POLICY INSIGHTS

A double win

A guide to integrating clean energy with nature restoration

JULY 2025

Created for Innovate UK Net Zero Living programme by Regen

About Net Zero Living

Net Zero Living (NZL) is a programme run by Innovate UK. The programme supports local authorities, their partners and communities in overcoming non-technical systemic barriers to scaling up and adopting net zero solutions. Within the programme are 52 local authorities – the NZL participants – who are at various stages in developing and delivering their local net zero plans.

This policy insight focuses on the overlap between clean energy and environmental policies. As well as summarising why it's important to consider these two areas together and providing an overview of current and ongoing policy developments, this report includes discussions of key environmental challenges and opportunities associated with different clean energy technologies, including examples.

This report was written by Regen, who provides expert support on policy and regulation to the NZL programme. Regen also coordinates a local energy and infrastructure policy working group for NZL participants, recognising the significance of local plans and the planning system for achieving net zero and aiming to support discussions and provide guidance for engaging in this area.

About Regen

Regen provides independent, evidence-led insight and advice in support of our mission to transform the UK's energy system for a net zero future. We focus on analysing the systemic challenges of decarbonising power, heat and transport. We know that a transformation of this scale will require engaging the whole of society in a just transition.

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- **Sophie Whinney**, Regen Associate
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Executive summary

The biodiversity and climate crises are closely linked, and a more joined-up approach to delivering nature restoration and clean energy could improve outcomes for both. Although decarbonising the energy system is crucial for protecting all nature from climate change, the impacts of clean energy infrastructure on local ecosystems still need to be considered. Nature and energy goals can be synergistic rather than competitive, and skills are needed in local authorities to assess opportunities for co-benefits from renewable energy projects, especially in the planning system.

Solutions already exist for benefiting nature through renewable energy infrastructure, but wider awareness and uptake are needed. Solar farms can support much higher levels of biodiversity than surrounding agricultural land if effective habitat management plans are put in place. The overlap between wind resource and peat soils has generated concerns that onshore wind farms will damage these valuable habitats and carbon stores, but new projects are minimising disturbance and working with local partners to deliver peatland restoration. Other energy infrastructure, such as networks and battery storage sites, can enhance nature through biodiversity net gain (BNG), as well as by implementing innovative nature-based solutions.

National policies and strategic energy plans are beginning to promote an approach to the energy transition which integrates nature, but how effective this will be depends on delivery at the local level. By understanding how changing policies and emerging guidance can support multifunctional projects, local authorities can promote clean energy infrastructure which benefits nature both locally and globally, as well as providing other social and economic benefits. This can be applied to local development and energy planning, public renewable developments and decision making in the local planning process.

Who is this report for?

This report is designed to help local authorities gain a high-level understanding of how policies for delivering clean power and nature recovery relate to one another, as well as the environmental challenges and opportunities associated with specific clean energy technologies. The opportunities discussed could be considered in local plans, local authority-led projects, and conversations with developers. This report may be of interest to local authority officers whose roles include planning, net zero, nature recovery, education or economic development. Beyond local authorities, other stakeholders may find this report useful as an overview of the topic.

Contents

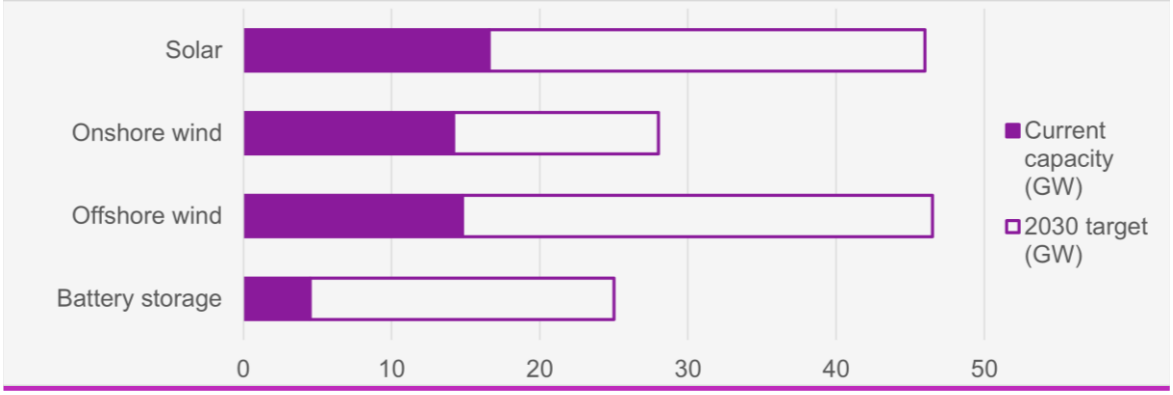
A joined-up approach can improve outcomes for clean energy and nature restoration

In 2022 at the UN Biodiversity Summit, the Kunming-Montreal Global Biodiversity Framework (GBF) established a global agreement to halt and reverse biodiversity loss by 2030. For the UK, this presents a significant challenge; it is currently one of the most nature-depleted countries in the world, with one in six species threatened with extinction.[1] The GBF includes a target to protect and effectively manage 30% of land and sea for nature by 2030 (known as 30by30). In England, only 7.1% of land currently meets these criteria,[2] with 18% in Scotland[3] and 10.6% in Wales.[4] Each nation has developed or is developing specific targets and actions to reduce pollution, restore habitats and increase species abundance.[5]

Climate change presents a significant threat to these goals, with changes to temperature and weather patterns exacerbating existing pressures on ecosystems.[6]

The government has also set big targets for decarbonising the energy system, which is crucial for reducing emissions and mitigating climate change impacts. The UK government and National Energy System Operator (NESO) have planned what infrastructure is needed to achieve a 95% clean energy system by 2030 (Figure 1).

Figure 1: Significant development of clean energy infrastructure is required by 2030[7]



[1] Zoological Society London, 2024. Prioritising Land Use in the Midst of a Climate and Nature Emergency

[2] DEFRA, 2024. 30by30 on land in England: Confirmed criteria and next steps

[3] Nature Scot, 2024. 30 by 30 explained

[4] Wales Environment Link, 2021. Protecting 30% of Wales' land and sea to help ensure nature's recovery

[5] UK Government, 2025. Blueprint for Halting and Reversing Biodiversity Loss: the UK's National Biodiversity Strategy and Action Plan (NBSAP) for 2030

[6] Royal Society, n.d. How does climate change affect biodiversity?

[7] Data sources: DESNZ, 2024. Clean Power 2030 Action Plan. NESO, 2024. Clean Power 2030

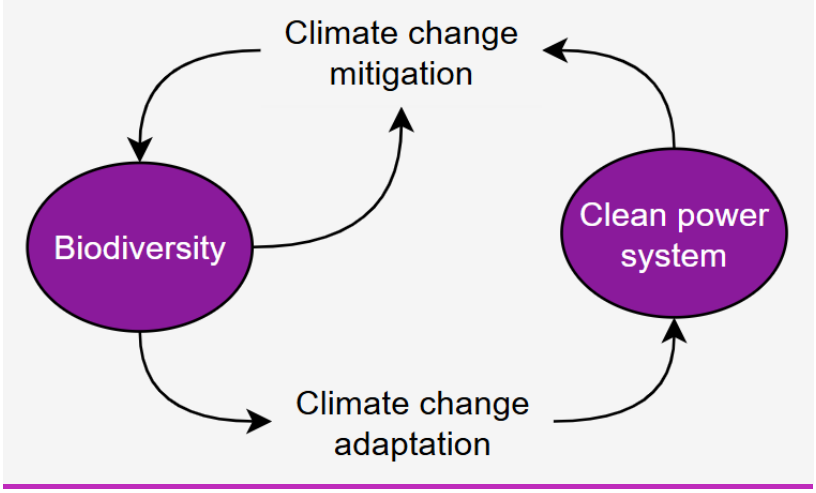
As well as large amounts of new generation and storage assets, new network infrastructure will be needed to transport energy from areas of high renewable generation to meet demand. Although energy infrastructure currently occupies less than 0.2% of land in England,[8] the scale of new development required for the energy transition has prompted concerns that local landscapes will be harmed by the cumulative impacts of new renewable developments. Opportunities exist, however, to develop energy infrastructure which not only minimises negative environmental impacts but actively contributes to local nature restoration.

A more joined-up approach to addressing the climate and biodiversity crises could improve outcomes for both.

Decarbonising the energy system protects nature from climate change, but directly supporting biodiversity through renewable projects can both improve climate mitigation and protect energy infrastructure from unavoidable climate impacts.

Natural assets provide many ecosystem services, and incorporating green infrastructure into renewable projects can provide protection from flooding and extreme weather events, cool equipment to increase efficiency and reduce visual impacts on landscapes. These services can help the energy system adapt to unavoidable climate change impacts over the coming decades.

Figure 2: Mutual benefits for biodiversity and clean power targets



[8] DEFRA, 2025. Land Use Consultation, page 16

By making sure a decarbonised energy system benefits nature locally, better environmental outcomes can be achieved, including for climate mitigation. The integration principle was introduced in the Environment Act 2021 and requires policymakers to look for opportunities to embed environmental protection and/or enhancement across all fields of policy, not just those directly related to the environment.[9] This has been recognised in the government's Clean Power 2030 Action Plan, which states:

> "Our core aim is making sure everyone has a reliable and affordable energy supply, in a way that protects our environment and quality of life."[10]

Other key energy stakeholders are mirroring this ambition:

> "DESNZ and DEFRA should better synthesise environment and energy policy, by setting out shared priorities and identifying opportunities for nature recovery and landscape enhancement from new energy infrastructure." – **RenewableUK, Aldersgate Group and CPRE**[11]

> "The transition to renewables is also an opportunity to promote the restoration of our natural landscapes, working hand in hand to cut emissions while safeguarding our environment." – **RenewableUK Cymru**[12]

This high-level commitment is expected to be achieved through changes to the planning system, requirements for developers such as BNG and NESO's strategic energy system planning. However, significant challenges remain in designing and implementing these levers, especially in ensuring they can be tailored to local contexts without placing unrealistic burdens on local authorities.

