Rural Design Centre
Innovation Project

Northumberland CAN a voice for rural communities

Community Action Northumberland

RCEF Northumberland Call

Opportunities For Aggregated Energy Generation, Management And Storage For Rural Northumberland (Project 1)

Summary (draft_v2) version

Issued 14th October 2021

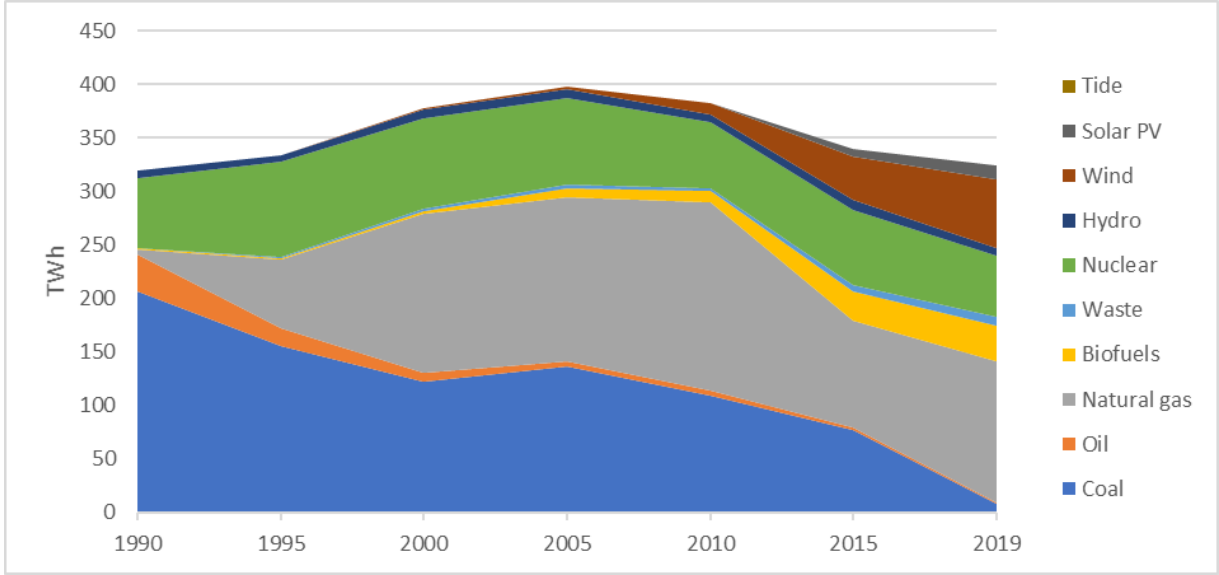
aquatera
environmental services and products

Contextual Note – Please Read

- This document is a public summary prepared by Aquatera in response to an invitation to tender issued by CAN and RDC, and awarded to Aquatera in June 2021
- Aquatera's objective is to produce a practical working document which may be used by CAN, RDC and local stakeholders/community groups etc
- The content is largely focused on solar PV and battery energy storage systems, to fit with early potential projects identified by CAN/RDC, and align with work undertaken by other parties
- Other technologies and areas are mentioned where relevant/considered potentially helpful
- Reliance on any of the content is subject to the original terms and conditions pertaining to the work, between CAN, RDC and Aquatera
- Aggregated energy systems are often referred to as virtual power plants (VPPs) or integrated energy systems (IES); there are some differences, but they essentially undertake the same basic functions

UK Electricity Generation – A Brief History…

- 30 years ago - large centralised generation
- Significant reliance on fossil fuels, mainly coal
- Synchronous generators ‘locked’ together, designed to follow (a largely passive) load
- Lots of (spinning) inertia in power station steam turbines to maintain constant system ‘speed’ (50Hz) during changes in demand
- Generation aggregated through bulk (alternating current, AC) transmission, and distribution to supply consumers
- Today, mainly gas, renewables and nuclear



