Net Zero Communities (NZCom)

Internal Project Note

M4.1 Review of Technical and System Options

Version	Written	Released	Notes/Changes
Draft	D. Parish/A. Forman	31st July 2021	
V 2	A. Forman/D. Parish	20th August 2021	Additions from the team.

Contents

1. Introduction

The Net Zero Communities project (NZCom) forms part of a larger project: Vulnerability and Energy Networks, Identification and Consumption Evaluation (VENICE). VENICE is funded by WPD under the NIA Call 2020 – 'Energy Transition - Leaving no one behind'.

NZCom is investigating the effects and opportunities created by the decarbonisation of the Wadebridge & Padstow Community Network Area, achieving a net zero condition in 2050. However, the work is undertaken such that many proposals will be suitable for scaling and relocation to other similar communities.

The overarching aim of NZCom is to propose methods and business models that use local solutions, for energy systems and generally, to prevent the more vulnerable energy users from being disadvantaged by the transition to net zero.

This early stage review of potential solutions sits within WP4 and is conducted ahead of or concurrently with, the development of scenarios being undertaken in WP2. This strategy provides the project with a foundation of potential solutions which will be iterated and finalised to mesh with the scenarios being developed and the methodologies for emissions assessment (WP3).

2. Scope

This document presents an early opportunity to define the scope of the solutions development work. Defining the scope raises some questions which are addressed here but these positions can be amended through project team discussions as necessary.

2.1 Geographical Boundary

The geographical boundary for the project is defined by the Wadebridge & Padstow Community Network Area, as shown in Figure 1. This boundary identifies the residential, business and public service communities that are the subject of the net zero study.

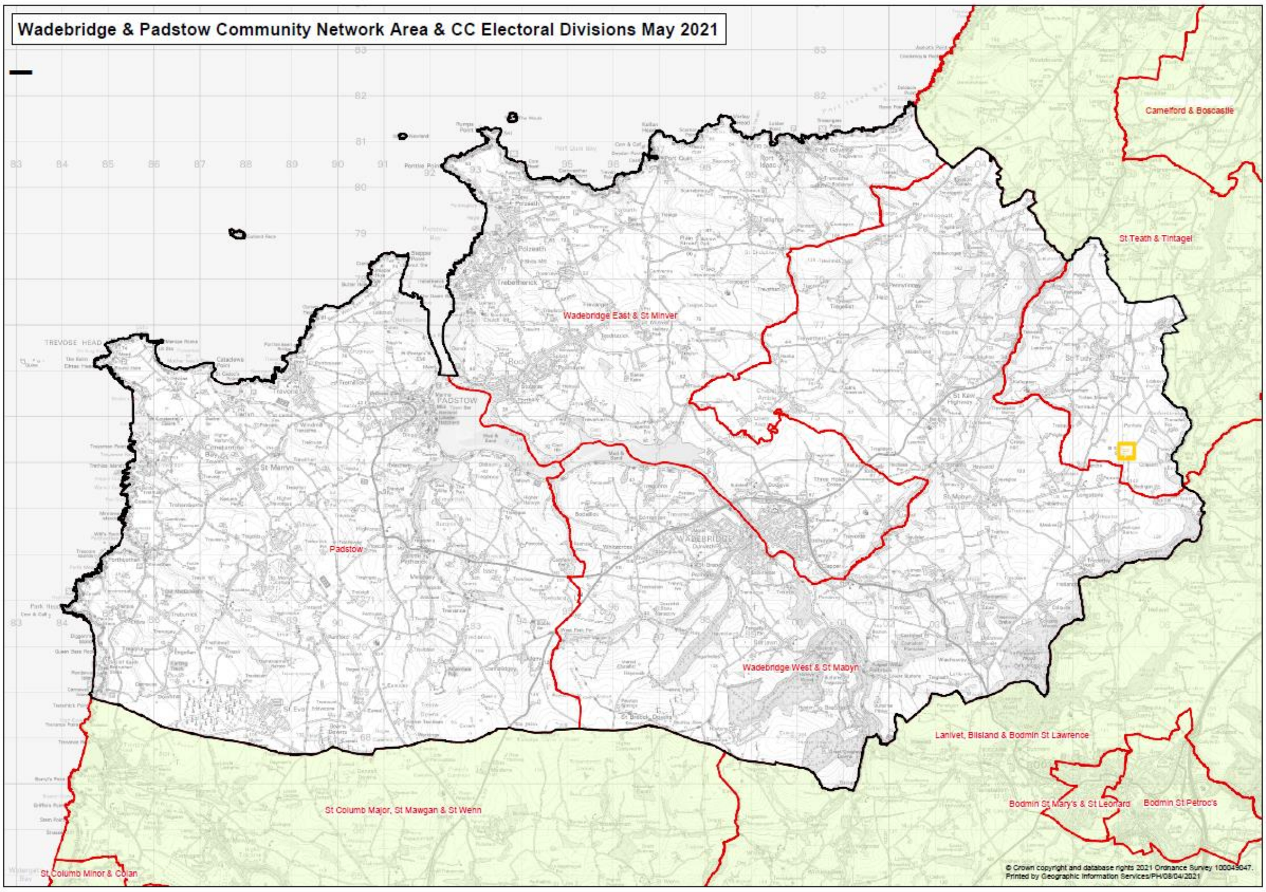

Figure 1: Map showing the project's geographical boundary in black.