Local authorities clearly play a key role in delivering national targets for energy and nature through local planning and decision making. It will be important for local authority officers in planning, or other related teams, to identify links between these policy areas and pursue opportunities for mutual benefits. This could include adopting preferential criteria in local plans to encourage applications from clean energy projects which integrate nature.

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[9] Defra, 2023. Environmental principles policy statement

[10] UK government, 2024. Clean Power 2030 Action Plan: A new era of clean electricity, page 18

[11] Renewable UK, Aldersgate Group and CPRE, 2024. Electric Dreams: How the planning system can help deliver the UK's low-carbon energy, page 6

[12] Renewable UK Cymru, 2024. Onshore Wind and Peatlands in Wales, page 1

Example
Cornwall Council has produced a Climate Emergency Development Plan Document which sets out criteria supporting sustainable development practices. Policy RE1 sets conditions under which renewable energy developments will be supported; for example, if renewables are developed on agricultural land, the site should continue to be used for some form of agricultural activity alongside energy generation and deliver a 10% net gain in biodiversity.

The following section takes a closer look at the policies, plans and regulations being developed across the energy and environmental sectors, including how they relate to one another. A spotlight on planning dives deeper into how existing and proposed reforms could impact energy projects. This is followed by a section on technologies, providing overviews of the environmental opportunities and challenges for different energy projects, along with key statistics, examples and useful resources.

Policies and implementation

The switch to a strategic, integrated approach is being implemented through a range of policies and initiatives.

The policies outlined in this section demonstrate that, after many decades of a market-led incremental approach, the UK is now adopting a more **strategic** approach to energy system planning, land use and environmental mitigation and restoration. These changes aim to improve outcomes for sustainable development and nature, grow the economy and deliver wider social benefits.

With key players such as the UK government, The Crown Estate and NESO taking on more responsibility for deciding what developments are needed where and simplifying environmental mitigation, the local and national processes for planning permissions should become simpler and faster for renewable energy and energy network developers.

As well as being strategic, this new approach has the potential to integrate climate and nature objectives.

The continued rollout of mandatory BNG and commitments to shape energy planning using new Local Nature Recovery Strategies (LNRS) and the Land Use Framework (LUF) show biodiversity and climate targets are being pursued together.

Whether on-the-ground delivery will live up to this high-level commitment depends on cross-sectoral collaboration, aligning devolved approaches and upskilling decision makers. Expert stakeholders interviewed by the UK Energy Research Centre (UKERC)[13] across the energy, environment and public sectors have suggested this will be especially challenging for local authorities due to issues with:

- **Resourcing:** Many local planning authorities (LPAs) are struggling to recruit and retain staff.[14] If these resource gaps are not addressed, LPAs may be unable to process the anticipated higher volumes of clean energy project applications, creating a barrier to delivering CP30.
- **Skill gaps:** Environmental expertise is limited across many LPAs, and guidance and support are needed to enable local authority officers to address energy and environment cohesively, balancing concerns and identifying mutual benefits. Skill and resource gaps could also be addressed by sharing resources across multiple local authorities.
- **Coordination:** Differences in policies between devolved nations and local authorities can create confusion for developers.

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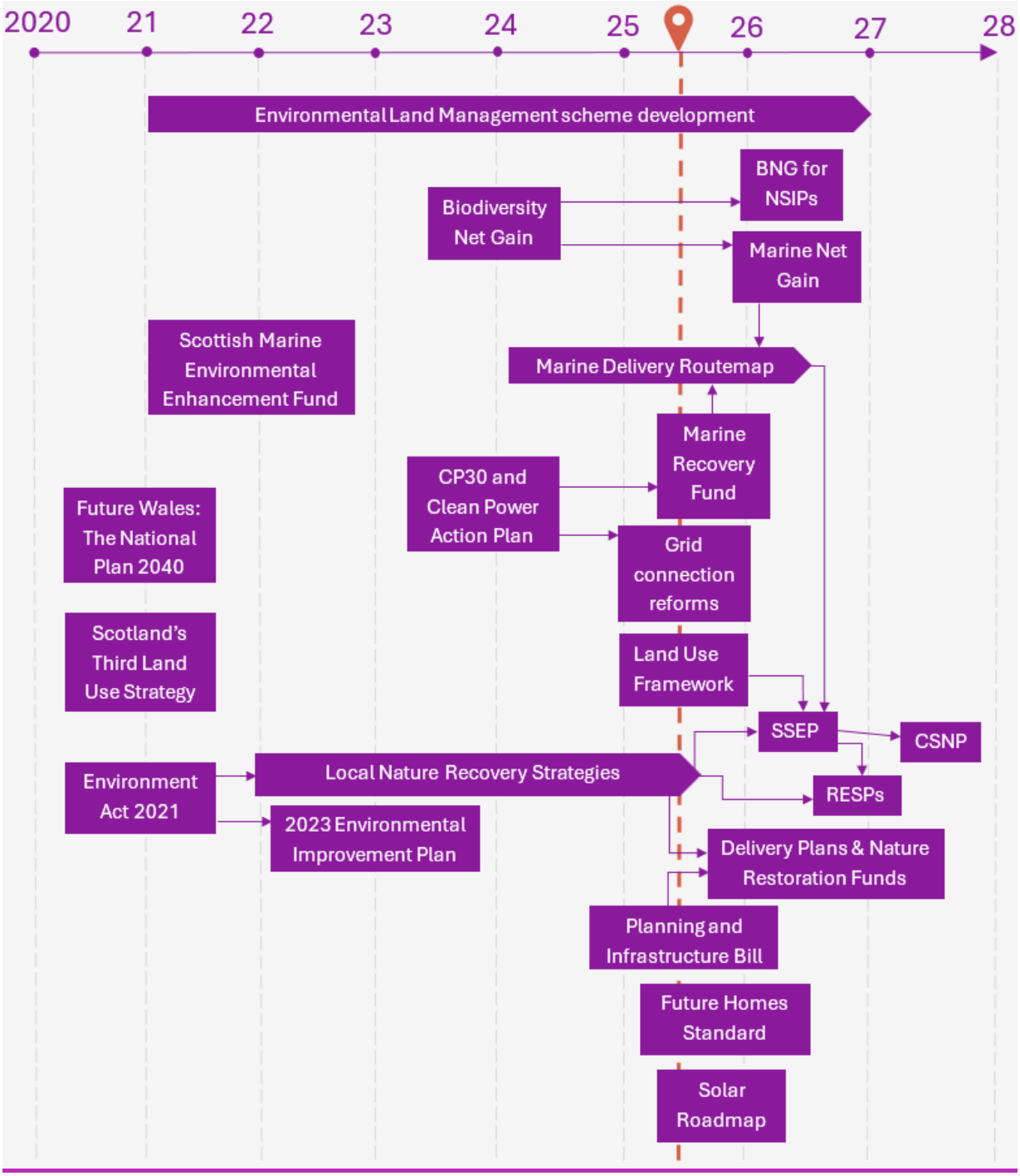
[13] UKERC, 2025. Infrastructure Transformation for Net Zero: Environmental Risks

[14] MHCLG, 2025. Local authority planning capacity and skills survey: 2023 findings

Policy timeline

Figure 3: New policies are enabling a more strategic and integrated approach to delivering clean energy and nature restoration in the UK. More details on the policies shown here are provided in Annexe Table 1.



https://iuk-business-connect.org.uk/programme/net-zero-living/

Key changes in planning are happening at the national and local scales to enable strategic, integrated action for energy and environment.

Local authorities play an important role in implementing national policies through local plans and the planning permissions process. As planning is a devolved issue, policies for England are set out below, and Table 2 provides an overview of similar policies for devolved nations.

Biodiversity Net Gain

Introduced in 2024, BNG requires developments above 25m^2 in England to deliver at least a 10% net increase in biodiversity from the site's baseline condition. Biodiversity is measured using Defra's metric, which calculates habitat values in standardised biodiversity units, and although on-site creation is prioritised, biodiversity units can be produced by developers off site, or purchased from managers of dedicated external sites, sometimes called 'habitat banks'. If managed for biodiversity, renewable energy developments such as solar farms could deliver gains exceeding 10% and tap into this market, selling excess units.[15] Local authorities can create habitat banks and sell biodiversity units, although not all own land suitable to do so.

Successful delivery of BNG can increase public support for projects and is currently the main driver of nature-positive approaches from developers. Evidence suggests, however, that some on-site BNG measures can remain undelivered, with LPAs unable to enforce planning conditions due to their resource and skill gaps.[16] With BNG due to be expanded to Nationally Significant Infrastructure Projects (NSIPs) from May 2026 and plans for Marine Net Gain (MNG) in development, better enforcement will be important for ensuring positive outcomes for nature.

Local Nature Recovery Strategies

LNRS are being developed by responsible authorities: counties and combined authorities working in partnership with nature conservation organisations and local stakeholders. They map opportunities and priorities for delivering nature recovery actions alongside other benefits, such as health and wellbeing and food security, aiming to support a national network of wildlife-rich places. These plans will help align strategic, top-down initiatives, such as the LUF and spatial plans, with local needs, as well as guiding land management, planning and BNG actions.

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[15] UKERC, 2024. Integrated Policymaking is Needed to Deliver Climate and Ecological Benefits from Solar Farms

[16] Chapman et al., 2024. Are housing developers delivering their ecological commitments?

Land Use Framework
This framework will provide guidance to help balance the range of demands on land across England, focusing on opportunities to deliver multiple benefits in the same place. It is expected to be published in 2025 and should help equip planners to embed joined-up approaches in their local context through Spatial Development Strategies, local plans and the planning system.

A land use consultation which will feed into the final framework ran from January to April 2025, and you can read Regen's response here. The consultation suggested the framework will include principles and data to inform decision making at national, regional and local levels. Regen has produced a LUF policy briefing for Innovate UK's Net Zero Living project which provides further details.

