Written evidence submitted by the British Hydropower Association

1. Background to the British Hydropower Association

The British Hydropower Association (BHA) is the leading trade membership association solely representing the interests of the UK hydropower industry and its associated stakeholders in the wider community.

Our Mission is to drive growth in the sector by engaging, influencing and promoting Hydropower, Tidal Range and Pumped Storage Hydro, as firm, renewable power, providing critical infrastructure for achieving Net Zero and Energy Security.

Table 1 – The BHA 'Asks' to Government

	Hydropower:	**Pumped Storage Hydro:**	**Tidal Range:**
Currently deployed	2GWs (900GWhs storage)	2.8GWs (27GWhs)	0GWs
Pipeline	1GW	7.8GWs (135GWhs)	20GWs
Potential deployable capacity	3GWs	15GWs	20GWs
What is the BHA calling for?	Move to 'Enhanced' Levelised Cost of Energy inc whole systems benefits. Replace 1 GW of coal with 1GW Hydropower. CfD tweak for AR6: – Strike price £140/180MWh. – Reduce >5MW to >1MW. – Ring fence and aggregation potential for Capacity Market inclusion	A cap and floor, to enable delivery of the **15GW** called for in this CCC report	Regulated Asset Base, used for Nuclear, to enable delivery of **20GW**
What are the main barriers to support?	Hard to raise relevance (see as, too small, can't scale, too expensive)	Geographically constrained, market can deliver batteries	Perceived to be too expensive (ie, Swansea Bay)

Why are these technologies important?	Resource adequacy, hydropower is cheaper than gas peakers (Reservoir hydro currently provides 900GWhs of storage and load follows)	Storage, reduced curtailment and balancing costs, grid stability/ flexibility (pumps and generates) currently 29GWhs, pipeline 135GWhs	Non-weather dependent, generation near increasing demand centres (circumvents transmission constraints), flood defence , socio economic value.
The counter points:	**Longevity:** All these technologies are intergenerational assets (100+ years) that will deliver well beyond 2050 – true energy security. **Resource adequacy:** What's the answer to 3 week Low wind period in 2035? Hydropower generates 2/3rds of its' energy in winter, 900GWhs of dispatchable, firm, low carbon generation. **Energy sovereignty:** Gas interruption, interconnector failure, French nuclear fleet refurbishment. **Reliability:** Hydro/ PSH/ TR are all proven, reliable, long lasting & deliverable with 80% of the supply chain in the UK. **Cost:** LCOE: cheapest kWhs will not deliver a stable grid. Lowest cost is not always best value. We need to move to 'Enhanced' LCOE and account for Non price factors. **Path to net zero:** • Fraught with delivery risk and time slippage • To mitigate risk, we need diversity. • We need all technologies being progressed rather than a favoured few. **Grid:** How can we deploy localised energy solutions that will not be hampered by Transmission constraints.		

The BHA is calling for the CfD to incentivise an additional 1GW deployment of hydropower, a no regrets option, with low risk of non-delivery.

2. Contents

3. The National Grid and the Government's energy targets

- What challenges does connecting more renewable electricity to the grid pose, both for those businesses and households who wish to connect to it, and for grid operators?

Currently there are very long queues to connect to the grid, this is in part due to Transmission congestion, creating constraints across the network at both Transmission and Distribution level. A large issue is lack of visibility across the networks, ie what's generating when and where, especially across Grid Supply points (GSPs). The network MUST get smarter a lot quicker through digitisation, active network management and flexibility if we are not to let these transmission constraints (which will take a least 10 years to resolve) halt our advance towards Net Zero.

- To what extent do the following act as barriers to the UK's targets to decarbonise the power supply? How well is the Government addressing these barriers, and what else can be done to address them? What, if any, targets should be set in these areas?
    1. grid connection delays and bottlenecks, onshore and offshore;
    2. lack of, or delays to developing, necessary infrastructure;
    3. insufficient scale or capacity;
    4. supply chain and skills constraints, and
    5. access to finance

3.1. 1. grid connection delays and bottlenecks, onshore and offshore;

The Government is delivering a substantial programme of upgrades through the Holistic Network Design and the ASTI, this is welcomed by the BHA and is key to resolving the issues that we face. Many of the issues have stemmed from the networks not being allowed to **build ahead of need**, even though we know that electricity demand will increase 2.5 times due to electrification of heat, transport and industry. The Hydrogen questions has not helped this deliberation, with the continual query around Hydrogen being used for domestic heat and therefore reducing the potential need for grid reinforcement. In the CCCs recent report Delivering a reliable decarbonised power system - Climate Change Committee (theccc.org.uk) they categorically state that there will be too much competition for Hydrogen and electrification of heat should be the preferred solution (although Government aren't due to make a decision on this until 2026). This decision does not impact on the rural low carbon heat transition where Hydrogen will never be part of the solution. Off-gas grid areas will not be allowed to replace domestic boilers with fossil fuels boilers after 2026, meaning the path to electrification of heat and the impact in rural grids must be urgently understood. The transmission upgrades are a blocker across the entire network and will take a long time to resolve, therefore there must be new and urgent attention on faster delivery of a smart, response grid at the Distribution network, through work on:

- Innovation

- Digitisation
- Flexibility
- Visibility
- Place based, NZ community solutions: where total load can be better understood helping develop plans for reinforcements that will be fit for purpose for a NZ future.
    - Local Area Energy Plans at community level will be key for this planning.
    - The Regional Systems Planners suggested by OFGEM within their Local Energy Institutions and Governance consultation will also be key to this delivery, with the speed and urgency that is necessary.

3.2. 2. lack of, or delays to developing, necessary infrastructure;

As stated above, transmission constraints are known, and work is being undertaken to resolve them. To stop the Transmission constraints being a blocker at distribution level for the next 10 years, we must work much faster to develop a smart, flexible grid that can maximise the capacity and head room that we know is there (ie, when the wind isn't blowing) but yet can't 'see' and therefore, the DNOs can't utilise.

DNOs have too little resource to resolve these issues at the speed we need them to. Ofgem, needs to progress this agenda at a much accelerated rate and ensure the DNOS have sufficient resource to unpick the barriers at distribution.

