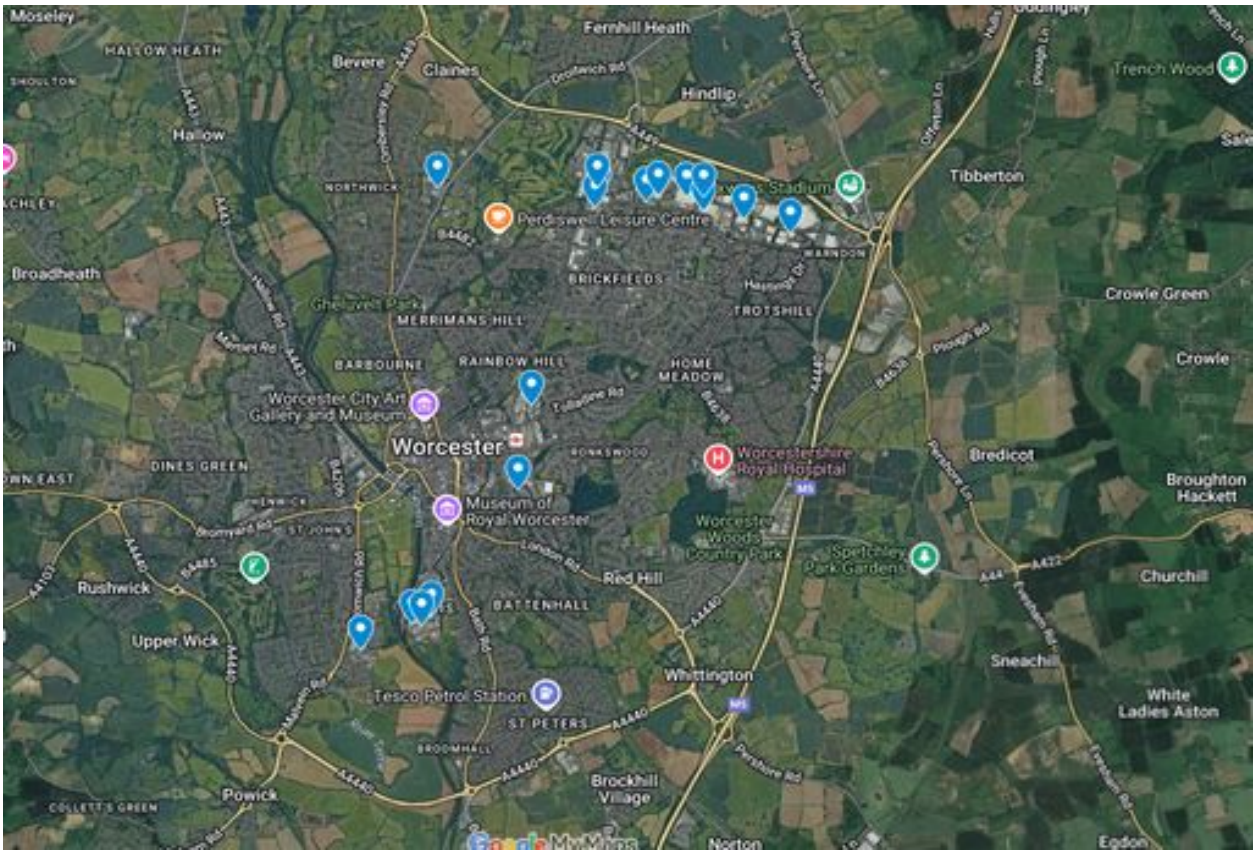


Figure 3 - 17 companies active in the tender for the Worcester City Industrial Cluster Decarbonisation Study (WICD), plotted on a Google Maps satellite view (coordinates 52.192001, -2.220000).

IDNI - Industrial Decarbonisation for Northern Ireland

The Industrial Decarbonisation for Northern Ireland (IDNI) project, led by Invest NI, addressed energy and productivity data gaps and promoted industrial cluster decarbonisation across Northern Ireland [2].

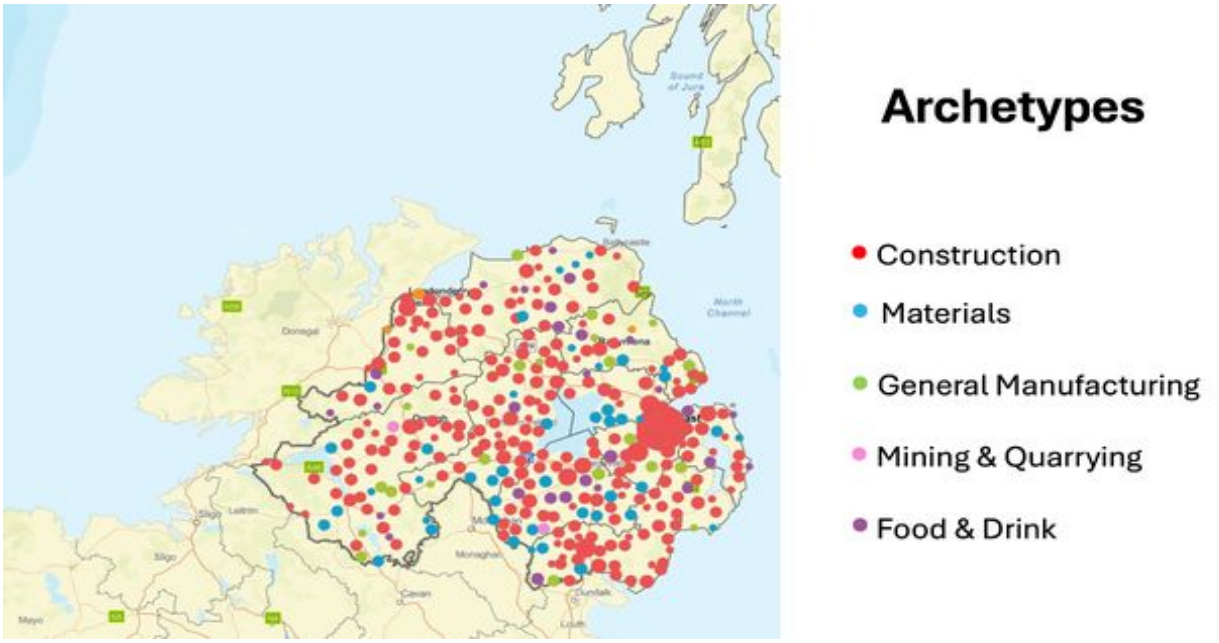


Figure 4 - IDNI mapping of Northern Ireland industry by sectoral archetype.

IDNI was an Innovate UK-funded Local Industrial Decarbonisation Plan (LIDP) project. Its main objectives were to develop plans for the decarbonisation of six industrial parks and one Community of Shared Interest (COSI) - the Mineral Products Association of Northern Ireland (MPANI). A total of 100 companies participated, of which 54 sites were audited; six industrial clusters were created alongside the MPANI COSI. Participating companies used a Knowledge Sharing Platform (KSP) which supported collaboration across the clusters.

The programme examined local heat networks, peer-to-peer electricity sharing (P2P), blockchain, private wire, PPA and VPPA options, and developed four digital twins of the largest industrial clusters to assess theoretical performance of candidate net-zero technologies. The Productivity and Emissions Tool (PET), developed by Pro Enviro, allowed companies to enter productivity metrics directly, supporting comparative sectoral analysis between GB and Northern Ireland [3].

Key takeaway for WICD

The bottom-up data-collection methodology developed for IDNI is directly transferable to Worcester. However, IDNI also illustrates a critical risk: when structured management and follow-on funding ceased at the end of the LIDP programme in January 2025, collaborative momentum dissipated. Continuity of coordination beyond the study phase is a non-negotiable success factor.

Repowering the Black Country

Repowering the Black Country (RtBC) was an Innovate UK-funded cluster programme establishing large-scale industrial cluster decarbonisation engagement and delivery across over 3,000 energy-intensive manufacturers in Wolverhampton, Walsall, Sandwell and Dudley. The cluster's total emissions exceed 1.35 million tonnes of CO_2e per year [4]. Twelve key sectors were identified by two-digit SIC code, with metal manufacturing being the largest local employment sector [5].

The programme established four Zero Carbon Hubs (ZCHubs) covering over 72 companies, alongside four Virtual Zero Carbon Hubs (VZCHubs) which fostered knowledge transfer between participants. The Phoenix 10 Enterprise Zone in Walsall was identified as a potential example of an aluminium reprocessing and re-manufacturing hub, promoting circular-economy principles [6] [7].

RtBC has since evolved into BCIC West Midlands, expanding to include manufacturing companies across the wider region. BCIC is one of 10 advanced-business networks supported by the West Midlands Combined Authority (WMCA) as part of its regional growth plans [8].

The Scottish Cluster

The Scottish Cluster (Acorn Project and SCO_2T Connect) is a CO_2 transport and permanent storage project covering emitters across Scotland and the wider UK. It is one of the drivers of Scotland's Net Zero target, projected for 2045 - five years ahead of the rest of the UK. The cluster's geographical focus is the East Coast from East Lothian to St Fergus, surrounding the Central Belt, which accounts for around 80% of Scotland's industrial CO_2 emissions.

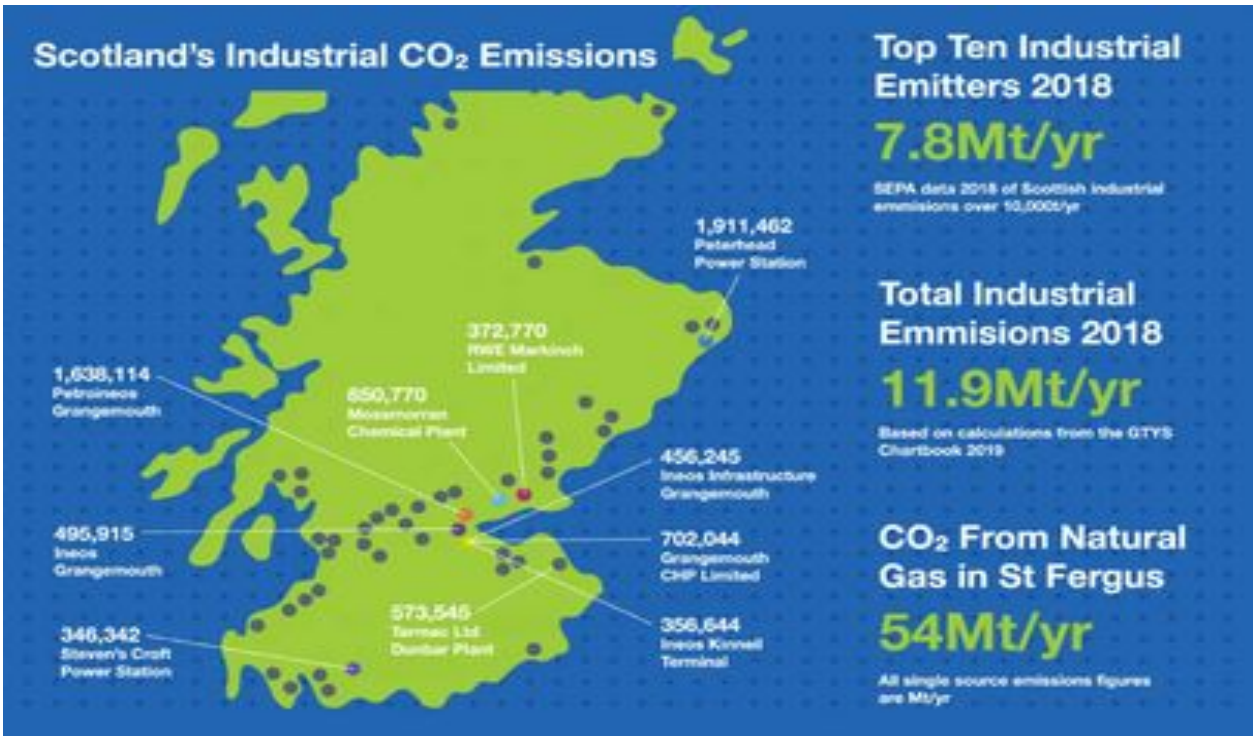


Figure 5 - Scotland's industrial CO_2 emissions and the location of key emitters within the Scottish Cluster [9].

Key companies involved include INEOS Grangemouth, SSE & Equinor (Peterhead Carbon Capture Power Station), Shell and ExxonMobil (SEGAL Capture), Brockwell Energy & Encyclis JV (Earls Gate Energy Centre), and Viridor and Equitix (Westfield ERF). The plan is to store CO_2 in depleted gas and oil reservoirs and saline aquifers approximately 2.5 km below the North Sea seabed, with an initial target of 5–10 million tonnes per year by 2030 and potential expansion to 20 million tonnes annually [10].

A major success is Acorn's reuse of existing oil and gas infrastructure at the St Fergus Gas Terminal in Peterhead, which reduces project cost and environmental impact while accessing one of the UK's most

mature geological CO_2 storage sites. After initially missing out on Track 1 funding in 2021, the project secured Track 2 status in 2023, signifying UK Government recognition as a priority for CCS deployment [11].

Key takeaway for WICD

Lessons from the Scottish Cluster underline the importance of funding certainty. Slow or uncertain funding leads to delays and loss of momentum. Early agreement and clarity on funding arrangements should be prioritised within any Worcester programme that follows this study.

Project Willow

Project Willow, located in Grangemouth, is a site-specific decarbonisation project designed to transition the Grangemouth Industrial Hub into a low-carbon manufacturing hub. A £1.5m feasibility study published in 2025 explored low-carbon technologies, creating nine mini-projects across three horizons - near-term (by 2028), medium-term (2030–2032) and long-term (2035–2039) - with a Net Zero target of 2045, aligned with the Scottish Government [12] [13].

Project Willow demonstrates how a structured, horizon-based framework can sequence interventions of differing maturity within a single industrial cluster. This phased approach is directly applicable to Worcester, where some opportunities (e.g. solar PV) are deliverable in the near term while others (e.g. emerging nuclear or hydrogen) belong on a long-term horizon scan.

The Greater South East Net Zero Hub

The Greater South East Net Zero Hub (GSENZH) is one of five Local Net Zero Hubs supporting local authorities and businesses across the Greater South East region. It has produced a substantial evidence base on industrial cluster opportunities, including framework development for decarbonisation of dispersed clusters where there is no single dominant anchor emitter - a context highly relevant to Worcester [14].

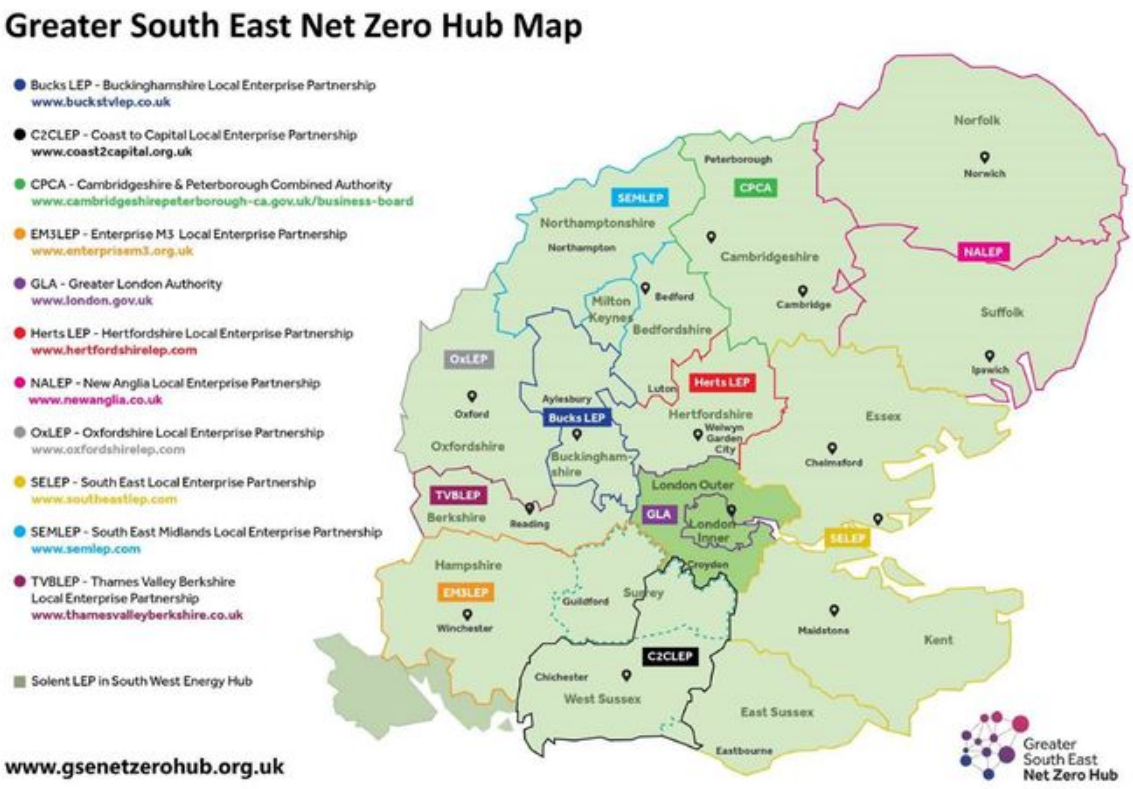


Figure 6 - Greater South East Net Zero Hub coverage area and member LEPs [15].

GSENZH's framework emphasises engagement, data, governance and finance as the four enabling pillars. Its insistence that successful clusters in dispersed settings are built around concrete projects (rather than networking alone) is consistent with messages later reinforced by BCIC West Midlands at the second WICD workshop.

Summary of findings from the literature review

Common themes across UK industrial decarbonisation programmes

- Successful clusters are built around concrete projects, not networking alone.
- Bottom-up data collection (energy, productivity, emissions per GVA) is the foundation of credible cluster planning.
- Continuity of management and funding beyond the initial study phase is the single most important determinant of long-term success.
- Anchor sites or "champions" - large, technically capable employers willing to host or participate in early demonstrators - accelerate adoption across the wider cluster.
- Phased delivery (near-, medium- and long-term horizons) allows technologies of differing maturity to be sequenced sensibly.
- Industry-led governance, supported but not dominated by the public sector, is more effective than top-down delivery.