Planning and Infrastructure Bill
The Planning and Infrastructure Bill was introduced to parliament in March 2025. Within this, Nature Restoration Funds have been proposed as a framework for conducting strategic mitigation of certain environmental impacts across an area. For impacts better addressed at scale than with project-specific measures, developers would pay a pre-determined sum into that area's Nature Restoration Fund, which would be used by Natural England to fund strategic actions set out in a Delivery Plan. This aims to improve outcomes for nature while making planning applications simpler and faster for developers.

UK government suggests this approach will not negate site-level environmental protection as developers will retain responsibility for delivering BNG and Environmental Outcome Reports (EORs), which will include mitigation for any impacts not included under the area's Delivery Plan. Amendments have been proposed to the bill to strengthen safeguards for existing environmental features, including irreplaceable habitats. EORs are planned to replace Environmental Impact Assessments (EIAs) as simpler reports but with more robust monitoring methods, focusing on outcomes rather than processes.

Spatial Planning in the energy system
NESO is developing a Strategic Spatial Energy Plan (SSEP) to guide the development of clean energy infrastructure across Britain beyond 2030. The SSEP will consider the LUF and LNRS in its Strategic Environmental Assessment (SEA), which, along with the Habitats Regulations Assessment (HRA), will aim to identify and address environmental risks and opportunities throughout plan development, including cumulative impacts and implications of future climate change. These assessments will provide support and guidance for project-level environmental assessments but will not replace them. Once published in 2026, the SSEP will

become part of the planning system framework, giving clarity on where infrastructure is needed. More details can be found in this Regen insight piece.

Strategic planning is also happening on a regional and national level. Regional Energy Strategic Plans (RESPs) will be informed by local government and Distribution Network Operators, with NESO working democratically and transparently to ensure local long-term visions are feasible, effective and align with national targets. They will build on existing plans and processes (such as Local Area Energy Plans, Local Heat and Energy Efficiency Strategies and Distribution Future Energy Scenarios) to model future supply and demand, identify system needs and coordinate local approaches.

Regen has produced a policy insights paper for the Net Zero Living programme, which provides advice and guidance on how to prepare institutionally for some of the changes that may come about as a result of the RESP. In the interim before RESPs become fully operational, transitional RESPs (t-RESPs) will be published by NESO early in 2026. More details can be found here.

Table 1: Planning and environmental policies are devolved and differ between nations. Welsh and Scottish policies address net zero and environmental targets together, providing greater clarity and cohesiveness than in England.[17]

Policy	Scotland	Wales	Northern Ireland
Land Use	**Scotland's Third Land Use Strategy 2021-2026** calls for a holistic, cross-sectoral approach to addressing twin biodiversity and climate crises. Sets out vision for Scottish landscapes which work with nature for economic and social benefits, better connecting people to the land. Emphasis on nature-based solutions (NbS) and carbon sequestration. **Regional Land Use Frameworks** are being developed.	**Future Wales: the national plan 2040**, outcomes include biodiversity, climate resilience, sustainable development and social benefits. Renewable energy seen as key opportunity area, at large and community scales. Plans for resilient ecological networks, green infrastructure and NbS which deliver economic, environmental and social benefits.	No land use framework or strategy, although stakeholders have called for one[18, 19]
BNG	Required by the **National Planning Framework**, adapting Defra's metric for Scotland.	**Net Benefit for Biodiversity** is required for **Developments of National Significance**, no metric in use and no minimum time length for management.	Not required by national policies. Included in some local planning policies and being undertaken voluntarily by some private and public organisations.[20]
Other existing plans	**Scottish Biodiversity Strategy to 2045**, updated with six-year delivery plans, includes environmental farming, fishing and forestry, nature networks, multifunctional NbS and social benefits.	**Nature Recovery Action Plan**, prioritises aligning responses to the climate and biodiversity crises, including through NbS with multiple benefits. **Well-being of Future Generations Act**, requires public	**Strategic Planning Policy Statement**, a plan for sustainable development, informs Local Development Plans. A review

[17] UKERC, 2025. Infrastructure Transformation for Net Zero: Environmental Risks

[18] Food, Farming & Countryside Commission, 2023. A Land Use Framework for Northern Ireland

[19] Northern Ireland Land Matters Taskforce, 2015. Towards a Land Strategy for Northern Ireland

[20] CIEEM, 2024. Biodiversity Net Gain in Ireland

		bodies to work for biodiverse, healthy ecosystems.	of the Renewable and Low Carbon Energy section was consulted on in 2023.
Being developed	The **Natural Environment (Scotland) Bill** was introduced to the Scottish Parliament in February 2025 and will include statutory targets for nature restoration.	A **Securing a Sustainable Futures Bill** is being developed to introduce environmental principles, a new environmental governance body for Wales and statutory biodiversity targets.	A **Nature Recovery Strategy** is being developed.[21]

[21] Defra, Welsh government, Scottish government, Department of the Environment (Northern Ireland) and Joint Nature Conservation Committee, 2025. UK national biodiversity strategy and action plan

Technologies

This section presents environmental aspects of energy projects which local authorities might want to discuss with developers or address through local plans and policies.

Context within the UK energy sector

Some developers are integrating environmental benefits into projects. Many energy projects, including renewable generation, storage and networks, are already seeking to reduce negative environmental impacts and deliver positive outcomes for local environments. In the private sector, this is motivated by a combination of:

- Regulatory requirements, including BNG and EIAs
- Competition with other developers for tenders and leases which are starting to include environmental and social value as assessment criteria
- Corporate environmental, social and governance (ESG) strategies
- Public concerns for the local environment (which can form a risk to gaining planning permission).

While some standards for good environmental practice in the clean energy sector exist, many projects develop their own approaches, often collaborating with local partners to deliver additional benefits for conservation, research, education or recreation.

Community energy projects provide good examples of integrating benefits for nature. Regen's Power of Places report on local energy found that "local initiatives tend to have environmental goals alongside energy", including planting wildflower meadows around solar panels and using energy revenues to fund tree planting. The environmental aspects of these projects can engage people who are less interested in the energy transition, demonstrating that renewables can benefit local places and people in a variety of ways.

Solar

Summary
Despite strong evidence that well-managed solar farms can benefit biodiversity, media headlines continue to criticise the 'industrialisation of the countryside', highlighting the cumulative impacts of large-scale projects and calling for greater prioritisation of rooftop and brownfield solar. Although installing solar panels on rooftops is important, solar farms are cheaper and faster to build at scale and will be crucial for delivering CP30, which includes a target for 45-47 GW of solar by 2030. Guides, standards and even accreditations for best practice in enhancing solar farm biodiversity have been developed, although Solar Energy UK monitoring suggests greater uptake is needed throughout the sector.

Statistics

- Some 88% of people support solar energy, 53% would be happy with solar farms in their local area, 9% are unhappy and 27% have no opinion.[22]
- Objections to solar farms are based on impacts on nature (57%) and views (51%).
- Objection is highest in the East Midlands and East of England, and there are more objections in rural areas than urban areas (17% vs 7%).
- In 2024, surveys of 87 solar sites (out of the 1,400 in the UK) recorded 298 botanical species, 83 invertebrate species, 99 bird species (of which 21% were red-listed birds of conservation concern) and 10 mammal species.[23]
- A 2025 study of birds at six solar farms in East Anglia recorded 830 individuals from 44 species, with 15.9% being red-listed species of concern and 25% amber-listed.[24]
- Almost half of ground-mount solar generation in England is already integrated with agriculture, predominantly through grazing; Defra statistics for England in 2024 recorded 3,683ha of ground-mount solar not integrated with agriculture, and 3,620ha which did integrate grazing or other forms of agricultural production. As of June 2024, solar panels covered 0.08% of English agricultural land.[25]

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[22] DESNZ, 2024. DESNZ Public Attitudes Tracker

[23] Solar Energy UK, 2024. Solar Habitat 2024: Ecological trends on solar farms in the UK

[24] Copping et al., 2025. Solar farm management influences breeding bird responses in an arable-dominated landscape

[25] DEFRA, 2024. Agricultural land use in England at 1 June 2024, accredited official statistics

- A CPRE-sponsored study from UCL[26] calculated 40-50 GW of solar could be produced on non-domestic roofs, new build houses and carparks, and the UK Warehousing Association (UKWA) estimates warehouse roofs alone could provide up to 15GW.[27] A call for evidence that closed in June 2025 considered whether solar canopies should be made mandatory for new car parks above a certain size – a rule already enforced in France. Rooftop solar panels will be a requirement for new homes under the Future Homes Standard, introduced in autumn 2025.

Key points for local authorities to consider:

- How a solar farm affects biodiversity depends on management methods
- Solar farms can be designed to provide recreational benefits for communities
- Solar generation can be combined with agriculture in agrivoltaics systems
- Leasing land for solar generation can provide a stable income for farmers
- Significant generation can be unlocked through rooftop solar, but ground-mount farms can be developed at a larger scale more quickly.

Further details

Management of solar farms is key to biodiversity impact: Studies have found that the way solar farms are managed determines a lot of their impact on biodiversity. A 2025 study measured bird species richness and abundance on solar farms and nearby arable land, with solar management classified as mixed habitat (where cutting or grazing is kept infrequent to encourage higher swards and wildflowers, and hedges or trees are managed along boundaries) or simple habitat (where cutting or grazing is frequent, and no woody features are present).[28] Mean abundance was highest at the mixed habitat solar farms for 34 out of 44 species, with 5.5 highest at simple habitat solar and 4.5 highest at arable sites.

The report suggested that incorporating biodiversity from the start of the solar planning process would help address public concerns about impacts on wildlife and habitats. This could include altering site location or panel layout, submitting an outlined habitat management plan with the planning application and discussing how nature could be enhanced at public engagement events.

Similarly, Solar Energy UK analysed the biodiversity focus of management regimes at solar farms and found that intentional actions for conservation improved outcomes

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[26] UCL and CPRE, 2023. Shout from the rooftops: delivering a common sense solar revolution

[27] UKWA, 2022. Investment case for rooftop solar power in warehousing

[28] Copping et al., 2025. Solar farm management influences breeding bird responses in an arable-dominated landscape

for biodiversity. They also noted that most sites will be required to use woody planting for screening at the planning stage, benefiting biodiversity incidentally.

