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# EVALUATING THE POTENTIAL FOR IMPROVING BIODIVERSITY IN SOLAR FARMS

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Based on the 2024 MSc Sustainability and Management dissertation by Ilyes Benbouzid

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## Abstract

The rapid expansion of solar farms in the UK, driven by the objectives of preventing climate change, poses diverse challenges and chances for the preservation of biodiversity. The present study investigates the intricate relationship between the expansion of solar farms and the enhancement of biodiversity, with a specific emphasis on policy frameworks and planning procedures. An examination of 30 planning applications from various local authorities indicates that 37% of solar farm proposals were declined, mostly because of concerns about the preservation of the Green Belt. This trend has the potential to impede the UK's achievement of its 2050 net-zero emissions goal. Statistical analysis revealed that pre-application consultations had a substantial impact on acceptance rates, indicating their potential as an option to enhance the quality of applications. The study highlighted areas in the National Planning Policy Framework (NPPF) where its broad guidelines allow for varying interpretations among local planning bodies. Illustrative case studies, such as the Southill Energy Community Solar Farm, show that solar farms have the potential to attain biodiversity net gains up to 70%, substantially surpassing the existing standards. Based on these results, we suggest enhancing the NPPF by establishing more explicit criteria, increasing the targets for biodiversity net gain in solar farms, strongly recommend consultations before applications, and implementing precise on-site measures such as optimising the height and spacing of panels, integrating various habitats, and reducing the effects of light. In order to match renewable energy goals with biodiversity conservation, this integrated method seeks to convert solar farms into multi-functional landscapes that produce clean energy while actively improving local ecosystems.

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## List of abbreviations and acronyms

BC: Borough Council

BNG: Biodiversity Net Gain

CCC: Committee on Climate Change

FiT: Feed-in Tariff

HSPG: Heathrow Strategic Planning Group

LNRS: Local Nature Recovery Strategies

LPA: Local Planning Authority

NPPF: National Planning Policy Framework

PV: Photovoltaic

SEUK: Solar Energy UK

SSE: Scottish and Southern Energy

SWT: Surrey Wildlife Trust

VSC: Very Special Circumstances

# Chapter 1: Introduction

Imagine a landscape in which extensive arrays of solar panels not only capture the sunlight energy but also flourish alongside a healthy biodiversity, with buzzing bees and singing birds. The present study tries to make this ideal, shaped by the combined prosper of renewable energy generation and biodiversity closer to reality. The fast growth of solar farms in the United Kingdom poses both difficulties and opportunities for the future of biodiversity as the country tries to achieve its ambitious climate objectives.

While several solar projects have shown the potential to enhance biodiversity, a considerable proportion of them fall short of properly fulfilling this commitment. Montag et al. (2016) indicated that well managed solar sites have the capacity to support a broader variety of plant species, invertebrates, and birds when compared to the surrounding agricultural region. However, it is apparent that a significant number of solar farms lack proper maintenance to effectively enhance biodiversity. Particular concerns include habitat fragmentation, soil degradation, and the impact of polarised light reflection from solar panels on animal populations (Harrison et al., 2017; Armstrong et al., 2016).

Moreover, there is a lack of comprehensive and long-term systemic data about the environmental impacts of solar farms in the United Kingdom. In their meta-analysis, Pearce Higgins and Thaxter (2021) emphasised that most studies on solar farms have concentrated on the immediate impacts, leading to significant gaps in understanding the long-term ecological transformations seen in these settings. The shortage of knowledge in this field, along with the anticipated exponential growth in solar energy production in the UK, shows the urgent need for study that might offer valuable insights for enhanced practices and laws.

This dissertation is a modest component of a larger project directed by Professor David Simon from the Geography Department, in collaboration with Doctor Rebecca Thomas from the Biological Sciences Department at Royal Holloway, University of London. The initiative, titled "Evaluating the potential for improving biodiversity in solar farms", involves partnerships with notable entities including Surrey Wildlife Trust, Surrey Amphibian and Reptile Group, Surrey County Council, Runnymede Borough Council, Woking Borough Council, Scottish & Southern Electricity (SSE), University of Surrey, and Heathrow Strategic Planning Group (HSPG).

Participating in this initiative, which combines academic expertise, local authorities, and industrial contributors, provides a unique chance to make a substantial academic contribution to the vital topic of environmental management. This opportunity offers a vehicle to bridge the divide between the progress of renewable energy and the conservation of biodiversity, with the capacity to influence policies and activities at both the local and national levels.
The current dissertation formulates the academic foundation for the project by doing an extensive literature review that offers a rigorous examination of existing research, policy, and approaches concerning biodiversity in solar farms. The study is in complete accordance with the core principles of the Sustainability and Management Master's degree, as it addresses the essential challenge of harmonising the expansion of renewable energy with the conservation of biodiversity. To achieve sustainable outcomes in the solar energy sector, it is imperative to adopt innovative management strategies.