3. Skills Needs for Decarbonisation

The decarbonisation skills landscape

The decarbonisation of UK industry depends on a workforce equipped with technical, digital and strategic competencies. The Humber Industrial Cluster Plan (HICP) Skills Report and similar national studies have highlighted that meeting net-zero ambitions requires substantial investment in skills development, particularly within energy-intensive and engineering-dominated sectors [16]. Worcester's industrial estates exhibit similar workforce structures to those analysed elsewhere, dominated by manufacturing, engineering, logistics and trade-based occupations, making this evidence directly applicable.

Skills context for Worcester (LSIP and LCEGS)

Worcestershire's Local Skills Improvement Plan (LSIP) and the Low Carbon and Environmental Goods and Services (LCEGS) framework both identify a structural shortfall in technical, digital and strategic capabilities relevant to decarbonisation. The findings echo national evidence and align with the kinds of capability gaps that would constrain delivery of any future Worcester cluster programme.

Technical and engineering expertise

Technical expertise underpins almost every aspect of industrial decarbonisation, from process optimisation through to deployment of low-carbon technologies. Required skills include mechanical, electrical and chemical engineering; thermodynamics and heat recovery; renewable systems integration; and proficiency with monitoring and control platforms. The University of the Built Environment has highlighted persistent shortages in low-carbon engineering capacity across the UK, and these gaps are reflected in Worcester's industrial workforce [17].

Digital and transversal skills

Digitalisation is increasingly central to industrial decarbonisation. Energy management systems, smart sensors, data analytics platforms and digital twins all require staff who can interpret data and translate it into operational decisions. Transversal skills - including project management, stakeholder engagement and systems thinking - are equally critical, especially within cluster initiatives where coordination across organisations is essential.

Whole-system and strategic capabilities

Decarbonisation requires whole-system thinking: the ability to understand interactions between energy infrastructure, supply chains, regulation and finance. Cluster anchors and SME representatives alike will need access to strategic skills to evaluate options such as private wire networks, peer-to-peer trading or shared procurement.

Barriers to decarbonisation

The workforce supply crisis

The UK is experiencing a sustained shortfall in skilled workers across the engineering, construction and energy sectors, exacerbated by demographic ageing, post-Brexit labour-market changes and competing demand from other infrastructure priorities [18] [19]. Without intervention, this constrains the pace at which any industrial decarbonisation programme can be delivered.

The 'just transition' and workforce sustainability

Place-based decarbonisation cannot be separated from the social context in which it occurs. A 'just transition' framework requires that workforce changes are managed in ways that protect existing jobs, support retraining, and ensure that the economic benefits of decarbonisation are shared [20]. For Worcester, this points to the value of partnerships between employers, further education providers and local authorities.

Utilisation of cluster models

Cluster models offer a practical mechanism for addressing skills gaps. By aggregating training demand across multiple employers, clusters can support shared apprenticeships, structured continuing professional development and joint engagement with FE/HE providers. The IDNI and Repowering the Black Country programmes both demonstrated the value of such arrangements.

Relevance to Worcester and the WICD study

Skills implications for the Worcester programme

- Any future delivery programme should embed workforce development from inception, working with the Worcestershire LSIP and local FE/HE partners.
- Cluster anchors (e.g. Worcester Bosch, Yamazaki Mazak, Aeromet International) could play a structural role in apprenticeships, placements and shared training.
- Digital data-analytics skills are a near-term priority if LCIDA-style data collection is to be embedded as the foundation of cluster activity.
- A just-transition lens should be applied to any workforce-mobility, transport or process-change initiatives.

4. Company Participation & Cluster Formation Challenges

Place-based industrial decarbonisation depends on voluntary engagement by businesses that often operate under competing commercial pressures. This section sets out the principal challenges identified through the literature review, stakeholder engagement and direct discussion with Worcester businesses.

Company participation

The 'Catch-22' of demonstrating benefits

Cluster programmes typically face a recurring tension: businesses are unwilling to invest time or capital until benefits are clearly demonstrated, yet benefits cannot be demonstrated without participation. This dynamic was repeatedly identified across the comparator programmes reviewed and was echoed by Worcester businesses during the workshops. Early demonstrator projects with low entry barriers and tangible outputs are essential to break this cycle.

Cluster anchors or 'champions'

Anchor sites - large, technically capable employers willing to host or participate in early demonstrators - accelerate adoption across the wider cluster. In Worcester, Worcester Bosch and Yamazaki Mazak at Berkeley & Shire, and Aeromet International and Neos Solutions at Blackpole, are well-placed to play this role. Their participation provides credibility, technical capability and the scale necessary to make shared infrastructure viable.

The landlord-tenant relationship

Split-incentive issues between landlords and tenants remain a persistent barrier to industrial decarbonisation. Capital investments in building fabric, on-site generation or shared infrastructure are typically made by landlords, while energy-cost benefits accrue to tenants. The FSB has highlighted how this misalignment of incentives can stall otherwise viable projects [21]. At Diglis, the separation of land (Canal & River Trust) from buildings, combined with leases of approximately seven years' remaining duration, illustrates the practical difficulty clearly.

Place-based vs. sector-based cluster challenges in Worcester

Worcester's industrial estates are place-based clusters rather than sectoral ones: they contain a diverse mix of activities rather than dominant single-sector concentrations. This has both advantages and disadvantages. The diversity creates opportunities for symbiotic relationships (e.g. waste-heat exchange, P2P energy trading) but also makes uniform sector-specific solutions harder to apply. Successful delivery will need to balance estate-wide infrastructure (e.g. shared solar) with sector-specific support tailored to individual businesses [22].

5. Energy Infrastructure & Policy

Introduction

This section sets out the energy-infrastructure and policy context within which any Worcester cluster decarbonisation programme would operate. It covers grid capacity, emerging tools and technologies, the impact of non-commodity charges, and the implications for cluster economics.

Background: the grid in Worcester and Worcestershire

Current grid capacity

Worcester sits within the National Grid Electricity Distribution (NGED) Midlands licence area. NGED publishes capacity information by primary substation, allowing prospective developers to assess the likely scale and cost of new connections [23]. Engagement with NGED early in any project lifecycle is essential, particularly for industrial sites where additional load or generation may exceed firm capacity at the local substation.

NGET: The Great Grid Upgrade

The Great Grid Upgrade represents the largest transformation of the UK's electricity transmission infrastructure since the 1960s. Driven by the transition away from fossil fuels, national electricity demand is expected to increase by approximately 50% by 2035 and potentially double by 2050 [24]. The programme includes new transmission lines, substations and offshore connections, particularly to support the integration of renewable generation. The UK has committed to connecting an additional 50 GW of offshore wind capacity by 2030 [25].

For industrial cluster projects, the Great Grid Upgrade has important implications. Expanded transmission capacity can relieve system-level constraints and facilitate new industrial connections. However, industrial developments will still require site-specific connection agreements, local infrastructure upgrades and long lead times [26]. Strategic planning at cluster level remains critical.

Emerging tools and technologies

The electricity network is evolving from a centralised system into a more dynamic and interactive platform that can support industrial decarbonisation. Smart grids, flexible smart contracts, behind-the-meter generation and peer-to-peer energy trading can be used together to make energy consumption more efficient, reliable and low-carbon.

Smart grid

A smart grid is a digitally enabled electricity network that uses advanced monitoring, communications and automation to manage generation, distribution and consumption in near real time. It supports two-way communication between consumers and the utility, enabled through smart meters, phasor measurement units, fault detectors, communications networks, automated controls and data analytics [27].

Smart grids enable flexible energy management across multiple businesses within an industrial cluster, improving resilience through reduced outage frequency, enabling demand-side response, and supporting the integration of behind-the-meter generation and storage. Where supply capacity can be allocated dynamically between businesses based on real-time demand, existing grid infrastructure can be used more efficiently, potentially delaying or reducing the need for costly reinforcements.



Behind-the-meter generation and peer-to-peer energy trading

Behind-the-meter (BTM) generation involves the on-site production of electricity at industrial facilities to meet local demand. Common BTM technologies include solar PV, combined heat and power (CHP), wind turbines and battery storage. These systems reduce operating costs and improve resilience by lowering reliance on grid imports.

Peer-to-peer (P2P) energy trading is a natural companion to BTM generation, allowing generators to sell surplus electricity directly to neighbouring businesses. P2P can include surplus electricity or by-products such as waste heat, adding circularity and resource efficiency to the cluster. Integration with battery storage and smart-grid functions allows charging when generation is high and discharge during peak demand, reducing imports and easing pressure on local network capacity [28].

Under current UK regulation, electricity cannot be sold over the public network without a supply licence, and customers are restricted to a single supplier. P2P models are therefore typically limited to private wire networks or microgrids. Ofgem has recently indicated support for trialling P2P arrangements under relaxed regulatory conditions, suggesting that the regulatory framework may evolve in the medium term.

Flexible smart contracts

Industrial sites in Worcester can leverage a variety of NGED flexibility products. Within sites, flexible import agreements (timed, phased or ANM-controlled) allow higher-than-firm-limit capacity, while BTM renewables, storage and microgrids can supply self-consumption and reduce peak demand. Beyond site

boundaries, shared connections, private wire PPAs and cluster-level coordination enable multiple businesses to optimise import and export and to pool renewable generation.

NGED's new Demand Turn-Up (DTU), Generation Turn-Up (GTU) and Demand Turn-Down (DTD) schemes enable industrial operators to shift consumption or generation according to network needs, earning revenue via scheduled or near-real-time utilisation products while supporting grid stability. Combined with flexible connections, BTM assets and cluster coordination, these schemes can materially improve cluster economics [29].

Update: Demand Flexibility Service (DFS) - April 2026 reforms

At a national-system level, the Demand Flexibility Service (DFS), operated by the National Energy System Operator (NESO), was materially expanded on 9 April 2026. The service now supports bi-directional flexibility - both demand turn-down and demand turn-up - and has introduced zonal procurement, allowing geographically targeted dispatch. Importantly, the minimum eligibility threshold has been reduced to 0.1 MW, making the service accessible to a far wider range of industrial sites than previously. A Self-Nominated Baseline option has also been introduced for non-domestic participants, which better reflects how industrial loads actually operate. From the 2024/25 season onwards, DFS revenues have been stackable with the Capacity Market and NGED's local DSO flexibility services, allowing participants to combine multiple revenue streams [30].

For Worcester's industrial estates, the practical implications are significant. Mid-sized manufacturers that would previously have been below the threshold can now participate, either directly or - more commonly - via an aggregator. Sites with battery storage, flexible process loads, on-site generation or large HVAC systems are best placed to benefit. The combination of DFS, NGED DSO services and Capacity Market participation creates a meaningful new income line that should be factored into the business case for shared infrastructure investments (particularly battery storage). The full set of flexibility income streams is summarised in Appendix B.

Impact of non-commodity charges

Non-commodity system charges - transmission and distribution, system balancing, policy and environmental levies, metering - are components of an electricity bill that reflect the costs of operating, maintaining and balancing the electricity system rather than the cost of the electricity itself. They make up around 35% of typical business electricity costs [31].

Why non-commodity charges matter for clusters

Non-commodity charges are often based on peak demand or connection capacity rather than actual energy consumption. Even when sites invest in BTM generation, storage or P2P trading, non-commodity charges often still apply to peak loads, limiting the financial benefits of these solutions. Where electricity is generated and consumed locally, either within a single site or shared between neighbouring users, exposure to system-wide charges is reduced, strengthening the economic case for BTM generation and private wire networks [32].

Grid capacity and connectivity requirements

Integrating a local energy system in which BTM generation, flexibility and storage are shared across multiple businesses requires coordination between industrial operators, network providers and local authorities. Many industrial sites will require technical retrofits to integrate new technologies, and grid reinforcement will frequently be necessary. These activities require significant investment, expertise and high-level project planning. Early engagement with NGED is essential to align cluster ambition with realistic delivery timescales.



6. Legal and Regulatory Framework

Important note

This section outlines a high-level legal and regulatory framework relevant to the study, based on academic literature, UK law and professional experience. This does not constitute legal advice. Formal legal advice can only be provided by a qualified solicitor authorised to practise law in the United Kingdom.

Cluster governance and investment structure

Establishing a cross-company vehicle that is practical for holding assets and managing joint interests is optimal for any shared infrastructure project. The choice of legal entity defines participants' relationships, benefits, tax implications and administrative obligations.

Entity formation

The Special Purpose Vehicle (SPV), typically a private Company Limited by Shares, is the most common legal structure used in the clean energy sector. The SPV acts as a separate legal entity, established exclusively for the industrial decarbonisation project. Participating companies contribute capital and receive equity in return. Contributions exceeding the nominal share value are frequently recorded as Additional Paid-in Capital (APIC), which increases equity without altering legal share value. The SPV structure is favoured for limited liability and suitability for raising project finance [33] [34].

Alternatively, a Non-Profit legal entity has members rather than shareholders (BCIC uses this structure for its network management). Its goal is service provision at cost rather than profit distribution. While administratively simpler, this model offers less investor familiarity and may expose participants to greater unintended liability compared with the limited liability afforded by an SPV.

SPV documents and policy

The legal framework is defined by legislation and agreement documents. The Articles of Association govern the internal workings of the company, while the confidential Shareholders' Agreement (or Joint Venture Agreement) is the principal transactional document, detailing members' rights, voting protocols and precise capital contribution mechanisms.

Commercial agreements

Commercial agreements translate the legal entity's structure into actionable business terms, ensuring the project is viable and attractive to investors.

Joint investment and risk allocation

A Joint Investment Agreement (JIA), often embedded within the Joint Venture Agreement, details financial commitment including the schedule and conditions under which capital contributions are made. Critically, the agreement must specify the allocation of performance risks - technological underperformance,

construction delays, regulatory or land-use changes. Proper risk allocation supports acceptable risk-adjusted returns for investors, a fundamental requirement for securing external private capital.

Heat and power cross-company contracts

Where energy is shared between companies - whether via private wire, heat networks or P2P arrangements - bilateral commercial contracts govern the terms of supply. These typically include pricing mechanisms (fixed, indexed, or time-of-use), volume guarantees, performance guarantees, dispute resolution and termination provisions. Coordination with the underlying SPV structure is essential to ensure that risk and reward are aligned.

Distributing equity, profit and loss

Distribution mechanisms within the SPV define how profits and losses are shared between participants. These are typically set out in the Shareholders' Agreement and may include preferred returns to early investors, performance-related distributions and provisions for new entrants. Clarity at the outset is essential to avoid later disputes.

Regulatory compliance and statutory constraints

Heat network and energy regulation

From 2025, heat networks in England, Wales and Scotland will be regulated by Ofgem under the Energy Act 2023 and associated secondary legislation (Energy Act 2023 (Heat Networks Regulations) etc.). This introduces new authorisation requirements, consumer protection standards and technical performance obligations [35] [36]. Any heat-network proposal arising from the WICD study will need to be designed with these requirements in mind.



Planning, land rights and permissions

Most cluster interventions require planning permission, environmental permits or both. Private wire networks crossing land owned by third parties require wayleaves or easements; these are frequently the critical-path risk in project delivery [37]. Heat networks, AD facilities and large-scale battery storage attract additional planning sensitivity. Early dialogue with Worcester City Council planners and (where relevant) the Environment Agency is essential.

Subsidies and subsidy control

Public-sector support for cluster projects is subject to the UK Subsidy Control Act 2022, which replaced the EU State Aid regime post-Brexit. Subsidy decisions must demonstrate that they meet the Act's principles, including necessity, proportionality and avoidance of distortion of competition. The Subsidy Advice Unit at the Competition and Markets Authority provides guidance, and certain subsidies must be referred for review [38].

Overview

The legal and regulatory landscape for industrial cluster decarbonisation is complex but navigable. The most important practical implication is that legal and regulatory work needs to begin early - alongside, rather than after, technical and commercial scoping - to avoid late-stage surprises that can delay or undermine otherwise viable projects.

7. Questionnaire

A questionnaire was issued to businesses operating across Worcester's industrial estates to gather insight into current energy use, decarbonisation activity, perceived barriers and support needs. The questionnaire was designed to complement site assessments and case studies by capturing perspectives directly from businesses, particularly where data was not otherwise available. Its primary value lies in identifying common themes, recurring barriers and areas where businesses are seeking support, which can be cross-referenced with findings from site visits, case studies and benchmarking analysis. The response set is not intended to be statistically representative, but the findings are consistent with the patterns observed through other components of the study.

Businesses' main energy uses

Respondents were asked to identify the main forms of energy use within their operations. The most frequently selected response was space heating of personnel (69% of respondents), followed by motors and drives (34%), and process heating, compressed air and "other" (each 24%).

Power and energy usage	% of companies selecting this option
Heat - space heating of personnel	69%
Motors & drives	34%
Heat - process heating	24%
Compressed air	24%
Other	24%
Transport	21%
HVAC, refrigeration & ventilation	3%

Table 1 - Questionnaire responses on main energy uses. Percentages reflect the proportion of respondents that selected each category, not the proportion of total energy consumed.

Interpreting the response data

These figures show how frequently each energy use was identified by respondents, not the share of total energy that each represents. A small office that selects "space heating" is counted equally with a large process plant that selects "process heating", even though the latter's absolute energy demand may be several orders of magnitude greater. The site assessments and case studies in Section 8 indicate that process heating, motors and compressed air typically dominate total energy consumption at manufacturing sites, even where space heating is more universally present across the business base.

With that caveat in mind, the responses still provide useful context. Space heating is near-universal across the business base, which means that even modest building-fabric and heating-control interventions could deliver value at many sites - albeit with limited impact on estate-wide energy totals. Process heating, motors and compressed air were each identified by roughly a quarter of respondents and are typically the dominant drivers of consumption at the sites that use them, making these a higher priority for energy-saving interventions in absolute terms. HVAC, refrigeration and ventilation were identified less frequently (3%), suggesting that these systems are not perceived as dominant energy drivers at most respondents' sites. Other responses included lighting, computer operations, welding and on-site forklifts.

Physical characteristics relevant to decarbonisation

A very high proportion of businesses (93%) indicated that they have available roof space that could be suitable for solar PV. This suggests that physical constraints are not the primary limiting factor for the deployment of rooftop renewables across the estates.

In terms of tenure, 38% of respondents reported owning their buildings, while the remainder operate from leased premises. A recurring theme within responses was that a lack of engagement or interest from landlords acts as a significant barrier to deploying on-site solar PV. Several businesses noted that communication is often mediated through management companies, limiting direct engagement and slowing decision-making.

