The Nature Conservancy

SolarPower Europe

Rewarding and incentivising nature-inclusive solar through EU policy

POLICY PAPER

Metabolic Consulting

Colophon

Acknowledgements:

Rebecca Humphries, *The Nature Conservancy*
Elif Gündüzyeli, *The Nature Conservancy*
Karen Petersen, *The Nature Conservancy*
Lina Dubina, *SolarPower Europe*
Jonathan Bonadio, *SolarPower Europe*
Alexandra Fox, *Metabolic*
Anne de Valença, *Metabolic*
Livia Maltese, *Metabolic*
Marta Sierra García, *Metabolic*
Jonathan Aronson, *Metabolic*

Reviewers and key stakeholders consulted:

Ingrid Nielsen, *Estonian Fund for Nature*
Kay Cesar, *TNO*
Harry Padfield, *Low Carbon*
Amelia Walsh, *Low Carbon*
Laura Conigliaro, *Low Carbon*

Martin Behar, *UNEF*
Costanza Rizzo, *Statkraft*
Eva Vandest, *Amarenco*
William van der Heiden, *Lightsource bp*

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1. Introduction

Solar photovoltaics (PV) is the largest growing renewable technology worldwide, accounting for 75% of renewable energy growth over the last decades (IEA, 2023). This growth is expected to continue in support of the global effort to reach net zero emissions by 2050, as established by the Paris Climate Agreement. The European Union set the ambitious target of reducing its Greenhouse gas (GHG) emissions by at least 55% by 2030. To meet this target, the EU Solar Strategy (part of the RePowerEU Plan) proposes a trajectory of 750 GWdc of solar PV by 2030. In 2023, the Renewable Energy Directive (RED) set a binding EU-wide target to achieve at least 42.5% (+2.5% indicative top-up) renewable energy in the final energy consumption by 2030 (European Commission, 2023).

While the primary objective of solar PV development is facilitating the energy transition to mitigate climate change, it is also important to consider how solar energy relates more broadly to land use and the global biodiversity crisis. In response to the rate of biodiversity loss in the EU, conservation and restoration of habitats has become a policy priority under the European Green Deal, exemplified by the passing of the EU Biodiversity Strategy (2020) and the Nature Restoration Law (NRL) in June 2024. Even though the projected share of land affected by current and future solar parks remains limited - around 0.3% of total EU land for solar PV, and 2.5% when considering related infrastructure (poles, substations, etc.) (European Environmental Bureau, 2021, 2024) - it's important to properly site and design solar parks so they can tackle both the climate and biodiversity crises at once.

Nature-inclusive solar parks are solar installations designed to not only produce sustainable energy but also enhance local biodiversity, combining restoration, conservation and energy production on the same plot of land. In this model, solar parks are strategically located to minimise negative impacts on native habitats, flora, and fauna, being designed to maximise benefits for the local ecosystem. Native plantings are integrated into the site design to maximise diversity and abundance of locally relevant species and habitats. Notably, nature-inclusive solar parks could play a crucial role in achieving the EU's ambitious Nature Restoration Law, which aims to achieve restoration goals covering at least 20% of degraded EU land and sea by 2030, and all degraded ecosystems by 2050. Since nature-inclusive solar parks can generate considerable revenue enhancing biodiversity, it is also a business model that is garnering significant interest from both private and public sectors.

This policy paper aims to explore how solar parks can contribute to the EU's nature protection and restoration ambitions and create a win-win for renewable energy and biodiversity. As the concept of nature-inclusive solar gains traction across the EU, there is a need now for clear policies to help define, incentivise and scale up. This can create a positive momentum towards developing more solar parks with truly nature-inclusive design supporting renewable energy deployment by facilitating environmental permitting acceleration if stakeholders and communities are adequately consulted.

This policy paper outlines: 1) the concept of nature-inclusive solar parks, proposing a definition and implementation criteria to ensure biodiversity net gain; 2) the key stakeholders involved in and affected by the development of these parks; 3) existing policy schemes that incentivise the development of renewable energy, solar parks, and nature protection; and 4) policy recommendations to scale up nature-inclusive solar parks across the EU.

2. What is nature-inclusive solar PV

2.1. DEFINING NATURE-INCLUSIVE SOLAR TO ENSURE BIODIVERSITY NET GAINS

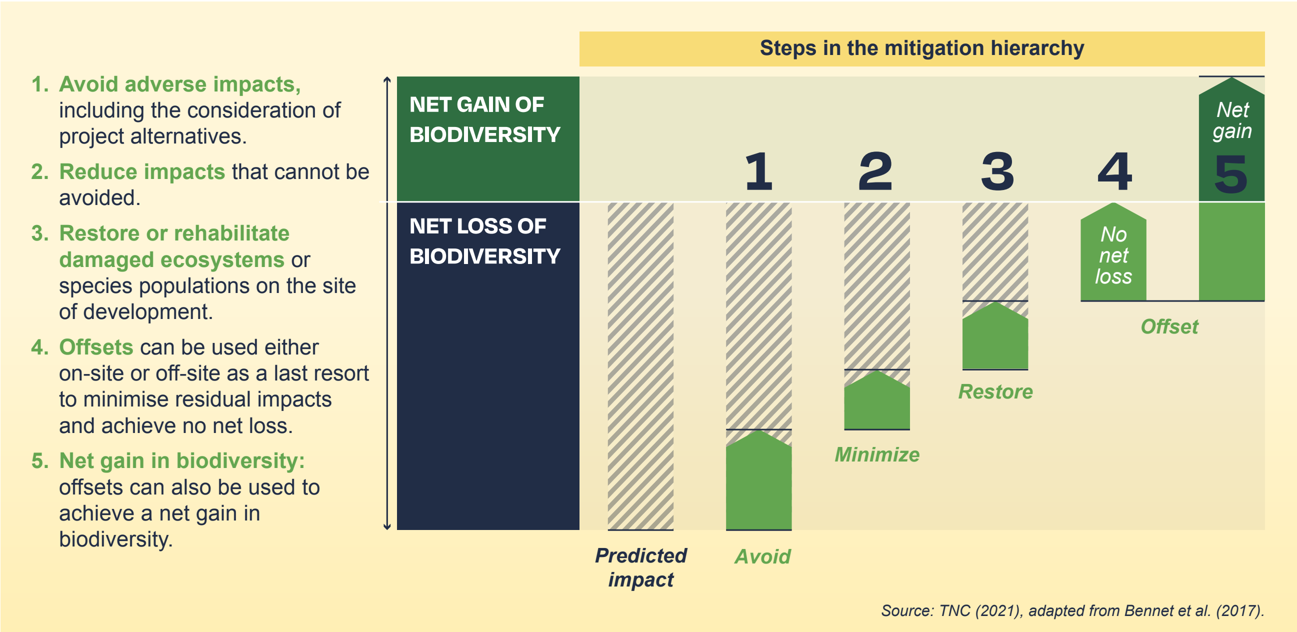


Figure 1: Mitigation hierarchy including biodiversity net gain. Source: TNC (2021).

Most existing policy frameworks lack a clear definition of nature-inclusive solar parks,[1] using different terms such as "biodiversity-friendly" or "nature-positive", leaving significant room for interpretation for renewable energy project developers. An important first step in any policy process is to clearly define the requirements for solar development to be considered nature-inclusive.

The **mitigation hierarchy framework** is useful to define how nature-inclusive solar can ensure biodiversity net gains. This conceptual framework can guide infrastructure development through a decision-making process that minimises overall adverse biodiversity impacts (Arlidge et al., 2018; Phalan et al., 2017). It comprises four stages, representing a phased approach to mitigating biodiversity impacts from infrastructure development:

1. **Avoiding** biodiversity loss and/or degradation
2. **Minimising** impacts to biodiversity
3. **Restoring** damages resulting from development
4. **Offsetting** unavoidable damages through nature restoration outside project boundaries

This mitigation hierarchy framework can be applied to solar park developments to evaluate their impact on biodiversity (Baker, 2016). Most importantly, avoiding biodiversity damage is the best way to truly implement nature-inclusive solar parks, as it ensures the preservation of existing native biodiversity. The most effective method to avoid any biodiversity loss and/or degradation is to site solar parks within the built environment (e.g. rooftops, parking lots, transport infrastructure, industrial land, etc.) or on low biodiversity-value lands (e.g. mine lands, landfills, degraded land) - thereby avoiding natural or semi-natural areas (SolarPower Europe; The Nature Conservancy).

