Net Zero Communities (NZCom)

Internal Project Note

M4.2 Characterisation of Confining Factors

Version	Written	Released	Notes/Changes
Draft	D. Parish/A. Forman	25th October 2021	
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Contents

1.0 Background

The purpose of milestone M4.2 is to identify and list the likely confines which could prevent technological and behavioural solutions to meeting net zero by 2050, from being deployed. Here we identify potential barriers to implementation which must be overcome to enable progress to be made in the energy sector. In M4.1, a number of solutions were listed which were ranked as possible ways to meet the critical mark of net zero by 2050, using solutions for electricity, heat, transport and cross vector.

It is clear that creating a fair national policy will be challenging and local solutions are required.

"Companies and consumers themselves will need to do things differently if we are to meet the challenge of net zero: to rewire the electricity system, to move away from natural gas (without carbon capture and storage), to operate and plan differently, and develop new approaches to provide energy and energy services to consumers – especially those that enable consumers to use less energy and to use it at different times." Ofgem Decarbonisation Action Plan, 2021

The NZCom Project, and the Wadebridge Net Zero Plan, aims to help the energy regulator and Distribution Network Operators to understand the regional challenges faced by communities in meeting the targets declared.

In June 2019, UK Parliament announced a net zero greenhouse gas emissions target by 2050. In order to meet this goal, significant changes are to be undertaken which must be met by individuals, businesses, communities, and local councils, underpinned by clear and strategic leadership. Changing current policy and legislation to meet new targets is arguably the most important step in encouraging others to follow suit. The BEIS Net Zero Strategy: Build Back Greener, was released on 19 October 2021. The Prime Minister states in the foreword "we will unleash the unique, creative power of capitalism to drive the innovation that will bring down the costs of going green, so we make net zero a win for people, for industry, for the UK and the planet".

We remind ourselves at this point that these are not confining factors relating to the ability to decarbonise, they are confining factors in our ability to provide inclusive, affordable solutions to a community.

The Net Zero Strategy must be inclusive and adaptable for communities to be able to embrace their own plans, and their own contribution to reducing emissions. That will not come without its challenges. The Secretary of State for BEIS states: "We will put consumers at the heart of this transition, helping them make their homes warmer, more efficient, and ensure they pay fair, affordable prices for their energy". This has not been done before, and the NZCom project should deliver feasible methods by which to assist with this transition locally. The Net Zero Strategy does not comment on the possible constraints of this transition and they are not to be ignored; the move to net zero is bound to present obstacles that we must learn to overcome locally, nationally and internationally in the development of innovative carbon free solutions to energy production.

This paper refers to the characterisation of confining factors relating to those chosen solutions from output M4.1, and the ability to integrate them into the project area.

2.0 Scope

Define the confining factors for delivering solutions for net zero by 2050 by the following methods, taken from the delivery of solutions in M4.1, specifically *Table 5.2: Ratings of technology suitability in order of ranking.*

The top-ranking solutions shown in Table 1 will act as the baseline from which we will build our work. These solutions are deemed to have the most impact in rapid decarbonisation and are therefore prioritised in their application and roll out. The main solution proposed here is the development of a pseudo microgrid to deliver clean electricity within the community using existing electrical infrastructure, and this being the most critical provision for regulatory change. If energy regulations and policies can be adapted to allow the development of pseudo microgrids, the delivery can be largely driven by the application of regulatory policy and smart technology, without the need for high Capex costs and materials for roll out of new infrastructure. The capacity of the existing infrastructure must be assessed and Western Power Distribution is asked to provide commentary on this.

Table 1 (below) shows the primary solution package which ranked the highest in the solutions table in M4.1 and shows a mix of heat, power and transport. This solution package is mostly electric, supported by hydrogen and HVO for transport, driving the argument for an electric solution to meeting the energy demand to be the most tangible. In essence, the replacement of fossil fuel with an electric solution to net zero, and that electric supply being local (as far as possible) and clean, powered by large scale renewable energy.

E2, E3, E4: Pseudo Local Microgrid at LV, HV and EHV level.
E6: New Community / Commercially Owned PV linked to E2/E3/E4
E7: New Community Owned Wind linked to E2/E3/E4
H3: Community Heat or DHN
H1: Electrification of Heat
T1: Zero Emissions Vehicle Fleet
T2: HVO Fuelling Stations
XV5: Upgrade of fuel poor houses via offsets
XV3 / T6: Hydrogen electrolyser for transport

Table 1 shows the top ranking solutions package from M4.1, driving an electric solution.

The scope of this paper is to define the above solutions package and discuss the constraints within it.

1. **Electricity. The development of a pseudo microgrid to allow transmission of locally generated energy to local users. Integration of new community owned solar PV and wind, alongside existing solar PV and wind which may be diverted to a microgrid.**
2. **Heat. The development of electric heat networks and private systems fed by (1). Other solutions listed in M4.1 may be brought in as interim measures to support the electrification goal by 2050.**
3. **Transport. Deployment of transport both private, public and commercial using electricity, hydrogen and HVO.**
4. **Cross Vector. Development and constraints around XV solutions to support and feed in to the zero-carbon agenda through delivery of a community friendly adoption plan.**

3.0 General Technical Constraints

3.1 Feasibility

The technical feasibility of any solution is framed by the ability to adopt technology which may be restricted in a number of ways. The constraints faced by the feasibility of an idea are widely varied and can include, for example, the size and orientation of a house roof in its suitability for solar PV, or the space required for a hot water store to adopt a heat pump system. On a wider scale, network restrictions, grid availability, and resource should all be assessed carefully to ensure the right technology is matched to serve the needs of the consumer.

Just as there are constraints, there are also design variations which may accommodate different scenarios. For example, it may be possible to put solar PV on a ground mounted system if the roof is unsuitable, or on the roof of a neighbouring building.

For this reason, a detailed technical feasibility study should be undertaken prior to any large project. A technical feasibility study will consider the desired outcomes, identify any constraints, and configure a solution that works. This allows plenty of time and attention to be paid to the design so constraints can be addressed early on, avoiding wasting valuable time and money further down the line.

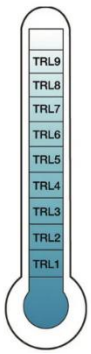
3.2 Market readiness / TRL

Some solutions to decarbonisation are absolutely viable, but not yet ready to be bought and sold on the market. In some instances, usually within Research and Development (R&D) stages, a Technology Readiness Level (TRL) indicator is given. We are not contemplating technologies which have not already achieved TRL levels of 7 or higher, this is the indicator level which assumes a product will reach the market. TRL levels seem to vary between industry sectors, figure 9 is a guide only.

