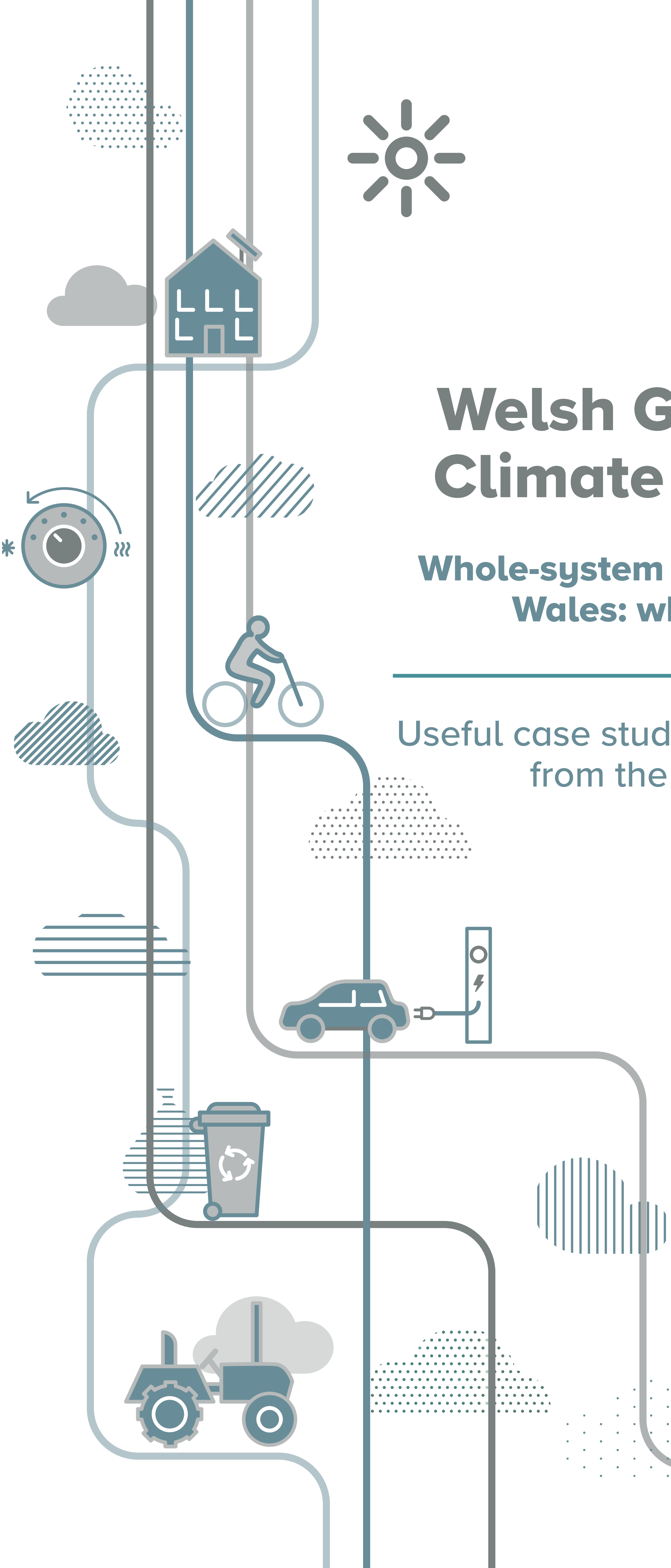
Llywodraeth Cymru
Welsh Government

Welsh Government Climate Innovation

Whole-system decarbonisation in Wales: what works and why

Useful case studies & lessons learnt from the WSRID Programme 2024-2026



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1. Introduction

The success of whole-system decarbonisation in Wales stems from the ability to innovate in real places, with real people, under real-world constraints. The **WSRID programme** was created to do exactly that, using the Contracts for Innovation approach to support pre-market research and development where solutions are not yet available, or not yet mature enough through the market in Wales. WSRID enabled public bodies, communities and industry to work together to test, demonstrate and refine responses to entrenched energy challenges, from rural electricity and gas bottlenecks and agricultural emissions to community energy ownership and the decarbonisation of local authority fleets.

This publication is a **How To Guide:** a practical resource that shares lessons from real climate innovation projects delivered in communities across Wales. It is written in plain English and brings together examples, tools and learning to help readers understand what it takes to design and deliver whole-systems innovation, from early problem framing through feasibility, prototyping and evidence-building, to credible pathways for investment and implementation.

Rather than offering simple solutions, the Guide focuses on **learning from experience**. It highlights what worked, what proved difficult, and what teams would do differently next time, drawing out common insights that others can apply when planning climate action within real budgets, policies and places.

The **case studies** show how technological innovation, place-based system thinking and collaborative delivery can unlock opportunities that would otherwise remain out of reach. They demonstrate the critical importance of skills, local capability and community leadership, as well as the value of high-quality data, modelling and digital tools in guiding decisions and tracking impact.

WSRID sits within a wider commitment to **strengthen Local Area Energy Planning** and accelerate practical routes to Net Zero. By prioritising solutions that make best use of constrained networks, maximise local renewable resources, reduce demand and retain value within communities, the programme supports decarbonisation that is fair, achievable and grounded in the specific needs of Welsh places.

Above all, this Guide is about **helping people work together to make change happen**. By sharing honest, real-world stories and practical resources, it aims to support more confident, joined-up and effective action towards a cleaner, fairer and more resilient future for Wales, and to inform future investment and delivery decisions as Wales moves through Carbon Budget 3 (2026-2030) and beyond.

2. Glossary of terms

- **AC (Alternating Current)** – The standard form of electricity supplied by the National Grid, where the direction of current flow alternates. Most grid connected electricity systems use AC.
- **AD (Anaerobic Digestion)** – A biological process in which organic materials such as food waste or livestock slurry are broken down without oxygen to produce biogas for energy generation.
- **Agrivoltaics** – A dual use of land for both agricultural production and solar electricity generation by integrating photovoltaic panels with crops or livestock on the same site.
- **Amber constrained grid load** – A point on the electricity network (such as a substation or connection point) where capacity is limited and a potential bottleneck has been identified, but the network is not yet in a critical or emergency state.
- **Anchor load** – A large, stable energy user (such as a school, depot or public building) that provides reliable demand for locally generated renewable energy.
- **BEV (Battery Electric Vehicle)** – A vehicle powered entirely by electricity stored in onboard batteries and charged from the grid or local renewable sources.
- **Biochar** – A carbon rich material produced from organic biomass that can store carbon long term and improve soil health.
- **Biomethane** – A renewable gas produced by upgrading biogas, suitable for injection into the gas grid or use as a low carbon fuel.
- **CCR (Cardiff Capital Region)** – A regional partnership covering ten local authorities across South East Wales, coordinating economic development, transport and decarbonisation activity.
- **CEE (Centre for Energy Equality)** – An organisation focused on inclusive, community led energy systems that support a fair and just transition to Net Zero.
- **CHP (Combined Heat and Power)** – A technology that generates electricity and captures waste heat for use in heating or industrial processes, improving overall efficiency.
- **Challenge Owner** – A public sector organisation that defines a place based decarbonisation Challenge within the WSRID programme, setting outcomes rather than prescribing solutions.
- **Climate Innovation** – A Welsh Government scheme (formerly *Smart Living*) supporting the development and testing of innovative decarbonisation solutions using pre commercial procurement.
- **Contracts for Innovation** – an Innovate UK initiative designed to tackle public sector Challenges through funded R&D contracts, see www.iuk-business-connect.org.uk/programme/contracts-for-innovation/
- **DC (Direct Current)** – An electrical current that flows in one direction only, often used in local energy systems to reduce conversion losses.
- **DC private wire** – A private electricity connection using direct current to supply power directly from a generator to a local user.

- **Digital Twin** – A digital representation of a physical energy system that uses real time and historic data to model and optimise performance.
- **DNO (Distribution Network Operator)** – The organisation responsible for operating and maintaining the local electricity distribution network.
- **DSO (Distribution System Operator)** – The evolving role of DNOs as active managers of electricity networks using digital tools and flexibility services.
- **EV (Electric Vehicle)** – A vehicle powered by electricity, including battery electric and hydrogen fuel cell vehicles.
- **Export limited operation** – Operation of a local energy system that restricts electricity export to the grid to manage network constraints.
- **FCEV (Fuel Cell Electric Vehicle)** – A vehicle that uses hydrogen in a fuel cell to generate electricity, producing only water vapour at the point of use.
- **GMW (Growing Mid Wales)** – A regional partnership covering Ceredigion and Powys, focused on economic growth, rural development and the energy transition.
- **Grid constraint** – A limitation in electricity or gas network capacity that restricts new connections for demand or generation.
- **Green hydrogen** – Hydrogen produced using renewable electricity, typically via electrolysis, with minimal associated carbon emissions.
- **HARVEST (Holistic Agricultural and Rural Virtual Energy System Transition)** – A WSRID Phase 2 demonstrator delivering a community led Social Virtual Power Plant in Mid Wales.
- **HBLL (Helping Business Lower the Load)** – An WSRID Phase 1 project exploring how reducing electricity demand at business parks can relieve rural grid constraints.
- **How To Guide to WSRID** – a practical resource that outlines a whole-systems innovation process from start to finish, helping readers understand how to deliver successful research and development bringing about lasting decarbonisation outcomes across Wales.
- **Hydrogen ICE (Internal Combustion Engine)** – An engine that burns hydrogen instead of diesel or petrol, offering a lower carbon option for heavy duty vehicles.
- **Islanded operation** – The ability of a local energy system to operate independently from the National Grid during outages or constraints.
- **LAEP (Local Area Energy Plan)** – A place based, evidence led plan setting out how local energy systems can transition to Net Zero.
- **LCA (Life Cycle Assessment)** – An assessment of the environmental impacts of a product or system across its full life cycle.
- **LCHG (Low Carbon Heat Grant)** – A Welsh Government Energy Service grant supporting installation of low carbon heating technologies such as heat pumps.
- **LEOS (Local Energy Operating System)** – A digital platform used to coordinate generation, storage, demand and trading within a local energy system.
- **NGED (National Grid Electricity Distribution)** – A Distribution Network Operator responsible for electricity distribution across South and Mid Wales.

- **NRW (Natural Resources Wales)** – The statutory body responsible for environmental regulation, including ecology, flood risk and water abstraction.
- **OEM (Original Equipment Manufacturer)** – A company that designs and manufactures vehicles or equipment.
- **Private wire** – A dedicated electricity connection supplying power directly from a generator to a specific user without using the public grid.
- **RCV (Refuse Collection Vehicle)** – A heavy duty vehicle used by local authorities for waste collection.
- **RCVPP (Rural Community Virtual Power Plant)** – A community owned model aggregating household, business and farm energy assets into a coordinated system.
- **RCT (Rhondda Cynon Taf) County Borough Council** – The local authority leading the Rhondda Cynon Taf WSRID Challenge.
- **RES (Renewable Energy Systems)** – Energy systems that generate power from renewable sources such as wind, solar or hydropower.
- **RIBA Stage 2** – An early design stage covering concept design and initial technical development.
- **SaaS (Software as a Service)** – A digital service delivered online rather than installed locally, allowing scalable access and deployment.
- **SBRI (Small Business Research Initiative)** – An Innovate UK pre commercial procurement model used to stimulate innovation, since 2024 replaced by Contracts for Innovation.
- **Slurry** – A semi liquid mixture of livestock manure and water, sometimes containing bedding material, managed as a nutrient rich by product of farming.
- **SLES (Smart Local Energy System)** – A locally integrated energy system coordinating generation, storage and demand using digital control.
- **Smart Living** – The former name of the Welsh Government Climate Innovation scheme.
- **SPEN (SP Energy Networks)** – A Distribution Network Operator responsible for electricity distribution across North and Mid Wales.
- **SVPP (Social Virtual Power Plant)** – A Virtual Power Plant model prioritising community ownership, social value and local reinvestment.
- **VREM (Village Rural Energy Model)** – A Challoch Energy concept exploring community led Smart Local Energy Systems in rural villages.
- **WSRID (Whole System Research and Innovation for Decarbonisation)** – A Welsh Government programme supporting whole system, place based decarbonisation innovation aligned with LAEPs.
- **Ynni Cymru** – A Welsh Government funding programme supporting community and locally owned renewable energy projects.

3. Introduction

Climate Innovation

WSRID was a programme of the Welsh Government Climate Innovation scheme ("Smart Living" until October 2025). Climate Innovation delivers development of innovative new climate action approaches and solutions with partners across government and civil society to support a net zero well-adapted future Wales.

To learn more visit www.gov.wales/climate-innovation-scheme.

Whole System Research and Innovation for Decarbonisation (WSRID)

The Whole System Research and Innovation for Decarbonisation (WSRID) programme was part of the Welsh Government's Climate Innovation initiative (formerly Smart Living). Launched in 2024, WSRID supported public sector organisations to develop and test innovative decarbonisation approaches shaped by local needs and priorities, particularly those identified through Local Area Energy Plans (LAEPs). The programme was delivered using the Innovate UK Contracts for Innovation pre commercial procurement approach, previously the UK Small Business Research Initiative (SBRI), to stimulate innovation where solutions are not yet available in the market.

WSRID was designed around a whole system approach to decarbonisation. Rather than focusing on individual technologies or single assets, the programme encouraged solutions that consider how buildings, infrastructure, energy networks, transport systems, natural assets and users interact within a place. This enables more robust system design, better understanding of trade offs, and clearer pathways towards scalable, Net Zero aligned solutions.

A core aim of WSRID was to help bridge known market, capability and delivery gaps that can limit the development and adaptation of innovative decarbonisation solutions. The programme was aligned with LAEPs, focusing support on priority areas where opportunities had been identified but could not yet be realised due to system complexity, delivery risk or resource constraints. By connecting public bodies with businesses and academia, WSRID supports the development of whole-system concepts and designs for net zero pathways across multiple sectors and energy vectors that respond directly to LAEP objectives and generate delivery-ready evidence. Through this process, WSRID helps build local capability, supports knowledge sharing and enables carbon reduction and wider system benefits which can be realised at scale.

WSRID was delivered in two stages. Phase 1 (Feasibility) projects focused on testing the viability of innovative concepts and exploring whole system options. Phase 2 (Demonstrator and Prototyping) projects supported deeper analysis, real world trials and evidence generation to inform future investment and delivery decisions. Together, these phases provide a structured pathway from early stage innovation to practical application.

