Electricity Distribution

REACH Innovate UK End of Phase Meeting

03rd June 2025

nationalgrid

End of Phase Review

	Agenda Item	Duration	Led by:
01	**Introduction**	2 minutes	LH
02	**High Level Learnings**	3 minutes	LH
03	**Project Findings** Step 1: Selection Analysis (15 minutes) Step 2: Detailed Feasibility (25 minutes) Step 3: Alternative Options & tool (20 minutes) Step 4: Ownership model & Carbon Accounting (20 minutes) Step 5: Wider engagement & Dissemination (10 minutes)	90 minutes	All
04	**BAU & Beta Application**	10 minutes	LH
05	**Risks review**	5 minutes	DP
06	**Project Finance Overview**	5 minutes	LH
07	**Meeting Closes**		

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02

High Level Learnings

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REACH Learning Outcomes

	Step 1: Selection Analysis	Step 2: Detailed Feasibility	Step 3: Alternative Options & Tool	Step 4: Ownership Model, Carbon	Step 5: Wider Engagement & Dissemination
Key Activities:	• Community interviews • Headroom assessments • Energy centre suitability assessment	• Site visits at 2 communities • Heat demand profiling and control • Energy centre sizing • Network Analysis	• Desktop literature review • Interviews with Community Energy groups • DNO interviews • Data archetype design	• Carbon impact assessment • Carbon methodology established • CBA and ownership models	• 2x stakeholder engagement workshops
Key Outputs:	• Strong engagement from community energy groups • Over **£1m average reinforcement costs** for communities	• MEC found to mitigate network constraints • Abnormal constraints not suitable for MEC • Coordinated heat control **reduces peak demand by 37%** without impacting comfort	• Literature review detailing alternative delivery options • Community user engagement supports development of tool • **System architecture** for Options Assessment Tool	• Carbon accounting methodology and literature review • Low carbon heat facilitates **50% reduction** in carbon emissions • Commercial model and SIF CBA assessment	• Two community engagement events with **70 attendees** • Significant interest in this topic from a wide range of local energy stakeholders • Community User Insights Report quantifies support

Electricity Distribution

03

Project Findings

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Step 1: Selection Analysis

Objectives:

- Initial community engagement and interviews
- Headroom assessments performed by NGED to determine network requirements
- Selection Criteria & Judging panel to identify communities for detailed work

Partners Involved:

nationalgrid

VEPOD The Power Behind The Charge

passiv

REGEN

Outputs:

- 11kV and LV network interventions established for 7 communities
- Two communities selected based on closest alignment to REACH energy centre

Selection Analysis → Detailed Feasibility → Alternative Options & Tool → Ownership Model, Carbon → Wider Engagement & Dissemination

Detailed engagement - Objective

Objective

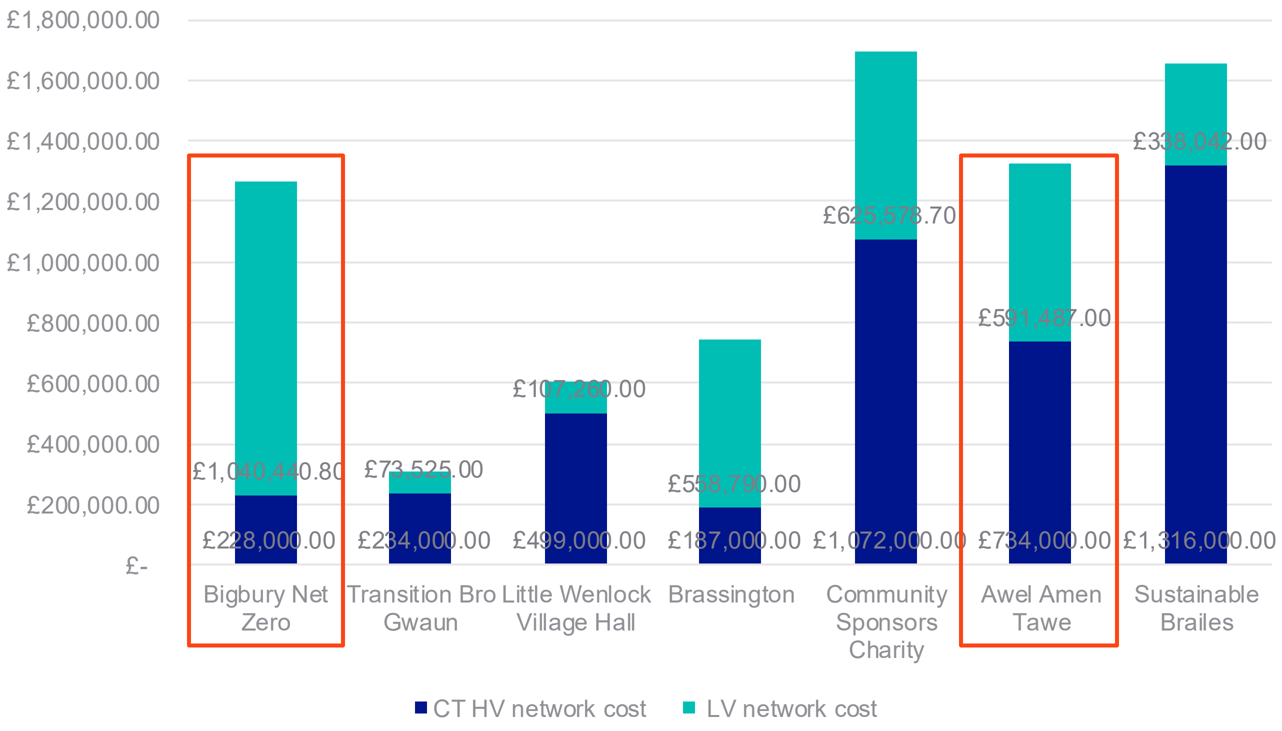
- *Develop detailed requirements: working directly with our communities to finalise project details and identify recommendations.*

Detailed engagement – Q1 Activity

- **Re-engaging the 7 community partners**
  - Onboarding & issuing contracts
- **Gathering data to enable site evaluation and technical assessment**
  - Desktop research
  - In-depth interviews
- **Creating and running a selection process**
- **Informing communities of the outcome**

Initial headroom assessment for 7 communities

- National Grid's Secondary System Planning Team undertook initial headroom assessments of the 7 communities
- Available network capacity was identified, along with expected reinforcement plans & costs under the Consumer Transformation DFES Scenario



Selection Process

Structured, Collaborative Evaluation

- ✓3-stage engagement: Expression of interest (82 groups) → Workshop (73 attendees) → Questionnaire (32 submissions)
- ✓7 communities shortlisted for Alpha Phase through interviews, site assessments, and technical analysis

Multi-criteria scoring (max 90 points) across:

- ✓Electricity demand growth (NGED)
- ✓Energy centre suitability (VEPOD)
- ✓Heat pump viability, community interest & experience (Regen)

Judging and Deliberation Approach

- ✓2.5-hour expert panel with NGED, Regen, VEPOD, SGC, and Passiv
- ✓Stepwise elimination based on:
  - Network constraints and intervention costs, Community engagement and delivery capability,
  - Practicality of energy centre sites and planning context, Heat pump feasibility confirmed for all

Selection Process Final Outcomes

Selected Communities and Rationale:

Awel Aman Tawe (Wales):

- High reinforcement costs; proven delivery record; community-owned land; experienced team.

Bigbury Net Zero (England):

- High intervention cost; viable sites; strong engagement; seasonal demand case

Not Selected and Why:

Sustainable Brailes:

- AONB concerns; visual impacts; lowest overall score

Eggardon CIC:

- Poorer site access; profile similar to Awel Aman Tawe

Brassington CIC:

- Project pace mismatch; low EV interest; low engagement

Little Wenlock:

- Lower network intervention needs

Transition Bro Gwaun:

- Low network reinforcement needs

Step 2: Detailed Feasibility

Objectives:

- Network load flow assessments to determine energy centre requirements
- Energy centre sizing to address network constraints
- Establish low carbon heat profiles (coordinated & uncoordinated)

Partners Involved:

REGEN

VEPOD — The Power Behind The Charge

passiv

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Outcomes:

- Energy centre sizing established and found to mitigate network constraints
- Abnormal constraints not suitable for energy centre
- Coordinated heat pump control able to reduce peak demand without impacting customer comfort

Selection Analysis → **Detailed Feasibility** → Alternative Options & Tool → Ownership Model, Carbon → Wider Engagement & Dissemination

A2 Capability Led Network Assessment

Partner: SGC

Objective

Understand where rural networks are likely to be overloaded and develop operational scenarios for where REACH energy centre would provide benefit over Counterfactual

Key Tasks

Work Completed

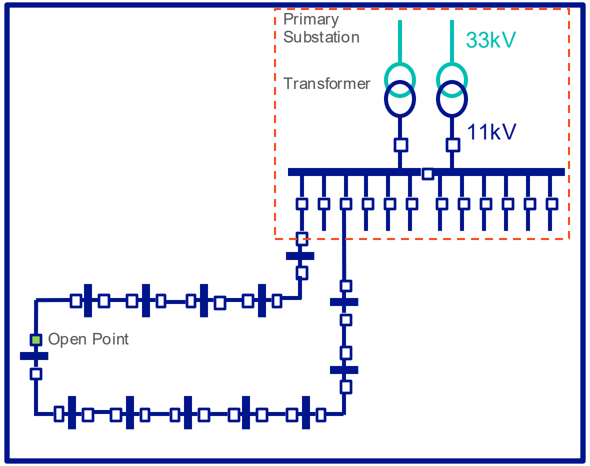
- Workshops conducted with NGED Planning Team to coordinate scope and methodology.
- Extensive data gathering from NGED systems, including EV capacity maps, heat maps, and feeder data.
- Mapped and analysed 403 rural primary substations to assess existing and future network loading.
- Compiled and processed transformer-level data for 7 REACH communities covering day/night demand profiles.
- Modelled load growth scenarios using 10-year projections for demand and EV charger uptake

WP Findings

- 75% headroom drop at rural substations (from 1127 MW to 284 MW) once accepted connections go live.
- Transformer and feeder stress: Some transformers 35% over capacity; 3 of 6 feeders projected to overload by 2030 or earlier.
- Nighttime peaks 50% higher than daytime in some areas, driven by EV charging.
- LCT-driven growth: 4.1% annual increase in heat pump and EV demand is straining the network.
- Primary substation limits: Several sites will have zero headroom once planned connections are live.