Hydrogen is a good example of a market readiness constraint. Hydrogen as a gas is commercially used and has been for many years. Equipment is readily available; electrolysers for the production of green hydrogen, hydrogen ready boilers, hydrogen fuel cell cars and lorries are on the market, and therefore hydrogen technologies may be regarded at TRL 8-9. The roll out of hydrogen generation, transportation and use of hydrogen is still in the early stages of commercial operations in the UK, but globally also, with different global economies prioritising the roll out accordingly. On a local scale, this brings commercialisation of hydrogen to a TRL level of around 6, although it already sits at a level 9

with regards to transportation and industrial activities such as ammonia production and oil refineries. Therefore, although it is technically feasible to do so, using hydrogen as a main gas supply alternative for heating homes currently still presents constraints because major infrastructure needs to change, there are few competent installers, and the cost is high. This is likely to change in the next 5-10 years as the government scales up the hydrogen economy and investment is given to rolling out infrastructure.

Technology Readiness Levels (TRL)



- TRL9 Operations
- TRL8 Active Commissioning
- TRL7 Inactive Commissioning
- TRL6 Large Scale
- TRL5 Pilot Scale
- TRL4 Bench Scale Research
- TRL3 Proof of Concept
- TRL2 Invention and Research
- TRL1 Basic Principles

Figure 9, TRL levels indicator

3.3 Availability and Access to Data

Availability and access to data is critical for planning. To understand energy loads, calculated assumptions must be made on the energy use for homes and businesses in the area. This varies greatly due to building fabric, age of buildings, how well insulated it is, and what the primary fuel source is.

NZCom project is using data from EPCs (Energy Performance Certificates) to determine different building typologies in the area and scaling it accordingly. The EPC data is available for some but not all residential properties, and it is often missing data. EPCs are conducted via a visual survey, therefore some valuable information on construction materials is sometimes not collected. In addition, not all houses have a valid and up to date EPC, and commercial buildings even less so.

The availability of good quality data is a huge constraint but could be addressed with the right support.

The roll out of SMET2 smart meters on all properties to measure electricity has been slow, and this information is confidential without explicit permission from the property owner. The DNO does not have access to this data. Half Hourly (HH) metering is becoming more commonplace for electricity but is still rare to find HH metering for gas. HH meters give a detailed breakdown of the average energy consumed every half hour, allowing tracking of energy use through peak times. The roll out of compliant and active smart metering is now overdue. With increasing ambition from energy suppliers for HH metering to be in place, this data would provide vital evidence for the development of net zero solutions and allow insight into balancing mechanisms and storage solutions.

3.4 Network Capacity

Areas of grid constraint cause difficulties for the implementation of new renewable energy generators onto the grid. Grid constraint relates to areas where there is too much electrical traffic at any one time. Commonplace in the South West of England, the electricity network infrastructure needs to be

upgraded to accommodate more flow of electricity in and out of the county, capacity needs to be free for further integration of renewable energy generators most especially because renewable energy is an intermittent supply meaning that at times when the resource is available (sun, wind) there can be more energy generated than used, if there is no capacity on the electricity lines for transmission, generators are switched off. In reverse, times of high demand may occur when there is little generation and the stress on the grid to deliver power where it is needed is inefficient. A pseudo microgrid is likely to relieve the flow of electricity on the main transmission lines because less power will be travelling long distances if it generated and used locally. This in turn will alleviate pressure on district network operators to upgrade lines.

Curtailment is a form of network restriction, when generators are switched off to prevent overstressing the networks, often leading to wasted generation which could be put to better use, either by supplying a direct load, or through storage.

Throughout this project, work will be undertaken to understand particular network capacity restrictions at the HV and LV substations within the region.

3.5 Skills and Training

To provide a roll out of heat pumps and other low carbon heating system there must simultaneously be a roll out in upskilling tradesmen and contractors to better understand the technology. Ratio of trained engineers, heat pump installers to gas engineers in currently thought to be low.
Lack of commercial providers currently presents a problem with the mass roll out of low carbon technologies, however it also provides an opportunity for further job creation which will help create a productive economy.

3.6 Existing Building Stock

Poorly insulated buildings cause a constraint to the roll out of low carbon heating systems. Without efficiency improvements, buildings will become more expensive to heat on an all electric network. This risk is increased in areas where income is already stretched. Poor building efficiency has a direct relationship to health, and to fuel poverty.

Data related by Community Energy Plus shows:

"The Committee of Fuel Poverty's latest report says 3.2 million households in or at risk of fuel poverty in England. 13.4 per cent of households (3.18 million) in fuel poverty in England under the LILEE metric (LILEE= Low Income Low Energy Efficiency).

The 2020 data release showed England at 10.3% and Cornwall at 13.54%.

Addressing the issue of poor building stock will have a positive effect in two major areas which cause a ripple effect within communities, these being improved health and well-being (mental and physical), and GHG emissions reduction. The benefit of these two contributors combined is a powerful tool in uniting communities. Retrofitting and improvement of building stock is included in the solutions package should remain as a prioritised outcome.

3.6.1 Domestic

Figures published by the Ministry of Housing, Communities and Local Government March 2020, show that "there were 24.7 million dwellings in England at 31 March 2020, an increase of 243,770 dwellings (1.00%) on the same point the previous year. 15.7 million dwellings were owner occupied dwellings, 4.8 million private rented dwellings and 4.1 million social and affordable rented dwellings (Private Registered Providers plus Local Authority)".

Using local knowledge, we have to consider pre 1930 is solid wall construction, post 1930 cavity wall insulation (CWI) starts to appear, and by the 50s the Cornish Units and pre-fabricated concrete typologies are prevalent in the post war era.

The EPC data for the geographic region of this project shows EPC data for approximately 50% of the properties within the curtilage, figure 10 shows that the majority of those properties have an EPC of D, a trend that is replicated by the data for non-domestic buildings.

