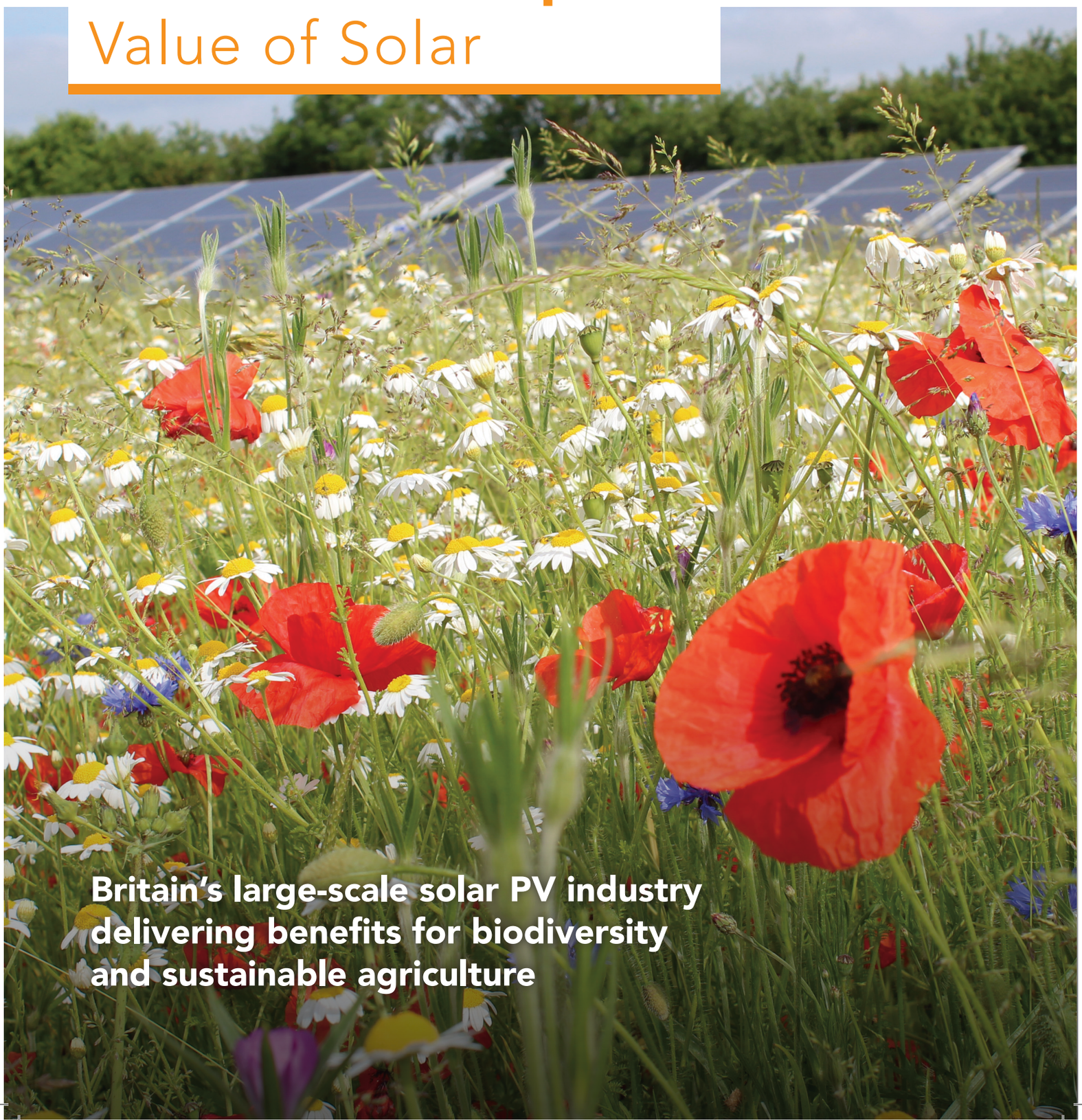
SOLAR TRADE ASSOCIATION

The **Natural Capital** Value of Solar



Britain's large-scale solar PV industry delivering benefits for biodiversity and sustainable agriculture

Editors: Nicholas Gall and Esther Rosewarne, Solar Trade Association.

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Dr Alona Armstrong, Lancaster University; David Eyre, Twig Group; Guy Parker, Wychwood Biodiversity; and Prof. Piran White, University of York, Ross Grier, NextEnergy Capital; James Jenkison, Foresight Group; Olivia lanagan, Wise Energy; Rebecca Hall, Wise Energy; Serena Thacker, Wise Energy; Sanna Magnusson, Wise Energy; Lee Moscovitch, Greencoat Capital; Karin Kaiser, Greencoat Capital; Esther Scott, Greencoat Capital; Tom Rayner, Greencoat Capital; Grace Chan, Low Carbon; Lara Jones, BayWa r.e.

Presented by the Solar Trade Association, in partnership with:

Foresight group

Wychwood BIODIVERSITY

low carbon powering tomorrow

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NEXTENERGY CAPITAL

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Foreword

Historians will look back on 2019 as the year Britain woke up to the reality of the climate crisis.

From rising sea levels and flooding, to increasing water scarcity and wildfires, there is undeniably a growing sense of urgency that, as a country, we must take on a greater share of responsibility in confronting this massive global threat. Meanwhile, here at home our biodiversity is also under threat – from agricultural intensification, plastic pollution, pesticides, habitat loss and more, with each of these factors exacerbated by the impacts of climate change. The landmark 'State of Nature Report' (2016) illustrated the severity of the challenges facing Britain's wildlife, with 60% of the 3,146 species monitored being recorded as declining over the past 50 years. At a global scale, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) 2019 assessment found that land degradation has reduced productivity in 23% of the global terrestrial area. Furthermore, the IPBES report also highlights the dangerous feedback loop between climate change and biodiversity loss: climate change is identified as among the top three most significant drivers of global biodiversity loss, while at the same time, the loss and degradation of carbon-absorbing marine and terrestrial ecosystems accelerates climate change. It is clear that these two inextricably linked crises must be confronted together.

> By supporting healthy ecosystems at a local level whilst avoiding climate change-causing emissions from coal and gas power stations, solar PV can play a significant role in the UK's response to both the climate and biodiversity emergencies.