Considering the current rate of global biodiversity loss, merely avoiding negative impacts to biodiversity alone is insufficient to meet the EU nature protection and restoration targets. When constructing, operating and dismantling a solar park, impacts on biodiversity should be minimised, and restoration/rehabilitation should be used to address any residual impacts after avoidance and minimisation. restoration is an important tool that will be covered in more detail below, the primary aim should be to avoid and minimise impacts on ecosystems entirely as true biodiversity restoration can take years or even decades.

[1] *A similar term 'Eco-PV' is commonly used among solar stakeholders to describe ground-mounted PV systems, where various biodiversity measures are implemented on the solar sites. For this report, the term 'nature-inclusive solar' will be used.*

Unavoidable losses of biodiversity which cannot be minimised or restored on-site, may be offset elsewhere as a last resort for managing impacts to biodiversity. These offsets should be bound to safeguards as part of government-administered programmes (Bull et al. 2013; World Bank, 2016):

- **Additionality:** biodiversity offsets must deliver conservation gains beyond those that would be achieved by ongoing or planned activities that are not part of the offset.
- **Equivalence:** biodiversity offsets should conserve the same biodiversity values (species, habitats, ecosystems, or ecological functions) as those impacted by original project.
  - Spatial equivalence: biodiversity gains should be located close to where impacts are occurring.
- **Permanence:** Biodiversity offsets are normally expected to persist for at least as long as the adverse biodiversity impacts from the original project; in practical terms, this often means in perpetuity.
  - Temporal: time-lags between biodiversity losses and gains should be avoided.

Another measure of nature-inclusive solar parks is **biodiversity net gain**,[2] a comparison of the assessed level of biodiversity before and after a development (Baker, 2016; Solar Energy UK, 2022). If the assessed level of biodiversity after a development is higher, it can be described as a net gain in biodiversity. Figure 1 shows how biodiversity net gain relates to the mitigation hierarchy, in that it goes beyond avoiding negative impacts to improving the status quo. For a solar park development to be categorised as contributing to biodiversity, the biodiversity net gain measure can be useful as it allows for distinction from developments that are simply achieving no net loss of biodiversity versus restoring previously deteriorated biodiversity.

To make a strong claim for nature-inclusive solar parks, developers need to understand how to apply the mitigation hierarchy and how to promote and evaluate biodiversity net gain. Governments can drive ambition by using these concepts to clearly define requirements for solar developments to be considered nature-inclusive through policies. A clear definition for solar developers should encompass the entire lifecycle of a solar park, including planning, implementation, and long-term management.

Our proposed definition of nature-inclusive solar parks is the following:

A solar park that follows the mitigation hierarchy - by avoiding the conversion of protected nature areas and rather developing on land with low-biodiversity value - and contributes to biodiversity net gain, by managing the land to create a net increase in native biodiversity relative to the assessed level prior to solar development.

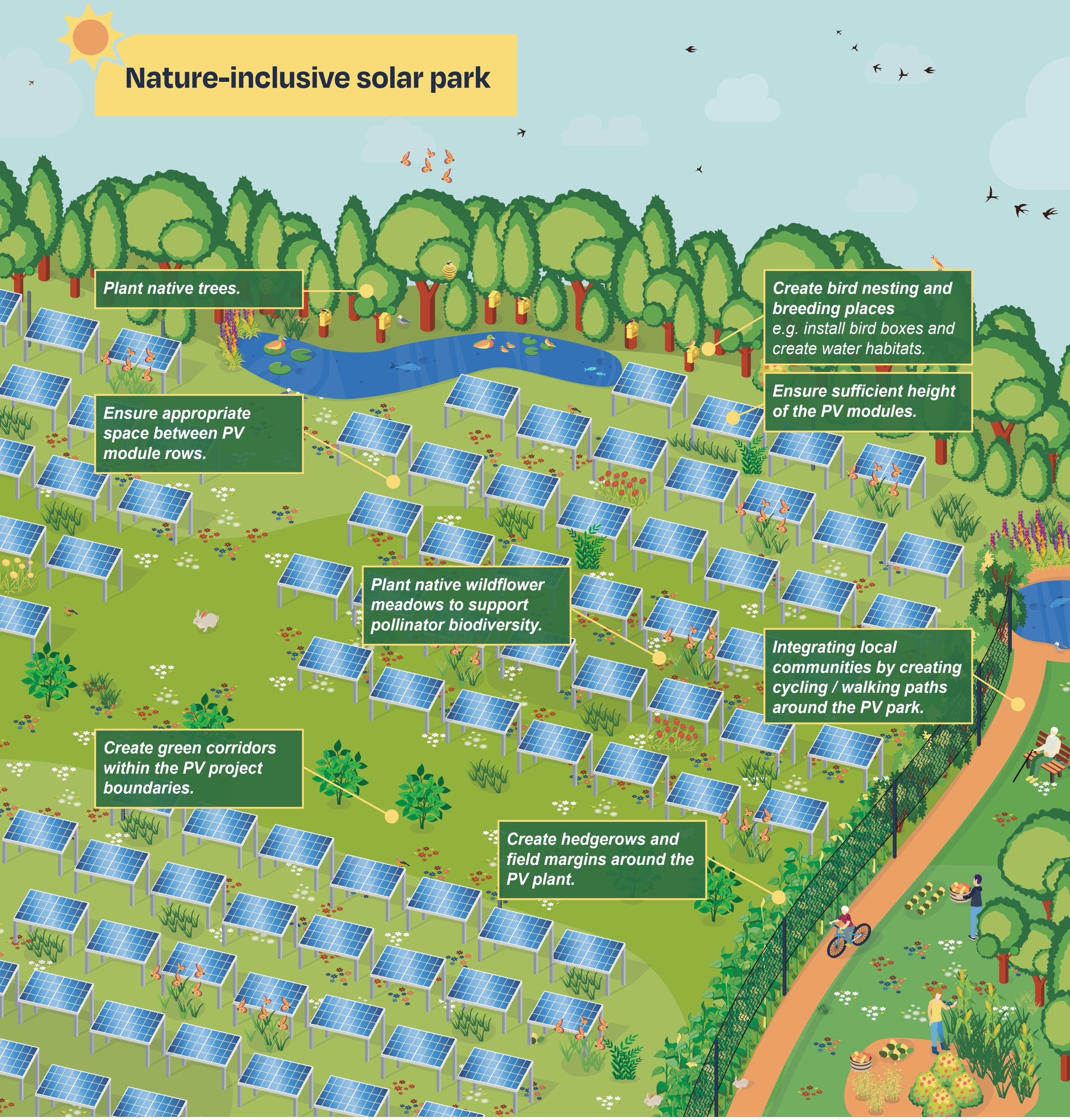
In practice, such a definition could include the following:

1. Completion of an environmental assessment (including a biodiversity baseline) as a prerequisite for granting planning permission to identify sensitive habitat and species and to set a baseline for existing biodiversity.
2. Avoidance of net biodiversity loss.
3. Active creation of locally appropriate habitat for native biodiversity on site.
4. Continuous site management for biodiversity outcomes during the entire period of solar production.
5. Measurable and maintained net increase of biodiversity on the plot of land compared to pre-development levels.

By establishing a clear, ambitious and non-negotiable definition of nature-inclusive solar PV, policy can guide developments to ensure biodiversity net gains. Such a definition also sets a baseline for any claims developers can legally make regarding their impact and provides assurance to energy offtakers that they are sourcing verified biodiversity-friendly solar energy.

[2] *For the purposes of this paper, use of the term biodiversity net gain refers to this definition under the mitigation hierarchy, and not the regulatory Biodiversity Net Gain scheme in application in England, unless this is explicitly referred to as under section 4.2.*

Figure 2: A nature-inclusive solar park.



Solar-inclusive nature restoration

An alternative angle worth considering is the primary purpose of the plot of land proposed for development. the above concept focuses on how solar parks can create co-benefits for biodiversity, if the primary purpose of the land in question is nature conservation, a new perspective on solar development becomes possible. In this case, ecosystem restoration is the primary purpose solar energy is rather a means to finance the restoration. This approach could significantly scale up nature restoration efforts and should be encouraged by governments where feasible. Although this model may not be viable as a standalone business model for energy generation, it could be valuable for community-led conservation. Given the EU's nature restoration goals, placing solar panels on land undergoing restoration could provide a revenue stream to support projects that contribute to national restoration targets.