2.2 Energy Users

The work is focussed on those in the community that will be or might be put at risk by the transition to net zero, these include residents and businesses. Solutions to mitigate the impact on the more vulnerable will draw on opportunities presented more generally by energy provision and use within the area.

2.3 Net Zero (GHG emissions)

Before developing solutions that aid progress towards an inclusive net zero, net zero itself must be defined. At the time of writing this document, the definition of net zero for the project area is being developed together with the means to evaluate current and future positions relative to net zero.

Carbon Trust note that there is not a globally recognised definition of net zero emissions for a city or a region but use the following in their work:

"A net-zero city or region will set and pursue an ambitious 1.5°C-aligned science-based target for all emissions sources covered within the BASIC+ reporting level of the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). Any remaining hard-to-decarbonise emissions can be compensated with certified greenhouse gas removal (GGR)." [1]

Carbon Trust go further to explain that this approach includes all scope 1 and scope 2 GHG emissions for the target area, together with scope 3 emissions relating to exported waste, transmission and distribution of energy (including energy carriers), and the transportation of goods.[1] The premise here is that the embedded energy of goods is accounted for in scope 1 and scope 2 emissions assigned to the area of origin and that it is only the emissions resulting from the transportation of such goods to the target area (the area being assessed) that are attributable to behaviours and activity within that area.

3. Methodology

This review of technical and system options comprises three stages:

1. A relatively unbounded 'brain-storm' which seeks to identify a large number of potential actions/solutions.
2. A detailed review of the actions and solutions output in stage 1.
3. Ranking of the actions/solutions

3.1 Brainstorm

Four categories are created for the generation of ideas relating to energy systems and use, these are:

a. Electricity
b. Heat
c. Transport
d. Cross vector

A fifth category is included that relates solely to the buying of goods within the area:

e. Importing goods

As an aide-mémoire, lists are drawn up comprising:

- Scope 1 type emissions – These are emissions that occur within the area itself from, for instance, burning fossil fuel within heating systems or internal combustion engines.
- Scope 2 type emissions – These are emissions that occur elsewhere so that energy can be delivered to the area, for instance, burning fossil fuel within a distant electricity generating station.
- Technology application groups – This list comprises broad definitions of technology applications such as roof-top PV, exterior thermal insulation, hydrogen fuel cell bus etc.

These lists are presented below.

Scope 1 type emitters

- Private local cars (diesel/petrol)
- Private visitor cars (diesel/petrol)
- Domestic space heating (gas/oil/LPG/solid fuel)
- Domestic water heating (gas/oil/LPG/solid fuel)
- Domestic cooking (gas/oil/LPG)
- Non-domestic space heating (gas/oil/LPG)
- Non-domestic water heating (gas/oil/LPG)
- Non-domestic cooking (gas/oil/LPG)
- Industrial process heating (gas/oil/LPG)
- Business cars (diesel/petrol)
- Public transport (diesel)
- Freight and goods transport (diesel)

Scope 2 type emitters

- Domestic electricity
- Business and other non-domestic electricity
- Private local EV charging
- Private visitor EV charging
- Community/car club EV charging

Technology application groups

- Domestic rooftop PV
- Larger scale rooftop PV
- Ground mounted PV
- Existing solar farms
- Existing windfarms
- Aggregated EVs
- Li-ion batteries
- Flow batteries
- Fleet FCEVs
- Hydrogen electrolysis, compression & storage
- HVO road fuel
- Load reduction
- Thermal insulation
- Electrification of heat
- District heat networks
- EV public transport
- FCEV public transport
- EV/FCEV last mile freight
- Electric bikes/buggies/scooters
- Anaerobic digestion
- Biomethane production
- Biomethane CHP
- Hydrogen CHP
- Fuel cells
- Biomethane road fuel
- Small windpower
- Utility scale windpower
- Small hydropower

3.2 Detailed Review of Actions/Solutions

The review in Chapter 4 explains each intervention and what it means in terms of community benefit*.

*Community benefit is defined by the project at Appendix A

3.3 Ranking of the Actions/Solutions

Ranking of the interventions is shown in Chapter 5. Table 5.1 extends the description in Chapter 4 to assess a rating for:

- Technical feasibility
- Regulatory feasibility
- GHG emissions reduction
- Community benefit
- Simplicity

The ranking awards 1 - 3 symbols to convey the relative merit of each category, with one symbol showing the least advantage and three symbols showing the greatest.

The proposed solutions are then grouped according to their score in carbon reduction and community benefit only; these metrics represent the best opportunity to meet net zero by 2050 without severely disadvantaging a sector of the community. Table 5.2 displays the grouped solutions which score between 6 (3 for GHG + 3 for community benefit) and 2 (1 for GHG + 1 for community benefit).

Simplicity and regulatory barriers are not included in this ranking of table 5.2 as the project aims to challenge regulatory barriers, and not to be put off by technical complexity.