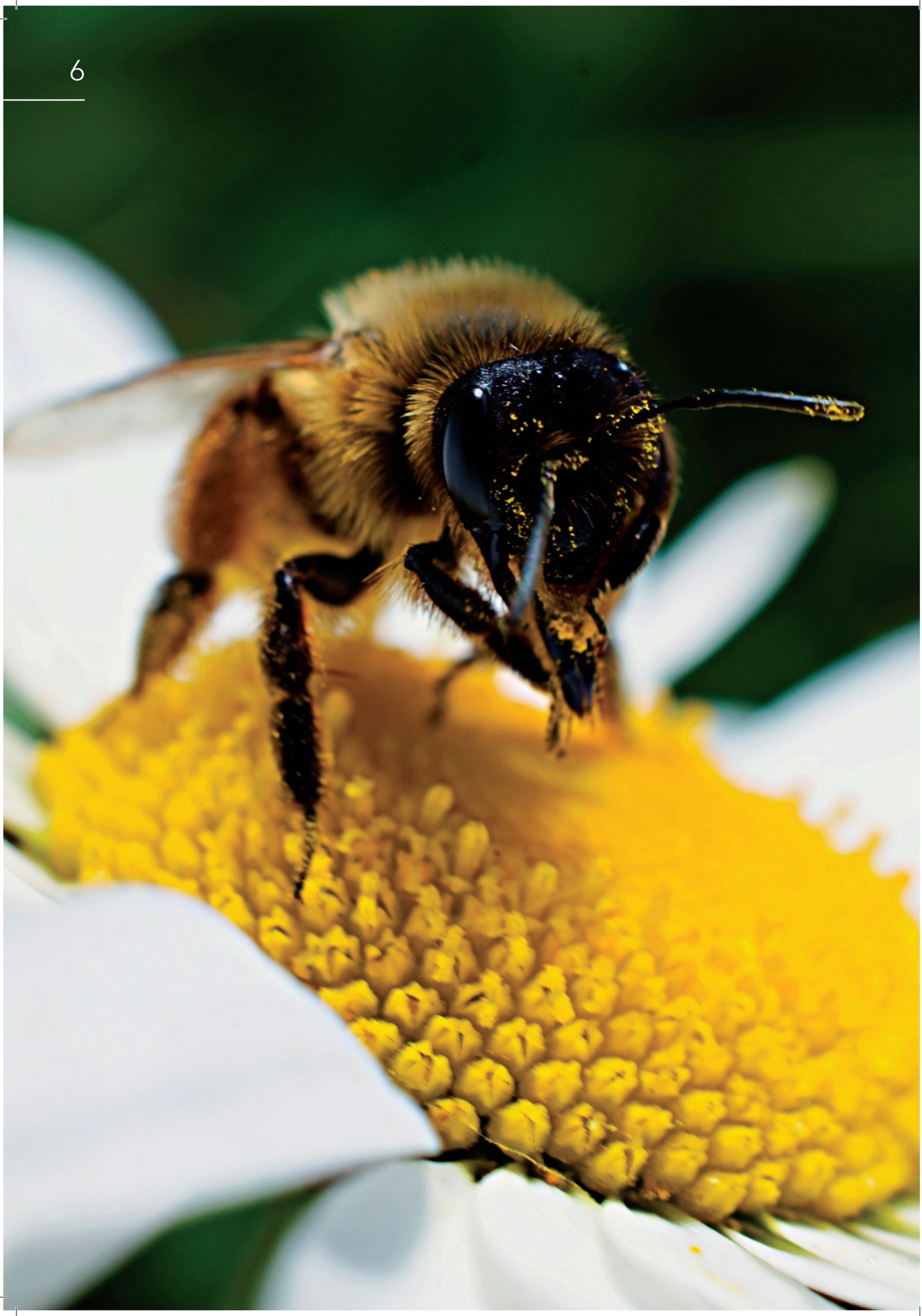
A growing body of scientific evidence indicates that well-designed and well-managed solar can support wildlife habitats and meaningfully contribute to achieving national biodiversity targets.

This document aims to present a broad range of examples of biodiversity enhancement and management, illustrating best practice through a series of case studies from our members, as well as new research from Lancaster University and the University of York who are driving this work forward.

Over the coming months and years, we look forward to working with our members, Government, local communities, stakeholders and academic experts to deepen cross-industry understanding of the clean energy and biodiversity nexus.

Chris Hewett

Chief Executive
Solar Trade Association
June 2019



What is Natural Capital?

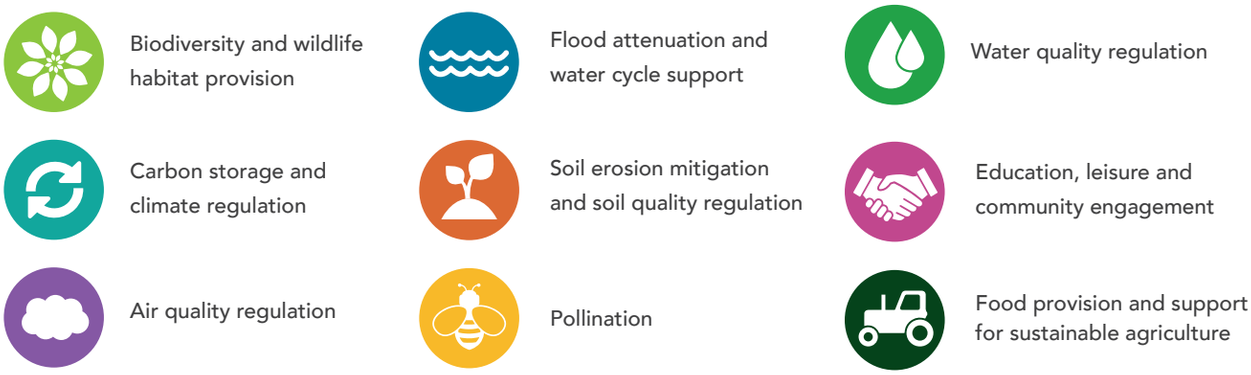
The Natural Capital Coalition, 2019

Natural capital is another term for the stock of renewable and non-renewable resources (e.g. plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people. All this means is that any part of the natural world that benefits people, or that underpins the provision of benefits to people, is a form of natural capital.

Natural capital is a stock, and from it flows ecosystem services or benefits. These services (where service is defined as 'a system supplying a public need') can provide economic, social, environmental, cultural, and spiritual benefits, and the value of these benefits be understood in qualitative or quantitative (including economic) terms, depending on context.

> "At the heart of a natural capital approach is the understanding that nature underpins human health, wealth, culture, identity and happiness, and that the ways in which it does so can be complex and little understood. A natural capital approach works to illuminate this value, and helps decision makers to understand the complex ways in which natural, social and economic systems interact, impact, and depend upon one another."
>
> - The Natural Capital Coalition, 2019

Across the UK, well-designed and well-managed solar parks directly provide a wide range of Ecosystem Services, including:



Overview: Land use impacts of large-scale solar in the UK

The rise of solar PV in Britain over the past decade is a remarkable success story, with the industry growing from less than 100 MW installed capacity in 2010 to more than 13,200 MW in 2019. Over the past 12 months, solar PV has contributed 4% of Britain's total electricity generation (surpassing coal, at 3.5%), in the process preventing almost **2.7 million tonnes of CO2-equivalent emissions from entering the atmosphere.**

This remarkable growth has been driven by a combination of policy support mechanisms (although these have been closed to large-scale solar since 2017), technological improvement and cost decreases in the global supply chain, and the efficiency and resilience of the UK solar industry. Indeed, it would be no exaggeration to say that the ingenuity and expertise of British solar park investors, developers and operators is now recognised and sought after worldwide. As knowledge and experience has grown across the sector, the quality of site construction and maintenance has also improved considerably, and the STA is proud of its role in driving industry standards of good practice, such as through our collaboration with BRE on the 2014 National Solar Centre Biodiversity Guidance for Solar Developments.

The size of the industry's footprint

The majority of Britain's solar PV capacity is deployed as ground-mounted solar parks. These are the lowest-cost and most efficient form of solar PV generation, as they can be optimally sited in areas with the greatest intensity of sunlight, and enable significant economies of scale, both in terms of components and operational efficiencies. Solar Trade Association analysis indicates that there are approximately 1,060 solar parks of at least 50 KW currently deployed across the UK, collectively accounting for approximately 7,550 MW of generation capacity. Of these, 300 are stand-alone systems accredited under the Feed-in Tariff (FIT) scheme, ranging in size from 50 KW to 5 MW, and a further 760 are ground-mount solar projects accredited under the Renewable Obligation (RO) and Contract for Difference (CfD) schemes, or deployed without subsidy. These larger solar sites average 8.8 MW in size.

PV module density per unit of land area varies depending on local conditions and solar park design, but as a rule of thumb, we estimate that 1 MW of PV generation capacity occupies a land area of 1.6 – 2 hectares (or between 4 and 5 acres). All large-scale ground-mounted solar parks across the UK therefore collectively occupy an estimated 13,749 hectares. This is a marginal share of the total UK land area of 24.3 million hectares. It is also important to bear in mind that the National Planning Policy Framework (and the STA's own Best Practice guidance) stipulates that ground-mount solar developments should be confined to the lowest-grade agricultural lands or brownfield sites.