Constraints can occur either in intact or abnormal running

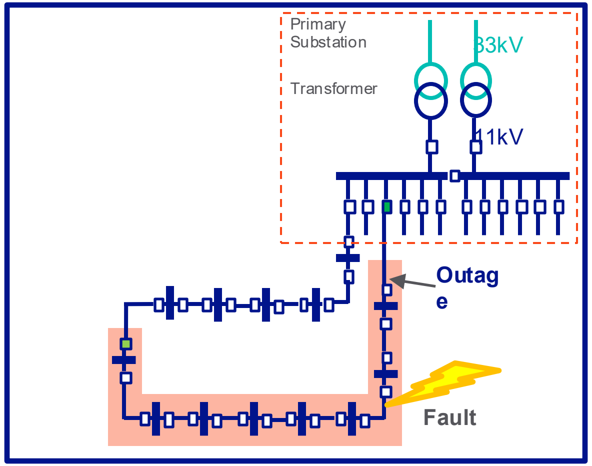
Intact Network



Our 11kV network is constructed with N-1 redundancy

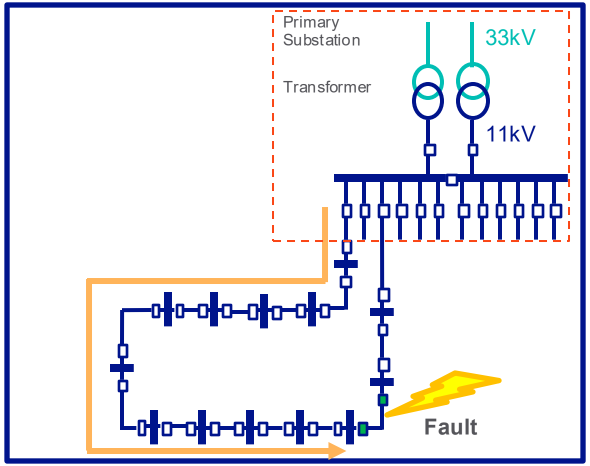
Open points divide circuits in half, allowing for re-configuration

11kV fault occurs



If a fault occurs on the network, our teams can isolate the faulty equipment, and get power back on supply

Abnormal Running Arrangements

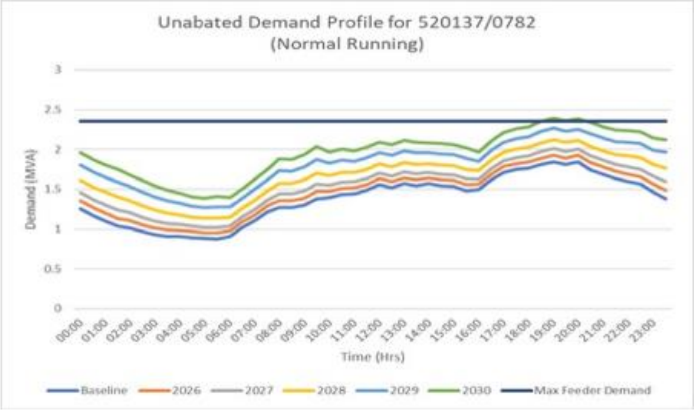


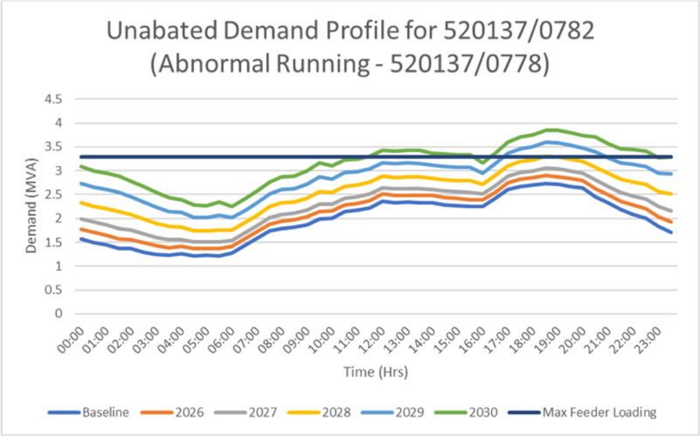
Faulty equipment isolated, power is restored via alternative route

Circuit temporarily takes additional load

A2 – Network Assessment

- Feeder 520137/0782 breached thermal and voltage limits under fault conditions (2028–2030).
- Energy center model at Cwmgors car park resolved both constraint types in worst-case scenarios.
- Passiv heat pump controls reduced peak demand across HV feeder by 9.6%, supporting network resilience.
- Other feeders remained within operating limits, no immediate upgrades required.
- Reinforcement is feasible; energy center and smart controls offer optional, effective mitigation.





A2 – Network Study Conclusions

- REACH Alpha did not identify any constraints amongst the 7 communities that were taken forward from Alpha, under intact network conditions
- Constraints do exist under n-1 conditions, but this is not what the REACH solution is intended to address
- Hypothesis for LCT derived constraints is ahead of the curve and expected to be the exception rather than the rule
- Pause before Beta application will allow consolidation of learning and additional network analysis to identify if there are communities that are most likely to encounter rural constraints
- Identification process includes several data sources that can't provide automated feeds such as lead time to reinforce which is a fundamental factor in REACH use case
- Some of the key assumptions will need regulatory review such as ownership conditions and regulatory settlement not covered in ED2

A3 – Energy System Break Points

Partner: SGC & NGED DSO

Objective

Establish a process diagram for communities to follow when initiating community energy projects. Community guidance document authored, mapping likely conventional network interventions and barriers for rural community energy projects

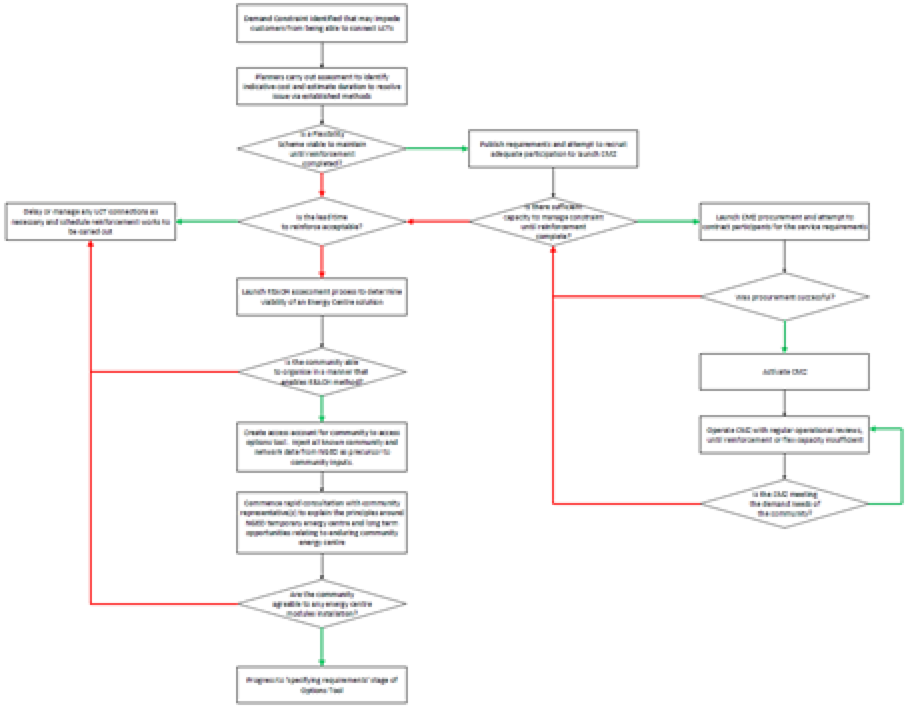
Key Tasks

Work Completed

- Developed a clear, community-friendly process diagram to guide stakeholders through typical connection hurdles and present outputs from detailed network studies.
- Performed headroom assessments and half-hourly demand modelling to understand current and future capacity constraints in selected communities.
- Evaluated the suitability of temporary versus permanent REACH energy centres, based on local demand patterns and resilience needs.
- Documented the end-to-end network connection process, including key DNO contact points, typical timelines, and common barriers experienced by community groups.
- Utilised ConnectLV and SINCAL modelling tools to assess low voltage (LV) and 11kV network reinforcement requirements across study areas.

A3 – Constraint assessment process

- Initial response by DNO is focussed on temporary resolution to local constraint
- DNO can rapidly deploy a Hybrid Module to manage until reinforcement possible
- Community engineers manage the engagement and explain possibility of enduring opportunity
- If suitable location for an energy centre is identified, then temporary intervention (18 months +) can proceed
- The intervening period can be used to interact with Options Tool (WPA5) to specify community project



B1 Energy Centre Design

Partner: VEPOD

Objective

Reach Energy Centre – Technical design and Perform high level & detailed feasibility studies.

Key Tasks

Work Completed

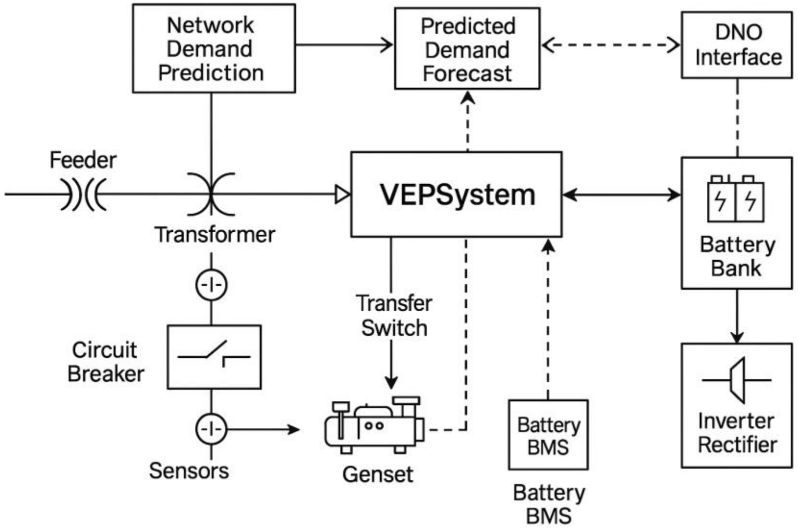
- Collaborated with Regen to evaluate rural REACH energy centres using twelve criteria.
- Community interviews and research provided data for ten criteria, while detailed studies assessed distance to HV connection and centre scale, influencing evaluations across seven communities.
- A Visio-based data map and Excel model illustrated data sources and relationships, calculating energy storage needs.
- Coordinated with NGED to establish an artificial network capacity value for energy storage sizing due to power demand variations.