Waste heat generation

21% of respondents indicated that their operations generate some form of waste heat. However, respondents noted that in most cases the available heat was either too low-temperature or too small in scale to support viable heat recovery for sharing within the estate. There was little interest in becoming part of a consortium of companies connected to an industrial-estate-wide district heat network. This reinforces the conclusion that waste heat recovery opportunities in Worcester are likely to be site-specific rather than estate-wide, requiring targeted assessment.



Opportunities for collaboration

Responses indicate varying levels of interest across different forms of collaborative activity. Shared renewables or microgeneration was selected by 59% of businesses, while collaborative energy purchasing was selected by 41%. Waste heat recovery was selected by 21%, and shared transport or logistics by 14%.

Opportunities for collaboration	% of companies selecting this option
Shared renewables / microgeneration	59%
Collaborative energy purchasing	41%
Waste heat recovery	21%
Shared transport / logistics	14%
Other	10%

Table 2 - Questionnaire responses on collaboration opportunities.

Additional responses highlighted interest in collaborative purchasing of alternative fuels, such as shared HVO for vehicle fleets. The distribution of responses suggests a stronger preference for collaborative approaches that are familiar and relatively low in complexity, compared with options that require greater technical integration or interdependency between businesses.

Main barriers to decarbonisation

The most frequently cited barrier was upfront cost, identified by 62% of respondents. Other responses provided further context, including challenges associated with landlord engagement, industry-specific regulatory constraints and reputational sensitivities. Some businesses noted resistance to activities such as waste treatment or recovery being located nearby, reflecting broader perceptions and stigma associated with certain industrial processes.

Main barriers to decarbonisation	% of companies selecting this option
Upfront costs	62%
Planning or permissions	34%
Lack of time / resources	28%
Partnering with other companies	17%
Technical advice	14%
Other	14%

Table 3 - Questionnaire responses on barriers to decarbonisation.

What type of support is needed

Responses indicate that businesses are primarily seeking enabling support that reduces financial risk and complexity. The most frequently selected form of support was access to funding, identified by 72% of respondents, reflecting the prominence of upfront cost as a barrier to decarbonisation.

What kind of support is needed	% of companies selecting this option
Access to funding	72%
Help navigating planning / permissions	21%
Technical advice	21%
Legal / commercial support	21%
Other	10%
Networking with other companies	7%

Table 4 - Questionnaire responses on support needs.

A secondary group of support needs was identified consistently, with planning and permissions support, technical advice, and legal or commercial guidance each selected by 21% of businesses. This highlights the need for assistance in navigating regulatory processes, understanding technical options and addressing contractual or landlord-related constraints. Requests for networking with other companies were less common (7%), though qualitative feedback suggests that existing engagement mechanisms can limit direct communication between businesses. Additional comments highlighted a desire for more locally focused sustainability and engagement events, as well as concerns around the availability of suitable premises for SMEs to network.

8. Site Assessments



Methodology

The three industrial estates in Worcester - Blackpole, Berkeley & Shire, and Diglis - were identified and mapped based on the companies operating within each location. For each company, Standard Industrial Classification (SIC) codes were compiled, along with available data on annual turnover, number of employees and (where identifiable) building type and approximate floor area. These parameters were used to estimate energy consumption at a company level.

Pro Enviro held existing energy consumption data for approximately 18% of the companies across the three industrial estates, obtained through previous energy assessment and review projects. For the remaining companies, energy consumption values were not available and therefore required estimation. A mixed-method approach was applied, combining an organisation-based benchmark drawn from Pro Enviro's own dataset with a building-based benchmark drawn from published CIBSE values. The two methods are described below.

Organisation-based benchmark (Pro Enviro ECP)

The primary benchmarking method was developed using data from over 1,500 companies recorded on the Pro Enviro Energy and Carbon Portal (ECP). This benchmark categorises companies by SIC code and estimates relative energy consumption using two independent indicators:

- Estimated energy consumption (kWh) based on the number of employees; and
- Estimated energy consumption (kWh) based on annual turnover (£).

For each company, both indicators were calculated and the final estimated energy consumption was derived by taking the average of the employee-based and turnover-based estimates. This approach was adopted to reduce uncertainty and provide a balanced representation of operational scale.

The benchmarking methodology provides an estimate of total energy use rather than a breakdown by individual energy types. Supplementary data collected directly from the surveyed industrial estates provides indicative insight into the typical distribution of energy consumption by fuel type: on average, total energy use can be broadly apportioned between electricity and gas, with an approximate split of 47%

electricity and 53% gas. This split should be regarded as a high-level approximation intended to support contextual understanding rather than a precise representation of energy use for individual companies.

Across the 160 companies assessed within the industrial estates, five companies were associated with SIC codes not represented within the ECP benchmarking dataset. In order to estimate energy consumption for these companies, a proxy approach was adopted whereby the closest available SIC code within the benchmark was selected and applied, based on alignment of core business activities.

Building-based benchmark (CIBSE TM46)

In cases where estimating energy consumption based on organisational metrics such as employee numbers and annual turnover was considered less representative of a site's energy use, an alternative estimation method was applied. This approach was used primarily for non-manufacturing and building-led operations, where energy consumption is more closely correlated with building type and floor area than with business size indicators. The method utilised benchmarks published by the Chartered Institution of Building Services Engineers in TM46 *Energy Benchmarks*, which estimate annual energy consumption per square metre by building type [39].

Each affected company was assigned a building type based on publicly available information, including company websites, planning records and site observations where available. The corresponding CIBSE typical energy benchmark was then applied to the estimated building floor area to calculate annual energy consumption. Where official floor area data was unavailable, building areas were estimated using satellite imagery and measurement tools within Google Maps. The building categories used in this assessment, and their associated typical energy benchmarks (combining electricity and gas), are summarised below.

Building type	Typical energy benchmark (kWh/m²)
Office	215
Shop	165
Showroom	240
Warehouse	195
Café	480
Industrial kitchen	480
Gym	600

Table 5 - CIBSE TM46 typical energy benchmarks used in the building-based estimation method.

Combining the two methods

The two methods were applied selectively rather than uniformly. For most companies on the three estates - manufacturing, logistics, trade and service occupiers where employee count and turnover were good predictors of energy use - the ECP organisation-based benchmark was used. For office-led, retail-led or hospitality-led occupiers whose energy use is dominated by building services rather than process load, the

CIBSE TM46 building-based benchmark was applied. In a small number of cases the two estimates were compared and the lower of the two was adopted where there was clear evidence that benchmarking on workforce alone would overstate on-site demand (for example, occupiers with substantial hybrid or off-site working patterns). Site-specific figures within case studies, where derived from meter data or direct engagement with occupiers, are noted as such and override both benchmarks.

Limitations of the benchmarking approach

Both benchmarking methods carry inherent limitations. Employee-based estimates can overstate on-site demand where staff work remotely, are based at alternative locations, or have roles that do not require regular on-site presence. Floor-area estimates derived from satellite imagery introduce measurement uncertainty, and the CIBSE typical benchmarks are by construction averages across a national population of buildings. Cross-referencing the two methods reduces but does not eliminate this uncertainty. The approach remains appropriate for generating indicative, high-level estimates across a large population of organisations; it is not intended to substitute for metered consumption data at any individual site.

Berkeley & Shire Business Park

Estate overview

Berkeley and Shire Business Park is one of Worcester's most significant industrial and commercial estates, located to the north of the city with direct access to the A44 and in close proximity to Junction 6 of the M5. This strategic position supports a wide range of industrial, commercial and logistics activities and makes the estate a key component of the region's economic infrastructure. The business park comprises a diverse mix of modern industrial units, warehousing facilities, trade premises and hybrid office-industrial buildings.

The estate hosts several major occupiers - Worcester Bosch, Yamazaki Mazak UK Ltd, Southco Manufacturing and Transmec - alongside a broad network of SMEs and service providers. This combination of large manufacturers and smaller firms contributes to a complex and multifunctional industrial environment with varying building types, operational patterns and energy consumption characteristics. The concentration of energy-relevant industries makes the estate a high-impact location for targeted decarbonisation and infrastructure-based solutions.

Sectoral composition (SIC code analysis)

The SIC code analysis for Berkeley & Shire shows a strongly industrial and trade-oriented estate, with manufacturing and vehicle-related activities forming the core of business activity. Across the 56 businesses assessed, manufacturing represents 25.0% of occupiers, followed by Wholesale and Retail Trade and Repair of Motor Vehicles and Motorcycles (23.2%) and Administrative and Support Service Activities (12.5%). The remaining occupiers are distributed across transportation and storage, information and communication, financial services, construction and a range of smaller sectors.

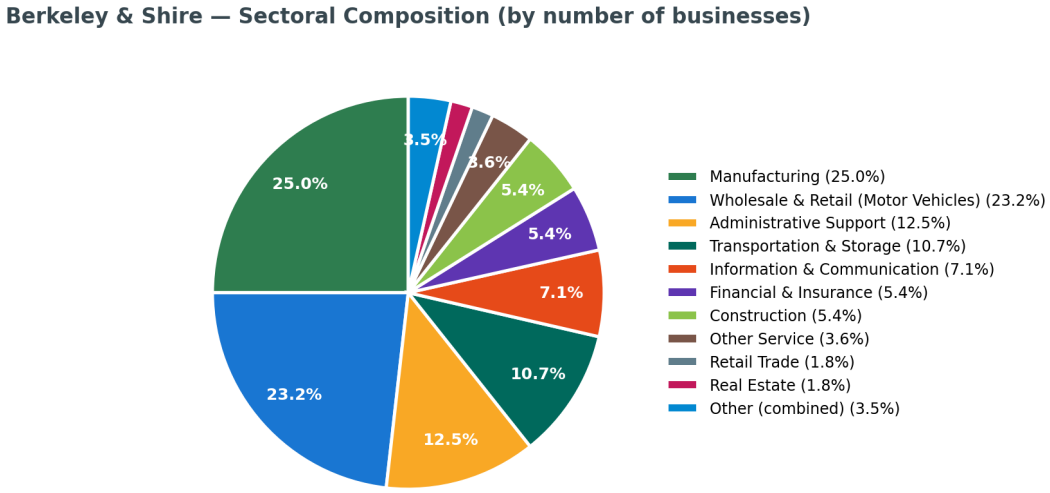


Figure 7 - Sectoral composition of Berkeley & Shire Business Park by number of businesses.

Data analysis

Analysis of estimated energy consumption across Berkeley & Shire indicates a strong concentration of demand within a limited number of sectors. Total estimated annual energy consumption for the estate is approximately 74.9 GWh.

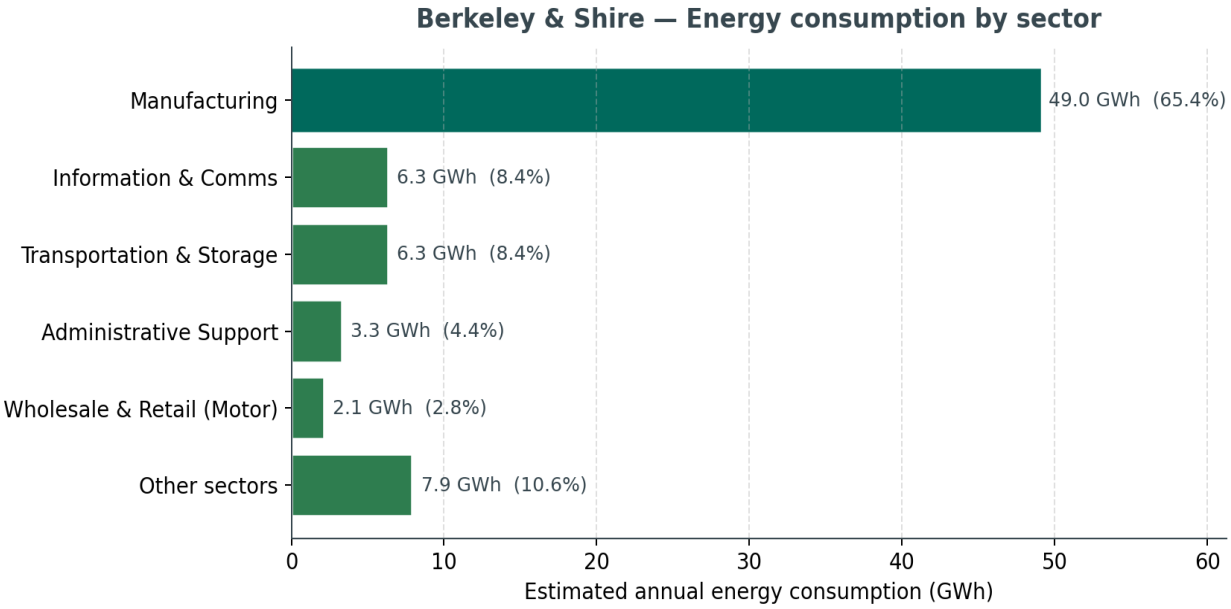


Figure 8 - Energy consumption by sector at Berkeley & Shire (estimated annual GWh).

Manufacturing accounts for 25.0% of businesses but approximately 65.4% of total estimated energy consumption (~49.0 GWh/year). This imbalance highlights the dominant influence of process-driven industrial activity on overall estate demand. Energy use within this sector is consistent with electricity for machinery operation, gas for process heating, compressed air and space conditioning within large-volume buildings.

A further notable contribution comes from Information and Communication, which represents 7.1% of businesses but accounts for approximately 8.4% of total energy consumption (~6.3 GWh/year). The sector

includes Open GI, which employs 300 staff; benchmarking suggests relatively high electricity consumption for the sector, but a significant proportion of Open GI's workforce is understood to operate off-site, so actual on-site energy use may be lower than the benchmarked estimate. This illustrates a known limitation of benchmarking approaches where occupancy patterns differ from assumed norms.

Transportation and Storage similarly contributes around 8.4% of total energy consumption from 10.7% of businesses, reflecting energy use associated with warehousing, lighting, materials handling and operational support systems. By contrast, Wholesale and Retail Trade and Repair of Motor Vehicles and Motorcycles represents 23.2% of businesses but only 2.8% of total energy consumption, indicating low average energy intensity per site consistent with workshop-based operations. Administrative and Support Service Activities represent 12.5% of businesses and approximately 4.4% of total energy consumption.

Smaller sectors - Construction, Real Estate, Utilities and Other Service Activities - collectively account for a minor proportion of total energy use, each contributing less than 1% individually. Overall, estate-wide energy consumption at Berkeley is dominated by a small number of higher-intensity users, particularly within manufacturing, with a broader base of lower-intensity occupiers contributing to background demand.

Major occupiers and energy-relevant features

The business composition at Berkeley & Shire indicates several themes relevant to decarbonisation planning:

Presence of large anchor manufacturers. The estate includes Worcester Bosch, Yamazaki Mazak and Southco, which operate from substantial industrial facilities and are likely to account for a significant share of total estate energy demand. These sites are characterised by process-driven electricity use, testing and CNC machining equipment, compressed air systems and large-volume space heating, suggesting that targeted, site-specific decarbonisation pathways may be required.

Supporting logistics and storage activity. Transportation and storage businesses contribute to baseline electricity demand through warehousing, lighting and handling equipment. These activities remain relevant when considering load profiles, peak demand management and lighting/equipment efficiency.

Vehicle-related trade and service activity. A substantial proportion of businesses are involved in wholesale and retail trade and repair of motor vehicles. These operations typically occupy workshop-style units and are associated with moderate energy demand from space heating, lighting, compressors and specialist tools, presenting opportunities for standardised efficiency improvements.

Office-based and administrative occupiers. Information and Communication and Administrative and Support Service Activities contribute to daytime electricity demand but generally exhibit lower energy intensity than manufacturing. Hybrid or off-site working patterns may reduce actual on-site consumption relative to benchmarked estimates.

Case study: Worcester Bosch

Worcester Bosch is the largest single occupier on Berkeley & Shire, operating extensive manufacturing, testing and administrative facilities. Indicative estimates have been developed based on information provided by the company regarding its existing solar PV installation. The company has demonstrated

continued interest in on-site renewable generation and is currently investigating the feasibility of building-mounted wind technology. While this remains under evaluation, its potential applicability to other industrial buildings makes the work relevant from a wider cluster-development perspective.

The curtailment opportunity

The site hosts approximately 2,000 roof-mounted solar PV panels (1.064 MWp), making it one of the most significant renewable installations on the estate. However, Worcester Bosch's grid connection is a zero-export agreement, meaning that excess generation, particularly during weekends, cannot be exported and is curtailed. An estimated 30% of generated electricity (~300,000 kWh/year) is therefore wasted. Recovering this surplus via a private wire link to a neighbouring site is one of the highest-value, lowest-complexity opportunities identified in this study.

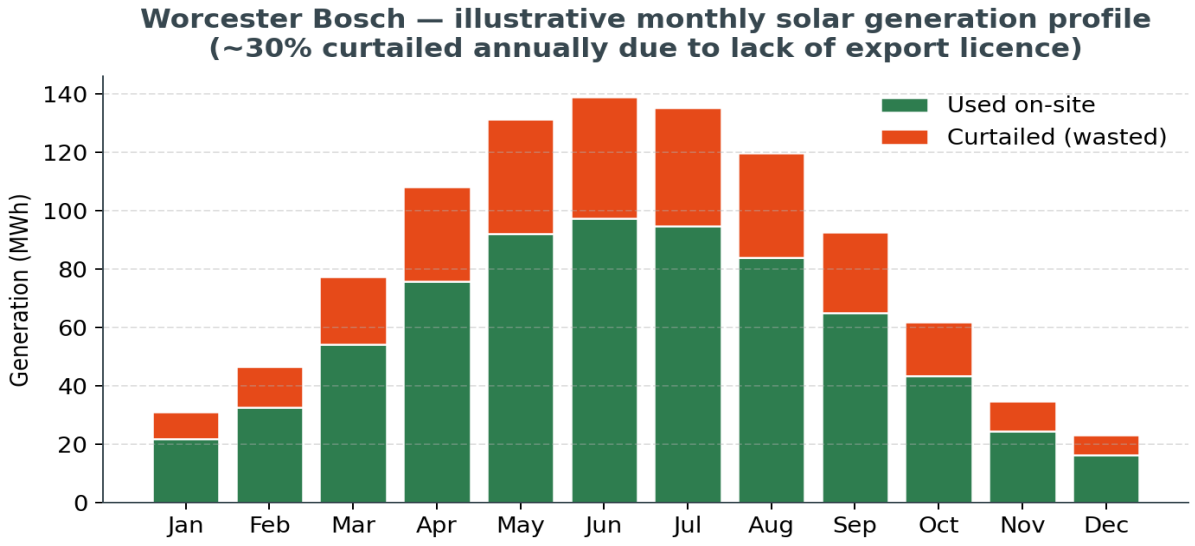


Figure 9 - Illustrative monthly solar generation profile at Worcester Bosch, showing the proportion currently curtailed.