4. Outcomes

4.1 Heat

The current fuel source for heat is likely to be varied across the geographical area. The project is aware that residential space heating and hot water will comprise of a mix of the following fuel types, which will be researched and represented as a percentage probability using county wide data and justified accordingly for:

i) electric emersion and direct electric heating systems
ii) electric emersion and night storage heaters (NSH)
iii) electric ground source or air source heat pumps
iv) gas
v) oil
vi) solid fuel

For businesses which are classified within the project the current fuel source is likely to be a mix of the following:

vii) direct electric
viii) heat pumps
ix) gas
x) oil
xi) Combined Heat and Power (CHP)

Emissions from heat will be justified within the Scope 1 & 2 emissions assessments. As part of the initial solutions development for heat, the following options are being considered.

H1: Electrification of Heat

Electrification of heat on a case-by-case basis is going to be a feasible and realistic way to reduce GHG emissions, as electricity is (currently) the only mainstream fuel source which has the potential to completely decarbonise. Properties should be prioritised which use primarily oil or coal, and secondary priority given to those on gas or inefficient wood fired systems. Electrification of heat solutions will include heat pumps (ground or air source) and new efficient direct heating systems such as infrared (IR).

Community benefit: Electrification of heat will be expensive compared to fossil fuels and is likely to have a negative financial impact unless significant action is taken to mitigate this. Bills will be high especially in poorly insulated properties.

H2: Solid Fuel Property Upgrade to Biomass

In this context solid fuel is taken to mean coal, charcoal, or wood on an open fire, range, or wood burner. These properties should be prioritised with a new heating strategy for biomass pellets (or electricity) in accordance with new government legislation on particulate emissions. GHG gas and particulate emissions will be reduced by upgrading wood fuel burners to more efficient gaseous pellet burners.

Community benefit: Allows homeowners to retain the popular wood stove option for additional heat. Resistance is often met by the suggestion of removing open fires and wood burners when retrofitting properties. Local air quality will improve with the upgrade of appliances.

H3: Community Heating Scheme or District Heat Network

Linked to a ground source or air source heat pump (or biomass/CHP) a community heating system may use a shared ground loop/water source which decreases the cost of multiple private installations and can volumetrically increase a system's stored hot water availability, making it more efficient and cheaper to run.

Similarly, a District Heat Network (DHN) is a bigger version of a community heating system which offers the same benefits over a wider area. The design may be more complex and could tap into multiple different heat sources, distributing hot water and space heating across a variety of property types.

Community benefit: DHN and Community schemes theoretically make the electrification of heat cheaper via use of a single large heat pump which implies reduced capex costs and a better co-efficient of performance (COP) than single individual units.

H4: CHP replaces commercial gas and oil

In commercial premises using mains gas and oil, Combined Heat and Power (CHP) should be considered for conversion to increase efficiency and subsidising grid import electricity by generating on site. Mains gas must be available on site and as CHP has specific load cycles, the load must be required over 24 hours with high hot water use. Green gas credit may be bought via the right broker and/or carbon offsetting may be invoked through XV5, it should be noted that CHP still relies on fossil fuelled gas, though there's no reason why CHP cannot run off green gas in the future.

Community benefit:

Financial benefit to businesses in the area which have suitable heat and power load profiles, through onsite generation of electricity. Suitable businesses for CHP may include hotels with swimming pools, or manufacturing /industrial processes with a 24/7 operating pattern. Reduction of imported (grid) electricity.

H5: Mains gas property boiler upgrade

Gas has a lower C02e factor than either oil or coal, there may be an argument for keeping residential properties already on gas and ensuring their boilers are improved. There is scope for further decarbonisation of the mains gas pipeline through injection of biomethane and hydrogen. Consideration should be given to carbon offsetting through XV5 for gas properties.

Community benefit:

Improved heating systems for sites with old gas boilers will result in direct savings on heating bills.

4.2 Electricity

Electricity emissions will be justified under Scope 2 emissions assessments. As assessment will need to be made of the implied increase in Scope 2 emissions as systems are switched from fossil fuelled heating to electric heating. Solutions which will reduce / neutralise these emissions to reach net zero by 2050 are:

E1: Behind the meter generation

When renewable power generation (e.g. solar PV) is fitted behind the meter (BTM), the site reduces grid import and benefits (where applicable) from avoidance of Final Consumption Levies (FCL), Transmission System Charges and Distribution System Charges. These cost avoidances help to soften the financial impact of the installation. We need similar advantage for all carbon reduction technologies; for example, if a heat pump is fitted there should be an exemption/ reduction in FCLs to acknowledge the contribution to decarbonisation. Currently, decarbonisation of heat increases electrical consumption which in turn increases the contribution to FCLs and system charges which financially acts against the efforts to decarbonise heating. Even without the added implications of system charges, switching from fossil fuel heating to electrical heating for a poorly insulated building will increase monthly outgoings significantly in kWh consumed, placing more households and business at risk of becoming vulnerable to fuel poverty.

Community benefit: Behind the meter generation typically provides a clear benefit by offering free electricity (for example from roof top solar) to the property if electricity is consumed while the resource is generating. If a microgrid is in use, BTM benefit will be absorbed through the microgrid and distributed evenly throughout the geographic area providing fair and equal distribution to the community at a lower rate per kWh than grid supplied electricity. Through smart management of a microgrid, exported unused solar / wind generation should be eliminated or minimised to a negligible level.