WP Findings

- Two communities (BNZ & AAT) analysed for REACH energy centre feasibility under N-1 scenarios
- BNZ requires hybrid system: 833 kW genset + 2 MWh BESS + 0.5 MW inverter (~£890k cost)
- AAT offers BESS-only or hybrid option; hybrid = 239 kW genset + 1.1 MWh BESS (~£610k)
- Coordinated heat pump control significantly reduces sizing and costs (up to 34% BESS savings)
- HVO fuel costs highlight need for efficiency – BNZ genset costs ~£7k/day at full load

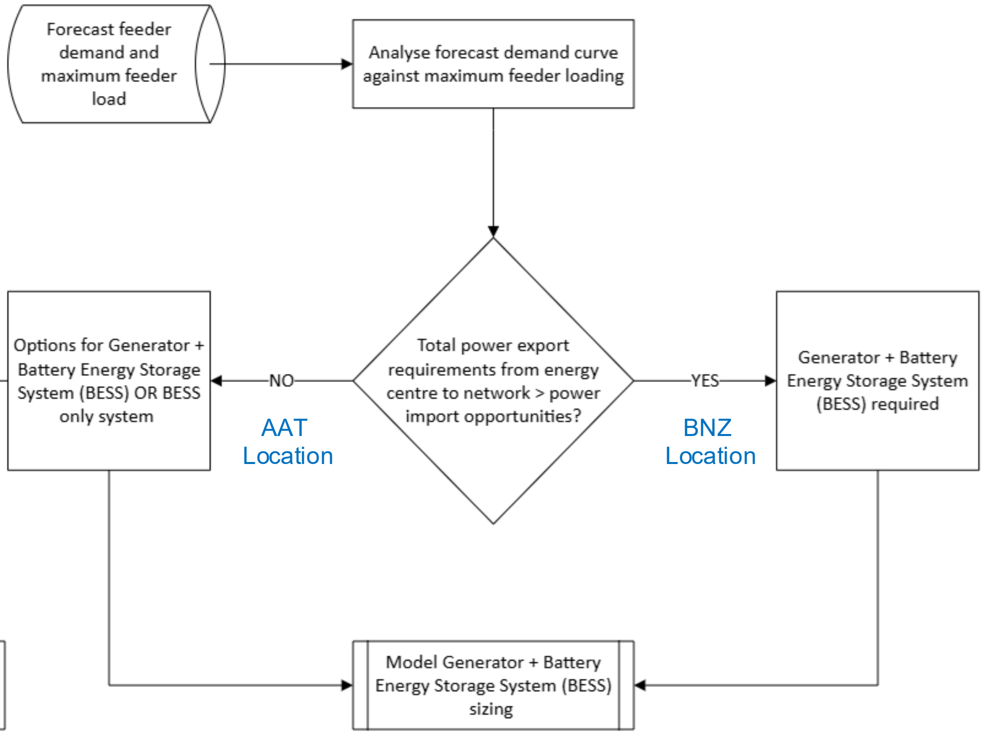
REACH Energy Centre Operational Workflow & Schematic

1. **Data Acquisition**
   - CT/PT sensors and BMS streams feed VEPSystem.
   - Forecast engine sends predicted demand profile.
2. **Decision & Scheduling**
   - VEPSystem calculates:
     - When to pre-start genset based on forecast.
     - How to split load between genset and battery.
     - Charging windows to restore SoC.
3. **Dispatch**
   - VEPSystem closes transfer switch, starts genset, sets its power to the continuous setpoint (e.g. 250 kW).
   - For any export above that, commands inverter to discharge from the Battery Energy Storage System (BESS) / Battery Bank.
   - For export below that, commands inverter to charge BESS at available headroom.
4. **DNO Coordination**
   - If the DNO issues a command (e.g. reduce local injection), VEPSystem adjusts setpoints accordingly.
5. **Protection & Fault Response**
   - On any grid fault or overcurrent, the breaker trips, VEPSystem gracefully shuts down assets, and notifies DNO.



This detailed layout ensures robust, forecast-driven control of local generation and storage, seamless DNO integration, and full protection for reliable feeder support. The REACH energy centre is thus well placed to ensure accelerated low carbon technology adoption in rural areas whilst maintaining the stability of the network.

VEPOD Initial Analysis



REACH – Battery Energy Storage System Only Sizing Approach

A three-stage approach was used to size the Battery Energy Storage System (BESS) based on the half-hourly forecast data provided where the positive intervals were those where forecast demand exceeded the maximum capacity of the feeder being analysed:

1) Sum of all positive intervals:

$$E_{\text{use}} = \sum_{i:\, E_i > 0} E_i =$$

2) Adjust for round-trip efficiency (η = 90 %):

$$E_{\text{needed}} = \frac{E_{\text{use}}}{\eta} = \frac{E_{\text{use}}}{0.90} =$$

3) Add 10% safety margin:

$$E_{\text{spec}} = E_{\text{needed}} \times 1.10 =$$

REACH – Hybrid (Genset & BESS) Sizing Approach

Generator Sizing

1. Calculate the average (mean) of all positive values (where demand exceeds the maximum feeder load)

$$\bar{E}_{+} = \frac{1}{\text{Number of positives (X)}} \sum_{i=1}^{X} E_i$$

2. We want a constant output genset whose 0.5 h energy exactly equals the mean export:

$$P_{\text{gen}} = \frac{\bar{E}_{+}}{0.5\,\text{h}} = 2 \times \bar{E}_{+}$$

3. Add a 10% safety margin

$$P_{\text{gen, rated}} = 1.10 \times P_{\text{gen}}$$

BESS Sizing (for peak exports only)

4. Compute the excess for each half hour where demand is greater than the amount provided by the genset and sum the values

$$\sum_{E_i > \bar{E}_{+}} \Delta_i =$$

5. Account for 90% round trip efficiency

$$E_{\text{batt,usable}} = \frac{\sum_{E_i > \bar{E}_{+}} \Delta_i}{0.90}$$

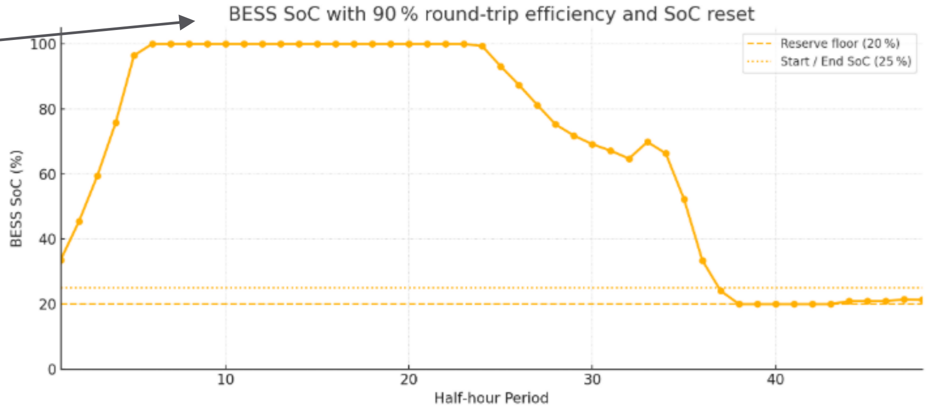
6. Add a 10% safety Margin

$$E_{\text{batt,rated}} = 1.10 \times E_{\text{batt,usable}}$$

AAT Results

OPTION	Specification
BESS Only	
Battery storage capacity	3.06 MWh
Inverter Sizing	0.6 MW
Hybrid (Genset & BESS)	
Rated Generator Size (continuous)	239 kW *
BESS Storage Capacity	1.1 MWh

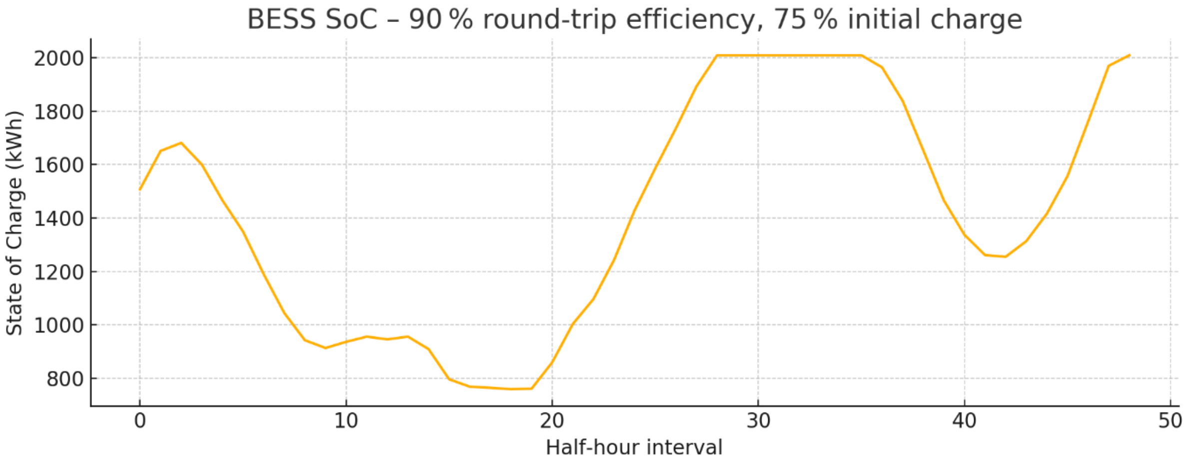
* In reality, Generator is likely to be 250kW



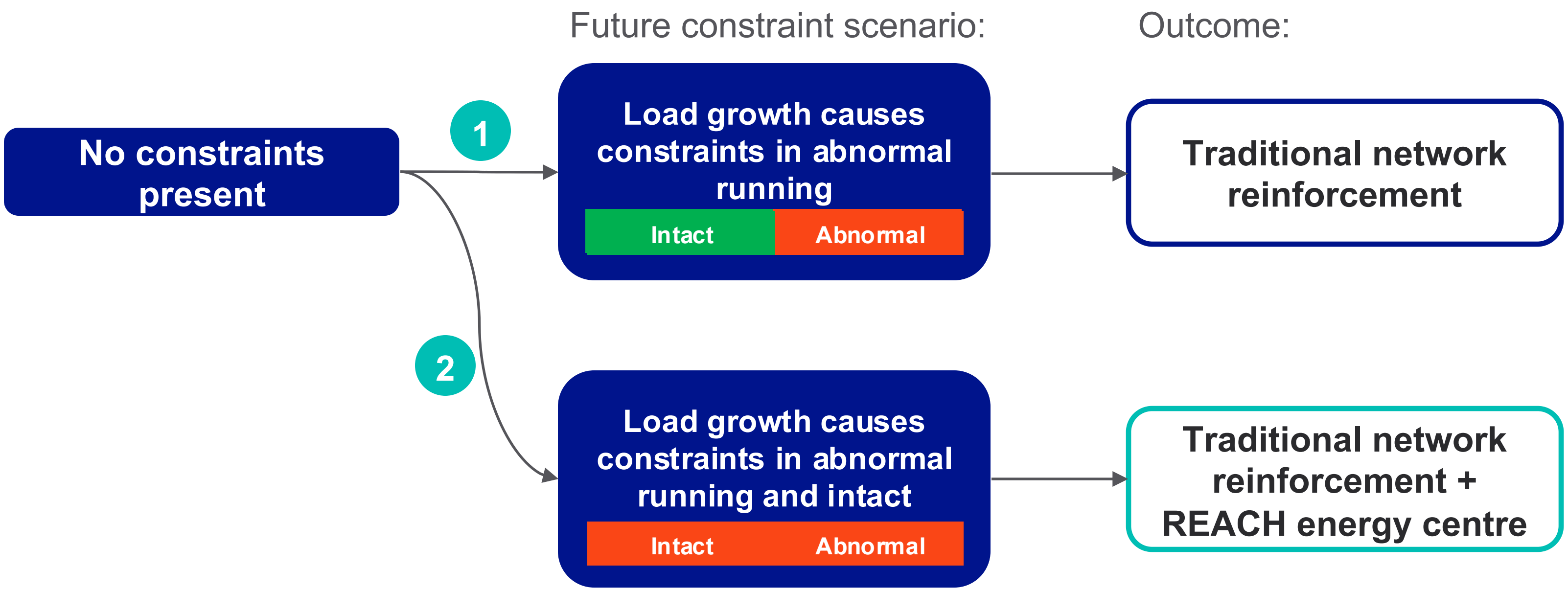
BNZ Results

OPTION	Specification
BESS Only	N.A.
Hybrid (Genset & BESS)	
Rated Generator Size (continuous)	833 kW *
BESS Storage Capacity	2.01 MWh

* In reality, Generator is likely to be 850kW



Use case for an energy centre



B2 Heat Solution

Partner: Passiv

Objective

Support the selection of sites where a shared heating solution is proposed; establish the techno-economic feasibility of a shared heating solution at each site; determine a high-level technical solution enabling central coordination of distributed heat pumps to minimise network load

Key Tasks

Work Completed

- Assisted project partners in selecting two shortlisted communities and defined data requirements.
- Compiled a report on residential heat decarbonisation pathways as part of a wider feasibility study for the communities.
- Simulation of annual, half-hourly power load profiles following mass heat pump adoption across the two shortlisted communities, looking at typical and coldest year weather scenarios.
- Assessed two control strategies for managing community heat demand and minimising network load from distributed heat pumps in the two shortlisted communities.
- Shared modelling data and presented findings from heat-pump power load simulations and evaluation of community level control solutions with partners.