3.3. 3. insufficient scale or capacity;

The inability to build 'ahead of need' has been a major constraint to the Grid being developed to be ready for NZ. The ability to plan at regional, local and community level is sadly lacking, and it is hoped that the suggested route forward put by Ofgem in their recent consultations on 'Local Energy Institutions & Governance' including the call for FSO to have Regional Systems planners, is very welcome and a very necessary step to bring together stakeholders in a coordinated way. Work must be done at pace on Local Area Energy Plans and Place Based NZ community solutions, to build up a patchwork picture of energy demand that can be met by the future network. There should be a target for regional areas to have indicative LAEPs and appropriate network plans by 2027. This will, in-part, build on the Distributed Future Energy Scenarios, but the granularity of detail must be significantly improved and the barriers to progress understood.

There needs to be more done to deliver new generation on the distribution network that can match the new demand that will be required for electrification of heat, transport and industry. A move towards smart local energy solutions will be key if we are not to stall progress on NZ whilst transmission upgrades are being delivered. Government does not have an incentive mechanism in place to progress new local generation, with the focus being 50GW of offshore wind and 70GWs of solar. The macro scale is important, but the smaller generation at distribution will be equally important. Hydropower, with it's winter generation matching the new demand from electrification of heat, needs to be a key focus for local energy solutions in rural areas. Local supply models would unlock and enable these smart local energy solutions, the BHA is very supportive of the Local Electricity Bill and encourages the Government to deliver a mechanism that will create this new market that will encourage new local generation.

3.4. 4. supply chain and skills constraints,

There is a huge issue with skill shortages across the Net Zero agenda. This is in part due to the start/ stop policy and legislation which has seen the NZ industry in a perpetual cycle of political toing and froing. There are not many industries that have been, and continue to be, at the mercy of political headwinds and having worked in this sector for many years, I can bear witness to the redundancies, liquidations and skill migration over the last 20 years, it's a sad fact that much of the expertise, knowledge &, momentum within this NZ transition, was lost 10 years ago when the Government moved support away from this agenda which was perceived to be 'green crap'.

To learn from and continue to build this sector, there must be solid policy and support from Government, so industry can invest in the jobs and skills it will need to give the acceleration that is required to meet the NZ agenda.

The BHA would also suggest that there needs to be more resource within DESNZ to work towards NZ at a faster pace. Teams/ Zoom offers us a real opportunity to collaborate much closer through virtual teams, working with different entities. This should open up opportunities for Civil Servants to reach further into the regions to understand the problems, barriers and opportunities that NZ can provide.

3.5. 5. access to finance

At a time where the imperative is to speed up deployment of renewables, the landscape for delivery is becoming increasingly challenging, not only due to grid constraints, but also due to global competition for investment (the industry is reporting that the USA's Inflation Reduction Act and EUs 'Green Deal Industrial Plan' is impacting on investment conversations). Investors also look at the planning and consenting delays (through resource issues and covid backlogs) and also unfavourable taxation, including the archaic system of business rates based on single individuals' assertions or interpretations. This all adds up to an unfavourable environment for investors.

Pumped Storage Hydro will need to be a key technology for a decarbonised grid with a high penetration of renewables. There is currently 7.8GWs in a pipeline of projects with 135GWhs of storage, waiting for the Government's decision on whether they will set forward a 'cap and floor' long term price signal, that will give investors confidence and lower the cost of capital. We now know that some of those investors are looking to the USA and re-thinking where they should invest? What is the cost of this delay in the Government's decision? With curtailment costs at up to £62m / day (according to the National Audit Office), and the fear of investor flight, the BHA thinks the cost of delaying these decisions, is impossibly high and not giving best value to consumers who will pay the higher price in the long term.

- How resilient is the National Grid? How does it need to adapt to achieve the Government's targets of (a) decarbonising the UK power system by 2035 and (b) becoming a net zero economy by 2050? What changes are needed to promote resilience through diversity of supply?

To understand resilience, we need to look at the deliverability risks to Net Zero.

3.6. Deliverability risks for Net Zero

As with investments, the best way to mitigate risk, is to have a board portfolio, this applies to the energy sector and should be considered when we're looking at the Net Zero Transition. We need all technologies to be mobilised towards deployment as rapidly as possible. Many will face long delays as they face the barriers of grid, planning, investment etc, so we need to start with as boarder a mix as possible, with the knowledge that only some of them will reach deployment. The queues for the grid give a false sense of security and certainly don't represent the reality of what will be delivered, nor how those technologies will deliver a secure, stable low carbon grid.

The key risks to achieving Net Zero are summarised below:

3.6.1. Emerging technologies to scale

The National Audit Office NAO) also highlight the many risks in meeting the statutory targets to become NZ, this includes ' for both offshore wind and nuclear power there are significant delivery risks that DESNZ needs to overcome to achieve the rapid increase in speed of deployment required to achieve its ambitions.' P17 They also suggest that DESNZ should P11 "establish arrangements to understand and respond to system-wide risks and opportunities, to ensure its plan is resilient to setbacks, disruption and future uncertainty."

What will be the cost of delay from those setbacks? Hydropower is a small part of the bigger picture, but it is a very relevant part that will reduce risk, bring system stability (inertia, voltage control, storage, flexibility and black start) and most importantly, it has minimal risk of delivery and can be guaranteed to bring 1GW online within the next 2-7 years.

Currently the Capacity Market is made up of 57% generation from gas. The recent consultation suggested that this will be decarbonised through:

- Abated gas with CCuS
- Hydrogen fired thermal generation (both blue and green)

These technologies are emerging and need significant processes in place to scale, including transmission or transport and storage. All of these processes are emerging and the timelines for the expected delivery are beyond ambitious. Alongside Nuclear SMRs, there is enormous expectation that all these technologies will deliver on time and at the scale predicted. The risk of non-delivery must be considered, and the evaluation of timescales and relevant mitigation plans must be in place, if we are not to fall well short of the NZ targets.

As stated in the NAO decarbonising the power sector report, p10: "DESNZ cannot be complacent about the challenges involved in decarbonising further while continuing to ensure a secure supply that meets the predicted electricity demand increases."

The BHA would agree with the NAO and suggest that there are not enough plans around contingency. The Government currently offers no support to the Tidal Range industry, which has been dismissed due to misaligned perceptions that it is too expensive. The Government must work with industry and continuously review every available option to develop any plentiful indigenous energy resources the UK can develop, including Tidal Range.