E2: Pseudo Microgrids at LV level

Low voltage (LV) on distribution networks is typically 430 volts (3 phase) or 230 volts (single phase). LV is used for connection between a residential or small commercial customer and the utility. Many embedded renewable energy generators are also connected to an LV branch of the network.

If locally generated energy flows across the DNO boundary onto the distribution network, any subsequent use of that energy attracts full system charges and final consumption levies. Therefore, private electrical microgrids are being considered by some designers, to share renewable electricity generation freely between local low voltage users without incurring these added charges.

However, there are complexities in owning and operating a private microgrid and little point in adding new private network infrastructure alongside the existing DNO system. It would be much better if the local DNO system could be used for the 'to and fro' conveyance of this 'local energy' as if it were a private microgrid, i.e. a pseudo microgrid. To achieve this, the local energy flow would need to be kept separate from any flow from or on to the non-local network. In this solution (E2), a boundary is set at the LV substation.

We can easily implement a scheme whereby G100 export limiting equipment is located at the low voltage (LV) feeder (or LV bus) within a LV substation, thereby isolating the local energy from the wider network. Embedded generation operated by the community (residential/business) can be prevented from passing in reverse through the LV substation and can be used by all fed by that LV supply without any justification to charge FCLs or Transmission system charges. Distribution system charges can be levied at a level that aligns with the LV only infrastructure being used. There are several simple variants to this scheme which might include, for instance, the 'community' taking ownership of the LV feeder to create a private microgrid. Community benefit: Renewable energy benefit will be absorbed through the microgrid and distributed evenly throughout the geographic area providing fair and equal distribution to the community at a lower rate pence/kWh within the LV distribution boundary.

E3: Pseudo HV Level Microgrid

High voltage (HV) on distribution networks is typically 11,000 volts (11 kV).

The HV microgrid operates as described in E1 but utilising a wider network to include HV electricity transmission lines with HV substations as the boundary. This design of an HV microgrid is explored using DNO transmission maps to define areas within the project's targeted geographical region which sit outside of the LV boundaries and would only be able to benefit from the microgrid if it were extended to HV. The solution may include a mix of LV and HV microgrid solutions. In this solution (E3), a boundary is set at the HV substation as shown in Figure 2.

<u>Community benefit:</u> Renewable energy benefit will be absorbed through the microgrid and distributed evenly throughout the geographic area providing fair and equal distribution to the community at a lower rate pence/kWh within the HV distribution boundary. Moving to an HV distribution boundary extends the area of benefit and increases the scale of renewables that is connected to the pseudo microgrid, thus achieving economy of scale.

E4: Pseudo EHV Level Microgrid

Extra high voltage (EHV) on distribution networks includes 33,000 volts (33 kV).

This solution is as described in E2 but encompassing EHV transmission lines with EHV substations as the boundary.

<u>Community benefit:</u> Renewable energy benefit will be absorbed through the microgrid and distributed evenly throughout the geographic area providing fair and equal distribution to the community at a lower rate pence/kWh within the EHV distribution boundary. Moving to an EHV distribution boundary, further extends the area of benefit and increases again, the scale of renewables that is connected to the pseudo microgrid, thus achieving greater economy of scale.