Challenge Owner model

At the core of the Contracts for Innovation approach is the **Challenge Owner model**, where public sector organisations define the Challenges they face rather than prescribing solutions. This shifts the focus from procurement to problem-solving. It creates space for innovative responses, encourages competition and collaboration, and enables suppliers to develop and refine solutions through phased support. WSRID builds on earlier Climate Innovation scheme programmes' experience with a stronger focus on whole system design and real-world application.

To translate this approach into delivery, the Welsh Government launched the WSRID challenge competition, making £1.5 million available across two phases. Public sector organisations (local authorities, health boards and regional economic development bodies) were invited to propose place-based decarbonisation challenges grounded in LAEPs and aligned with Regional Energy Plans. Phase 1 (Feasibility) provided funding for selected Challenge Owners to scope and test innovative approaches. A subsequent closed competitive process then enabled the most promising projects to progress into *Demonstrator and Prototyping* (Phase 2), supporting real-world testing, deeper analysis and robust evidence generation.

For more information on this pre-commercial R&I procurement framework, visit the Innovate UK Contracts for Innovation website.

Introduction to the Challenges

WSRID was designed to test how place-based innovation can unlock progress where traditional, technology-led approaches fall short. The programme was delivered through **three distinct regional Challenges**, each led by a public-sector Challenge Owner responding to its own energy system pressures, local priorities and delivery conditions. What follows introduces these Challenges, explaining why each was selected, the issues they sought to address, and how they aligned with LAEPs and wider regional objectives. Together, they provide the context for the detailed project work explored in the next sections of this report.

Growing Mid Wales (GMW)

The GMW Challenge responded to the specific energy system constraints facing rural and agricultural communities across Ceredigion and Powys.

LAEPs for both authorities forecast a significant increase in the uptake of electric heating and transport. Without intervention, this transition was expected to require up to £559 million in electricity network upgrades, presenting a major barrier to decarbonisation and economic growth in the region.

The Challenge focused on how SLES could reduce the need for costly grid reinforcement while delivering social and economic value locally. Supported by over £640,000 of WSRID funding (including substantial additional support from WG Agriculture) across the two phases, it focused on innovative, farm based and rural energy solutions that reflected the dispersed demand, limited grid capacity and high reliance on fossil fuels across Mid Wales. With agriculture as the dominant industry, the Challenge responded directly to the realities facing rural and agricultural communities in the region.

Rhondda Cynon Taf County Borough Council (RCT)

The RCT Challenge was rooted in a LAEP vision that places communities at the centre of the area's energy transition, with an emphasis on affordability, local ownership and community led solutions.

Supported by over £429,000 of WSRID funding, the Challenge focused on maximising the community benefits of renewable energy generation, using the hydroelectric potential of the Nant Clydach watercourse. This included exploring supplying renewable power directly to local assets, such as a nearby school, as well as the potential to offer cost competitive electricity to other users through a local energy market. Flexibility services that support the wider electricity system at times of peak demand were also a key consideration.

Cardiff Capital Region (CCR)

The CCR Challenge reflected a shared priority across all ten local authorities in the region, each of which has identified decarbonising council owned vehicle fleets as a key objective in their LAEPs. Backed by over £423,000 of WSRID funding (including funding from WG Circular Economy), the Challenge took a coordinated regional approach to tackling one of the most persistent sources of transport-related carbon emissions.

Fleet emissions represent a significant and persistent source of transport related carbon, particularly for heavy and high duty vehicles.

Adopting a coordinated regional approach, the CCR Challenge explored the most appropriate low carbon solutions for vehicle types where battery electric options may not yet be viable, due to factors such as steep gradients, stop start driving patterns and charging constraints.

In particular, the Challenge explored if hydrogen based alternatives could complement existing electrification efforts, which could help to relieve pressure on the grid and ensure that grid investments are targeted where they are most needed.

Viewed together, these three Challenges show the breadth of system issues WSRID was designed to tackle: from rural grid constraints and agricultural decarbonisation, to community-owned energy and regional fleet transition. The sections that follow take each Challenge in turn and delve into the Phase 1 and Phase 2 project portfolios, outlining what was tested, what was learned and how the work has informed delivery-ready designs, demonstrators and wider investment pathways. This provides a clear bridge from high-level Challenge framing to the programme's practical findings, cross-cutting insights and the lessons that shape the remainder of this report.

4. Growing Mid Wales

Growing Mid Wales: the challenge

Mid Wales presents a distinctive energy context. It is characterised by low population density, a high proportion of homes and businesses off the gas grid, and an economy strongly shaped by agriculture, forestry and rural industry. These land based industries, including dairy farming, livestock production and forestry, play a central role in the Mid Wales regional economy but are also among the most challenging sectors to decarbonise. Rural businesses and communities face rising energy costs and limited access to low carbon technologies that restrict both electrification and renewable deployment. At the same time, the region has significant renewable energy potential, much of which is constrained by limited electricity network capacity. These constraints limit both electrification and the export of locally generated renewable power. Therefore, the key question GMW sought to address through the WSRID Challenge was how to manage demand on rural grid infrastructure in a way that delivered sustainable economic growth, all while decarbonising their key economic sectors.

Rather than focusing on single technologies, GMW sought to test whole system solutions that could work within existing network limits, make better use of local renewable resources and deliver tangible benefits to rural communities, while building an evidence base to support future LAEPs in rural settings. GMW set out to explore how SLES could support decarbonisation in these rural and agricultural communities while responding to the realities of significant grid constraints. Across WSRID Phase 1 and Phase 2, the programme explored how local generation, storage, flexibility and demand could be better integrated across farms, communities and businesses. The challenge was delivered through a coordinated portfolio of projects, carried out by solution providers Water to Water, Lafan, Challoch Energy, Severn Wye Energy Agency and the Centre for Energy Equality. Working closely with GMW and regional partners, these projects generated practical, place-based evidence to inform future LAEPs, particularly in rural contexts where standard urban approaches are not easily transferable.

The GMW Challenge project portfolio:

First Net Zero Milk Wales – RuraVolt

First Net Zero Milk Wales was a place-based demonstrator exploring how dairy farms can generate and manage 100% of their energy needs on-site through SLES, reducing grid demand and supporting decarbonisation in the Welsh agricultural sector.

Within GMW's WSRID Challenge, Water to Water led this work on farm scale SLES, focusing on the dairy sector and the specific challenges faced by farms operating at the edge of weak rural electricity networks. Working in partnership with First Milk, the project focused on dairy farms in Ceredigion. Dairy farming relies on energy intensive processes including milking operations, water heating, manure management, and space heating and cooling. Despite this, agricultural decarbonisation has historically lagged behind other sectors, in part due to a reliance on centralised grid solutions that are poorly suited to rural areas.

In Wales, farming accounts for around 12% of total greenhouse gas emissions, with the sector aiming to reduce emissions by 95% by 2050. This project directly addressed that Challenge by exploring decentralised, farm based approaches that enable on site generation and storage of renewable energy. By doing so, it opens a pathway for dairy farms and wider rural communities to participate directly in the renewable energy economy, while reducing reliance on constrained rural grids.

Phase 1 – Feasibility

Phase 1 focused on understanding how energy was used on working dairy farms, and what this meant for decarbonisation in practice. Water to Water identified and worked with three First Milk dairy farms in Ceredigion, selected to represent low, medium and high production profiles. These farms acted as test sites to explore how local renewable generation, energy storage and emerging technologies such as hydrogen could interact with real, day to day electricity and heat demand.

Detailed data collection and site visits were undertaken to map energy use across core farming activities, including milking, cooling, cleaning and ancillary processes. This work helped identify operational constraints and opportunities for deploying SLES. High level system models were developed for each farm to explore potential configurations of generation, storage and demand management. However, the short project duration and limited availability of granular, time resolved data meant that assumptions were required to address gaps in hour by hour demand variability.

The analysis captured differences in farm scale, production intensity and location on the electricity network, as well as physical constraints such as available space for infrastructure and proximity to suitable connection points. Renewable generation options were assessed alongside existing electrical and thermal loads, with particular attention to how energy demand varied across the day and week.

Phase 1 demonstrated that decarbonising dairy farms is primarily a whole systems challenge rather than a question of deploying individual technologies. Energy demand was found to be highly time specific and closely linked to milking cycles, while renewable generation, particularly solar, often occurred outside peak demand periods, creating a structural mismatch. As a result, energy storage emerged as a critical enabler for improving self consumption and delivering meaningful emissions reductions.

The work also highlighted significant variation between farms, driven by scale, production profile and grid constraints, confirming that no single solution will be universally applicable. In a region where electricity network upgrades are estimated to cost hundreds of millions of pounds, Phase 1 showed that farm scale energy systems designed around existing constraints could offer a realistic alternative, provided they are informed by detailed, time specific data and aligned with how farms already operate.

Phase 2 – Demonstrator

Phase 2 built on Phase 1 learning and focused on removing some of the complexity that often prevents farm based energy projects from getting started. Water to Water developed an online feasibility tool, RuraVolt to support SLES assessments designed specifically for farms.

RuraVolt guides users through a structured process, capturing site information, planning and feasibility constraints, electricity and heat demand, tariffs and available feedstocks. It integrates external modelling for technologies such as anaerobic digestion, combined heat and power, and hydrogen, while filtering out non essential calculations to keep outputs clear and usable.

Since October 2025, Phase 2 focused on clearly defining the scope of the work and simplifying the original feasibility tool. The team reviewed planning and on-farm constraints, gathered data from participating farms and brought this information together into a single, usable system. The final stage concentrated on making the outputs easier to understand, testing the tool with partners and preparing it for wider rollout.

By moving to a simple, standardised digital approach, the project made it easier for farmers and advisors to see what could realistically work on a specific site. This will help users to understand the feasibility of their options early on, before investing time, money or effort in more detailed studies.

Key insights

- **For dairy farmers:** There is no single model for a Net Zero dairy farm. Energy solutions must reflect individual production cycles, demand patterns and physical constraints. The project shows that meaningful progress is possible even where grid capacity is limited, provided systems are designed around local conditions rather than assuming major network upgrades.
- **For farm advisors and intermediaries:** One of the clearest insights was that complexity is a major barrier. The move from bespoke feasibility studies to a standardised digital tool highlighted the value of clear, repeatable approaches that support confident conversations with farmers and reduce uncertainty at the early stages before going into the detail.
- **For local authorities and regional planners:** The project reinforced that grid constraint is a defining feature of rural energy systems, not a marginal issue. Local energy solutions can help manage demand and generation within existing limits, providing an important complement to longer term network reinforcement. The work also offers practical evidence to inform LAEPs in rural contexts.
- **For technology providers and delivery partners:** Phase 1 demonstrated the importance of designing systems around operational reality rather than theoretical optimisation. Phase 2 showed how early feasibility work can be translated into tools that support scale and replication, creating clearer routes from innovation to delivery.
- **For policymakers and funders:** The project highlighted the value of phased support that allows ideas to move from feasibility to scalable delivery mechanisms. Investment in tools and frameworks that reduce risk and complexity can unlock wider uptake and better value for money than focusing solely on individual installations.

Benefits

The Water to Water project demonstrated that dairy farms can play an active role in the transition to Net Zero, even in areas with limited grid capacity. By focusing on locally appropriate, farm scale solutions, the approach can help reduce emissions while improving energy resilience and security for farms.

The feasibility tool developed through the project provides a practical benefit beyond individual sites. It reduces complexity, supports better informed decisions and helps identify projects that are genuinely viable, saving time and cost at early stages. By enabling more consistent and comparable assessments, the tool also supports better coordination between farmers, advisors, delivery partners and regional planners.

More broadly, the project helped keep more energy value within rural communities, supported innovation in a hard to decarbonise sector, and provided evidence that can inform future programmes, funding decisions and LAEPs.

What's next?

The next stage of the project focuses on refining and expanding the feasibility tool, including broadening the range of technologies it can assess and strengthening its usability for farmers and advisors.

There is also scope to support wider rollout across Wales, helping build a pipeline of farm based energy projects that are aligned with grid constraints and regional priorities. There is potential for the tool to support more targeted financial incentives, by providing a consistent way to identify viable projects and appropriate scales of investment. For example, loan products from public or private development funds could be aligned with the tool, giving farmers and advisors a practical means of scoping where finance could be applied.

Learning from the project will continue to inform future energy and agricultural programmes, providing practical insight into what works for rural decarbonisation and how early stage support can support wider delivery.

Get involved

Farmers, advisors and organisations interested in exploring farm scale energy options can use the feasibility tool, free of charge, as a starting point to understand what might work on their site. Designed for early stage exploration, it helps users identify realistic options and ask the right questions before moving into detailed design, funding or delivery. By providing a clear, structured entry point, the project helps turn interest in low carbon farming into informed action, by building confidence and reducing risk at the earliest stages. Organisations interested in this approach are encouraged to get in touch to learn more, explore opportunities for collaboration, or apply the learning in their own context.

Project lead

Huw Williams, Regional Energy Officer – Growing Mid Wales
Email: huw.williams2@ceredigion.gov.uk

Organisation contacts

Growing Mid Wales (Challenge Owner)
Website: www.growingmid.wales/

Water to Water (Project delivery)
Website: www.watertowater.co.uk/

Further information

Programme/project overview:
www.growingmid.wales/WSRID

Relevant tools, outputs or case studies:
www.watertowater.co.uk/ruravolt/

News and social media:
www.businessnewswales.com/exploring-energy-independence-for-mid-wales-farms/

Water to Water: Smart Local Energy Systems for Dairy Farms
www.businessnewswales.com/growing-mid-wales-digital-discussions/

www.youtube.com/watch?v=8EFVBxBxU8Y

Advancing Sustainable Agriculture and Renewable Energy in Mid Wales

Advancing Sustainable Agriculture and Renewable Energy in Mid Wales was a demonstrator exploring how livestock slurry can be treated as a resource, converting agricultural waste into renewable energy and bio based products while reducing nutrient pollution and pressure on rural infrastructure.

Lafan and the Agriculture Research Centre at Coleg Sir Gâr worked as solution providers, combining business innovation with applied agricultural research to address nutrient management challenges in Mid Wales. Lafan brought strategic, entrepreneurial and delivery expertise focused on practical, scalable solutions for rural economies, while the Agriculture Research Centre contributed deep technical knowledge, specialist facilities and a strong track record in on-farm research and innovation. Together, the partnership integrated research, system design and real-world farming insight to develop solutions that support sustainable agriculture, renewable energy generation and improved environmental outcomes.

Lafan worked with farmers, colleges, utilities and public sector partners to address surplus livestock slurry and nutrient loading in Mid Wales by treating it as a resource rather than a waste. The project explored how excess nutrients can be converted into clean energy and bio based products, while supporting more sustainable farming practices and reducing pressure on rural infrastructure.