WP Findings

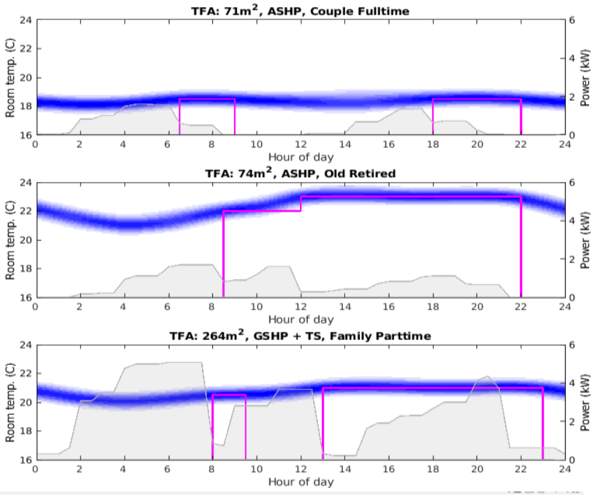
- Cold weather and peak EV charging can create severe electrical demand spikes, especially by 2050.
- Naive switch-off strategies reduce peak load but lead to significant household discomfort and delayed heat recovery.
- Passiv coordination flattens load effectively, reducing peaks without compromising comfort (≤0.5° C below setpoint).
- Hybrid systems and thermal stores offer the most flexible, resilient heating behaviours under coordination.
- Smart coordination outperforms basic control, enabling demand shaping aligned with energy centre capabilities.

B2 Heat Solution

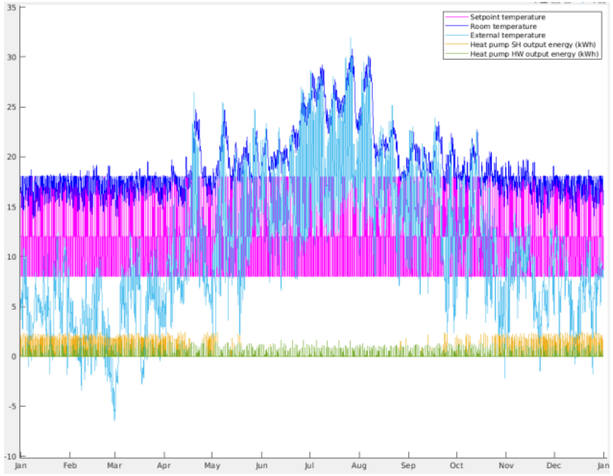
Heat Demand Modelling

- Forecast the total electricity demand for each community from low-carbon heating
- Modelling based on National Grid 2035/2050 projections for – heat pump types and uptake rates
- Generate 20 digital twin heating archetypes per community (BNZ & AAT).
- Digital twins represent thermal usage behaviours based on occupancy, heating patterns, and technology combinations.
- The Passiv modelling tool simulates year-round, half-hourly heat pump electricity profiles.
- Assign heating systems and map them to archetypes for load simulation.
- Model typical and extreme (coldest winter) heat pump load scenarios
- Generate projections for REACH Energy Centre sizing

Daily forecast



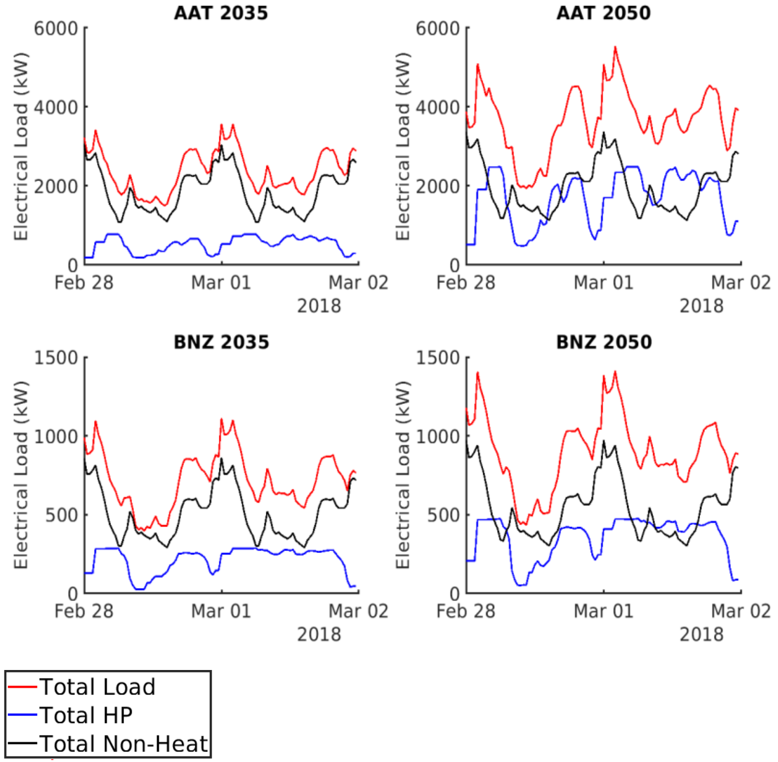
Half-hourly annual forecast



B2 Heat Solution

Scenario Modelling

- Aggregate community demand = heat load + non-heat (EV + baseload).
- EV and baseload profiles provided by National Grid were used to simulate non-heat loads.
- EV profiles have overnight usage and other baseload use peaks during the morning and evening.
- In the coldest conditions, heat pumps are running near their capacity most of the time
- Even with an optimum start, time-clock control strategy, the heat pumps have to run throughout the night to hit any morning setpoints.
- This results in even higher demand during the EV peak.
- As heat pumps become a larger proportion of the total electricity load, the network challenge increases.



B2 Heat Solution

Demand Mitigation Strategies

Coldest conditions risk overlapping EV and heating peaks

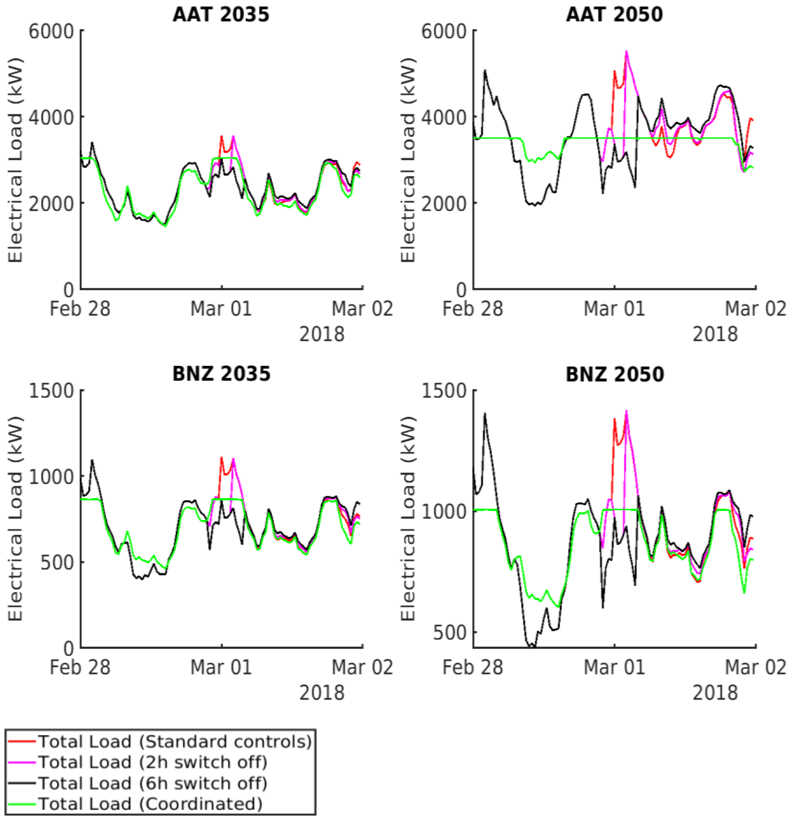
Simple turn-down request across the communities

- We simulate scenarios where an automated command is used to adjust heat pump settings to reduce the overnight peak *(Cold day in February – 2 hrs 22:00-00:00 and 6 hrs between 22:00-04:00)*
- *Result* - overnight peak is reduced, but causes a major drop in indoor temperatures and household discomfort.

Passiv coordination across the communities

- Passiv automated coordination attempts to restrict aggregate power to set levels within certain times using machine learning.
- *Result* - Much flatter demand profile seen around the overnight EV peak. No impact on indoor temperature (+/- 0.5 °C of setpoint)

Conclusion: In all scenarios, Passiv ML coordination provides a better reduction in peak load across communities than a simple turn-down request method, without compromising household comfort.



Step 3: Alternative Options & Tool

Objectives:

- Establish alternative delivery options for community energy developments
- Provide structured framework specifying calculations, interconnections and dependencies for community decision making tool

Partners Involved:

SGC

REGEN

Outputs:

- Literature review detailing alternative delivery options
- Community user engagement results
- System architecture for Options Assessment Tool

Selection Analysis → Detailed Feasibility → Alternative Options & Tool → Ownership Model, Carbon → Wider Engagement & Dissemination

A4 Review Delivery Options (Project Direction)

Partner: Regen, SGC

Objective

Establish alternative delivery options for community energy developments according to key network parameters and provide to the monitoring officer by the end of the Alpha Phase comparisons with other innovative approaches to support rural communities in accelerating connection time.

Key Tasks

Work Completed

- Identified key network parameters such as capacity constraints and substation proximity.
- Developed alternative delivery models tailored to different community and network conditions.
- Mapped models against three representative community archetypes.
- Assessed each model for delivery speed, funding needs, risk levels, and community involvement.
- Compared these with other innovative approaches from REACH and external pilots.
- Engaged stakeholders (e.g., NGED, Regen) to validate and refine delivery options.