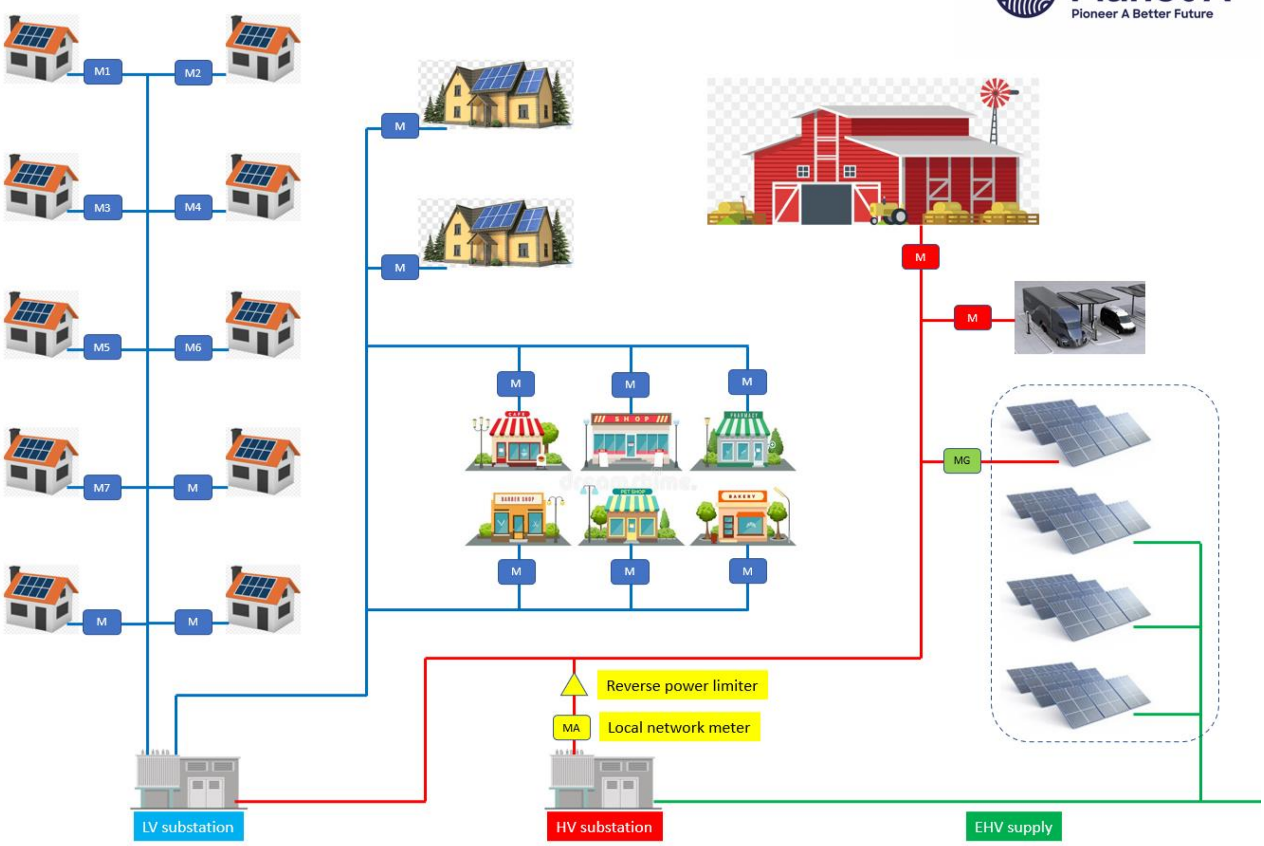

Figure 2: Pseudo local microgrid concept applied to an HV substation.

E5: Divert Existing Commercial Generation

Review existing solar and wind farm capacity within and close to the boundary of the geographical area. Investigate the impact of diverting a proportion of the exported energy to a local substation for use in E2/E3/E4 or E9.

<u>Community benefit:</u> Provides additional power generation to the microgrid, the benefit will be shared by the community by way of a reduced cost of electricity through the reduction of transmission and distribution charges. No additional greenhouse gas merit as system have already been installed. The supplier may receive a better rate per kWh than current PPA agreement, and microgrid users should receive a lower rate than grid supplied electricity purchase, making the community financial benefit promising.

E6: New Community/Commercially Owned PV

An assessment will be made of aggregated capacity from installation on every appropriate roof to invoke the benefits for E2/E3/E4 or E9. As this is data dependant, this may be done using assumptions across the area for suitable roof spaces. Residential building types will be considered with clear unshaded roof space (no Velux, shading).

Community benefit: Provides additional power generation to the microgrid, the benefit will be shared by the community by way of a reduced cost of electricity through the reduction of transmission and distribution charges. Additional greenhouse gas merit as system is new.

E7: New Community Owned Wind

Suggestion of potential new sites suitable for community owned wind turbines, to be connected to a local energy substation to invoke the benefits for E2/E3/E4 or E9.

New onshore wind sites may be developed under current governmental legislation if the local neighbourhood plan designates areas within it which may be used for such development. The success of this aspect very much depends upon local support and understanding and will benefit from a clear expression of the financial and carbon advantage of using wind to assist with the move to net zero. It should be exemplified through community engagement that wind power is a vital contribution to reaching net zero carbon by 2050 the electricity generation from which compliments solar PV and provides much needed electricity during the winter months when solar PV generation is not contributing as much.

Community benefit: Provides additional power generation to the microgrid with good capacity during the winter when solar generation is low and consumption of electricity is high, the benefit will be shared by the community by way of a reduced cost of electricity through the reduction of transmission and distribution charges. Additional greenhouse gas merit as system is new.

E8: Community/Commercially Owned Anaerobic Digestion

Community/commercially owned farm slurry to produce biomethane through the process of anaerobic digestion (AD) may be coupled to a gas engine to produce electricity and connected to a local energy substation to invoke E2/E3/E4 or E9. Bennamann are a local company based on the outskirts of Newquay, not far from the geographically boundary of the project area, already developing scalable AD solutions using slurry and cut grass to produce biomethane for rollout over different sites across Cornwall. E8 suggests meeting with Bennamann to look at suitable sites in the area and how this might benefit the NZCom project goals. Solutions for E8 (and T5) can be considered under XV6 as they cover AD options for transport and heat, as well as electricity generation through a gas cycle turbine relevant to E8.

Community benefit: Provides additional power generation to the community primarily as green gas, the benefit more likely to be shared via generation of electricity via a gas turbine, or development of a road transport fuel. Greenhouse gas merit as system is new. Feelgood factor turning waste to power, and circular economy benefits.

E9: Replication and Advancement on Bethesda Community Hydro Scheme

The Bethesda hydro scheme with Co-op energy and Energy Local was a pilot scheme set up to allow the scheme members to benefit from reduced price electricity as it was generated from a local hydro scheme. The project was a sandbox trial and avoided T&D charges being passed onto residents who received an advantageous time dependant rate of electricity at 7p/kWh and therefore showed significant annual savings to the scheme members. The scheme incentivised local PPA's to community scheme via energy supplier (Co-op Energy) who took the financial hit on the T&D charges to allow the scheme to trial. The E9 proposal for NZCom aims to advance this model to take into account the physics of the energy supply and transmission, taking this up a level from a simple buy-in scheme. The regulatory framework surrounding this needs to change to allow these schemes to be successful.