2.2. AREAS SUITABLE FOR NATURE-INCLUSIVE SOLAR PARKS

As environmental organisations have repeatedly established, the land required by renewables is limited, by contrast to other industrial activities: the European Environmental Bureau (EEB) has highlighted only 0.3% of the EU's total land would be needed for current and future solar projects (and 2.2% of total EU land for current and future solar and wind projects together) and there is sufficient land to roll out renewables sustainably (EEB, 2024). Yet, given that solar parks have relatively high land requirements per unit of energy produced (Bennun et al., 2021) and may intensify local competition for land (EEB, 2024), site selection is crucial for mitigating biodiversity risks and supporting conservation efforts (Kiesecker et al., 2024).

As the definition above refers to protected nature areas, it is important to align these definitions with existing EU classifications. Renewable mapping guidance identifies specific areas as unsuitable for solar development projects within acceleration areas (with the exclusion of artificial surfaces in those areas). Outside of acceleration areas, development remains exceptionally possible in these zones under the condition of stringent environmental impact assessment (EIA):

- Areas strictly protected according to international law (such as IUCN categories 1A and 1B, core zones of IUCN categories 2 and 5, RAMSAR sites)
- Protected areas under EU law, specifically the Natura 2000 network.
- Nationally designated strictly protected sites, including core areas of national parks and buffer zones.
- Primeval forests recognised through national legislation.

In addition, nationally implemented regulations that are equivalent to the EIA should also be considered.

SolarPower Europe (2024) provided guidance on the suitability of landscapes for solar parks and concluded that degraded lands have the highest potential for nature-inclusive solar developments. These areas mainly include artificial surfaces and agricultural land with low biodiversity value (The Nature Conservancy, n.d). The key distinction is therefore the state of the landscape before solar development: if the land has low biodiversity value to begin with, nature-inclusive solar has the potential to positively affect biodiversity (Semeraro et al., 2018). If biodiversity is high, the land should be protected and not be deemed suitable for development (Nordberg et al., 2021). To make this distinction, a biodiversity assessment should be conducted early in the planning process, before any development occurs.

2.3. BEST PRACTICES

Besides choosing the most suitable location for solar development, ecologically sensitive site design and sustainable land management practices are also key to increasing biodiversity in solar parks. It is possible to minimise impacts on the local environment and enhance habitat value by: restoring and protecting natural features on the site; improving soil quality through proper ground irradiance; planting native, pollinator-friendly vegetation in and around solar panels; creating additional habitat around the perimeter; reducing barriers to wildlife movement with unfenced wildlife passages and wildlife-friendly fencing; and by sustainably managing the site over the long-term.

Minimise disturbance to natural features

If the site's boundaries contain natural features of ecological significance, such as wetlands, streams, or forest patches, steps should be taken to restore and/or protect those areas. These features can be maintained within the solar park to enhance the site's value to local biodiversity and ecosystem services.

Install technology that contributes to vegetation growth below panels

Managing irradiance effectively in solar parks can significantly contribute to soil health. By optimising the design to allow more sunlight to reach the ground between and under solar panels, it is possible to maintain or improve soil quality and vegetation cover, preventing soil degradation over time (Zon in Landschap, 2021). This can be done by using semi-transparent, bifacial solar panels that increase the amount of light reaching the ground supporting plant growth and therefore also soil's organic matter deposition. Another technology that can contribute to healthier soil and vegetation below panels is solar trackers, which orient the panel towards the sun and therefore reduce the amount of soil that is constantly shaded. As these technologies are often more expensive than conventional panels and more suitable for agri-PV applications, and may also yield lower energy production, there may be an economic trade-off with these technologies that need to be accounted for in policy guidelines. Therefore, aspects such as design of the PV structures (distances between rows, height of the PV panels, etc) might provide similar benefits being more economically feasible and should be considered.

Plant native ground cover

Planting and maintaining diverse native seed mixes under and around solar arrays is a key part of maximising the ecological benefits of a solar park. A diverse seed mix should be selected that provides vital habitat for a variety of pollinators throughout their lifecycle, including pollen and nectar for sustenance, nesting sites for reproduction, and refuge for overwintering (Tölgyesi et al., 2023). Critically, solar panels should be mounted sufficiently high off the ground. This provides sufficient sunlight, airflow, and room to maintain healthy plant growth below. Solar panels mounting height greatly influences the overall potential for plant diversity, with higher mounted panels allowing for greater diversity and providing more flexibility when selecting appropriate species for the site.

Create habitat around the perimeter

A broader diversity of native plant species can be planted around the site's perimeter to create a biodiverse vegetated buffer. Since height is not a barrier, a mix of native trees and shrubs can be planted where appropriate to increase structural and species diversity (Semeraro et al., 2018). A well-designed buffer can also increase the attractiveness of the site by creating a visual screen and augment community support.

Reduce wildfire barriers

Traditional fences can create a barrier to wildlife movement. To prevent disruption where wildlife movement is likely, wildlife passages – unfenced pathways with vegetative cover - can be integrated into the site design. Wildlife-friendly fencing, which has larger holes at the bottom to allow small to mid-sized animals to pass through, can also be used to facilitate movement of specific species.

Sustainably manage the site over the long term

Once native habitat has been established on a solar park, ongoing management is required to sustain the ecological health of the site and to prevent re-establishment of non-native and invasive species. While land management will be required over the project's lifetime, more intensive management will be required during the first few years. Management requirements will decrease once the habitat is fully mature. If mowing is required to maintain the site's health, it is imperative to establish mowing guidelines and a mowing schedule that supports native plant growth and protects sensitive species on the site. While some herbicides may be useful for the spot treatment of weeds, care should also be taken to minimise their use to avoid deleterious effects (Solar Energy UK, 2022; Uldrijan et al. 2022).

To maximise the potential benefits of the nature-inclusive approach, these best practices must be incorporated into the early planning phases of a solar PV project. Site-specific designs and management plans should be developed in close coordination with specialists with knowledge of local environmental considerations and native plants. Practices must be adapted to each site, considering different ecosystems and unique differences in landscapes, natural resources and habitat features.

Case study 1.

Sustainable solar parks (Enel Green Power)

Enel Green Power is developing 'Sustainable Solar Parks,' a global initiative which tests tailor-made agrozootechnical solutions and sustainable practices on different photovoltaic (PV) sites. The company implements biodiversity measures in selected PV sites, including in marginal unused areas. The demonstrator sites were selected based on different criteria, for instance, sites with different operational years and different soil characteristics (compaction grade, nutrient concentration, etc.) to assess feasibility and impact within selected areas. For full-scale plants, a mitigation hierarchy is followed from the design to the operation of the projects.

Several demonstrations have occurred in different PV plants, across 5 countries and 3 continents. Enel's programme has been developed for standard PV plants (height of 2.2-2.5 m), to improve their environmental/ ecological sustainability and social acceptability. The programme is intended to create a shift from the concept of Industrial Solar Plants to 'Sustainable Solar Parks.' This innovative vision is focused on multipurpose land use through the harmonisation of solar PV energy production, biodiversity preservation, the improvement of ecosystem services, and the integration of agrozootechnical activities.

The initiative outlines two main targets:

- Solar inclusivity, which focuses on crops, regenerative agriculture and pasture, ensuring a collaborative multi-stakeholder approach.
- Solar diversity, which focuses on safeguarding biodiversity and habitats everywhere improving overall ecosystem services.

The 'Sustainable Solar Park' concept incorporates agrozootechnical activity integration in PV plants (agri-PV concept), in addition to specific measures for safeguarding biodiversity and ecosystems. Consequently, these solar PV plants are both renewable energy generators and biodiversity promoters, as seen with plants in Spain, Greece and Italy. For example, in Spain, through the creation of ecological corridors, biodiversity safeguarding measures for wild and domestic pollinators have been implemented, as well as solutions for the protection of steppe birds. In Greece, the creation of biodiversity hotspots within the plant and in marginal areas have been carried out. Wild pollinators, particularly endangered butterflies, are safeguarded on sites due to larval host plants and smart grass management practice. In Italy, an oasis for bees and other wild pollinators (bumble bees, etc.) with different flower mixes has been implemented. In this case, the pollinators are used as biosensors for evaluating the evolution of the ecosystem and soil regeneration over a set period. Another fundamental aspect is the local community's integration, with dedicated training sections for students, young people and families. Moreover, the adoption of high-technology sensors and innovative tools promote more efficient and environmentally friendly practices (i.e. water use reduction) which decrease the stress on the surrounding ecosystems.