The following diagram illustrates the scale of large-scale solar in the UK relative to other major land uses:

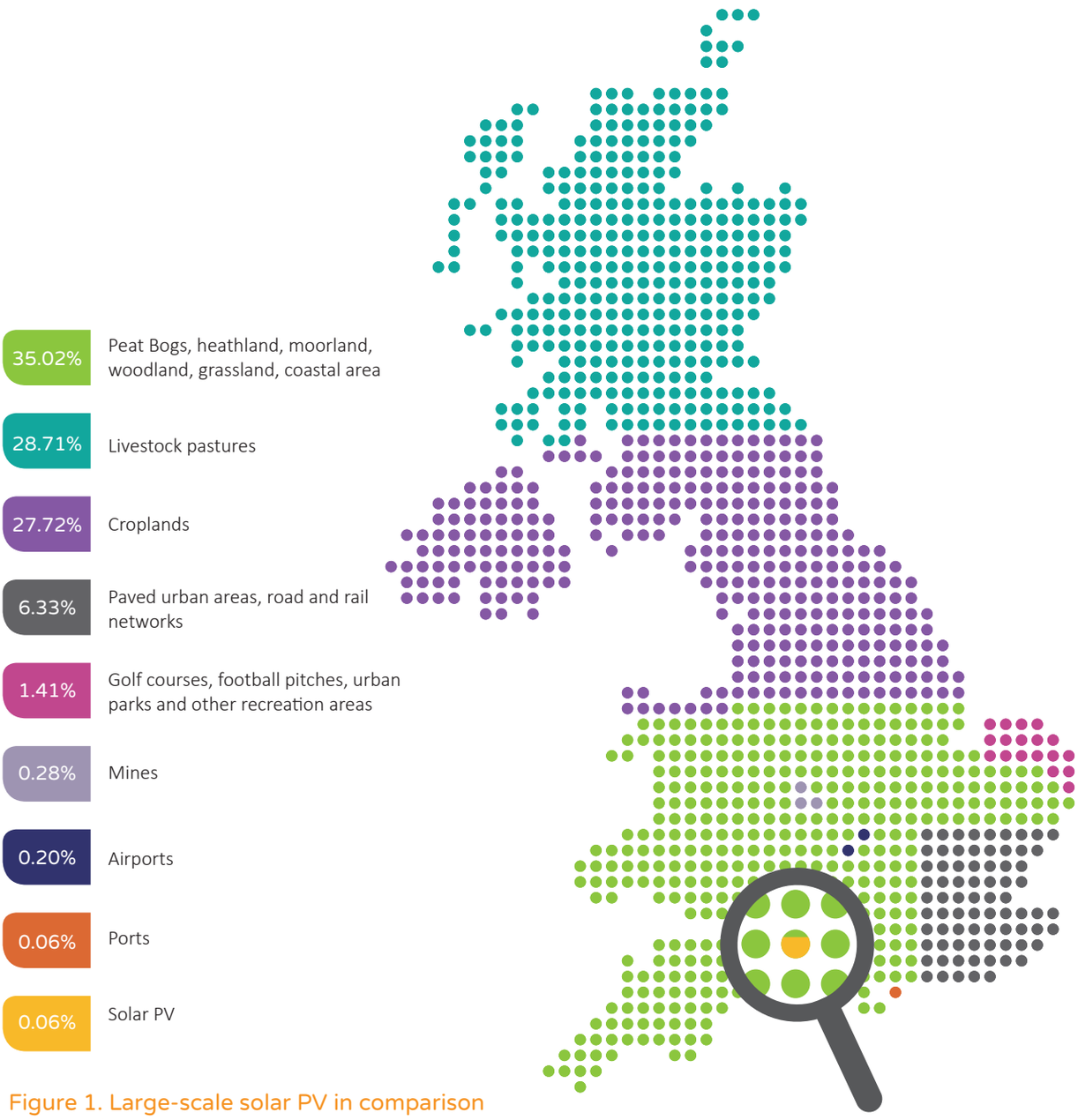


Figure 1. Large-scale solar PV in comparison to other land uses in the UK

Solar parks are a temporary and, in the vast majority of cases, a completely reversible land use. Modules and all other project components are reusable or readily recyclable through UK or European schemes. For almost all ground-mount solar parks, panels are set on posts and there is minimal disturbance to the ground (typically less than 5%). The remainder of a field utilised for solar park development is still accessible for plant growth and potentially for wildlife enhancements and complementary agricultural activities such as conservation grazing. Solar parks are secure, long-term (with 25-40-year operational lifespans), require minimal human disturbance of the grounds, and occupy a minimal infrastructure footprint – all attributes that engender them as good areas to enhance the ecological value of the landscape.

Solar Park Impacts on Ecosystem Services (SPIES)

Dr Alona Armstrong, Lancaster University, and Prof Piran White, University of York

The management of solar parks for wider environmental benefits contributes to UK statutory and voluntary nature and sustainability goals but, historically, has been hampered by limited evidence of their ecosystem impacts. Moreover, incorporating scientific evidence into environmental management decisions is challenging, as research efforts are often predominantly driven by scientific enquiry rather than practical management application, making the evidence difficult to access and interpret.

> The Solar Park Impacts on Ecosystem Services (SPIES) decision support tool fills this gap, providing an accessible, transparent and evidence-based means of informing management actions on and around solar parks.

Consequently, use of the SPIES tool will lead to ecosystem improvements around solar parks across the UK, potentially including increasing habitats, biodiversity, carbon sequestration and pollination. Further, it provides a robust evidence base to inform the 'net environmental gain' target in Defra's 25 year Environment Plan.

Three aspects of the SPIES tool differentiate it from other ecosystem service and natural capital tools, setting it apart as a new innovation that enables a significant advance in solar park management:

- It is designed specifically for solar parks, ensured through co-development with a cross-sectoral stakeholder group, including those involved in solar park development, operation and maintenance, nature conservation, land management, and solar trade advice centres.
- It focuses on management actions and changes in habitat quality resulting from these actions, rather than habitat conversion, making it more relevant to improving the quality of natural capital, and ensuring that outcomes are readily implementable by practitioners.
- It is underpinned by over 700 pieces of evidence from over 450 peer-reviewed scientific publications identified through a systematic review. The evidence is accessible to the user and portrays both the spread and strength of the evidence, ensuring that the tool is transparent, robust, and unbiased.