WP Findings

- No single best approach; success depends on community readiness and network conditions.
- Community-led models need support but offer high local engagement and benefit.
- DNO-led and third-party approaches deliver quickly but may reduce local control.
- Hybrid models show promise by blending community involvement with professional delivery.
- Innovations like Cornwall LEM and Energy Local illustrate how flexibility and trading can speed up connections.

A4 – Alternatives Interventions

- With the 2-stage process, the scope for the initial intervention by DNOs became clearer
- DNOs require a rapidly deployable solution that can maintain constraints for 18+ months
- The use cases are very different from 'critical supply' & 'short-term' supply issues for which DNOs have existing solutions
  - Reconfigure the network
  - Dynamic / Re-rate assets
  - Temporary generation (diesel)
- Longer term Options
  - Flexibility
  - Smart / Micro Grids & VPP
  - ANM

A4 – Alternatives Interventions

After exhaustive investigation it is apparent that none of the alternatives identified provide a good fit for the use cases that are created by the rapidly developing constraints at low voltage, where a rapid intervention is required that can sustain efficient operation of the network for an extended period (18 months+)

A Hybrid Energy centre offers some unique capabilities that are intended to protect the network through active monitoring & load forecasting, utilizing the best combination of battery, generation and demand side management to address the constraints.

There are regulatory and funding barriers that require to be resolved before it would be possible for a DNO to own and deploy this type of asset class.

The adoption of the connection and location for an enduring energy centre post-reinforcement creates a unique / positive opportunity for the community which can be leveraged for increased LCT support and system efficiency by creating a flexibility hub and public EV Charging schemes

A5 Options Assessment Tool

Partner: SGC

Objective

Provide a structured framework specifying the calculations, interconnections, and dependencies for the community decision-making tool to be built during the REACH Beta phase.

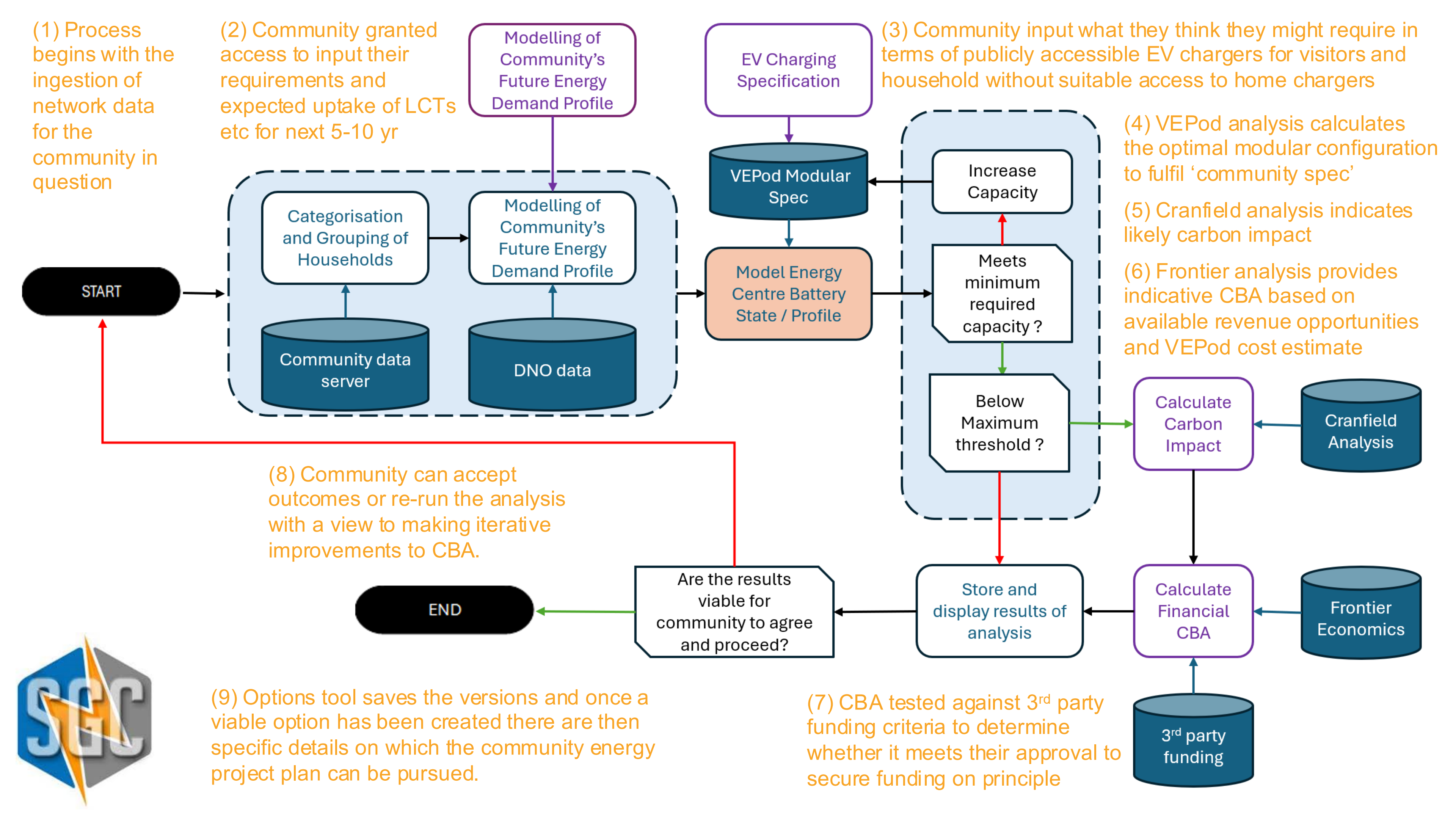
Key Tasks

Work Completed

- Designed a structured framework to guide communities from input data to viable energy centre options.
- Defined a two-part logic: forecasting future demand and modelling energy centre specifications.
- Mapped data flow and interdependencies between community inputs, DNO constraints, and tool outputs.
- Developed category-based demand modelling using housing, heating, and EV archetypes.
- Established methodology for battery sizing based on grid constraints and economic optimisation.
- Built in flexibility to test different LCT and EV uptake scenarios for tailored decision-making.
- Produced a design specification to inform the Beta-phase tool build and integration.

Options Tool – Functional Design

- The options tool requirement shifted focus to be dedicated solely to support communities as the 2-stage approach meant the DNO carries out their assessment based on arbitrary sizing of Hybrid Module
- Options tool access and period of use takes place while the Hybrid Unit is temporarily deployed to manage critical constraints ahead of reinforcement being completed
- Primary function is to help the community establish the optimal sizing and configuration, primarily based on CBA, carbon reduction and functionality to meet community's practical needs.
- The goal is to determine viability of an energy centre which then becomes the starting point for commercial discussions and commencing work that will realistically result in a project that builds the community energy asset(s)


(1) Process begins with the ingestion of network data for the community in question
(2) Community granted access to input their requirements and expected uptake of LCTs etc for next 5-10 yr
Modelling of Community's Future Energy Demand Profile
EV Charging Specification
(3) Community input what they think they might require in terms of publicly accessible EV chargers for visitors and household without suitable access to home chargers
START
Categorisation and Grouping of Households
Modelling of Community's Future Energy Demand Profile
Community data server
DNO data
VEPod Modular Spec
Model Energy Centre Battery State / Profile
Increase Capacity
Meets minimum required capacity ?
Below Maximum threshold ?
(4) VEPod analysis calculates the optimal modular configuration to fulfil 'community spec'
(5) Cranfield analysis indicates likely carbon impact
(6) Frontier analysis provides indicative CBA based on available revenue opportunities and VEPod cost estimate
Calculate Carbon Impact
Cranfield Analysis
(8) Community can accept outcomes or re-run the analysis with a view to making iterative improvements to CBA.
END
Are the results viable for community to agree and proceed?
Store and display results of analysis
Calculate Financial CBA
Frontier Economics
3rd party funding
(9) Options tool saves the versions and once a viable option has been created there are then specific details on which the community energy project plan can be pursued.
(7) CBA tested against 3rd party funding criteria to determine whether it meets their approval to secure funding on principle

Options Tool – Functional Design

- A functional design has been developed for the Alpha phase
- If REACH progresses to Beta we would expect the functional design to be furthered evolved into a working version
- As and when other alternative solutions become available, they could provide a similar input as the VEPod analysis to create competing technology options.
- The community engagement data from the tool would also be of benefit to LAEP processes as it is likely to be accurate and granular.

Step 4: Ownership Model & Carbon Assessment

Objectives:

- Develop methodology for a carbon assessment decision support tool to assess and compare carbon impacts of the baseline case and the proposed solutions.
- Generate commercial and ownership models for the REACH energy centre, and produce a CBA workbook to evaluate it's economic feasibility.

Partners Involved:

frontier economics

Cranfield University

Outputs:

- Carbon accounting methodology and literature review
- Commercial model and SIF CBA assessment

Selection Analysis → Detailed Feasibility → Alternative Options & Tool → **Ownership Model, Carbon** → Wider Engagement & Dissemination

B3 Commercial Model and Ownership structure

Partner: Frontier Economics

Objective

Generate commercial and ownership models for the REACH energy centre and produce a CBA workbook to evaluate its economic feasibility.

Key Tasks

Work Completed

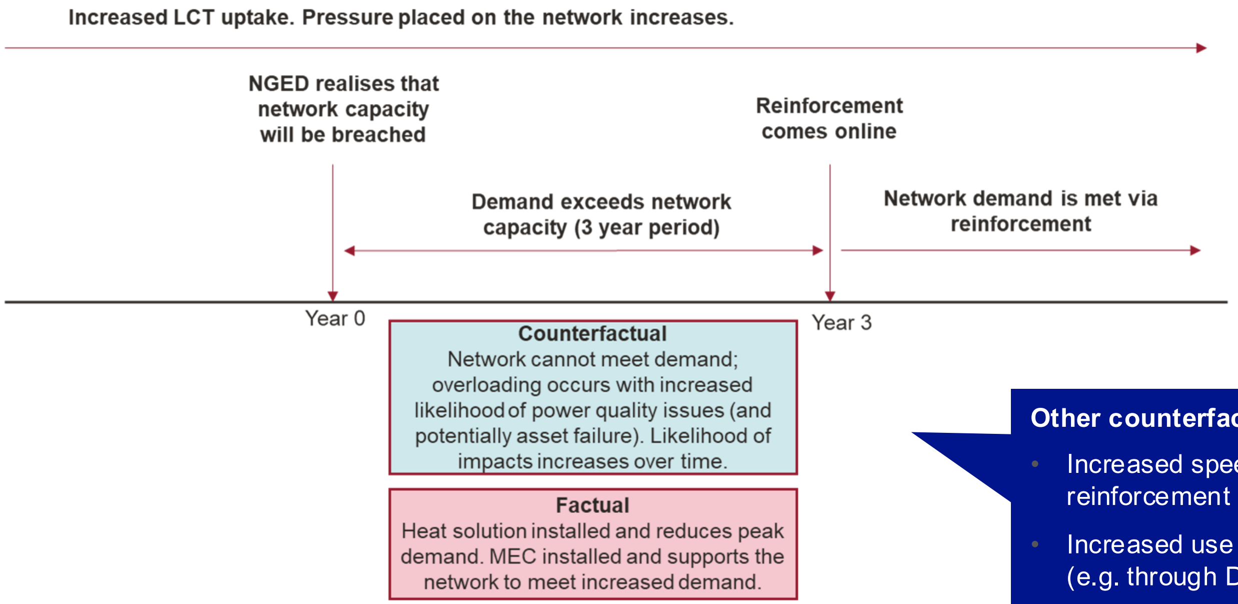
- Defined the REACH intervention (energy centre and coordinated heat solution) and developed the counterfactual
- Developed and evaluated potential commercial models – i.e. which entities own which assets, and how revenues are recovered to cover the costs of installing and operating the REACH intervention
- Undertook cost benefit analysis in line with SIF CBA guidance
- Described financial flows between different parties arising under the commercial model, and produced illustrative calculations

WP Findings

- In the counterfactual, an unexpected increase in demand on the 11kV network leads to overloading – the REACH intervention can be rapidly deployed as a temporary solution to mitigate.
- Key benefits include: avoided cost of overloading; reduced electrical losses and emissions from loses; and renewable generation and system benefits.
- DNO ownership is the preferred model in the short term (but would need to clear regulatory hurdles). But greater benefits may be realised under a model where the energy centre can participate in energy markets.