Case study 2.

PV park Spitalhöfe in Germany (BayWa r.e.)

Spitalhöfe solar PV park, located in Villingen-Schwenningen, Germany, is one of the first hybrid energy plants in Germany that combines a 7.5 MWp ground-mounted solar plant and a 4 MWh battery storage. This plant was commissioned in May 2022. The Spitalhöfe site did not follow a regular site selection process. The landowner reached out to the energy company to help develop a solar project promoting biodiversity on the site.

Various long-term measures to preserve and promote biodiversity have been integrated. Flowering islands were planted on the site to improve biodiversity, and to increase the number of pollinating insects, e.g. wild bees. The islands have a positive effect on neighboring agricultural land. They promote insect abundance and secure the food source for many breeding bird species. The project has also incorporated nature-positive elements such as nest boxes, biodiversity corridors that provide paths for wild animals (e.g. deer and wild boars), and habitats for reptiles, small mammals, hedges, and trees. Sheep grazing has also been introduced on site to improve soil health fertilizer and herbicide use has been restricted. The project has brought in local nature conservation organisations into the planning and project design process.

Case study 3.

Adapting to biodiversity net gain regulation in the UK (Low Carbon)

Low Carbon is a global renewable energy company headquartered in London aiming to create as much large-scale clean energy as possible to help fight climate change, and in the process, protect the natural environment.

In February 2024, the UK government made it mandatory for all future solar developments in England to have a biodiversity net gain of at least 10 per cent. Projects can deliver above this figure and are encouraged to do so, both for the sake of benefiting local ecosystems, and as projects developing surplus units may have an opportunity to sell to developers who are unable to meet the minimum targets themselves.

For a solar farm, only a small proportion of land needs to be taken up by infrastructure. This means that the remaining area on each site can be set aside to increase the diversity of habitats and species including planting boundary trees and woodland, installing bird boxes, planting wildflowers, sheep grazing and management measures that minimise the disturbance of resident species.

For each project, biodiversity must be protected for a minimum of 30 years under the new law, and Low Carbon has developed robust plans for each of its renewable energy projects to implement biodiversity net gain over their lifespan. Many of Low Carbon's solar farm developments in the UK have been calculated to provide estimated net gains of more than 80%, presenting significant biodiversity-related opportunities. However, this requires collaboration between developers, planners, ecologists, and other stakeholders to ensure that conservation objectives are effectively integrated into development plans. Low Carbon achieves this in several ways:

- Forming a long-term partnership with Lancaster University, where they recently deployed AI technology alongside acoustic monitoring devices to provide near continuous assessment of pollinators on solar farms.
- Employing its own Operations & Management team to further measure the impact of development on nature. Often these services are performed by third-party contractors, however, by doing this in-house it has allowed Low Carbon to build an invaluable knowledge base backed up by solid and robust data enabling them to meet the Biodiversity Net Gain scheme requirements more effectively and respond more nimbly to future regulatory changes.
- Working closely with landowners to implement land and biodiversity management programmes, aligning with the conditions and circumstances unique to each site, enables Low Carbon to uncover opportunities that both enhance biodiversity and yield direct commercial benefits.

For Low Carbon, the new law will not only help to protect the planet by reversing biodiversity loss across its sites – it will also create an investment opportunity through the sale of surplus biodiversity net gain units helping to create a new revenue stream that can support the build out of more renewables in their portfolio.

3. Key stakeholders

Any project development involves stakeholders that influence the process and are affected by its outcomes. This section highlights the most important stakeholders involved and/or affected by the development of nature-inclusive solar parks. The Appendix contains a more extensive list of stakeholders, and the involvement of a variety of stakeholders in the policy-making process is recommended to allow for dialogue and broad support for the final policy.

3.1 THE SOLAR SECTOR

Nature-inclusive solar can provide a reputational benefit to solar park developers by creating opportunities to make sustainability claims. New solar park proposals are also more likely to be attractive for legal permittance and investors if a developer can make a credible claim about restoring nature also generating renewable energy and revenue, especially on previously degraded land. To the extent that nature-inclusive solar creates a more visually appealing landscape, it can also increase community support for solar projects. Solar park developers may be more likely to employ cost-cutting methods, including covering as much of the area as possible with solar panels, installing low-mounted panels, and using turf grass or low-diversity seed mixes as ground cover. Therefore, governments need to create the right regulatory and market mechanisms to ensure that developers follow best practices to protect and augment biodiversity in the landscape. One key selling point could be the stability of returns that governments can provide compared to fluctuating energy prices determined by the market.

3.2 THE AGRICULTURAL SECTOR

Agricultural land is often considered optimal for solar parks, since the land has already been cleared and is easily accessible, especially land located in areas with good grid connectivity. In the EU, around 48% of agricultural land is farmed by the landowner, 46% is rented by farmers to cultivate (Eurostat, 2020). For farmers that own their land, adding solar panels to the land can be an attractive way to add an additional income stream. They can do this by either integrating solar panels with their farmland or by renting out a certain amount of land to a solar company. Farmers can potentially benefit from additional income if using set aside land or degraded agricultural land for nature-inclusive solar parks. For those farmers that do not own the land they farm, solar development can become a competing land use which may be more attractive to the landowner. This dynamic needs to be considered when creating policies that favour the creation of nature-inclusive solar parks on agricultural land. Ownership structures will determine who receives the additional revenue from the development, and farmers must be involved in the planning process.

3.3 LOCAL COMMUNITIES

Local communities can be directly affected by the landscape changes from solar parks. Backlash is not uncommon when landscape changes are announced, and communities can mobilise and hinder solar developments in their area. On the other hand, nature-inclusive solar parks can bring ecosystem services to communities, by potentially providing access to recreational areas in the green spaces, access to locally produced renewable energy, and cleaner air and water. Involving local communities in the planning process is fundamental to ensure their voices are heard and they do not feel a loss of control over their local surroundings. There is much potential for creating socio-economic synergies such as: directly feeding generated solar energy to local industry, including a local livestock farmer in grazing management, or engaging local nature groups in the management and monitoring of biodiversity in the solar park. Besides these benefits, local communities also often hold locations-specific knowledge about native and indigenous habitats that need protecting or restoring. Meaningful community involvement can therefore contribute to a more suitable approach to conserving biodiversity and reduce the likelihood of conflicts arising.

3.4 ECOLOGISTS AND LANDSCAPE ARCHITECTS

the solar industry is well placed to provide technical advice and guide the installation of solar panels, other experts need to be consulted to assess landscape features and biodiversity needs and benefits. Ecologists can conduct assessments to determine current levels of biodiversity and recommend how to best enhance this existing biodiversity. They can also provide advice on a locally appropriate seed mix to sow in the solar park, which can help create habitat suitable for local fauna. Landscape architects can provide expertise on how to best integrate solar parks avoiding the degradation of the local landscape. Consulting external experts can add credibility to a development and avoid unintended consequences on biodiversity and landscape integrity.

4. Existing policy schemes for nature-inclusive solar development

To ensure that solar development creates a positive impact on biodiversity, a policy environment that encourages management for biodiversity is key (Phalan et al., 2017). In this section we review existing policies that are or may be relevant to nature-inclusive solar development, with a focus on the supranational (EU), national and regional levels. Table 1 lists several policy schemes that aim to catalyse the transition to renewable energy and some of them (highlighted in bold) include measures to protect the environment. This section outlines key EU policies and policies from countries that are major solar energy producers in Europe, including Germany, France, the Netherlands, Italy, and Spain. Note that this overview does not include all potentially relevant policies across the EU but rather a subsection of examples.

Table 1: Schemes across EU about the intersection of renewable energy, solar PV and/or nature protection.