3.6.2. The grid

Increasingly, the issue of grid constraint will determine the amount of new connection coming online. The risk that grid constraints pose on the delivery of net zero transition are substantial. The grid adds risks of non-delivery but also has an impact on the increasing costs of curtailment and rebalancing.

Digitisation of the Grid, fed with meteorological data, machine learning and automated demand side response load shifting in real time will be a key part of the future grid. This will bring huge efficiencies in what generation we need, and the network capacity required to balance the demand and generation. Acceleration of innovation to achieve this, with much tougher penalties for TOs and DNOs that aren't achieving this, must happen if we are going to provide best value to consumers.

3.6.3. Resource/ Capacity Adequacy and meeting Net Demand

The Capacity Market is the Government's main incentive mechanism to provide resource adequacy which will become more important as the penetration from intermittent renewables increases.

Although both wind and solar will play a huge role in decarbonising the UK's energy supply, the **increased penetration of intermittent renewables on the system, means that increased storage and flexible technologies are needed** to counteract the issue. Unpredictability of Net demand will be an increasing challenge especially when events such as 'Dunkelflaute' or a period of no-wind besets the UK.

The aspiration for the CfD mechanism should now be to deploy a more diverse and secure energy mix that will meet the more holistic requirements of a decarbonised Grid. The drive to bring low cost MWhs on to the grid should make way for a more strategic approach that will deliver capacity that will bring grid security.

Government must move away from being focused on MWs delivered, but rather consider the MWhs generating and what is the profile and certainty of that generation. We need to move away from thinking about installed capacity and move to the just in time model of energy generation meeting demand.

Net demand, or resource adequacy, will be especially relevant in the next 25 years whilst the transition is in phase. The government plans for new nuclear, Hydrogen and abated gas with CCuS are longer term solutions and will not mitigate the resource adequacy risk in the shorter term. Hydropower and PSH are no-regrets decisions that must be delivered rapidly if we are going to continue to provide a decarbonised grid by 2035 with best value for the consumer. The interconnectors also provide backup, but Energy security through Indigenous energy development, circumvents issues around geo-political risks.

- What contribution do, or should, localised mini-grids make to achieving the Government's targets of (a) decarbonising the UK power system by 2035 and (b) becoming a net zero economy by 2050? What role ought there to be for decentralised energy distribution points and distributed energy generation in the future of electricity supply?

See case studies in the Appendices to see how localised energy solutions will have to be key to our NZ transition, in part to be able to keep pushing forward whilst the Grid barriers at Transmission level are overcome in the next decade. Also, to overcome the issues of the rural 'weak' grid:

- What role will, or should, artificial intelligence play in decarbonising UK's power supply?

Digitisation of the Grid, fed with meteorological data, machine learning and automated demand side response load shifting in real time will be a key part of the future grid. This will bring huge efficiencies in what generation we need, and the network capacity required to balance the demand and generation. Acceleration of innovation to achieve this, with much tougher penalties for TOs and DNOs that aren't achieving this, must happen if we are going to provide best value to consumers.

See case study in Appendix A: Alt ne Moine

- To what extent will the measures in the British Energy Security Strategy and the Powering Up Britain plan deliver the Government's high-level targets of (i) decarbonising the UK power system by 2035 and (ii) becoming a net zero economy by 2050?

The headline figures given in the BESS and PUB strategies do not account for the issues of grid constraints, resource adequacy, emerging technologies not scaling in the allotted timescale, Nuclear timelines over-running, digitisation of the grid not happening as fast as it needs to, people taking longer to take up the electrification of heat. Head line grabbing figures belie the fact that the grid is a just in time model, where generation and consumption must match in real time. Resource adequacy will be an increasing issue as the penetration of intermittent renewable energy increases over time. We must bring the 1GW of additional Hydropower that can be delivered with a strike price of £180/MWh online. This is going to generate across the winter peak demand periods and will be cheaper that gas peaking plant which is at least £250/MWh. We will need significant amounts of storage to replace the large volumes of storage currently available through fossil fuels. The Government has indicated that they will give a decision on the 'cap and floor' incentive mechanism in 2024. The BEIS committee suggested this must be moved forward to 2023 to allow the Pumped Storage Hydro pipeline of projects to mobilise and the BHA agree, the cost of delaying this decision, (up to £62 million/ day in curtailment costs) is too high.

- How will the design of the future grid incorporate adaptation measures so as to minimise the potential impacts on the electricity system from extreme weather events, such as Storm Arwen in November 2021?

Most of the outages from Storm Arwen were centred around rural communities. Historically, DNOs do not want to create electricity 'islands', however this precedent was set long ago as a safety precaution for engineers and the risk of electrocution whilst working on reconnections. As we move to a digitised grid with smart local energy solutions, localised balanced solutions, with local generation, community battery storage, shared ground loops (or smart ASHPs) smart water cylinders, will have to prevail. In part, due to the inability of the DNOs to reinforce the rural grid (too costly and timely) ahead of need and the issue of not being able to replace fossil fuel boilers from 2026 in off-gas grid areas, these factors will bring the issue of grid constraints in rural areas to the fore within the next few years. Localised solutions like this will offer significantly more resilience in the event of storms, as there will be some generation, storage, smart load shifting capabilities. Also, if there are EV

charges points with Vehicle to grid, the DNOs can also plug into the islanded micro grid to give extra power, rather than bring a diesel generator.

See Appendix for case studies.

4. Storage and flexibility

What developments, including technological developments, and incentives are required in the areas of:

1. *storage;*
2. *transmission and distribution;*
3. *demand management and flexibility, and*
4. *interconnection with neighbouring grids?*

How will the expected growth of demand for electricity to power low-carbon technologies such as electric vehicles and heat pumps affect how supply and demand is balanced across the electricity system?

4.1. Storage

We will need significant amounts of storage when we consider Resource adequacy and the question of '3 week low wind in 2035' problem.

PSH is a tried, tested, proven, deliverable technology. We have 27GWHs operating, there is 135GWhs in a pipeline wating for a government decision on the 'Cap and floor' mechanism. This long term price signal is crucial for cost of capital and investor certainty. These are big infrastructure projects, being financed privately, they take 5-7 years to be developed and every month counts. The BEIS committee recommended that the promised decision by 2024 is moved forward to before the end of 2023. The BHA heartily agrees and suggests that the Government considers 'what is the cost of delay'?? with the NAO calculating the costs of curtailment are up to £62 million/day, something that PSH could help alleviate, the delay in decision making looks profligate at best.