CBA assessment – methodology

Illustrative timeline of REACH intervention and counterfactual



Other counterfactuals considered:

- Increased speed of network reinforcement
- Increased use of flexibility services (e.g. through DSO markets)
- Delayed LCT uptake

CBA assessment – results

Key findings:

- Energy centre does not deliver a net benefit unless the asset is able to participate in wider energy markets – which is expected to be restricted under DNO ownership
- Results (Scenario 3) show that that the energy centre (as sized for BNZ and AAT) may not always deliver a net benefit even if it can participate in the wholesale markets – but more detailed analysis of the full set of revenues from 'stackable' market services would be needed to conclusively test this
- Household participation in flexibility markets (via heat pumps and smart thermostats) generates material benefits – however these are not entirely attributable to the intervention, as these could also be realised by households in the counterfactual

	Bigbury Net Zero (BNZ)	Awel Aman Tawe (AAT)
Scenario 1 – MEC with no PST flexibility benefits	- £1.2m	- £589k
Scenario 2 – MEC with full PST flexibility benefits	- £1m	+ £423k
Scenario 3 – MEC market participation with no PST flexibility benefits	- £122k *Note: +£99k in enhanced version including 33kV transformer*	- £215k
Scenario 4 – MEC market participation with full PST flexibility benefits	+ £69k	+ £797k

MEC = modular energy centre; PST = Passiv smart thermostat
Analysis assumes MEC asset deployed 5x over 15 year asset life
Note figures are draft results subject to final QA

B4 Carbon Accounting

Partner: Cranfield University

Objective

Develop methodology for a carbon assessment decision support tool to assess and compare carbon impacts of the baseline case and the proposed solutions

Key Tasks

Work Completed

- Conducted geospatial analysis of off-grid households across UK regions
- Reviewed heating source data to characterise rural energy reliance
- Mapped greenhouse gas emissions by region, per capita, and land area
- Modelled Scope 1 and 2 emissions for Awel Aman Tawe and Bigbury
- Simulated low-carbon technology scenarios, including 70% heat pump adoption
- Developed comparative methodology to assess baseline vs. intervention carbon impacts

WP Findings

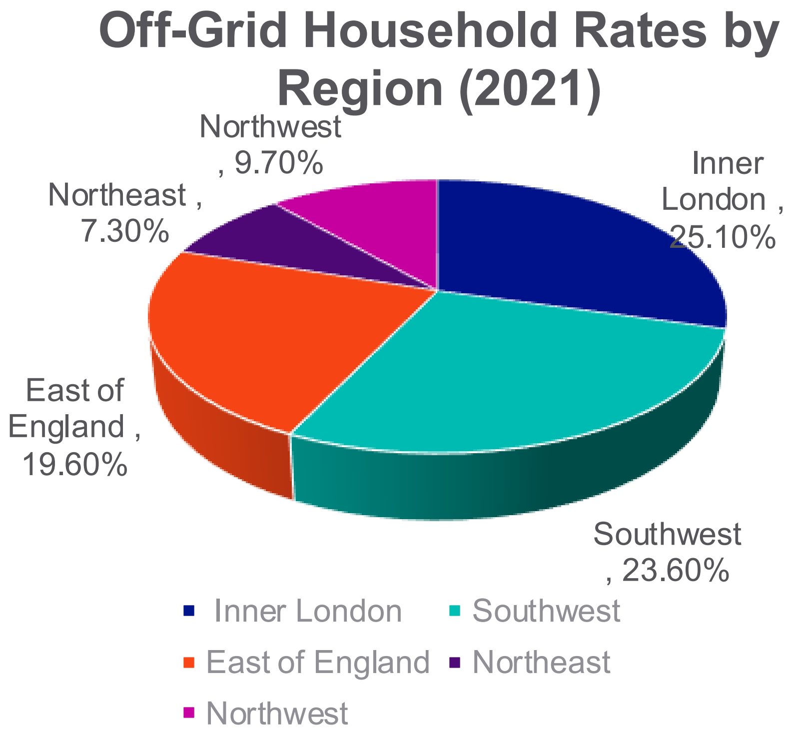
- 1 in 4 rural homes are off the gas grid, with some areas exceeding 50%—making decarbonising heat a rural priority.
- Over 10% of rural households rely on oil heating, compared to just 0.4% in urban areas—locking in high emissions.
- Heating is the dominant emissions source in rural areas, reaching 69% of total household emissions in some communities.
- Rural transport emissions remain high, driven by widespread petrol and diesel vehicle use.
- Deploying heat pumps in rural homes can cut heating emissions by over 50%, but must be supported by clean electricity to avoid grid carbon spikes.

Proportion of Off-Grid Households by Region

- Off-grid properties exist in both rural and urban areas, with some high-rise flats lacking gas connections due to safety concerns.
- In 2021, 4.4 million GB households (15.1%)—were not connected to the gas grid.

Regions with the highest off-grid proportions:

- Inner London (25.1%)
- Southwest (23.6%)
- East of England (19.6%)



UK GHG Emissions Across Regions

Total Emissions (Highest Regions)

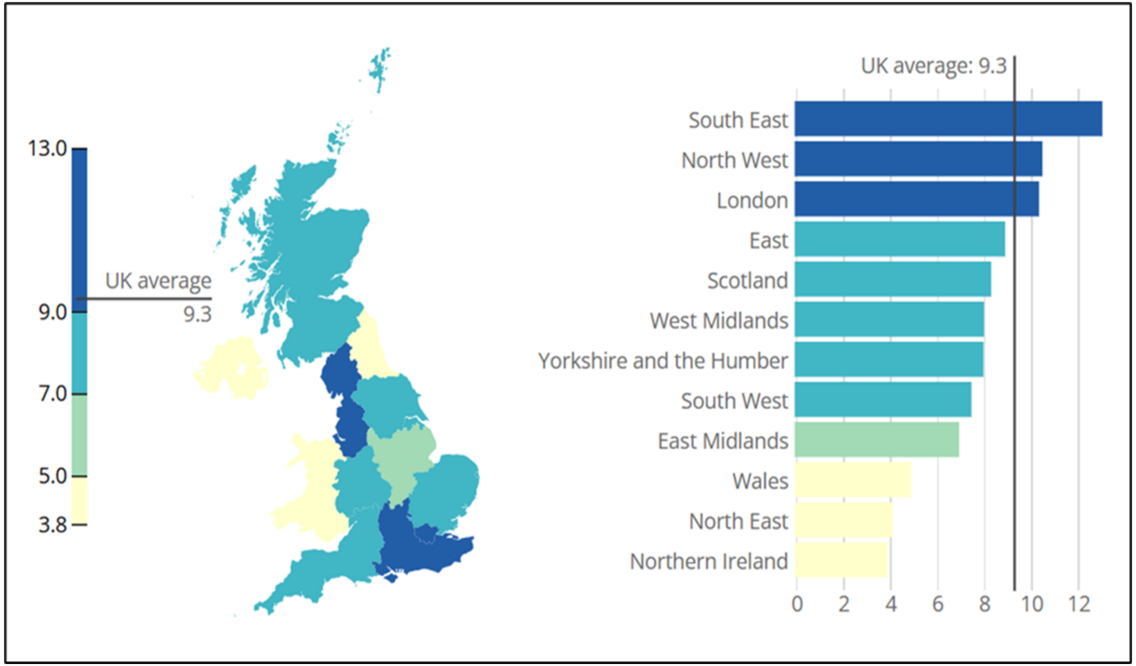
- **Southeast: Highest, exceeding 12 $MtCO_2e$.**
- **Northwest & London: Above UK average of 9.3 $MtCO_2e$.**

Per Capita Emissions

- **Northern Ireland has the highest per capita emissions when adjusted for population size**
- **London has higher population density and lower per capita energy use.**

Emissions Per Square Kilometre

- **Highest: London (dense population & concentrated energy demand).**
- **Lowest: Scotland (lower population density & extensive rural areas**



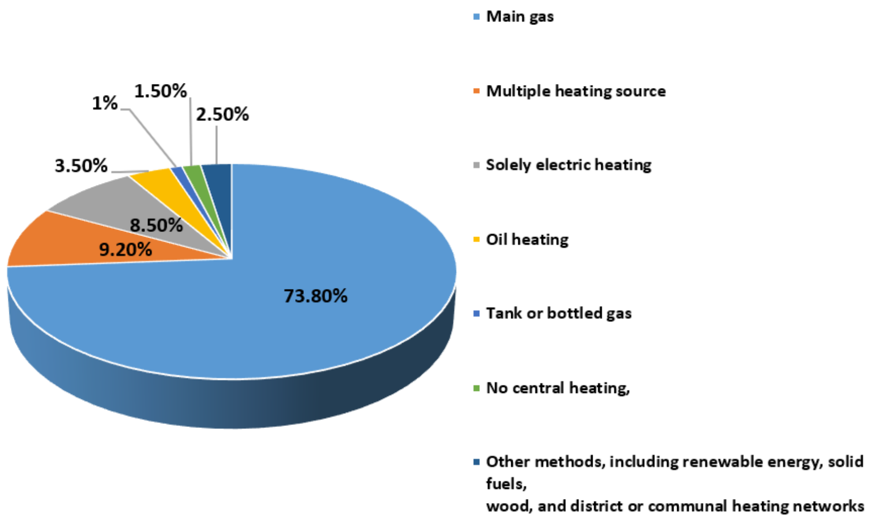
Source of Heating and Rural Energy Challenges

Limited Gas Grid Access

- 1 in 4 rural properties (1.4 million homes) are off grid.
- Some areas have even higher off-grid rates, such as Eden and Mid-Suffolk, where more than 50% of properties are not connected to the gas network.