Given the UK's objective to raise its solar energy capacity from 14 GW to 70 GW by 2035 (Searchland. 2024), it is crucial to guarantee that this growth does not come at the expense of biodiversity. Instead, our research is motivated by the conviction that by implementing effective planning, design, and management, solar farms may serve as vital resources for the preservation of biodiversity while simultaneously performing their main function in generating green energy. Through the identification and resolution of existing gaps in both practical implementation and policy, this research aims to make a valuable contribution towards a future in which solar farms not only reduce their ecological impact but also actively improve local ecosystems, therefore transforming a possible menace into a prospect for biodiversity.

The importance of this research resides in its capacity to provide essential information for policymaking, direct industrial practices, and eventually facilitate the advancement of solar farms that function as both sources of clean energy and habitats for biodiversity. The results of this study might hopefully influence the development of a more sustainable and biodiverse future for the UK as it strives to fulfil its climate commitments and address the crisis of biodiversity decline.

The main aims of this research are:

1. To examine and suggest changes and adjustments to the current planning policy framework that regulates the construction of solar farms and the management of biodiversity in the UK.
2. To evaluate current condition of biodiversity in solar farms in the UK by conducting an extensive literature research and interviews with stakeholders.
1. To identify best practices and innovative approaches, including how local planning authorities (LPAs) assess applications, for enhancing biodiversity within solar farm environments.
3. To formulate recommendations for augmenting biodiversity in solar fields.
   To achieve these goals, the review commences with an extensive literature review that serves several functions.

The text conducts an analysis and critical evaluation of the primary policy frameworks that govern solar farms and their influence on biodiversity in the United Kingdom. These frameworks include the Climate Change Act, the 2021 National Planning Policy Framework (NPPF) (with its Green Belt policy being a pivotal element), and the Environment Act 2021. This critical study assesses the inherent advantages, limitations, and possible opportunities for enhancement in the existing regulatory framework.

Furthermore, the study examines current research on the ecological consequences of solar systems, analysing both obstacles and possibilities for biodiversity. Furthermore, it evaluates the most effective methods for managing biodiversity in solar farm settings. Through the synthesis of this material, the literature review not only offers a strong basis for the study but also emphasises important areas that need more detailed examination, especially where policy and practice may not be in line or adequate to achieve biodiversity objectives. Employing this critical approach guarantees that the following study is based on a comprehensive comprehension of both the legal framework and the present level of scientific knowledge concerning biodiversity in solar farms.

Subsequently, the methodology chapter describes the research methods employed for this study. It provides a comprehensive account of the qualitative methodologies used, which include conducting in-depth interviews with important stakeholders such as planning officers, ecologists, and solar farm operators. Furthermore, it outlines the procedure of evaluating

planning applications from several borough councils in the surrounding areas of London. This chapter elucidates the integration of many data sources to offer a comprehensive perspective on the obstacles and possibilities for improving biodiversity in solar farms.
The next chapter provides an exposition of the study findings and delivers an elaborate analysis of their consequences, including outcomes of the stakeholder interviews and planning application evaluations, highlighting noteworthy patterns, obstacles, and prospects for improving biodiversity in solar farms. Within the framework of the literature review, the discussion analyses these findings and extracts important lessons for both practical management methods and policy formulation.

The dissertation concludes by consolidating the key discoveries, presenting implementable recommendations for improving biodiversity in solar farms, and suggested adjustments to the current policy framework that regulates the development of solar farms and the management of biodiversity. In addition, this concluding chapter evaluates the constraints of the study and proposes potential directions for further investigation in this area.

# Chapter 2: Literature review

## 2.1 History of Solar Farm Development in the UK

The solar farm industry in the United Kingdom (UK) has grown significantly over the past two decades, primarily attributed to the implementation of various laws and incentive schemes.

The progression of solar farm development in the UK may be described as a period of rapid increase followed by consistent expansion. According to the BEIS (2021), the United Kingdom had very little large-scale solar capacity in 2010. However, this industry had a swift and substantial growth in the early 2010s, mainly as a result of the introduction of government subsidies, such as the Feed-in Tariff (FiT) in 2010.

The programme was an important phase in the progress of solar energy in the United Kingdom. The objective of the scheme was to encourage the use of renewable energy technologies by providing financial incentives to both residential and commercial businesses for the surplus energy that was sent back to the national power grid.