There have been numerous reports to suggest that PSH is a no-regrets option for Government and will sit alongside other storage technologies and be the cheapest solution for 4- 48 hours.

It's also well worth noting that non-pumped storage hydro already provides 900GWhs of storage. There is another 1GW of hydropower to be developed with a CfD tweak, which will procure more storage. (See case study in Appendix for Alt Ne Moine) There is potential to develop further reservoir storage hydropower to add further GWhs to the UK energy mix.

4.2. Transmission and distribution

There has been an 8-fold increase **in the cost of managing congestion on the transmission network** since January 2010 and this trend is set to increase to up to £3bn per year by 2035 even after more transmission and distribution lines are built.

The Electricity System Operator (ESO) – originally envisaged as purely a residual balancer to reposition the market – is increasingly acting more as a central dispatcher, frequently re-dispatching more than 50% of demand (compared to only 10% in 2008).

The Capacity Market offers weak incentives for flexibility (e.g. storage and demand side response) which is needed for resource/ capacity adequacy – currently 57% is from gas.

Visibility between Transmission and Distribution at grid supply points is a major barrier, this will be helped and enabled by digitisation, however, this is happening very slowly and DNOs need additional resource and incentives to push this through at a faster pace.

4.3. demand management and flexibility

Demand management and flexibility will be key to the real time balancing of the grid as we have increased amounts of intermittent renewables online. OFGEM suggest we will need 30GWs of flexibility by 2030. PSH and reservoir hydro are key technologies that can assist with flexibility.

Smart local energy solutions will also be key (see chipping case study) the ability to load shift heat at local substation level will be key.

4.4. interconnection with neighbouring grids

The cap and floor mechanism has brought real success in the ability to deliver extra capacity through multiple new interconnectors. However, the safest way to ensure UK Energy security is to ensure that we are maximising the enormous indigenous energy generation that we have across the UK including Tidal Range. Becoming a net exporter of energy will other our Island nation more resilience that relying on interconnectors to meet generation gaps. There is also a concern that low wind periods will happen across Europe, rather than just the UK, so will not be the solution to 'dunkelflaute'.

How will the expected growth of demand for electricity to power low-carbon technologies such as electric vehicles and heat pumps affect how supply and demand is balanced across the electricity system?

As with the case studies given, planned and phased, smart local energy systems will be key to the ability of low carbon solutions being rolled out without being massively delayed by the upgrades required at Transmission network. This offers a more cost efficient and timely solution. This requires a bottom up approach, alongside top down solutions. See Net Zero Terrace street case study.

5. Governance and institutional arrangements

Are the current governance arrangements for the grid fit for purpose? To what extent do the proposals in the Energy Bill address any issues in governance?

The DNOs are private monopolies, gate-keepers, owners, operators, answerable to shareholders and OFGEM, which makes for a complex paradigm when NZ transition has to be achieved in a very short time frame with costs socialised on bill payers, many of whom are in fuel poverty.

The recent Ofgem consultation on 'future of local energy institutions and governance' addressed some of these issues. The proposed Regional systems planners will need to be a key architect with the ability to bring Local Area Energy Plans, place based Net Zero community solutions and the requirements of the grid together.

DNOs must be persuaded to pick up the pace and the only way that can happen is via Ofgem and public/ political pressure, for the reasons stated above. The energy bill deals with the issue of Ofgem having to consider Net Zero in its remit, but Ofgem must be enabled to speed up the cascade of pressure down to DNOs to get moving faster on innovation, digitisation and the ability to accept and work with flexibility, shared connections, visibility of what's on the network at any one time,

Does the current Electricity System Operator—or will the proposed Future System Operator—have sufficient powers? If not, what further powers will they need?

According to the NAO P40 In the decarbonising the power sector report March 2023:

"DESNZ plans to establish a Future System Operator (FSO) in 2024 to increase coordination across the power sector. The FSO will have a key role in advising government to inform key policy decisions and facilitating net zero while maintaining security of supply, and an efficient, coordinated and economical system."

The FSO will need to move the Government forward from the belief that the market alone can deliver NZ. The grid is physics and requires a 'just in time' delivery model of generation meeting demand. The market is skewed between cheap fossil fuels and the Government's incentives to bring forward the cheapest kWhs, regardless of when or where they're generated or where they're consumed. There must be a move away from Levelised Cost Of Energy (LCOE) to 'enhanced' LCOE that takes into account the systems benefits of technologies rather than headline figures and cheap prices.

If the FSO can be more directive about what they NEED on the grid for a stable secure decarbonised grid and if that can be brought forward through Non-price factors (as per the recent Government CfE) then we may be able to move towards best solutions rather than market solutions.

The grid operators appreciate PSH because of its scale, speed, flexibility, ability to pump (or put immediate load on the grid) or generate. No new PSH has been brought forward since

1966 as all PSH was state backed and originally developed to balance the nuclear generation overnight, as it couldn't turn down to respond to the reduced demand.

We need the FSO to have the ability to be directive and use the Future Energy Scenarios to determine what we need to achieve a NZ stable grid and then the Government can work towards developing mechanisms to bring forward the appropriate technologies.

Is there enough resource available—across the Electricity System Operator, regulatory bodies, Government, and network companies—to deliver policy, regulatory and industry workstreams at the pace necessary to achieve Government targets? If not, what additional resource is required?

As suggested above, if OFGEM moves towards DSOs and RSPs with the FSO leading this work, that regionally focused workforce will have to be very skilled and well resourced as it will be crucial that they have the ability to pull together regional decarbonisation at a speed that is unprecedented. As suggested in the Ofgem consultation, this will need to bring together the many strands of local stakeholders into a concerted and connected plan. This is where top down, must meet bottom up. The temptation for many is to progress 'top down' which can be more 'concept/ theoretical' however, a faster progression will be to do grass roots up. (see case studies) A patchwork of solutions being pushed forward by communities will shift the political agenda and encourage local authorities to mobilise.

Is Ofgem fit for purpose as a regulator to deliver the increase in electricity supply and grid connection needed? Should Ofgem have a net zero remit?