Scheme/ Policy	Government level	Key features
European Green Deal	EU	Policy that aims to achieve EU carbon neutrality and biodiversity protection and restoration.
EU Biodiversity Strategy for 2030		Strategy for conservation and restoration of biodiversity across the EU, including a target to protect 30% of land and restore 20% of degraded habitat by 2030 and all degraded habitats by 2050.
Nature Restoration Law (NRL)		Policy that aims to restore degraded habitats.
Horizon Europe		Funding for innovation and research.
Common Agricultural Policy (CAP)		Policy and subsidies to support farmers.
Solar Energy Strategy		Plan to simplify permitting processes and streamline grid integration; invest in innovation, research, and development to drive down costs; and improve the efficiency of solar technologies.
Renewable Energy Directive (RED)		Legislation setting EU definitions and targets for renewable energy generation.
Renewable Energy Sources Act (EEG)	National - Germany	Feed-in tariffs and market premiums.
Energy Transition Law	National - France	Law that encourages the development of **solar parks that include ecological features.**
SDE++ (Stimulation of Sustainable Energy Production and Climate Transition)	National - Netherlands	Funding program that favours **nature-inclusive solar parks.**
Conto energia	National - Italy	Incentive schemes for renewable energy.
Guidelines on Agri-PV systems		Framework providing economic incentives and addressing environmental issues.
Royal Decree-Law 23/2020	National - Spain	Law to promote renewable energy and biodiversity protection.
Renewable energy auctions		Funding for solar energy.
Biodiversity Net Gain within the Town and Country Planning Act	National - England	Mandatory requirement for new developments to deliver a biodiversity net gain of 10% or more.

4.1 EU POLICIES

At the EU level, several policies and programs exist that encourage the transition to renewable energies and some of them demand biodiversity preservation as a prerequisite.

The European Green Deal, launched in December 2019, aims to make Europe the first climate-neutral continent by 2050. It includes measures to reduce greenhouse gas emissions, invest in renewable energy, enhance energy efficiency, and promote sustainable agriculture and halting and reversing biodiversity loss. It mentions the importance of incorporating biodiversity measures into various economic sectors, including the renewable energy sector but it does not explicitly refer to nature-inclusive solar parks nor does it provide a definition for the latter.

The EU Biodiversity Strategy for 2030, a key component of the EU Green Deal, focuses on enhancing biodiversity conservation and restoration across the EU (European Commission, 2020). Notably, the strategy highlights the importance of "solar-panel farms that provide biodiversity-friendly soil cover," although it does not provide further details on this aspect.

One of the actions set out in the EU Biodiversity Strategy for 2030 is to strengthen legal frameworks for nature restoration. This objective has been partially realised through the adoption of the Nature Restoration Law, a pioneering regulation formally approved by the European Council on June 17, 2024. Once the law enters into force, it will become directly applicable in all member states setting legally binding targets for the restoration of degraded habitats and ecosystems by 2030 targeting, among others, wetlands and grasslands.

The Nature Restoration Law and its relevance to nature-inclusive solar

This section provides an overview of the main provisions of the NRL that are relevant to and provide opportunities for nature-inclusive solar park development.

General objectives of the NRL

The NRL establishes rules to reach the following objectives:

- The long-term recovery of biodiverse and resilient land and sea ecosystems through the sustained restoration of degraded ecosystems
- The achievement of climate change mitigation, adaptation and land degradation neutrality
- The enhancement of food security

For this purpose, the Regulation establishes a set of measures with the aim to restore at least 20% of the land and sea ecosystems by 2030, and all ecosystems in need of restoration by 2050.

Restoration targets

Under Article 4, Member States are requested to put in place the measures that are necessary to restore to good condition areas of habitat types listed in Annex I (land ecosystems) which are not in good condition.

Such measures shall be in place:

- on at least 30% by 2030 of the total area of all habitat types listed in Annex I that is not in good condition;
- on at least 60% by 2040 and on at least 90% by 2050 of the area of each group of habitat types listed in Annex I that is not in good condition.

Under Article 5, Member States are requested to put in place the measures that are necessary to restore to good condition areas of habitat types listed in Annex II (marine ecosystems) which are not in good condition.

Such measures shall be in place:

- on at least 30% by 2030 of the total area of groups 1–6 of habitat types listed in Annex II that is not in good condition;
- on at least 60% by 2040 and on at least 90% by 2050 of the area of each of the groups 1–6 of habitat types listed in Annex II that is not in good condition.

Renewable energy sources

Article 6 recalls the presumption of Overriding Public Interest that applies to renewables. In particular, Member States can derogate from the principle of absence of less damaging alternative, provided that a Strategic Environmental Assessment or Environmental Impact Assessment has been carried out.

Nature-inclusive solar parks may in some cases align with the presumption of Overriding Public Interest for renewables by ensuring that environmental impacts are minimised through the mitigation hierarchy framework.

Restoration of pollinator populations

Under Article 10, Member States shall, by timely putting in place appropriate and effective measures, improve pollinator diversity and reverse the decline of pollinator populations at the latest by 2030 and achieve thereafter an increasing trend of pollinator populations, measured at least every six years after 2030, until satisfactory levels are achieved.

Nature-inclusive solar parks can significantly boost pollinator populations by incorporating diverse flowering plants and habitats that support pollinators like bees and butterflies, including endangered species and species that are at risk of extinction.

Restoration of agricultural ecosystems

Under Article 11, Member States shall put in place the restoration measures necessary to enhance biodiversity in agricultural ecosystems, in addition to the areas that are subject to restoration measures, considering climate change, the social and economic needs of rural areas, and the need to ensure sustainable agricultural production in the Union.

Member States shall put in place measures which shall aim to achieve an increasing trend at national level of at least two out of the three following indicators in agricultural ecosystems by 2030:

- grassland butterfly index;
- stock of organic carbon in cropland mineral soils;
- share of agricultural land with high-diversity landscape features.

In the same article, Member States shall put in place measures which shall aim to restore organic soils in agricultural use constituting drained peatlands. Those measures shall be in place on at least:

- 30% of such areas by 2030, of which at least a quarter shall be rewetted;
- 40% of such areas by 2040, of which at least a third shall be rewetted;
- 50% of such areas by 2050, of which at least a third shall be rewetted.

Nature-inclusive solar parks can enhance biodiversity in agricultural ecosystems by following best- practices that increase pollinators presence and soil organic content. Installing pollinator habitats not only can benefit local biodiversity but can also provide ecosystem restoration services (e.g. crop pollination).

Solar can also help restore degraded ecosystems and has the potential to revitalise degraded peatlands by integrating site-specific management practices.

National Restoration Plans (NRP)

Two years after the entry into force of the Regulation, Member States shall submit their National Restoration Plan (NRP). These plans shall contain i.e. a map of the habitats that are not in good condition and that need to be restored by 2030 and shall also cover long-term restoration targets by 2050. The monitoring of the restoration will be ensured by clear indicators. Member States shall identify synergies with agriculture and forestry, including CAP interventions, that contribute to the restoration objective. The implementation of the regulation shall however not imply re-programme any CAP funding.

In the NRP, Member States shall also coordinate the exercise with the renewable energy spatial mapping and shall ensure that the functioning of the renewable acceleration areas remains unchanged.

The Commission will then assess the draft NRP within six months of the date of receipt. The plan shall be revised by the Member States before July 2032 and before July 2042.

Member States shall monitor key performance indicators (including at least two of the indicators of biodiversity in agriculture) and report at least every three years to the Commission the areas subject to restoration.

The NRPs, the monitoring and reporting are included in Articles 20 and 21.

Nature-inclusive solar parks can support the reporting and monitoring of biodiversity indicators as this is part of the process to calculate biodiversity net gain.

Horizon Europe, a research and innovation program, offers grants for developing and testing innovative projects, including solar park design. As a key funding and support initiative for solar PV research and innovation, Horizon Europe plays a significant role. However, it currently lacks programs that incentivise solar deployment in a nature-inclusive manner.

The Common Agricultural Policy (CAP) aims to support agricultural production, ensure a fair standard of living for farmers, stabilise markets, and guarantee food security. The energy transition and biodiversity are prioritised in the policy, especially regarding Agri-Photovoltaics (Agri-PV) systems that integrate solar panels with crops or forage. CAP's conditionality mechanism requires farms to comply with certain environmental standards in exchange for receiving direct payments. Even though these payments include some provisions to support solar energy and biodiversity stimulation, the focus remains on conventional agricultural activities.

The **EU Solar Energy Strategy** aims to accelerate the deployment of solar energy in Europe. It includes simplifying permitting processes and streamlining grid integration, investments in innovation, research, and development to drive down costs, and improving the efficiency of solar technologies.

The **Renewable Energy Directive (RED)** is a legislative framework promoting the use of renewable energy sources for electricity, heating, and cooling. The goal is to reach at least 42,5% renewable energy by 2030. Incentive mechanisms include feed-in tariffs, premium payments, favourable tendering processes, quota systems, tax incentives and grants. The Directive also includes the obligation for Member States to do a mapping exercise of future renewable installations and to designate Renewable Acceleration Areas where the environmental impact is expected to be the lowest. These policies, however, do not specify how biodiversity net gain might favour project developers, farmers, landowners and other stakeholders.

