Hope Valley Energy and Renewables

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Dawn Ward

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Stephen Platt

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Hope Valley Climate Action (HVCA)

Hope Valley Climate Action (HVCA) was set three years ago to act on climate. It has nearly 800 supporters. We have three main groups: Travel, Energy and Land. The Energy Group has been conducting a feasibility study of solar, wind and hydro.

https://hopevalleyclimateaction.org.uk

Accompanying reports

HVCA Renewables Technical Study

HVCA Public Acceptance of Renewables

Hope Valley Energy and Renewables

Introduction

Eliminating the use of fossil fuels for domestic purposes - heating our homes and driving our cars - is going to be an essential part of reaching 'net zero'. This will entail wholesale conversion to electrical power for both, with that electricity being generated from renewables or other zero carbon sources. So how much electricity will we need in the Hope Valley, and how feasible would it be to generate that locally? What would need to change to enable that local generation to happen? This study, led by our Energy Group, explores those questions, and we hope will help move the very necessary debate forward.

I am very grateful to Dawn Ward and Stephen Platt for all their work on this, to the steering group for overseeing it, to Breedon for the necessary funding, and to all the respondents to the survey.

Jeremy Wight, Chair Hope Valley Climate Action

The purpose of this study is to investigate the feasibility of installing renewables in Hope Valley. HVCA's Energy Group is involved in a related programme of work on energy efficiency and retrofitting homes.

We set ourselves 3 simple questions.

1. How much electricity will we need in Hope Valley as we electrify our homes and vehicles?
2. What mix of renewables would meet this demand?
3. What is the range of public opinion to different large-scale renewables?

In addition, the study threw up two further issues which we were able to investigate and answer:

4. What else will be needed, like storage, to cope with fluctuations in supply and demand?
5. What barriers will need to be overcome to make any of this possible?

Our study area extends from Ladybower in the North to Tideswell in the South and from Edale in the West to Ringinglow in the East and is defined by S33 and S32 postcodes as well as the northern part of SK17.

1 How much electricity will we need

In 2021 the total annual domestic energy demand, which includes heating, vehicles, and electricity, was about 154,000 MWh. This released 32,000 tonnes of CO2 emissions. The annual domestic base electricity demand[1] for this study area was about 23,000 MWh.[2] This does not include commercial or industrial demand.

The UK Government has pledged to more than halve our carbon emissions by 2030 and to get to net zero by 2050. The strategy for achieving this includes electrifying our home heating and vehicles. This means that as we switch from using fossil fuels to electricity to heat our homes and power our vehicles our emissions will fall but our demand for electricity will increase. Our study suggests that the annual base domestic electricity demand in Hope Valley will rise from 23,000 to 60,000 MWh by 2050, which means we will need two to three times as much electricity.

Scenarios

Three future energy scenarios have been used to predict domestic electricity demand: a best-case scenario based on the National Grid's Consumer Transformation scenario called scenario A; a likely mid-way scenario, called scenario B and a little change scenario based on the National Grid's Steady Progress scenario, called scenario 'C'.

Table 1 Scenario assumptions (percentages)

'Gas Boilers' means homes heated by gas; 'Fossil Fuel Cars' means private diesel and petrol cars)

Scenario		2021	2030	2050
A	Gas Boilers	85	66	2
	Fossil fuel cars	97	62	3
B	Gas Boilers	85	70	30
	Fossil fuel cars	97	62	3
C	Gas Boilers	85	83	69
	Fossil fuel cars	97	90	25

Scenario A assumes a radical improvement in building energy efficiency as well as a switch from fossil fuel to renewable power. Energy efficiency is perhaps not as glamorous as solar or wind, but it is even more cost-effective, has the fewest obstacles to implementation and is essential if we are to meet our net zero targets.

[1] Base electricity demand is the minimum level of demand on an electrical supply system over a given period.

[2] The difference between the total annual domestic energy demand of 154,000 MWh and the annual domestic electricity demand of 23,000 MWh is the energy used to heat our homes and power private vehicles ie. 131,000 MWh.

Energy and electricity predictions[3]

Our main finding is that the electricity requirements within Hope Valley will rise, at least doubling, by 2050 under all future energy scenarios.