Heavy Reliance on Oil Heating

- Over 1 in 10 rural households use oil for heating.
- In contrast, only 4 in every 1,000 urban homes rely on oil.
- The more rural the area, the greater the dependence on oil heating.



Source of heating across England and Wales

Regional and Technology-Specific Effectiveness of Low-Carbon Solutions

- Effectiveness of low-carbon technologies varies by region.
- Heat pumps are most effective in the Northwest due to cleaner electricity grids.

Technology-Specific Impacts:

Thermal Energy Storage (TES):

- Reduces localized emissions.
- Has a low coefficient of performance (COP), which can increase overall energy demand.

Lithium-Ion Batteries (LIBs):

- Production is carbon-intensive.
- Requires 328 Wh of energy and emits 110 gCO_2eq per Wh of storage.
- Environmental impact linked to rare metal extraction and fossil-based electricity.

Electric Vehicles (EVs):

- Environmental benefits depend on grid energy sources and battery production.
- Fossil fuel-based grids increase NO_2 and SO_2 emissions.
- Heavier EVs lead to more PM2.5 emissions if power is generated from fossil fuels.

Methodology

•The analysis examines private transport emissions in Awel Aman Tawe and Bigbury parish.

•Local Authority boundaries were used as proxies due to limited community-level vehicle data.

Scope 1 emissions include:

•Direct GHGs from household fuel use (heating, hot water).

•Emissions from private vehicle fuel combustion.

Scope 2 emissions include:

•Indirect GHGs from electricity used for lighting, heating, hot water, and EV charging.

	SCOPE 1 EMISSION SOURCES	
	Amen Awel Tawe	Bigbury
Household (heating, hot water)	Coal and anthracite; Smokeless coal; Biodiesel; Dual fuel (oil & wood logs); Gas; LPG; Oil; Wood and pellets	Coal and anthracite; Smokeless coal; Dual fuel (oil & wood logs); Gas; LPG; Oil; Wood and pellets
Transportation at local authority level (Neath Port Talbot) (South Hams)	Diesel (including plug-in hybrid diesel); Petrol (including plug-in hybrid petrol); Hybrid petrol	Diesel (including plug-in hybrid diesel); Petrol (including plug-in hybrid petrol); Hybrid petrol

	SCOPE 2 EMISSION SOURCES	
	Amen Awel Tawe	Bigbury
Household (lighting, heating, hot water)	Electricity	Electricity
Transportation at local authority level	Neath Port Talbot: Charging of battery electric vehicles and plug-in hybrids	South Hams: Charging of battery electric vehicles and plug-in hybrids

Key Insights on Scope 1 and Scope 2 Emissions in Awel Aman Tawe and Bigbury

Heating is the main driver of Scope 1 emissions in both communities:

- Awel Aman Tawe: **69%** of Scope 1 emissions
- Bigbury: **60%** of Scope 1 emissions

Total Scope 1 emissions:

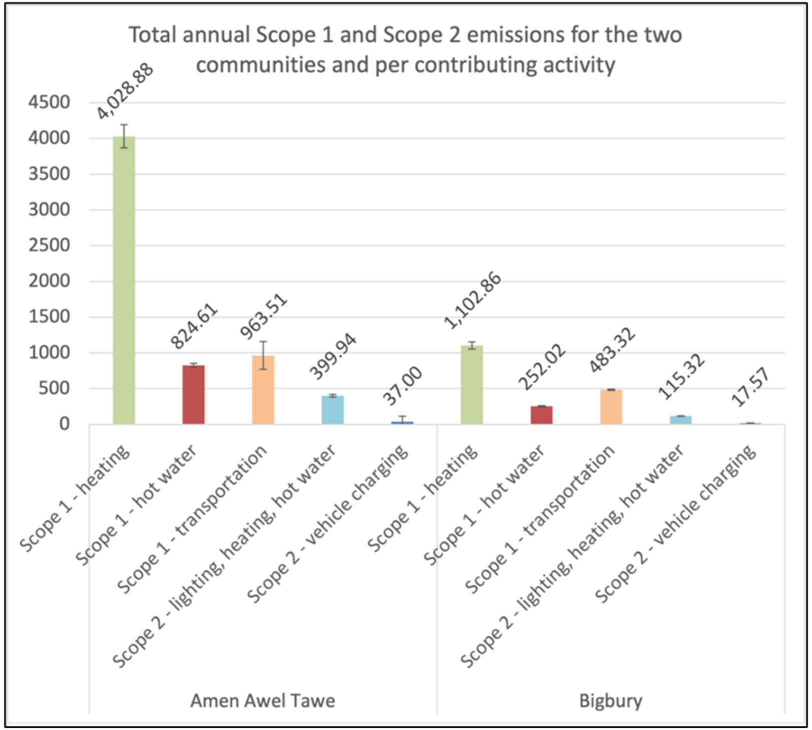
- Awel Aman Tawe: 5,854 tonnes CO_2/year
- Bigbury: 1,856 tonnes CO_2/year
- Transport-related emissions are notably higher in Awel Aman Tawe due to widespread use of petrol/diesel vehicles and the size of community.

Scope 2 emissions primarily come from electricity used for lighting:

- Awel Aman Tawe: 92% lighting, 8% EV charging
- Bigbury: 87% lighting, 13% EV charging
- EV charging emissions are relatively low in both communities
- Scope 2 estimates rely on local authority-level EV data, adjusted proportionally by household count

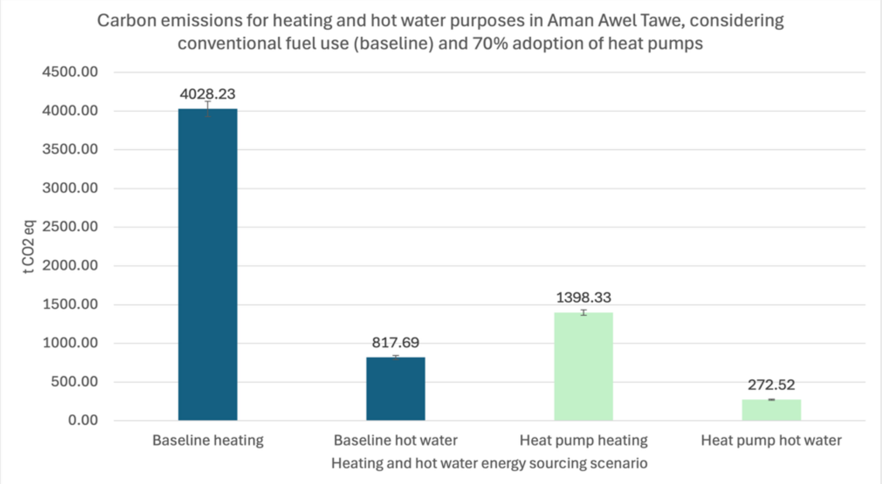
Comparison of Emissions Sources Between Awel Aman Tawe and Bigbury

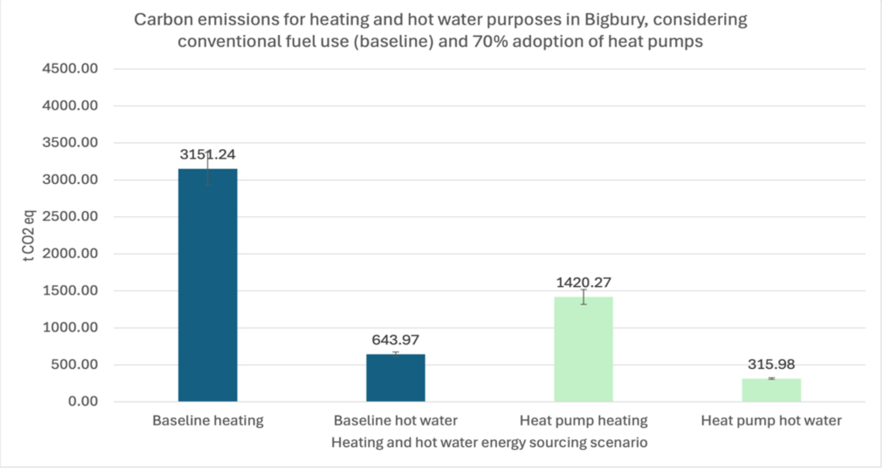
- Awel Aman Tawe has higher emissions than Bigbury, mainly due to heating.
- Scope 1 emissions (from direct fuel use) are the dominant source in both communities.
- Scope 1/ Scope 2 emission ratios: 13.3 (Awel Aman Tawe) vs.13.8 (Bigbury), indicating higher reliance on fossil fuels.
- Scope 2 emissions—from electricity used for lighting, heating, and hot water—are higher in Awel Aman Tawe than Bigbury.
- Vehicle charging emissions are minimal in both areas.
- High numbers of detached homes and fossil-fuel vehicles suggest strong potential for low-carbon technology adoption and transport electrification.



C-emission mitigation potential with adoption of heat pumps at selected communities

- Hypothetical simplistic scenario for 70% adoption of heat pump in selected communities (random households)
- Significant emission reductions achieved in Awel Aman Tawe for heating and hot water at -55% and -67% respectively
- Carbon grid intensity significantly increased with adoption of heat pumps (0.62 kgCO2eq / kWh for Awel Aman Tawe and 1.97 kgCO2eq / kWh for Bigbury)





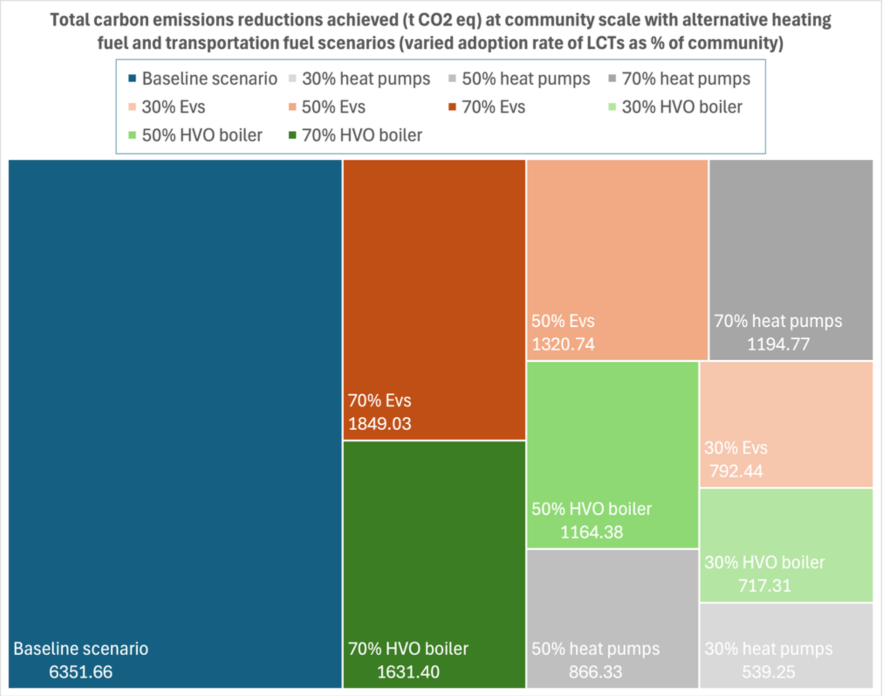
Scenario analysis for varied LCT adoption rates at community scale

- Community scale scenario analysis in the M4 Carbon Footprint Framework

- Baseline scenario (hypothetical):
  - 1000-household community
  - random mix of building archetypes, random mix of gas – oil – coal – dual (oil/wood) - dual (gas/electricity)
  - two diesel cars per household at 6.5k miles annually each

- Emission reductions compared to baseline ranged between 8.49% and 29.11%

- Replacing diesel vehicles with EVs at 70% achieved the largest reductions (29.11%), followed by adoption of HVO boilers at 70% (25.68%), and EVs at 50% (20.79%).