Transport accessibility and workforce mobility

Despite Berkeley & Shire's economic importance, public transport use remains limited in practice. Bus services operate through the estate but engagement with Worcester Bosch indicates these are rarely used by employees, suggesting the primary constraint is not the absence of infrastructure but a lack of alignment between service provision and workforce needs.

Worcester Bosch has over 850 staff arriving around 08:00 and more than 300 leaving at approximately 15:00. Current timetables, journey times and overall convenience are not perceived as compatible with these concentrated shift patterns, and private car use remains the dominant mode of travel. The estate also lacks Beryl Bike or e-Bike docking stations, limiting opportunities for active travel or first/last-mile connections [40]. Collectively these constraints significantly limit the potential for modal shift.

Fuel use and low-carbon opportunities

Worcester Bosch has recently transitioned its forklift fleet and lorry operations to Hydrotreated Vegetable Oil (HVO) as a low-carbon alternative to diesel. While current pricing is comparable to diesel, the company has identified that national HVO supply remains inconsistent, with risks of availability constraints and price volatility. Most businesses on the estate procure diesel or HVO individually, leading to fragmented purchasing, inconsistent pricing and reduced bargaining power. A clear opportunity exists to develop shared HVO storage infrastructure, enabling bulk purchasing and improving security of supply.

Case study: Calder Ltd

Company profile. Calder Ltd, based on Berkeley Business Park and operating from a steel-framed industrial unit with integrated office and assembly areas, is a manufacturer of flow solutions - pump packages, vacuum systems, compressors and other specialist flow systems.

Energy consumption. Annual energy use comprises 145,146 kWh of electricity and 470,550 kWh of natural gas, with gas forming the majority of the site's carbon footprint. The site also consumes approximately 11,250 litres of diesel per year, used both for transport and for specific operational requirements such as pump testing.

Forklift fleet. The business operates a mixed forklift truck fleet (one diesel, multiple LPG). Electrification was explored but capital and infrastructure costs currently outweigh potential savings, resulting in an extended payback period.

Compressed air and heating. Compressed air is used within processes, with routine leak detection and maintenance in place. Office areas are heated using air source heat pumps, while industrial areas rely on gas-based space heating.

Solar PV. A 58 kWp system is recommended, sized to match on-site demand and avoid significant export. No battery storage is recommended due to limited economic benefit; however, the available roof space would allow for a larger system for shared generation capacity if cluster-level arrangements were established.

Case study: Bridge Aluminium (Worcester)

Bridge Aluminium undertakes sand-core manufacturing and non-ferrous aluminium casting. The site was established in 2023 and employs approximately 26 staff, operating Monday to Thursday between 05:00 and 17:00. The facility is a relatively young manufacturing operation combining process-driven production with workshop and technical support activities.

2.8 GWh	1.68 GWh	1.12 GWh
Total annual energy	Gas (metal melting & casting)	Electricity (furnaces, compressors)

Gas consumption is primarily associated with melting metal and casting processes, while electricity demand is used by holding furnaces, compressors and ancillary equipment. This mixed energy profile reflects the inherently energy-intensive nature of metal casting operations, even at relatively modest

employment levels. Half-hourly electricity data shows strong alignment between energy use and operational hours, a consistent baseload of approximately 60 kW (including during periods of reduced or no production), and continued consumption outside working hours - suggesting opportunities for improved shutdown and control procedures.

Decarbonisation opportunities identified

Compressed air optimisation. Significant compressed air leaks were observed, with estimated losses of over 25 MWh per year. Repairing leaks offers rapid payback and highlights compressed air as a critical but often inefficient ancillary technology in manufacturing.

Automated monitoring and targeting (aM&T). Installation of an aM&T system is a key enabling measure, with potential to reduce non-productive baseload consumption and improve operational awareness across both gas and electricity.

Compressor upgrade. The site currently operates a fixed-speed 90 kW compressor. A variable speed drive (VSD) alternative is a medium-term opportunity to better match compressed air supply with variable demand.

On-site renewable generation. A roof-mounted PV system of up to 302 kWp is technically feasible, subject to structural and grid-connection assessments. While capital-intensive, this option would offset daytime electricity demand and reduce reliance on grid supplies.

Blackpole Industrial Estate

Estate overview

Blackpole Industrial Estate is one of Worcester's longest-established industrial areas, located to the northeast of the city along the A449 and Blackpole Road corridor. The estate has evolved over several decades and now accommodates a wide variety of industrial, engineering, commercial and trade-focused businesses. The building stock reflects this mixed development pattern, ranging from older brick and steel-framed workshops to mid-sized industrial sheds, trade counters, retail warehouses and hybrid office-industrial units.

The estate hosts several large and energy-intensive occupiers whose activities can positively influence the wider industrial cluster decarbonisation profile:

Aeromet International. A high-precision aerospace manufacturer based at Blackpole. Aerospace production typically involves CNC machining, alloy processing and controlled-environment testing, suggesting high process-driven electricity use.

Neos Solutions. A specialist manufacturing company operating within the advanced engineering sector. Activities commonly involve high-temperature metal forming and pressing, CNC machining, compressed air systems and space heating.

Recycling and materials-recovery businesses. Blackpole Metals, Blackpole Recycling and others form a small but meaningful circular-economy sub-cluster, with operations including sorting, shredding, cutting and compaction - typically associated with electrically intensive material-handling equipment.

Sectoral composition (SIC code analysis)

Blackpole has 96 identified businesses, with a sectoral profile that is predominantly industrial and trade-focused. Manufacturing is the largest single category at 32.3% of businesses, followed by Wholesale and Retail Trade and Repair of Motor Vehicles (18.8%), Wholesale Trade excluding motor vehicles (14.6%), Construction (10.4%) and Administrative and Support Service Activities (8.3%). Service and professional activities are present but secondary, supporting rather than defining the estate's primary function.

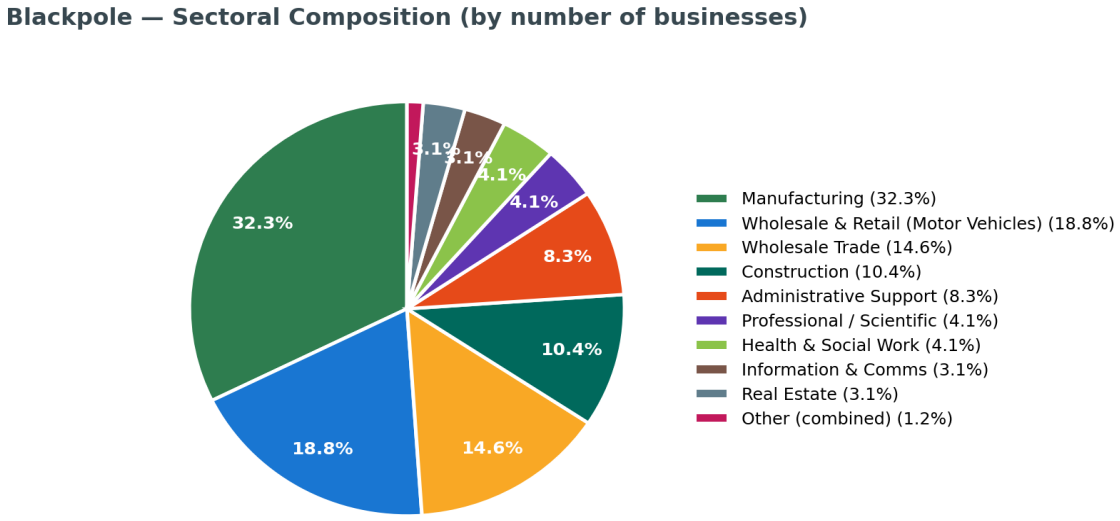


Figure 10 - Sectoral composition of Blackpole Industrial Estate.

Data analysis

Total estimated annual energy consumption across Blackpole is approximately 58.2 GWh. This figure represents an aggregated, sector-based estimate and should be treated as an order-of-magnitude indication of estate-wide demand. Where actual consumption data has been available from a subset of sites, analysis indicates an approximate 60% electricity and 40% gas split. While this sample is not sufficient to define a definitive estate-wide fuel mix, it provides an indicative reference point for the relative importance of thermal and process-driven energy use.

Major occupiers and energy-relevant features

Like Berkeley & Shire, Blackpole's energy demand is concentrated within a small number of energy-intensive manufacturing occupiers. The diversity of the wider business base - across manufacturing, construction, trade and service activities - creates opportunities for collective action where shared infrastructure or coordinated procurement can deliver value to a broad range of businesses.

Case study: Neos Solutions Ltd

Neos Solutions is a specialist advanced-engineering manufacturer based at Blackpole. The site combines metal forming, pressing and CNC machining with extensive use of compressed-air systems and substantial space-heating requirements. Half-hourly electricity data indicates strong alignment with operational hours, with significant scope for compressed-air optimisation, controls and sub-metering improvements.

The recommended interventions are characteristic of those applicable across similar manufacturers within the estate.

Case study: Froude Ltd

Froude Ltd designs and manufactures dynamometer test systems at a large, older industrial unit on Blackpole. The site has a substantial heated volume, ageing space-heating systems and significant scope for control and stratification improvements. Half-hourly data analysis indicates a persistent baseload outside core operating hours and non-productive consumption during weekends and shutdown periods - characteristics typical of engineering and test facilities operating within older, large-volume industrial buildings.

Key decarbonisation opportunities identified at site level include upgrading space-heating systems to improve efficiency and controllability, reducing heat stratification through destratification fans, addressing non-productive electrical baseloads through improved controls and sub-metering (including installation of aM&T), and further lighting upgrades where legacy systems remain. The case study demonstrates how space heating can dominate energy use in large industrial units, particularly where building fabric and heating systems are ageing.

Diglis Industrial Estate

Estate overview

Diglis Industrial Estate is a small, tightly defined industrial area located to the south-east of Worcester city centre, adjacent to the River Severn. The estate comprises a limited number of occupiers operating from established industrial buildings, with activity primarily focused on manufacturing and trade-related activities. Unlike larger estates such as Blackpole and Berkeley, Diglis has a relatively small business base but includes several energy-intensive operations.

Discussions with local occupiers indicate that the land underlying the estate is owned by the Canal & River Trust, while buildings are held separately. The majority of occupiers are reported to have approximately seven years remaining on their current leases. This ownership and lease structure is an important contextual factor when considering the feasibility and timing of longer-term decarbonisation interventions, particularly those requiring estate-level coordination or significant capital investment.

Sectoral composition and energy consumption

Diglis comprises 8 businesses, with a strongly industrial profile: 4 in manufacturing (50%), 3 in wholesale trade excluding motor vehicles (37.5%), and 1 in wholesale and retail trade of motor vehicles and motorcycles (12.5%). Despite manufacturing accounting for half of businesses, it dominates the estate's energy profile entirely.

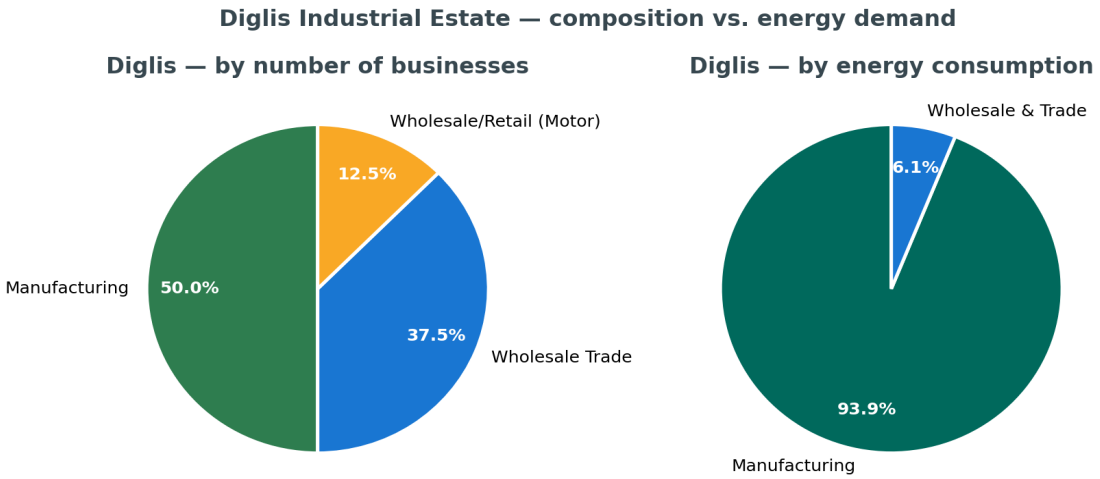


Figure 11 - Diglis Industrial Estate: composition by number of businesses (left) vs. composition by energy consumption (right).

Manufacturing accounts for 93.9% of total estimated annual energy consumption, equivalent to around 6.31 GWh per annum. By contrast, wholesale and trade-related activities collectively represent 50% of businesses but only 6.1% of total energy consumption (~0.41 GWh per annum). These uses are characterised by lower power density and energy demand driven primarily by building services rather than process-related loads. Total estimated annual energy consumption across Diglis is approximately 6.73 GWh, with a collected-data split of approximately 30% electricity and 70% gas, indicating estimated total carbon emissions of approximately 1,320 tCO_2e.

Interpretation and implications for decarbonisation

Diglis's energy profile is notably more concentrated than that of larger estates. A small number of manufacturing occupiers account for the vast majority of energy use, meaning that estate-wide energy demand is highly sensitive to the operational characteristics of a limited number of sites. This creates both opportunity and risk from a cluster decarbonisation perspective. Targeted engagement with one or two high-energy manufacturing sites could materially influence total estate emissions. However, the lease structure and land ownership arrangements introduce additional considerations: with approximately seven years remaining on many leases, occupiers may be cautious about investing in long-payback infrastructure unless there is clarity on lease extension, asset ownership or cost recovery mechanisms.

The estate's proximity to Worcester Sewage Treatment Works - located approximately 200 metres away on the opposite bank of the River Severn - presents a potential longer-term opportunity for exploring Anaerobic Digestion (AD) as part of a wider place-based strategy. An AD facility could be relevant where there is a combination of organic waste arisings, process heat demand and interest in localised low-carbon energy generation, with potential outputs (biogas or biomethane) supporting thermal demand, vehicle fuel substitution or grid injection.

Case study: Industrial & Tractor Ltd

Industrial & Tractor Ltd operates from Diglis Industrial Estate and undertakes energy-intensive manufacturing, primarily focused on tube bending and metal fabrication. Core operations include CNC tube bending, brazing, welding, electroplating and associated finishing processes. Total annual energy consumption is estimated at approximately 3.6 GWh, comprising around 2.3 GWh of electricity and 1.3 GWh of natural gas.

Electricity demand is dominated by manufacturing processes - furnaces, electroplating systems, welding extraction, compressed air generation and distribution systems, and ancillary motors. Gas consumption is largely associated with space heating and process heat requirements, including brazing furnaces and steam generation. The assessment identified optimisation-focused opportunities (compressed-air improvements, enhanced control of extraction and motor-driven equipment, targeted plant upgrades) with combined potential savings of approximately 330 MWh per annum - equivalent to around 10% of total site energy consumption.

Case study: Griffin Enamellers Ltd

Griffin Enamellers Ltd operates a specialist powder-coating facility on Navigation Road, Worcester, providing industrial surface finishing and controlled curing for manufactured components. The site employs a small workforce (four employees) but undertakes energy-intensive thermal processes associated with curing and drying ovens operating at circa 200 °C. Despite its modest scale, the site exhibits characteristics typical of process-driven manufacturing units found across Worcester's industrial estates.

Total annual energy consumption is approximately 585 MWh, split predominantly between natural gas (~538 MWh) and electricity (~47 MWh). Gas use accounts for the majority of demand and is directly attributable to the operation of curing ovens rather than space heating. This profile highlights how even small industrial units can have disproportionately high thermal energy requirements when process heat is required for production purposes.

The assessment identifies several low-to-medium capital interventions with relevance to similar process-based SMEs across the cluster: process heat containment measures (automatic doors or air curtains on the powder coating line, to reduce convective heat losses from ovens) and incremental electrical efficiency (replacement of remaining fluorescent lighting with LEDs). Together, the recommended measures could reduce site energy use by approximately 6%, with simple payback ranging from 4.5 to 6.8 years depending on the intervention selected.

Cluster-level insight from Griffin Enamellers

Energy intensity is not solely correlated with business size. Small manufacturers with large thermal demand or energy-intensive processes can play an important role in planning of cluster decarbonisation. Any future Worcester programme should design support mechanisms that are accessible to energy-intensive but small-sized SMEs, not only large energy users.

Other industrial sites of interest

Case study: JVM Castings Ltd

JVM Castings Ltd operates a metal casting manufacturing facility within Worcester. Although the site does not sit within one of the three primary industrial estates assessed in this study, it represents a form of energy-intensive high-temperature industrial activity that is relatively rare within the city context. The site is located adjacent to a large retail occupier (Lidl), creating an unusual juxtaposition of industrial heat generation and nearby potential heat demand.

Half-hourly metering data indicates total annual electricity consumption of approximately 16.2 GWh, with no natural gas use on site. Energy demand is driven predominantly by electrically powered casting and associated process equipment. This places JVM Castings among the highest single-site electricity consumers identified within Worcester. A previous study explored the feasibility of a local heat network linking JVM Castings with the adjacent Lidl site; at the time, the project was deemed economically unviable due to capital and infrastructure requirements rather than a lack of technical heat availability.



JVM Castings is an illustrative example of threshold-scale industrial heat generation within Worcester. While most industrial sites do not appear to produce sufficient surplus heat to support off-site utilisation, a small number of operations may be capable of doing so under the right conditions - creating a 'mini-cluster' opportunity. Should energy prices, capital funding mechanisms or local demand profiles change, sites of this nature may become increasingly relevant to place-based heat reuse strategies.

Case study: Goodfish Group (Powell & Harber)

Goodfish Group (Powell & Harber) operates a plastics and composite manufacturing facility specialising in injection moulding, extrusion, vacuum forming and tooling. The site is a single manufacturing unit surrounded by housing. The company operates extended hours (typically 05:00–21:00 on weekdays, ~4,000 operating hours per year). Annual energy consumption is approximately 1.0 GWh, with electricity accounting for around 79% of total energy use and gas the remaining 21%.