Delivered through the GMW WSRID programme, the project sits within a wider regional effort to address rural grid constraints, agricultural decarbonisation and environmental pressures in Mid Wales.

Phase 1 – Feasibility

Phase 1 focused on a core and growing problem facing livestock farming in Mid Wales: surplus nutrients. Increased winter rainfall associated with climate change, combined with closed storage periods, has intensified slurry storage pressures and reduced opportunities for safe land application. When slurry is applied under unfavourable conditions, excess nutrients can enter surface and groundwater, leading to eutrophication, oxygen depleted waters and damage to river habitats and biodiversity.

The project explored whether these pressures could be reduced by treating surplus slurry as a resource rather than waste. Instead of recycling nutrients back onto land that cannot safely absorb them, the project examined the potential to export excess nutrients off farm and convert them into energy without placing additional demands on already constrained electricity or gas networks.

The Phase 1 concept centred on slurry dewatering at or near the farm, separating liquids from a dry biosolid. The dry material is lower risk to store and transport than liquid slurry and can be moved to a centralised treatment hub located close to suitable energy demand or grid infrastructure. This approach supported grid optimisation by avoiding generation in locations where network capacity is already full.

Phase 1 showed that grid constraints fundamentally shape what is feasible. Across much of Mid Wales, new electricity generation at scale is unlikely to secure a grid connection in the near term. The work demonstrated that defaulting to on farm energy generation is often unrealistic, and that system design must prioritise where energy can be used, not just where slurry is produced.

The work also highlighted the importance of separating slurry into dry and liquid fractions. Dewatering improves safety, reduces transport risk, and creates flexibility in how and where downstream processing takes place. Centralised treatment hubs emerged as a practical way to align nutrient processing and energy generation with local demand, rather than forcing generation into constrained parts of the network.

Alongside technical findings, Phase 1 identified wider delivery considerations. Community engagement and public sector involvement were shown to be critical where solutions serve multiple farms. The work also identified biochar produced from biosolids as an under explored opportunity, offering potential environmental benefits alongside energy generation without the risks associated with handling liquid digestate.

Overall, Phase 1 confirmed that effective nutrient to energy solutions depend on integrated system design, not single technologies, and must address environmental protection and infrastructure constraints together from the outset.

Phase 2 – Demonstrator

Building on Phase 1 learning, Phase 2 focused on refining system design and clarifying feasible routes towards demonstration and commercial delivery, while remaining aligned with regulatory and grid requirements. Phase 2 explored two complementary routes for processing exported nutrients at a centralised facility:

1. **Anaerobic digestion (AD) with combined heat and power (CHP) and storage**, generating electricity where there was immediate local demand.
2. **Biomethane production with direct injection to the gas grid**, avoiding electricity export constraints by using existing gas infrastructure where available.

Both routes incorporated a “dry in, dry out” approach, meaning digestate was not returned to farms. This reduced regulatory complexity and avoided creating new nutrient management issues at farm level.

A central feature of Phase 2 was the development of a mobile dewatering unit, designed to operate across multiple farms. Phase 2 activity included finalising the design of this unit, testing its practicality and robustness, and assessing how it could be deployed flexibly across dispersed rural areas. This approach reflected the reality of Mid Wales, where fixed infrastructure at every site was neither practical nor affordable.

Phase 2 also integrated biochar production into the overall system design. Biochar offered multiple benefits, including long term carbon sequestration, soil health improvement and reduced reliance on chemical fertilisers, while avoiding the risks associated with liquid digestate handling. This phase examined environmental risks, nutrient transfer and regulatory considerations to ensure responsible use, while also exploring potential applications beyond agriculture, such as horticulture and ground stabilisation.

Alongside technical development, Phase 2 strengthened engagement with utilities, colleges, local authorities and Welsh Government partners. Discussions covered options for gas grid injection, potential capital investment and future funding routes.

Overall, Phase 2 positioned Lafan's project as a delivery ready agricultural strand within the wider GMW WSRID programme. It demonstrated how early stage innovation could be translated into practical, investable system designs, with clear pathways towards a next phase of demonstration and commercial rollout, which Lafan is currently exploring with potential partners including Wales & West Utilities and the Development Bank of Wales.

Key insights

Lafan's work showed that nutrient management, energy generation and environmental protection were closely linked and needed to be addressed together. Removing surplus nutrients from farms that could not safely reuse them significantly reduced environmental risk while enabling low carbon energy generation aligned with grid and demand constraints.

The project demonstrated that rural innovation was most effective when based on system integration rather than novel technologies alone. Combining established approaches such as dewatering, anaerobic digestion, biomethane production and biochar within a single, flexible system created solutions that better reflected real farming practices and rural grid conditions.

- **For livestock farmers:** This approach reduced operational and regulatory risk by removing surplus nutrients from holdings where land application was constrained, while avoiding the need for permanent on site infrastructure.
- **For utilities and public sector partners:** Centralised treatment hubs offered a practical way to align energy generation with available network capacity and local demand.
- **For farmers and local communities:** Exploring alternative revenue streams (energy, biochar, fertiliser) to improve commercial viability.
- **For policy makers and funders:** Providing evidence-based clarity on regulatory and planning pathways, reducing uncertainty for future deployment.

The project also reinforced learning seen across the wider GMW programme: phased support enabled ideas to progress from feasibility to credible delivery pathways, building confidence among delivery partners and creating clearer routes to future investment.

Benefits

Overall, Lafan delivered value by addressing multiple rural challenges through a single, integrated approach. It reduced environmental risk associated with surplus nutrients, supported compliance with tightening nutrient management requirements, and created new opportunities for renewable energy generation without exacerbating electricity network constraints. By designing systems around real world farming, infrastructure and regulatory conditions, the project supported a more inclusive and practical transition to low carbon agriculture in rural Wales.

What's next?

The next stage of the Lafan project focuses on moving from defined pathways to delivery readiness. This includes finalising the design of the mobile dewatering unit, completing life cycle assessments (LCA) and farm impact assessments (FIA), and identifying suitable locations for treatment facilities.

Alongside technical refinement, the project continues engagement with utilities, regulators and potential delivery partners to clarify routes to demonstration and commercial rollout. The project sought to complete LCAs, FIAs and a full economic evaluation, ensuring decisions were supported by robust evidence. This work helped determine where early deployment could have the greatest impact.

Overall, the project provided a strong evidence base for future investment and delivery. By progressing from feasibility to defined delivery pathways, Lafan's project reduced uncertainty for partners, funders and policymakers, helping turn complex environmental pressures into long term opportunities.

Get involved

Lafan's project provides a practical entry point for farmers, land managers and organisations facing nutrient management challenges. Engagement typically begins with a high level discussion to understand farm context, nutrient pressures and local constraints, before exploring whether nutrient to energy solutions could be appropriate. The project is designed to support early exploration rather than immediate commitment. By setting out realistic options, limitations and next steps, this approach helps stakeholders make informed decisions before progressing to detailed feasibility, funding or delivery stages. Organisations interested in this approach are encouraged to get in touch to learn more, explore opportunities for collaboration, or apply the learning in their own context.

Project lead

Huw Williams, Regional Energy Officer – Growing Mid Wales
Email: huw.williams2@ceredigion.gov.uk

Organisation contacts

Growing Mid Wales (Challenge Owner)
Website: www.growingmid.wales/

Lafan (Project delivery)
Website: www.lafan.cymru/

Coleg Sir Gâr/Coleg Ceredigion (Project delivery)
Website: www.csgcc.ac.uk/en

Further information

Programme/project overview:
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Village Rural Energy Model (VREM)

The Village Rural Energy Model is a place-based feasibility project exploring a locally owned renewable energy and green hydrogen system to decarbonise rural industry and reduce grid pressure in Mid Wales.

Delivered through the GMW WSRID programme, the project was led by Challoch Energy, a specialist consultancy in rural and community energy systems, which explored how community-led SLES could improve energy security, support decarbonisation and maximise local benefit in rural villages.

The project responded to persistent grid constraints across Ceredigion and Powys, where many communities face high energy costs, limited access to low carbon technologies and restricted opportunities to connect new generation.

Phase 1 – Feasibility

Phase 1 focused on feasibility and place based assessment where rural villages were mapped against electricity network constraint data from SPEN and NGED to identify priority locations where major grid upgrades are expected to be required by 2050. This analysis helped pinpoint communities where local energy solutions could deliver the greatest impact by working within existing network realities rather than relying on future reinforcement.

The project explored how locally owned renewable generation could reduce dependence on the national grid while delivering financial and social value locally. Particular attention was given to villages already demonstrating readiness for community energy, including those with active community organisations, strong local leadership or existing renewable assets.

As part of this, Phase 1 assessed potential hydrogen demand by engaging with land based industries such as forestry, where diesel use for transport, harvesting and processing is a significant source of emissions and a major contributor to local air pollution. Battery-electric alternatives were found to be limited by range and refuelling constraints, making hydrogen a potential complementary solution.

Overall, Phase 1 demonstrated that electricity network constraint is a defining factor shaping decarbonisation options in rural Mid Wales, and that effective solutions must work within existing grid limits rather than assume future reinforcement. The feasibility work showed that locally owned renewable generation and SLES approaches could reduce reliance on the national grid while retaining economic and social value within communities.

It also highlighted that community readiness, including local leadership, organisational capacity and existing assets, is critical to successful delivery. Engagement with land based industries confirmed that hydrogen has a potential role where battery electric alternatives are impractical, but only where there is clear, place specific demand. Together, these findings provided a clear evidence base for narrowing focus in Phase 2 to a single location and developing a more targeted, demonstrator led approach at Devil's Bridge.

Phase 2 – Demonstrator

Phase 2 built on the feasibility work by focusing on the Devil's Bridge area which is home to a large Natural Resources Wales (NRW) forestry fleet and several visitor centres, with a high concentration of vehicles and forestry operations nearby. This sector is one of the largest employers in Mid Wales and a significant source of regional emissions.

This phase explored whether locally generated, green hydrogen could support decarbonisation of forestry transport and processing activities that are difficult to electrify. The work was grounded in the realities of rural industry, where vehicles operate over long distances, refuelling flexibility is critical and downtime has direct economic impacts.

The work assessed local wind resource potential at sites including Pond yr Oerfa Wind Farm (2.4MW capacity) and Cefn Croes Wind Farm (capacity of 58.5 MW, due for repowering to 180MW), recognising the opportunity to align hydrogen production with existing and future renewable generation in a highly constrained grid environment.

This was combined with detailed electrolyser feasibility, alongside assessment of planning and regulatory pathways, and the development of commercial and financial models appropriate to rural and industrial contexts.

Engagement with potential off-takers, including sawmills and NRW, played a central role in shaping the work. These discussions moved beyond high-level feasibility to explore practical operational considerations that could help determine whether hydrogen may be viable in practice.

Stakeholders raised questions around security of supply, for instance how hydrogen availability could be made as reliable and continuous as today's diesel supply. Also raised was how production and storage would need to be configured to avoid disruption to time-critical forestry operations.

Different refuelling models were explored, including depot-based refuelling, compared to public or semi-public refuelling stations, and hybrid approaches combining fixed and mobile refuelling. These options were considered in alignment with current practices rather than requiring significant changes to working routines. The need for driver and operator training was also examined, with emphasis on minimising disruption.
In parallel, the work addressed safety, insurance and storage considerations, and how risks associated with hydrogen storage could be managed.

Phase 2 progressed wider stakeholder engagement with SP Energy Networks, Powys County Council planning and environment teams, and work to narrow down a preferential hydrogen supply location.

Overall, Phase 2 provided evidence to suggest that hydrogen could play a role in decarbonising land based industries in certain contexts, but only where it is closely aligned with local renewable generation, supported by viable delivery pathways and designed to deliver community benefit alongside industrial decarbonisation. The work highlighted the need for careful integration of technology, place and ownership models to ensure feasibility and long term value.

Key insights

Challoch's VREM project showed that decarbonising rural and land based industries depended on aligning technology choices with place specific demand, grid constraints and operational realities.

Electricity network limitations were shown to be a decisive factor, reinforcing the need for solutions that worked within existing capacity rather than relying on future reinforcement.

The work demonstrated that community led SLES approaches could reduce reliance on the national grid while retaining economic and social value locally, but only where there was sufficient community readiness and delivery capacity. Local leadership, organisational capability and existing assets emerged as critical enablers of successful delivery.

- **For land based industries:** The project confirmed that hydrogen could play a complementary role where battery electric options were impractical. However, viability depended on clear, concentrated demand, alignment with local renewable generation and delivery models that matched existing operational practices. Engagement with off takers highlighted the importance of security of supply, flexible refuelling models and minimal disruption to working routines.
- **For utilities and public sector partners:** Responding directly to severe grid constraints by proposing an off-grid energy solution that avoids reinforcement.

Across both phases, the project reinforced the wider GMW learning that phased support enabled ideas to move from feasibility to targeted demonstration, reducing delivery risk and creating clearer pathways to future investment.

Benefits

Overall, the VREM project delivered value by demonstrating how community energy and industrial decarbonisation could be integrated within constrained rural energy systems. It identified practical pathways to reduce emissions from hard to electrify sectors, supported more resilient local energy systems, and helped retain economic value within rural communities. By grounding innovation in real world grid, industry and community conditions, the project supported a credible and deliverable transition to low carbon energy in rural Mid Wales.

What's next?

The next stage of the VREM project focused on progressing from feasibility and design toward delivery readiness. This included narrowing preferred hydrogen locations, refining delivery models, and continuing engagement with utilities, regulators and potential delivery partners to clarify routes to demonstration and investment.

Building on the evidence generated through WSRID, the work provided a strong foundation for future decision making. By moving from broad feasibility to targeted, place based solutions, the project reduced uncertainty for partners and funders and supported the development of investable, community aligned decarbonisation pathways for rural Wales.

Get involved

Organisations, land managers and public sector partners interested in rural decarbonisation can use the VREM project as a starting point to understand how place-based energy systems and hydrogen solutions might work in constrained grid environments. Engagement typically begins with exploring local demand, grid conditions and community readiness, before considering whether SLES or hydrogen approaches could be appropriate. Designed to support early-stage exploration rather than immediate deployment, the project helps stakeholders identify realistic pathways, constraints and next steps. By grounding decisions in local context and operational realities, it supports more informed progression towards feasibility, funding and delivery. Organisations interested in this approach are encouraged to get in touch to learn more, explore opportunities for collaboration, or apply the learning in their own context.