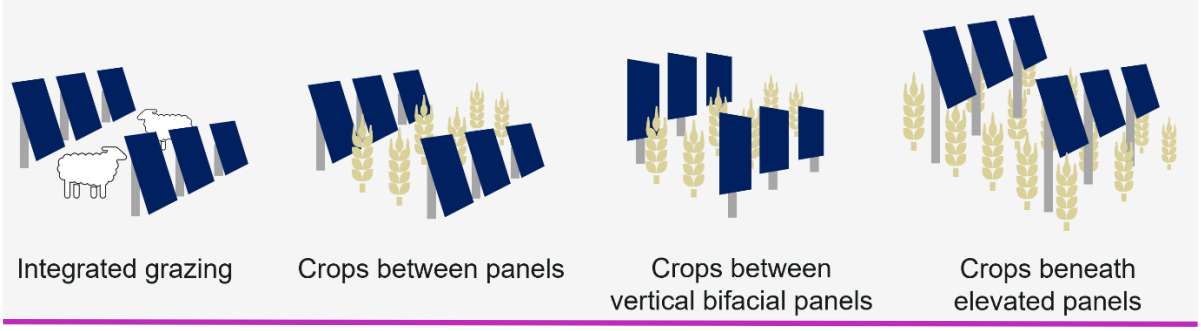
Research from UKERC has emphasised that historic misalignment between climate and nature policies has limited the benefits delivered by solar farms.[29] By recognising the potential for solar farms to contribute to local nature restoration targets and encouraging developers to bring forward habitat management plans at the start of the planning application process, local authorities could help unlock more benefits from projects.

Building in benefits for communities: The Solar Energy UK Natural Capital Best Practice Guidance describes how solar farms can benefit local communities by creating new footpaths, providing educational opportunities for schools and community groups and supporting local conservation priorities.

Wiltshire Wildlife Community Energy partners with Wiltshire Wildlife Trust to create and manage habitats on their solar sites, including grasslands, trees, hedges, ponds and bee hives, improving the land's resilience to climate change as well as its ecological value.[30] Biodiversity can provide an alternative route for people less interested in energy to engage with the transition.

Agrivoltaics should be considered where possible: Due to shared requirements for relatively flat terrain and high levels of sunlight, the most suitable locations for solar farms are often on agricultural land, and loss of food production is a common objection to proposed solar farms.

Figure 4: Examples of different agrivoltaics systems

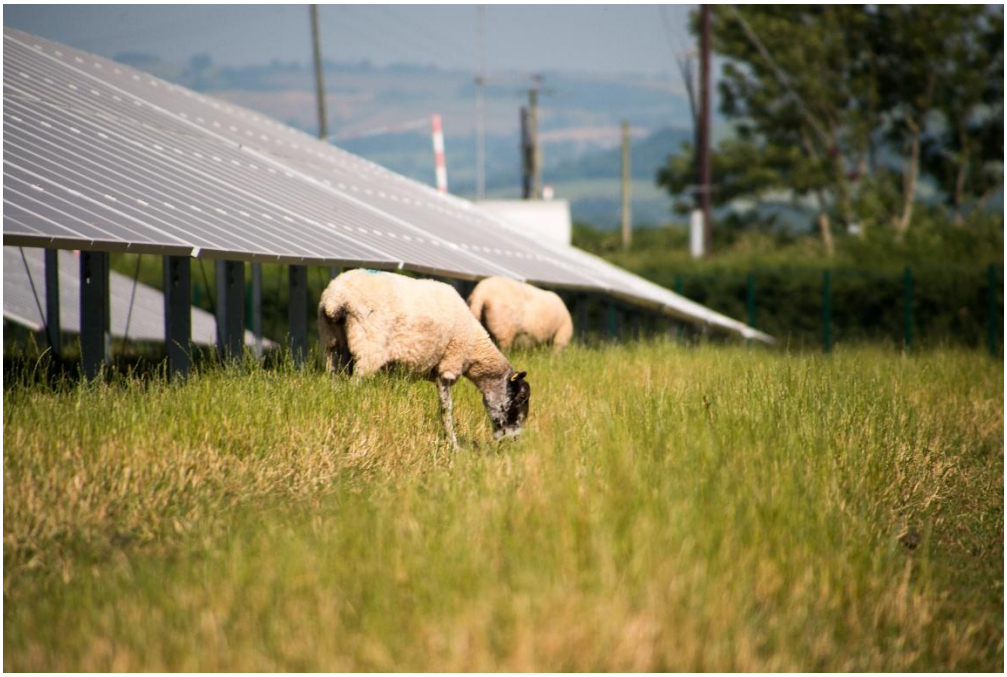


[29] UKERC, 2024. Integrated Policymaking is Needed to Deliver Climate and Ecological Benefits from Solar Farms

[30] Barlow, J., 2024. More than just clean energy – the many benefits of community energy organisations

A 2025 study found that agrivoltaics, the practice of integrating solar generation with food production, could reduce these land use conflicts effectively in GB.[31] Spatial analysis found that the East of England has the greatest potential for agrivoltaics, followed by the South East and South West. In areas where increasingly frequent heat events and unpredictable rainfall are heightening water stresses, agrivoltaics can deliver additional benefits by reducing evaporation from crops, conserving water on farms.

Figure 5: Grazing is the simplest way of combining solar energy with food production. Pic credit: Marley Thatch Solar Farm.



A survey-based study sponsored by Solar Energy UK found that leasing land for solar PV systems can also increase financial stability for farms, providing resilience in years like 2024, where a rainy winter and cold summer led to poor harvests for many. Key barriers to uptake include grid connectivity, planning restrictions and perceptions among some farmers that solar competes with food production, is unreliable and will do little to mitigate climate change.[32]

[31] Neesham-McTiernan et al., 2025. The spatial potential for agrivoltaics to address energy-agriculture land use conflicts in Great Britain

[32] Meeting Place and Solar Energy UK, 2025. Farming Sustainably Report

Agrivoltaics systems have already been well tested in Europe, with new research focusing on how to optimise site designs, rather than feasibility.[33] Recent developments suggest vertical bifacial panels can act as windbreaks for crops while generating power, and German tech firm Next2Sun has developed these into viable commercial projects, including solar fencing.[34] This integrated approach supports multifunctional land use, although could require closer collaboration between solar developers and farmers for delivery at scale.

Useful resources

Guidance for best practice has been produced by Solar Energy UK, the International Union on the Conservation of Nature (IUCN) and Solar Power Europe. Solar Energy UK has also produced guidance for monitoring biodiversity on solar farms and reports annually on ecological trends at participating sites.

[33] Reasoner M. and Gosh A., 2022. Agrivoltaic Engineering and Layout Optimization Approaches in the Transition to Renewable Energy Technologies: A Review

[34] New Scientist, 2025. Farms can install vertical solar panels without reducing crop yields

Onshore wind

Summary

Onshore wind turbines are highly suitable for integration with other land uses, including forestry and agriculture. There is significant overlap, however, between areas identified as suitable for onshore wind by NESO in CP30 and areas of peatlands, mainly in Scotland, Wales and Northern England. Balancing wind developments with peatland restoration targets has been difficult for decision makers, but examples of best practice combining on-site and off-site mitigation and enhancement are being developed, especially in Scotland.

Statistics

- Some 77% of people support onshore wind, 43% would be happy with a wind farm in their local area, 13% would be unhappy and 28% have no opinion.[35]
- Objections are based on impacts on views (64%) and nature (56%), are greatest in East and South East England and are generally higher in rural (20%) than urban areas (12%).
- Government has set a target for 27-29 GW of onshore wind by 2030,[36] mostly in south Scotland (11.1 GW), north Scotland (9 GW), Wales (3.1 GW) and north England (2.4 GW).[37]
- Scotland has 1.5 Mha degraded peat, with a target to restore 250,000ha by 2030; 40,607ha was restored in 2018-24; funding target of £250m by 2030, £67.8m delivered 2020-23.[38]
- England has a target to restore 280,000ha of peat by 2050; 15,000ha was restored 2020-24; funding target of £50m by 2025; £33m delivered 2018-23.
- Wales has a target to restore 45,000ha of peat by 2050; 5,150ha restored 2020-23; funding target of £1m per year until 2025; £6.4m delivered 2018-23.

[35] DESNZ, 2024. DESNZ Public Attitudes Tracker

[36] DESNZ, 2024. Clean Power 2030 Action Plan

[37] NESO, 2024. Clean Power 2030

[38] IUCN, 2024. UK Peatland Strategy Progress Report 2024

Key points for local authorities to consider

- Building wind farms on peatland can release carbon and harm biodiversity, but Scottish policy and sector best practice are leading the way in mitigating impacts and delivering peatland restoration
- Public access and recreation can be delivered on wind sites – Whitelee Wind Farm, the UK's largest onshore wind farm, features more than 130km of multi-use trails and attracts around 200,000 visitors annually, serving as an important recreational space for local communities[39]
- In some areas, strong local opposition to onshore wind remains
- Small-scale onshore wind projects on farms could help decarbonise the agricultural sector[40]
- Shared ownership, where a community group becomes a financial partner in a renewable energy project, is most often delivered through onshore wind.