From This

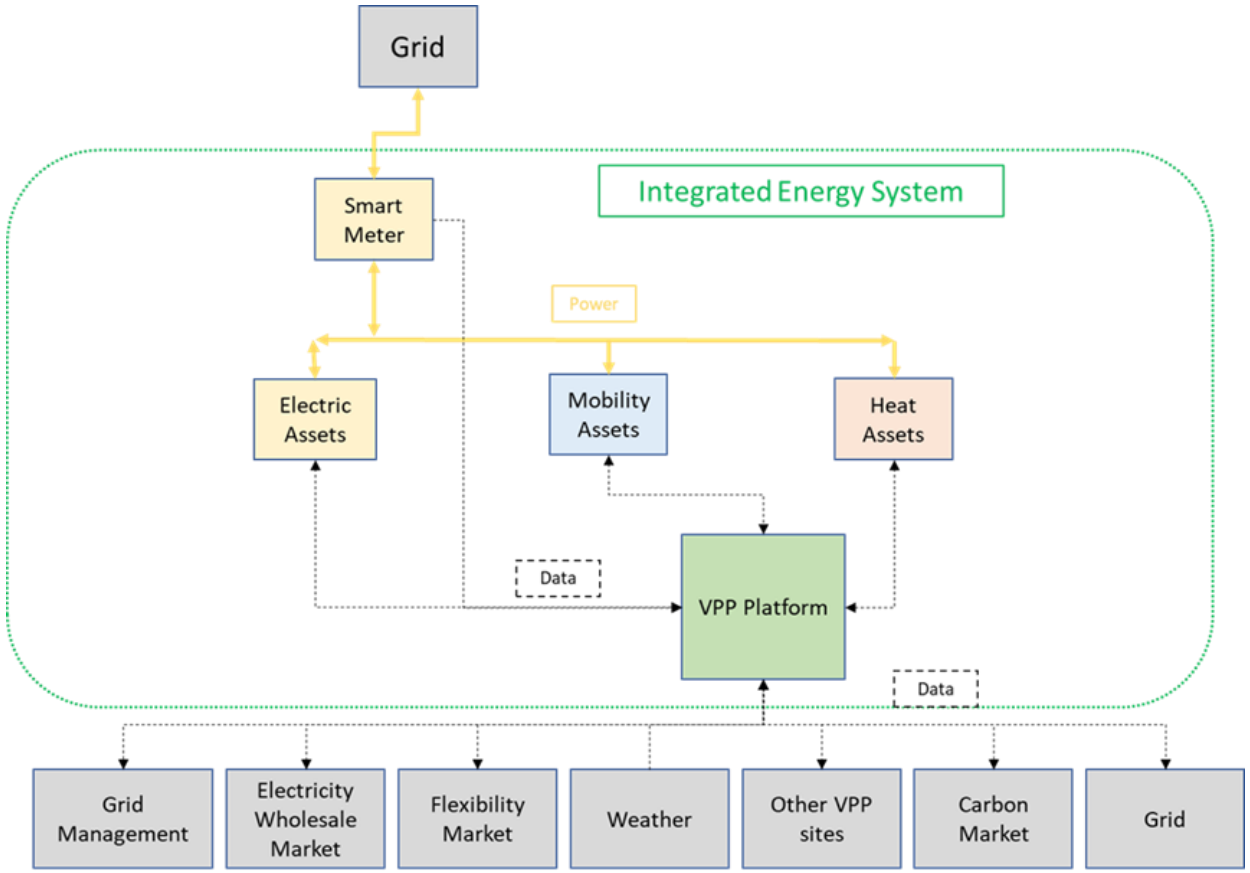
To This

Key Organisations in UK Electricity System

Role	Organisation(s)	Responsibilities
Regulation	Office of Gas and Electricity Markets (OFGEM)	Protect consumers now and in the future by working to deliver a greener, fairer energy system
Electricity System Operator (ESO)	National Grid ESO	Move the electricity to where it is needed, balancing supply and demand second by second, 24 hours/day, 365 days/year
Transmission Owners (TOs)	National Grid Electricity Transmission (NGET), Scottish Hydro-Electric Transmission Ltd (SHETL) & SP Energy Networks plus some independents/off-shore	Maintaining and investing in the transmission network
Distribution Network Operators (DNOs)	Seven (7) separate businesses across the UK (public network) plus some independents, including Northern PowerGrid, which is responsible for Northumberland	Take the electricity from the grid and move it through their own network of power lines and underground cables, taking it to homes and businesses
Generators	Hundreds of companies and organisations from large multi-nationals to communities	Generation of electricity from non-renewable and renewable sources
Energy Suppliers	Around 60 companies across the UK from large multi-nationals to local authorities	Buy electricity from generators and then sell it on to customers, competing to supply homes and businesses who are free to choose any supplier they like
Aggregators	Around 20 companies across the UK	Work with industrial and commercial energy consumers, who are able to flex their energy use to reduce or increase their demand in response to price signals