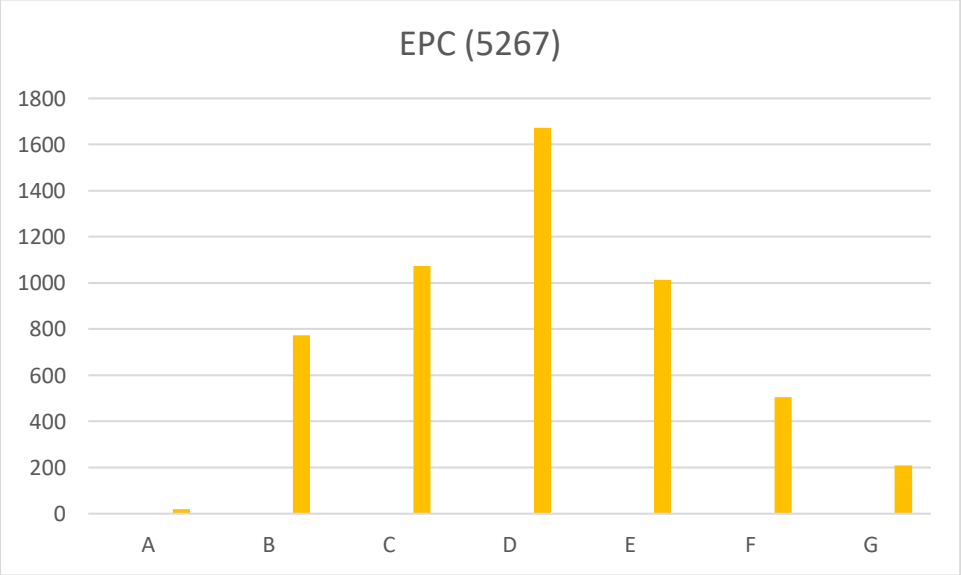


Figure 10, EPC data levels graph for the NZCom region.

Sitting within the community we know that a number of people live in park home accommodation within this region. This is a difficult sector to quantify, and only 1 EPC record exists for park homes. The project draws upon expertise within the partners, particularly that of Community Energy Plus, to conclude that in Cornwall the number of residents in park home accommodation is 0.014% of Cornwall's domestic properties. That would give us 73 as a proportion of the 5267 EPCs within the project boundary. Therefore 70-75 households living in park homes in the network area would be a reasonable estimate for this demographic. (reference: CEP, 2021)

3.6.2 Non-Domestic Premises

Similar to the domestic EPC issue, not all commercial premises will have an EPC rating. Data will be used from the Government published services providing data for: A - Number of Non-Domestic Energy Performance Certificates lodged on the Register in England & Wales by Region, Energy Performance Asset Rating - in each Year/Quarter to 30/06/2021.

Data is to scaled appropriately to represent the project area, noting the constraints and making calculated assessments based on the project teams experience to accurately represent the energy performance of buildings in the region.

To overcome this constraint, the project aims to develop a model to calculate energy heating demand in kWh/m2 which using heating degree day data to assess the energy required for space heating through the year based on the gross internal area (GIA) of a building. This method takes into account the EPC rating of A-F buildings but avoids complicating the assessment with variations in building age and fabric. For example, a building with an EPC level C will have a heating requirement of 60 – 80 kWh/m2.

3.7 Social

Social constraints which have been identified so far include

- Education
- Community perception
- Behaviour change
- Challenge reluctance
- Broadband connection, IT savviness
- Landlords / social / owner differences in adoption.
- Overpressure due to Brexit and Covid

The project aims to gain further insight of these constraints through the WREN community outreach programme, from which the WREN team will address concerns and assist those that need it.

The progression of the solutions development will depend upon public engagement and support which can only come from ensuring a good understanding of the solution. For this purpose, the "Net Zero Carbon Wadebridge by 2050" report which will be produced in May 2022 should aim to engage the community using infographics, non-technical language and stakeholder engagement exercises where necessary to ensure a wide range of community members are able to engage with the programme.

The use of social and cross vector (XV) solutions from M4.1 will be delivered alongside CEP. These solutions will offer significant community benefit and aim to improve the quality of living within these communities which is critical to successful adoption of electric heating.

The difference between adoption practices of owners/ renters and landlords represents a constraint which should be considered in the business plan, as these social groups are likely to consider the benefits separately, particularly where there is a trade-off between upfront capital expenditure (status is likely to influence grant suitability) and future savings.

3.8 Financial

Financial constraints often present the largest barrier to solutions development. One of the goals of this project is to look at carbon cost over financial cost, and to encourage decisions to be based on the carbon cost of any solution, rather than base decisions on financial cost.

If we are to overcome the climate emergency, decision making must change to prioritise **emissions over economy**.

Financial constraints highlighted within the project so far are:

- Investment
- Capex / Opex
- Funding
- Cost of energy' projections
- Building retrofit work
- Instability of the energy market

To face these challenges, the project work should include some estimates of Capex and Opex in the solutions model. A mix of funding and investment opportunity should be presented from the financial projections and potentially a follow up piece of work could be delivered to look at the investment potential more closely.

The cost of energy projections and the instability of the energy market will feed into this work and with the unprecedented rise in fuel we have seen in the past week it could be expected that the ROI on the project will look more attractive than it did against lower mainstream energy prices.

One of the main outputs of the NZCom project will be to provide a stable and affordable rate of clean energy to the community that invests in it.

3.9 Geographical

Geographical constraints vary across the UK, with some areas having a higher proportion of poor building stock, off gas grid networks, resource availability, and different demographics. Regional variations in condition should be considered in the preparation of any net zero plan, using local data to build the strategy according to need and resource.

Cornwall is recognised as a particularly good geographical area for the extraction of heat via deep geothermal, due the presence of radiogenic granites. Deep geothermal has not yet been considered as a solution for the NZCom project due to the engineering cost, however it perhaps should be considered as it holds potential to supply heat directly for space heating and for production of electricity. Ground source heat pumps, which utilise the surface ground heat (indirectly from solar energy) are considered as a more viable solution.

Other geographical considerations include sharing resources and land boundaries lines, which should be considered in a full feasibility study.

3.10 Legal

Legal barriers do exist in any development which utilises land or assets owned by multiple parties. In the case of any project legal advice should be given on element of infrastructure, planning, land ownership and asset ownership/management over the lifespan of the project.

NZCom aims to raise awareness of these barriers and suggest solutions. In current legislation, legal issues often stop projects in their tracks. If we are to meet net zero by 2050, some legal barriers will undoubtably need to be challenged.

Initially we agreed not to cover standard policies like planning in much detail here, except to mention that they must change and adapt to meet the requirements of net zero. However, they do currently

represent a real problem in the development of solutions to net zero. Overcoming this will require collaborations and co-operation from parish and local councils, and landowners. Local Authorities should be invited to attend stakeholder group meetings so comments can be recorded.