Further details

Onshore wind enhancing peatland management: Peatlands not only provide valuable habitats for biodiversity, but are also dense carbon stores. Many have been damaged through drainage, forestry and excavation, and restoring them is important for delivering climate action. Onshore wind projects should establish good mitigation and enhancement practices when built on peat to avoid increasing emissions; the UK peatland strategy states "strategic planning is needed to ensure that environmental sectors which are all striving for action in support of net zero and nature targets do not compromise each other".[41]

Scottish policy requires onshore wind farms to deliver conservation, restoration and enhancement of biodiversity, including on peatlands. In Scotland the wind sector has collaborated with environmental agencies to create a guide to good environmental practice, and Scottish Renewables has produced guidance on best practice for benefiting peatlands on wind farm sites. Dunmaglass wind farm in Inverness has an annual commitment to delivering peatland restoration, including through blocking drainage channels and reprofiling exposed soils.[42]

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[39] Regen, 2025. Best Practice in Community Engagement: A guide for renewables and storage developers, page 28

[40] Great South West, 2024. Delivering Future Food Security, pages 27 and 35

[41] IUCN, 2024. UK Peatland Strategy Progress Report 2024, page 24

[42] Scottish government, 2022. Onshore wind: policy statement 2022

Renewable UK Cymru has suggested that contributions from onshore wind projects could provide an important alternative funding stream for peatland restoration.[43] In Wales, EDF project Garn Fach wind farm in Powys has been approved following concerns over peat impacts. The peat management plan submitted as part of the proposal included measures to store and reincorporate all excavated peat on-site, maintain water levels, avoid disturbing areas of deep peat and use floating tracks to access areas where peat depth exceeds 0.5m, as well as outlining a Habitat Management Plan (HMP) for the project.

Vattenfall's Pen y Cymoedd wind farm has 76 turbines with a total capacity of 228 MW, making it the current largest wind farm in England and Wales. A 25-year £3m HMP is delivering peatland restoration across 1,500ha, implemented by Natural Resources Wales, local authority ecologists and the RSPB as part of the wider Lost Peatlands of Wales project, which includes volunteering and other engagement opportunities for local communities.

Figure 4: Vattenfall's Pen y Cymoedd wind farm is delivering peat restoration[44]

Useful resources

Best practice guidance for enhancing biodiversity at wind farms has been produced by the IUCN, Nature Scot and Scottish Renewables. The Scottish Renewables guide focuses on peatland habitats and is particularly accessible, with case study examples.

[43] RenewableUK Cymru, 2024. Onshore Wind and Peatland in Wales

[44] Vattenfall, 2024. Restoring peatland: From carbon leak to biodiverse carbon sink

Battery storage

Summary

Limited information is available on the environmental challenges and opportunities of battery energy storage sites (BESS). They have relatively small physical footprints but cannot be integrated with agriculture or biodiversity enhancements in the same way as solar and wind developments. BNG can be at least partially delivered on-site using hedgerows, trees and managed grassland. Some projects are incorporating areas for public amenity adjacent to battery sites. BESS are not included in the NSIP regime and sustainability standards focus on supply chains, including the upstream and downstream impacts of rare mineral extraction, processing, recycling and disposal.

Statistics

- The Clean Power 2030 Action Plan set a target for 23-27 GW of battery storage, mostly in North England (9.3 GW), South Scotland (4.7 GW) and South East England (3.8 GW).

Key points for local authorities to consider

- Battery storage projects have relatively small physical footprints and can deliver BNG at least partially on-site, although if off-site BNG is required, it may increase land requirements
- Most environmental impacts associated with batteries are in the supply chain or disposal stages, not operation
- Concerns around fire risks continue to drive public opposition.

Case study

Biodiversity net gain: Thorpe Marsh battery energy storage system (BESS) was granted planning permission on 28 January 2025 and will provide 1,450 MW of storage (3,100 MWh) on 55 acres of land which was part of a former coal power station site.[45] The ecological assessment found that, with on-site enhancement of trees, hedgerows and grasslands, the development would still generate an 18.77% net loss of biodiversity. To compensate this, Fidra (the developer) will create new pond, woodland and grassland habitats, as well as enhancing existing scrub and wetlands, on land adjacent to the BESS site. These measures will create an overall

[45] Rocket Environmental Services, 2025. Thorpe Marsh Green Energy Hub

18.62% net gain in biodiversity for the project, which Fidra will aspire to achieve while legally committing to deliver a 15% increase.

Figure 5: Landscape strategy plan for Thorpe Marsh BESS site[46]

Useful links

The 2024 Strategic Research & Innovation Agenda published by Batt4EU sets out current trends in battery innovation with a focus on improving the use of critical raw materials, recycling and whole lifecycle sustainability. It aims to reduce reliance on foreign critical raw materials by supporting local and circular supply chains and researching alternative battery chemicals.

[46] City of Doncaster Council planning application 23/00537/FULM

Alternative storage (Long Duration Energy Storage)

Summary
The Clean Power 2030 Action Plan states that Long Duration Energy Storage (LDES) needed to meet government targets will include pumped hydropower and other technologies such as liquid air energy storage. Pumped hydropower developments often raise environmental concerns and there are limited examples of projects incorporating BNG since its recent introduction. Newer technologies, such as liquid air, could have low physical footprints but would likely be unsuitable for integration with other uses, necessitating off-site BNG delivery.

Statistics

- The Clean Power 2030 Action Plan set a target for 4-6 GW of Long Duration Energy Storage (LDES). Current capacity is 2.9 GW.

Key points for local authorities to consider

- Pumped hydropower projects can have significant impacts on freshwater ecosystems, but biodiversity net gain measures are enhancing terrestrial habitats and improving routes for public recreation.

Further details

Guidance on environmental impacts of pumped hydropower: The DESNZ National Policy Statement for Renewable Energy Infrastructure provides guidance on potential environmental impacts, mitigation and enhancements associated with pumped hydro storage. They suggest that, in addition to mitigation, "applicants should have consideration for the potential benefits to local biodiversity, including through habitat creation and/or enhancement, fish re-stocking, and bankside planting. Further, some turbines may assist in increasing dissolved oxygen levels."[47]

Benefits for recreation may also be incorporated: "Schemes should be designed to minimise impacts on existing recreational activities, and consideration should be given to how schemes can be designed in such a way that enhances such recreational activities."

[47] Dissolved oxygen levels can be reduced by pollution or heating events in freshwater habitats, which threatens aquatic life.

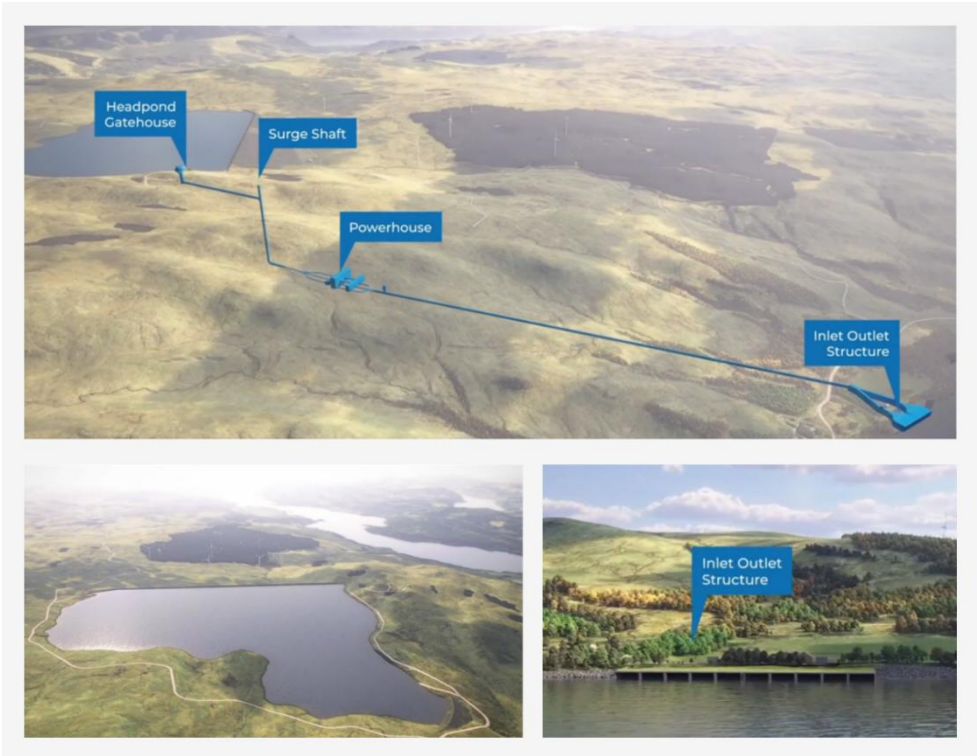
Case study: The Balliemeanoch pump storage hydro scheme is a 1,500 MW, 45,000 MWh project which submitted a planning application to the Scottish government energy consents unit on 4 July 2024.

Proposed environmental mitigation includes an agreement not to abstract water from or release water into Loch Awe during times of extreme low or high water levels, and a commitment to ensure water level fluctuations driven by the project remain within the natural historic range.

Alongside plans to mitigate environmental impacts, the Landscape and Ecology Management Plan (LEMP) outlines proposed enhancement actions such as heathland and grassland planting, native woodland planting and blanket bog restoration on and near the site.

Impacts still deemed significant after these actions include the potential barrier to migration for fish species caused by fluctuating water levels, and the loss of Gold Eagle habitat, which it is hoped the LEMP will recover in time.

Figure 6: 3D visualisation of proposed Balliemeanoch pumped storage hydro site showing the head pond located above Loch Awe[48]



[48] ILI Group, n.d. 3D Visualisation

Useful links

The International Hydropower Association has developed Hydropower Sustainability Guidelines which address environmental impacts, mitigation and compensation for projects including pumped storage, as well as suggesting how additional social and environmental benefits can be delivered. EIA documents for the Balliemeanoch project can be found here, with the non-technical summary providing a good overview.

Bioenergy

Summary
While CP30 didn't set specific targets for bioenergy, DESNZ and the Committee for Climate Change (CCC) see it playing an important role in meeting net zero, especially through carbon negative BECCS (Bioenergy with Carbon Capture and Storage). The UK already uses biomass combustion for power and some biofuel for transport and gas networks, and future development plans focus on increasing domestic cultivation of bioenergy crops and utilising more municipal and agricultural waste as feedstocks. Longer-term visions include using biomass-derived products to replace wider fossil fuel uses, including in the chemical and manufacturing sectors.

If bioenergy crops are managed in line with the transition to more sustainable agricultural practices, they could help diversify landscapes and enhance biodiversity. Land availability, however, will limit the UK's capacity to produce domestic feedstocks, making it important to prioritise biomass uses for hard-to-decarbonise sectors and ensure any imports are not driving environmental impacts abroad.