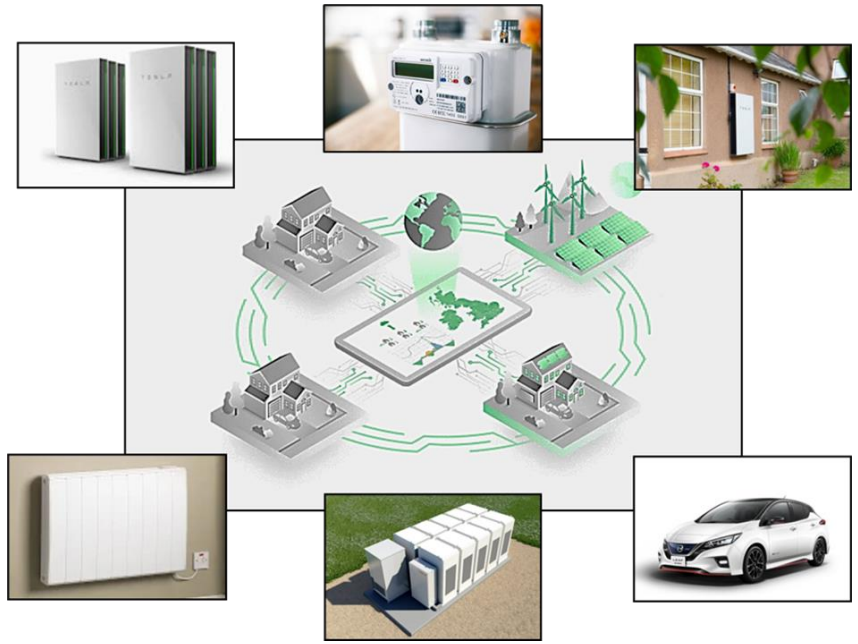
Aggregated Energy System – a Virtual Power Plant (VPP)

- VVPs seek to replicate the characteristics of larger power plants by digitally integrating a range of energy generation, storage and demand assets under a single, overarching control platform
- Designed and implemented correctly they can contribute to the reliability of local and national energy supplies, accelerate decarbonisation of energy, and help address affordability of energy supplies
- Can work across the 3 main areas in which we use energy: power/electricity, heating and mobility/transport



Aggregated Energy System – Creating Local Benefits

- An aggregated energy system can create local benefits in a number of ways, including by:
  - Maximising the use of locally generated renewable energy locally
  - Maximising the utilisation of existing assets
  - Increasing energy efficiency by reducing losses arising from the transport of energy over long distances
  - Offering services to support the operation of both the local (distribution level), and national (transmission level) electricity systems
- A fully Integrated Energy System (IES) will seek to integrate other aspects of delivering an energy service, such as: a one stop shop for customers, common branding of services and products, financing solutions, and potentially asset installation and operational services



ReFLEX Orkney (www.reflexorkney.co.uk) – digitally connecting energy

Physical Infrastructure Required for Aggregated Generation

- Infrastructure can comprise of new and existing assets
- Energy generation (or supply) is one part of a wider aggregated or integrated system, including energy storage and energy demand
- Works across power, heat and mobility/transport