We predict that by 2050 the annual domestic energy demand[4] will fall with an improvement in energy efficiency, but falls more under scenario A than B or C. Under scenario A energy demand would be around 65,000 MWh, compared to 90,000 MWh under scenario B and over 130,000 MWh under scenario C.

However, electricity demand rises dramatically as we switch from fossil fuels to renewable energy. Under all three scenarios we predict an increase in the domestic base electricity demand[5] in Hope Valley of more than double the current requirement, rising from 23,000 MWh to between 50,000 – 60,000 MWh by 2050.

By 2050 the increased electricity demand could be met from a combination of renewable energy installations, stored energy such as large or domestic scale battery banks, hydro storage systems and electric cars along with flexible generation such as biogas. This would require smart technology control.

We predict that under scenario A, as we electrify our home heating and reduce our use of fossil fuel vehicles, there will be a reduction in carbon emissions from 32,000 tonnes of CO2 emissions to 10–14,000 tonnes (ie. 55-70% reduction). Since the reduction depends on government policy and on individual household behavioural change there is considerable uncertainty in the prediction.

[3] It should be noted that there is a level of uncertainty within all the results presented.

[4] Domestic energy is the energy required to run domestic vehicles and to heat and electrify homes. The sources of this energy include natural gas, oil and petroleum, and electricity generated from fossil fuel, renewables and nuclear.

[5] domestic base electricity includes electric space heating and vehicles.

Table 2 Domestic energy and electricity predictions for 2030 and 2050 (MWh)

	2021	2030			2050		
Scenario		A	B	C	A	B	C
Energy demand	154,000	152,000	133,000	128,000	65,000	90,000	130,000
Electricity demand	23,000	33,000	31,000	27,000	60,000	52,000	50,000