Electricity demand is dominated by injection moulding equipment, ancillary plant, compressed air systems and production infrastructure. The site exhibits a clear weekday operational profile with reduced but persistent overnight and weekend baseloads, indicating opportunities for operational optimisation rather than purely capital-led interventions. The site's authorised supply capacity exceeds recorded maximum demand, suggesting flexibility to accommodate electrification or additional loads without immediate grid reinforcement.

Several themes have broader relevance for Worcester's industrial clusters: replacement of older hydraulic injection moulding machines with modern servo-electric alternatives delivers substantial energy and carbon savings; compressed air optimisation is a recurring opportunity across multiple sites (Froude, Bridge Aluminium, Goodfish); and large-scale roof-mounted solar PV is technically feasible at sites of this type, supporting the case for rooftop solar across similar low-rise industrial buildings. Located in a housing estate, any surplus renewable power could be shared with neighbouring domestic dwellings, though this would require a different regulatory framework, planning approach and legal structure to that applicable within an industrial estate.

9. Energy Solutions

Introduction

This section provides a roadmap for cluster decarbonisation, identifying opportunities for 'clustering' activities and quantifying carbon and cost savings where applicable. Solutions focus on energy efficiency and collaboration, circular economy, and decarbonisation of fuels and power.

Emissions are both temporal and spatial. Here, 'fixed' emissions refer to those associated with stationary processes or usage; 'transient' emissions refer to those during transportation of goods. Where applicable, UK Government GHG Conversion Factors are utilised to assess carbon emission savings [41].

Note on cost and saving figures in this section

All capital cost, annual saving and payback figures presented in this section are indicative only. They are intended to demonstrate the order of magnitude of each opportunity and to support prioritisation, not to provide a procurement-grade estimate.

Where capital costs are quoted (for example, the £8.5M and £3.36M figures for the Berkeley and Blackpole shared solar PV systems), they cover the photovoltaic equipment only. They exclude private wire infrastructure, grid connection works, planning and legal costs, contingency and ongoing operation and maintenance - all of which can be material and site-specific.

Annual saving figures assume a baseline grid electricity unit rate of 20 p/kWh and a gas unit rate of 5 p/kWh. Actual savings will vary with future tariffs, non-commodity charges, export arrangements and the precise contractual structures put in place.

Fixed energy analysis

Berkeley and Shire Business Park

Drawing on the case studies presented in Section 8 and the estate-wide benchmarking analysis, fixed energy demand at Berkeley & Shire is dominated by a small number of manufacturing sites. Although energy demand is concentrated at the anchor manufacturers, the most suitable rooftops for shared solar PV are the large, lightly loaded distribution and warehousing buildings on the estate. This combination - manufacturers providing the demand base, neighbouring warehousing providing the generation surface area - makes the estate well-suited to shared infrastructure interventions, particularly collective solar PV linked through a private wire network.

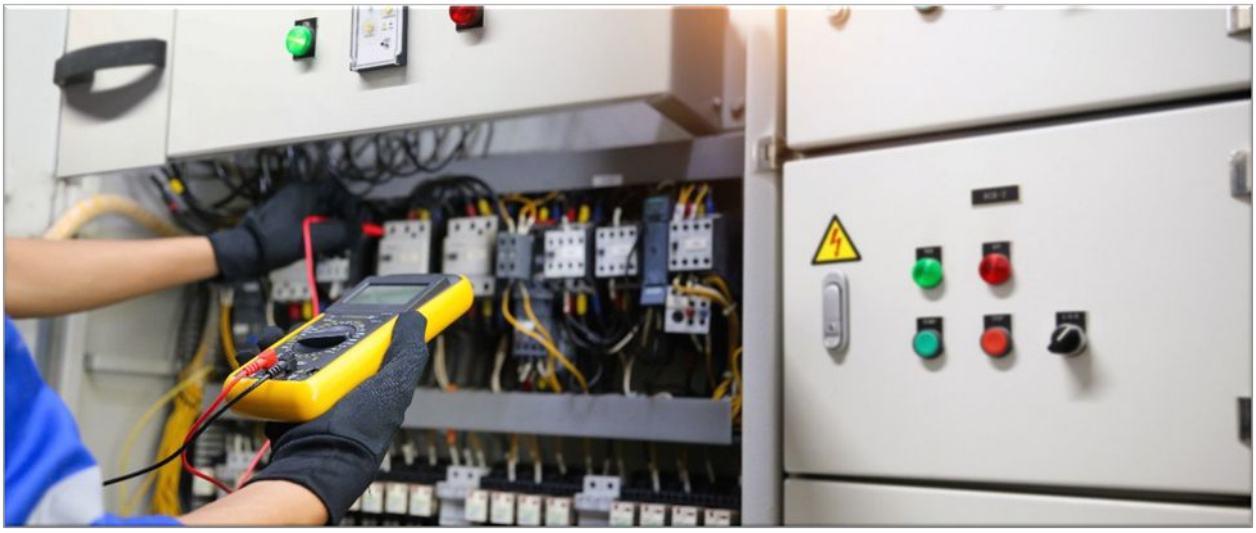
Blackpole Industrial Estate

Blackpole's energy demand is also concentrated within manufacturing, with substantial scope for both site-level efficiency interventions (compressed air, controls, lighting, heating) and shared infrastructure. The estate's mix of older and modern building stock means that the most appropriate intervention will vary site-by-site, but solar PV across the largest distribution roofs offers a clear shared opportunity.

Low-Cost Industrial Data Analytics (LCIDA) and Monitoring

Relevance to Worcester's industrial estates

Across the three estates, a recurring observation from site assessments and case studies is the limited availability of granular consumption data. Where half-hourly metering and sub-metering exist, optimisation opportunities can be identified quickly; where they do not, businesses often rely on intuition or supplier-led advice. Low-cost industrial data analytics (LCIDA) - combining affordable hardware (clip-on CTs, low-cost sensors), digital communications and lightweight analytics - offers a pragmatic way to close this gap.



Potential benefits at site and cluster level

Where advanced monitoring and targeting is applied, businesses typically realise median energy efficiency savings in the order of 10–15%. While these figures cannot be assumed to translate directly to Worcester, they highlight the scale of opportunity that improved data visibility can unlock. At cluster level, aggregated data supports informed decision-making for BTM investment, participation in flexibility markets, and access to NGED products such as flexible contracts and shared maximum demand.

LCIDA as a foundation for cluster activity

Installation of affordable data collection and analytics should be considered a foundational first step for effective planning of any cluster decarbonisation activity. It underpins informed decisions on subsequent investments - solar PV, private wire, flexibility, AD - by replacing benchmarked assumptions with real, site-specific data.

Constraints and considerations

Data governance and confidentiality. Particularly where cluster-level aggregation is involved, businesses need confidence that their data will be handled appropriately.

Engagement and capacity. Businesses need to be supported to interpret and act on insights rather than being presented with unmanaged data.

Proportionality. Over-instrumentation of low-intensity sites where benefits may be limited should be avoided.

Integration with local programmes. Future programmes succeeding the now-closed Business Energy Advice Service (BEAS) in Worcestershire, or other local authority support mechanisms, could host the deployment and provide an entry point for SMEs [42].

Collective Renewable Generation - Solar PV - Berkeley

The presence of warehouses and distribution centres at Berkeley & Shire represents an opportunity for cost-effective installation of collective solar PV arrays and batteries. The transportation and storage sector occupies a large area at low energy intensity. A private wire network and battery system could be designed to provide low-carbon electricity for the cluster.

Suitable locations for implementation

The following structures are within close proximity (800 metres between A and D), with ample roof space and relatively low consumption:



Figure 12 - Aerial view of Berkeley & Shire Business Park showing the candidate roof areas identified for collective solar PV (Google Earth).

Reference	Building	Roof area (m^2)
A	Transmec Ltd	9,100
B	Eastbrook Distribution Centre	17,000
C	Shire Park – Sainsburys Warehouse	25,000
D	Worcester Bosch Distribution Centre	11,500
Total	-	62,600

Initial estimates indicate that an array of 24,222 × 500 W monocrystalline PV modules can be installed across the four roof spaces to create a 12.11 MWp photovoltaic system for shared use (P2P) or private wire within the Berkeley estate.

Energy calculation assumptions and results

Solar assumption	Value
Generation surface area	62,600 m²
Total number of solar panels	24,222
Angle (from horizontal)	20°
Direction (angle from south)	90°

Table 6 - Berkeley solar PV: technical assumptions.

The estimated quantity of energy generated by the recommended array is 10,140,000 kWh per annum. This is 34.7% of the electricity consumption of the industrial estate (estimated at 29,225,000 kWh per annum).

Economic assumptions and results

Economic assumption	Value
Unit rate (p/kWh)	20
% of energy utilised across the cluster	95.00%
Energy cost inflation	0.00%
Annual performance degradation factor	0.50% /yr
Capital cost*	£8,500,000

*Table 7 - Berkeley solar PV: economic assumptions. *Cost is solely for the installation of solar PV arrays and batteries; grid and private wire network costs are anticipated to be significant.*

Annual cost savings are estimated at over £1,900,000 per annum. The cash flow chart below represents the cumulative projected return on investment.

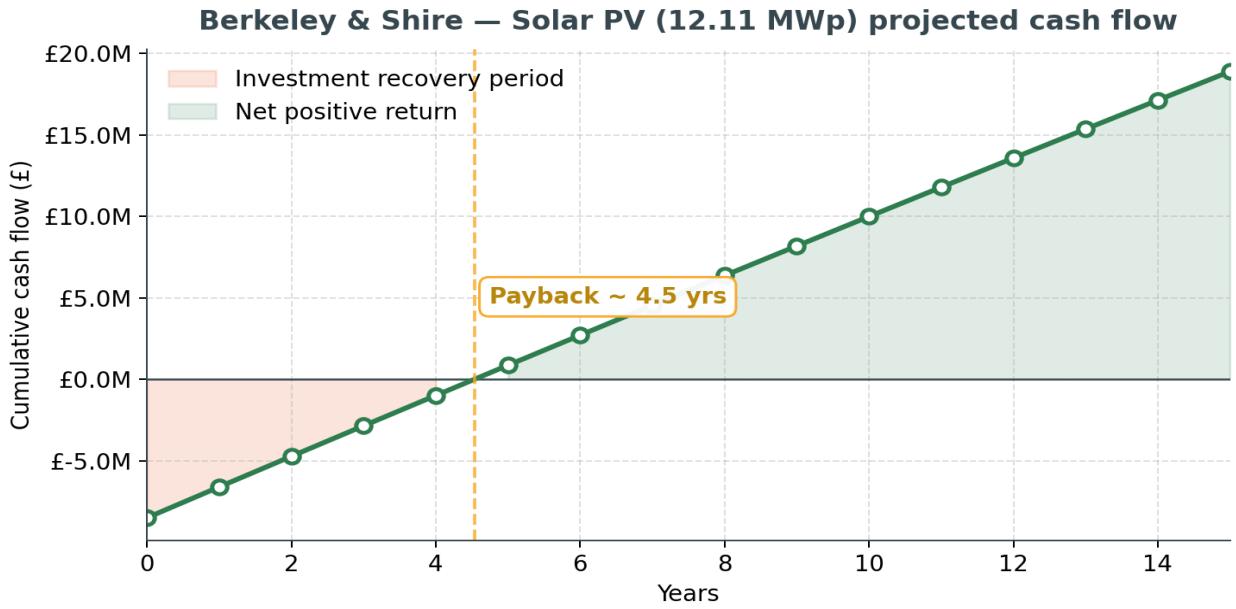


Figure 13 - Berkeley & Shire: projected cumulative cash flow for the 12.11 MWp solar PV system.

A 0.5% degradation factor has been applied. A full solar PV survey will be required to determine the precise cost-benefit of any actual installation.

Collective Renewable Generation - Solar PV - Blackpole

A similar exercise has been undertaken for Blackpole Industrial Estate.

Suitable locations for implementation

The following locations have been identified as most suitable:



Figure 14 - Aerial view of Blackpole Industrial Estate showing the candidate roof areas identified for collective solar PV (Google Earth).

Reference	Building	Roof area (m²)
A	ArrowXL by JP Home	15,000
B	Exhaust, Tyres & Batteries	9,800
Total	-	24,800

Note: a small solar PV array is currently installed on both buildings; figures exclude areas with existing panels.

Using the area figures above, it is estimated that 9,596 × 500 W monocrystalline PV modules can be installed to create a 4.8 MWp photovoltaic system.

Energy and economic results

Solar assumption	Value
Generation surface area	24,800 m²
Total number of solar panels	9,596
Angle (from horizontal)	20°
Direction (angle from south)	90°

Table 8 - Blackpole solar PV: technical assumptions.

The estimated annual generation is 4,015,000 kWh, which is approximately 11% of the estimated electricity consumption of the industrial estate (35,070,000 kWh per annum).

Economic assumption	Value
Unit rate (p/kWh)	20
% of energy used across the cluster	95.00%
Energy cost inflation	0.00%
Annual performance degradation factor	0.50% /yr
Capital cost*	£3,360,000

*Table 9 - Blackpole solar PV: economic assumptions. *Cost is solely for the installation of solar PV arrays; grid and private wire network costs are anticipated to be significant.*

Annual cost savings are estimated at over £760,000 per annum.

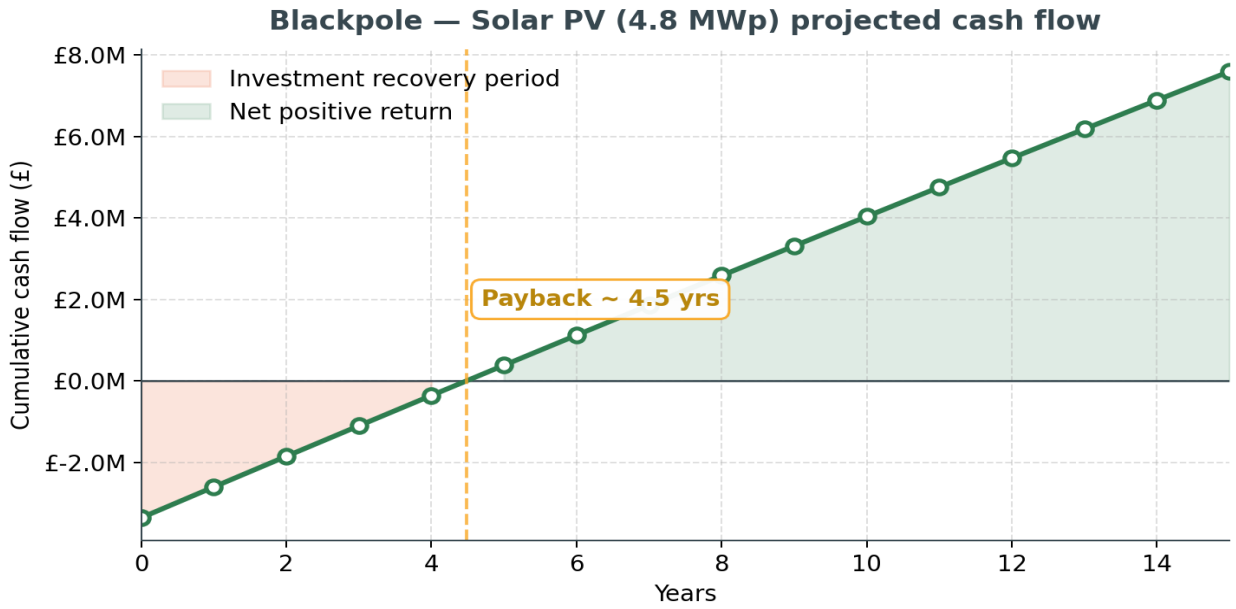


Figure 15 - Blackpole: projected cumulative cash flow for the 4.8 MWp solar PV system.

Combined solar potential vs estate demand

Together, the two arrays would generate ~14.2 GWh per annum - a meaningful but partial offset against estate electricity demand. The Berkeley array delivers a markedly higher offset percentage (35%) than Blackpole (11%) due to the larger relative roof area to estate demand, illustrating the importance of site-by-site assessment.

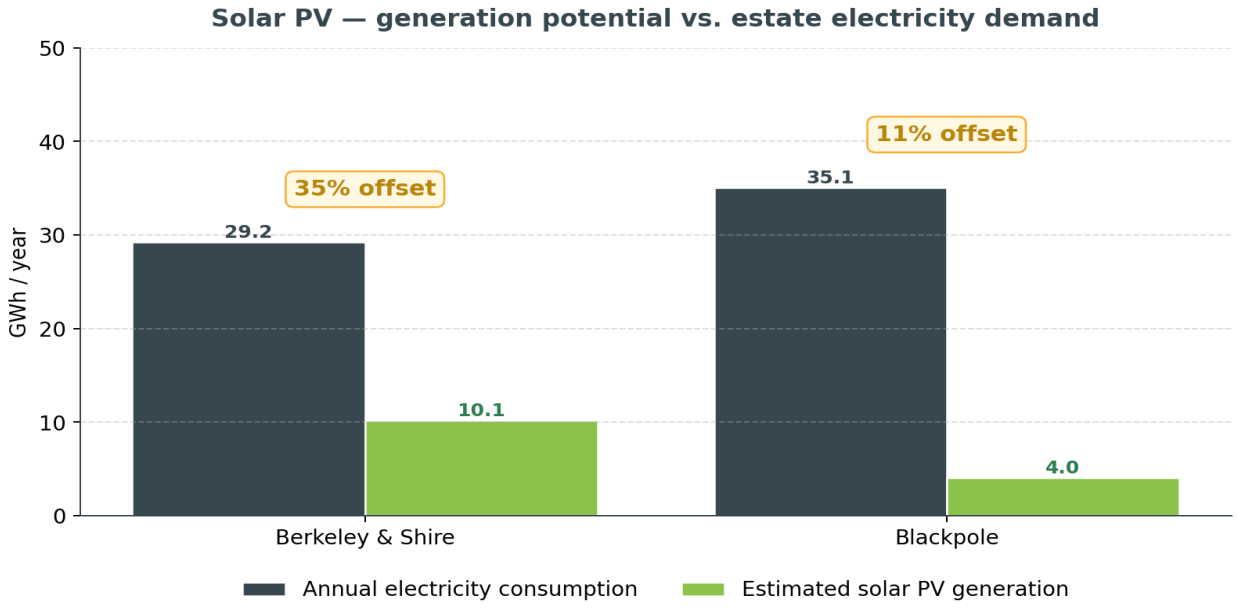


Figure 16 - Solar PV generation potential as a proportion of estate electricity demand.