Energy Generation

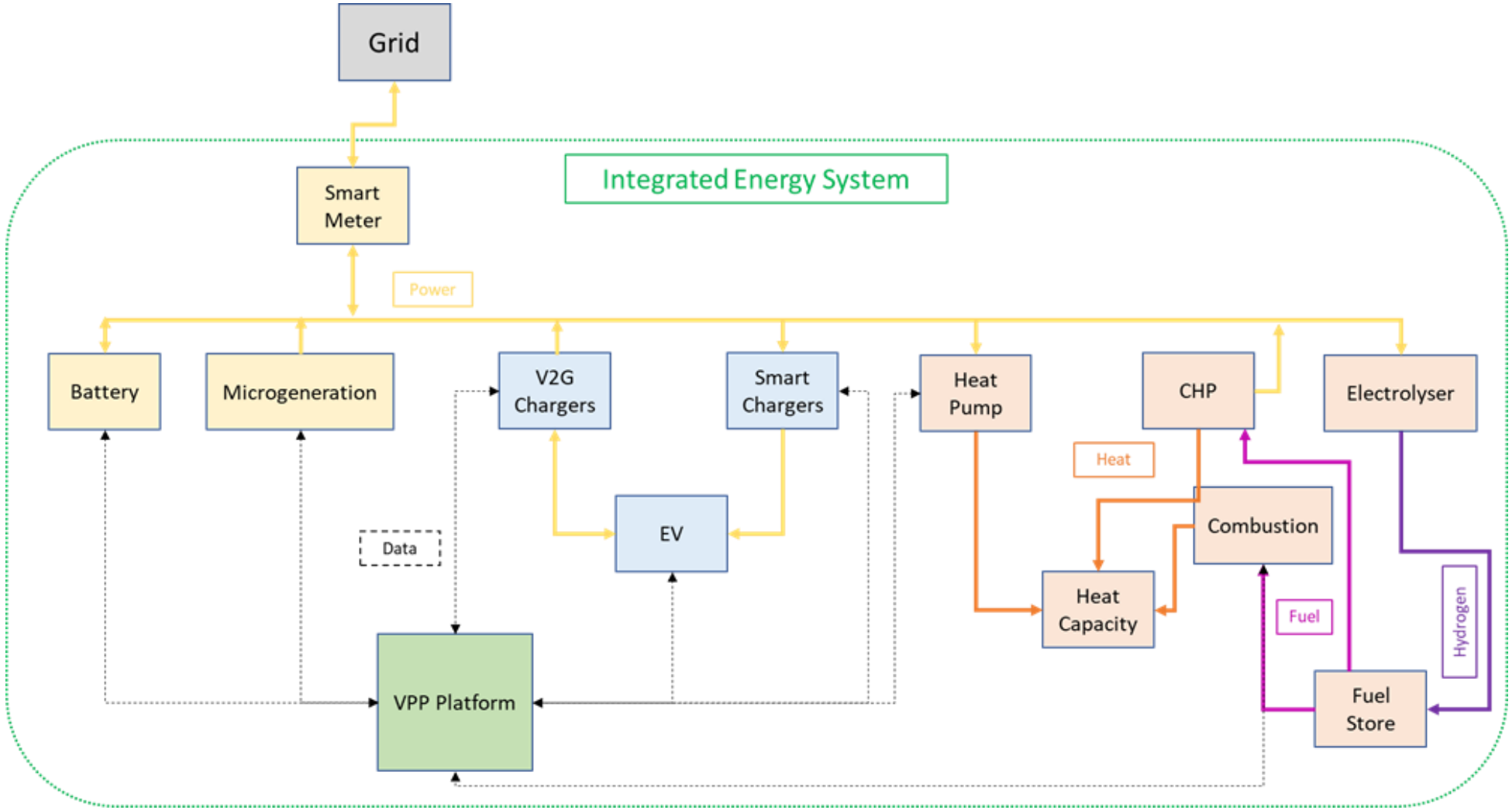
Energy Storage

Energy Demand

Physical Infrastructure of Aggregated Energy Systems

- Aggregated or integrated energy systems, sometimes referred to as Virtual Power Plants (VPP) allow remote control and/or monitoring of energy production, demand and increasingly storage assets, to match (local) supply and demand.
- They are particularly useful to link sources of renewable energy and storage systems, as peak production and peak demand do not normally align e.g. solar output during daylight hours whereas domestic energy usage is usually highest in the evening.
- An aggregated energy system uses hardware and software to digitally 'connect' assets which may not be directly physically connected together, and in the same location, so they can act as a single controllable system.
- The system platform is usually cloud based and comprises two main components
  - Decision/optimisation engine used to make decisions about the operation of the connected devices and assets using all available information e.g. local weather, user requirements (such as heating, EV usage needs), outputs from renewable sources of generation, any grid constraints, assets undergoing maintenance etc
  - Control engine used to communicate information and commands to and from connected devices and assets e.g. switching on EV chargers, heating pumps, charging batteries on the system etc
- Several parameters will influence hardware considerations (data storage, processing power, processing speed etc), including the level of control and the number, size and type of assets

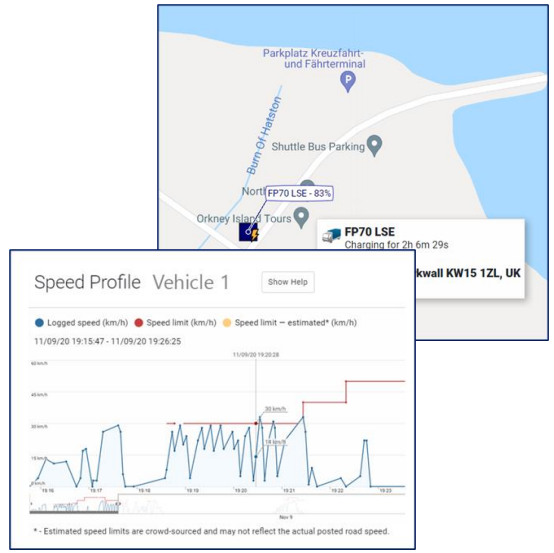
Physical Infrastructure of Aggregated Energy Systems



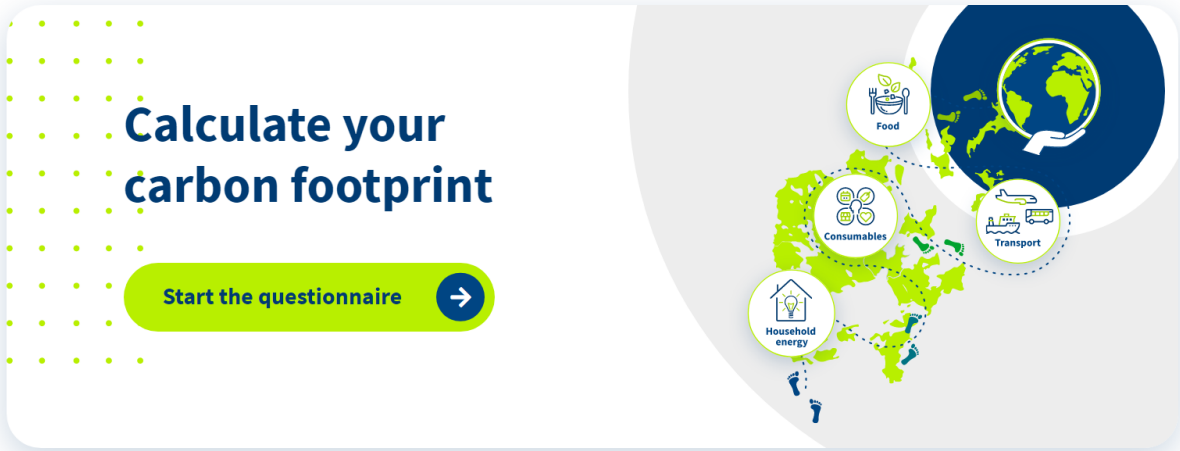
Mindware, Human Behaviour & Technologies