Project lead

Huw Williams, Regional Energy Officer – Growing Mid Wales
Email: huw.williams2@ceredigion.gov.uk

Organisation contacts

Growing Mid Wales (Challenge Owner)
Website: www.growingmid.wales/

Challoch (Project delivery)
Website: www.challoch-energy.com/

Natural Resources Wales (Project delivery)
Website: www.naturalresources.wales/?lang=en

Further information

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Helping Business Lower the Load (HBLL)

Helping Business Lower the Load was a feasibility project demonstrating how demand-led SLES on business and industrial parks can reduce peak electricity demand, relieve rural grid constraints and improve energy resilience without the need for network reinforcement.

Through the GMW WSRID programme, Severn Wye Energy Agency led the Helping Business Lower the Load (HBLL) project, bringing deep expertise in energy efficiency, SLES and stakeholder engagement. The project focused on industrial and business parks in Powys and Ceredigion, concentrated, high-energy users with strong potential to unlock wider decarbonisation benefits, working closely with businesses, local authorities and network operators to reduce electricity demand and manage peak loads in grid-constrained rural areas, while aligning delivery with real-world operational and network constraints.

Rather than focusing solely on adding new generation, HBLL explored how lowering demand through energy efficiency, local generation, storage and smart control could free up grid capacity for other priority uses, including electrification of heat, agricultural machinery, agrivoltaics and electric vehicles in rural communities.

Phase 1 – Feasibility

Phase 1 focused on feasibility and real world testing of a demand led SLES approach. The project selected Four Crosses Business Park near Welshpool, and Powys County Council's Village Workshops as representative rural business sites. These locations sit on an amber constrained grid node (Llandrinio T1) directly adjacent to the red constrained Welshpool substation, identified in Powys's LAEP as one of the most critical areas requiring infrastructure upgrade.

Severn Wye undertook detailed energy assessments of participating businesses, collecting 12 months of electricity usage data to understand demand profiles, peak loads and operational patterns. This data was used to produce tailored energy reports, identifying opportunities for demand reduction through retrofit measures and informing the specification of site level SLES.

The feasibility work examined how on site solar PV, combined with battery storage, could be used to generate and store energy locally, reduce peak demand and shift consumption to off peak periods. The project explored multiple deployment scenarios, including full roof mounted solar, innovative layouts such as raised structures and carports, and agrivoltaics approaches, with a centralised battery modelled to support load leveling and peak shaving.

A key principle tested in Phase 1 was operating SLES behind the meter, meaning systems would not export to the grid. Engagement with SPEN confirmed that this approach aligned with DNO preferences in highly constrained areas, as it avoids the need to accommodate additional generation capacity while maximising the benefits of demand reduction.

To support feasibility analysis, Severn Wye developed simplified modelling tools and calculators to test how combined efficiency measures, renewables and storage could reduce declared capacity and overall grid impact. The project also explored how a business park could operate as a single energy entity, sharing energy between units to further smooth demand and reduce reliance on the grid.

Key Insights

Phase 1 demonstrated that lowering demand can be as impactful as adding generation in grid constrained rural areas. Reducing peak loads through efficiency, storage and smart control significantly reduces both grid impact and capital requirements for SLES.

The work showed that business and industrial parks are well suited to SLES, due to clustered demand, robust building structures and shared governance, making them ideal testbeds for SLES approaches.

Engagement with SPEN and participation in a DSO stakeholder event confirmed that the HBLL methodology was technically sound, aligned with emerging grid flexibility requirements and compatible with future digital twin approaches. The project also highlighted the value of using known technologies in innovative combinations, providing a faster route to deployment while minimising delivery risk.

Benefits

HBLL demonstrated a pathway for relieving grid pressure in rural areas while delivering direct benefits to businesses. By reducing demand at the source, the approach helps unlock capacity for wider decarbonisation, including electrification of heat in homes, adoption of electric vehicles and low-carbon agricultural practices.

For participating businesses, the project showed how local generation and storage can improve energy resilience, reduce exposure to peak time electricity costs and lower carbon emissions without requiring grid reinforcement.

At a regional level, the project generated transferable learning that supports LAEPs, helping planners understand how demand led SLES can complement longer term network upgrades.

What’s next?

While HBLL did not progress as a standalone Phase 2 project, its core concepts and outputs were directly integrated into the HARVEST Phase 2 demonstrator (the following project in this Guide), ensuring that learning from business scale SLES feasibility was carried forward into live system development.

Phase 2 activity focused on the development of a Digital Twin approach for business parks in Wales, creating a virtual representation of physical sites that integrates real time and historic data to model energy demand, generation, storage and flexibility. This approach enables predictive analysis and optimisation of SLES, supporting more effective load lowering and grid aware operation.

Within HARVEST, this Digital Twin capability was positioned as a Software as a Service (SaaS) model, providing the systems and processes needed to operate SLES at scale. Rather than treating business parks as isolated assets, the model allows industrial and SME sites to be analysed alongside domestic and agricultural assets, enabling coordinated operation across a wider local energy system.

The integration of HBLL learning into HARVEST demonstrated how business scale demand reduction can complement community led and agricultural energy assets within a SVPP. By lowering peak demand at business sites, the approach helps free up grid capacity that can be used more strategically elsewhere, including for domestic electrification, low carbon heat and electric vehicle uptake in rural communities.

The Digital Twin approach also supports replication and scale up, allowing site profiles developed in Phase 1 to be overlaid onto similar business parks across Powys and Ceredigion. This creates a transferable methodology for assessing grid impact, commercial viability and operational performance without requiring bespoke modelling for every new site.

Although additional Phase 2 funding for a standalone HBLL project was placed on hold, its integration into the HARVEST demonstrator ensured that the work continues to deliver value. The combined approach brings together industrial, agricultural and community energy systems within a single operational framework, supporting grid resilience, flexibility and rural decarbonisation. Organisations interested in applying demand-led SLES approaches can engage with the HARVEST project as the natural next step, using the HBLL methodology as a starting point to explore how site-specific demand reduction, local generation and smart control can be adapted to their own context and progressed towards feasibility, funding and delivery.

Holistic Agricultural and Rural Virtual Energy System Transition (HARVEST)

Holistic Agricultural and Rural Virtual Energy System Transition (HARVEST) was a demonstrator testing how a community-led Social Virtual Power Plant can coordinate locally owned renewable generation, storage and flexible demand to reduce peak loads and improve resilience on highly constrained rural grids in Mid Wales.

Through the GMW WSRID programme, the Centre for Energy Equality (CEE) developed the Rural Community Virtual Power Plant (RCVPP) concept and delivered the Holistic Agricultural and Rural Virtual Energy System Transition (HARVEST), bringing together household, business and farm-based renewable energy assets within a coordinated, community-governed model. Designed for rural and agricultural areas with weak grid infrastructure and high energy costs, CEE's approach focused on locally owned generation, flexibility and digital coordination to improve system resilience, reduce energy bills and support a just transition to Net Zero.

Phase 1 – Feasibility

Phase 1 focused on developing and testing the concept of a RCVPP as a new way to manage energy in rural and agricultural communities with weak grid infrastructure. Led by CEE, the work explored whether locally owned energy assets could be coordinated to reduce costs, relieve grid constraints and deliver wider community benefit.

The RCVPP model linked household, business and farm based renewable energy systems, such as solar PV, batteries and flexible demand, into a single, digitally coordinated Virtual Power Plant. By aggregating these assets, the system enabled communities to generate, store and use energy more efficiently, while also participating in energy and flexibility markets that are typically inaccessible to individual households or farms.

Phase 1 was designed to support regions with high energy costs and limited grid capacity, where traditional approaches to decarbonisation have been slow or difficult to deliver. A core aim was to empower rural residents and farmers to play an active role in the energy system, rather than remaining passive consumers constrained by network limitations.

The work prioritised low income and vulnerable households, recognising that rising energy costs and poor infrastructure disproportionately affect rural communities. At the same time, Phase 1 explored the role of agriculturally owned energy assets, such as on farm solar installations and battery storage, as part of a wider community system. These assets can reduce operating costs for farm equipment while also providing additional flexibility and capacity to the shared energy system – a dual purpose approach that maximises the value of local renewables.

Phase 1 activity was structured around five key work packages:

- Stakeholder engagement, including farmers, community groups and DNOs, to test appetite and practical considerations.
- Grid constraints and technical analysis, using DNO data to assess where flexibility and local coordination could reduce pressure on the network.
- Community energy asset mapping, including interviews and analysis of existing and potential renewable assets, such as agrivoltaics.
- Business model development, focusing on community ownership, value sharing and reinvestment of surplus revenue.
- Synthesis and recommendations, drawing together learning on implementation pathways and scalability.

The feasibility work demonstrated that a community driven Virtual Power Plant could offer financial, technical and social benefits. Analysis showed potential for meaningful energy bill savings, alongside improved grid management through flexible generation and storage. Importantly, the model enables surplus value generated through flexibility markets to be reinvested locally, supporting energy efficiency measures and wider community projects.

Phase 1 also showed that a user-friendly, adaptable digital platform is essential for rural deployment. Energy management tools developed through the project provide real time insight to participants, simplify optimisation and support engagement, while remaining flexible enough to reflect the specific needs of different communities. This modularity also creates a foundation for future growth, including the potential integration of emerging technologies such as hydrogen.

Overall, Phase 1 established the RCVPP as a replicable, community owned energy model aligned with Welsh Government priorities for a just transition to Net Zero. It provided a strong evidence base that rural communities can reduce costs, improve resilience and actively participate in the energy transition, setting the foundation for progression into live delivery through HARVEST Phase 2.

Phase 2 – Demonstrator

Phase 2 progressed the Rural Community Virtual Power Plant concept into HARVEST, a Social Virtual Power Plant (SVPP) demonstrator based in Llanidloes. The project brought together locally owned renewable generation, battery storage and flexible demand assets across households, businesses and farms, coordinated through a community driven digital platform that enables local energy optimisation and trading.

HARVEST was designed to move beyond feasibility by testing how a community led Virtual Power Plant can operate in practice within a highly constrained rural grid environment. By aggregating distributed assets rather than relying on large scale grid reinforcement, the project aimed to reduce peak demand, improve resilience and unlock greater value from existing renewable resources.

Phase 2 integrated learning from three complementary Phase 1 projects:

- RCVPP (Centre for Energy Equality), providing the community ownership model and SVPP platform.
- Helping Business Lower the Load (Severn Wye Energy Agency), contributing demand reduction approaches and business scale SLES learning.
- VREM Cymru (Challoch Energy), informing wider system integration and future pathways, including hydrogen.

Together, these strands explored how domestic, agricultural and SME assets can be coordinated within a single local energy system, rather than operating in isolation.

The agreed Phase 2 deliverable was an operational SVPP in Llanidloes, integrating locally owned solar PV, battery storage and flexible demand. The platform enabled local level energy trading, supported by digital forecasting, optimisation and governance tools that reflect community priorities.

Three trial modes will be demonstrated to test different approaches to participation and control, allowing the project to assess how households, farms and businesses can engage with the SVPP under varying levels of automation and user involvement.

HARVEST Phase 2 was also closely aligned with wider investment and delivery pathways; Welsh Government Ynni Cymru funded the community led Llanidloes and District Energy Local Club (£606k) for physical assets including battery storage, a PV array, and domestic PV and battery installations. This demonstrates how the SVPP platform can act as a coordination layer for future capital investment.

Early Phase 2 activity included the launch of the HARVEST platform website, initial engagement with potential participants, and outreach with DNOs, community energy organisations and regional stakeholders. Grid constraint and technical feasibility assessments have identified where flexibility can be deployed most effectively, ensuring that the demonstrator is grounded in real network conditions.

Overall, Phase 2 positioned HARVEST as a live testbed for community led energy systems, demonstrating how rural communities can reduce energy costs, manage constrained grids and retain value locally. It provided an investable, scalable model that supports a fair and inclusive transition to Net Zero, while generating practical evidence to inform future rollout across Mid Wales and beyond.

Key insights

- **For households and communities:** The project showed that community led energy coordination can reduce energy bills and improve resilience in rural areas with weak grid infrastructure. By pooling assets and sharing value through community ownership, households, including those on lower incomes, were able to benefit from local generation and flexibility markets that would otherwise remain inaccessible.
- **For farms and rural businesses:** Participation in a SVPP reduced operating costs and enabled local assets such as on farm solar and batteries to serve both private and community purposes. This dual use approach maximised the value of rural renewables while supporting more efficient energy use across mixed use rural systems.

- **For energy system and network operators:** From a system perspective, aggregating distributed assets delivered clear technical benefits, including reduced peak demand and more effective use of constrained grid capacity. Engagement with DNOs identified tangible opportunities for flexibility to alleviate local constraints without relying on major network reinforcement.

HARVEST highlighted the importance of user centred digital design and strong local governance. A modular, adaptable platform enabled communities to reflect local priorities, build trust and scale participation over time, while phased delivery reduced risk and supported learning by doing.

Benefits

Overall, CEE's work demonstrated how community led energy systems can deliver financial, social, technical and environmental value simultaneously in rural areas with weak grid infrastructure. By reducing energy costs, retaining value locally, improving grid resilience and supporting increased deployment of locally owned renewables, the project provided a credible, inclusive pathway for rural communities to participate actively in the Net Zero transition.

What's next?

HARVEST demonstrated strong commercialisation potential as a community owned energy coordination model. By separating digital system operation from asset ownership, the approach reduced delivery risk while enabling scalable revenue streams through flexibility services, trading and optimisation. Its modular design supports blended delivery models that combine public funding, community investment and private finance, allowing expansion without compromising local governance or inclusive outcomes.

The project also achieved high visibility, supporting confidence building and wider uptake. Activity included the launch of a dedicated HARVEST website hosting the SVPP platform and engagement materials, Welsh Government site visits and briefings showcasing live installations and early learning, and presentations to regional stakeholders, distribution network operators and community energy networks. Together, these activities positioned HARVEST as a flagship example of rural, community led decarbonisation.

Looking ahead, the SVPP model was designed to scale across other rural and agricultural communities facing similar grid and cost challenges. Digital coordination allows new participants and assets to be added incrementally while maintaining system performance and governance. The integration of domestic, business and agricultural assets within a single platform makes the approach particularly well suited to rural contexts, where mixed use energy systems are common.

Overall, the project offers a repeatable blueprint rather than a one off solution. The core elements of community ownership, digital coordination, asset aggregation and value reinvestment can be adapted to different local conditions without redesigning the system from scratch, supporting roll out across Wales and providing a transferable model for rural communities elsewhere in the UK.