Collective Renewable Generation - Wind

Due to the high density of buildings and resulting wind turbulence, neither Berkeley nor Blackpole industrial clusters are suitable sites for installation of collective wind turbines.

High-level feasibility analysis

Global Wind Atlas data indicates that at a height of 50 metres for the 10% windiest areas, the average mean windspeed and power density at the estates are approximately 5.5 m/s and 170 W/m² respectively [43]. For context, the mean values for the entire UK onshore are 7.52 m/s and 519 W/m². Installation of wind turbines at the scale required to support industrial decarbonisation would also be heavily disruptive to industry and the surrounding environment (e.g. Offerton Lane Local Nature Reserve).

Building-mounted and novel wind technologies

This conclusion does not preclude all forms of wind-related technology. As highlighted in the Worcester Bosch case study, the company is currently investigating the feasibility of building-mounted vertical axis wind turbines (VAWTs) as part of a wider on-site renewable energy strategy. These differ fundamentally from conventional turbines, operating at much smaller scales and relying on localised airflow patterns rather than free-stream wind resource.

Renewable Generation, Battery Storage and a Private Wire Network

A private wire network involves connecting privately-owned electrical generation equipment to a localised grid. This allows companies on the industrial estate to share power directly without relying on the national grid, providing energy security and lower costs.



Case study private wire: Worcester Bosch and Yamazaki Mazak

A demonstrator-scale opportunity

Worcester Bosch operates a 1.064 MWp solar PV array under a zero-export connection agreement due to grid capacity constraints. Renewable power is curtailed during peak generation and weekends, with an estimated 30% (>300,000 kWh per annum) currently wasted. Yamazaki Mazak UK Ltd ('Mazak') sits forty metres across Ebrington Drive from Worcester Bosch and lacks the means to generate renewable electricity. A private wire network between the two businesses could harness this otherwise-wasted power. Using a market-average unit rate of 20p/kWh, indicative monetary savings exceed £60,000 per annum on avoided grid costs.

A power purchase agreement (PPA) could be set up between the two businesses, whereby electricity is sold at a competitive price greater than typical export prices (currently 6–9 p/kWh for large generators) but without the transmission and distribution costs of the grid. The necessary groundworks and wiring require a specialist survey to ascertain accurate costs; an indicative figure of £100,000 is used for this report. The headline saving and the small distance involved make this an attractive demonstrator on paper, but the deliverability questions below should be addressed openly before any commitment is made.

Deliverability assessment

Private wire arrangements between two industrial sites are well established in the UK; six such on-site PPAs concluded in 2025 alone. The Bosch–Mazak case is technically and commercially feasible, but several

factors push it from “straightforward” to “moderately complex”, and the project value is modest enough that diligence costs need to be managed carefully if the business case is to remain positive.

1. Public highway crossing. Ebrington Drive is a public highway. Laying a cable across it requires a Section 50 licence under the New Roads and Street Works Act 1991, granted by Worcester City Council as highway authority [44]. This involves notice periods (typically four weeks to three months depending on classification), traffic management, public liability indemnity, and a 2–3 year guarantee period for reinstatement. Buried services beneath the road (gas, water, telecoms) need to be located in advance; encountering them may require rerouting or directional drilling. Alignment between the project and the Council's wider cluster decarbonisation aims may smooth the approvals process but does not bypass it.

2. Electricity supply licensing. Under the Electricity Act 1989 it is a criminal offence to supply electricity without either a licence or an exemption. For a point-to-point supply of approximately 300 MWh per year between two industrial parties, exemptions under the Electricity (Class Exemptions from the Requirement for a Licence) Order 2001 will almost certainly apply, but the exact structure needs specialist legal review [45]. Following the Citiworks judgment of 2008, the wire owner (Bosch) is in principle required to allow third-party suppliers to use the network; in a two-party point-to-point arrangement this is not a practical issue but it must be considered in the legal structuring [46].

3. Connection linking and parallel operation with the public network. This is the central engineering and regulatory issue. Both Bosch and Mazak each have their own existing NGED connection - their own MPAN, metering point and supply contract - and a private wire between them creates a physical link between two parties who remain independently connected to the public distribution network. Under the standard EREC G99 connection agreement, operating in parallel with the DNO network in this way requires explicit NGED consent and imposes specific technical obligations: loss-of-mains and anti-islanding protection at the boundary, synchronisation equipment, and type-tested protection systems witnessed by NGED [47]. Without these, a fault on one site could propagate via the private wire to the other and back into the public network, and Bosch’s generation could in principle back-feed onto the public grid via Mazak’s connection - which is exactly what Bosch’s zero-export connection agreement does not allow. NGED retains the right under standard connection terms to require disconnection of any private supply arrangement that threatens local network stability.

4. Metering boundary and settlement. Mazak’s existing MPAN is registered to its current supplier and assumes that all electricity consumed at the site passes through that single meter. Introducing a private wire supply means some consumption arrives via Bosch instead. Three structures are possible: (i) a new sub-MPAN with import/export metering at the boundary, supplied by Bosch as a licence-exempt generator alongside Mazak’s continuing licensed supply through its existing MPAN; (ii) a “switched supply” arrangement where Mazak can take electricity from one source at a time but not both - simpler but significantly less useful in practice, since the private wire would have to be off whenever Bosch is not generating; or (iii) formal settlement via an Exempt Supply Notification Agent (ESNA) under the BSC modifications introduced from 2023, which is the cleanest long-term route but adds administrative overhead. Each option needs to be evaluated against the project economics; specialist metering and settlement advice will be required.

5. Backup supply and commercial implications. Mazak still requires its existing grid connection for periods when Bosch is not generating sufficient surplus - nights, winter, weekends when Bosch is not running its own load. The private wire reduces Mazak’s grid import but does not eliminate it, and commercial terms

with its existing supplier may need renegotiation: a supplier that was contracted to provide 100% of the site's power may price differently once the contracted volume drops materially. Similarly, Bosch's existing supplier needs to be aware that some of Bosch's generation is being supplied to a third party rather than self-consumed.

6. Generation profile vs Mazak demand. The 300,000 kWh/year curtailment figure is concentrated in summer weekends and outside Bosch's production hours. The value to Mazak depends on whether its operations can use power at those times. If Mazak's demand is also low at weekends, headline savings may be lower than indicated; a baseline assessment of half-hourly demand at both sites is a prerequisite for confirming the business case.

7. Long-term commercial structure. Private wire PPAs in the UK typically run 10–20 years and are commonly treated as asset leases under IFRS 16, with implications for both parties' balance sheets. A clear position is needed on cable ownership at end of contract, treatment if either site changes ownership or operations contract, force-majeure events affecting generation, and indexation of pricing.

Net assessment

The Bosch-Mazak private wire is deliverable, but NGED engagement on connection linking and parallel operation needs to come at the very start of feasibility work, not at the end; without their support on the protection arrangements, the project cannot proceed. The headline £100,000 groundworks figure underestimates the total cost to reach financial close. A realistic all-in figure including specialist engineering, G99 protection systems, legal structuring, Section 50 application and reinstatement, metering and settlement arrangements, and ongoing contract administration is more likely in the range £200,000–£400,000. Against a saving of just over £60,000 per year, the project payback remains acceptable (5–7 years), but the diligence work itself represents a meaningful portion of project value. The most realistic delivery route is therefore as a funded demonstrator - for example under the Innovate UK Local Industrial Decarbonisation Plans (LIDP) competition described in Appendix B - with Worcester City Council acting as facilitator on the highway-crossing approvals and NGED engaged from the outset on the connection arrangements.

Private wire network with batteries - Berkeley and Blackpole

As discussed, 12.11 MWp and 4.8 MWp solar arrays could be installed across the principal clusters of Berkeley and Blackpole respectively. By installing battery storage at each site, the system becomes a distributed battery system capable of storing excess generation, used during peak demand or when solar generation is low - ensuring a stable power supply and minimising net import. The deliverability considerations described above for Bosch–Mazak apply with greater force at estate scale: multiple highway crossings, easements across third-party land, more complex supply licensing arrangements, and a corresponding need for a shared governance vehicle (the SPV approach discussed in Section 6) rather than a bilateral PPA.

Grid connection

A managed common coupling point (CCP) could be established to connect the private wire network to the national grid. This allows export of excess energy and import of additional power when needed. The CCP

must be managed to ensure compliance with legal and regulatory requirements. A detailed feasibility study would be required to assess the potential for solar generation and battery storage; a detailed design for the private wire network, including solar panel installations and battery storage systems, would be required; and the necessary licences and permissions from the regulator would be required.

Virtual Power Purchase Agreements (VPPAs)

Virtual Power Purchase Agreements (VPPAs) are financial contracts whereby a buyer agrees to purchase the environmental attributes of renewable electricity from a generator at a fixed price, without taking physical delivery of the electricity itself. VPPAs are particularly relevant for clusters of businesses whose individual demand profiles may not justify a dedicated PPA, but where collective purchasing power can secure long-term renewable supply at competitive rates.

For Worcester, a cluster-level VPPA arrangement could provide member businesses with renewable energy certificates (REGOs) and price certainty over a long contract period (typically 10–15 years), supporting corporate ESG and Scope 2 reporting commitments. VPPAs are commercially complex and typically require legal and treasury support to structure correctly; this has implications for SME participation, which may be best routed via a cluster-level vehicle (such as an SPV) rather than direct contracting.

Decarbonisation of Transportation - Hydrotreated Vegetable Oil

Role of HVO in the local decarbonisation context

Hydrotreated Vegetable Oil (HVO) is a drop-in renewable diesel replacement that can be used in existing diesel engines and storage infrastructure without modification. For sites with existing diesel fleets - forklifts, lorries, generators or specialist plant - HVO offers a near-term emissions reduction with very low capital expenditure. Worcester Bosch has already transitioned its forklift and lorry operations to HVO and reports comparable pricing to diesel.



Supply constraints and price volatility

National HVO supply remains inconsistent, with risks of availability constraints and volatility in market pricing. If costs rise materially or supply tightens, reversion to diesel becomes a real possibility, potentially undermining early decarbonisation progress. Worcester Bosch has explicitly identified this risk in conversation.

Collaborative purchasing and on-site storage

Most businesses on Berkeley & Shire currently procure diesel or HVO individually, leading to fragmented purchasing, inconsistent pricing and reduced bargaining power. A clear opportunity exists to develop shared HVO storage infrastructure at estate level, enabling bulk purchasing and improving security of supply. This would support continuity of low-carbon fleet operations for Worcester Bosch and other businesses, and represents a practical collaborative decarbonisation intervention aligned with the wider cluster strategy. Governance arrangements (a shared SPV, a cluster company or a managing agent) would need to be defined, alongside fire-safety and planning approvals for the storage facility.

Decarbonisation of Transportation - Workforce Mobility

Transport emissions associated with employee commuting represent a significant but often overlooked element of an industrial site's overall carbon footprint. Across Worcester's industrial estates, private car use remains the dominant mode, reflecting both shift patterns and limited integration of public transport with workforce needs.

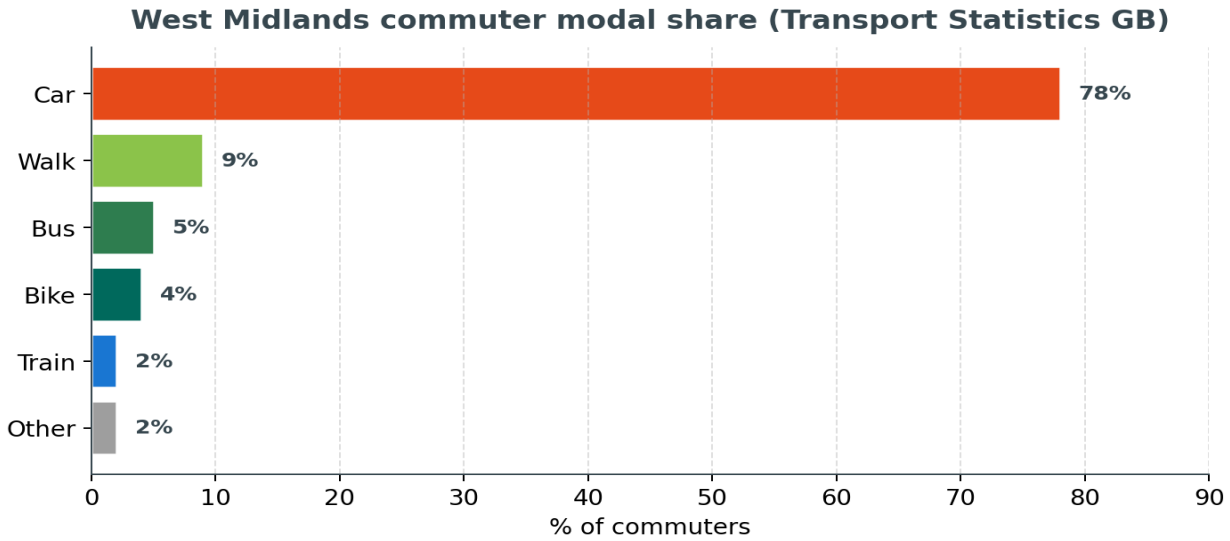


Figure 17 - West Midlands commuter modal share (Transport Statistics GB).

Anchor sites - Worcester Bosch and Yamazaki Mazak

Worcester Bosch and Yamazaki Mazak combined have 1,526 on-site employees. Collaboration between these companies and the local authority is necessary to arrange suitable electric bus travel to and from the Berkeley industrial park. Assuming current trends from Worcestershire's Local Transport Plan, only ~5% of employees (~76 people) use the bus network to commute. The extremely low uptake reinforces that public transport does not currently serve Worcester's industrial sites effectively, suggesting

infrequent services, poor alignment with shift patterns, or non-competitive cost. Addressing these barriers directly - through tailored routes, timetables and service quality - is essential to reduce private car use.



Assumptions and parameters

In the absence of localised census data, national figures from Transport Statistics Great Britain (TSGB) inform the calculation [48]:

- 78% of people in the West Midlands use a car to commute to work.
- 25 minutes is the average journey time by car.
- Average commuter speed by car is 32 km/h.
- A factor of 60% accounts for variation in site attendance and a conventional Monday–Friday week.
- Carbon Conversion Factor for travel by an 'average' car of unknown fuel type: 0.17322 $kgCO_2e$ per km.
- Carbon Conversion Factor for travel by an 'average local' bus: 0.10385 $kgCO_2e$ per km. (Note: this is for buses of all fuel types, as a factor for electric buses does not yet exist; the estimate is therefore conservative.)

Potential emissions savings

4.76M km	825 tCO_2e	330 tCO_2e
Annual employee car travel from anchor sites	Current annual commuting emissions	Conservative saving from electric bus provision

Integration of electric buses with V2G technology

Building on the concept of Vehicle-to-Grid (V2G), electric buses could be utilised in tandem with the proposed collective solar arrays, batteries and private wire network. V2G offers three primary benefits: grid stability and balancing (a fleet of V2G buses can act as a 'virtual power plant' providing fast-responding frequency regulation and voltage support); peak shaving and load shifting (buses charge during off-peak

times when electricity is cheap and clean, then discharge during peak demand); and renewable energy integration (storing excess renewable energy when production is high and feeding it back when production drops, maximising clean power use and reducing curtailment).



Futures for decarbonising transportation

The constraints in the current public transport system represent a structural barrier to sustainable transport across the industrial estates. However, Worcestershire County Council's 2024 Bus Service Improvement Plan (BSIP) has identified and is addressing several of these issues. The BSIP suggests improved integration approaches - increased bus-rail interchange, inter-bus transfers and 'next generation mobility hubs' incorporating service provision, active travel and rail services [49].

The BSIP provides a future roadmap supported by Department for Transport funding. Short-term strategic goals for 2025/26 include increasing passenger numbers by 10% (to return to pre-pandemic levels), 95% of services running on time, and 100% of buses meeting Euro VI emissions standards or better. The 'Tap on – Tap off' system financially incentivises workers to use the service, while 'Worcester on Demand' expands bus services in rural areas. Together these initiatives should reduce constraints previously experienced by the commuting population.

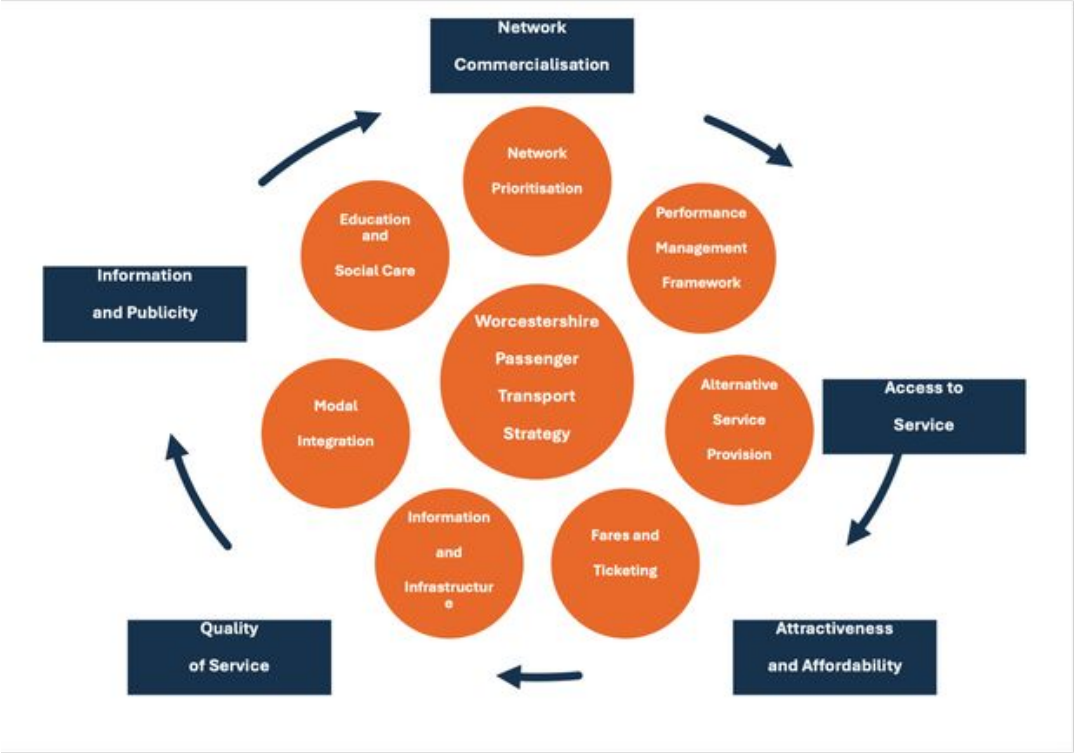


Figure 18 - Worcestershire Passenger Strategy aims and objectives (extracted from BSIP, 2024).