Ofgem MUST have a NZ remit, we have lost a decade because they have needed to be 'technology agnostic' and give 'lowest cost to consumer' without counting the cost of climate change? Ofgem must have more ability to push the DNOs to digitise and innovate. Digitisation & innovation will be the only thing we can progress due to the massive constraints on the transmission networks. The transmission Networks have the Holistic Network Design and ASTI, but that's going to take at least 10 years. In the meantime we have the option of:

- waiting for the transmission constraints to be lifted after reinforcements;
- or, working at distribution, local/ rural and creating smart local energy systems that are digital and can work within any transmission constraints
- we need more visibility across grid supply points

Could the introduction of competition in parts of the network be used to reduce the cost to consumers in delivering a net-zero power system?

To reach Net Zero, we need certainty, creating new competition may lead to uncertainty. We need the regulator, Ofgem, to have more vision and ability to be directional on innovation and digitisation.

Is the five-year business plan cycle appropriate to achieve the overarching objectives of delivering a net zero grid by 2035 and a net zero economy by 2050? How does

the pricing review process need to evolve to achieve the UK's strategic objectives on decarbonisation?

No, the DNOs work slowly and have many years of institutional inertia embedded within them. They have greatly improved and have some great people who are highly skilled, however, there is always the conflict of systems risk and innovation and also the backstop that Ofgem 'won't let us'. They are naturally cautious (rightly so) but this translates to a 'computer says no' approach without encouragement of entrepreneurial, or problem solving for on the ground issues. Developers have to pay huge fees, pay for upgrades, give bonds etc but this is a one side contract with the DNO creating cost escalation, time slippages without penalty, whereas developers continue to foot the bill (see case study Alt ne Monie)

DNOs must be more flexible, have more resource into innovation and problem solving, have a tripartite relationship with Ofgem, DNOs and developers trying to deliver NZ.

6. Planning, local government and communities

What barriers are there in the planning process? Do the proposed changes to the National Policy Statements on energy infrastructure address these adequately? Can the grid development required be undertaken wholly under the nationally significant infrastructure project planning arrangements in the Planning Act 2008?

Is land availability a constraint? If so, how can the constraint best be addressed?

How can communities be encouraged to accept the infrastructure required to increase capacity? What compensation, if any, might be required?

Having worked with many communities the key is to understand what is important to the community. Currently with the energy crisis and the move to NZ technologies, working with a community to enable the transition to low carbon, affordable energy could be a key enabler within community conversations. If the community feel like they are a partner in the NZ journey, they are more likely to feel empowered and therefore accepting/ interested in the conversation/ project/ delivery.

What potential is there for community energy schemes to contribute to sustainable electrification? How can they be encouraged to develop?

See the case studies in Appendix B.

There is interest, motivation, and substantial skill sets within the communities to deliver community NZ schemes. Community Energy England is a fantastic network (also CES and CEW) there is a wealth of expertise to enable delivery with the right support, information and enabling networks.

Community heat can't be delivered without these community networks, it will be too expensive, resource heavy and take too long.

What role are local authorities playing in delivering the Government's targets to decarbonise the grid by 2035? Should net zero energy plans be mandated at a local level?

Local authorities are at varying stages on their NZ journeys, with some embracing change and others doing nothing more than declaring 'climate emergency' without any follow up plan. This has a big impact on how communities can advance their ambitions. It depends what type of project communities are working towards, but if it is a heat project and requires coordination with planners, highways etc, but the council in not mandated to prioritise, then this becomes a reason why the LA can't spare the resource. Carbon targets must be devolved and LAs must be resourced to enable delivery, otherwise LAs in some areas will become one of the main barriers to deliver NZ. LAs should not be leading the delivery, as many do not have the resource or skills. The Regional System planner (as suggested in the Ofgem consultation), should be the leader of a regional decarbonisation plan, with that sole remit. Most LAs have personnel spread over many functions without the time or skill to dedicate the resource necessary to take on this complex and important challenge.

May 2023

7. Appendix A: Case Study Grid barriers: Allt na Moine Hydro

Summary

- Allt na Moine is a recently completed 2 Megawatt storage hydro scheme, located to the north of Applecross in Wester Ross.
- The final Feed in Tariff scheme to be completed, Allt na Moine has the capacity to generate more than 10,000,000 kilowatt hours of renewable electricity each year – equivalent to the annual consumption of more than 2,500 homes.
- The reservoir allows 150MWhs of storage, meaning the scheme can be responsive to the needs of the grid and local wind farms.
- Due to protracted delays in upgrading the Transmission network between Fort Augustus and Broadford, Allt na Moine is only permitted to export 50 kilowatts of electricity until such time as these works are completed. As things stand, this restriction will apply until the end of 2026 at least.
- The UK urgently needs to get additional renewable electricity on to the grid to address short-term energy security issues and to get back on track to achieve the declared ambition of Net Zero by 2035.
- Storage hydro represents the ideal technology to complement other renewables, most notably onshore and offshore wind.
- The opportunity exists for all parties to achieve a win by enabling Allt na Moine hydro to make use of the considerable 'dynamic headroom' that is understood to exist, but this will requires a shift in approach from the rigid policies and procedures of the past to a much more flexible approach that utilises the latest grid management technology.

Background

Allt na Moine is a 2 megawatt storage hydro scheme, 6 miles north of Applecross. The scheme completed construction in summer 2022 and has now been energised and G99 certified in conjunction with SSEN but is unable to export more than 50 kW due to a grid constraint that was originally due to be removed in 2021 but is now scheduled for late 2026….at the earliest.

Figure 1 – Reservoir with 150MWhs storage

Developments such as Allt na Moine have for many years been actively encouraged by UK and Scottish Governments in the critical drive to reduce carbon emissions. The introduction of Feed in Tariffs by the UK Government in 2010 was specifically intended to stimulate the construction and commissioning of renewable electricity generating schemes such as this. In order to qualify for Feed in Tariffs, applicants required to have full planning consent, a CAR licence from SEPA, and a grid connection offer from the relevant DNO. All three of these items placed demanding obligations on the developer, however in the case of the grid connection offer, the arrangement was very one-sided, with no obligation on the DNO or Transmission counterparts to adhere to quoted timescales or costs, as so clearly demonstrated in the case of Allt na Moine.

The table below details the extent to which the cost of connection and the projected connection dates have moved in the past 5 years. It should be noted that the costs shown in the table do not include any amounts for attributable transmission works (c. £265k) or wider cancellation charges.