Get involved

Communities interested in developing a SVPP can begin by exploring local renewable and flexibility assets, engaging residents, farmers and businesses, and assessing grid constraints in partnership with local authorities or DNOs. The HARVEST approach supports early stage engagement and learning, allowing communities to build understanding and confidence before committing to large scale investment. By starting with digital coordination and phased asset deployment, communities can reduce risk while creating a clear pathway towards long term resilience and local energy ownership. Organisations interested in this approach are encouraged to get in touch to learn more, explore opportunities for collaboration, or apply the learning in their own context.

Project lead

Huw Williams, Regional Energy Officer – Growing Mid Wales
Email: huw.williams2@ceredigion.gov.uk

Organisation contacts

Growing Mid Wales (Challenge Owner)
Website: www.growingmid.wales/

Centre for Energy Equality (Project delivery)
Website: www.cee-uk.com/

Severn Wye Energy Agency (Project delivery)
Website: www.severnwye.org.uk/

Further information

Programme/project overview:
www.growingmid.wales/WSRID

Relevant tools, outputs or case studies:
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5. Rhondda Cynon Taf CBC

Rhondda Cynon Taf CBC: the Challenge

The Rhondda Cynon Taf County Borough Council (RCT) WSRID Challenge responded to a place based opportunity to support the transition from a predominantly export-led, grid-dependent renewable energy model to one that prioritises local use, resilience and community value in a densely populated Valleys context. Led by Rhondda Cynon Taf County Borough Council (RCTCBC), the Challenge focused on how small scale renewable generation could be better integrated with local demand, public sector assets and community priorities, rather than exporting value out of the area.

The Challenge centred on the renewable energy potential of the Nant Clydach corridor, where a micro hydroelectric scheme at Clydach Vale was explored alongside complementary technologies including solar PV, battery storage and the electrification of heat. Rather than treating generation, consumption and trading as separate activities, the RCT Challenge brought these elements together within a single, coordinated system designed to deliver direct local benefit.

Responding to Local Area Energy Plans

The RCT Challenge was grounded in the council's LAEP objectives, which emphasise affordability, local benefit and community focused delivery as central principles of the area's Net Zero transition. In particular, the LAEP identifies the need to move from strategic ambition to practical delivery of locally integrated energy systems that improve resilience and affordability for public assets and communities.

The Challenge addressed a recognised gap between renewable generation potential and the ability of local communities and public assets to access low cost, locally generated electricity. This gap represented a key transition Challenge identified through the LAEP: how locally generated energy can be retained and used locally, rather than exported through the national grid.

A core focus was the development of a private wire connection between the proposed Clydach micro hydro scheme and Ysgol Nantgwyn, a local school identified as a priority local off-taker. This approach was designed to supply renewable electricity directly to local assets, reducing exposure to wholesale market volatility while retaining economic and social value within the community. In doing so, the project tested a transition away from reliance on national market pricing towards locally supplied, price-stable renewable energy. Surplus generation was intended to be managed through a SLES, enabling controlled export, flexibility and future participation in local energy trading arrangements.

By integrating generation, local consumption and energy management within a single scheme, the Challenge addressed both technical and market barriers that can limit the delivery of decentralised renewable energy. The work explicitly tested how innovative approaches to private wire infrastructure, licence exempt local energy trading and digital energy system integration could support wider replication across RCT and similar urban and semi urban areas.

A whole system, community benefit approach

WSRID Phase 1 and Phase 2 activity in RCT was structured around collaboration between multiple specialist suppliers, with each contributing to different elements of the overall system. This included hydropower design and consenting, civil engineering and planning, private wire and solar PV integration, and the development of a local energy trading framework supported by a digital Local Energy Operating System.

Rather than pursuing a single technology outcome, the Challenge explored how coordinated system design can unlock greater community benefit from existing renewable resources. This reflected a deliberate transition from asset-by-asset decarbonisation towards whole-system design. It included assessing AC and DC coupled system configurations, export limited operation, islanding options and the role of battery storage in enabling flexibility and resilience. The work also considered how schools, community organisations and council buildings could participate as priority local off-takers within a future local energy market.

Position within WSRID

Within the wider WSRID programme, the RCT Challenge provided an urban Valleys counterpart to the rural and agricultural Challenges delivered elsewhere. It demonstrated how whole system innovation can be applied in a more densely populated setting, where renewable generation opportunities are smaller in scale but closely aligned with concentrated local demand.

By progressing from feasibility through to detailed design, planning and system integration, the RCT Challenge generated delivery ready evidence to support the transition from LAEP strategy to implementation on how local authorities can maximise the social, economic and carbon value of renewable energy assets. This learning directly supports future investment decisions, informs LAEP delivery and provides a transferable model for community focused renewable energy schemes across Wales.

The RCT Challenge project portfolio:

Clydach Micro-Hydroelectric Scheme

Clydach Hydroelectric Challenge: a place-based challenge exploring how locally owned hydroelectric generation on the Nant Clydach watercourse can directly supply public assets and deliver wider community benefit, while reducing reliance on constrained electricity grids.

The Clydach Micro Hydroelectric Scheme was developed by Stantec (formerly Hydrock). The proposed scheme was a 100-150 kW installation supplying renewable electricity directly to Ysgol Nantgwyn via a 1.3 km private wire, with surplus energy exported to the grid. Across Phases 1 and 2, the work focused on confirming feasibility, preparing the scheme for planning and establishing a clear route toward delivery. This was undertaken through concept design, environmental assessment and financial modelling to support future implementation and community benefit.

Phase 1 – Feasibility

Phase 1 focused on confirming the feasibility of the Clydach Micro Hydroelectric Scheme and defining a clear route toward planning and delivery. The work tested whether a locally-integrated hydropower scheme could be delivered in practice and identified the technical, environmental and commercial considerations that would shape subsequent development.

The Phase 1 programme was delivered by Hydrock/Stantec. Activity included review of a formal grid connection application and completion of surveys covering the intake location, penstock and cable routes, and potential powerhouse locations. Concept designs were developed for all core elements of the scheme, with drawings produced to a level consistent with RIBA Stage 2 to support planning discussions and future design work.

Planning feasibility was strengthened through receipt of formal pre application advice from the local authority and early engagement with Natural Resources Wales (NRW). Environmental considerations were integrated from the outset, including a preliminary ecological appraisal, tree survey work and a flood consequences assessment, to identify constraints and inform future consenting requirements.

Phase 1 also established a robust energy and commercial evidence base. Annual energy yield modelling was undertaken alongside capital cost estimates, revenue projections and a cashflow model. Scenarios were tested at different abstraction levels, reflecting uncertainty prior to the granting of a formal abstraction licence. This allowed early testing of financial viability and sensitivity, helping to shape priorities for further work.

Innovation formed part of the Phase 1 approach. Innovation workshops were held with RCT and Welsh Government to explore opportunities to incorporate new technical approaches into the concept design, including the potential for DC private wire connections. Informal engagement with turbine suppliers supported early consideration of buildability and equipment selection.

Phase 1 also identified the key risks and considerations requiring further investigation. These included noise, coal mining legacy risk, flood risk, construction and traffic impacts, land ownership considerations, and potential effects on green infrastructure, ecology and arboriculture, including the presence of ancient woodland within the site context. These risks were documented to inform the scope and priorities of subsequent phases.

Phase 1 concluded that the Clydach Micro Hydroelectric Scheme:

- Was technically feasible, aligned with local policy and LAEP priorities, and capable of delivering clear public benefit.
- Established a favourable planning position, including a defined planning strategy and early engagement with key constraints.
- Produced credible evidence on buildability, affordability and financial viability in principle.
- Identified and scoped the remaining technical, environmental and consenting risks.
- Set out a clear and structured pathway for progression into Phase 2 through targeted survey work, refined design and further consenting activity.

Phase 2 – Demonstrator

Phase 2 focused on advancing the Clydach Micro Hydroelectric Scheme from feasibility into a planning ready proposition. Building on the foundations established in Phase 1, the work concentrated on:

- Progressing detailed design development.
- Completing environmental and geotechnical assessments.
- Preparing the scheme for planning submission.
- Strengthening procurement readiness.
- Refining cost estimates and financial models to support future delivery decisions.

Phase 2 activity was delivered in close coordination with wider local energy infrastructure and community benefit objectives, to ensure the scheme remained aligned with LAEP priorities and future investment decisions.

Key insights

- **For project development and delivery:** Phase 2 demonstrated that advancing small-scale hydropower in constrained environments requires early and sustained integration of engineering, environmental and planning workstreams. Progressing these elements in parallel allowed design decisions to respond directly to site-specific constraints, regulatory requirements and buildability considerations, reducing the risk of late-stage redesign and strengthening confidence in deliverability.

- **For regulators and consenting bodies:** The work reinforced the importance of early and ongoing engagement with regulators, particularly NRW. Sustained dialogue supported progress on abstraction and impoundment licensing and helped align environmental mitigation measures with scheme design, reducing uncertainty ahead of planning submission and supporting a more efficient consenting process.
- **For system integration and local energy use:** A key insight was the value of designing hydropower as part of a wider local energy system rather than as a standalone asset. Coordination with private-wire infrastructure and local energy use proposals ensured the scheme was shaped to maximise local benefit, support long-term system resilience and align with LAEP priorities.
- **For multi-disciplinary delivery teams:** Phase 2 highlighted the benefits of coordinated working across civil engineering, planning, ecology, arboriculture, geotechnical assessment and cost consultancy. Addressing site constraints, environmental requirements and constructability together supported a coherent, planning-ready proposition and reduced delivery risk across disciplines.

Benefits

Overall, Phase 2 delivered a planning ready Clydach Micro-Hydroelectric Scheme supported by a comprehensive and coordinated evidence base. The work resolved key technical, environmental and commercial uncertainties, strengthened confidence in feasibility and deliverability, and established a clear, structured pathway toward procurement and future implementation. By embedding regulatory requirements, system integration and community benefit considerations from the outset, the project was positioned to progress efficiently toward planning determination while maximising long term local value.

What’s next?

Following Phase 2, the project is positioned to move toward planning determination, targeted for March 2026. Subject to planning approval and confirmation of funding pathways, the next steps include progression to detailed design, contractor procurement and pre construction activity.

The evidence and documentation produced during Phase 2 provide a strong foundation for these next stages, enabling informed decision making and reducing uncertainty as the project moves toward delivery.

Get involved

The Phase 2 approach offers transferable learning for local authorities and public sector bodies considering hydropower or other place based renewable energy projects. Early investment in integrated design, environmental assessment and planning preparation can significantly reduce risk and improve deliverability. Engaging regulators and technical specialists early, and aligning renewable generation with local demand and community benefit objectives, can help create resilient pathways from feasibility to implementation while maximising local value. Organisations interested in this approach are encouraged to get in touch to learn more, explore opportunities for collaboration, or apply the learning in their own context.

Project lead

Katie Trembath, Carbon Reduction Officer – Rhondda Cynon Taf CBC
Email: katie.trembath@rctcbc.gov.uk

Organisation contacts

Rhondda Cynon Taf County Borough Council (Challenge Owner)
Website: www.rhondda-cynon-taf.gov.uk/

Stantec (Project delivery)
Website: www.stantec.com/en

Further information

News and social media:
www.linkedin.com/feed/update/urn:li:share:7422200423371083776/

Ysgol Nantgwyn Smart Local Energy System (SLES) Assessment

RCT's Ysgol Nantgwyn Smart Local Energy System Assessment assessed how on-site and locally generated renewables, centred on a proposed micro-hydro scheme, can be integrated with storage, electrification and smart controls to maximise on site energy use and distribute surplus power through an Energy Club model, delivering direct cost and resilience benefits to the school and wider local community.

Challoch Energy ltd led the work to assess how benefits from locally generated renewable energy could be maximised at Ysgol Nantgwyn. The focus was on integrating a proposed micro hydro scheme with complementary technologies. The project explored how hydropower, solar PV, battery storage, electric heating and smart energy systems could be combined to reduce reliance on grid electricity, lower energy costs and support wider decarbonisation and community benefit objectives. This work provided an evidence-based foundation for developing a SLES aligned with RCT's LAEP priorities.

Phase 1 – Feasibility

Phase 1 focused on assessing how renewable electricity from the proposed micro hydro scheme could be used most effectively to maximise its utilisation at Ysgol Nantgwyn. Working closely with RCT, Challoch assessed how different energy assets could be integrated to support decarbonisation, improve energy resilience and reduce operating costs for the school and the wider council estate.

The assessment examined multiple options, including a direct current (DC) private wire connection between the hydro scheme and the school, designed to reduce conversion losses; the role of battery energy storage in load balancing, peak shaving and resilience; and opportunities to deploy additional renewable generation. Rooftop solar PV, ground mounted solar and wind were also assessed.

The work also considered how a SLES could coordinate generation, storage and demand using digital tools, enabling licence exempt local energy supply and virtual energy trading between council buildings and community assets.

Detailed analysis of the school's hourly electricity and gas demand was undertaken to understand usage patterns and peak demand periods. This analysis informed modelling of renewable generation from solar PV and wind, alongside initial consideration of hydro generation profiles. Gas consumption was assessed to evaluate the feasibility of replacing fossil fuel use with heat pumps, supporting electrification of heat and reducing long term operating costs.

Phase 1 moved beyond high-level option appraisal into early system definition. The private wire route between the hydro scheme and the school was designed and the powerhouse location confirmed, enabling clearer understanding of infrastructure requirements and constraints. Designs were also developed for additional rooftop solar PV at Ysgol Nantgwyn, and the core architecture for a Local Energy Trading Scheme and Local Energy Operating System was set out. This aligned with the school's wider decarbonisation plans and Low Carbon Heat Grant activity.

The study included a detailed review of the private wire connection, with assessment of both AC and DC transmission options. Two potential route options were examined: one constrained by third party land ownership and protected woodland, and another requiring careful management of trenching space and routing around existing infrastructure. Following technical and efficiency assessments, DC transmission at 1,500 volts was identified as the preferred solution due to reduced conversion losses, improved efficiency and greater flexibility for future system expansion.

Alongside technical assessments, Phase 1 considered economic and delivery factors. Cost-benefit analysis was used to assess capital and operational costs, payback periods and overall economic viability. Regulatory compliance, grid integration requirements, site constraints and existing infrastructure were reviewed to identify potential deployment barriers and inform future project development. Grid export limitations at the site were identified early, reinforcing the need for smart control, battery storage and selective islanding to maximise local use of renewable generation.

Overall, Phase 1 demonstrated that integrating hydropower, solar generation and battery storage at Ysgol Nantgwyn could significantly reduce reliance on grid electricity, lower carbon emissions and improve energy resilience. The work confirmed that a DC private wire connection, supported by smart energy management and licence exempt local energy supply, offered the most efficient and flexible approach to maximising the value of locally generated renewable energy.