Step 5: Wider Engagement & Dissemination

Objectives:

- Wider cohort engagement: supporting broader engagement and knowledge exchange
- Define user requirements for the options support tool

Partners Involved:

REGEN

Outputs:

- Two community engagement events
- Significant interest in this topic from a wide range of local energy stakeholders
- Community User Insights Report

Selection Analysis → Detailed Feasibility → Alternative Options & Tool → Ownership Model, Carbon → Wider Engagement & Dissemination

REGEN

Wider engagement – activity

Activity

- Q1
  - Dissemination event attended by 50 stakeholders
- Q2
  - Interviews with 10 community energy stakeholders
  - Dissemination event attended by 70 stakeholders
    - Interview results verified via event poll
  - Sharing insights from engagement with REACH project team

Findings and reflections

Interviews

- While interviewees aspired to pursue a coordinated approach, the significant challenges could mean that many communities will likely adopt an ad hoc approach.
- Interviewees raised several concerns about the energy centre's acceptability. Strategies to address these concerns need consideration.

Direct engagement

- Pathway for BETA

03

BAU Challenges & BETA Application

REACH Alpha Summary: Delaying Beta to Focus on Targeted Evidence

Insights from Alpha:

- The Alpha phase delivered robust insights into the technical feasibility, community expectations, and regulatory environment for modular energy centres.
- As expected, evidence shows that in most locations, networks perform adequately under normal conditions, meaning currently energy centres are only required in rare fault scenarios — limiting their operational role.
- Based on these findings and the need for additional network analysis, we are taking a strategic pause and will review outputs from Alpha before targeting a Cycle 4 beta application

Next Step:

1. **Knowledge sharing:** Ensuring Alpha insights inform local area energy planning, policy development, and future innovation programmes.
2. **Targeted network modelling:** Undertaking detailed analysis for specific communities where early indicators suggest an energy centre may be needed even under intact network conditions.

This ensures the project continues to deliver impact — by influencing wider decarbonisation efforts and focusing future work where the need is both clear and actionable

Electricity Distribution

04

Risks review

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RISKS Review – Key Statistics

Total Risks Logged: 28	• Documented across technical, commercial, and strategic areas of the REACH Alpha project.
High Likelihood Risks: 6	• These include uncertainties around viable ownership models, evolving deployment scenarios, and heat provision assumptions.
High Impact Risks: 12	• Risks that could significantly affect project outcomes, including funding model viability and technical deployment feasibility.
Commercial Risks: 4	• Focused on investment viability, ownership structures, and return on investment for energy centres.
Technical Risks: 24	• Related to grid constraints, modelling assumptions, deployment logistics, and integration of low-carbon technologies.

RISKS Review – Key Statistics

Materialised Risks: 3

These include issues with use case revisions and alignment between network stability needs and project objectives

Open Risks: 4

Active risks primarily in areas where future tool development or external engagement is needed.

Closed Risks: 21

Successfully addressed risks, often through refinements to scope, proactive stakeholder engagement, or confirmed technical pathways.

RISKS Review – Materialised Risks

Materialised Risks:	Energy centre only required under fault conditions within the stakeholder communities; limited usage weakens economic case under standard CBA for ED2
	Infrequent use challenges funding for Temporary Module and would require regulatory approval ; alternative ownership models now under review.
	Communities expect ongoing value beyond fault support; options tool design broadened to primarily provide economic assessment to reflect this and improve likelihood of enduring community scheme.
Open Risks:	Energy centre deployment use case still evolving; regulatory sandbox engagement (Beta)
	Local planning and technical constraints may affect delivery timelines (Beta).
	Options Tool may not reflect future needs; alignment with project sponsors (Beta).
	Solution being developed ahead of 'network need' requires to be balance with responsible use of innovation funding or more detailed forecasting of likely quantity / locations.

Electricity Distribution

05

Project Finance Overview

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Project Finance Summary

	Total Project Costs	Project Contribution	SIF Funding requested
National Grid Electricity Distribution	£57,685.00	£6,893.00	£50,792.00
Cranfield University	£57,376.00	£11,475.00	£45,901.00
Frontier Economics	£55,265.00	£5,526.00	£49,739.00
Regen SW	£171,475.00	£17,147.00	£154,328.00
Smart Grid Consultancy Ltd	£206,050.00	£83,432.00	£122,618.00
VEPOD	£36,281.00	£8,994.00	£27,287.00
Passiv UK	£43,725.00	£4,373.00	£39,352.00
Total Cost by Category	**£627,857.00**	**£137,840.00**	**£490,017.00**

A **total project expenditure of £627,857** is expected,

With total **contributions totaling £137,840** made across project partners

The total **SIF funding requested is £490,017**

Expecting to finish on budget

SIF Funding Requested Spend Profile

Budgeted

Partner	December 24	January 25	February 25	March 25	April 25	May 25	Total
National Grid Electricity Distribution	£0.00	£0.00	£0.00	£0.00	£0.00	£50,792.00	£50,792.00
Cranfield University	£0.00	£17,365.00	£0.00	£16,635.00	£11,901.00	£0.00	£45,901.00
Frontier Economics	£0.00	£0.00	£0.00	£34,817.00	£0.00	£14,922.00	£49,739.00
Regen SW	£0.00	£0.00	£77,792.00	£0.00	£0.00	£76,536.00	£154,328.00
Smart Grid Consultancy Ltd	£8,478.00	£14,353.00	£14,475.00	£30,178.00	£10,728.00	£44,406.00	£122,618.00
VEPOD	£7,670.00	£0.00	£12,028.00		£3,149.00	£4,440.00	£27,287.00
Passiv UK	£4,293.00	£0.00	£0.00	£35,059.00	£0.00	£0.00	£39,352.00
Total	**£20,441.00**	**£31,718.00**	**£104,295.00**	**£116,689.00**	**£25,778.00**	**£191,096.00**	**£490,017.00**

Actual

Partner	December 24	January 25	February 25	March 25	April 25	May 25	Total
National Grid Electricity Distribution	£3,786.10	£3,156.00	£1,578.00	£3,156.00	£5,579.87		£17,255.97
Cranfield University	£0.00	£0.00	£0.00	£17,365.00	£0.00	£0.00	£17,365.00
Frontier Economics	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
Regen SW	£0.00	£0.00	£0.00	£62,060.00	£0.00	£62,856.00	£124,916.00
Smart Grid Consultancy Ltd	£8,478.00	£8,478.00	£8,478.00	£8,478.00	£5,772.00		£39,684.00
VEPOD	£0.00	£7,670.00	£12,028.00		£3,149.00	£0.00	£22,847.00
Passiv UK	£0.00	£0.00	£0.00	£0.00	£4,293.00	£0.00	£4,293.00
Total	**£12,264.10**	**£19,304.00**	**£22,084.00**	**£91,059.00**	**£18,793.87**	**£62,856.00**	**£226,360.97**

Forecast

Partner	May 25	Total
National Grid Electricity Distribution	£33,536.03	£33,536.03
Cranfield University	£28,536.00	£28,536.00
Frontier Economics	£49,739.00	£49,739.00
Regen SW	£29,412.00	£29,412.00
Smart Grid Consultancy Ltd	£82,934.00	£82,934.00
VEPOD	£4,440.00	£4,440.00
Passiv UK	£35,059.00	£35,059.00
Total	**£263,656.03**	**£263,656.03**

Note: Due to several payment milestones falling at the end of May, several invoices have not been received yet and will be processed in June

Total Project Cost Spend Profile (SIF funding + Contributions)

Budgeted

Partner	December 24	January 25	February 25	March 25	April 25	May 25	Total
National Grid Electricity Distribution	£0.00	£0.00	£0.00	£0.00	£0.00	£57,685.00	£57,685.00
Cranfield University	£0.00	£21,706.16	£0.00	£20,793.66	£14,876.19	£0.00	£57,376.00
Frontier Economics	£0.00	£0.00	£0.00	£38,685.17	£0.00	£16,579.83	£55,265.00
Regen SW	£0.00	£0.00	£86,435.28	£0.00	£0.00	£85,039.72	£171,475.00
Smart Grid Consultancy Ltd	£14,246.62	£24,119.10	£24,324.11	£50,711.78	£18,027.57	£74,620.82	£206,050.00
VEPOD	£10,198.09	£0.00	£15,992.52	£0.00	£4,186.93	£5,903.46	£36,281.00
Passiv UK	£4,770.06	£0.00	£0.00	£38,954.94	£0.00	£0.00	£43,725.00
Total	**£29,214.77**	**£45,825.25**	**£126,751.90**	**£149,145.54**	**£37,090.69**	**£239,828.84**	**£627,857.00**

Actual

Partner	December 24	January 25	February 25	March 25	April 25	May 25	Total
National Grid Electricity Distribution	£4,299.91	£3,584.30	£1,792.15	£3,584.30	£6,337.12	£0.00	£19,597.78
Cranfield University	£0.00	£0.00	£0.00	£21,706.16	£0.00	£0.00	£21,706.16
Frontier Economics	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
Regen SW	£0.00	£0.00	£0.00	£68,955.33	£0.00	£69,839.77	£138,795.11
Smart Grid Consultancy Ltd	£14,246.62	£14,246.62	£14,246.62	£14,246.62	£9,699.40	£0.00	£66,685.87
VEPOD	£0.00	£10,198.09	£15,992.52	£4,186.93	£0.00	£0.00	£30,377.54
Passiv UK	£0.00	£0.00	£0.00	£0.00	£5,300.07	£0.00	£5,300.07
Total	**£18,546.53**	**£28,029.01**	**£32,031.29**	**£112,679.34**	**£21,336.58**	**£69,839.77**	**£282,462.53**

Forecast

Partner	May 25	Total
National Grid Electricity Distribution	£38,087.22	£38,087.22
Cranfield University	£35,669.84	£35,669.84
Frontier Economics	£55,265.00	£55,265.00
Regen SW	£32,679.89	£32,679.89
Smart Grid Consultancy Ltd	£139,364.13	£139,364.13
VEPOD	£5,903.46	£5,903.46
Passiv UK	£38,954.94	£38,954.94
Total	**£345,924.48**	**£345,924.48**

Note: Due to several payment milestones falling at the end of May, several invoices have not been received yet and will be processed in June

06

Any Other Business & Close

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