4.2 NATIONAL POLICIES

Policies at the national level are responsible for making EU regulations effective but also for setting ambitious standards for EU Member States. Here we describe specific policies related to solar energy and biodiversity net gain, focusing on Germany, France, Netherlands, Italy and Spain, which are the major producers of solar energy in Europe (Ember, 2024). Lastly, after leaving the EU, England has adopted an ambitious law around biodiversity net gain, which is the first of its kind in Europe and is therefore also included in this review.

In **Germany,** the **Renewable Energy Sources Act (EEG)** provides feed-in tariffs and market premiums for renewable energy projects with the aim of expanding renewable energy sources. The EEG provides mechanisms to incentivise renewable energy projects and includes Monitoring, Reporting and Verification (MRV) mechanisms.

EEG also aims to foster the nature-inclusive design of solar parks. To be eligible for funding, at least three out of five minimum ecological criteria must be implemented. The EEG refers to biodiversity enhancing or biodiversity-friendly solar facilities (Biodiversitätssolaranlagen), entail nature-inclusive solar parks. The use of additional (net) biodiversity gains is highlighted in the 4th criterion: at least 10% of the area of the installation will have site-adapted types of biotope elements.

Furthermore, **Germany** applies the so-called **nature conservation intervention regulation** (Eingriffsregelung), which primarily aims to prevent significant impairments to nature (general principle according to § 13 BNatSchG) through site selection with minimal impacts. The mentioned intervention regulation aims to secure and maintain the functionality of the natural capital and the landscape, even outside protected areas. Unavoidable impairments must be mitigated or compensated. If this is not feasible, monetary compensation should be provided. This is facilitated through the so-called "*Biotopwertverfahren*" (biotope value procedure), which calculates the compensation requirement in biotope value points ("eco-points") and is regulated according to state-specific regulations. These points can be bought or sold and serve as a regulatory mechanism (prevention), corresponding to a deterioration prohibition.

France adopted its **Energy Transition Law for Green Growth** in 2015, which regulates the roll-out of renewable energy across France. In 2019, the law was updated to include a requirement for investors to report on biodiversity impacts as part of their non-financial reporting. In addition, France passed the "Renewable Energy Acceleration Bill" in 2023 which aims to speed up renewable energy deployment, primarily through fast tracking planning permissions. In addition, the chances of obtaining planning permission are increased if the development promises the integration of biodiversity-inclusive measures. The specific measures encouraged include:

1. **Vegetation management:** Solar parks are encouraged to use native plant species and create habitats for local wildlife. This can involve planting wildflowers, maintaining grassland areas, and implementing managed grazing by livestock to control vegetation growth naturally.
2. **Pollinator habitats:** Creating environments that support pollinators, such as bees and butterflies, is a key biodiversity measure. This can include planting flowering plants and maintaining habitats that are conducive to the life cycles of these insects.
3. **Water management:** Proper management of water resources to avoid negative impacts on local ecosystems is also recommended. This includes the use of drainage systems that minimise soil erosion and protect aquatic habitats.
4. **Habitat corridors:** Establishing green corridors that connect different habitats can help maintain wildlife movement and biodiversity. These corridors facilitate the migration and interaction of species across different areas.

The Netherlands has seen a rapid growth in the solar sector over the past decades making solar power a significant component of its renewable energy mix. To enhance the transition to solar energy the government developed the **SDE++** (Stimulation of Sustainable Energy Production and Climate Transition). This program provides subsidies for renewable energy projects that contribute to climate goals, including those that integrate biodiversity conservation. In 2024 the budget was increased, offering for the first-time additional funding for nature-inclusive solar parks. Despite requiring further technical and legal implementation, this opens the door to new funding criteria that set ecosystem benefits as a baseline requirement for solar parks rather than an additional feature. If policymakers streamline such requirements, biodiversity net gain could become a standard metric for assessing the impact of solar parks on the surrounding landscape.

Another example for enhancing the transition to solar energy combined with biodiversity lay in the '**Gedragscode zon op land**'. This is a code of conduct established in the Netherlands (by branche organization Holland Solar) to guide the development of solar parks on land. It outlines principles and guidelines for responsible and sustainable development, covering aspects such as spatial planning, landscape integration, biodiversity conservation, and community engagement. The code aims to ensure that solar projects are developed in harmony with their surroundings, minimise negative impacts on the environment, and foster positive relationships with local communities.

A project worth mentioning is the Eco Certified project, Europe's biggest research on solar park ecology, that was launched in 2022 by Wageningen University & Research, TNO, Eelerwoude, Holland Solar and NL Greenlabel. Over a period of 4 years, they will investigate how different design and management methods affect nature in solar parks and create a certification to help developers make their park more eco-friendly, very useful for policy makers and developers at the end of the project (Wageningen University and Research, 2022).

Italy presents national and regional policies as well as incentives that regulate solar PV installation and ecosystem impact. Italy's feed-in tariff program, known as **Conto Energia**, provided financial incentives for renewable energy projects, including solar parks developed between 2005 and 2013. The program was structured to enhance the deployment of solar energy, but it did not integrate specific provisions or guidelines for biodiversity preservation or nature-inclusive practices within solar parks. A new incentive scheme is currently under development and will likely be launched this year.

Regarding regional and local incentives, some regions like Sicily, Piedmont and Veneto have specific environmental regulations that solar park developers must comply with, including requirements related to biodiversity protection. Developers are often required to conduct environmental impact assessments (EIA) and implement mitigation measures to minimise their projects' impact on local ecosystems. The EIA must include a pre- and post-development assessment of local flora and fauna. The mitigation measures cover requirements around wildlife-friendly fencing and perimeter native vegetation planting.

In **Spain**, the **Royal Decree-Law 23/2020** established measures to promote renewable energy and includes provisions for integrating biodiversity considerations into renewable energy projects. Developers are encouraged to implement biodiversity enhancement measures as part of their project planning and execution. Spain also has national laws and regulations aimed at conserving biodiversity, such as the Biodiversity Law (Ley 42/2007) and the Natural Heritage and Biodiversity Law (Ley 42/2007). These laws provide a framework for protecting ecosystems, habitats, and species, which can influence solar park development. Finally, Spain holds renewable energy auctions to support the development of solar parks and other renewable energy projects. Developers may receive subsidies or guaranteed power purchase agreements to incentivise investment in renewable energy generation. Once again, there is no specific mention of biodiversity net gain, which would make the environmental benefit more explicit.

England introduced a mandatory **Biodiversity Net Gain** scheme requirement of at least 10% on all new developments in 2024. This also applies to new solar parks. The biodiversity gain must be managed and maintained for at least 30 years to achieve the target condition. In the case that a project cannot meet the 10% requirement onsite, a developer must compensate by buying offsite offsets, with an emphasis on purchasing local credits where available. Often, these support enhancement and maintenance of conservation areas across England. On the other hand, if a development creates a biodiversity net gain larger than 10%, it can register as a biodiversity net gain site itself, and sell credits to other developers, thereby rewarding and incentivising net gain for biodiversity within developments. Underlying this mandatory scheme is a regulated biodiversity unit metric used to calculate the number of biodiversity units produced by an area of land based on habitat size, quality, location, type, and value. This type of standardised assessment method is required to apply a law consistently across developments and ensure units represent genuine biodiversity gain and are used appropriately by buyers.

The English Biodiversity Net Gain scheme also affects the planning process, as proving compliance with the scheme requirements is a prerequisite to receive planning permission. Landowners are legally responsible for creating and enhancing the habitat within the biodiversity unit and managing it for at least 30 years. The landowner and/or developer is required to enter into a legal agreement on how the habitat will be enhanced and maintained for that period or beyond, for example through conservation covenants. This agreement must provide detailed information on the planned habitat enhancement and who is responsible for enhancing, maintaining and monitoring the habitat. In addition, developers should submit a “Habitat Management and Monitoring Plan” developed in collaboration with an ecologist, which forms part of the planning approval process.

This English law combines a legal requirement around biodiversity net gain with a financial reward for exceeding the minimum requirement. Compared to many other developments, solar parks generally tend to increase biodiversity levels, especially when situated on degraded land. Since this scheme is very recent, it remains to be seen whether this development will result in improved biodiversity levels in England.