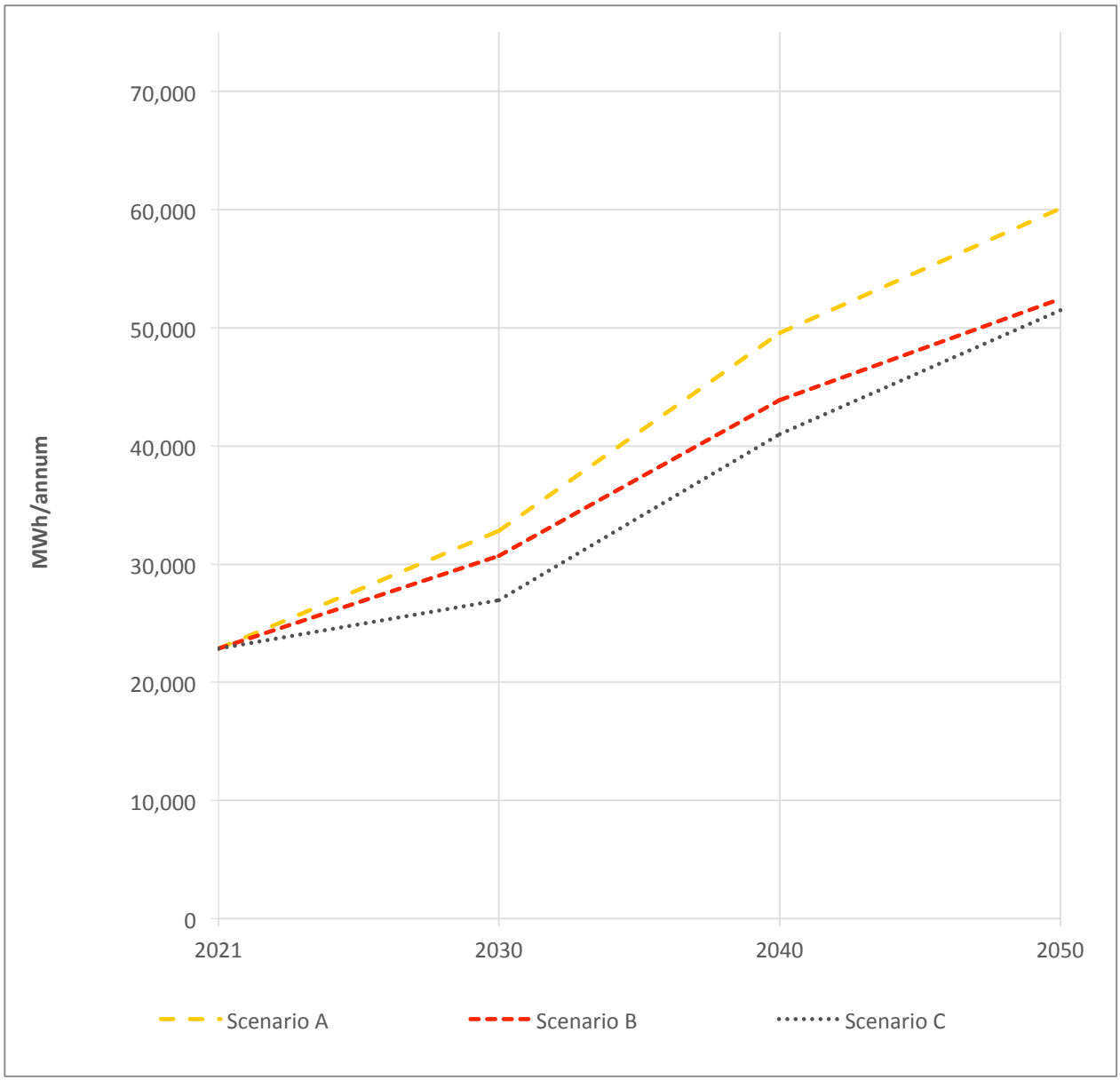

Figure 1 Projected domestic electricity demand in Hope Valley[6]

[6] including electric vehicles and heat pumps (MWh)

2 What mix of renewables would meet this demand?

Three families of renewables were chosen for investigation - solar, wind and hydro - as these were seen to be the most appropriate options within the study area.

Solar PV on roofs

Solar PV on the roofs of buildings, whether domestic, public, or industrial means that electricity can be generated without the need to take land from other uses. An average domestic 4 kW system provides around 3400 kWh annually in the UK, which is equivalent to the current electricity demand of the average 3-bed domestic household. Unfortunately this is not produced when most needed. Nevertheless, if 1 in 3 domestic and non-domestic buildings were to incorporate a solar array on their roofs, as much as 12,000 MWh of electricity per year could be generated within the community, enough to power 2,000 homes in 2050.

Large scale solar photovoltaics

Within Hope Valley there is the potential for both land-based and floating solar arrays. A 5 MW single access array would require around 20 acres and could provide over 6,000 MWh annually; enough to power over 1,000 homes in 2050. The average capacity factor in the UK is 10% and maximum generation occurs in the summer, whereas more electricity is required during the winter months.

Wind turbines

There is also potential for wind turbines on sites such as Bradwell Moor or Sir William Hill and Shatton Edge. A 4.5 MW turbine could produce 10,000 MWh annually, with more generation being likely, during times of maximum demand, in the winter months; enough to power 1,600 homes in 2050. Generation obviously varies with the weather and the average capacity factor is currently 30.5%. Nationally, this will increase as more modern machines displace older installations.

Micro-hydro

A report commissioned by Friends of the Peak District in 2010 assessed the small-scale hydro potential of the Peak District National Park. It concluded that the total generation potential in the PDNP is 2.9 MW. This is likely to be an over-estimate of the realistic potential given licensing/planning/commercial issues. The actual total potential the report suggests is 1-1.5 MW with a capacity factor of 40-50%. This is the equivalent of 1 wind turbine. Although the total potential for hydro generation in Hope Valley is low micro-hydro is quite predictable. Calver Mill on the River Derwent has the potential continuous capacity of 125 kW, which could generate around 500

MWh annually; enough to power about 80 homes in 2050. The site is close to homes in Calver and Curbar and is less than a 100 m to a grid connection point.

Large-scale solar and onshore wind are now the cheapest forms of electricity, across both renewable and non-renewable technologies, within the UK. Is there a place for larger scale renewable local generation within Hope Valley? If so, what type of renewable installations are most appropriate and where should they be sited, recognising the importance of landscape sensitivity in the national park?