4.0 Constraints around Pseudo Microgrids

4.1 Solution Description and Associated Constraints

The principle behind the pseudo microgrid solution is that the DNO network, below a defined boundary point (e.g. substation), acts as though it is a private network for all energy that is generated, stored and used on that part of the network. This is explained in M4.1 but certain key aspects of the scheme are repeated and discussed here for clarity. In addition to the advantages to energy users described below, opportunities also exist to balance local low carbon energy supply & demand, offer more equality in system costs and therefore better support vulnerable customers.

The advantage afforded to the community by the scheme is linked to the non-commodity charges that ordinarily accompany energy imported to a premises from the DNO network. A private network can deliver energy that is charged for on a commodity basis with perhaps a single additional charge to cover the cost of operating the private network. In order that the proper non-commodity charges can be levied and settled for the energy that doesn't originate on the pseudo microgrid, this energy must be differentiated from the 'local' energy. This differentiation implies the use of real time digital data for all users on the pseudo microgrid and automated data processing, the outcome of which must be available to the external suppliers, the operator(s) of the pseudo microgrid and the DNO. Such differentiation of energy will be based upon the real time energy flow across the boundary onto the pseudo microgrid and the simultaneous energy use by all of the MPANs (premises meters) served by the pseudo microgrid. This means a roll out of smart metering to all consumers and generators to provide details data on the generation and use across every half hour period.

The premise behind the scheme, that local energy originating on, and used by, the pseudo microgrid should not attract charges that are founded outside of it and is only valid if the local energy flow is limited to the pseudo microgrid. If this energy spills over the notional boundary onto the wider system, it contributes to effects on the wider system that require control and or corrective action and would therefore not warrant exemption from some related charges. Therefore, a means of preventing this unwanted spill must be incorporated into the scheme. This implies the utilisation of real time digital data for all generators (including storage discharge) on the pseudo microgrid and automated control of these assets via an export limitation type control device.

Existing and new generators (including storage discharge) that have or obtain traditional export agreements and power purchase agreements, must not be inhibited from operating normally and will not be controlled by an export limitation device that is associated with the pseudo microgrid. Because these generators are likely to be of variable and intermittent output, these too must be monitored in real time so that a variable and corresponding export limit can be set on the pseudo microgrid's export limitation device to prevent the unintentional export of 'local' energy.

The method by which energy is bought and sold on a pseudo microgrid is likely to be determined by an ESCO model (energy services company). Tariffs and fair distribution will be determined through further work on the modelling and business structure yet to be considered in depth. It is possible that a tariff might be devised to protect fuel poor consumers.

4.2 Policy and Regulatory Constraints

Policy and regulatory frameworks in the UK create the rules in which we must work to meet net zero. The key policies in the Net Zero Strategy; Build Back Greener (2021) state clearly on P19 "40GW of offshore wind by 2030, with more onshore, solar, and other renewables with **a new approach to onshore and offshore electricity networks to incorporate new low carbon generation and demand in the more efficient manner that takes account of the needs of local communities**". The reference to 'onshore' in this sentence is ambiguous with regards to its reference being to onshore wind, or onshore solar, or generally onshore renewables. There is no other specific mention to a change in the planning policy for onshore wind development.

The balancing of energy on the electricity system relies on a complex system whereby the first actions are taken by the suppliers in balancing their projected supply to the predicted load. There are many components to the Balancing and Settlement Code (BSC) that regulates this matter; these are too complex to include in this work. The principal that the ordinary supply of electricity is differentiated from the local electricity should prevent any interference with this part of the system as it stands, providing that the real time data streams and automated data processing is properly facilitated. The outcomes of such differentiation and perhaps the process itself, will need to be integrated into the systems operated by Elexon, the entity that operates the BSC. In any case, there will need to be substantial code modifications to accommodate this change. This might be timely as Elexon are suggesting major reforms to the collective of codes that regulate the energy sector.

DNOs are regulated by the terms of their Distribution Licence which itself defines the requirements carried by the Distribution Code, which is managed by the Energy Networks Association (ENA). The structure and content of the Distribution Code is summarised in Table 1. Further requirements affecting the DNOs include the Distribution Connection and Use of System Agreement (DCUSA), a multi-party contract between licensed electricity distributors, suppliers and generators.

Table 1: The Structure of the Distribution Code. Source: Distribution Code Summary, 2017.

	Guidance Notes	
	Annex 1	Lists the Electricity Industry Standards in which Distribution Code requirements are implemented
	Annex 2	Lists the Standards that are not implemented via the Distribution Code but have an impact
DGD	Distribution Glossary and Definitions	Defines terms used in the Distribution Code
DIN	Distribution Code Introduction	Introduces the Distribution Code
DGC	Distribution General Conditions	Contains conditions that apply to all aspects of the Distribution Code
DPC	Distribution Planning and Connection Code	Specifies technical, design and operational criteria and procedures
DOC	Distribution Operating Code	Sets out operating procedures and information required
DDRC	Distribution Data Registration Code	Provides guidelines for the collection of information exchanged between Users and DNOs

The distribution licence and associated codes do not currently align with the 'shared use' model under discussion here. The principle of local use in parallel to normal 'top down' use does not seek to affect ownership, design or routine operation of the network but does require some additional monitoring

and control functions that will need to be addressed by licence and code modifications. Additionally, facility will need to be provided with the Common Distribution Charging Methodology (CDCM) and the EHV Distribution Charging Methodology (EDCM) for an appropriate charge to be levied by the DNO for use of the network below the notional boundary point for the pseudo microgrid and for the implementation of the dual accounts at every MPAN demanding energy within the pseudo microgrid.

The codes that govern the connection of generation and storage to distribution networks are ENA ER G98 (up to 16 A per phase) and ENA ER G99 (above 16 A per phase). These do not adversely affect the proposed pseudo microgrid but might need some additional clauses to add context around the pseudo microgrid control system. It is envisaged that individual domestic rooftop solar PV installations that fall under G98 will be dealt with as normal and would not be part of the power limitation control, this falling to the larger generators on the pseudo microgrid that are connected under G99 and have the requisite turn down capability.

The Electricity (Class Exemptions from the Requirement for a Licence) Order 2001, defines certain conditions under which an organisation can act in generation, distribution and supply without a licence. This is important for the local energy being generated, distributed, stored and used on the pseudo microgrid. The process of taking out these licences is very onerous and ties the licenced operator into regulations that are counter to the purpose of the local system. Currently the following summary applies to the pseudo microgrid scheme:

- Unlicensed generation is not considered to be an issue as the current order allows a maximum of 10 MW at any individual station without a generation licence.

- Unlicensed distribution will not be a consideration for the pseudo microgrid because the licenced DNO will still be conducting the distribution for the local energy.