Table 2 – Grid connection cost escalation and time slippage

Offer date	Connection costs (Distribution) exc. VAT	Connection date (Distribution)	Connection date transmission
April 2017	£829,806	31 August 2020	31 October 2022
September 2019	£1,455,685	31 December 2020	31 October 2024
March 2022	£2,155,187	15 December 2022	31 December 2025
September 2022 Additional substation costs of c. £336,000	£2,491,177		31 October 2026

Since the original grid connection offer was made to Innogy (now RWE) in April 2017, the overall costs, excluding transmission related payments, have trebled from £830k to £2,491k. And there is no guarantee that the costs will not increase further.

At a time of national and international energy crisis, when plans are being made for power cuts and old coal plants are being readied for use, there has to be a way of bringing the full generating potential of this renewable generation asset on to the national grid. The situation during week commencing 12 December 2022 confirmed the preposterous situation facing Allt na Moine. A prolonged spell of very cold, still weather resulted in power shortages, as neither wind nor solar was able to deliver any meaningful volumes of electricity. During this period, Allt na Moine hydro could have been running at full capacity, taking advantage of the 150 MWh storage capability of the scheme. However, due to the Transmission constraint, lack of active network management or visibility of the scheme for the Transmission operator, Allt na Moine was still constrained to deliver a meagre 50kWs to the Grid.

Figure 2 – intake to penstock from Reservoir

At such times when other sources of renewable generation are subdued, there will be capacity available on the grid to accommodate not just Allt na Moine, but other generators waiting for the Broadford Transmission upgrade.

A Derogation has been in place, covering the Broadford GSP, since 2010. When it was introduced, it was a positive initiative that enabled the early access to the grid for many renewable generators who would otherwise have had to wait for upgrades to the Transmission network. But over time, the same Derogation has become an obstacle to new development. With this Derogation in place, there would appear to have been less onus on completion of the otherwise required upgrades to the Transmission network.

It is evident that the Derogation achieved its original aim of getting more renewable generation on to the grid, but for the reasons stated above it has failed to optimise utilisation of available grid capacity. Because of the related obligation to make constraint payments to generators in circumstances when combined output exceeded physical capacity, it was wholly understandable that the Derogation only allowed for a fixed % of 'overselling', but the circumstances in 2023 are quite different, therefore the challenge is to find a way of getting more generation on to the grid, 365 days of the year, without increasing the financial exposure to constraint payments.

The solution proposed is for future beneficiaries of the Derogation not to be eligible for constraint payments. They will be the first generators to be temporarily excluded from grid access and will receive no compensation in return. For generators with storage assets, such as Allt na Moine Hydro, this will impact the timing of output, but with little or no impact on overall generation.

Each scheme that operates under the G99 regime can be directly managed from the SSEN Control Centre in Perth, as was demonstrated during the G99 witness testing at Allt na Moine on 17 January 2023.

Obstacles to connection

The primary obstacle to Allt na Moine being fully connected to the grid before the Broadford Transmission upgrade works are completed is the Derogation covering the Broadford GSP has been applied by SSEN Transmission. This states that no new connections of more than 50 kW can be added until further Transmission upgrades are completed.

There are two connected schemes in the vicinity currently restricted to 50kW which contracted prior to Allt Na Moine. They will increase their export to 90kW and 100kW

(+90kW total) respectively upon completion of the Transmission reinforcements. Allt Na Moine is next in queue followed by an already connected scheme restricted to 50KW who will increase to 100kW, and a contracted scheme of 137kW.

In summary, the total extent of 'the queue' is less than 2.5 MW.

Figure 3 – Turbine and power house, a low visibility, low impact scheme that will generate for 100+ years (true energy security)

Conclusion

As can be seen from the case study, trying to connect schemes to the grid is an expensive and moving feat, with no guarantees, moving goal posts and no obligation from the Grid operator, to the developer, to deliver on time, with the specified capacity. This scheme has the very real threat of going bankrupt and due to very high business rates, the cheapest option would be to bulldozer the infrastructure, leaving the gird minus a 2MW, storage scheme with flexibility, storage, inertia for what should be 100+ years.

As stated above, much of the issue lies with the inability of the grid operator to build ahead of need, however, there is also an inability to be innovative and work with developers to explore all options, often due to resourcing and finding constraints.

This scheme can be turned on and off within the distribution control room at Perth, however, as this is manual and not automatic, there is a risk that if there is a fault, the person watching the scheme may not be able to turn it off in time, this could be resolved if the process was automated.

8. Appendix B: Case Studies: place based, Net Zero Communities

8.1. Introduction

The net zero future potentially offers many economic and social opportunities. However, if rural communities are to lower their carbon footprint and reap the benefits that Net zero promises, then radical and significant changes will be required at infrastructural and policy levels.

The Rural Net Zero Challenge highlights:

- There is currently no policy support recognising the specific barriers of the Net Zero transition in Rural areas;
- There is a policy gap which exposes Rural areas to the risk of being left behind and locked out of the Net Zero transition;
- The risk to rural areas unable to capitalising on the benefits Net Zero will bring: boosting the rural economy, jobs, skills, lower energy bills and warmer homes.

NB: Rural Broadband is a prime example of delayed policy that impacted and is still impacting on Rural economies. We need proactive policy support to be ahead of the problem.

8.2. Grid Constraints

Grid constraints pose a major barrier to our Net Zero Transition. Transmission constraints flow through to the distribution network, with many projects over 1MW queued and receiving connection dates for 2028, 2030 or even 2035, due to waits for transmission reinforcement.

The Rural Net Zero transition poses a significant challenge to the Distribution Network Operators. The problem arises as the grid was designed for:

- Centralised generation, distributing electricity one way, with rural areas at the 'end of the line', often with the least demand;
- Rural areas often have lower electrical capacity to match their low demand, this does not make allowance for the ***total electrification of heat & transport*** required in the future.

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Rural Grid:

This is the 'end of the line' in many areas and some rural areas have 'weak' grid, meaning it may not have capacity for 'additional loads' to be added.

Reinforcing the entire rural grid to enable and meet the total demand of electrification of heat and transport will be too expensive, take too long and will not be a priority due to low population density of rural areas.