Community benefit: Reduced electricity rates to the community via avoidance of transmission and distribution charges. Increases understanding and awareness of localised electricity.

E10: Multiple Small Hydro

Hydro power provided steady electricity supply which surpasses the intermittent nature of solar and wind providing a more regulated supply of electricity to the recipient. This option does not appear viable due to several determining factors, including the following:

i) Lack of suitable sites for development within the area.
ii) Heavy administration in planning and licensing.
iii) Lack of subsidy (FIT) to provide financial support for development with a high CAPEX.

Community benefit: Where feasible, microhydro provides continuous supply of electricity and is not intermittent; which wind and solar are. Hydropower sometimes provides interest and attracts visitors.

4.3 Transport

When considering the area of interest as one project, emissions from transport are considered for privately owned residential vehicles, company owned fleet vehicles, upstream and downstream delivery of goods to the area, and public transport. The definitions and accounting methodology for transport emissions is currently being considered via scope 1 and scope 3 emissions, through WP3; Carbon Accounting Methodology (UoE), in conjunction with Planet A's WP4; Solutions, Impacts & Mitigation.

T1: Zero Emissions Vehicle Fleet for Tourism

A community owned company may operate a battery electric vehicle (BEV) or fuel cell electric vehicle (FCEV) car hire fleet aimed at the green tourist market. This may incentivise tourists to travel to the county by alternative means, incentives may be given to use the train over air or car, for example. However, increased cost implications may disincentivise this option and thought needs to be given to how these cost factors may be overcome.

Community benefit: Increased air quality, potentially less traffic due to less tourism by car.

T2: HVO Fuelling Stations

Hydrotreated vegetable oil (HVO) is a fuel made by hydro processing of vegetables oils and fats which can replace diesel as a fuel with no vehicle modifications (such as those necessary for use of biodiesel). Currently the cost of HVO is higher than that of diesel and consideration should be given to the cost, but reduction in carbon emissions is claimed to be 90% from that of diesel, including sizable reductions in tailpipe emissions (WPgroup,2021). Cornish start up 'Other Oils' is attempting to bring this option into the county for camper van owners for which BEV and FCEV options are not yet on the market and even when they are, may continue to run the classic engines well up to 2050.

Community benefit: Financial incentives for this option are much more attractive than the reality of affordability in buying new EV models for most users. However, the cost of fuel may increase. HVO supply chain must be assessed to receive positive carbon reduction benefit. May impact vegans as some materials contain animal waste products. May impact deforestation as palm oil is a major ingredient in some producers.

T3: Use Existing Car Share Schemes

Existing car share schemes such as Co-Cars already operate, incentivising BEVs, hybrid cars, and electric bikes. Members pay by the mile and book a car (or bike) from a convenient pick-up location. Suitable for local and tourist use, incentives may be given for swapping out the fossil fuel motor for a number of trips a week in a low emissions vehicle, or reducing the number of cars in one family, if such a scheme existed in the main towns.

Community benefit: Existing car share schemes give the opportunity for local people to use a brand new, fuel efficient car without having the financial burden of ownership and maintenance. Increasingly popular in cities

T4: Clean Air Zones

Setting up a clean air zone within town centres, or at popular tourist destinations would decrease air pollutants and reduce traffic problems. At peak times, fossil fuel vehicles may be charged for entry. The revenue for which may subsidise local community transport and fleet cars. Local exemptions may be appropriate and defining factors for exceptions will need to be considered. Ultimately, everyone will need to move away from fossil fuelled transport to meet net zero by 2050. A staged approach will be considered.

Community benefit: Improved local air quality.

T5: Biomethane for Transport

Similarly to E7, Bennamann will be approached to discuss viability of this solution using AD plant to create transport fuel as biomethane.

Community benefit: Feel good factor; local waste is turned into road transport fuel. Cost unknown.

T6: Hydrogen Refuelling Centres

Hydrogen fuel cell vehicles can only become an option once refuelling is available. Currently there are none within the SW. This option considers hydrogen re-fuelling as a standalone option managed by an external company with hydrogen generated offsite and delivered. However, this option could be coupled XV3 to generate hydrogen onsite using an electrolyser with a substantial amount or wind and solar, green hydrogen in selected areas.

Locations on trunk roads are key to progressing the development of hydrogen as a road (and other) fuel and present an opportunity to assist in the pathway to decarbonisation by 2050. This option should be reviewed to meet the scalability aspect of the project, even if no suitable sites are found within the NZCom project area, it is a useful way to gain access for further deployment of renewables, avoid grid constraints and assist developments which may be on a LIFO stack (Last in First Off) or Active Network Management (ANM) area.

Community benefit: Opportunity for localised investment in hydrogen fuel cell vehicles.

4.4 Cross Vector

Cross Vector Solutions are designed to assist with the decarbonisation of electricity, heat and transport, i.e. multiple vectors. Cross Vector Solutions may provide social and environmental incentives towards decarbonisation and are discussed as such.