4.3 REGIONAL POLICIES

national policy is an important tool to ensure that the same conditions apply across a country, each country has regional differences that can affect how laws need to be enacted. Regions vary in terms of existing biodiversity, land uses, population density and climate conditions which can affect the potential for renewable energy generation and biodiversity restoration or conservation potential. Regional and local authorities are therefore key players to include in any planning efforts as they have a better understanding of the local context and needs (The Nature Conservancy, 2023). In Italy, the regional programs take different approaches to encourage biodiversity, some regions provide financial incentives others have legally binding requirements in place. Allowing regions to take differentiated approaches to reach the same goal gives the regional governments more flexibility to find a program which suits the local needs. This is a similar relationship to the one between the member states and the EU, where it is important for the EU to define a direction and certain outcome requirements, but the member states need to have sufficient flexibility for how they reach those targets.

4.4 THE NEED FOR ALIGNED EU

POLICY TO ENHANCE NATURE-INCLUSIVE SOLAR

The above section illustrates that European countries have a range of incentive schemes around renewable energy in place, some of which specifically touch upon nature-inclusive solar. Both financial incentives and simplified permitting procedures are commonly used. Yet very few countries have a clear and science-based method underlying their nature-inclusive solar policies. This policy gap potentially creates misalignment and unintended consequences for biodiversity and developers, both within and across countries. A well-aligned EU-wide approach is needed to fill this gap in an effective and consistent way. Creating a coherent policy framework that provides a clear definition of nature-inclusive solar and clarifies how these developments align with existing EU policy, including the NRL, has the potential to mainstream nature-inclusive solar parks across EU member states.

As many developers work across different EU countries, a unified approach will be beneficial, especially if the EU decides to phase in a biodiversity certification scheme. The Biodiversity Net Gain scheme in place across England can serve as an example as it has effectively mainstreamed the biodiversity net gain concept across all development industries, using both a legal and regulated financial mechanism. For the EU to move towards such an approach, a clear legal framework is needed in the first place. This framework should be complemented with a definition of nature-inclusive solar, a monitoring and evaluation framework and requirements around the biodiversity measures and long-term management of solar parks. The section below provides specific policy recommendations to work towards such legal EU framework.

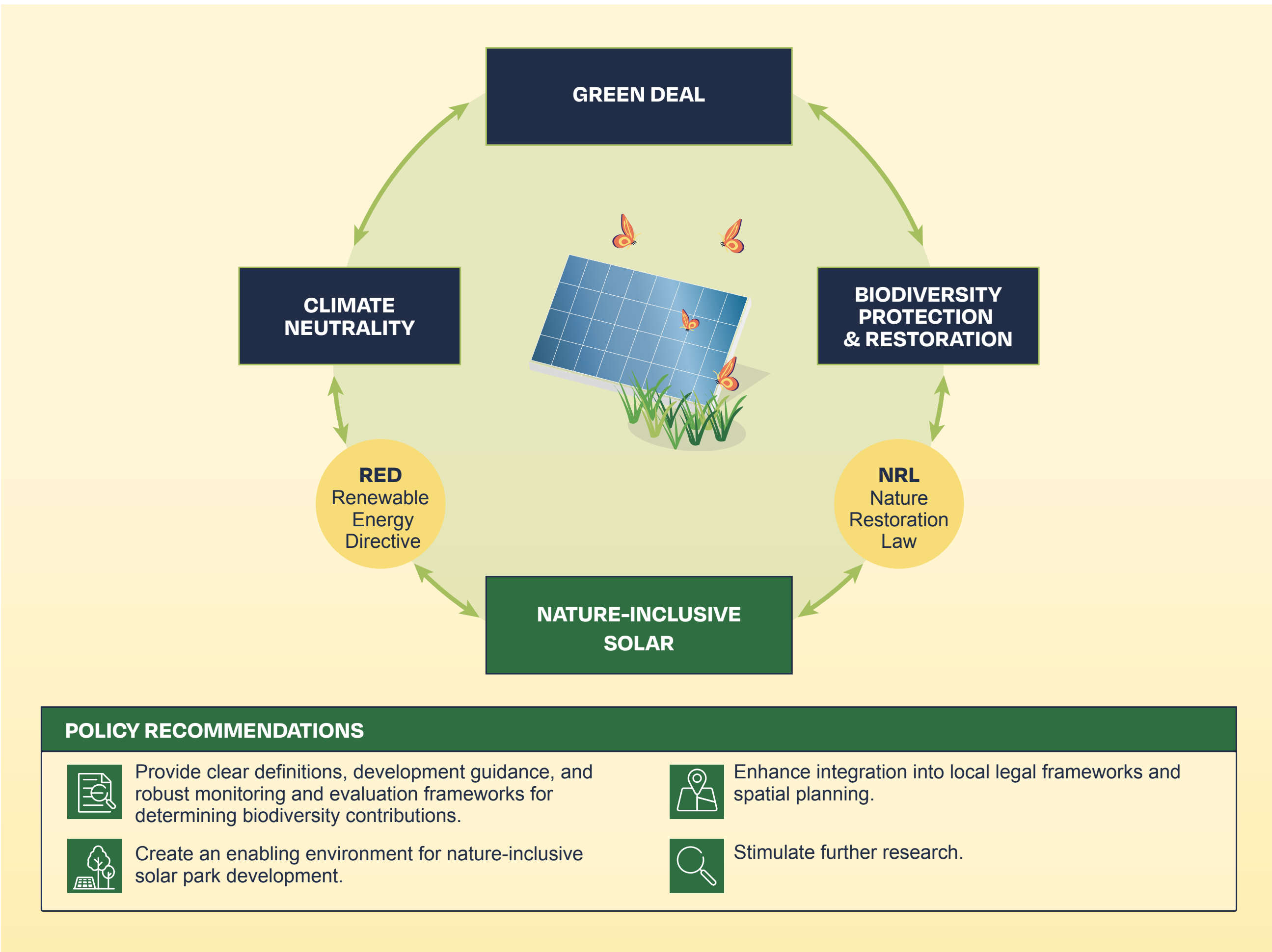


Figure 3: Schematic overview of the relation between nature-inclusive solar and EU policy objectives, strategies and regulations. The policy recommendations, as elaborated on in chapter 5 of this report, are suggested to design (more) effective and ambitious EU policies for enhancing the development and scaling of nature-inclusive solar parks.

5. Policy Recommendations

Building on the concepts, challenges and existing policies discussed above, this section introduces recommendations to design effective and ambitious EU policies for nature-inclusive solar parks. Firstly, policy could overcome a key barrier by establishing clear definitions, development guidelines, and monitoring and evaluation frameworks. Secondly, policy can create an enabling environment to enhance and favour nature-inclusive solar development. Thirdly, policies should allow for and enhance integration into local legal frameworks and spatial planning. Existing national policies can help inform how to best design these policies and the following section outlines key findings and suggestions derived from current policies. Lastly, further research is needed to address topics that are not covered by these recommendations but are important to consider for effective nature-inclusive solar development.

Provide clear definitions, development guidance, and robust monitoring and evaluation framework for determining biodiversity contributions

Summary of recommendations

- *Create a common, clear and ambitious definition of nature-inclusive solar parks at EU level.*
- *Provide solar park development guidance to avoid and minimise biodiversity loss in planning during and after the construction phase, alongside practices to restore, offset, and/or add (net gain) biodiversity.*
- *Develop and implement a robust monitoring and evaluation system.*

The first recommendation is to create a common, clear and ambitious definition of “nature-inclusive solar parks”. Such a definition is essential for guiding solar park developers, policymakers, and other stakeholders. The definition should encompass ecological, social, and economic dimensions, ensuring a comprehensive understanding and implementation. The definition suggested in this paper (page 6) refers to the mitigation hierarchy to define biodiversity net gain as a measure for nature-inclusive solar. A more granular definition, specifying other measures such as “no net loss” and “net-positive”, could be useful to clarify if and how different levels of nature-inclusiveness are relevant. It’s recommended to establish a more refined definition in consultation with ecologists, renewable energy specialists, policy makers, local communities, and other relevant stakeholders. The criteria should include aspects such as habitat preservation, wildlife corridors, plant diversity, water management and soil health. Once established, this definition should be integrated into national and regional renewable energy policies and guidelines to ensure uniformity and commitment.