Technologies

Information & Data



Tools e.g. Carbon Calculator, Apps



Physical Infrastructure of Storage Systems

- Energy storage can take many forms, including:
  - Domestic/home units for load shifting with or without local generation (e.g. solar PV, micro-wind etc)
  - Commercial scale units for community centres, offices etc
  - Large grid scale units specifically designed to provide local or national grid support services including load management and frequency response
  - Electric vehicle chargers:
    - standard (plug and charge)
    - smart (remotely controllable to charge at say times of low demand)
    - Vehicle to grid (V2G) or two-way chargers
  - Thermal stores, including:
    - Hot water storage systems
    - Other storage mediums, such as heat bricks (used in storage heaters)
    - Phase change materials (PCM) based systems
    - Designed to work with heat source e.g. solar thermal, heat pumps etc

Some Guides & Standards

- The Microgeneration Certification Scheme Service Company Ltd (MCSSCo Ltd), which trades as MCS provide an excellent standards and tools library (https://mcscertified.com/standards-tools-library/).
- Some of the most relevant documents and installation standards are:
  - MCS001-1 – Requirements for MCS Contractors
  - MIS3001 – The Solar Heating Standard
  - MIS3002 – The Solar PV Standard
  - MIS3003 – The Wind Power Standard
  - MIS3004 – The Biomass Heating Standard
  - MIS3005 – The Heat Pump Standard
  - MIS3012 – The Battery Storage Standard
- The MCS also produce a range of Product Standards which can be found at the above link.
- Requirements for Electrical Installations (BS7671 – IET Wiring Regulations) – the UK "authority" on the electrical installations, ensuring consistency and improve safety

Planning Process

- Permitted Development
  - Small installations, especially roof mounted panels may be approved under the permitted development system which requires a basic application, drawings and technical specifications
  - Some stand alone ground mounted solar installations may also fall within permitted development, however these are typically small in scale and the permitted development only applies to the first installation, further extensions/installs will require full planning permission
- Churches and associated religious buildings
  - Religious buildings which are in current use under Church of England or certain Diocese of the Catholic Church have autonomy over consents for building repairs, maintenance and in some cases, alteration
  - This includes the installation of roof mounted solar panels
  - They also do not need consent from Historic England where the building is Listed (Grade I or Grade II), or where the building is located in a conservation or other protected area

Full Planning Application

- Larger or additional installations may be subject to full planning applications although are unlikely to require an EIA at the scales indicated for community based projects. Typically, EIA thresholds (under Schedule 2 of the EIA Regs) begin at energy developments of 5MW or above or where the project has potential to have significant impacts (regardless of scale). Local Authorities have discretion over the requirement so, if in doubt, a screening opinion should be obtained for direction on level and key assessments required for a successful planning application.

- Smaller installations may also require planning permission where the project is located within areas of protection such as conservation areas, AONB, SSSI's SPA or SAC's or where the building or grounds are Listed.