XV1: New Energy Supply Chain

A new energy supply offering may be trialled that sells demand reduction alongside supply. This allows grid services to be offered by the energy supplier who then passes that service on to its customers, for example, a business may be paid to turn down it's freezers for two hours during peak times, reducing demand on the grid. Similarly, this may be extended to householders (similar yet different to the Octopus Agile Tariff) which pays its customers to scale back demand during peak hours. This may link to a sliding scale energy tariff which triggers cost increase past a certain allocation of kWh energy use to incentivise energy reduction. Pre-payment energy meter credit should also be integrated to this scheme, with a credit operated system linked to XV4 positive feedback scheme.

Community benefit: Cost savings to users.

XV2: PV and BEV park with V2G

Many local facilities such as Park and Ride now offer EV charging facilities. Combine that with solar PV on (a car port) to offer subsidised charging and use car batteries to store energy to avoid waste during the day. Using the V2G capability for some cars, e.g. Nissan Leaf, electricity used in the car battery can then be used to power certain reasonably sized community assets in the evening, such as a community hall, leisure centre, cinema etc.

Community benefit: Novelty.

XV3: Hydrogen Electrolyser

Green hydrogen generation by renewables as described in T6, but with multiple uses. Hydrogen can be used as a gas with a dedicated hydrogen boiler, used for re-fuelling vehicles, injected into the mains gas network, or stored in the electrolyser and converted back into electricity using a fuel cell. Currently it's expensive to do and would likely need the backing of some major finance, but it remains a technical possibility and one that is being actively chosen by many countries around the world to meet zero carbon targets. Hydrogen is a key player in reducing grid constraints via flexibility services.

Community benefit: Interest in localised investment in hydrogen technology, potential new business and employment opportunities. May free up expensive grid connection upgrades and create space on the network.

XV4: Positive Feedback Scheme

There is likely to be resistance from some sectors to decarbonisation due to the realities of the changes which need to be met. To encourage behavioural change, credits for positive impact behaviour may be given to trigger energy cost reduction. Linked to E1/E2/E3/E8.

Community benefit: Positive reward scheme to include using public transport, buying local produce etc in return for lower household / business energy supply rates.

XV5: Upgrades of Fuel Poor Houses via Offsets

A carbon offset scheme is set up to support upgrades and retrofit work offered to fuel poor households or vulnerable businesses. Classification of which to be determined in WP5 & WP8.

Community benefit: housing upgrade benefits occupants by energy cost reduction, less maintenance and less damp. Health benefit for occupants. House prices in the area may inflate due to improved housing stock and quality of living improved through healthy buildings.

XV6: Roll out of AD Plant to Cover Heat Transport and Electricity.

Using Benemann model.

See also E7 and T5.

Community benefit: Local waste turned into energy, fed into microgrid for reduced energy cost benefit.

XV7: Building Society Approach

An original building society approach (non-permanent) whereby members contribute to a monthly fund which is used to upgrade houses – insulation, heating apparatus and PV.

A building society is an organisation that is owned and operated exclusively by its members, and as such, could be well suited for use within defined communities. As building societies are not publicly listed on stock markets and beholden to their shareholders, they can make decisions that are solely for the benefit of their members. If enough community members were prepared to invest their savings in a turnkey building society, the profit made from investment of savings could be returned through the building societies business aspects, i.e, retrofitting buildings to make them more efficient, and installing behind the meter renewable energy generation to subsidise bills. This could be an excellent incentive to remove members money from mainstream banks and re-invest in an ethical manner which directly benefits the local area.

Community benefit: Positive investment in the local area through building society scheme, improved housing stock improves quality of life and provides feel good factor.

5. Detailed Review of Options

5.1 Rating

Some solutions will be more suited to the NZCom project area than others and have different viability levels. This section explains how the technology options are ranked as being feasible for the NZCom project. Other options listed in Chapter 4 may be suited to other regions looking to decarbonise and should be considered in the final report as considerations for other projects and areas needed to meet net zero targets.

Solutions are considered in relation to the following characterisation

- **Technical feasibility** *(suitability to location, technology availability, technology readiness)*
- **Regulatory feasibility**
- **GHG reduction impact**
- **Community Benefit**
- **Simplicity**

The rating is shown between one and four icons, with four being judged as having the most benefit within each sector, shown in Table 1. From Table 1, the ideas which merit the highest ratings for community benefit and show the highest impact on GHG reduction are shown in Table 2.

There is only one solution considered, not technically viable, which is micro hydro, which otherwise would have scored high within the community benefit and GHG reductions impact.