- Unlicensed supply is possible under the current regulations but must fall into one of two categories, self-generated (by the body operating the local energy system in this case) or re-sold. Regulations govern the resale value of electricity which must be passed on to domestic customers at the same value it was purchased for. This will cause a problem because the local organisation (e.g., cooperative society) will need to add a cost component to energy purchased from a local generator (by private wire) to cover its own operation. However, to qualify as self-generated in the private wire example, the coop might need to rent the generating station rather than purchase the energy from it; again, this adds complexity and risk.

The Electricity (Class Exemptions from the Requirement for a Licence) Order 2001 is currently under review by BEIS and it is hoped and expected that amendments will be made that reduce the complexity of the exemptions and better facilitate local energy systems.

4.3 Specific Technical Considerations

There are no technical issues associated with the conveyance of energy around a pseudo microgrid; the DNO will operate the relevant part of the network in the same manner that it would ordinarily.

The additional technical burden associated with the pseudo microgrid results from the need to differentiate between the local energy and the top-down energy. This calls for near real time monitoring and analysis of the energy flows to each premises (including storage charge), from each generator (including storage discharge) and across the notional boundary onto the pseudo microgrid. SMETS 2 meters being rolled out at residences can achieve 'near' real time data output and this is

likely to suffice. Similarly, the latest smart half hourly meters can output near real time data via a variety of communications options. Power monitoring at the boundary point of the pseudo microgrid is also achievable with existing meter products.

Communications of the numerous meters to a central processor is also within the capabilities of existing equipment and systems. It is likely that the reverse power flow control at the boundary point will need to be failsafe, so this adds incentive to configure a robust and reliable data communications system. Additional complexities lie within the regulation concerning the sharing of data, as smart meter data is not shared with anyone except the suppler. Therefore the supplier needs to be part of the solution.

Limiting the power output of G99 connected generators to achieve the reverse power control at the pseudo microgrid boundary point merits consideration. Inverters that are routinely used in larger, non-domestic systems typically have the capability to respond to an input signal and to modulate their output downwards accordingly. If the reverse power flow control is to align with the requirements of ENA ER G100 (export limitation), then this response must be complete within five seconds. Whilst this is standard performance for solar PV inverters, it is not standard for wind energy systems. Wind turbines with full power conversion such as the Enercon range, do have the capability to ramp down their output very quickly. However, in cases where the pseudo microgrid seeks to acquire wind energy by private wire from a more typical existing windfarm, special consideration will need to be given to the means of reducing output to the pseudo microgrid. The solution might be to employ a park control regime rather than an individual turbine control regime. An existing windfarm will have an existing export capacity to suit the peak output. If one or more of these turbines is assigned to a new feed to the pseudo microgrid, then when this feed needs to cease, a switching system might transfer the generation output back to the original windfarm connection. This 'make then break' type of switching is technically feasible and is certainly done at lower power levels but will need further investigation in this case.

5.0 New Community / Commercially Owned PV linked to a Pseudo Microgrid

This solution utilises the local loads sitting within a pseudo microgrid, to accommodate new solar PV generation at a scale greater than rooftop schemes can achieve. All or part of the generation from the new generating station can be linked by a dedicated DNO wire to the pseudo microgrid. Ordinarily, a private wire connection is considered for direct supply to a load but in the case of the pseudo microgrid, which replicates the advantages of private wire supply, there would seem to be no reason why the DNO couldn't own and operate the direct connection of the generating station to the pseudo microgrid.

Network capacity restrictions and re-enforcements can be avoided within the boundaries of a pseudo microgrid, allowing large scale development to proceed where they might otherwise have been prevented or subject to punitive costs.

5.1 Policy and Regulatory Constraints

The regulatory consideration here is concerned with the distribution and supply of electricity as discussed in section 4.1 and covered by the Electricity (Class Exemptions from the Requirement for a Licence) Order 2001. As mentioned in section 3.1, the dedicated wire feeding the pseudo microgrid

might be owned and operated by the DNO, much like the rest of the network behind the pseudo microgrid boundary point. This negates any issues pertaining to a distribution licence but again, will require amendments to the Distribution Licence and the Distribution Code. A secondary advantage of the dedicated wire being DNO asset, is that the DNO has utility rights to run cabling across land which is not the case for other organisations such as a local energy cooperative.

Wadebridge neighbourhood plan (draft) supports community energy: Support will be given to community energy projects which have as their primary purpose long term and inclusive economic, social and environmental benefits for the community and: fall within the definitions of community energy contained in the Cornwall Council's Revised SPD on Renewable Energy; i. meet the local community ownership criteria*, and ii. is acceptable to the local community (as represented by its Town or Parish Council)

But has limited support on commercial i.e. Proposals for medium sized arrays (between 1 and 2 MW capacity) must demonstrate that they are sited entirely on a brownfield site, where one is available, or otherwise on land which is assessed as Grade 3B or below and is in full compliance with Cornwall Council guidance on siting for the relevant Land Character Area. Development proposals for larger (over 2 MW capacity) solar arrays will not be supported.

Policy and regulatory constraints will also impact the development models for an ESCO, which currently govern some important factors such as price of re-sale electricity, unlicensed supply and distribution, and metering requirements to differentiate local electricity from imported electricity.

The Net Zero Strategy; Build Back Greener (2021) mentions onshore solar will be supported.

5.2 Specific Technical Constraints

From a technical perspective, this solution is routine. However, some thought must be put into the point of connection for the dedicated 'private wire' into the pseudo microgrid. This will require a switch panel and other protection equipment requiring an electrical housing. It is likely that the best position for this will be immediately downstream of the boundary point i.e. adjacent to the LV/HV/EHV substation. However, if the location of the new generating station makes this uneconomic, then another connection station will be required at an appropriate upstream location within the pseudo microgrid.

6.0 New Community Owned Wind linked to a Pseudo Microgrid

This solution replicates that of solar PV but substitutes wind energy generation for solar PV. There is also recognition that commercial wind energy projects can be frowned upon by some members of a community and therefore such a facility might be better in community ownership. Aside from this, the major difference from a solar PV generating station is that most wind turbines do not have full inverter connection to the network and that this might pose some difficulty in applying the rapid turn down control to prevent reverse power flow across the pseudo microgrid boundary point.