Secondly, a clear framework for solar park developers is crucial to avoid and minimise biodiversity loss during the construction phase and enhance biodiversity post-construction. This framework should establish clear criteria to choose the optimal location and size of solar parks. Regarding locations, we recommend avoiding protected nature areas and rather targeting areas with low biodiversity-value. Moreover, best practices for construction should be mandated to ensure net positive impacts on biodiversity. Importantly, guidance must also cover a solar park’s entire life cycle, including management during its use and end of life stage. With the EU’s recent release of the guidance on Renewable Acceleration Areas (Directorate-General for Energy, 2024), the EU has indicated that it is investigating best practices around accelerated permit granting process and improved auction design. Aligning these recommendations with those for nature-inclusive solar could be an important first step towards mainstreaming nature-inclusive solar in the EU.

The third suggestion is to develop a robust monitoring and evaluation system to assess the environmental impact of solar parks before and during construction. This includes mandatory pre-construction environmental studies focusing on local flora and fauna to inform the design of solar parks. Continuous monitoring of biodiversity indicators and transparent reporting protocols should be established throughout the whole lifespan of the solar park to ensure accountability and long-term commitment to nature-positive goals. This monitoring can be further used as part of the implementation of the Nature Restoration Law, esp. Article 14 on National Restoration Plan and Article 20 on monitoring, and for Carbon Removal Certification Framework.

Create an enabling environment for nature-inclusive solar park development

Summary of recommendations

- *Develop legal requirements that provide guidelines for nature-inclusive solar parks. Regulatory measures could be used to ensure that solar parks contribute to biodiversity and reward developers that include biodiversity enhancement measures in their projects, including through the planning process and renewable energy auctions. Nature-inclusive solar parks that contribute to restoring nature should be included and incentivised in the National Restoration Plans that Member States will draw up to implement the Nature Restoration Law.*
- *Provide the necessary knowledge and infrastructure needed by solar developers to create nature-inclusive solar parks.*

Legal tools are most effective for integrating solar parks into broader environmental initiatives at the EU level. It is crucial to establish legal definitions and guidelines for nature-inclusive solar parks. Building on the French Energy Transition Law, these requirements should ensure that nature-inclusive solar parks adhere to specific biodiversity-enhancing practices, and for example get access to a fast-tracked planning process.

The contribution of solar parks to nature could be considered as part of non-price criteria and/or pre-qualification criteria in renewable energy auctions. This means that, in addition to financial and technical criteria, the positive impact of solar parks on biodiversity is a key factor in awarding contracts. This ensures that environmental considerations are integrated into the competitive bidding process, and a level-playing field is laid for developers who aim to set the bar high in biodiversity restoration.

Moreover, solar parks can play a significant role in National Restoration Plans that Member States will formulate to implement the Nature Restoration Law. Solar parks that contribute to restoring nature should be explicitly included in these plans and incentivised. This integration can be achieved by recognising the dual function of solar parks in both generating renewable energy and enhancing local ecosystems. Policies that regulate nature-inclusive solar parks should therefore be developed in coherence with existing EU regulations, first among these the Nature Restoration Law, but also the Green Deal and the Common Agricultural Policy (CAP).

Lastly, solar developers will need access to certain markets and information to comply with the requirements around nature-inclusive solar. These will be somewhat regionally specific but generally include expert information about the landscape and its ecology, and a market from which to buy suitable seeds and infrastructure such as wildlife-friendly fencing. Here, countries are recommended to stimulate the necessary markets and enhance local capacity building.

Enhance integration into local legal frameworks and spatial planning

Summary of recommendations

- *Policies on nature-inclusive solar parks must be effectively integrated into local planning frameworks.*
- *Implement good spatial planning practices by consulting landscape architects and ecologists.*

Policies on nature-inclusive solar parks must be effectively integrated into local planning frameworks. This requires a coordinated effort between national, regional, and municipal authorities to ensure that objectives are aligned, and processes are streamlined. This alignment will facilitate the implementation of nature-inclusive practices and ensure consistency in policy application across different regions. Spatial planning practices must be integrated to ensure that the surrounding landscape and ecosystems are not damaged.

Moreover, by involving landscape architects and ecologists in the planning, solar parks can be designed to enhance local ecosystems and provide habitat for wildlife, contributing to overall biodiversity goals. Financial incentives can be granted at this level to help involve such specialists in the planning and monitoring phase. Moreover, incentives can be used to support the local native seed market to promote the development of diverse native seed mixes appropriate for solar parks, as explained in the best-practices section.

Stimulate further research

Several important topics which are crucial for comprehensive and sustainable solar energy development are out of scope for this paper but warrant further research.

These include:

- Adding definitions and guidelines for new solar projects that want to engage in nature-inclusive PV, or for retrofitting or upgrading existing solar installations. This could involve implementing biodiversity-enhancing practices such as planting native vegetation, creating wildlife corridors (including for large mammals), and incorporating habitat structures.
- Expanding on meaningful stakeholder involvement. This includes identifying best practices for involving a diverse range of stakeholders, including residents, environmental organizations, and industry experts, in all phases of solar park development.
- Employing socio-economically inclusive design principles. It is vital to ensure that the benefits of solar energy are equitably distributed, matching energy gains with local energy needs and deploying energy locally.
- Optimising the use of scarce land through multiple land-use approaches including nature conservation, regenerative agriculture and recreation.
- Better understanding financial frameworks to incentivise and reward nature-inclusive efforts driving ambition and positive biodiversity impacts.
- Boost innovation in technical machineries for solar park construction that are not harming and compacting soils.

Further research and policy development in these areas are essential to fully realise the potential of solar energy to contribute to both biodiversity conservation and socio-economic well-being.

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Appendix: Stakeholder List

Stakeholder group	Subgroups	Roles and impacts
Solar power industry	-	Represents solar power companies and advocates for policies that support market growth, innovation and competitiveness.
Local and regional authorities	-	Have authority over land use planning, building codes, and permitting processes, which can directly impact the installation and integration of solar energy systems within their jurisdictions.
Agricultural industry	-	Represents farmers and cooperatives. Currently determines land use of majority of EU land (...%), making it a key player for land use planning, including solar PV and biodiversity gain.
Farmers Individuals or businesses owning or renting land dedicated to farming	Heterogeneous group but for this part are considered as one stakeholder type	Can be affected by land use planning changes, increased competition for land and agrisolar development. Benefit from improved ecosystem service provision.
Landowners Stakeholders that own land which could be used for solar PV and biodiversity net gain (excluding farmers)	Private landowners	Individuals that own parcels of land or land investors may see solar power to diversify their income. Interest in biodiversity gain varies.
	Land trusts and conservation organizations	May see solar energy as a way to generate revenue to support conservation efforts and maintain ecological integrity of their land. Generally more likely to prioritize conservation over solar developments.
	Real estate developers	May incorporate solar energy and biodiversity in their construction plans to differentiate their properties in the market.
	Public sector entities	
Nearby communities	-	Could potentially benefit from solar energy for example by creating new jobs, easier access to affordable energy, ecosystem services. May also oppose developments due to perceptions around deterioration of familiar landscapes.
EU institutions	-	Develop policies and regulations that influence solar energy deployment across member states. This includes directives, targets, and funding programs.

Stakeholder group	Subgroups	Roles and impacts
National policy makers *NGOs*	National governments	Set policies related to renewable energy, including solar. They establish targets, incentives, and regulations that can either promote or hinder the deployment of solar energy.
	Energy ministries and agencies	Key stakeholders in shaping solar energy policies. They develop strategies, design support schemes, and oversee the implementation of renewable energy policies.
	Environmental ministries and agencies	Involved in setting environmental standards, conducting impact assessments, and ensuring that solar energy projects adhere to environmental regulations.
	Finance ministries and agencies	Provide financial support and incentives for solar energy deployment. They may offer subsidies, grants, tax credits, or loans to promote investment in solar projects.
	Regulatory authorities	Oversee the energy market and ensure compliance with regulations. They may establish rules for grid connection, net metering, and tariff structures that impact the economics of solar energy.
NGOs	Environmental	Advocate for nature, sustainability and preservation of key ecosystems. Able to mobilize public opinion and policy makers.
Scientific experts	Ecologists, landscape designers and engineers	Interested in balancing environmental, aesthetic and technical considerations to maximize benefits of solar energy and minimize environmental footprint. Can be consulted about solar PV developments.
	Academia	Provides scientific overview of benefits and costs with no vested interest in the topic.
Energy providers	-	Ensure access to the grid and market for solar energy.

Metabolic

+31 (0) 203690977
info@metabolic.nl
www.metabolic.nl

Gedempt Hamerkanaal 29
1021 KL Amsterdam
The Netherlands