By aligning technical feasibility with economic viability, grid constraints and LAEP priorities, Phase 1 established a clear strategic direction for future development, identifying priority technologies, optimal system sizing and key delivery considerations. This provided a robust evidence base to support progression into further design, system optimisation and exploration of additional opportunities in subsequent phases.

Phase 2 – Demonstrator

Phase 2 focused on refining the Phase 1 system assessment into designs that could support implementation at Ysgol Nantgwyn and form the basis of a wider SLES. Building on the feasibility work, Phase 2 progressed detailed design, system integration, planning and procurement readiness, with the aim of maximising the local use of renewable energy while delivering community benefit and long term resilience.

Drawing on detailed supplier modelling and technical reports, the work moved the project from concept into a delivery ready position, with final specifications completed for the private wire connection, rooftop solar PV installations and system integration architecture. This was supported by detailed energy modelling, design risk assessment and planning documentation prepared during Phase 2.

Low Carbon Heat Grant Funding

Phase 2 activity was closely aligned with parallel investment through the Welsh Government Energy Service's Low Carbon Heat Grant (LCHG), which part-funded (£277k) the installation of four 50kW air source heat pumps at Ysgol Nantgwyn. Although the heat pump installation was outside the WSRID funding scope, supplier modelling confirmed that coordinating the two programmes was beneficial to overall system performance.

Running the WSRID Phase 2 work alongside the LCHG installation ensured that electrified heating demand was designed as a key part of the wider energy system. This avoided increasing reliance on grid electricity and instead enabled new electrical loads to be optimised through on site renewables, battery storage and smart control, as evidenced in the supplier energy models.

Key insights

- **For system design and technical integration:** Phase 2 demonstrated the importance of progressing renewable generation, demand reduction and system control together rather than as separate workstreams. Finalising the private wire design, solar PV layouts, battery storage and energy trading architecture in parallel allowed decisions to be tested against real site constraints, grid limits and operational requirements, avoiding late stage redesign and strengthening overall system performance.

  Supplier energy modelling showed that combining additional solar PV, hydropower delivered via a DC private wire and expanded battery storage could reduce grid electricity imports to minimal levels, while enabling the site to become a net exporter of renewable electricity. This whole system approach delivered significantly stronger carbon and cost outcomes than deploying individual technologies in isolation.

- **For RCT and public sector estates:** The work highlighted the value of treating public sector buildings as anchor assets within a wider local energy system. Designing storage, control and trading infrastructure around Ysgol Nantgwyn enabled the school to support optimisation across the wider council estate, while maintaining alignment with LAEP priorities and long term decarbonisation objectives.

  Phase 2 also reinforced the benefits of coordinating capital programmes. Supplier modelling confirmed that aligning WSRID system design with Low Carbon Heat Grant-funded electrified heating delivered stronger system level outcomes than progressing interventions independently.

- **For Ysgol Nantgwyn and local users:** The project showed that electrified heat, on site renewables, storage and smart control could be integrated into a single, efficient energy system at school scale. Modelling confirmed that this approach could significantly reduce reliance on grid electricity, lower long term operating costs and improve resilience compared to the original gas heated baseline, while creating the conditions for wider local benefit beyond the site.

- **For community organisations and wider local benefit:** Engagement with community stakeholders, including Cambrian Village Trust, demonstrated the importance of designing energy trading and system control around real demand profiles and local use cases. Locating storage and control infrastructure at the school, rather than at remote generation assets, delivered greater flexibility, resilience and value retention, supporting future community energy participation and just transition objectives.
- **For delivery partners:** Phase 2 confirmed the value of integrated system design across generation, demand, storage and control. Finalising specifications for the DC private wire, rooftop solar PV, Energy Trading Scheme and Local Energy Operating System in parallel enabled technical, commercial and regulatory considerations to be addressed together, reducing delivery risk and strengthening confidence in the robustness and scalability of the solution.

Benefits

Overall, Phase 2 established a clear, deliverable pathway for implementing a locally optimised renewable energy system at Ysgol Nantgwyn. By integrating hydropower, solar generation, battery storage, electrified heat and smart control within a single system architecture, the work reduced delivery risk, strengthened alignment with LAEP priorities and maximised the value of locally generated renewable energy. The project positioned the school as an anchor asset within a wider local energy system, supporting lower energy costs, improved resilience, reduced carbon emissions and the potential for shared community benefit, while providing a replicable model for other public sector sites.

What's next?

With final specifications, modelling and risk assessments completed, the project is well positioned to move toward implementation, subject to planning outcomes and confirmation of capital funding. Near term priorities include installation of additional rooftop solar PV at Ysgol Nantgwyn, progression of the private wire connection and phased activation of the Energy Trading Scheme.

Further development opportunities include wind turbine feasibility, ground mounted solar deployment and exploration of green hydrogen production, building on the system architecture defined through supplier reports and modelling.

Phase 2 outputs directly informed wider Challenge activity and subsequent delivery planning. In parallel, a supplier led energy audit was completed for Cambrian Village Trust to assess suitability for participation in a local energy trading arrangement, providing a practical route for extending the benefits of locally generated renewable electricity into the surrounding community as the system develops.

Get involved

The Phase 2 approach provides a replicable model for schools and other public sector sites seeking to maximise local renewable energy use. Supplier led modelling and system design demonstrated the value of early, integrated assessment followed by phased delivery, enabling organisations to reduce risk while unlocking early carbon and cost benefits.

Outputs from Phase 2, including system architecture, modelling approaches and delivery documentation, are being used to inform a practical "How to" guide to support replication across other public sector and community sites. Organisations interested in this approach are encouraged to get in touch to learn more, explore opportunities for collaboration, or apply the learning in their own context.

Project lead

Katie Trembath, Carbon Reduction Officer – Rhondda Cynon Taf CBC
Email: katie.trembath@rctcbc.gov.uk

Organisation contacts

Rhondda Cynon Taf County Borough Council (Challenge Owner)
Website: www.rhondda-cynon-taf.gov.uk/

Challoch (Project delivery)
Website: www.challoch-energy.com/

Further information

Addition support by: www.gov.wales/local-authority-low-carbon-heat-capital-grant

News and social media:
www.linkedin.com/feed/update/urn:li:share:7422200423371083776/

Wind Turbine Assessment & detailed hydro design

RCT's Wind Turbine Assessment and detailed Hydropower Design project undertook an initial borough-wide assessment of wind resource and grid constraints to inform local renewable opportunities, followed by detailed, delivery-ready design of the Clydach micro-hydro scheme as the most viable route to near-term community-benefit generation.

Renewables First Ltd led the work to assess the potential for wind energy generation across Rhondda Cynon Taf. The assessment focused on identifying deliverable opportunities for new wind development, with an emphasis on local authority controlled land and models that could maximise local and community benefit.

Phase 1 – Feasibility

Phase 1 focused on assessing the potential for wind energy generation across upland areas within the RCT local authority boundary. While the area already hosts several operational wind farms, the assessment concentrated on undeveloped land, prioritising areas under local authority ownership or control to maximise opportunities for local benefit and delivery.

The core activity was the development of a comprehensive physical and planning constraints map covering the full RCT area. Using GIS tools, Renewables First produced a detailed spatial model incorporating environmental, planning and technical constraints to identify land unsuitable for wind development. Upland areas were prioritised due to their higher wind resource potential, with council controlled land assessed first where data was available.

Following this initial filtering, the remaining unconstrained land was subjected to more detailed analysis to identify developable areas and consider appropriate turbine scales, including large-scale (around 5 MW), medium-scale (around 1 MW) and smaller-scale 100 kW turbines. The study assessed both RCT owned and third party land, recognising that a mix of ownership models may be required to unlock the full potential of wind generation in the area.

Wind resource analysis was undertaken to estimate mean wind speeds at hub height, enabling indicative assessments of annual energy production. This was combined with high level estimates of project costs, potential income and peak power output to understand the scale of opportunity across different sites. Consideration was also given to proximity to publicly owned energy loads, highlighting opportunities for local consumption of generated electricity rather than export alone.

The work was structured to enable progression beyond high level assessment. For sites identified as potentially viable, Renewables First set out indicative next steps, typically involving full wind feasibility studies covering detailed environmental assessment, ground conditions, access and grid connection requirements. Distribution Network Operator (DNO) heat maps were also reviewed to provide early insight into connection opportunities and constraints.

Phase 1 concluded that:

- There is substantial untapped potential for wind energy generation within RCT.
- Sufficient unconstrained land exists to support up to approximately 237 MW of additional installed capacity, capable of generating an estimated 955 MWh of electricity annually. This level of generation could meet a significant proportion of the county borough's electricity demand, supporting decarbonisation ambitions and reducing reliance on imported grid electricity.
- Grid constraints are likely to be less limiting where wind generation is designed to support local consumption rather than export alone.
- Designing schemes around local use and ownership models could unlock wider benefits, including lower cost electricity and retention of economic value within the local area.
- Key issues requiring further investigation were clearly identified, including grid connection capacity, site access and the presence of coal tips.
- The work established a clear and prioritised pipeline for further feasibility and development activity.
- Wind energy was positioned as a strategic component of a locally integrated, community focused renewable energy system for Rhondda Cynon Taf.
- The initial driver for assessing wind potential across the borough was to gather evidence on how wind energy could be integrated into the local supply mix at Ysgol Nantgwyn. While this remains a viable option, RCT chose to prioritise further development of the hydropower scheme. As a result, Phase 2 focused on utilising Renewables First's expertise to progress a detailed and delivery-ready hydro design, building on the strongest and most immediate opportunity identified through earlier work.

Phase 2 – Demonstrator

Phase 2 focused on enabling delivery of locally integrated renewable energy projects by providing detailed technical design and advisory support to the Clydach Micro hydropower scheme supplying Ysgol Nantgwyn. Building on the Phase 1 evidence base for local renewable generation, Renewables First's role in Phase 2 centred on progressing a real world, buildable project that demonstrated how generation can be directly linked to local demand through innovative system design.

Alongside hydropower design, Renewables First supported the development of a Local Energy Market approach by attending stakeholder group meetings and providing technical input. This ensured that learning from the hydropower project could inform wider thinking on how wind and other renewable technologies might be deployed for local energy use rather than export alone.

Key insights

- **For strategic planning and local authority decision making:** Phase 1 demonstrated that Rhondda Cynon Taf has substantial untapped potential for wind energy generation, particularly on upland land under local authority ownership or control. The use of GIS based constraint mapping provided a robust, evidence led way to identify developable sites and prioritise a pipeline of opportunities aligned with local benefit and delivery objectives. Designing wind generation around local consumption rather than export alone emerged as a critical factor in reducing grid constraints and maximising value for the local authority.
- **For system integration and local energy use:** Phase 2 reinforced the importance of linking renewable generation directly to local demand through integrated system design. Technical work on the Clydach Micro hydropower scheme demonstrated how private wire connections and DC linked systems can enable renewable electricity to serve anchor loads efficiently, reducing reliance on grid export. Learning from generator control, electrical configuration and operational stability under DC linked systems provides transferable insight for future wind projects intended to support local energy use rather than standalone generation.
- **For technical design and buildability:** The work highlighted that locally integrated renewable projects require early, detailed technical design to address buildability, consenting and operational constraints. Iterative design development during Phase 2 allowed site specific issues to be resolved while maintaining compatibility with an innovative local energy system. Optimising available resource within constrained sites was shown to be critical, with relatively small design decisions having a material impact on output, efficiency and long term viability.
- **For regulators and consenting bodies:** Early and ongoing engagement with NRW and other consenting bodies supported alignment between scheme design and environmental requirements. Integrating environmental considerations from the outset reduced uncertainty ahead of consent applications and helped ensure that mitigation measures were embedded within layout and design decisions, rather than retrofitted later in the process.
- **For community benefit and just transition outcomes:** Across both phases, the work reinforced that renewable generation delivers greater social and economic value when designed around local use, ownership and benefit. Prioritising local offtake supports affordability, resilience and retention of economic value within the community, aligning wind and hydropower development with just transition principles and wider place based decarbonisation strategies.

Benefits

Overall, the Renewables First work strengthened the strategic and technical foundations for locally integrated renewable energy delivery in Rhondda Cynon Taf. Phase 1 established a clear, prioritised pipeline for wind development aligned with local authority ownership, community benefit and system constraints, while Phase 2 demonstrated how renewable generation can be designed to serve local demand directly through innovative system integration. Together, the work reduced delivery and consenting risk, improved confidence in feasibility and buildability, and provided transferable learning for future wind and hydropower projects. By embedding local consumption, system integration and community benefit into project design, the approach supports lower cost, more resilient and more inclusive renewable energy delivery aligned with LAEP priorities.

What's next?

The next step is to finalise detailed designs and progress installation of the Clydach Micro-hydropower scheme, subject to planning and environmental consents. This will include refining civil, electrical and control systems and continuing coordination with project partners.

For wind projects, Phase 1 learning supports the move from high level assessment to site specific feasibility and delivery, with a stronger focus on designing schemes around clear local demand and integrated system operation. This approach creates opportunities for community ownership, public sector power purchase arrangements and hybrid commercial structures that are directly applicable to future wind projects.

Learning from Phase 2 was shared through WSRID programme reporting and mid term review materials, contributing to wider communications on maximising renewable energy generation for community benefit. The approach tested combining detailed technical design with engagement in a Local Energy Market and whether this is scalable across other sites and technologies, with principles that can be applied to wind projects of varying scale where local demand and system integration are priorities. Taken together, Phases 1 and 2 provide a repeatable framework: identifying local renewable potential, progressing priority projects through delivery focused design, integrating generation with local demand, and sharing learning through collaborative stakeholder structures.

Get involved

Phase 2 illustrates the value of pairing early renewable resource assessment with targeted technical design and system integration support. Local authorities and community organisations seeking to develop wind projects for local energy use can benefit from adopting a similar approach: identifying anchor loads, considering private wire or alternative connection strategies, and engaging early with technical specialists and regulators.

Participation in local energy forums and stakeholder groups can help align individual projects with wider system objectives and reduce delivery risk. Organisations interested in this approach are encouraged to get in touch to learn more, explore opportunities for collaboration, or apply the learning in their own context.

Project lead

Katie Trembath, Carbon Reduction Officer – Rhondda Cynon Taf CBC
Email: katie.trembath@rctcbc.gov.uk

Organisation contacts

Rhondda Cynon Taf County Borough Council (Challenge Owner)
Website: www.rhondda-cynon-taf.gov.uk/

Renewables First (Project delivery)
Website: www.renewablesfirst.co.uk/

Further information

News and social media:
www.linkedin.com/feed/update/urn:li:share:7422200423371083776/

6. Cardiff Capital Region

Cardiff Capital Region: the Challenge

The Cardiff Capital Region (CCR) Challenge responded to one of the most persistent and complex decarbonisation challenges facing local authorities in Wales: reducing emissions from council vehicle fleets, particularly heavy and specialist vehicles that can be difficult to electrify.