8.3. The Distribution Network Operators:

8.3.1. Reinforcement

When additional load triggers 'reinforcement' of the grid, this means the wires need to be replaced with higher capacity cables and transformers. This process has multiple issues:

- The DNO does not always know when a reinforcement will be 'triggered'
- Grid reinforcements in rural areas are more complex than urban areas as the potential to reinforce and have spare excess capacity is higher than in urban areas where it is likely that any reinforcements will be utilised
- Communities that trigger a reinforcement don't have to pay directly, as the costs are 'socialised' on all our bills, however, there is no guarantee when that reinforcement work may happen.

The historic model has been:

- Constraint ⟶ Reinforcement ⟶ Costs socialised. (for domestic – developers or commercial will pay directly.
- This has driven DNOs to find 'smarter' more efficient, innovative solutions to get better value from the assets they already own.
- Strategic Innovation Fund:- however, not enough resource to bring through innovations at the pace we need and move away from the historic model.

8.3.2. The Distribution Network Operators: The Questions

DNOs are still trying to answer some fairly unanswerable questions in terms of the Rural NZ transition:

1. When and where will the constraints appear as people take up EVs and Heat pumps and when will rural communities trigger reinforcements?
2. What will the peak load be?
3. How will behaviour change, as we electrify heat and transport, and what impact will that have on load on the network?
4. How can the advent of 'smart systems' and 'smart grids' enable an efficient Grid to minimise the cost of reinforcements.
5. How many people will take up low carbon technologies and utilise smart appliances, and when?

8.3.3. The Cost of reinforcement

- The cost of reinforcement may be higher than the total cost of installing new generation and creating new demand to match that generation, e.g. with electrification of heat for an entire village.
- Currently there are no mechanisms to use avoided costs of delivering a NZ solution, over the delivery of reinforcements to give a better "value for money" solution.

- A planned approach will be much more cost effective than ad hoc delivered by reaction to demand.
- Demand side response is going to be key to grid flexibility (As shown in the Future Energy Scenarios) this needs to be planned for in rural areas.

8.4. What are Localised Energy Solutions?

Each localised energy solution will be bespoke to each community, but there will be intrinsic similarities that can form the basis of real world scenarios and the ability to share, learn and create a pool of knowledge. This will provide invaluable evidence the DNOs can utilise for their planning when looking at the future systems scenarios. Examples of localised energy solutions:

- Collective community low carbon heating solutions.
- Rural hydropower generation, matching the winter demand from the electrification of heating homes.
- Solar PV panels with solar thermal capacity combined with smart water cylinder and domestic battery storage providing spring/ summer domestic hot water.
- Active network management and Smart Local Energy Systems balancing the grid at a local level to allow Electric Vehicle charging points.
- Community, containerised battery, backup solutions.
- EV car shares.

8.5. What are 'Smart' systems?

Smart Grid systems provide real time, data sharing, monitoring and optimizing capability for electricity generation and consumption, bringing benefits for both providers and consumers enabling the matching of generation to demand and demand to generation.

8.6. Active Network Management, Demand Side Response & Flexibility

Active network management is a control system that manages generation and load / demand for specific purposes.

Demand Side Management is where consumers reduce the energy they are using, to match the energy that is available from the Grid at that time.

The main pinch point for demand is during the winter months between 4-7pm, when people get home from work/school and want to heat and light in their homes, start cooking and possibly want to plug in their EV. However, these demand profiles may change in the future. Working from home has seen a change in demand profiles and also anomalous weather patterns may excerpt a bigger influence on demand and generation profiles.

Flexibility is where the DNO or National Grid will pay for people to generate energy or reduce or increase their demand, according to the needs of balancing the grid at that time.

All these systems are going to be crucial if we are to achieve a net zero grid powered by intermittent renewables. This is important at all levels of the grid, Transmission, Distribution and down to domestic.

8.7. How do we deliver Localised Energy Solutions?

Policy and funding for Rural Net Zero transition **Pilot Rural communities**:

a) What will a Net Zero solution look like in the pilot community?

b) What impact will NZ have on the grid?

c) How much will the reinforcements cost?

d) How much will localised energy solutions cost?

e) What are the avoided costs and how can they be mobilised for d rather than c?

The Aspiration is to manage:

- local energy consumption needs met through new small scale local generation,
- storage and Smart local energy systems,
- circumvents the need for costly reinforcement, that may be triggered by the increased load of electrification of Heat and Transport.

These real-world examples can be used for templates for the DNO to transpose to other communities.

8.8. The Local Electricity Bill

- **Local Electricity Bill** – a local supply model will create a sustainable business model for new distribution generation that will support decarbonisation in rural areas.
- The Bill would enable small-scale generators to sell the electricity they generate to local households and businesses, getting a fair and guaranteed price for their electricity and offering consumers discounted electricity.
- This allows the sector to grow and thrive, communities will reap substantial benefits by keeping revenue within local economies and creating new skilled, local jobs.
- localised solutions mean reductions in expensive grid reinforcements and increased community resilience
- Encourage more community owned renewable energy generation with the local economic benefits realised through the lifetime of the project
- Supporting rural businesses as energy price crisis causes overheads to soar.

8.9. Community Action

- Collective action will be cheaper, faster and more effective.
- We need localised energy solutions.
- Community action leads to collaboration, networks and knowledge transfer.
- A just and equitable Net Zero transition, people don't get left behind.
- Keen and informed Community members are trusted messengers within their communities advocating for new, and often little understood technologies.
- Community Wealth Building via Community Benefit Societies
- Community action needs support for community energy planning, seed and development – cheaper than total grid reinforcements.

8.10. Community centred, localised energy solutions

Community centred, localised energy solutions offer a practical and strategic way forward, giving more certainty to the DNOs, which in turn should offer a more cost-effective solution.