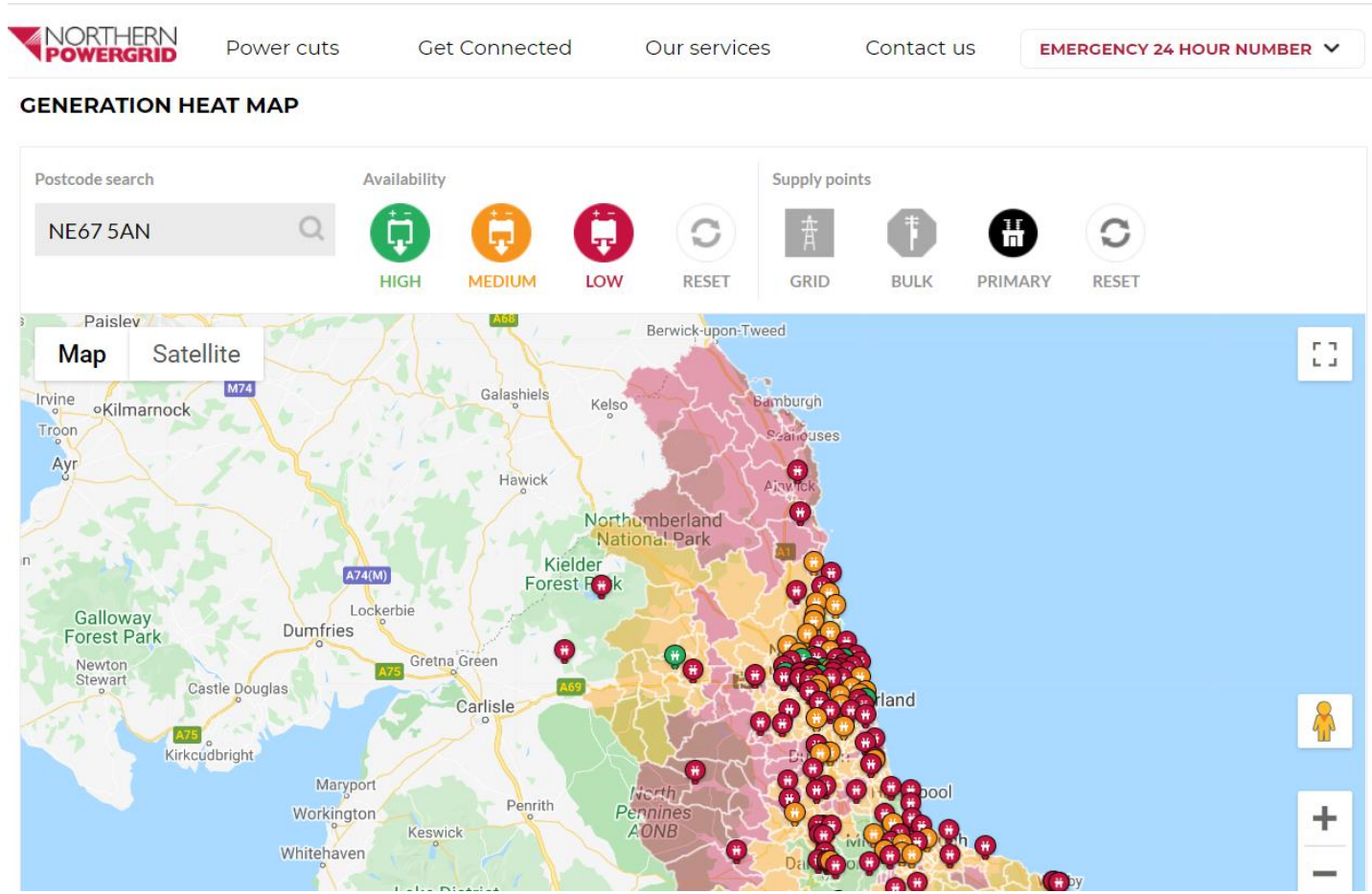
- Planning applications will require some key assessments such as glint/glare, visual impact, grid connection and ecological impact (typically where ground mounted or where there are a number of installs in proximity to a waterbody for bird impact). Additional assessments may be requested by statutory stakeholders.

Useful Planning Links

- Planning and Development : Northumberland Coast - an Area of Outstanding Natural Beauty (northumberlandcoastaonb.org) – Useful information and links to relevant planning documents
- Northumberland County Council - Planning policy – Access to planning policy documents, information and supporting documents
- Northumberland County Council - Northumberland Local Plan - Publication Draft - Northumberland Local Plan - Publication Draft (January 2019) (objective.co.uk)
- Northumberland County Council - Neighbourhood planning – Links to all neighbourhood planning information, maps and documents
- Beadnell Parish Council – Serving the Community – Parish council website with planning documents and other local community information
- BeadnellLocalList.docx.pdf (northumberlandcoastaonb.org) - List and descriptions of non-designated sites of cultural or historical local importance
- Northumberland Local Plan Draft Policies Map (arcgis.com) – interactive map showing key policies for selected areas