CCR is a partnership of ten local authorities in South East Wales, focused on economic growth, investment, and transport infrastructure. This region is home to almost half of Wales' population and spans a highly diverse geography. It includes dense urban centres, former industrial Valleys communities, rural hinterlands and a coastal belt. This diversity creates wide variation in fleet operations, with routes that are long and short, flat and steep, urban and rural, often within the same local authority. These conditions place significant demands on vehicles and infrastructure, making fleet decarbonisation more challenging than in more uniform urban areas.

While greenhouse gas emissions across the region have fallen substantially since 2005, transport emissions have reduced at the slowest rate and have increased in recent years. Local authority fleets, and in particular refuse collection vehicles (RCVs), represent one of the largest remaining sources of operational emissions. RCVs are energy intensive, operate on fixed daily routes, and must perform reliably in demanding conditions, making them a critical but challenging target for decarbonisation.

LAEPs across CCR consistently identify fleet decarbonisation as a priority action. However, they also highlight clear constraints. While battery electric vehicles (BEVs) are expected to be the dominant solution for many fleet types, LAEP evidence shows that electrification alone may not be viable for all vehicle classes or routes. Challenges include long daily duty cycles, steep gradients, limited depot electrical capacity, high power charging requirements and operational inflexibility where vehicles cannot be taken off route or out of service for extended charging periods.

Against this backdrop, the CCR WSRID Challenge was designed to take a whole systems approach to fleet decarbonisation. Rather than prescribing a single technology pathway, the Challenge set out to generate robust real world evidence on how different zero emission options perform under CCR's varied operating conditions. It explored how hydrogen based solutions compare to battery electric vehicles for the most demanding fleet applications, helping local authorities decarbonise without compromising service delivery.

The Challenge focused on two closely linked questions:

- **Which RCV routes and duty cycles are most difficult to decarbonise using BEVs, and why?** In particular, the work examined RCV operations involving long daily routes, steep gradients, high payloads, frequent stop-start driving and limited depot electrical capacity, all of which can constrain BEV range, charging time and operational flexibility.
- **Where can hydrogen fuel cell electric RCVs provide a more practical zero-emission alternative to BEVs for these use cases, and under what conditions?** The Challenge set out to compare hydrogen and battery-electric RCVs on the same collection routes, assessing performance, refuelling and charging requirements, infrastructure needs and operational impacts to determine which technology is best suited to different RCV operating contexts.

To answer these questions, CCR used WSRID to bring together multiple local authorities, specialist delivery partners and academic expertise. Phase 1 focused on detailed fleet analysis, route and duty cycle assessment, and feasibility studies for both hydrogen vehicles and refuelling infrastructure. This work identified RCVs as the priority vehicle type for further investigation and confirmed that hydrogen fuel cell electric vehicles could offer operational advantages on certain routes where battery electric options face limitations.

Phase 2 moved beyond feasibility into real world demonstration. By trialling hydrogen and battery electric refuse vehicles side by side on live council routes in different parts of the region, the Challenge is generating practical evidence on vehicle performance, energy use, reliability, driver experience and infrastructure requirements. This approach directly responds to LAEP priorities by reducing technology risk, informing future investment decisions and supporting a coordinated regional approach rather than fragmented authority by authority trials.

Within the wider WSRID programme, the CCR Challenge provides a regional transport counterpart to the place based energy system Challenges delivered elsewhere. It demonstrates how whole systems thinking can be applied to fleet decarbonisation, integrating vehicles, infrastructure, energy supply and operational realities. The learning generated is designed to support not only CCR local authorities, but councils across Wales facing similar fleet Challenges, helping accelerate progress towards zero emission public sector transport.

The CCR Challenge project portfolio:

Optimal Locations for Hydrogen Refuelling Infrastructure

Optimal Locations for Hydrogen Refuelling Infrastructure focused on a regionally coordinated assessment of green hydrogen production and refuelling infrastructure to support decarbonisation of heavy-duty local authority fleet vehicles where battery-electric options are not currently viable.

Challoch Energy Ltd led Phase 1 feasibility work for this CCR WSRID Challenge project, assessing whether and where hydrogen refuelling infrastructure could support the decarbonisation of local authority fleets. The work focused on heavy duty vehicles that are challenging to electrify and aimed to generate robust, place specific evidence to inform future decisions, aligned with LAEP priorities and real fleet operations.

Phase 1 – Feasibility

Phase 1 explored the potential role of hydrogen in supporting fleet decarbonisation across CCR, recognising that hydrogen may offer a solution for certain heavy-duty vehicles and operational contexts where electrification alone is constrained. The work was deliberately framed to test feasibility, risks and delivery conditions, rather than assuming hydrogen deployment as a default outcome.

The study combined fleet, route and operational data from three lead local authorities: Monmouthshire County Council, Rhondda Cynon Taf County Borough Council and Caerphilly County Borough Council, with technical and spatial analysis of potential refuelling locations. This enabled Challoch to assess hydrogen refuelling requirements in the context of real duty cycles, depot locations and operational constraints.

Potential refuelling sites were assessed against a range of practical criteria, including space and accessibility, proximity to depots and routes, availability of utilities and non-potable water, flood risk, security considerations and proximity to existing or potential renewable energy assets. While a number of sites were identified as capable of supporting refuelling activity, later findings confirmed that none were immediately suitable for on-site hydrogen production without further development.

Building on this evidence, Challoch analysed spatial alignment between potential refuelling locations and areas of highest fleet demand across CCR, alongside technical feasibility of different infrastructure models. Fixed and mobile refuelling options were assessed in relation to safety, regulatory compliance, supply chain readiness, infrastructure complexity and cost.

Five potential hydrogen production and supply locations were identified and assessed in detail: Bryn Pica, Coed Top, Rhymney, Caldicot and Raglan. Of these, Bryn Pica emerged as the most favourable option, with Caldicot and Coed Top identified as viable alternatives. To manage development risk, the study recommended progressing more than one site in parallel.

Overall, the evidence supported a hybrid refuelling approach during early stages of hydrogen adoption. Combining a fixed production and storage facility with mobile refuelling to serve satellite depots was identified as a lower-risk and more flexible pathway while demand builds and technology matures.

The work highlighted that hydrogen refuelling feasibility is shaped as much by operational reality as by technology readiness. It reinforced the importance of designing infrastructure around fleet routes, depots and duty cycles; recognising that early hydrogen demand from local authority fleets alone may be insufficient to justify permanent infrastructure without aggregation; and coordinating across multiple authorities to create a shared demand base. This structured feasibility approach helped clarify where hydrogen could play a role, and where it may not, within LAEP delivery.

While the Optimal Locations for the Hydrogen Refuelling project generated valuable feasibility insight during Phase 1, it did not progress into Phase 2. This decision reflected the scale of capital investment required to develop hydrogen refuelling infrastructure at this stage, which was not considered proportionate within the scope of the Phase 2 demonstrator programme. Nevertheless, the work provided an important evidence base that informed wider fleet decarbonisation activity and supported decision-making on hydrogen deployment pathways, ensuring that learning from the project continued to add value beyond Phase 1.

Key insights

- **For local authorities and fleet operators:** The feasibility work showed that hydrogen may play a role in decarbonising specific heavy duty fleet applications where electrification is constrained, but only under clearly defined operational conditions. Designing refuelling infrastructure around real fleet routes, depot locations and duty cycles was critical to understanding where hydrogen could be viable in practice. The work reinforced that early hydrogen demand from individual local authority fleets is unlikely to justify permanent infrastructure without aggregation across authorities or vehicle types.
- **For Cardiff Capital Region and LAEP delivery:** At a regional scale, the study demonstrated the value of coordinating hydrogen planning across multiple authorities rather than progressing isolated, site by site solutions. Assessing refuelling locations alongside spatial patterns of fleet demand helped clarify where shared infrastructure could support LAEP objectives, manage risk and avoid stranded assets. The work also highlighted that hydrogen's role must be considered alongside grid constraints, renewable generation potential and wider decarbonisation pathways, rather than in isolation.

- **For infrastructure design and delivery models:** The assessment confirmed that early hydrogen adoption is better supported through flexible, lower risk delivery models. A hybrid approach: combining fixed production and storage with mobile refuelling, emerged as a more practical pathway while demand builds and technology matures. Evaluating fixed and mobile options together allowed safety, regulatory, cost and operational considerations to be tested realistically, reducing the risk of over committing to permanent infrastructure too early.
- **For delivery partners and the supply chain:** The work highlighted the importance of early clarity on delivery risks, infrastructure requirements and timescales. By identifying sites that were technically feasible but not yet suitable for on site production, the study provided valuable insight into where further development, investment or enabling work would be required. It also identified opportunities to align future hydrogen deployment with skills development and training provision, supporting longer term supply chain readiness.

For Phase 2 vehicle trials and live demonstrations

Although hydrogen refuelling infrastructure was not progressed into a standalone Phase 2 demonstrator, the feasibility evidence directly informed the design of the Phase 2 hydrogen refuse vehicle trials. Findings shaped decisions on temporary refuelling arrangements, site selection, safety controls and risk management, ensuring that Phase 1 learning reduced uncertainty and de risked live vehicle demonstrations.

Benefits

Overall, Challoch’s Phase 1 feasibility work provided CCR and participating local authorities with a clear, evidence based understanding of where hydrogen refuelling could realistically support fleet decarbonisation and where constraints remain. By grounding analysis in real fleet data, operational requirements and spatial constraints, the study reduced uncertainty around infrastructure needs, delivery risk and timescales. The work strengthened strategic decision making for LAEP delivery, informed Phase 2 vehicle trials, and ensured that hydrogen was considered as a targeted, conditional option within a wider, place based decarbonisation approach rather than a default solution.

What’s next?

While Phase 1 identified technically feasible options for hydrogen refuelling in CCR, the project was not progressed into a standalone Phase 2 infrastructure demonstrator. Instead, learnings from this project directly informed the design and delivery of the Phase 2 vehicle trials. The feasibility work shaped decisions around temporary refuelling arrangements, site selection, safety requirements and risk management for the live hydrogen refuse vehicle demonstrations. This ensured that Phase 1 evidence continued to add value by de risking delivery, even without immediate infrastructure investment.

Get involved

Local authorities considering hydrogen refuelling can draw on the Challoch Phase 1 approach by starting with evidence rather than technology commitment. Practical first steps include identifying vehicle types and routes that are genuinely difficult to electrify, mapping depots and spatial constraints, assessing opportunities to aggregate demand across fleets or neighbouring authorities, and considering mobile or hybrid refuelling solutions as an entry point. The Challoch Phase 1 work demonstrates how early, structured feasibility can support informed decisions, reduce risk and align fleet decarbonisation with LAEP priorities. Organisations interested in this approach are encouraged to get in touch to learn more, explore opportunities for collaboration, or apply the learning in their own context.

Project lead

Emma Wakeham, Local Area Energy Plan Programme Manager – Cardiff Capital Region
Email: Emma.Wakeham@cardiffcapitalregion.gov.uk

Organisation contacts

Cardiff Capital Region (Challenge Owner)
Website: www.cardiffcapitalregion.wales/

Challoch Energy (Project delivery)
Website: www.challoch-energy.com/

Further information

News and social media:
www.linkedin.com/feed/update/urn:li:share:7422200423371083776/

Hydrogen and Battery Electric Refuse Vehicle Trial

The Hydrogen and Battery Electric Refuse Vehicle Trial carried out a real-world, side-by-side trial of hydrogen fuel-cell and battery-electric refuse collection vehicles on live council routes to generate operational evidence on performance, reliability and suitability for heavy-duty fleet decarbonisation in the Cardiff Capital Region.

Ricardo-AEA Ltd was solution provider for this project. They are a global strategic, environmental and engineering consultancy with extensive expertise in transport decarbonisation and low-carbon vehicle technologies. Within the CCR WSRID project, Ricardo's work focused on supporting local authorities to make informed, evidence-based decisions on how to decarbonise the most demanding elements of their vehicle fleets, particularly in cases where battery-electric solutions alone may not be suitable.

The work sought to identify which RCV duty cycles are most challenging to electrify, and to understand where hydrogen based solutions could offer a practical zero emission alternative. Phase 1 established an evidence base using real fleet data, routes and duty cycles across three local authorities, while Phase 2 tested these findings in practice through live trials of hydrogen and battery electric RCVs on operational council routes. Together, this approach aimed to generate robust operational insight to inform future fleet investment decisions and LAEP delivery.

Phase 1 – Feasibility

Phase 1 of the CCR Ricardo project focused on building a robust understanding of which local authority vehicle types are most challenging to decarbonise using current battery electric technology, and where hydrogen powertrains could offer a viable alternative.

Working with three local authorities in the Cardiff Capital Region: Monmouthshire County Council, Rhondda Cynon Taf County Borough Council and Caerphilly County Borough Council, Ricardo undertook a structured feasibility study that combined fleet and route data, vehicle technical specifications and operational constraints. The work began with a review of existing literature to ensure the study complemented, rather than duplicated, previous research, before moving into detailed data gathering on vehicle duty cycles, daily energy consumption and route characteristics across the participating fleets.

This analysis covered a wide range of vehicle types, including RCVs, street sweepers and other specialist vehicles, and assessed the suitability of battery electric options to identify those vehicles where electrification alone may not be feasible. Building on this, Ricardo investigated hydrogen fuel cell electric vehicles, hydrogen internal combustion engine (ICE) options and dual fuel pathways, using Original Equipment Manufacturer (OEM) technical data and energy consumption modelling to assess feasibility. The study then compared multiple transition scenarios, including dual fuel, fuel cell electric and hydrogen ICE, against a diesel counterfactual, calculating emissions reductions and total cost of ownership for each option, with indicative milestones in 2030 and 2035. This also enabled Ricardo to estimate potential hydrogen demand across the participating authorities under different uptake scenarios. Together, the Phase 1 work provided a clear prioritisation of vehicle types and routes suitable for hydrogen deployment and established a strong evidence base to inform the design of real world trials in Phase 2.