6.1 Policy and Regulatory Constraints

Comments made in section 4.2 are equally valid here. However, the outstanding policy problem in this case stems from the infamous ministerial statement made in 2015 that effectively stopped the onshore wind industry in the UK. Onshore wind energy must be included within the local plan for it to be considered for planning permission. Some parish, town and borough councils are beginning to

address this sensibly in the light of an awakening to the climate emergency but a change back to the position set by Planning Policy Statement (PPS) 22 would unlock the potential for local onshore wind energy projects. In an ideal scenario, it would be prudent to consider that planning might be fast tracked for the development of renewable energy systems for the purpose of meeting net zero by 2050. The Wadebridge local plan does consider community owned assets but does not favour anything considered to be commercial of over the 1MW threshold. Again, the community will need to be on board with modifying the local plan to support new renewables.

The key policies in the Net Zero Strategy; Build Back Greener (2021) still focus of offshore and floating offshore wind, and do not embrace any change to the current prohibition to onshore wind power in the energy policy (figure 5). In terms of hydrogen production and meeting demand locally, wind is a vital tool in meeting seasonal variations in load and demand of electricity. Therefore, all local parishes should include a wind development zone in their local plan as quickly as they are able to, enabling the integration of onshore wind to a community energy plan within the law.

Key policies:

- By 2035 the UK will be powered entirely by clean electricity, subject to security of supply.
- Secure a final investment decision on a large-scale nuclear plant by the end of this Parliament, and launch a new £120 million Future Nuclear Enabling Fund, retaining options for future nuclear technologies, including Small Modular Reactors, with a number of potential sites including Wylfa in North Wales.
- 40GW of offshore wind by 2030, with more onshore, solar, and other renewables – with a new approach to onshore and offshore electricity networks to incorporate new low carbon generation and demand in the most efficient manner that takes account of the needs of local communities like those in East Anglia.
- Moving towards 1GW of floating offshore wind by 2030 to put us at the forefront of this new technology that can utilise our North and Celtic Seas – backed by £380 million overall funding for our world-leading offshore wind sector.
- Deployment of new flexibility measures including storage to help smooth out future price spikes.

Figure 5, key energy policies from the Net Zero Strategy; Build Back Greener.

6.2 Specific Technical Constraints

As discussed in section 4.3, the technical difficulty here is associated with rapid turndown of wind turbines. The park control method as discussed previously is probably not suitable for a new community owned facility dedicated to the pseudo microgrid as it would not necessarily have the export connection and capacity to bypass the pseudo microgrid.

7.0 Community Heat or District Heat Networks (DHN)

Heat networks present an opportunity for lower cost development of heat from space heating and hot water production. They typically use heat pumps and may use bore holes to provide a deeper heat source. This can be expensive, and a community or shared programme can significantly reduce the costs of building a larger system, and reduce maintenance and operational costs, bearing in mind these are typically fairly minimal for a heat pump.

7.1 Policy and Regulatory Constraints

There is no prohibitive policy or legislation to the development of heat networks in the UK, they are already being developed successfully. The restrictions around heat networks tend to be related to ownership disputes, and physical challenges presented by the layout of the networks.

Heat networks are subject to the Heat Network (Metering and Billing) Regulations which came into force in 2014. Under these regulations, the operators of heat networks must submit notifications of the networks under their operation, and in most cases will be required to install metering devices on those networks.

The Net Zero Strategy lays out key policies to support the roll out of heat and buildings, also relevant to electrification of heat in buildings. See figure 6. It supports the continued roll out of heat networks and introduces the concept of heat network zones to be established by 2025 where "heat networks are the default solution for decarbonising heating". New legislation will be passed to regulate the sector for consumers and give heat networks the statutory powers they need.

Key policies:

- An ambition that by 2035, no new gas boilers will be sold.
- A new £450 million three-year Boiler Upgrade Scheme will see households offered grants of up to £5,000 for low-carbon heating systems so they cost the same as a gas boiler now.
- A new £60 million Heat Pump Ready programme that will provide funding for pioneering heat pump technologies and will support the government's target of 600,000 installations a year by 2028.
- Delivering cheaper electricity by rebalancing of policy costs from electricity bills to gas bills this decade.

Figure 6, key heat and buildings policies from the Net Zero Strategy; Build Back Greener.

8.0 Electrification of Heat

Western Power are being asked to comment on the move to all electric systems and how the system will cope. It is likely the move will it be more manageable area by area, but inevitably DNOs will face challenges surrounding the increased electricity demand providing heat, electricity and

transport requirements to many homes and businesses. An area-by-area approach will help to iron out some of the obstacles and provide vital data and understanding to roll out a wider programme.

Electrification of Heat

Electrification of heat is a straight route to decarbonising the heating of buildings providing that the electricity generators for the national grid are clean – in short this means replacing gas cycle turbines which currently contribute to grid powered electricity, entirely to renewables. The gas industry is still very active in the UK and may well play a part in decarbonisation by switching from natural gas to biogas. This is a hotly debated topic and the policy surrounding the use of natural gas is not clear, with some government backed schemes such as ECO still funding the replacement of gas boilers.

Coal powered generation is already on the decline and should be completely phased out (alongside gas) to create mainstream clean electricity. The government plans to increase use of new nuclear reactors as a source of low carbon electricity, which is a contentious subject and has a carbon / environmental impact in the sourcing of nuclear fuels. Common nuclear reactors use enriched uranium and plutonium as a fuel. Locally generated renewables such as those mentioned in the use of a pseudo microgrid provide local solutions to reduce the requirement for centralised energy from nuclear and fossil sources. The increase and development of smart local energy consumption such as is presented here will reduce the necessity and requirement for centralised systems.

8.1 Policy and Regulatory Constraints

There are no restrictive technical policies to the furthering of electrification of heat. See also figure 6.
Refer to the policy support in the heat in buildings strategy for networks p 99
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1026507/heat-buildings-strategy.pdf

9.0 Zero Emissions Fleet for Transport

Zero emissions fleet for transport and tourism represents a business opportunity within the community using electric vehicles to replace fossil fuel transportation as a car share scheme, taxi service, or car hire. Emissions free vehicles compliment clean air zones and are a tax efficient purchase for any business operation.

9.1 Policy and Regulatory Constraints

Zero emissions fleet for transport has no specific policy and regulatory restrictions. In essence, electric cars are readily available on lease or purchase from almost all garages.

10.0 HVO Fuelling Stations

Hydrotreated vegetable oil (HVO) offers a quick switch from diesel vehicles to a lower carbon alternative with no engine/filter changes such as those associated with biodiesel. HVO is described as a second generation, synthetic, advanced renewable diesel alternative that eliminates up to 90% of net C02 and significantly reduces nitrogen oxide (NOx), particulate matter and carbon monoxide emissions.