Grid Availability Information

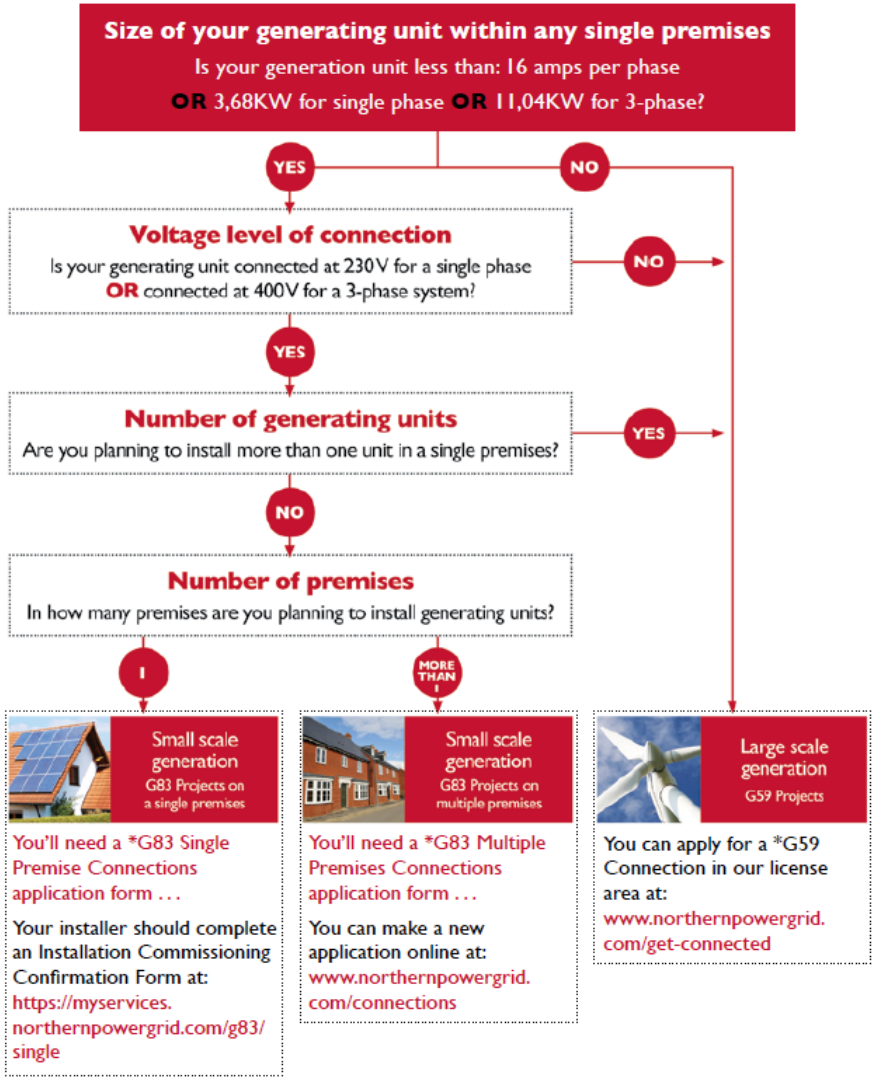
- Northern PowerGrid provide an interactive online tool (heatmap) to provide a high-level indication on the capability of the network to accept new generation connections
- Provides high level details on the network capacity including primary substations
- Local areas in red/amber/green (postcode) zones
- Resolution of data doesn't cover individual villages or properties
- Grid connection process still needs to be followed



Source: https://www.northernpowergrid.com/generation-availability-map

Grid Connection Process

- Process depends on size and type of local generation
- Key threshold of 16A (equivalent to 3.68kW on a 230V single phase supply), from the Electricity Safety, Quality and Continuity Regulations (Reg 22)
- Single generation below 16A may 'connect and notify':
  - G83 Stage 1 Single Application - Legal Obligation for installers to notify the DNO within 28 days of commissioning
  - No charge/cost
- Multiple generation sources, each below 3.68kW, must apply to the DNO before connecting:
  - G83 Stage 2 Multiple Applications
  - Charges dependent on number of sources/premises
- Single and multiple generation sources above 3.68kW must apply to the DNO before connecting:
  - G59 Larger Applications
  - Charges dependent on scale, voltage and complexity of connection



Source: Northern PowerGrid: Community Energy Projects – A guide to getting a connection

Assessment Tool - Energy Balance/Audit

Scope

A tool to identify, quantify and present all the energy inputs and outputs for a defined system. The law of conservation of energy states that the total energy of an isolated system remains constant, that energy can neither be created nor destroyed. This tool allows a baseline to be accurately established, against which future improvements to the system may be measured e.g. carbon reduction