The SPIES tool has two entry points, both of which capitalise on a substantial evidence base of the effects of land management on ecosystem services. Further, both provide the user with a straightforward route to information needed to inform solar park management, by filtering and presenting relevant evidence in a clear and consistent way. The scientific evidence and its relationship to management actions and ecosystems services is stored in an online database, allowing users to intuitively and efficiently explore alternative scenarios. The first entry point enables the user to enter two management action scenarios, delineates the impact on the full suite of ecosystem services and facilitates comparison. The second enables the user to select ecosystem services and then details which management actions affect them. The outcomes are underpinned by scientific evidence, with the magnitude of impact categorised as significantly degraded, degraded, no change, enhanced or significantly enhanced to give a measure of effect size. In addition, every piece of the evidence is

Impact from proposed actions:

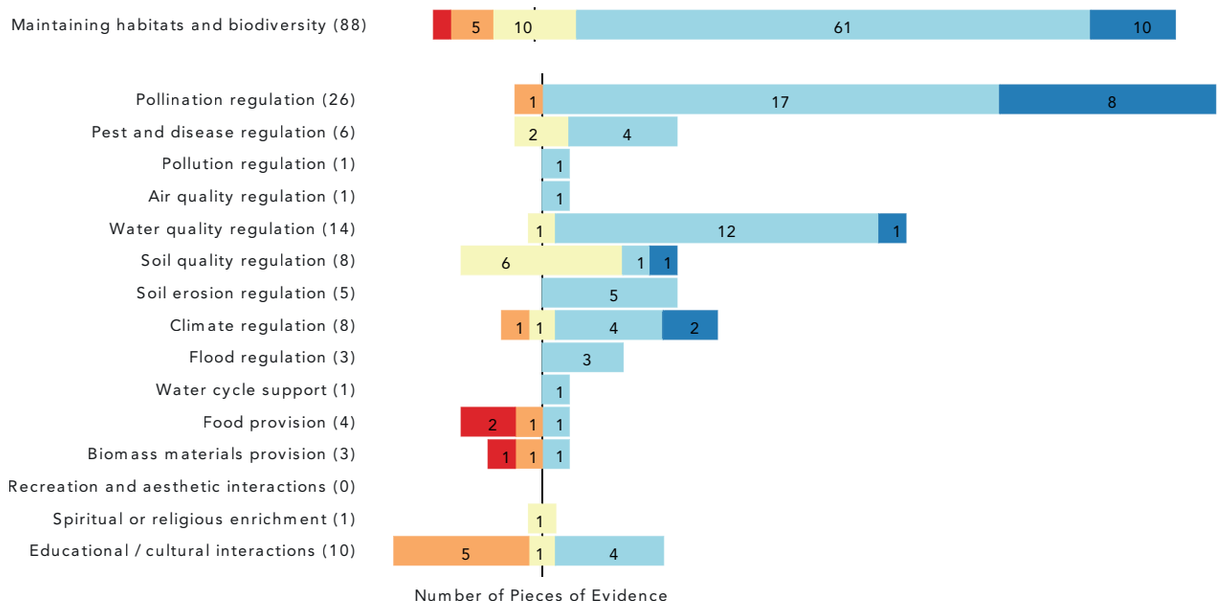


Figure 2. Excerpt from the pdf summary document detailing the number of pieces of scientific evidence that indicate an effect of a set of management actions on ecosystem services. The red bars represent evidence that indicate the ecosystem service has been significantly degraded, orange bars those that have been degraded, yellow neutral effects, pale blue enhanced and dark blue significantly enhanced

categorised as strong or weak to provide a measure of confidence. The tool provides users with links to the underpinning scientific articles, along with a summary that precludes the need to pay for closed-access journal papers. This direct linking to the evidence is rare in this type of tool but is particularly important given the importance of site-specific contexts in management decisions. Further, the SPIES tool is delivered via an accessible cloud-deployed tool that enables the evidence to be kept up-to-date without user action and produces a concise pdf summary document (Figure 2).

Short of setting aside land for conservation, land use change for solar parks arguably offers more potential than any other land use change to deliver much needed deliver natural capital and ecosystem service benefits. The SPIES tool maximises the potential to realise these benefits using a robust, transparent and evidence-based approach. The SPIES tool will be of value to policy-makers, providing local authorities an evidence-based means of assessing the 'net environmental gain' of solar parks, a stipulation in the updated 2018 National Policy Planning Framework. For the solar industry, it will provide an easy to implement assessment of environmental impacts to inform environmentally beneficial solar park management that can be used to support planning applications, sustainable investment criteria and social, environment and governance targets.

For more information, including log-in details for the SPIES tool, visit www.lancaster.ac.uk/spies. The SPIES tool is a collaboration between Lancaster University and the University of York funded by the Natural Environment Research Council (NE/N016955/1 & NE/R009449/1). The web-based version of the SPIES tool was developed by Simomics Ltd.

Principles of solar park design and management for maintaining and enhancing natural capital

Many options exist to enhance the natural capital value of a solar park, and it should be noted that while some enhancements may have broad suitability, there is no 'one size fits all' approach. Value for biodiversity can be gained through creating different habitats within a solar park, including hedgerows, field margins, wild flower meadows, nectar-rich areas, winter bird crops and many others. In many cases, comprehensive enhancements across wide areas are possible, if properly maintained through the lifetime of the project. Opportunities are likely to be more limited where the land is also being used for agricultural production. Whatever habitat enhancement is selected it is generally desirable that the species used are native to the UK[1]. Where possible, species selected should tie in with local and national biodiversity targets.

Consideration may need to be given to future climate conditions in the provenance and choice for establishing longer lived species. Each site is unique in terms of environment, location, existing biodiversity and land use, and these factors all influence which habitat enhancements will be most appropriate. Several of the more common options are presented as examples below. Some guidance documents for the establishment and maintenance of these habitats are included in the bibliography at the end of this document.

Hedgerows

Being mostly isolated from human impact, solar parks can provide ideal habitat for local wildlife. One of the key opportunities for enhancing habitat provision is in the design and maintenance of hedgerows surrounding an array of modules.

Site managers can enhance the effectiveness of field margins by diversifying the types of habitat available. Studies suggest that those who integrate spatially varied margins - including scrub grass, wildflower strips, and woody hedgerows - can restore a wealth of habitat niches in which many distinct species can flourish, such as moths[1], butterflies and syrphids[2], a multitude of invertebrates[3], and predatory birds[4]. There is substantial evidence to suggest that the maintenance of traditional hedgerow structures in field margins plays a pivotal role in this. For example, one study found that survival rate of Chaffinch chicks correlated strongly with the presence of woody hedgerows, and similar results are anticipated for many other bird species[5]. Further research suggests that developers who cultivate tree-rich hedgerows have an overwhelmingly positive impact on the abundance rare species specifically; including moths[6], native birds (such as the yellowhammer and grey-legged partridge[7]), and foraging bats[8].

Chaffinch chick


Brownstreak butterfly

Field margins and wildflower meadows

Diversity and abundance of species correlate directly with the structural complexity of field margins. The benefits of cultivating a landscape of diverse flora are numerous. Not only do they provide habitat for pollinators[1], butterflies[2], and ground nesting birds[3], but also, density of flowering plants in a given area can be a direct indicator of abundance for bees and syrphids. The decline in abundance of these species is of utmost concern at present, and the provision of sufficient forage is key to supporting and promoting their populations in human-impacted landscapes. Further incentive for sowing wildflower meadows is posed by a growing body of research which suggests that when cultivated in agricultural areas, meadows can have a direct impact on the yield of select nearby crops[4]. For example, one study[5] found that the crop pollination parameters of a variety of fruit crops were significantly greater in fields adjacent to wildflower meadows than those that were not; this effect continued year-on-year, and secured a considerable return on investment of the initial meadow sowings.

Case Study: Meadows and grasslands at Next Energy's Berwick site

ECOSYSTEM SERVICES IN FOCUS:

Provided by Next Energy Capital

Working in partnership with Wychwood Biodiversity, NEC has developed a strategy to deliver biodiversity net gain across its portfolio of 80 solar sites, in line with the aims of the Defra 25-year environment plan, whilst assisting the industry in establishing which measures add maximum value without undermining the operations of a solar park.

NEC has a two-phase action plan which is being tested across 9 targeted sites, known as the 'exemplars'. Each site has its own unique, evidence-based Biodiversity Management Plan ("BMP") that outlines a strategy to implement biodiversity value and test innovative ideas. Lessons learnt through the exemplars will help establish a global approach for NEC in implementing biodiversity net gain on all its solar assets.

NEC's Berwick Solar park is an exemplar site that demonstrates the company's approach. Berwick Solar park in East Sussex is a 9MW site covering 30 hectares. It is managed by ENcome Energy, with land management input from Wychwood Biodiversity.