Statistics

- Some 70% of people support bioenergy, fewer than for other renewable technologies, with people concerned it could deter other actions to mitigate climate change, increase land use conflicts and drive deforestation[49]
- Bioenergy is included in 'low-carbon dispatchable' generation in CP30, which has an overall current capacity of 4.3 GW and a target of 2-7 GW for 2030
- 66% of biomass used for UK energy generation is sourced domestically and 1 Mt of a total 3-4 Mt of UK agricultural residues are used in the bioenergy sector[50]
- In 2023 133,000ha of bioenergy crops were grown in the UK, representing 2.2% of arable land; 36% of this land was used to produce biofuel for transport and the remainder used for heat and power.[51]

[49] DESNZ, 2024. DESNZ Public Attitudes Tracker

[50] DESNZ, 2023. Biomass Strategy

[51] DEFRA, 2024. Bioenergy Crops in England and the UK: 2008-2023

- The CCC's Seventh Carbon Budget includes 700,000ha of energy crops by 2050, covering almost 3% of the UK's land area with miscanthus, short-rotation coppice and short-rotation forestry.[52] It also sets targets for domestic bioenergy supply to increase from 60% in 2025 to 85% by 2040, with net imports reduced to close to zero by 2050.

Key points for local authorities to consider

- Bioenergy crops can be cultivated in ways which support biodiversity
- Bioenergy crop cultivation is limited by land availability, so uses will need to be prioritised. Producing biomethane from food and agricultural wastes can help reduce this issue.
- Imported biomass can drive environmental impacts abroad and, despite Ofgem's biomass sustainability criteria, there are past examples of misreporting from bioenergy generators.

Further details

Growing bioenergy crops could increase biodiversity: A study of bioenergy crops cultivated on farms, typically at scales below 10ha, found they could increase landscape heterogeneity, reduce management pressure and provide features similar to natural ecosystems.[53] Switching arable crops or grassland to bioenergy crops increased biodiversity by 75% (± 13%), with gains measured across bird abundance (81% ± 32%), bird species richness (100% ± 31%), arthropod abundance (52% ± 36%), microbial biomass (77% ± 24%) and plant species richness (25% ± 22%).

The perennial nature of common energy crops, including miscanthus and willow, means they don't need to be replanted each year, which can reduce soil disturbance, protecting stored carbon and subterraneous organisms. The study emphasised that management methods will determine the environmental outcomes of bioenergy crops, and large-scale monocultures would likely have fewer benefits for biodiversity. Cultivation could be aligned with actions in the Environmental Land Management (ELM) scheme and LUF to benefit nature and resilience.

Combining bioenergy with peat restoration: The IUCN suggested in the UK Peatland Strategy that paludiculture – the practice of farming on peat soils while maintaining a high water table, also known as 'wet agriculture' – could be used to

[52] CCC, 2025. The Seventh Carbon Budget

[53] Donnison et al., 2021. Land-use change from food to energy: meta-analysis unravels effects of bioenergy on biodiversity and cultural ecosystem services

cultivate bioenergy crops such as willow, reeds and bulrushes while restoring lowland peatlands previously degraded through more conventional agriculture.

Case study: Lapwing Energy is testing this model on its estate in a DESNZ-funded project called Reverse Coal. Historically, drained peatlands have been re-wetted and planted with short-rotation coppiced willow, meaning the fast-growing trees are cut back to ground level every three years to promote new growth. This practice improves water quality, restores wetland habitats and improves flood and drought resilience across the wider catchment, as well as turning the land back into a carbon sink.

The harvested wood undergoes high-temperature pyrolysis, meaning it is combusted without oxygen, to avoid producing carbon dioxide. This produces heat and electricity, which power 'controlled environment agriculture' in greenhouses on-site, with excess electricity exported to the grid. The biochar produced through pyrolysis is buried on-site to store remaining carbon, although other potential uses include field application as a fertiliser or a replacement for coal in industry. By combining this process with on-farm solar and wind generation, the Lapwing Estate has reduced its operational emissions. The organisation is investigating revenue streams to commercialise the project, including BNG, ELMs and sale of biochar for industrial or agricultural use.

A key challenge is space: The CCC target for 700,000ha of bioenergy crops in 2050 would constitute 11.7% of the UK's arable land, with a significant impact on domestic food production. DESNZ stated in its 2023 Biomass Strategy that domestic biomass cultivation will be considered alongside commitments to maintain food production and meet environmental targets, but the lack of specific bioenergy targets in NESO and government plans means it remains unclear how this will be achieved.

An expert stakeholder workshop in 2023 concluded that, while bioenergy could deliver benefits for the environment, agriculture and industry, clearer policies and greater collaboration are needed. The Clean Power 2030 Action Plan also noted that a lack of suitable storage areas for carbon dioxide may limit deployment of BECCS.

Useful links

The DESNZ biomass strategy outlines the anticipated role of biomass in achieving net zero, including areas of opportunity and challenge, and Defra statistics on UK bioenergy use provide a good outline of the current context. This report summarising outcomes from an expert stakeholder workshop gives an accessible overview of key sector challenges, including finance models and public acceptance, and some guidance on sustainability criteria is provided by Ofgem and the Forestry Commission.

Offshore wind

Summary
Environmental impacts from fixed and floating offshore wind are being addressed by developers, researchers and The Crown Estate. While impacts during construction are generally negative, a net positive outcome can be achieved during operation. Nature-inclusive design features are being tested to increase marine biodiversity at wind farm sites, integration with aquaculture and fishing is being trialled and a strategic marine enhancement fund is already operational in Scotland, with one planned for the rest of Britain soon. Discussions on whether and how Marine Net Gain should be introduced for marine developments are ongoing.

Statistics

- Some 83% of people support offshore wind[54]
- UKERC research surveyed offshore wind farm stakeholders and found 59% agreed MNG should be mandatory for all future offshore wind developments
- The clean power 2030 Action Plan target is for 43-50 GW of offshore wind, most in north England (15.6 GW), east England (15.2 GW) and north Scotland (7.6 GW).[55]

Key points for local authorities to consider

- The Crown Estate is incentivising projects to deliver nature enhancement through lease requirements, as well as supporting environmental research
- MNG may be introduced for marine developments, alongside initiatives to pool funding from developers for larger-scale strategic restoration.
- Nature inclusive designs of offshore wind farms can support species to colonise infrastructure, increasing marine biodiversity but also creating a decommissioning dilemma – should colonised infrastructure be removed at its end of life, or left in place to continue supporting marine life?
- Mitigation is being developed to reduce impacts from construction and operation, including noise and pollution
- As more offshore infrastructure is built, there are uncertainties surrounding how cumulative impacts will affect broader marine ecosystems, either negatively or positively.

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[54] DESNZ, 2024. DESNZ Public Attitudes Tracker

[55] DESNZ, 2024. Clean Power 2030 Action Plan

Further details

The Crown Estate: As the organisation which manages the seabed around England and Wales, The Crown Estate is responsible for creating and awarding leases which determine where successful developers can build offshore wind projects. In the most recent leasing round (the Round 5 offshore wind tender), it incorporated nature enhancement categories, incentivising developers bidding for a lease to include biodiversity improvements in their project's design. It is also developing a Marine Delivery Routemap which aims to catalyse net zero energy goals, promote nature recovery for a thriving marine environment and optimise value for the economy and communities.

Nature-inclusive design: UK organisations are developing new products to support marine life at offshore wind farms, such as Reef Cubes, which can be used for both scour protection (which shields turbine foundations and cables from erosion) and habitat provision.

The Rich North Sea project brings together offshore wind developers and scientific experts to enhance biodiversity at project sites and monitor ongoing impacts, restoring ecosystems damaged by activities such as trawling. Examples of outputs include artificial reef installations at the Borssele offshore wind farm and oyster cages installed at the Blauwind offshore wind farm, both in the Netherlands. Learning from all projects is collated in the Rich North Sea Toolbox digital learning hub to inform good practice in the sector.

Marine Net Gain and strategic funding: MNG was consulted on in 2022 and a government response published in December 2023, with next steps to develop this policy expected in 2025. The Marine Recovery Fund, which is also expected in 2025, will allow developers to pay compensation for impacts on Marine Protected Areas (MPAs).[56] Similarly to the Nature Restoration Funds proposed in the Planning and Infrastructure Bill, this strategic approach aims to deliver larger-scale and more coherent nature recovery projects while simplifying the development process.

In a UKERC study, offshore wind stakeholders agreed that pooling funding through an industry levy to deliver strategic national projects could have a greater impact for environmental recovery, but also cautioned that it shouldn't exclude site-level measures. The Scottish Marine Environmental Enhancement Fund avoids this by requiring developers to demonstrate they are taking measures to reduce their own carbon emissions and environmental impacts before allowing them to donate.

[56] Freeths, 2024. Legal Framework and Emerging Policy for Development in the UK Marine Environment: End of year update

Mitigating construction noise: The construction of offshore wind farms, especially the installation of turbine foundations through pile driving, can generate significant levels of marine noise. This can obscure natural sound, which is an important cue for many species in the marine environment, helping them navigate, communicate, find food, avoid predators and locate mates.[57] The National Policy Statement for Renewable Energy Infrastructure requires offshore wind developers to follow noise mitigation guidelines from the Joint Nature Conservation Committee, which includes monitoring an area to check for marine mammals before beginning a noisy activity, and using acoustic deterrent devices to exclude animals from an area prior to starting the activity.

Some developers are pursuing more innovative solutions: RWE has worked with Hydrotechnik Offshore to deploy a 'bubble curtain' at the Sofia Offshore Wind Farm.[58] This is created by pumping compressed air through a perforated hose on the seabed around the area where a turbine foundation is being installed. The bubbles reduce the spread of noise underwater, reducing impacts on the marine environment.