A credible mix of renewables that would generate the amount of electricity needed by 2050 (60,000 MWh), given the environmental sensitivity of the national park, would be solar on 1 in 3 residential roofs, 2 x 5MW solar arrays and 3 large wind turbines. Wind and solar are, given the environmental sensitivity of the national park, to an extent complementary; solar is at maximum capacity in the summer and during the day while wind is at maximum capacity in the winter, day and night. This level of investment and the potential environment impact seems reasonable given the climate emergency and the UK Government's legislation on net zero.

However, this alone would not make Hope Valley self-sufficient in electricity. It would only meet domestic demand. We predict that in 2050 non-domestic demand on the 33/11kV network (ie. the distribution network in Hope Valley other than that for Hope Cement) will be at least a further 50,000 MWh. More solar on all suitable non-domestic roofs makes obvious sense.

There is also the fundamental issue of managing daily and seasonal variation in the supply of renewable power. We'll come back to this later under the section on grid connection.

3 What is the range of public opinion to different large-scale renewables

National policy prohibits large scale renewables in national parks. To gauge public opinion, we conducted a survey in January.

Response

675 people responded. 400 live in Hope Valley, 100 elsewhere in the Peak and the rest are visitors from further afield. Half are members of a climate group or are HVCA supporters and half are neither. The scope of the survey also covered energy savings, retrofitting and electric vehicles.

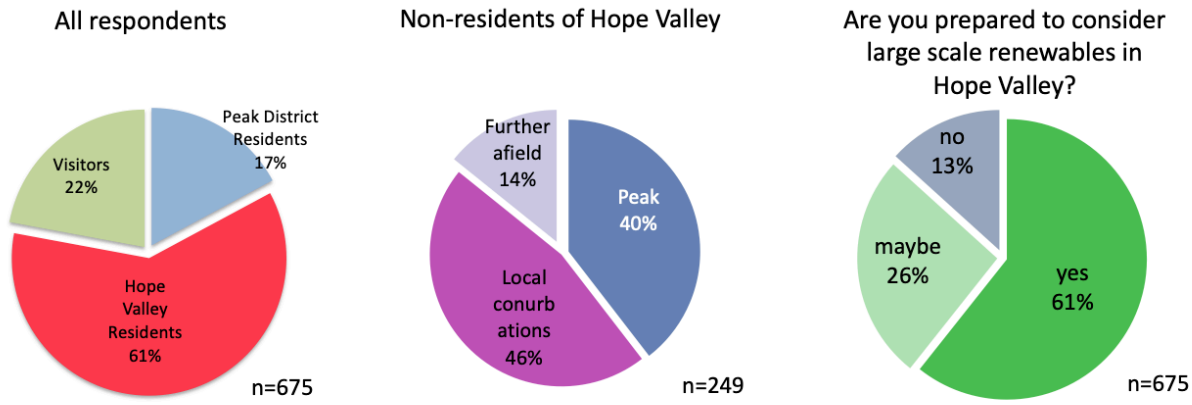

Figure 2 Renewables public opinion

Over half of all respondents (61%) are prepared to consider large-scale renewables in the Peak Park; a quarter might consider them and 13% said no.

Hydro

Hydro was excluded from the study because the potential capacity is extremely small, and we concluded that hydro could only make a small contribution to local electricity generation. However, many respondents asked about hydro in their comments, and, with hindsight, it would have been sensible to have included hydro as an option.

Solar and Wind

Most respondents are in favour of solar generation in Hope Valley and solar on houses and non-domestic roofs was liked by 90% of respondents. Two-thirds are in favour of ground-based or floating solar arrays and small wind turbines.

There is less support for large wind turbines. Nevertheless, 59% of respondents support single large wind turbines and 46% like multiple turbines. There was little difference in opinion by age or where people live. 79% of respondents are in favour, in principle, of large-scale renewables in Hope Valley being owned and managed by a Community Benefit Society with any surplus being ploughed back into the community. 9% are against the idea.