Shared Energy Management and Social Value Models

Across Worcester's industrial estates, there is clear variation in internal capacity to manage energy and decarbonisation activity. Larger and more publicly visible organisations often employ dedicated energy, sustainability or facilities managers, while many SMEs operate without specialist resource and rely on external support. This disparity presents an opportunity for shared, estate-level support models where existing expertise within larger organisations could be made available to neighbouring businesses in a structured and time-limited way.

Concept overview

Under such a model, larger occupiers with in-house energy or sustainability professionals could allocate a defined proportion of staff time to support smaller businesses on the same estate. This could include basic energy walkthroughs, identification of low-cost efficiency opportunities, support with interpreting energy data or bills, assistance engaging with advisory schemes or grant funding, sharing of equipment such as ultrasonic compressed air leak detection, and knowledge-sharing workshops on measures already implemented on-site. Rather than being a commercial consultancy arrangement, this could be positioned as a social value contribution, with staff time recognised against corporate commitments linked to procurement, accreditation or reporting.

Relevance to social value and corporate reporting

Many larger businesses are increasingly required to demonstrate social value outcomes through public-sector procurement, ESG reporting or voluntary accreditation schemes such as B Corp. Contributing staff expertise to local SMEs could be recognised as supporting local economic resilience, enabling skills transfer and capacity building, and contributing to place-based decarbonisation objectives. As Scope 3 reporting

requirements grow, supply-chain accounting amplifies the incentive for larger businesses to support the decarbonisation of smaller ones with which they trade.

Limitations and practical considerations

Several constraints would need to be considered: participation would be voluntary and dependent on internal corporate priorities; clear boundaries would be needed to avoid creating liability or unrealistic expectations; governance arrangements would be required to coordinate activity and manage requests; and the approach is likely most effective for early-stage or low-complexity interventions and knowledge sharing rather than technical redesign or capital projects. Shared energy management should therefore be viewed as a complementary mechanism, not a substitute for formal advisory programmes or professional consultancy.

Waste to Power: Anaerobic Digestion

State of play

CSG Worcester Ltd, located at Berkeley industrial estate, treats and recovers oil fuels from oily water and non-hazardous aqueous waste. The site is equipped to process 150 tonnes of waste per day. Using a conservative percentage recovery rate of 75%, this equates to a production capacity of 112.5 tonnes per day, or circa 30,000 tonnes of oil per annum. Worcester Sewage Works, operated by Severn Trent, is situated adjacent to the Diglis Industrial Estate - a potential location for anaerobic digestion.

Biomethane

According to CSG Worcester Ltd, treated biosolids such as Fats, Oils and Greases (FOGs) are currently used in agriculture as fertilisers, but this waste stream presents an opportunity for anaerobic digestion of waste to biomethane. Biomethane is a biofuel with significantly reduced net carbon impact compared with conventional natural gas: on a Scope 1 basis, biomethane has an emissions factor of approximately 0.0003 $kgCO_2e/kWh$ against 0.183 $kgCO_2e/kWh$ for natural gas (UK Government 2025 GHG conversion factors) [50]. Combustion emissions per kWh are broadly similar between the two fuels, but for biomethane these are largely offset by the carbon dioxide absorbed during the growth of bio-energy feedstocks, which is why the Scope 1 reporting factor is so much lower.

Anaerobic digestion process

The anaerobic digestion process is well understood. Biowaste such as FOGs is pre-treated and fed into a digestion tank with water, where complex organic compounds (carbohydrates, proteins, lipids) sequentially undergo hydrolysis, acidogenesis, acetogenesis and methanogenesis to produce biogas and leachate. Leachate is also commonly utilised as a fertiliser. It is assumed that FOGs sent to agriculture comprise 10% of the input waste, equivalent to around 15 tonnes per day at maximum capacity. As a conservative starting point, the calculation below assumes that only 15 tonnes of fats per year (around one day's output at maximum capacity) would be made available for digestion. This reflects that most of this stream is currently committed to agricultural use and that FOGs recovered from oily water have a high water content, whereas the biogas yield used below applies to fats. If a larger share of the stream could be secured, biogas output would increase substantially.

Co-digestion of FOGs with food waste is suggested to increase biogas yield [51]. This raises the possibility of co-digesting fats with food waste generated from businesses in Worcester's industrial parks. Aeromet International (Blackpole), Southco Manufacturing (Berkeley), Worcester Bosch (Berkeley) and Yamazaki Mazak (Berkeley) collectively employ 2,089 people. Assuming up to 30% of office waste is food waste, and total waste per person in the UK is 2 kg per day, a baseline output of approximately 460 tonnes of food waste per annum is estimated from these companies [52]. Worcester Bosch has on-site kitchens, which may result in a greater proportion of food-related waste.

In this context, a proposal has been submitted to Worcestershire County Council for the development of an anaerobic digestion plant at Court Farm, Hindlip Lane (WR3 8SS), by Stenergy (Worcester) Limited. This new AD facility is intended to produce biomethane gas for injection into the national grid. The site lies within the Green Belt and outside the current development plan boundary and could affect the setting of nearby Conservation Areas and Listed Buildings, so the application has been subject to amended and further information submissions and renewed public consultation.

Calculation parameters and results

Feedstock	Biogas yield (m^3/tonne)
Fats	1,200
Potatoes	276

Table 10 - Biogas yields by feedstock (potatoes selected as a median representative of food waste) [53].

Feedstock	Input (t/yr)	Biogas yield (m^3/yr)	Biogas (kWh/yr)	Biomethane (kWh/yr)	NG offset (kWh/yr)
Fats	15	18,000	173,000	102,000	93,000
Potatoes	460	127,000	1,220,000	717,000	650,000
Total	475	145,000	1,393,000	819,000	743,000

Table 11 - AD output potential for Worcester cluster co-digestion scenario.

Biomethane energy density is assumed to be 34.7 MJ/m^3, whilst natural gas is 38.2 MJ/m^3. The possible increase in productivity due to co-digestion is not modelled.

Indicative cluster AD impact

Total natural gas offset from this source is 743,000 kWh per annum, equivalent to a carbon saving of 119 tonnes of CO_2e and around £40,000 in fuel savings. Implementation of a dedicated AD facility may not be feasible at Worcester's scale; collective negotiation and waste collection with a nearby existing unit (such as the proposed Stenergy facility) may be more practical.

Emerging Nuclear Technologies in Long-Term Regional Decarbonisation

As part of this feasibility assessment, it is important to acknowledge wider national energy developments that may influence Worcester's long-term decarbonisation trajectory, even if they do not represent near-term or locally deployable solutions. Small Modular Reactors (SMRs) and Micro Modular Reactors (MMRs) are two such technologies. Neither is being considered as a project for Worcester itself; their inclusion provides context for how the regional and national electricity system may evolve over coming decades, and ensures the study remains aligned with national energy policy trajectories.

Strategic context and potential benefits

SMRs are compact nuclear reactors - typically between 50 and 470 MW electrical - intended to deliver continuous, low-carbon baseload power. They are being considered by the UK Government through Great British Nuclear (GBN) as part of the national long-term energy mix. For Worcester's industrial cluster, the relevance of SMRs lies in their potential to act as a regional enabler of decarbonisation rather than a local siting option.

If deployed nationally, SMRs could lower the carbon intensity of grid electricity, support the expansion of electrified industrial processes, and provide firm power for base-load generation to complement variable renewable inputs. This benefits Worcester indirectly by strengthening the grid's long-term low-carbon supply, enabling companies on the principal industrial estates to decarbonise their electricity consumption. Future decarbonisation of industry - heat electrification, EV fleet charging, advanced manufacturing - will depend on the availability of reliable low-carbon electricity, and SMRs could contribute to the continued growth of the national pool of firm power that underpins such transitions.

Limitations and considerations for Worcester

SMRs are not appropriate as a local intervention for Worcester. Their deployment is governed by the national nuclear licensing regime under the Office for Nuclear Regulation, with siting decisions made strategically. They are included in this report as a long-term horizon-scanning consideration only - affecting Worcester through the wider grid carbon intensity rather than through any local installation.

Micro Modular Reactors (MMRs)

Micro Modular Reactors (MMRs), typically 1–20 MW electrical, are a longer-term concept that could, in principle, be scale-appropriate to individual large industrial sites or clusters. The technology is at an early stage of development internationally and is not currently a candidate for near-term deployment in the UK; it is mentioned for completeness and to note that future regulatory and technological developments may make it relevant to industrial decarbonisation conversations in the 15–25 year horizon.

Carbon Capture, Utilisation and Storage (CCUS) and Low-Carbon Hydrogen

Overview

Carbon Capture, Utilisation and Storage (CCUS) and low-carbon hydrogen are central pillars of the UK Government's industrial decarbonisation strategy. CCUS captures CO_2 emissions from industrial processes (or directly from the air) and either stores it permanently in geological formations or utilises it as an input

to other processes. Low-carbon hydrogen (produced via electrolysis from low-carbon electricity, or from natural gas with CCUS) is positioned as a key fuel for sectors that are difficult to electrify.

System-level benefits and strategic role

Nationally, CCUS and hydrogen will play a significant role in decarbonising heavy industry, cement, refining, chemicals and power generation. The UK Government's Track 1 and Track 2 CCS clusters (HyNet, East Coast Cluster, the Scottish Cluster) are intended to provide CO_2 transport and storage infrastructure for emitters in their respective regions.

Applicability to Worcester's industrial areas

Worcester is not within the geographical footprint of any of the funded UK CCS clusters, and the scale of individual emitters within the city does not justify dedicated CCS infrastructure. Hydrogen production at scale is similarly unlikely in the near-to-medium term. These technologies are therefore not deliverable at the WICD scale and are included for completeness and to acknowledge that, should regional CCS or hydrogen infrastructure expand in the longer term, the picture may evolve.

Table of licences and consents for decarbonisation projects

The table below summarises the principal licences, consents and authorities relevant to each category of intervention discussed in this report. It is indicative only and should be supplemented with site-specific legal and planning advice.

Intervention	Key consents / licences	Lead authorities	Key considerations
Solar PV (single site)	Planning (if outside permitted development); grid connection	Worcester City Council; NGED	Most rooftop PVs are permitted development, but constraints may apply for building height, structural change or heritage. Export agreements required.
Solar PV (collective / multi-site)	Planning; grid connection; private wire easements	Worcester City Council; NGED	Shared systems increase complexity. Early dialogue on private wire routing, land rights and export limitations essential.
Onshore wind (small-scale)	Full planning; EIA; grid connection	Worcester City Council; NGED	Heightened planning sensitivity. Noise, visual impact and aviation constraints often decisive.

Intervention	Key consents / licences	Lead authorities	Key considerations
Battery storage (BTM)	Planning (site dependent); grid connection modification	Worcester City Council; NGED	Fire safety, layout and building proximity may trigger additional conditions.
Private wire networks	Planning; wayleaves/easements; connection agreements	Worcester City Council; landowners; NGED	Land rights are often the critical-path risk. Legal agreements may be as complex as technical design.
VPPAs	Market registration; contractual agreements	Ofgem (indirect); market counterparties	Primarily commercial and regulatory rather than planning-led. Requires legal and financial structuring.
HVO storage / collective fuel	Planning; environmental permit (storage); fire authority approval	Worcester City Council; Environment Agency; Fire Authority	Storage thresholds determine regulatory burden. Shared use raises governance requirements.
E-bus / V2G	Planning (charging infrastructure); grid upgrades	Worcester City Council; NGED	Public realm interfaces and depot locations may need additional permissions.
Shared energy management	None specific	N/A	Non-infrastructure. Governance and liability considerations more relevant than statutory consents.
Anaerobic digestion	Planning; environmental permit; gas grid connection (if biomethane)	Worcester City Council; Environment Agency; gas network	High regulatory burden. Odour, traffic and feedstock sourcing are common planning risks.
Heat networks (cluster scale)	Planning; Heat Network authorisation (post-2025); land rights	Worcester City Council; Ofgem	Regulatory framework evolving. Early-stage feasibility strongly advised.

Intervention	Key consents / licences	Lead authorities	Key considerations
Smart grid / flexibility	Grid agreements; data and market compliance	NGED; Ofgem (indirect)	Generally lighter-touch planning, but strong technical and contractual coordination required.
CCUS / hydrogen	Major infrastructure consents; environmental permits	National regime	Not considered viable at Worcester scale; included for completeness.
SMRs / MMRs	National nuclear licensing and planning regime	ONR; national planning	Horizon scanning only. No near-term local applicability.

Table 12 - Licences, consents and lead authorities by intervention type.

10. Workshops

Stakeholder engagement has been a central component of the Worcester City Industrial Cluster Decarbonisation Study (WICD) throughout its delivery. The first workshop, held on 23 September 2025 at the Guildhall, Worcester, introduced the concept of industrial cluster decarbonisation, outlined the WICD delivery approach, and shared examples of successful cluster programmes nationally and from other regions. It brought together representatives from national, regional and local organisations - including DESNZ, Worcester City Council, Worcestershire County Council and the West Midlands Combined Authority - alongside a number of industrial stakeholders. That session laid the groundwork for sustained dialogue between the study team, the local authorities and Worcester's industrial community.

Building on this foundation, the second workshop took place on 28 April 2026, again at the Guildhall in Worcester. The session was attended by approximately 35 delegates, drawn from a deliberately broad cross-section of the city's industrial community. Anchor manufacturers were represented alongside smaller and medium-sized businesses operating across Berkeley, Blackpole and Diglis Industrial Estates. Public-sector and policy representatives from Worcester City and County Councils, DESNZ and the WMCA also attended, together with the Midlands Net Zero Hub.

Workshop structure and content

The afternoon was structured around a sequence of short presentations followed by interactive discussion. After welcome remarks from Worcester City Council, Pro Enviro presented the headline findings of the study, framed around three questions: how energy is used across the estates, where the real opportunities lie, and how those opportunities can be delivered.

74.9 GWh	58.2 GWh	6.7 GWh
Berkeley & Shire annual energy use	Blackpole annual energy use	Diglis annual energy use

The presentation set out the figures above and demonstrated how a small number of manufacturing sites account for the majority of demand on each estate. Headline opportunities were illustrated through the proposed collective solar arrays at Berkeley and Shire and Blackpole, the private wire concept between Worcester Bosch and Yamazaki Mazak, the anaerobic digestion case, workforce mobility, and the supporting roles of HVO and shared energy management.

To place these findings within a wider context, the workshop heard from external speakers with direct experience of comparable programmes elsewhere in the UK. Invest Northern Ireland presented lessons learned from the IDNI programme, including the value of structured data collection, the role of Communities of Shared Interest, and the importance of continuity in coordination beyond the initial funded phase. The Black Country Industrial Cluster (BCIC) followed with a session on the practical mechanics of cluster formation, drawing on the evolution of Repowering the Black Country into BCIC West Midlands and on international examples such as the Basque Supercluster and Eastman Business Park. The

central message was that successful clusters are industry-led rather than driven by the public sector or utilities, and tend to be built around concrete projects rather than networking alone. Both contributions reinforced points made throughout this report: cluster decarbonisation is feasible in dispersed, SME-dominated settings provided the right governance, data and engagement frameworks are in place.

The Midlands Net Zero Hub addressed the practicalities of moving from study findings into deliverable cluster activity. The session emphasised the value of starting with efficiency measures (compressed air, lighting, process and space heating) before turning to generation technologies. It also outlined the role of flexibility markets, Great British Energy and community energy in shaping the funding and delivery landscape. The session then opened into a facilitated panel discussion, which gave Worcester-based businesses the opportunity to question the speakers, share their own observations, and respond directly to the study's findings. Worcester City Council closed the session, framing the workshop as the conclusion of the study phase rather than the start of any specific delivery commitment.

Themes emerging from the discussion

Engagement throughout the afternoon was strong. The level of participation in the panel session in particular indicated that the study's headline messages resonated with the audience - including the concentration of energy demand within a small number of sites, the dominance of upfront cost as a barrier, and the practical relevance of shared solar generation, collective procurement and shared energy management.

Recurring themes from workshop discussion

- Shared solar PV across distribution and warehousing roofs was widely identified as the most tangible near-term opportunity.
- PPAs and other forms of collective energy procurement were of clear interest, especially among smaller businesses with limited individual bargaining power.
- Shared energy management and SME-focused support emerged as a strong cross-cutting theme, consistent with questionnaire findings.
- Collaboration on transport-related decarbonisation - shared HVO supply, coordinated charging infrastructure - featured prominently.
- Data and monitoring recurred: without better visibility of consumption, businesses find it difficult to act with confidence.
- The Midlands Net Zero Hub's emphasis on efficiency-first measures aligned closely with the low-cost, near-term interventions several attendees identified as practical starting points.

Equally instructive were the practical concerns raised. Questions around split-incentive issues between landlords and tenants, the complexity of grid connection arrangements, the time required to secure planning and other consents, and uncertainty over the long-term funding landscape were all raised. These echo points already identified in the report and underline that, while businesses are open to collaboration,

the structural and regulatory environment will need to be navigated carefully if collective opportunities are to be realised.

A short feedback questionnaire was distributed to attendees on the day, asking how they would like to be involved going forward, which of the solutions presented were of greatest interest, and whether they would be willing to share basic energy data to support future work. The session ran slightly over its scheduled time, which limited the opportunity for delegates to complete the form before leaving, and the volume of returns was therefore limited. The responses received were consistent with the broader pattern of discussion observed during the session, with shared energy management, collective solar PV and PPAs identified as the solutions of greatest interest, and a willingness expressed to participate in feasibility work and to share consumption data.

Concluding reflections

The second workshop marked the close of the Worcester City Industrial Cluster Decarbonisation Study (WICD). It was not designed to commit any party to a specific course of action. Rather, it brought together the full body of evidence developed over the course of the study and tested it against the perspectives of the businesses, authorities and delivery partners who would be affected by, or involved in, any future programme. In doing so, it provides Worcester City Council, the Midlands Net Zero Hub and their partners with a clearer view of where appetite, capability and constraint sit across the city's industrial estates.