Figure 7: A bubble curtain reduces marine noise around a turbine foundation under construction at RWE's Sofia Offshore Wind Farm[59]

[57] Defra, 2025. Reducing marine noise

[58] RWE, 2025. RWE's Sofia Offshore Wind Farm deploys innovative underwater bubble curtain to protect marine life

[59] RWE, 2025. RWE's Sofia Offshore Wind Farm deploys innovative underwater bubble curtain to protect marine life

Corrosion protection pollution: A 2025 study used available data to estimate pollution of trace elements such as aluminium, zinc and indium from offshore wind turbine corrosion protection systems.[60] Galvanic anode cathodic protection was found to release zinc and aluminium, which could be accumulated by seaweeds or shellfish cultivated close to turbines in newly developing co-located aquaculture systems. Estimates suggested this could cause health risks for humans consuming contaminated produce. The report proposed that the emerging alternative impressed current cathodic protection be used for all new developments and retrofitted to existing turbines to reduce pollution risks. More robust monitoring of these elements could be incorporated into the Environmental Impact Assessments (EIAs) conducted by The Crown Estate for future leasing areas.

Broader ecosystem impacts: Less is understood about how the cumulative impacts of rapidly expanding offshore wind infrastructure will affect wider marine ecosystems. These structures can alter hydrodynamics, including surface wave energy, upwelling and levels of mixing, which play an important role in determining the availability of nutrients in the euphotic layer, and could have significant implications for the distribution of primary and secondary production.[61]

A 2025 study has suggested that offshore infrastructure could act as 'stepping stones' within areas of marine connectivity.[62] James et al. found that ocean winds and currents create paths of connectivity in the North Sea, meaning larvae and particles dispersed from existing habitats often colonise infrastructure located downstream in the connected area. By leaving turbine foundations in-situ following decommissioning, and strategically siting new offshore wind farms in similarly 'connected' areas, these structures could support complex and biodiverse ecosystems, especially if combined with nature-inclusive designs like the Reef Cubes mentioned previously.

Useful links

The Rich North Sea toolbox provides useful case studies and practical information for developers looking to incorporate nature enhancement. Blue Marine Foundation has produced a report on opportunities for nature recovery within UK offshore wind farms and the IUCN has developed standards for enhancing biodiversity in offshore wind farms.

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[60] Watson et al., 2025. Offshore wind energy: assessing trace element inputs and the risks of co-location of aquaculture

[61] Trifonova et al., 2025. Fishing, offshore wind energy, climate change and marine spatial planning: Is it possible to plan for a best use of space?

[62] James et al., 2025. The 'everything is everywhere' framework: Holistic network analysis as a marine spatial management tool

Tidal & wave

Summary

The Clean Power 2030 Action Plan did not set targets for tidal and wave energy generation but suggested they could become more important for the energy system beyond 2030 as costs are reduced. Although these technologies are less mature than other renewables, Scotland is well positioned to take a global lead in marine energy, with 10 MW of commercial tidal stream projects already operational and more in development which have secured Contracts for Difference (a government funding mechanism for renewables). Significant research gaps remain surrounding the environmental impacts of these technologies, but studies to date suggest they are not significantly detrimental to marine life.

Tidal range projects, particularly barrages, are well known to have controversial environmental impacts, driving significant hydrological changes which can affect species differently. Guidance is needed to support the development of tidal lagoon projects and suggest solutions for integrating BNG into new developments.

Statistics

- Some 83% of people support wave and tidal energy[63]
- There is already 10 MW of tidal energy installed in the UK
- A government debate in January 2025 voiced strong support for marine energy, with suggested targets of 1 GW tidal stream and 300 MW wave generation by 2035[64]
- Scotland could deliver 8.8 GW of marine energy by 2050, with capacity rising to 12.6 GW for the whole UK and 300 GW globally[65]

[63] DESNZ, 2024. DESNZ Public Attitudes Tracker

[64] UK Parliament, 2025. Debate on government support for the marine renewables industry

[65] The University of Edinburgh, 2025. Future Economic Potential of Tidal Stream & Wave Energy in Scotland

- In the AR6 Contracts for Difference auction, six tidal stream projects across five sites secured contracts to deliver a total of 28 MW at £172/MWh: HydroWing (10 MW, Wales), MeyGen (9 MW, Scotland), Seastar (4 MW, Scotland), Magallanes (3 MW, Scotland) and Ocean Star Tidal (2 MW, Scotland). The UK is on track to deliver 130 MW of tidal stream energy by 2029.[66]

Key points for local authorities to consider

- There is a need for further research on environmental impacts and benefits as technologies develop, especially cumulative impacts
- Environmental monitoring from test projects can be shared to support wider conservation efforts
- Tidal range projects have significant environmental impacts, but tidal lagoon projects are developing mitigation and measures to enhance catchment areas.

Further details

Existing research on marine energy impacts: Potential negative environmental impacts from tidal stream and wave energy projects include collision risk, underwater noise, electromagnetic fields and changes to habitats, but research to date suggests these are unlikely to be significant.[67] Most studies have focused on solitary installations, however, and more understanding of cumulative impacts from multiple devices or arrays is required. Underwater infrastructure could provide artificial reef effects or create effective marine reserves protected from fishing, delivering similar benefits to offshore wind farms. Long-term, continuous monitoring will be an important component of new projects, and public funding could support these processes to prevent projects becoming too expensive to develop.

Case study: The Crown Estate is collaborating with the Morlais tidal project in north Wales to make environmental survey data from the project more widely accessible using the Marine Data Exchange platform.[68] The project will aim to help develop the sector while protecting local marine wildlife and habitats. Menter Môn, the project developer, is a not-for-profit social enterprise and plans to channel revenue from Morlais into supporting people, economy, environment and culture across Wales.

Tidal lagoons: In a study of industry and stakeholder perspectives on tidal lagoon developments, participants identified key impacts as changes to sediment regimes

[66] UKMERC, 2024. 6 tidal stream projects successful in the UK's latest renewable auction

[67] Ocean Energy Europe. 2020. Ocean energy and the environment: Research and strategic actions

[68] Morlais Energy, 2025. 'Game-changer' for tidal energy as Morlais and The Crown Estate publish environmental survey data

and hydrodynamics, and restricted passage and migration of fish.[69] Key additional benefits identified included flood defence and control, habitats and biodiversity, leisure and recreation and local area regeneration. Solutions identified were focused on minimising impacts through engineered or technological solutions and delivering compensation through catchment measures, highlighting a need to develop BNG solutions for the often-unique habitats found in areas with high tidal ranges. The study concluded that "the lagoon industry is collectively working towards a good environmental outcome".

Tidal barrage: A 2009 report on the French tidal barrage La Rance suggested that not all environmental changes caused by tidal generation are negative. The 240 MW site opened in 1966 and, although initial construction led to "mass mortality of most marine species", once operational, the barrage increased siltation of intertidal and subtidal beds, leading to clearer water and prolonged feeding periods on tidal flats.[70]

The change in estuary characteristics promoted more biodiverse and productive benthic communities, supporting a greater number of waterbirds and potentially contributing to the area's designation as a Ramsar wetland site of international importance. The slow-turning turbines allow fish to swim through without requiring a separate fish pass, and monitoring suggests the diversity of fish species has increased.

It is important to note, however, that increased biodiversity is not always a sign of success if rare or unique habitats and species are replaced. The unavoidably significant impacts of tidal barrage projects mean that they are generally unsuitable for development in protected areas.

Useful links

This study by Elliott et al. provides a good overview of existing research on the environmental impacts of wave and tidal stream energy devices. The Morlais project provides insight into best practice for environmental data collection and sharing, and the University of Edinburgh's report on Scottish marine energy potential provides a holistic picture of the economic and social opportunities associated with developing this sector.

[69] Elliott et al., 2018. Environmental interactions of tidal lagoons: A comparison of industry perspectives

[70] Kirby and Retière, 2009. Comparing environmental effects of Rance and Severn barrages

Hydropower

Summary

Hydropower generation can vary greatly in size and associated impacts, from large dams or reservoirs which store potential energy to increase generation, to run-of-the river schemes which can avoid diverting or storing water. Larger schemes have significant environmental impacts, including flooding terrestrial habitats, altering hydrodynamics downstream and releasing methane from reservoirs. Smaller schemes without dams don't restrict fish movements and are generally less impactful, although they lack efficiencies of scale.

Hydropower is a relatively reliable and constant form of renewable energy generation, and schemes have long operational lifetimes. Generation is greatest during winter, which aligns well with peak energy demand. Although targets for hydroelectricity were not included in CP30 (other than for pumped storage), small-scale projects could be useful in decarbonising rural areas with limited access to the grid.

Stats

- At the end of 2024, the UK had 419 MW of small-scale hydropower and 1,471 MW of large-scale hydropower, generating 2% of the UK's electricity[71]
- Hydropower generators can be large (over 1 MW), small (0.1-1 MW), micro (0.05-0.1 MW) or pico (<0.05 MW). Most micro and pico schemes are domestic or community-owned, whereas generators above 1 MW are more likely to be commercially owned.[72]
- As of 2024, there were 13 MW of community-owned hydropower generation in the UK, with a further 3 MW planned for future development.[73]

Key points for local authorities to consider

- There is a lack of examples of hydropower generating positive benefits for local aquatic ecosystems
- Large hydropower projects generate significant environmental impacts, but these can be reduced through mitigation

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[71] DESNZ, 2025. Energy Trends: UK renewables, Renewable electricity capacity and generation (ET 6.1 – quarterly)

[72] British Hydropower Association, n.d. Types of Hydropower

[73] Community Energy Scotland, Community Energy England and Community Energy Wales, 2024. Community energy: State of the Sector 2024

- Smaller schemes have lower environmental impacts, and although it may be difficult to incorporate environmental benefits, they are unlikely to cause significant environmental harm[74]
- Small hydro schemes can be used to replace diesel generators in rural off-grid communities, and in urban areas can be incorporated into city water mains (conduit hydropower).[75]

Further details

Large hydropower projects can alter sediment dynamics, block fish movements and release methane. When a large dam or reservoir is constructed to store water for a hydropower project, the flooded vegetation is decomposed anaerobically, resulting in high levels of methane emissions from the newly formed lake.[76] Sediment builds up behind the dam instead of being transported downstream, changing conditions on the riverbed and causing bankside or even coastal erosion. Dams also present barriers to fish movements, although fish passes can mitigate this issue.