Table 5.1: Ratings of technology suitability in order of vector

Solution	Technical Feasibility	Regulatory Feasibility	GHG Reduction	Community Benefit	Simplicity
H1: Electrification of Heat	✔	★★★	🏭🏭🏭	£	😇😇😇
H2: Solid Fuel Property Upgrade to Biomass	✔	★★★	🏭🏭	£	😇😇😇
H3: Community Heat or DHN	✔	★★★	🏭🏭	£££	😇
H4: CHP Replaces Commercial Oil & Gas	✔	★★★	🏭🏭🏭	£	😇
H5: Main gas property boiler upgrade	✔	★★★	🏭🏭	£££	😇😇😇
E1: Behind The Meter Generation	✔	★★★	🏭🏭🏭	£	😇😇😇
E2: Pseudo Local Microgrid at LV level.	✔	-	🏭🏭🏭	£££	😇
E3: Pseudo Local HV Level Microgrid	✔	-	🏭🏭🏭	£££	😇
E4: Pseudo Local EHV Level Microgrid	✔	-	🏭🏭🏭	£££	😇
E5: Divert Existing Commercial Generation to E1/E3/E4/E9	✔	★★	-	££	😇😇
E6: New Community / Commercially Owned PV to E2/E3/E4/E9	✔	★★★	🏭🏭🏭	£££	😇😇😇

E7: New Community Owned Wind to E2/E3/E4/E9	✓	★	🏭🏭🏭	£££	😇😇😇
E8:Community / Commercially Owned AD	✓	★★	🏭🏭🏭	££	😇😇
E9: Replication and Advancement on Bethesda Hydro	✓	★★	🏭🏭🏭	££	😇😇
E10: Multiple Small Hydro	✗	★★	🏭🏭🏭	£££	😇
T1: Zero Emissions Vehicle Fleet for Tourism	✓	★★★	🏭🏭🏭	£	😇😇😇
T2: HVO Fuelling Stations	✓	★★★	🏭🏭🏭	££	😇😇
T3: Use Existing Car Share Schemes	✓	★★★	🏭	£	😇😇😇
T4: Clean Air Zones	✓	★	🏭	£	😇
T5: Biomethane for Transport coupled XV6	✓	★★	🏭🏭🏭	£	😇😇
T6: Hydrogen Refuelling Centres	✓	★★	🏭🏭🏭	£	😇
XV1: New Energy Supply Chain	✓	★★	🏭🏭	£	😇😇
XV2: PV and BEV park with V2G	✓	★★★	🏭🏭	££	😇
XV3: Hydrogen Electrolyser coupled T6	✓	★★	🏭🏭🏭	£	😇
XV4: Positive Feedback Scheme	✓	★★	🏭🏭	££	😇😇

XV5: Upgrades of Fuel Poor Houses via Offsets	✔	★★★	🏭🏭🏭	£££	☺☺☺
XV6: AD Plant for Heat Trans and Elec. Coupled T5	✔	★★	🏭🏭🏭	££	☺
XV7: Original Building Society Approach	✔	★★★	🏭🏭	££	☺☺

5.2 Detailed review of viable options

Table 5.2: Ratings of technology suitability in order of ranking

Solution	**GHG Reduction**	**Community Benefit**
E2: Pseudo Local Microgrid at LV level.	🏭🏭🏭	£££
E3: Pseudo Local HV Level Microgrid	🏭🏭🏭	£££
E4: Pseudo Local EHV Level Microgrid	🏭🏭🏭	£££
E6: New Community / Commercially Owned PV to E2/E3/E4/E9	🏭🏭🏭	£££
E7: New Community Owned Wind to E2/E3/E4/E9	🏭🏭🏭	£££
XV5: Upgrades of Fuel Poor Houses via Offsets	🏭🏭🏭	£££
H3: Community Heat or DHN	🏭🏭	£££
H5: Main gas property boiler upgrade	🏭🏭	£££
E8:Community / Commercially Owned AD	🏭🏭🏭	££

E9: Replication and Advancement on Bethesda Hydro	🏭🏭🏭	£ £
T2: HVO Fuelling Stations	🏭🏭🏭	£ £
XV6: AD Plant for Heat Trans and Elec. Coupled T5	🏭🏭🏭	£ £
H1: Electrification of Heat	🏭🏭🏭	£
H4: CHP Replaces Commercial Oil & Gas	🏭🏭🏭	£
E1: Behind The Meter Generation	🏭🏭🏭	£
T1: Zero Emissions Vehicle Fleet for Tourism	🏭🏭🏭	£
T5: Biomethane for Transport coupled XV6	🏭🏭🏭	£
T6: Hydrogen Refuelling Centres	🏭🏭🏭	£
XV2: PV and BEV park with V2G	🏭🏭	£ £
XV3: Hydrogen Electrolyser coupled T6	🏭🏭🏭	£
XV4: Positive Feedback Scheme	🏭🏭	£ £
XV7: Original Building Society Approach	🏭🏭	£ £
H2: Solid Fuel Property Upgrade to Biomass	🏭🏭	£
XV1: New Energy Supply Chain	🏭🏭	£

E5: Divert Existing Commercial Generation to E1/E3/E4/E9	-	££
T3: Use Existing Car Share Schemes		£
T4: Clean Air Zones		£
E10: Multiple Small Hydro		£££

Note: E10 excluded because it is deemed to be unrealistic due to geographical resource.

References

[1] Carbon Trust, ‘What does net zero mean?’, available at https://www.carbontrust.com/what-we-do/net-zero, 2021.

[2] WP Group, ‘How we are fuelling change; HVO fuels’ available at Hydrotreated Vegetable Oil - (HVO) (thewp-group.co.uk) 2021.

Appendix A – Definition of Community Benefit

Community Benefit*: An advantageous outcome which directly enhances quality of life for those living within the geographical boundary, through improved health, social, and environmental standards.*