Three concluding observations from the workshop and the study as a whole

First, the technical case for a place-based approach is sound. Energy demand across Berkeley & Shire, Blackpole and Diglis is concentrated in a relatively small number of manufacturing sites, and this concentration creates real opportunities for shared infrastructure, joint procurement and targeted technical support that would not be viable at a single-site level.

Second, the appetite within Worcester's industrial community to engage with these opportunities is genuine but conditional. Willingness to commit time and capital depends on clarity of benefit, manageable governance, and confidence that early participants will not bear disproportionate risk on behalf of the wider group.

Third, the structural conditions for cluster activity will shape what is achievable as much as the underlying technical opportunity. These conditions include the regulatory framework for shared energy, the planning and land-rights environment, grid capacity, and the funding landscape.

The lessons drawn from comparator programmes - IDNI, Repowering the Black Country and its evolution into BCIC West Midlands, and the Greater South East Net Zero Hub - reinforce a consistent point. Clusters succeed where coordination is sustained beyond the initial study phase, where data and evidence underpin engagement, and where governance is proportionate to the scale and maturity of the activity. Worcester now has the evidence base to follow that pattern, and a community of businesses and partners that has demonstrated, through both workshops, the willingness to engage with it. The decision on whether and how to take this forward now sits with Worcester City Council, the Midlands Net Zero Hub and their partners, alongside the businesses themselves.

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Appendix A - Consolidated Measures Table

This appendix consolidates the decarbonisation measures identified across the three estates into a single reference table, fulfilling the requirement set out in Work Package 2 of the project specification. Each measure is broken down by industrial area where applicable, with indicative cost, capacity, annual generation/savings, simple payback and delivery horizon. Figures are taken from the analysis presented in the body of this report. Where exact figures are not available, ranges or qualitative indicators are given.

How to read this table

Costs are indicative and exclude items such as grid connection, private wire infrastructure, planning, legal and contingency unless stated. Site-specific feasibility work is required before commitment.

Annual savings assume a baseline grid electricity unit rate of 20p/kWh and a gas unit rate of 5p/kWh. Real values will vary with future tariffs, non-commodity charges and contractual arrangements.

Horizon: Near = within ~3 years; Medium = 3–7 years; Long = 7+ years.

Estate-level shared infrastructure

Measure	Estate / location	Capacity / size	Annual generation / savings	Indicative cost	Simple payback	Horizon	Notes
Shared rooftop solar PV	Berkeley & Shire	12.11 MWp / ~62,600 m² roof	~10.14 GWh/yr generated; ~£1.9M/yr saving	£8.5M (PV only - excludes private wire & grid)	~4.5 yrs (PV only)	Near–Medium	Anchor roofs identified (Transmec, Eastbrook, Shire/Sainsburys, Bosch DC). Private wire routing and grid export will materially alter total cost.
Shared rooftop solar PV	Blackpole	4.8 MWp / ~24,800 m² roof	~4.02 GWh/yr generated; ~£760k/yr saving	£3.36M (PV only)	~4.5 yrs (PV only)	Near–Medium	Anchor roofs identified (ArrowXL/JP Home, Exhaust/Tyres/Batteries). Existing small arrays excluded from area.
Private wire - Bosch to Mazak	Berkeley & Shire	~300,000 kWh/yr recovered	>£60k/yr saving; carbon avoided	£200–400k all-in (engineering, S.50 highway licence, G99 protection, legal, metering)	5–7 yrs	Near	Recovers existing curtailed generation. Central issue is NGED connection linking and parallel-operation consent (since both sites are independently grid-connected); secondary issues are Section 50 highway crossing of Ebrington Drive and licence-exempt supply structure. Best delivered as a funded demonstrator (e.g. via LIDP funding) with NGED engaged from the outset.
Battery storage (cluster scale)	Berkeley & Blackpole	Sized to PV array & profile	Improves self-consumption from ~80% to	Site-specific (~£300–	7–10 yrs	Medium	Economics depend on flexibility revenue

Measure	Estate / location	Capacity / size	Annual generation / savings	Indicative cost	Simple payback	Horizon	Notes
			~95%; reduces non-commodity charges	500/kWh installed)			stacking. Best evaluated after PV deployment.
Collective HVO storage & procurement	Berkeley & Shire (initially)	20–100 m³ shared tank capacity	Improved supply security; potential bulk-buy savings	£50–150k (indicative - site-dependent)	4–7 yrs	Near–Medium	Bosch already on HVO. Governance, fire safety and planning are the limiting factors, not technology.
Anaerobic digestion (use of existing/proposed facility)	Cluster-wide (Stenergy proposal at Hindlip Lane)	Up to 475 t/yr cluster feedstock (15 t fats, 460 t food waste)	~743,000 kWh/yr NG offset; ~119 tCO_2e; ~£40k/yr	Capital not borne by cluster (off-take arrangement)	N/A (off-take)	Medium	Use existing/planned AD; do not build new. Subject to Stenergy planning outcome and Severn Trent engagement.

Site-level efficiency measures (representative)

Measure	Estate / location	Capacity / size	Annual generation / savings	Indicative cost	Simple payback	Horizon	Notes
Low-cost industrial data analytics (LCIDA)	All estates	50–100 sites instrumented	10–15% typical energy reduction; underpins all other measures	£2–10k per site	<2 yrs	Near	Foundational. Should precede major capital decisions.
Compressed air leak repair & VSD upgrades	All estates (where compressed air used)	Site-specific	Typically 10–20% of compressed-air energy	£5–40k per site	1–3 yrs	Near	Identified at Calder, Bridge Aluminium, Neos, Goodfish, Industrial & Tractor. Quick win across the cluster.
Servo-electric injection moulding (vs hydraulic)	Blackpole (Goodfish & similar)	Per machine	40–70% energy saving per machine	£80–250k per machine	3–6 yrs	Medium	Replacement-led; align with capex cycles.
Space heating controls & destratification	Blackpole (Froude & similar large-volume units)	Site-specific	Up to 30% space-heating energy	£10–60k per site	3–5 yrs	Near–Medium	Particularly relevant for older, large-volume industrial units.
LED lighting & lighting controls	All estates (where not yet completed)	Site-specific	40–60% lighting energy	£10–80k per site	2–4 yrs	Near	Mature technology; ROI well-established.
Process heat containment (oven doors, air curtains)	Diglis (Griffin Enamellers & similar)	Per oven	5–10% process gas use	£5–20k per intervention	4–7 yrs	Near–Medium	Particularly relevant for small, gas-intensive process SMEs.
On-site solar PV (single-site)	All estates (e.g. Calder, Bridge Aluminium)	50–300 kWp per site	40–80 MWh/yr per 50 kWp	£800–1,200/kWp installed	5–8 yrs	Near–Medium	Suitable for individual sites where a shared array is not viable; sizing should match

Measure	Estate / location	Capacity / size	Annual generation / savings	Indicative cost	Simple payback	Horizon	Notes
							daytime load to avoid export.
Forklift electrification	All estates	Per truck	50–70% energy/carbon vs diesel	£20–60k per truck + charging	5–10 yrs	Medium	Charging infrastructure and grid headroom are the practical constraints. HVO interim measure already in use at Bosch.

Workforce mobility and supporting interventions

Measure	Estate / location	Capacity / size	Annual generation / savings	Indicative cost	Simple payback	Horizon	Notes
Electric bus services tailored to shift patterns	Berkeley & Shire (initially)	1 - 3 routes	~330 tCO_2e/yr if anchor-site car commuters switch to electric bus	Operator-led under BSIP - council/operator capex	N/A	Near-Medium	Worcestershire's BSIP and Enhanced Partnership provide a delivery route via DfT funding. Requires anchor employer engagement on timings.
Active travel infrastructure (Beryl Bike docks, secure storage)	All three estates	2 - 6 docking stations	Modal shift dependent on uptake	£30 - 100k per dock	5+ yrs	Near	Low-cost enabler; benefits realised only with bus integration.
EV charging hubs (workplace)	All three estates	4 - 20 chargers per site	Supports staff EV adoption; potential V2G revenue	£40 - 150k per site	6 - 10 yrs	Medium	Best paired with shared solar PV to maximise local consumption.
Shared energy management (social-value model)	All three estates	Anchor sites supporting SMEs	Non-monetary; capability uplift	Staff time only - contributed	N/A	Near	Voluntary; aligned with Scope 3 reporting and procurement social-value requirements.

Long-horizon / national-system enablers (not for local delivery)

Measure	Estate / location	Capacity / size	Annual generation / savings	Indicative cost	Simple payback	Horizon	Notes
Small Modular Reactors (SMRs)	National grid (not Worcester)	N/A locally	Lower grid carbon intensity benefits all electrified Worcester demand	National programme	N/A	Long	Horizon-scan only. No local siting role for Worcester.
CCUS / industrial hydrogen	Not within Worcester cluster scope	N/A	N/A	N/A	N/A	Long	Worcester not within funded CCS cluster footprint. Included for completeness only.

Table A1 - Consolidated decarbonisation measures by estate. Cost and saving figures are indicative; site-specific feasibility work is required before any commitment. Horizons: Near = within ~3 years; Medium = 3–7 years; Long = 7+ years.

Indicative delivery timeline for Worcester

The measures above can be sequenced into a horizon-based delivery plan, modelled loosely on the Project Willow framework discussed in Section 2. This timeline assumes that the necessary governance vehicle (SPV or equivalent), data baselining and stakeholder buy-in are established as foundational steps:

Horizon	Timeframe	Indicative measures
Horizon 1 - Near term	2026 – 2028	LCIDA / data baselining across willing sites; Bosch–Mazak private wire demonstrator; compressed air & lighting interventions at willing SMEs; collective HVO scoping; shared energy management pilot; BSIP bus route engagement with anchor employers.
Horizon 2 - Medium term	2029 – 2032	Berkeley shared solar PV deployment; Blackpole shared solar PV deployment; battery storage where economics support; AD off-take arrangement (subject to Stenergy outcome); EV charging hubs and active travel; servo-electric machine replacements as capex cycles allow.
Horizon 3 - Long term	2033 – 2040	Cluster-level VPPA arrangements once participant base is established; further building fabric retrofits; emerging technologies (MMRs, hydrogen) re-evaluated against then-current cost & policy landscape; full integration with regional grid upgrades from The Great Grid Upgrade.

Table A2 - Worcester delivery horizons. The timeline is illustrative and assumes appropriate governance, funding and stakeholder commitment from the outset.

Critical-path dependencies

Governance vehicle: Without a legal entity (SPV or equivalent) to hold shared assets and contract on behalf of multiple businesses, none of the cluster-level infrastructure measures can proceed. This should be established early in Horizon 1.

Data baseline (LCIDA): Investment decisions on shared infrastructure should be informed by site-specific consumption data, not benchmarking. LCIDA is therefore a prerequisite for the Horizon 2 capital measures.

Grid connection lead times: Engagement with National Grid Electricity Distribution should begin in Horizon 1 even for Horizon 2 measures. Connection timescales for large arrays can exceed 24 months.

Appendix B - Grants, Funding and Income Streams

This appendix addresses the requirement in Work Package 5 of the project specification to produce a table of grants and funding sources available to businesses in the study area, alongside potential income streams. Information is current to the date of this report and is necessarily indicative - scheme eligibility, value and availability change frequently, and businesses should verify current status before relying on any specific entry.

Important context

Scheme availability changes. The Industrial Energy Transformation Fund (IETF), which featured prominently in earlier industrial decarbonisation programmes, is no longer open to new applicants as of 2026 [55]. Several of the schemes listed below are subject to deadlines or capacity caps.

Local advice landscape is in transition. The Business Energy Advice Service (BEAS), which previously offered free energy audits to Worcestershire SMEs, closed to new applicants on 16 March 2026 [54]. A similar replacement scheme is understood to be in development but has not yet been clarified at the time of writing. In the interim, Worcester City Council, Worcestershire Growth Hub and the Midlands Net Zero Hub remain the most appropriate first points of contact for SMEs seeking guidance.

B1 - Grants and capital support

Scheme	Indicative value	Eligibility / focus	Notes & status
Net Zero Growth Grant Scheme (UKSPF-funded)	Up to £25,000 (80% intervention rate)	SMEs; capital equipment for energy efficiency, generation, retrofit, low-carbon products	Live; current round runs until 30 Sept 2026 or until funding cap is reached. Delivered through local authorities and growth hubs.
Innovate UK - Local Industrial Decarbonisation Plans (LIDP)	£75k - £800k per project (up to 70% for micro/small)	Place-based cluster feasibility & planning (not deployment)	Direct successor to the funding stream that supported IDNI. Suitable for follow-on Worcester scoping work.
Innovate UK Smart Grants	Up to £2M (collaborative), 6 - 36 months	Industrial research & experimental development across any sector	Competitive open call; relevant for technology demonstrators (e.g. P2P trading, private wire monitoring).
Innovate UK - Energy Catalyst	Variable; up to ~£2M	Clean energy innovation, including smart energy systems and storage	Themed competitions; check current open rounds.

Scheme	Indicative value	Eligibility / focus	Notes & status
Boiler Upgrade Scheme	Up to £7,500 (heat pump), £5,000 (biomass)	Air/ground source heat pumps and biomass boilers	Generally domestic/small-scale; some commercial applications eligible. Operated by Ofgem.
British Industry Supercharger (NCC scheme)	90% Network Charging Compensation from 2026 (uplifted from 60%)	Energy-intensive industries meeting eligibility thresholds	Reduces electricity non-commodity charges for ~500 eligible UK businesses. Unlikely to cover most Worcester SMEs but relevant for larger anchor manufacturers.
Energy Intensive Industries Compensation Scheme	Compensation for indirect ETS/CPS costs	Energy-intensive industries (NACE codes)	Under review pending UK CBAM implementation in 2027. Worcester applicability limited.
Carbon Trust SME Assessment	Free assessment + onward routing	Eligible SMEs	No direct cash but identifies opportunities and supports grant applications.
Business Energy Advice Service (BEAS) - West Midlands	Closed to new applicants in Worcestershire from 16 March 2026	Was: Worcestershire SMEs	Pilot closed. A successor scheme is understood to be in development but has not yet been clarified. Worcester City Council and Worcestershire Growth Hub can advise on interim alternatives.
Scottish/devolved schemes (Scottish Heat Network Fund etc.)	Various	Geographic restriction	Not applicable to Worcester; included for reference only.
Energy Redress Scheme	Capital grants from £20M April 2026 round	Charities, community energy organisations, CICs, co-operatives	Not generally available to private SMEs but relevant if a community-energy SPV is established to deliver shared cluster infrastructure.

Table B1 - Indicative grants and capital support relevant to Worcester businesses. Eligibility and availability change frequently; verify current status before relying on any entry.

B2 - Flexibility and income-stream opportunities

In addition to one-off grants, ongoing income streams are available to businesses that can offer flexibility to the electricity system. The spec specifically calls out grid services, demand response, firm frequency response, heat networks and peer-to-peer trading; these are summarised below.

Service / market	Indicative scale	Who operates / contracts	Notes for Worcester sites
Demand Flexibility Service (DFS)	£/MWh per event; volumes depend on dispatch	NESO (formerly National Grid ESO); accessed via aggregators or directly	Expanded 9 April 2026 to include demand turn-up AND turn-down, with eligibility threshold reduced to 0.1 MW. Year-round service. Stackable with capacity market and DSO services from 2024/25.
Capacity Market	Availability payment £/kW/yr; T-1 and T-4 auctions	NESO; via aggregators or direct registration	Predictable revenue stream for sites that can commit to be available. Now stackable with DFS.
Firm Frequency Response (FFR) / Dynamic services (DR/DM/DC)	Variable; sub-second response services pay highest rates	NESO; via aggregator (most practical for industrial sites)	Best suited to battery storage and large flexible loads. Smaller industrial sites typically participate via aggregator.
NGED DSO flexibility services	Site- and location-specific; constraint-managed	National Grid Electricity Distribution (Midlands)	Local-network flexibility (DTU/GTU/DTD). Particularly relevant where distribution capacity is constrained. Engage with NGED to identify constraint zones.
Triad replacement (DUoS revised charges)	Charge avoidance rather than direct payment	Embedded in supplier tariffs	Triad payments largely replaced under the Targeted Charging Review. Site demand profiles still matter for total cost.
Smart Export Guarantee (SEG)	~6–9 p/kWh export tariff	Licensed suppliers	Baseline export tariff for solar PV up to 5 MW. Significantly lower than private wire / direct PPA equivalents.
Power Purchase Agreements (direct PPAs)	10–20 p/kWh, typically 10–15 year contracts	Bilateral commercial counterparty	For the Bosch–Mazak case in this report, indicative pricing midway between SEG and import rate represents value for both parties.
Virtual PPAs (VPPAs)	Settlement-based; price + REGOs	Generator + commercial buyer; financial counterparty	Useful for cluster-level renewable procurement at scale. Legal and treasury complexity makes SPV routing typically more practical than individual SME contracting.

Service / market	Indicative scale	Who operates / contracts	Notes for Worcester sites
Peer-to-peer (P2P) trading	Currently restricted to private-wire networks under UK regulation	Within microgrid / private-wire arrangement	Ofgem has signalled openness to public-network P2P trials under relaxed conditions; medium-term opportunity rather than near-term.
Heat network participation	Site-specific; either supply or off-take	Heat network operator (post-2025 regulated by Ofgem)	Limited near-term applicability in Worcester given dispersed industrial geography, but relevant if specific co-located heat opportunities emerge (e.g. JVM Castings).
REGOs and Guarantees of Origin	£0.30–£3 per certificate	Generator (issued via Ofgem)	Modest direct value but supports corporate Scope 2 reporting.

Table B2 - Flexibility services and income streams. Rates and structures change frequently; engagement with an aggregator or supplier is the most reliable way to determine current value for a specific site.

B3 - How to engage

A practical sequence for Worcester businesses considering participation: (1) contact Worcester City Council or Worcestershire Growth Hub for current local advice and signposting (noting that the previous BEAS free-audit route closed in March 2026 and a successor scheme is awaited); (2) engage with NGED to understand local connection and flexibility opportunities at the relevant primary substation; (3) for capital projects, consult the Net Zero Growth Grant Scheme and Innovate UK current open competitions; (4) for cluster-level activity, contact the Midlands Net Zero Hub to align with any follow-on programme arising from this study.



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