Berwick is located next to Arlington Reservoir, a 100-hectare Site of Special Scientific Interest (SSSI) and a Local Nature Reserve on account of its bird life, especially wintering widgeon. The solar park was constructed to maintain two large ponds and mature hedgerows, and so ties into the natural features of the wider landscape.

There is also a 0.5Ha area designated for community use and an active community group, Cuckmere Community Solar, is establishing an orchard there, with initial steps already implemented by NEC.

In 2017, Berwick was selected as an exemplar site to advance initial steps taken during development, and a biodiversity management plan was developed by Wychwood and NEC with the following being achieved in the first phase:

Native wild flowers have been sown on spoil heaps across the site, providing food and habitat for pollinators as well as an impressive display of colour during the Spring. On other NEC sites, this approach has seen significant increases in bumblebee abundance

Bug hotels were constructed to encourage invertebrates to breed and over-winter on the site. The bug hotels were built as part of an educational

visit from a local school, so providing a valuable outdoor learning opportunity.

Local apple varieties were planted, in partnership with Brighton Permaculture Trust, Wychwood Biodiversity, the Royal Society of Arts, Cuckmere Community Solar, Community Energy South and local volunteers. Also, conservation sheep grazing occurs from autumn through to spring, thus maintaining a level of agricultural production on site, whilst avoid grazing during the flowering season.

Conservation sheep grazing occurs from autumn through to spring, so maintaining a level of agricultural production on site, but avoiding grazing during the main flowering season.

In the next phase during 2019, NEC aim to:

- Create a Kingfisher nesting area within one of the ponds located on site
- Place educational sign boards for visitors on the local biodiversity and wildlife
- Introduce innovative solar thermal beehives to the site for bee keeping and honey production. The solar thermal hives use sunlight to protect the colony from the varroa mite.
- Place hedgehog houses across the site
- Plant soft fruit and herbs to enhance the community orchard (which are also a great nectar source).
- After a successful trip in 2018, a further school trip with over 200 students is currently being planned and expected to occur in July over a three day period.

A bug hotel constructed at Berwick solar farm as part of a school educational visit

Berwick solar park historically suffered from a persistence of perennial weeds such as docks and nettles across the site which if left unattended can overshadow the panels. Beyond the biodiversity management plan, NEC are currently working to phase out herbicide use on the site, and will instead manage these weeds through grazing and cutting through the Spring.

Annual wild flowers on a NextEnergy solar farm

Wetlands, drainage and on-site water management

Land drainage is a key factor to be considered during the early stages of solar site development. Surface water must be adequately managed on sites so as to maintain ease of vehicle access, protect electrical components, and promote healthy vegetation at ground-level. Furthermore, if utilised effectively at the planning stage, drainage management presents ample opportunity for the establishment of wetland habitats and artificial fens - both of which are in steep decline. Solar parks can readily incorporate wetland habitat areas, and thus can help to mitigate some of the habitat loss caused by agricultural land drainage on surrounding fields.

By implementing open drainage structures - such as ditches, swales, and balancing ponds - instead of sub-surface drainage, site managers create rich habitats for many water-dependent invertebrates and amphibians[1]. This in turn provides foraging resources for other species, including fowl and waders[2]. Evidence suggests that fields with open drainage have significantly higher plant and invertebrate diversity than those without, or those with aggressive drainage structures, with numbers of farmland birds such as meadow pipits reaching according prevalence[3]. Several studies have found that even small artificial wetland features can attract waders and positively impact on breeding statistics, as has been observed with Lapwings in agricultural areas[4].

The use of constructed wetland habitats for drainage solutions at solar parks can be instrumental in managing chemical run-off from intensive agriculture on surrounding lands. Nitrogen load can be reduced by 30%[5] when hydraulic pathways in artificial wetlands are optimised, whilst intermittent pesticide fluxes can be reduced by up to 50-80%[6]. The creation of reedbeds in field margins, for example, acts as a filtration system for waste waters - harmful NO2 is stored in vegetation, and surrounding ecosystems flourish as a result.

Case Study: Wetlands and on-site water management

ECOSYSTEM SERVICES IN FOCUS:

Provided by Foresight Group

A long-term sustainability vision is at the heart of Foresight Group's approach to improving and maintaining the solar parks the company owns and operates.

In some cases, a site the company has acquired may have been poorly maintained by its former owner, and Foresight Group have worked hard to turn these sites around. With the right natural solutions-based approach, these sites can be turned into thriving habitats, while also improving safety and energy productivity.

Effective land drainage is a critical aspect of the management of solar farms. In order to enable a wide variety of grasses and wildflowers to flourish,

Strategically placed filter drains (trench drains with heavy-duty geotextile base and perforated pipes overlaid with stones) placed between selected solar arrays keep the land beneath and around the arrays sufficiently dry to prevent rutting by maintenance vehicles and sufficiently moist to promote good grass and wildflower growth to maintain soil structure. Importantly, site maintenance staff have safe access to panels and equipment over firm ground.

Conceptual diagram. Experience shows that substations, transformer and inverter building require roadways to prevent ground damage and designs should incorporate this requirement.

and to ensure that equipment is easy to access, it is critical that sites are protected from excessive exposure to water. Many farm fields have existing land drains that can be effectively utilised if incorporated into the solar farm construction designs.

> Effective land drainage is a critical aspect of the management of solar farms and ensure that the ground is kept in suitable condition to enable a wide variety of grasses and wildflowers to flourish

If implemented effectively at construction stage, drainage systems can be economical to install and can be integrated with an extensive habitat enhancement programme utilising swales and balancing ponds for aquatic habitats. Effective

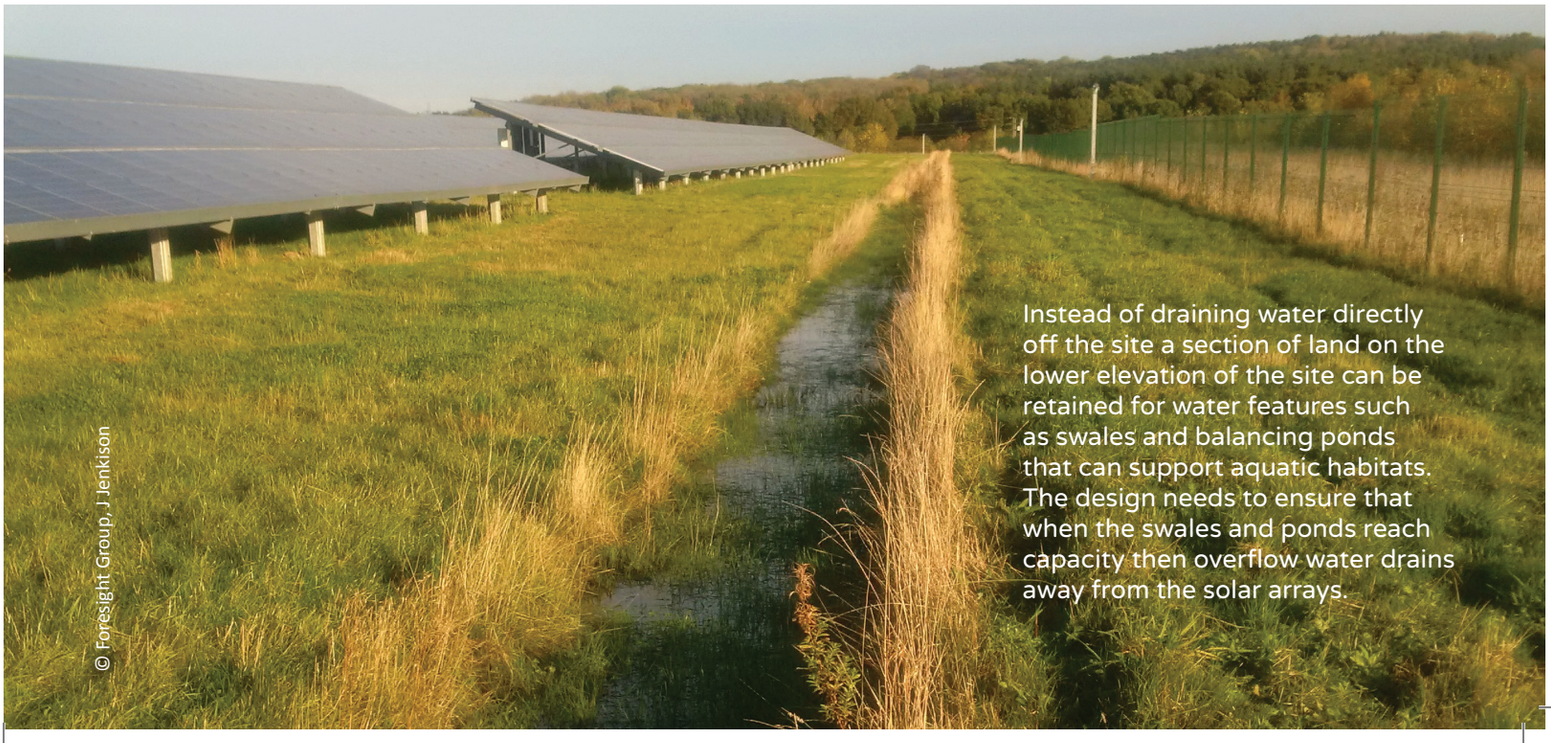
land drainage solutions are required for all sites as even relatively level sites will have sufficient variations in topography to cause potential flooding and waterlogging issues.