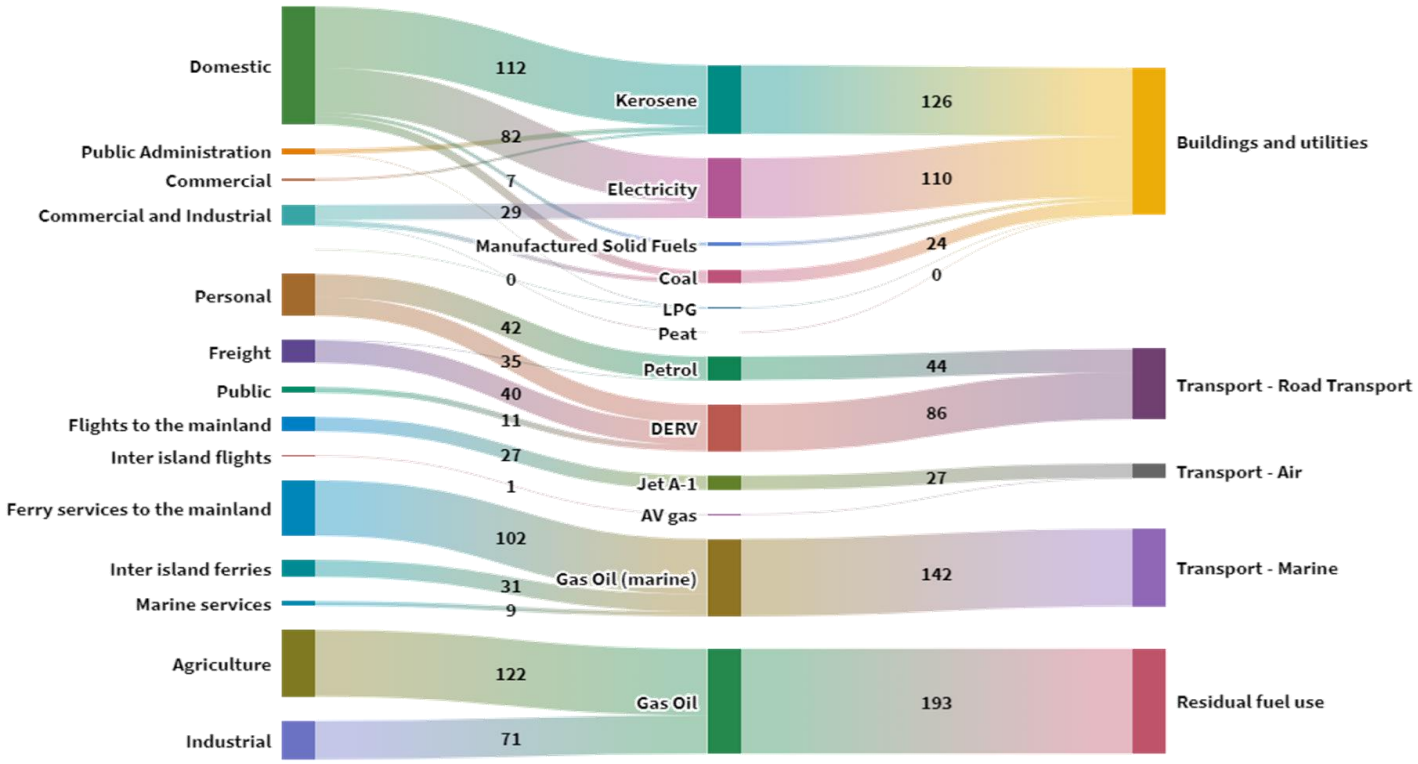
Inputs

- Sources of energy e.g. oil, gas, electricity
- Users of energy e.g. homes, public buildings
- Other energy inputs to or outputs from the system e.g. transfers across a defined geographic boundary, energy losses etc

Outputs

- Collation of energy data by category e.g. type of use
- An energy flow visual such as a Sankey diagram (see opposite)

Complexity: low



Sankey diagram from Orkney energy audit showing sources of energy, who uses it and where. Figures in GWh

Assessment Tool - Carbon (Footprint) Calculator

Scope

A tool to estimate the (annual) carbon emissions for an individual, household, building etc. Tools can use generic, such as UK wide average, data sets or more locally tailored/specific data sets. Scope can include energy use within the home/building as well as leisure and recreation, travel etc

Inputs

- Household/building energy consumption data
- Dietary information (for individual carbon footprints)
- Details of travel/journeys by bike, car, bus. Train, ferry, plane etc
- Details on goods and services consumed/used

Outputs

- Total annual carbon emissions/footprint (tonnes per year)
- Breakdown by sources
- Some carbon calculators generate recommendations on how to reduce carbon emissions/individual footprint

Complexity: low

Interactive personal/household carbon calculator from ReFLEX Orkney, available via the project website: www.reflexorkney.co.uk

Key Challenges

Community energy projects and the implementation of aggregated generation, energy storage and load management schemes span a number of areas, each of which can be presented with their own challenges. The following charts draw on some of the specific challenges faced in developing the ReFLEX integrated energy system project in Orkney:

Technical

- Deploying new technologies – testing, performance, reliability
- Interfaces with existing assets and systems (e.g. grid)
- Integrating numerous assets across supply and demand
- Grid connection process – costs and time
- System data – managing and valuing

Political & Regulatory

- Consumer Credit Act – need for Financial Conduct Authority licence for certain activities
- National procurement processes (required for local authorities)
- Listed buildings and conservation areas
- Structure of local energy company – local control/ownership
- Legal complexity & contractual arrangements e.g. with suppliers
- Challenges of getting insurance, licences etc with little/no trading record

Societal & Environmental

- Measuring and tracking carbon reduction benefits/project impact
- Personal data e.g. general data protection regulations (GDPR)
- Customer expectations – aligning service/product offering with communications/marketing materials
- Customer systems including account management and billing
- Ensuring services/products/new technologies are affordable and socially inclusive

Finance & Economics

- Funding new technologies and demonstrator projects
- Monetary recognition of carbon reduction benefits
- Cost efficient and effective working across multiple project partners
- A comprehensive financial model takes time to build but is vital for securing investment
- Upfront investment can be significant – lever in capital from key suppliers