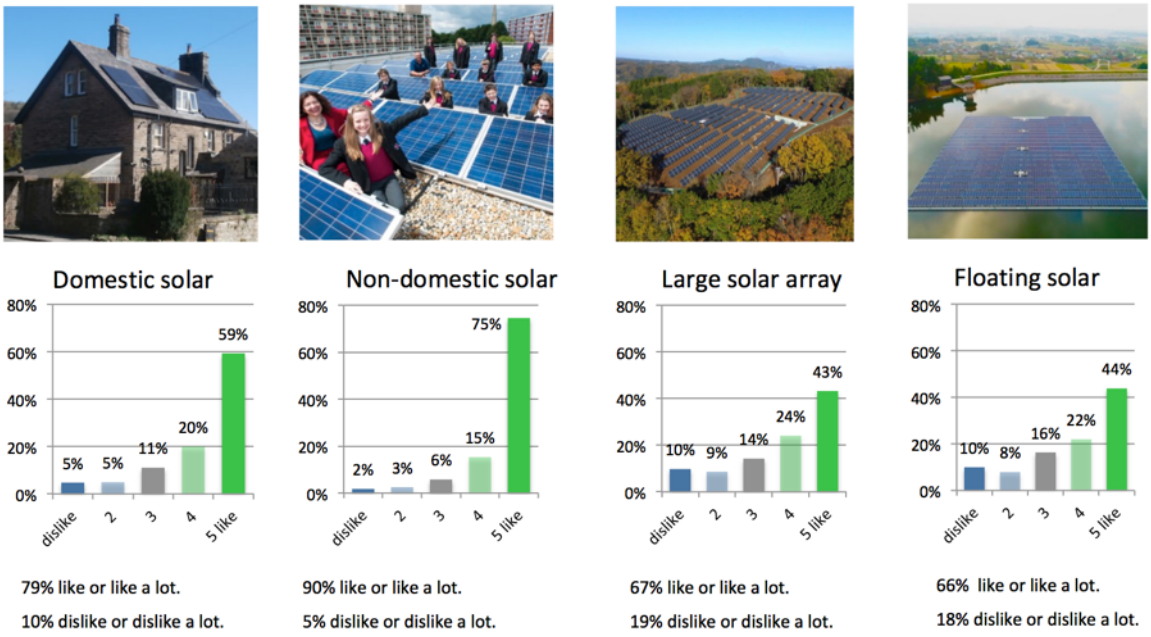

Figure Solar renewable options

Figure 3 Wind renewable options

Respondents were more concerned about climate change than they were about energy bills. 92% were concerned or highly concerned about climate change, compared with 72% who were concerned or highly concerned about energy bills. This may change with the dramatic hike in energy costs in April 2022.

Energy efficiency

Since reducing consumption is clearly preferable to increasing generation, we also asked about reducing demand with improved insulation. A third of respondents think their homes are already well insulated; a half are interested in improving insulation and a further 11% might be. 4% are not interested at all. Of the 488 people for whom further insulation is relevant, if the total cost were £10-20K, 61% would seriously consider investing if a grant covered 50% of the cost and 90% would if a grant covered 75%.

11% of respondents already have an electric car and a further 39% are considering buying one in the next 4-5 years. (18% of new UK car registrations in 2021 were for plug-in EV)

18% have already installed solar panels and 20% are considering installing them. 16% are interested in installing heat pumps. These figures need to rise if the Government is to meet its carbon reduction targets.

4 What else will be needed, like storage?

Electricity storage will be needed to cope with fluctuations in demand and supply. There are peaks in consumption during the day and demand is higher in winter and renewable energy generation fluctuates with the weather, whereas gas-fired and nuclear power stations run continuously.

Storage can be provided at both the household and community level. Domestically, batteries incorporated into solar installations or in electric vehicles will help balance fluctuating demand and, with smart meters and variable tariffs, will allow consumers to buy electricity from the grid when demand and prices are low and sell electricity back to the grid to help Distribution Network Operators[7] (DNOs) to manage peaks in demand, reducing the need for extra generation capacity.

Community level storage could operate in the same way as a domestic system, with an automatic energy management system controlled by the DNO. This community storage might be in the form of large batteries sited in villages or might be high density fluid hydro systems sites in disused quarries with head heights of at least 75 m.

[7] There are 2 DNO's in Hope Valley Northern Power Grid supplies power to the western end of the Valley from a sub-station in Hope, while Western power supplies the east and southern end of the Valley from a sub-station in Eyam.