Poorly managed drainage ditches can become rapidly overgrown with brambles and unmanaged hedge plants and clogged with deadwood that can prevent effective drainage and result in flooding of the site and neighbouring land.

Balancing ponds are both an effective drainage management method that fill during high rainfall and gradually recede during dry weather periods whilst at the same time providing diverse habitats.

In this instance an existing public footpath in a natural depression was prone to flooding and the solution of slight levelling and planting dense hedgerows along either side of the route has resulted in hedge plant roots absorbing excess water flowing from higher ground and allowing the public footpath route to be rehabilitated as a wildflower meadow that is comfortable to traverse.

Hedgerow and shrub planting at the lowest elevations, in addition to providing additional habitat and food sources for wildlife, also provide visual screening, security; soil stability and plant root systems will also absorb higher quantities of water.



Instead of draining water directly off the site a section of land on the lower elevation of the site can be retained for water features such as swales and balancing ponds that can support aquatic habitats. The design needs to ensure that when the swales and ponds reach capacity then overflow water drains away from the solar arrays.

Case Study: Measuring what matters, and forging local partnerships for sustainable agriculture

ECOSYSTEM SERVICES IN FOCUS:

Provided by Bluefield LLP

It is often said in business that what gets measured gets managed, and this philosophy is being put into action by a number of Solar Trade Association members as they pursue Environmental, Social and Governance (ESG)-based sustainable investment strategies.

Bluefield LLP, the investment advisor to Bluefield Solar Income Fund (BSIF) - one of the UK's leading solar investors - recently completed a rigorous benchmarking study of the biodiversity enhancement measures implemented on the company's large-scale solar. The study aimed to measure performance against specific criteria in wildflower meadow creation, native tree and hedgerow planting and creation of habitat to support local wildlife, including bat boxes, bird boxes, beehives.

The company's portfolio of large-scale solar sites was growing at a rapid pace, and Bluefield realised the need for a biodiversity benchmarking exercise, in order to ascertain the introduced biodiversity mitigation measures at each of the assets to identify areas of improvement. The first step was to collect all the relevant documentation for each site (Ecological Assessment, Tree and Habitat survey, Biodiversity management plan, Landscaping Plan, Planning Consent, NMAs). This was followed by a 'gap analysis' to ensure sites are up to standard and in the best place to enable a diverse habitat and range of species to prosper. Ecological inspections and reviewing of the LEMPs enables considered adjustments to the way a site is managed and is key to biodiversity enhancement.

Bluefield is also currently developing additional, ambitious improvements and initiatives to further encourage and enhance biodiversity across the portfolio including the large-scale deployment of bug hotels and beehives and the creation of new ponds.

Enhancing the productivity of local agriculture through the provision of pollinator habitat on solar sites is one promising area of potential synergy between solar parks and sustainable agriculture. Another common approach across the UK is to make large-scale solar sites available to local farmers for conservation-focused grazing.

> When designing and negotiating the contract to build a new solar park, Bluefield considers the possibility of sheep grazing on site from the early stages.

This includes a contractual requirement for the sheep protection of the relevant equipment (cables), and encouraging a design which inherently considers the need of sheep grazing when defining the clearance between ground level and the front row of PV panels and other equipment.

Sheep grazing may not always be the optimal choice from an ecological standpoint. However, if implemented properly, there are a number of possible advantages of the practice for both local farmers and solar site operators.

Best practices for on-site grazing

Many solar site managers collaborate with local farmers and landowners to manage grassland areas with livestock grazing. If implemented correctly, livestock grazing can be a more sustainable and cost-effective way of maintaining optimal access and functionality of solar sites when compared with regular mowing. Furthermore, studies have shown that grassland managed with grazing typically has a higher carbon sequestration potential than that which is mowed.[1] The cessation of mowing correlates directly with increased species richness and abundance; instead, a combination of low stocking density and breaks in grazing can lead to a high diversity of wild flowers and invertebrates as well as benefiting ground nesting birds and mammals. Timely breaks during the spring and summer months allow ground nesting birds to reproduce and vegetation to flower for pollinator fodder.[2]

Equally, where there is concern for habitat reduction due to grazing, biodiversity can be improved across a site with additional habitat enhancements, such as bug hotels and woody hedgerows.

© Crundale Solar Farm, J Scurlock, 2016

Case Study: Low Carbon's solar-powered honey

ECOSYSTEM SERVICES IN FOCUS:

Provided by Low Carbon

In a low-lying farm field just outside the central Suffolk village of Lackford, hidden from view behind dense cypress woodland, honeybees are hard at work.

Completed in 2014, Low Carbon's award-winning 20.9 MW Lackford Estate Solar Park supports thriving resident populations of birds, reptiles and invertebrates, including - but by no means limited to - honeybees.

Low Carbon are committed to making a positive and significant impact on both causes and effects of climate change, and supporting biodiversity on their solar parks is integral to their work. The company works closely with landowners and developers to implement comprehensive land management programmes. With assets across a diverse range of locations, the company adapts management techniques according the unique requirements of each site: Construction is carefully timed to avoid impacts on reptiles and ground-nesting birds, indigenous local flora and fauna are prioritised, and site managers are always exploring new opportunities for habitat provision in each specific location.

For example, at their Lackford Estate site, Low Carbon has re-seeded field margins with a range of native wildflower species, whilst also introducing

a selection of native grasses suited to the climate and landscape of Central Suffolk. This diversity of plant life provides a wealth of habitat niches for wildlife.

Low Carbon's site-tailored approach to land management has enabled them to go the extra mile for honey bee populations. In light of the increasing presence of agricultural monocultures, overuse of pesticides, and a worrying increase in the practice of hive theft on bee farms, UK populations of honey bees have fallen by half over the past two decades – an alarming reality when considering their critical role in crop pollination.

> Low Carbon's solar parks provide an excellent home for honey bees – not least because sites are secured, thereby safeguarding hives from theft and damage.