A community working collectively, also gives the DNOs a community liaison point, which allows useful and productive dialogue for both parties. Examples of Collective community low carbon heat solutions being brought forward by Rural communities include:

1. **Barcombe** – transition to individual ASHP and community solar, in a planned and staged way to limit impact on the grid. A study showed the cost of grid reinforcement for an unplanned transition to electric heating is considerably more expensive than working with the community to follow a staged approach. How can those avoided costs be monetised to deliver low carbon solutions. Grant funding
2. **Swaffham Prior** – centralised GHP with bore hole array, with small scale heat insulated heat network delivering water at 75degrees C (funded by RCEF and then LA)
3. **Stithians** –Heat the Streets- clusters of houses with ambient ground loop and shared boreholes. Each home has a small heat pump to raise temperature of water from ~12 degrees C to required radiator temp – ideally 45 Degrees C (ERDF funding)
4. Chipping Community Energy – see 8.11.3 . (RCEF and then moving towards Green Heat Network Fund (GHNF))

Whole, community- led solution, clustered Ground source ambient heat or centralised heat network

A number of other communities are also following suit creating a useful model of community centred small scale local area energy planning that will help inform DNOs and enable them to build up 'real world' examples of community led, NZ transition. There is now

no RCEF or ERDF grants available and the GHNF closes in 2025, shutting off the route for progressing new projects.

The Net Zero Terrace Street: https://youtu.be/gI7xJJgz55A. Is an Urban community solution, creating an affordable, low carbon solution that is standardised, replicable and scalable. These solutions will be key to smart local energy solutions with new generation also required to ensure affordability and the ability to take people out of fuel poverty.

8.11. Local supply models

8.11.1. Local electricity Bill

The Local Electricity Bill has been a campaign to include clauses in The Energy Bill to make allowances for the delivery of local energy supply models which will help create a sustainable business model for new distributed generation of electricity to be sold to local consumers.

The Enabling small-scale generators to sell the electricity they generate to local households and businesses, getting a fair and guaranteed price for their electricity and offering consumers discounted electricity will allow the proliferation of new community owned energy assets, which will allow the sector to grow and thrive. Communities will reap substantial benefits by keeping revenue within local economies and creating new skilled, local jobs.

Localised solutions could mean reductions in expensive grid reinforcements and increased community resilience, encouraging more community owned renewable energy generation, local economic benefits realised through the lifetime of the project.

8.11.2. Energy Local model at Ynni Ogwen: Community energy solutions

The 100kW hydro scheme generates 450MWhs pa was developed and is owned by Ynni Ogwen Cyf a locally owned community benefit company, operated for the environmental and social benefit of Dyffryn Ogwen. Any surplus income generated is transferred to a community fund, which is set up to fund other environmental and community projects within Dyffryn Ogwen. The Community owned Hydro scheme is clearly an asset the community are rightly proud of and is a great tool for educating about energy, climate change and energy efficiency. The scheme hosts regular school trips and other tours.

'Energy Local' is a community project that works with Ynni Ogwen Cyf, where the community benefit company encourage households to sign up to an 'energy club' which helps them match their electricity use with power from a local hydro plant. This enables savings on their electricity bills while supporting local renewable energy. Ynni Ogwen Cyf offer energy advice to the community, and they are also looking at an affordable, community scale, low carbon heating solution which will include hard to treat buildings and households vulnerable to fuel poverty.

The community group are trusted messengers within their community. This is key, when we're looking at the whole systems transformation which is required for achieving Net Zero

Coanda screen and intake

Powerhouse

8.11.3. Buttermere: Community Hydro

- A 45kW high head hydro scheme generating 225MWh and being led by Melbreak C.I.C
- Rural Community Energy Fund seed and development grant
- Private wire to the hotel
- Requested an EV charge point at the hotel, but Grid is too constrained. The EV charge point can be installed with Active Network Management and when Hydro is operational, the EVCP should be able to operate without constraint.

The Melbreak Valley has 800kW of further Hydro potential, much of which can not be installed due to grid constraints – ***will the cost of adding this new generation, balanced with uptake of electrification of heat, be less than reinforcing/upgrading the Grid?***

The hydro scheme will meet the heating needs of ~27 homes.

Map showing length of penstock (pipe line taking water from the intake to the power house which will be located near the Bridge Hotel

8.11.4. Chipping Community Energy: community scale low carbon heat

CHIPPING
COMMUNITY
ENERGY

Chipping Community Energy have been working to develop a community scale, low carbon energy solutions that can allow residents to move away from fossil fuel heating.

Work to date has included surveying of the heat demand for the village, collation of energy data, engagement and technical studies to consider the following technologies:

- High Temperature Ground Source heat pumps (GSHP)
- Air Source Heat Pump network (ASHP)
- Ambient temperature loop system vs High Temperature loop
- Biomass Boiler network

A second stage of work is currently underway to apply a solution that has been delivered across many social housing portfolios, but not been replicated across private or mixed tenure residential areas.

The system is called a ground (ambient) temperature loop and captures ground source heat from 200m deep bore holes with pipes filled with a water based fluid in localised shared clustered networks. The shared ambient loop will be connected to ground source heat pumps in the individual dwellings, and where appropriate supported by solar generation. The ability to develop these small shared ambient loop offers a more cost effective and efficient heat solution for villages like Chipping, helping to make energy more affordable.

The project has the following primary aims:

- To build understanding of potential low carbon solutions and benefits to the community;
- To engage the community in the project development process to ensure the community is instrumental in shaping the project as it develops;
- To raise the profile of the project to key stakeholders;
- To improve understanding of the energy needs of the varied housing stock in Chipping;
- To develop a heat map for the village;
- To undertake technical surveys and investigations;
- To develop a conceptual energy system design;
- To assess the effectiveness of using lower temperature heating systems to heat homes;
- To forecast the energy costs for the different house types within the village;
- To develop a techno-economic model for the proposed energy system;
- To better understand any constraints for the system;
- To develop a roadmap for delivery, including permits, consenting, commercial arrangements, land agreements and consumer contracting.

The key objective is to find an affordable, inclusive, low carbon heating solution for residents, so no one in the community gets left behind in the Net Zero transition.

See more here: Chipping Community Energy

8.12. Conclusion

'**The Rural Net Zero Challenge'** highlights how the Electrification of Heat and Transport pose a large problem for rural communities.

Currently there is no policy to support Rural local Net Zero solutions

Rural communities are at risk of being 'locked out' of the NZ transition.

The solution:

- Smart localised energy Local solutions
- The Local electricity Bill
- Policy support and funding is needed now:
    - eg, Rural Broadband project – Rural Gigabit voucher with a new Rural Giga Watt scheme
    - provide funding for community scale area energy plans.
    - iCfD for Hydropower to encourage new generation to match increased rural demand for electrification of heat and transport.

The rural transition poses some big unknowns for those invested in the NZ transition and policy and funding support will be needed to gather evidence and provide real world examples of the cost effective and timely solutions available.