Phase 2 – Demonstrator

Phase 2 moved from feasibility into real world demonstration, translating Phase 1 evidence into live operational trials. Building on the identification of RCVs as a priority use case, the project tested whether hydrogen fuel cell electric vehicles and battery electric vehicles could meet the demanding duty cycles of local authority operations in practice. Live trials were delivered across two participating councils: Caerphilly County Borough Council and Rhondda Cynon Taf County Borough Council, enabling side by side comparison of hydrogen and electric refuse vehicles on real routes, under real operating conditions. The demonstrator was designed to generate both quantitative performance data and qualitative operational insight, capturing how vehicles performed in terms of range, gradient capability, payload, energy use and reliability, alongside feedback from drivers, crews and fleet managers. Refuelling and charging were supported through temporary infrastructure, with safety cases, training and operational planning embedded from the outset to minimise risk and disruption. While the BEV trial progressed largely as planned, technical issues with the hydrogen RCV caused delays, with repairs ongoing at the time of writing and trials not yet completed, meaning that final performance conclusions will depend on the completion of further testing.

Key insights

- **For local authorities and fleet managers:** The project demonstrated that not all local authority vehicles are equally suitable for battery-electric transition using current technology. Detailed analysis of real routes and duty cycles showed that certain refuse collection and specialist vehicles face constraints related to range, payload, gradients and operational intensity. Using fleet-specific data to identify these priority use cases was critical to avoiding premature or unsuitable technology choices and to targeting hydrogen or alternative powertrains where they may add most value.
- **For Cardiff Capital Region and regional coordination:** At a regional level, the work highlighted the benefits of coordinating feasibility analysis and trials across multiple authorities. By comparing hydrogen and battery-electric refuse vehicles under the same operational conditions, CCR strengthened its evidence-based understanding of where different zero-emission technologies are most appropriate. This supported more informed regional planning, including opportunities to aggregate demand, align future infrastructure investment and reduce duplication of effort across councils.
- **For vehicle technology selection and performance assessment:** Phase 1 analysis showed that hydrogen fuel cell electric vehicles, hydrogen internal combustion engines and dual-fuel pathways may offer viable alternatives for specific high-demand duty cycles where battery-electric options are constrained. Phase 2 trials highlighted the importance of testing these technologies in real-world conditions.

Combining telematics data with qualitative feedback from drivers, crews and fleet managers ensured that performance assessment went beyond headline specifications to reflect operational reality, reliability and user experience.

- **For infrastructure planning and operational delivery:** The trials demonstrated that early hydrogen deployment can be supported using temporary refuelling solutions, provided safety, training and operational planning are embedded from the outset. Early engagement with suppliers, detailed site surveys and structured risk management were critical to mitigating delivery risks associated with vehicle availability, refuelling logistics and site suitability. This approach enabled initial live trials to proceed without committing to permanent infrastructure prematurely.
- **For wider learning and market readiness:** The project showed the value of staged, evidence-led progression from feasibility to demonstration. Using formal gateways and structured checkpoints helped manage risk and ensured readiness before moving into live operation. The approach is creating transferable learning on trial design, data collection and evaluation that can be applied by other authorities considering hydrogen or alternative zero-emission technologies for heavy-duty fleets.

Benefits

Overall, the Ricardo CCR WSRID project provided local authorities with practical, real-world insights to support informed fleet decarbonisation decisions for the most demanding vehicle applications. By combining detailed Phase 1 feasibility analysis with Phase 2 live trials, the work reduced uncertainty around vehicle performance, costs, operational fit and safety, while helping to clarify where hydrogen may play a complementary role alongside electrification. The project strengthened regional coordination, informed future infrastructure planning and contributed to market readiness for zero emission heavy duty vehicles, supporting a more practical, evidence based and just transition for public sector fleets.

What's next?

The CCR WSRID Challenge created a strong foundation for future commercial and delivery pathways by reducing uncertainty around both zero-emission vehicle technologies and the infrastructure required to support them. Evidence generated through Phase 1 feasibility work and Phase 2 real-world trials supported more informed decision-making on performance, costs, operational fit and safety considerations, enabling more informed engagement with vehicle manufacturers, infrastructure providers and funders.

By completing the battery-electric refuse vehicle trial in real operational conditions and progressing hydrogen refuse vehicle testing where possible, the project has strengthened understanding of BEV readiness today while building emerging evidence on the role hydrogen could play for heavy-duty public-sector fleets.

The Challenge also achieved significant national and sector-specific visibility. The media coverage following the launch of the hydrogen and electric RCV trials highlighted Wales' first hydrogen refuse vehicle demonstrations, the side-by-side comparison with battery-electric alternatives, and the role of local authorities in driving innovation through real-world testing. This helped position CCR and Welsh Government as emerging leaders in practical fleet decarbonisation and raised awareness among other councils and industry stakeholders.

A key strength of the approach is its scalability and repeatability. The Phase 1 methodology for analysing fleet data, routes and duty cycles can be readily applied by other local authorities to identify priority vehicle types and appropriate decarbonisation pathways. Similarly, the Phase 2 trial design provides a scalable template for future demonstrations, showing how hydrogen and electric vehicles can be tested safely and effectively without committing to permanent infrastructure at the outset. By working across multiple councils, the Challenge also demonstrated the value of coordinated regional planning, including opportunities to aggregate demand, align infrastructure investment and support a consistent yet locally responsive pathway to decarbonising public-sector fleets.

The next stage focuses on analysis and knowledge sharing, drawing on the completed BEV trial and any additional hydrogen trial data generated once testing concludes. Telematics, route logs and user feedback will be analysed to produce a final report covering performance, costs, emissions impacts and operational considerations. The results will be shared with participating authorities, CCR and the wider stakeholder group, helping inform future fleet strategies and potential next steps for zero emission vehicle deployment. Learning from the project will also contribute to broader Welsh Government and local authority understanding of where hydrogen may play a complementary role alongside electrification.

Get involved

Local authorities interested in fleet decarbonisation can use the Ricardo project as a reference point for how to move from ambition to evidence. A practical starting point is to analyse fleet routes and duty cycles to identify which vehicles are genuinely difficult to electrify, before considering alternative technologies. The project demonstrates the value of starting with data, testing options through limited, well planned trials, and combining technical performance metrics with operational feedback. Councils can also benefit from engaging early with neighbouring authorities and delivery partners to explore shared learning and coordinated approaches. Organisations interested in this approach are encouraged to get in touch to learn more, explore opportunities for collaboration, or apply the learning in their own context.

Project lead

Emma Wakeham, Local Area Energy Plan Programme Manager – Cardiff Capital Region
Email: Emma.Wakeham@cardiffcapitalregion.gov.uk

Organisation contacts

Cardiff Capital Region (Challenge Owner)
Website: www.cardiffcapitalregion.wales/

Caerphilly County Borough Council (Partner organisation)
Website: www.caerphilly.gov.uk/main.aspx?lang=en-GB

Rhondda Cynon Taf County Borough Council (Partner organisation)
Website: www.rhondda-cynon-taf.gov.uk/

Ricardo-AEA (Project delivery)
Website: www.ricardo.com/en

Hyppo hydrogen solutions (Project delivery)
Website: www.hyppo.co.uk/

Further information

News and social media:
www.linkedin.com/feed/update/urn:li:activity:7402768977543761920/

www.linkedin.com/feed/update/urn:li:ugcPost:7432832831027941376/

7. Practical takeaways: delivering whole-system decarbonisation in Wales

The WSRID programme showed that successful decarbonisation innovation is grounded in place, shaped by real-world constraints, and focused on delivery instead of isolated technology roll-out. Across very different contexts, the most valuable outcomes came from projects that treated energy, infrastructure, operations, people and governance as one connected system, and generated evidence that decision-makers could act on. The lessons below are written as a practical guide to help public bodies, communities and delivery partners design and deliver whole-systems decarbonisation projects that are credible, investable and replicable in Wales.

1) Start with the place-based problem, not the solution

Whole-systems projects work best when they begin with a clear articulation of what is limiting progress locally such as network constraints, delivery capacity, affordability, planning and consenting realities, operational requirements, or community readiness. Strong projects define why the issue matters now in that place, what outcomes are needed, and why conventional approaches are unlikely to succeed. This clarity improves alignment, speeds up design choices, and makes it easier to build partnerships around a shared problem rather than competing preferred technologies.

2) Build a whole-system logic, not a list of technologies

A whole-systems approach is more than combining multiple interventions. It requires a coherent "system logic" showing how demand, supply, storage, flexibility, networks, users and governance interact, and how value is created and retained locally.

In practice, this means designing technologies as part of a wider architecture such as linking generation to anchor loads through private wire, using flexibility and demand reduction to operate within constrained capacity, or coordinating assets digitally so they behave like one system rather than isolated components.

3) Treat constraints as design inputs, not future risks

Across the programme, constraints were rarely marginal, they were often the defining delivery condition. Projects progressed most effectively when they treated grid limitations, planning and consenting pathways, safety and operational constraints, and affordability as fixed parameters that shape design from day one. This approach avoids late-stage redesign, prevents solutions that cannot be implemented, and helps teams focus effort on options that remain viable under real-world conditions.

4) Create a delivery pathway early, and keep it multidisciplinary

Whole-systems delivery depends on doing enabling work early and in parallel. The strongest projects ran technical, commercial, regulatory, and stakeholder workstreams together, so engineering decisions reflected consenting requirements, commercial models reflected operational constraints, and stakeholder engagement supported real delivery choices. Early engagement with the right actors (e.g., regulators, planner, network stakeholders, asset owners/operators, community organisations) reduced uncertainty and improved readiness for the next stage of delivery.

5) Generate "decision-useful" evidence

The most useful outputs were those that directly enabled decisions such as defined system designs, feasibility tools, delivery models, planning and consenting documentation, operational trials, robust modelling, and clear evidence of what works under which conditions. Narrative outputs are helpful, but they rarely unlock delivery on their own. Whole-systems innovation becomes investable when evidence is designed to answer practical questions: Is this feasible here? What are the constraints? What are the costs and benefits? What needs to happen next? Who is impacted and who needs to do what?

6) Put people, governance and local benefit at the centre

Whole-systems projects succeed when delivery roles and decision rights are clear, and when governance is designed to maintain momentum across multiple parties and workstreams. In community-led contexts, "community readiness" is not optional. Local leadership, organisational capacity, existing assets and workable governance arrangements are often prerequisites for success. Projects were strongest where social value, affordability, resilience, local benefit and value retention was embedded in the system design rather than added at the end, because this builds legitimacy, improves participation, and strengthens long-term viability.

7) Use phased delivery to de-risk, learn, and decide what not to do

A practical lesson from WSRIDis that good ideas do not always progress – and this is not necessarily failure. Sometimes feasibility work shows that the investment scale, infrastructure needs, or delivery conditions are not yet proportionate for the next stage. In those cases, the value lies in clarifying what is viable, under what conditions, and what enabling work would be required before progressing later. A structured, phased pathway supports better decisions by creating space to test assumptions, surface constraints, refine the problem framing, and then move into real-world demonstration only when the delivery route is credible.

In summary, WSRID reinforced a simple but important point: whole systems decarbonisation succeeds when teams design for the reality of place, constraints, people, operations and governance. The projects captured in this case study provide transferable approaches that can strengthen future programme design, investment decisions and place based delivery across Wales, even where the specific WSRID mechanism itself is not available.

8. Appendix

How to deliver whole-system decarbonisation in Wales (quick guide)

Use this as a quick self-check when designing, reviewing or delivering a whole-systems project:

A. Place and problem

- Is the local problem clearly defined, and why it matters now explained?
- Are constraints (grid, geography, assets, sector needs, affordability, capability) explicit and evidenced?

B. Whole-system logic

- Is there a coherent system model linking demand, supply, storage, flexibility, networks, users and governance?
- Are technology choices justified as part of that system model (not standalone components)?

C. Delivery pathway

- Is there a realistic route from concept to delivery, including dependencies (planning, consenting, safety, procurement, operations)?
- Are the right delivery stakeholders engaged early and for the right reasons?

D. Evidence

- Are deliverables designed to be decision-useful (designs, trials, tools, models, documentation, delivery models)?
- Is the data approach clear, including assumptions, gaps and how these will be addressed?

E. Governance and benefit

- Are roles, responsibilities and decision rights clear?
- Is social value/local benefit designed into the approach (affordability, resilience, value retention, just transition)?

F. What happens next

- Is there a credible next-step pathway (scale/replication/investment), with enabling steps identified?
- Is there a plan to share learning so others can reuse what has been developed?

Resources, references and further reading

A. Funder and programme references

www.gov.wales/climate-innovation-scheme

www.gov.wales/whole-systems-research-and-innovation-decarbonisation-wsrid-programme-challenge-competition

www.gov.wales/energy-service

www.gov.wales/ynni-cymru

www.ukri.org/what-we-do/browse-our-areas-of-investment-and-support/innovate-uk-contracts-for-innovation/?_ga=2.136567607.669549093.1692703594-1582658415.1686748784

B. Challenge owner references

www.growingmid.wales/

www.rhondda-cynon-taf.gov.uk/

www.cardiffcapitalregion.wales/

C. Supplier references

www.watertowater.co.uk/

www.lafan.cymru/

www.csgcc.ac.uk/en

www.challoch-energy.com/

www.naturalresources.wales/?lang=en

www.cee-uk.com/

www.severnwye.org.uk/

www.stantec.com/en

www.renewablesfirst.co.uk/

www.ricardo.com/en

www.hyppo.co.uk/

D. Other references, social media, news articles and tools

www.growingmid.wales/WSRID

www.watertowater.co.uk/ruravolt/

www.businessnewswales.com/exploring-energy-independence-for-mid-wales-farms/

Water to Water: Smart Local Energy Systems for Dairy Farms

www.businessnewswales.com/growing-mid-wales-digital-discussions/

www.youtube.com/watch?v=8EFVBxBxU8Y

www.growingmid.wales/WSRID

www.businessnewswales.com/turning-a-farming-challenge-into-a-local-energy-asset/

www.linkedin.com/posts/growingmidwales-wsrid-netzerowales-share-7435280190059999233-Zrk_/?utm_source=share&utm_medium=member_desktop&rcm=ACoAADJp1XwBlqI5me_tEyyUNOIjTXJ7OIlL3CO

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www.growingmid.wales/article/20779/New-clean-energy-project-explores-green-hydrogen-for-sustainable-forestry-in-Mid-Wales

www.businessnewswales.com/growing-mid-wales-digital-discussions/

www.wales.poweringtogether.com/

www.businessnewswales.com/what-local-energy-trading-could-mean-for-rural-wales/

www.youtube.com/watch?v=QiogXlgSIDQ

www.youtube.com/watch?v=Za2PMAPwuGQ

Growing Mid Wales: Digital Discussions – Business News Wales

www.en.powys.gov.uk/article/20083/Mid-Wales-projects-move-into-prototype-stage-to-deliver-real-world-clean-energy-solutions

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