To mitigate this pollinator population decline, Low Carbon have implemented specific measures across sites with plentiful pollinator fodder, extensive field margins, and minimal use of harmful chemicals on neighbouring farms. Five of these locations across Suffolk, Devon and Cornwall have each had five beehives installed, and an additional ten hives were installed at Low Carbon's Callington site. Four years since these hives were first established, Low Carbon's solar sites are now home to over two million honey bees, with each hive accommodating around 60,000 bees.

Low Carbon's solar parks provide an excellent home for honey bees – not least because sites are secured, thereby safeguarding hives from theft and damage. Additionally, beekeepers are able to monitor closely the health of colonies; Low Carbon are trialling methods to connect each hive to the web so that key parameters can be better measured and monitored remotely. Factors such as brood temperature, humidity, hive mass, and external weather conditions can therefore be compared quickly and accurately. Additionally, the beekeepers

work hard to ensure parasites and mites are kept at bay on Low Carbon sites – a significant achievement at a time when many wild hives are struggling in our volatile, changing climate.

Perhaps the most rewarding aspect of Low Carbon's work with honey bees is the tangible result. Making sure to leave plenty for the bees' winter reserves, Low Carbon's Beekeepers bottle excess reserves of honey produced in their hives each year, and use samples as a means for spreading the word on their efforts to enhance species richness and diversity across the UK. Low Carbon gift their natural, lightly-filtered honey to key stakeholders, including partner schools, to highlight their belief that the enhancement of biodiversity should be a core responsibility for renewable energy companies.

Greencoat Capital: Creating and enhancing habitat for wildlife

ECOSYSTEM SERVICES IN FOCUS:

Provided by Greencoat Capital

Promoting biodiversity is an integral part of Greencoat Capital's ESG approach; from the company's pre-investment processes, through to ongoing operational planning for assets, as well as in concert with partners such as BayWa r.e Operations Services Ltd and Low Carbon.

For the solar farms under its stewardship, Greencoat Capital's ambition is to ensure the associated natural assets are protected, and, where possible, improved over the lifetime of the site.

First and foremost, establishing and maintaining the right balance of plant species on a large-scale solar site is essential for promoting wildlife; planting and sowing native flora supports a range of micro-habitats - and thereby associated species - through a natural process of colonisation.

The importance of hedgerows to the UK's net biodiversity is well-documented; the creation of new hedges in addition to supplementary planting helps to strengthen the connectivity of these boundary habitats. Existing UK hedgerows are typically formed from a limited number of plant species, so increasing the diversity of flora by planting other locally native species can improve wildlife habitat and significantly enhance the ecological value of the area, acting as a foundation for other species and ecological networks.

At Greencoat's Westover site, new native hedgerows were created around the perimeter, with a mix of species including field maple, hawthorn, common hazel, holly, blackthorn, wayfaring tree, honeysuckle, and dog rose. Greencoat has implemented a comparable programme at its Grange Farm site, where they have established new hedgerows with a native species mix consisting of over 2000 plants.

Furthermore, to maximise the benefits of rich hedgerow habitats, Greencoat has implemented tree planting across developments such as their Henley site, where they have planted new trees every 8m along existing hedgerow margins alongside a new understory of shrub. Increasing the density of tree cover in hedgerows increases connectivity of field margins and enhances value for wildlife.

Areas outside a solar farm's perimeter fence can also be cultivated to benefit wildlife. For example, at Greencoat's Ramsey site, species-rich grasslands have been established through sowing land strips with a floristically-enhanced pollen and nectar mix. These enriched grasslands provided varied habitats for invertebrates, small mammals, a plethora of butterfly species, as well as plentiful nesting, roosting, and feeding opportunities for native birds. During a recent site walkover at Greencoat's Sellindge site twelve species of butterfly were recorded, including Small heath (Coenonympha pamphilus) and Hairstreak butterflies (Theclinea sp). Also spotted were multiple species of passerine birds, including Linnet (Linaria cannabia) and Yellowhammer (Emberiza citronella), and the elusive Brown hare (Lepus europaeus).

> At Greencoat's Westover site, new native hedgerows were created around the perimeter, with a mix of species including field maple, hawthorn, common hazel, holly, blackthorn, and dog rose.

Artificial habitat measures can – and should – also be implemented into a site management plan; at the Hoplass site, Greencoat has installed badger

gates within the site security fence to accommodate nearby badger setts which are located close to the site's eastern boundary.

> At Greencoat's Berthllwyd site, birds categorised as amber and red-listed were found to be using artificial nesting boxes across the site, including kestrel, meadow pipit, redwing, mistle thrush and starling.

Finally, large-scale solar sites are ideal locations for bird and bat boxes, providing improved nesting opportunities and encouraging each of these species to nest in the area. At Greencoat's Berthllwyd site, birds categorised as amber and red-listed were found to be using artificial nesting boxes across the site, including kestrel, meadow pipit, redwing, mistle thrush and starling. At the Henley site, a variety of bat species make good use roosting boxes on mature trees. Coupled with the enhancement of the site's hedges, this provides

green corridors along which the bats can feed and commute, providing an ideal habitat for bats overall.

Greencoat Capital and its partners, Low Carbon and BayWa r.e. Operation Services Limited, also work actively to support scientific research such as a recent soil study from the University of Worcester investigating the effect of solar panels on the ecosystems beneath them. In addition, we host regular educational visits to the sites from the local community and from local schools.

Greencoat's ESG approach benefits many species - from the smallest invertebrates to larger land mammals.

The STA Land Management Charter

These industry commitments were developed in 2017 by the Solar Trade Association, in consultation with a wide range of experts and stakeholders, to promote best practice among STA asset owners, O&M providers and land managers.The charter covers maintenance and grounds-keeping practices, end-of-life disposal of generation assets, and training and education of contractors as well as local community engagement. The document is freely available for download on the STA website.

Solar farm developers, builders or tenants who are members of the STA will comply with the following best practice guidance:

- Deliver on planning conditions by meeting or exceeding planning requirements for management of land, biodiversity and visual screening for the life of the project
- Commit to using local firms and farmers for subcontracting wherever possible
- Maintain sites in a tidy and presentable state, ensuring solar farms are kept free from construction and maintenance debris and present a well-managed appearance to casual visitors, with site contact information clearly displayed
- Demonstrate multi-purpose land use, with periodic review of the biodiversity and land management plans
- Encourage engagement with the local community through consultations and events where appropriate
- Ensure solar asset owners, farm owners and O&M providers understand responsibility and risks, complying with all H&S requirements
- Where required, manage and alleviate surface drainage as part of regular maintenance, in consultation with bodies like the Environment Agency and local stakeholders
- Anticipate and work towards end-of-life decommissioning, avoiding compaction and monitoring soil characteristics

Bibliography

Principles of Solar Park Design

1) BRE, eds Parker, G; Greene, L. 2014 Biodiversity Guidance for Solar Developments.

Foreword

(1) Hayhow D; Burns F; Eaton MA; Al Fulaij N; August T; Babey L; Bacon L; Bingham C; Boswell J; Boughey KL; Brereton T; Brookman E; Brooks D; Bullock D; Burke O; Collis M; Corbet L; Cornish N; De Massimi S; Densham J; Dunn E; Elliott S; Gent T; Godber J; Hamilton S; Havery S; Hawkins S; Henney J; Holmes K; Hutchinson N; Isaac NJB; Johns D; Macadam C; Mathews F; Nicolet P; Noble D; Outhwaite C; Powney G; Richardson P; Roy D; Sims D; Smart S; Stevenson K; Stroud R;

Walker K; Webb J; Webb T; Wynde R;Gregory R. 2016. State of Nature 2016. The State of Nature partnership.