Changes to water levels can cause significant impacts, but can be mitigated. Output from large hydropower stations can be increased or decreased rapidly to respond to changes in demand, an operational technique known as hydropeaking. These changes can cause frequent and significant variation in downstream flow rates, significantly impacting aquatic species. Mitigation solutions include regulating hydropeaking to cause less significant changes in downstream flow, widening the downstream channel to reduce overall level changes or restoring tributaries and side channels to provide species with refuges during times of high flow.[77]

Useful links

The British Hydropower Association has more information on the sector, including case studies.

[74] Hedger et al., 2025. Evaluating environmental impacts of micro, mini and small hydropower plants in Norway

[75] Project drawdown, n.d. Small Hydropower

[76] Encyclopédie de l'énergie, 2021. Hydroelectricity: Environmental and social impacts

[77] Hayes et al., 2022. Hydropeaking: Processes, Effects and Mitigation

Electricity network infrastructure

Summary
Since 2023, Ofgem has required all electricity networks to complete annual environmental reports measuring progress across areas including carbon emissions, supply chain management and biodiversity. Networks are embracing opportunities to enhance nature on their sites, recognising the potential to support a National Nature Recovery Network by creating wildlife corridors, and working with partners to deliver off-site restoration. As networks own a relatively small amount of the land associated with their infrastructure, on-site enhancements are mostly occurring at substations.

Statistics

- Some 79% of people are aware of the need for more electricity infrastructure[78] and 30% would be unhappy and 23% happy if it was built in their local area
- People's main concerns are impacts on views (61%), nature (58%) and health (45%)
- CP30 set out targets for 1,000km of new transmission onshore and 4,500km offshore, and stated that "network expansion must proceed at more than four times the rate of the last decade".[79]

Key points for local authorities to consider

- In some areas there is strong public opposition to new network infrastructure, including arguments that offshore grids and underground cables should be used instead of new overhead lines (although these measures are more expensive and network costs are recouped through customer bills)
- Networks have limited land ownership, restricting the scale of projects which can be delivered for nature. Offsetting is required to deliver BNG and some projects include collaborating with other landowners.
- Access and safety requirements limit tree heights near powerlines, although management regimes are shifting towards coppicing rather than clear-felling, and in some cases replacing trees with smaller native shrubs
- BNG projects at substations are introducing wildflower and hay meadows, trees, hedgerows and native shrubs. Some off-site BNG projects are collaborating with community groups and delivering social benefits such as recreation.

[78] DESNZ, 2024. DESNZ Public Attitudes Tracker

[79] NESO, 2024. Clean Power 2030: Advice on achieving clean power for Great Britain by 2030

Further details

Case study: Scottish & Southern Electricity Networks (SSEN) is currently testing four nature-based solutions through an innovation project called Nature4Networks. These include:

- Using linear woodlands to reduce the visual impact of powerlines as an alternative to undergrounding. For a similar cost, this solution also connects habitats, provides new opportunities for recreation and shelters powerlines from high wind speeds, increasing resilience.
- Using sustainable drainage systems (SuDS) to protect substations from flooding, avoiding the emissions associated with traditional concrete defences
- Using bioswales (vegetated ditches) to contain potential oil spills from transformers at substation sites
- Using thorny planting to protect wooden electricity poles in fields from animal intrusion and to reduce risk of farm vehicle collisions.

For each solution, SSEN is conducting cost-benefit analysis to ensure value is delivered to customers, with positive initial results. The evidence base created by the project could support implementation across other networks or sectors.

Key actions from the electricity networks' annual reports include:

Scottish & Southern Electricity Networks

• Committed to restoring 258ha of woodland, 522ha of peatland and 17ha of seagrass meadows in and around licence areas
• On- and off-site BNG for all projects from May 2023-March 2024 delivered 20.4% BNG

NORTHERN POWERGRID

• Completed 20 out of 40 targeted on-site biodiversity initiatives in 2023/24 (conservation mowing)
• Engaging employees with biodiversity
• Planning social impact projects for half of major work schemes, including wildflower planting

SP ENERGY NETWORKS

• Collaborated with Cheshire Wildlife Trust to deliver wetland and wildflower projects below powerlines needing refurbishment
• Worked with partner to restore 116ha of lowland peat at Slamannan Peat Bog since 2016, with another 114ha planned

nationalgrid

• Legally binding conservation covenants set up at 40 substation sites with 30-year biodiversity management plans; 40 more sites to be identified in 2024/25
• Transmission: aiming to benefit nature and people through enhancements on 1,800ha of non-operational land, working with local environmental groups and aligning initiatives with LNRSs

UK Power Networks

• Target to deliver 30% biodiversity enhancement on 100 sites by 2028, 24 completed in 2023/24
• Employee team volunteering days to deliver biodiversity enhancements, communicated projects to local communities

electricity north west

• Target to plant 10,000 trees/yr, planted 11,000 in 2023/24 in collaboration with a community group and Cumbria Wildlife Trust
• 100 biodiversity uplift sites identified (mostly substations) for low-intensity grass cutting regime and some small-scale woodland management

Useful resources

The SP Energy Networks Action Plan for Nature provides a good sample of the types of targets and initiatives being implemented by networks. Environmental reports from the electricity networks can be found using the following links:

- SSEN distribution and transmission
- Northern Power Grid
- SP Energy Networks distribution and transmission
- National Grid distribution and transmission
- UK Power Networks
- Electricity North West

Other considerations

Local environmental impacts are only one component of a renewable energy project's overall sustainability. A UKERC-supported study calculated that 57.77% of impacts on biodiversity from Europe's electric power system occur outside the continent, with 96.7% of the UK's impacts occurring internationally.[80] In Latin America, 25.68% of threats to biodiversity associated with the electric power system are embodied in goods and services primarily exported to Europe and North America.

To minimise such impacts, it will be important to grow domestic production capacity and improve supply chain sustainability for renewable energy technologies. Where standards for best practice exist, guidance for supply chain management includes how to reduce environmental and social impacts in the resourcing, manufacturing and decommissioning stages. Circular economy principles for resource use are recognised as important in ensuring long-term sustainability for the sector, with a need to incorporate avoidance, repair, reuse and recycling into design processes.

Although renewable energy has the potential to protect nature by tackling climate change and contributing towards local nature restoration, reducing energy consumption remains an important component of delivering a sustainable system.

[80] Holland et al., 2019. The influence of the global electric power system on terrestrial biodiversity

Annexe

Annexe Table 1: Policies, plans and initiatives relating to energy and the environment

Sector	Initiative	Date	Key actors	Description
	Environment Act (EA21)	2021	Defra	Applies to England, sets out aim to leave nature in better state than inherited, established 30 by 30 goal, legislated Local Nature Recovery Strategies (LNRS) and established concept of a Nature Recovery Network of wildlife-rich places.
	Future Wales: The national plan 2040	2021	Welsh government	National development framework which includes ambitions for renewable energy, for more details see Table 1.
	Scotland's Third Land Use Strategy 2021-2026	2021	Scottish government	Sets out aims, objectives and policies for sustainable land use in Scotland, for more details see Table 1.**Error! Reference source not found.**
	Environmental Land Management	2021-27	Defra	Post-Brexit agricultural subsidy scheme supporting more sustainable land management practices in England.
	Scottish Marine Environmental Enhancement Fund	2022	Crown Estate Scotland and NatureScot	Strategically redistributes voluntary contributions to marine enhancement projects across Scotland in the form of grants. Developers wanting to contribute to the fund must demonstrate they are reducing their environmental impact.
	Environmental Improvement Plan 2023	2023	Defra	The first five-year review of the 25-year Environment Plan, sets out actions to restore nature, reduce pollution and increase prosperity across 10 goals.

	Biodiversity Net Gain (BNG)	2024, 2026 for NSIP	Defra	Requires all developments in England (above 25m^2) to deliver a 10% net increase in biodiversity. Can include off-site actions. Will be extended to Nationally Significant Infrastructure Projects in May 2026, Marine Net Gain may be developed in future for offshore developments.
	Clean Power 2030 (CP30)	2024	NESO	Plan for energy system development up to 2030, including targets for generation and storage technologies.
	Clean Power 2030 Action Plan	2024	DESNZ	Plan to implement CP30, sets out consultations and proposed actions.
	Marine Routemap	2024-	The Crown Estate	Strategic plan for marine development, including energy and conservation targets.
	Future Homes Standard	Autumn 2025	MHCLG	New regulations aiming to ensure all new-build homes are zero-carbon ready, will require energy-efficiency measures, low-carbon heating and solar panels.
	Solar Roadmap	2025	Solar Taskforce	Sets out government and industry actions needed to drive ground-mount and rooftop solar.
	Local Nature Recovery Strategies	2025	Responsible Authorities	Developed by 48 Responsible Authorities across England, links to Environmental Land Management, BNG and Local Planning Authorities.
	Planning and Infrastructure Bill	Introduced March 2025	Defra & MHCLG	Aims to make planning in England more strategic to speed up development, includes Delivery Plans and Nature Restoration Funds.

	Land Use Framework (LUF)	2025	Defra	Principles, policies and data for policymakers, land managers and local authorities in England to use land more effectively for multiple outcomes.
	Marine Recovery Fund	Autumn 2025	Defra	Proposed under Energy Act 2023, will support strategic compensation and conservation to simplify marine development, including offshore wind.
	Strategic Spatial Energy Plan (SSEP)	2026	NESO	A longer-term, holistic plan for the UK energy system, will include Strategic Environmental Assessment and Habitat Regulation Assessment.
	Regional Energy Strategic Plans (RESPs)	2026	NESO	Will be informed by SSEP and work with local authorities and Distribution Network Operators to create a regional-scale energy plan. Transitional RESPs (t-RESPs) are expected in 2025.
	Centralised Strategic Network Plan	2027	NESO	Informed by the SSEP and RESPs, will be used to plan for network development.