The supply chain is critical to ensuring that HVO is produced sustainably, as it can come from a number of sources including virgin plantations of crops such as palm oil, which would inevitably cause a

secondary problem. Most suppliers seem aware of this and Proof of Sustainability certificates can be requested to ensure the origins of the raw material. In many cases HVO is derived from 100% waste products. Cornwall already has suppliers of HVO for some purposes but it has not arrived on the market with traditional fuel suppliers like Shell or BP.

Crown Oil is one the largest suppliers of HVO (and other oil based fuels) in the UK and summarises: The road transport and Non-Road Mobile Machinery (NRMM) industries are facing a number of challenges due to climate change, localised emission control and immature or outdated technologies. HVO fuel solves these issues, being used by many industries in off-road and on-road vehicles and industrial machinery. It's virtually the same fuel as mineral diesel but has a large number of logistical and environmental benefits.

Local Cornish start-up Other Oils is starting to investigate the market locally and aims to provide local diesel drivers with a trial in 2022. This is an example of the supply chain expanding, research has found HVO is available to buy in large quantities but is not get available via standard fuel station as an alternative to diesel, possibly just because the large fossil fuel providers don't want it there. The power of the large providers to act as a barrier to deployment is considered a constraint.

10.1 Policy and Regulatory Constraints

HVO is governed under the Biofuels and other fuel substitutes (Excise Notice 179e) but this seems more aimed at producers and sellers, and HVO is not specifically listed.

11.0 Upgrade of Fuel Poor Houses Via Offsets

NZCom recognises the absolute requirement for houses to be retrofitted / upgraded to an improved standard to require less energy for heating. Carbon offset funding is a mechanism by which funds can be raised by organisations with high emissions. It would not be appropriate for this fund to be open to social housing (who's obligation for building improvement should come via the council) or for private rented properties, whose landlords already have a responsibility (which arguably should be higher than EPC D). This fund will be aimed at those who own a property, who are considered to be in a financial position where upgrades to the property may be out of their capability to achieve.

In the southwest, most of the housing is owner occupied (Fig 2), with 60% of homes in Cornwall off the gas grid (figures are slightly less if taken from Cornwall Cornwall). Owner occupied properties mark the biggest benefit, but often present challenges in raising capital for retrofitting works. If we zoom in further using the nongasmap.org.uk (Figure 3) we can see the situation for the Wadebridge and Padstow Community Network Area. This represents 85-95% of homes in the rural area who are off gas, with most houses in every off-gas area relying on oil (or other carbon intense heating fuel). The map in figure 3 also shows data on the percentage of people in fuel poverty, and house type and heating type, presumably taken from the EPC data.