5 What barriers will need to be overcome to make any of this possible?

Planning

Current planning policy prevents the installation of large-scale renewables in the Peak Park. The National Planning Policy Framework says that permission should be refused for major development in national parks other than in exceptional circumstances, and where it can be demonstrated that the development is in the public interest. We believe that the limited investment needed to meet our increased demand for electricity outlined earlier in this report could be sympathetically introduced into the Valley without damaging environmental effects or a negative impact on biodiversity. We hope to be able to work with the National Park Authority to define the criteria to be used in deciding which of the many area s of the Park would be inappropriate for large scale development and where renewables might be permitted.

Licencing

Currently it is not possible for community groups to get a licence to sell energy directly to domestic consumers. We need the Local Electricity Bill to become law to allow this to happen and make local generation and consumption viable.

Costs and hence payback of the different renewable options are dependent on the site, grid connection and scale. Currently community energy projects face severe problems in accessing the grid. Northern Powergrid and Western Power Distribution, our two distribution network operators (DNOs), charge millions to connect large renewables into the grid and don't guarantee the supply contracts.

Grid connection

Unless we can consume locally generated power locally the extra electricity demand both nationally and locally will require major grid infrastructure reinforcing, along with mass electricity storage.

Grid connection is also a major factor affecting the viability of community energy generation projects. Hope Valley is at the end of the distribution networks of both DNOs. This lack of capacity in the distribution network of Hope Valley is a major limiting factor in the development of renewable power.

As mentioned earlier, there are both diurnal and seasonal fluctuations in the supply of renewable power. The diurnal fluctuation can be addressed through local domestic and community level storage. Seasonal variation is more difficult because the amount of electricity storage needed. Unless there was over-capacity of both generation and storage, which would be uneconomic, there will be times when local power plants are unable to meet local demand and electricity would need to be

imported from the grid, for example during periods of still weather in winter. Conversely there will be times when local supply exceeds demand and electricity could be exported to the grid. Ideally these would balance each other. However, the distribution network operator might need to curtail supply in times of excess, for example during a long, sunny period in summer. One long-term storage solution nationally would be to convert excess renewable energy into green hydrogen if this became commercially viable.

Energy efficiency

As home heating electrifies, the thermal efficiency of homes will need to significantly improve, both to provide sufficient warmth and to prevent further fuel poverty and the knock-on effects that this has on people's quality of life and wellbeing. Currently progress on retrofitting homes to improve their energy efficiency is painfully slow. It is limited by the high cost, poor pay-back, limited grant aid and a severe lack of trained assessors and installers.

6 Conclusion

Under all future energy scenarios presented, we see an increase in the predicted domestic electricity requirements within the Hope Valley, to at least double the current demand. However, if most of this was from renewable generation our emissions would reduce by more than 55% as renewables replace fossil fuels.

Hope Valley could provide for its own domestic electricity demand in 2050 with a modest mix of renewables for example with solar on 1 in 3 roofs, two 5 MW solar arrays and three 4.5 MW wind turbines.

Some of the necessary measures required to achieve this rely on homeowners improving the energy efficiency of our homes, switching to electric heating, and changing the way we travel. This would require government policy change and support. If these changes are slower than predicted then our electricity demand will continue to rise past 2050, and there will still be an increase in demand for domestic electricity three times our current annual usage.

To meet the Government's target to halve our carbon emissions by 2030 and to get to net zero by 2050 we will need to ensure that increased electrification comes from renewable sources. It makes sense to explore whether some or all of this could be generated locally. Community energy has a part to play in the push towards a net zero carbon emission future. Hope Valley and the Peak District National Park are sensitive landscapes, but with the increased electricity demand the option of large-scale local renewable generation needs to be reconsidered.

Acknowledgements

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Jeremy Wight, Chair HVCA

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We would also like to acknowledge the support of the HVCA Energy Group coordinated by Zee-Zee Heine, to which we reported monthly.

Terminology

Base electricity demand (load)

Base load is the minimum level of demand on an electrical supply system over a given period.

Peak electricity demand (load)

Peak load is the energy required at a time of high demand, for example at 6pm on weekdays.

Capacity factor

Is the ratio or percentage of actual energy output to the theoretical maximum output over a period.

MWh

A megawatt hour (Mwh) is equal to 1,000 kilowatts of electricity used continuously for one hour. It is about the amount of electricity used by about 330 homes for one hour or the energy produced by 10 car engines.

GWh

A gigawatt hour (GWh) is 1,000 MWh.