(2) IPBES, (eds) Brondizio, E; Settele, J; Díaz, S; Ngo, H. 2019. Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science- Policy Platform on Biodiversity and Ecosystem Services. IPBES Secretariat.

Overview

Figure 1. Values for solar PV provided by Solar Trade Association. All other values retrieved from https://www.sheffield.ac.uk/news/nr/land-cover-atlas-uk-1.744440 (accessed 10/06/2019)

Hedgerows

1) Merckx, T; Marini, L; Feber, RE; Macdonald, DW. 2012. Hedgerow trees and extended-width field margins enhance macro-moth diversity: implications for management, JOURNAL OF APPLIED ECOLOGY, 49: 6, 1396-1404.

2) Burgio, G; Sommaggio, D; Marini, M; Puppi, G; Chiarucci, A; Landi, S; Fabbri, R; Pesarini, F; Genghini, M; Ferrari, R; Muzzi, E; van Lenteren, JC; Masetti, A. 2015. The Influence of Vegetation and Landscape Structural Connectivity on Butterflies (Lepidoptera: Papilionoidea and Hesperiidae), Carabids (Coleoptera: Carabidae), Syrphids (Diptera: Syrphidae), and Sawflies (Hymenoptera: Symphyta) in Northern Italy Farmland, ENVIRONMENTAL ENTOMOLOGY, 44: 5, 1299-1307.

3) Joyce, K; Holland, J; Doncaster, C. 1999. Influences of hedgerow intersections and gaps on the movement of carabid beetles, BULLETIN OF ENTOMOLOGICAL RESEARCH, 89, 523-531.

4) Parish, T; Lakhani, KH; Sparks, TH. 1995. Modelling the relationship between bird population variables and hedgerow, and other field margin attributes. 2. Abundance of individual-species and of groups of similar species, JOURNAL OF APPLIED ECOLOGY, 32: 2, 362-371.

5) Whittingham, M: Bradbury, R; Wilson, J; Morris, A; Perkins, A., Siriwardena, G. 2001. Chaffinch Fringilla coelebs foraging patterns, nestling survival and territory distribution on lowland farmland, BIRD STUDY, 48, 257-270.

6) Merckx, T; Feber, RE; Mclaughlan, C; Bourn, NAD; Parsons, MS; Townsend, MC; Riordan, P; Macdonald, DW. 2010. Shelter benefits less mobile moth species: The field-scale effect of hedgerow trees, AGRICULTURE ECOSYSTEMS & ENVIRONMENT, 138, 147-151.

7) Cornulier, T; Robinson, RA; Elston, D; Lambin, X; Sutherland, WJ; Benton, TG. 2011. Bayesian reconstitution of environmental change from disparate historical records: hedgerow loss and farmland bird declines, METHODS IN ECOLOGY AND EVOLUTION, 2: 1, 86-94.

8) Rands, MRW. 1987. Hedgerow management for the conservation of partridges perdix-perdix and alectoris-rufa, BIOLOGICAL CONSERVATION, 40: 2, 127-139. 63-2.

9) Boughey, K, Lake, I, Haysom, K, Dolman, P. 2011. Improving the biodiversity benefits of hedgerows: How physical characteristics and the proximity of foraging habitat affect the use of linear features by bats, BIOLOGICAL CONSERVATION, 144, 1790-1798.

Field margins and wildflower meadows

1) Bernhardt, CE; Mitchell, RJ; Michaels, HJ. 2008. Effects of population size and density on pollinator visitation, pollinator behaviour, and pollen tube abundance in Lupinus perennis, INTERNATIONAL JOURNAL OF PLANT SCIENCES, 169: 7, 944-953.

2) Holland, JM; Smith, BM; Storkey, J; Lutman, PJW; Aebischer, NJ. 2015. Managing habitats on English farmland for insect pollinator conservation, BIOLOGICAL CONSERVATION, 182, 215-222.

3) Burgess, MD; Bright, JA; Morris, AJ; Field, RH; Grice, PV; Cooke, AI; Peach, W. 2015. Influence of agri-environment scheme options on territory settlement by Yellowhammer and Corn Bunting, JOURNAL OF ORNITHOLOGY, 156: 1, 153-163.

4) Orford, KA; Murray, PJ; Vaughan, IP; Memmott, J. 2016. Modest enhancements to conventional grassland diversity improve the provision of pollination services, JOURNAL OF APPLIED ECOLOGY, 53: 3, 906-915.

5) Blaauw, BR; Isaacs, R. 2014. Flower plantings increase wild bee abundance and the pollination services provided to a pollination-dependent crop, JOURNAL OF APPLIED ECOLOGY, 51:4.

Wetlands, drainage, and onsite water management

1) Bradbury, R; Kirby, W. 2006. Farmland birds and resource protection in the UK: Cross-cutting solutions for multi-functional farming? BIOLOGICAL CONSERVATION, 129, 530-542.

2) Eglington, S; Bolton, M; Smart, M; Sutherland, W; Watkinson, A; Gill, J. 2010. Managing water levels on wet grasslands to improve foraging conditions for breeding northern lapwing Vanellus vanellus. JOURNAL OF APPLIED ECOLOGY, 47, 451-458.

3) Marja, R; Herzon, I; Rintala, J; Tiainen, J; Seimola, T. 2013. Type of agricultural drainage modifies the value of fields for farmland birds, AGRICULTURE ECOSYSTEMS & ENVIRONMENT, 165, 184-189.

4) Eglington, Bolton, Smart, Sutherland, Watkinson, Gill, (n 2).

5) Jensen, J; Skop, E. 1998. Alternative strategies for reducing nitrogen loading, ENVIRONMENTAL POLLUTION, 102, 741-748.

6) Gregoire, C; Elsaesser, D; Huguenot, D; Lange, J; Lebeau, T; Merli, A; Mose, R; Passeport, E; Payraudeau, S; Schutz, T; Schulz, R; Tapia-Padilla, G; Tournebize, J; Trevisan, M; Wanko, A. 2008. Mitigation of agricultural nonpoint-source pesticide pollution in artificial wetland ecosystems. ENVIRONMENTAL CHEMISTRY LETTERS, 7:3, 205-231.

Best Practices for onsite grazing

1) Senapati, N; Chabbi, A; Gastal, F; Smith, P; Mascher, N; Loubet, B; Cellier, P; Naisse, C. 2014. Net carbon storage measured in a mowed and grazed temperate sown grassland shows potential for carbon sequestration under grazed system, CARBON MANAGEMENT, 5:2, 131-144.

2) Catorci, A; Cesaretti, S; Malatesta, L; Tardella, FM. 2014. Effects of grazing vs mowing on the functional diversity of sub-Mediterranean productive grasslands, APPLIED VEGETATION SCIENCE, 17:4, 658-669.

Case study: Low Carbon's solar-powered honey

1) Potts, S; Roberts, S; Dean, R; Marris, G; Brown, M; Jones, R; Settele, J. 2009. Declines of managed honey bees and beekeepers in Europe. JOURNAL OF APICULTURAL RESEARCH, 49:1. 15-22.

Our work helps to create and expand UK markets in solar and storage. For 40 years we have promoted solar energy and worked to make its adoption easy and profitable for all users. As a not-for-profit we are funded by our membership which includes manufacturers, distributors, developers, asset owners, O&M providers, law firms, consultants, academics and innovators.

Solar's exceptional synergies with storage, EVs and smart grids mean we work on the frontline of technology and system change. Our incisive research, policy-development and lobbying shapes Government policy and regulation. In partnership with key players across the energy industry, the STA is working to secure the smart systems that solar and storage need to thrive.

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