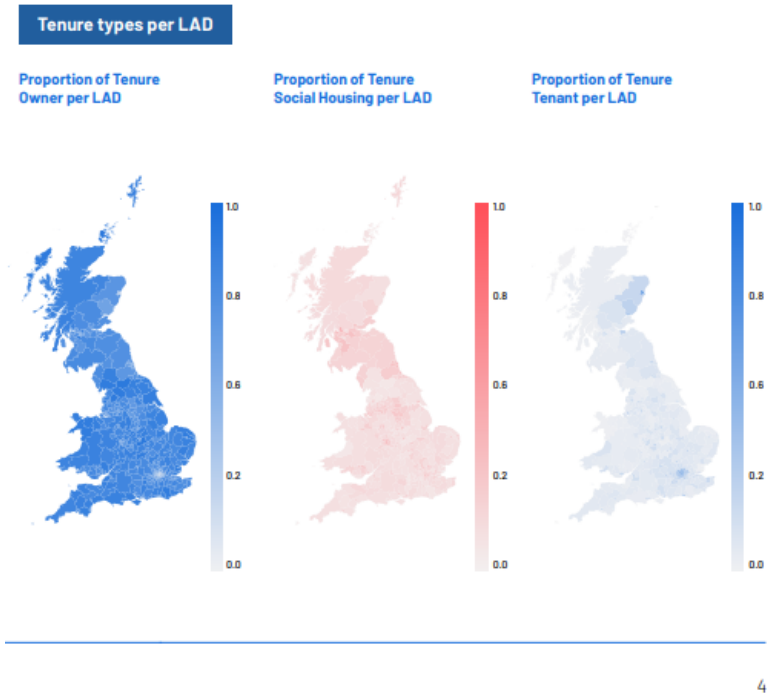


Figure 2, tenure types per local area

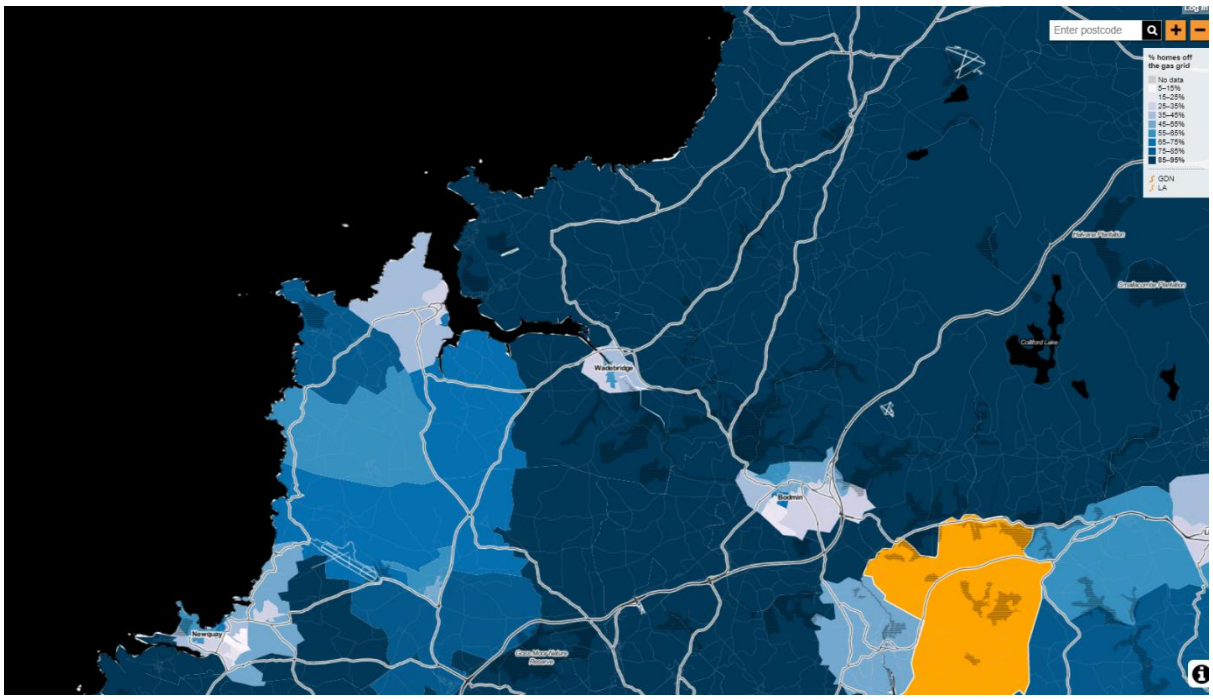


Figure 3, off gas grid map

11.1 Policy and Regulatory Constraints

The upgrade of housing is a huge challenge in the UK as described in more general terms in 6.6, but there are no specific policy restrictions on building improvements, except through planning and listed buildings. The challenges are mainly financial, owner related, and accessibility to suitable materials. Landlords have a legal obligation to meet a minimum EPC requirement of E for their rental properties, but many of them may not be aware of this. The level of information supplied on an EPC is not adequate to thoroughly understand a buildings energy requirement.

Policy should be adapted to provide an affordable and situational solution to energy efficient building improvements by providing the means for homeowners to upgrade their property with little or no upfront capital expenditure.

The Net Zero Strategy offers a key policy for funding shown in Figure 7, the concern being that the funding may underdeliver on the scale of the challenge.

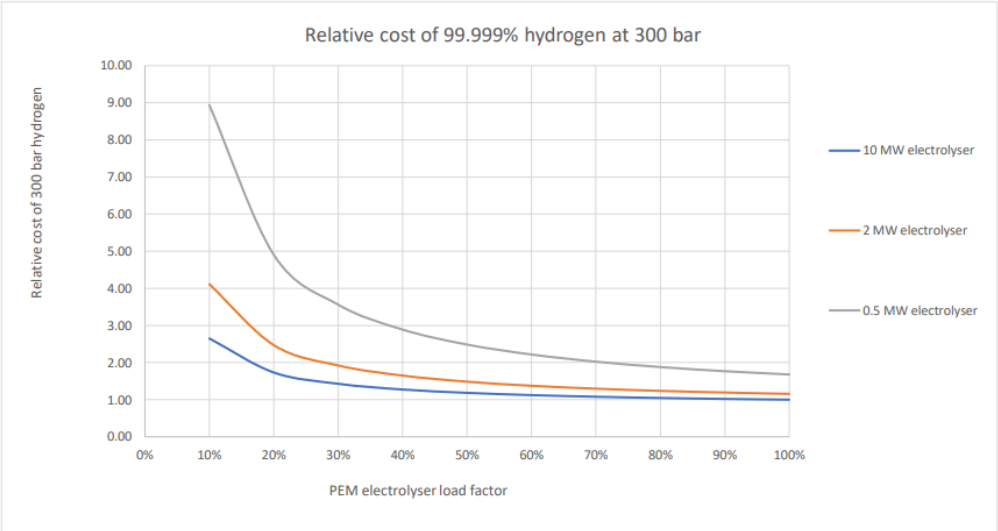
- Further funding for the Social Housing Decarbonisation Scheme and Home Upgrade Grants, investing £1.75 billion. Additional funding of £1.425 billion for Public Sector Decarbonisation, with the aim of reducing emissions from public sector buildings by 75% by 2037.

Figure 7, key heat and buildings policy from the Net Zero Strategy; Build Back Greener.

12.0 Hydrogen Electrolyser for Transport

The government recognise that electricity will be the primary source of energy, but we cannot rely on it alone, and that hydrogen and biofuels will play a part in the energy mix – most importantly in that of transportation. Hydrogen represents an opportunity for all transport including heavy freight, aviation, and shipping. Road transport and fright vehicles being the most relevant to the NZCom area.

Hydrogen production currently faces a chicken and egg scenario. The technology is available to produce green hydrogen but the cost is high. Previous research by Planet A shows that hydrogen as road transport fuel, produced at scale above 10MW is currently the most cost-effective use for hydrogen, see figure 4.



Assumptions

- 20 year project life
- 7% discount rate
- Electricity supplied by onsite (private wire) renewables at commodity plus 10% price
- CAPEX according to generic manufacturers curves
- OPEX according to generic manufacturers guidance

Figure 4, relative cost of hydrogen.

12.1 Policy and Regulatory Constraints

Hydrogen is a fast growing economy and doubtless there will be more regulation surrounding it's safe use as time goes on. Currently the use of hydrogen is governed by the following regulations in the UK.

The Gas Safety Installation and Use Regulations (GSIUR) cover the supply of all gas, including methane and hydrogen, to any commercial or domestic properties (excluding laboratories). The supplier of the gas is subject to health and safety regulations and responsibilities under GSIUR as 'the supplier'. The UK HSE Guidance document "Installation permitting guidance for hydrogen and fuel cell stationary applications: UK version" is applicable as guidance. The government body HSE plays a key role in a number of initiatives, such as the International Energy Authority Tasks 31 (Hydrogen Implementation Agreement) and 'Hyfacts' which focuses on co-ordinating and developing and disseminate regulatory codes and standards. (HSE, Hydrogen Safety, 2020)

The Net Zero Strategy (2021) lays outs new key policies for hydrogen. See figure 8.

The government's 10 point plan for a green industrial revolution says on hydrogen: "Working with industry aiming to generate 5GW of low carbon hydrogen production capacity by 2030 for industry, transport, power and homes, and aiming to develop the first town heated entirely by hydrogen by the end of the decade." It is not yet clear what regulations this project will have to overcome.

The roll out of a hydrogen plan to replace the natural gas network to power homes and business must largely be defined by central government and industry leaders as the materials and major infrastructure required to realise its potential is considered beyond the capabilities of local

communities. Hydrogen for transport is considered within this report as being the only feasible community owned hydrogen facility at this time.

Key policies:

- We have set up the Industrial Decarbonisation and Hydrogen Revenue Support (IDHRS) scheme to fund our new hydrogen and industrial carbon capture business models. We will be providing up to £140 million to establish the scheme, including up to £100 million to award contracts of up to 250MW of electrolytic hydrogen production capacity in 2023 with further allocation in 2024.
- Introducing a new climate compatibility checkpoint for future licensing on the UK Continental Shelf and regulating the oil and gas sector in a way that minimises greenhouse gases through the revised Oil and Gas Authority strategy.

Figure 8, key hydrogen policies from the Net Zero Strategy; Build Back Greener.

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