The influence of the FiT was significant. In 2010, the solar photovoltaic (PV) capacity built in the UK was a modest 95 MW (DECC, 2014). By the end of 2015, the reported figure had risen significantly to 8,915 MW according to BEIS (2016).

Despite the decrease in government subsidies after 2015, the industry continued to expand, yet at a slower pace. As reported by BEIS (2021), the total installed capacity of the system witnessed a growth from around 10 GW in 2016 to 13 GW in 2018 and proceeded to reach 14.5 GW by 2020. The most recent data from Solar Energy UK in 2023 indicates that the United Kingdom's total installed solar capacity as of the first quarter of 2023 was 14.6 GW.

Notably, the BEIS in 2023 reported that big solar farms, which are classified as installations with a capacity over 5 MW, account for around 45% of the whole installed capacity. This underscores the pivotal significance of large-scale solar farms in the UK's renewable energy industry.
Future projections indicate a substantial growth in the number of solar farms in the UK.

According to BEIS (2022), the UK government has set a highly ambitious goal of increasing solar capacity to 70 GW by 2035. This target represents a significant increase of almost five times compared to current levels, suggesting significant potential growth for the solar farm sector.

## 2.2 Policy Drivers of Solar Farms Expansion in the UK

The substantial growth and future potential of solar farms in the UK may mostly be attributed to two critical policy frameworks: the Climate Change Act, together with its Net Zero amendment, and the National Planning Policy Framework (NPPF). The implementation of these rules at all levels of administration has created a comprehensive environment that facilitates the expansion of solar farms.

### 2.2.1 Climate Change Act

The Climate Change Act, introduced in 2008, has the most substantial policy impact on the United Kingdom's approach to renewable energy and the reduction of emissions. It sets a binding objective to reduce greenhouse gas emissions by at least 80% by 2050, relative to the emission levels documented in 1990. The Act is important not only for its ambitious objectives, but also for the establishment of the Committee on Climate Change, an independent body tasked with providing guidance to the government on emissions goals and making progress reports (Lockwood, 2013).

Amendments were made to the Climate Change Act in 2019 to strengthen the climate objectives. This included the adoption of a novel goal to attain a state of net zero carbon emissions by the year 2050. The change has had a significant influence on the renewable energy industry, particularly in relation to the building of solar farms. Grubb and Newbery (2018) argue that the presence of legally binding goals creates a strong motivation for policy intervention across all industries, resulting in heightened levels of investment in low-carbon technologies like solar energy.

### 2.2.2 The National Planning Policy Framework

The primary role of the NPPF, which was first published in 2012 and later revised in 2018 and 2021 (and is again currently under consultation by the new Government), is to transform national climate goals into specific localised execution. It provides guidance to local planning authorities (LPAs) on how to include renewable energy projects, such as solar farms, into their development plans (Ministry of Housing, Communities & Local Government, 2021).

Paragraph 158 of the existing NPPF mandates that Local Planning Authorities (LPAs) must approve renewable energy projects if the potential impacts of the projects are deemed acceptable or can be made so. The implementation of this provision has created a favourable planning environment for the establishment of solar farms. Moreover, the NPPF facilitates the process of identifying suitable sites for renewable energy in the Local Plans of local authorities, therefore providing developers with enhanced confidence (Rydin et al., 2015). The progressive development of these rules over time demonstrates their evolving attributes and interdependence.

The implementation of the Climate Change Act in 2008 laid the groundwork for a pervasive focus on reducing national emissions. A four-year later implementation of the NPPF aligned planning policy with these climate commitments. Both rules have been therefore amended to strengthen their support for renewable energy initiatives. Cowell and Devine-Wright (2018) argue that the 2019 net zero amendment to the Climate Change Act has had a significant impact on the development of planning policy.

The interplay among these rules offers crucial understanding of how different levels of government cooperate to enable the growth of solar farms. The Climate Change Act sets forward the comprehensive mandate for renewable energy sources, while the NPPF provides the pragmatic approaches to meet this mandate via the planning system (Foxon, 2013).

The climate change Act and the NPPF are the primary laws and regulations that shape the growth of solar farms in the UK. The rationale for choosing these two policies for study is in their comprehensive reach of the policy landscape, which includes both national strategy and local implementation directives. Their prolonged duration, with both having been established for more than 10 years, allows for the assessment of enduring trends and impacts. Furthermore, the recent modifications made to these regulations ensure their continued importance for the expansion of solar farms in both the current and future scenario (Geels et al., 2016). This policy framework study is not based on arbitrary selection. The reason behind this decision is as follows:

• Hierarchical Significance: The chosen regulations provide a hierarchical structure that comprehensively addresses the policy environment. The Climate Change Act operates at the highest echelon, establishing the all-encompassing legislative structure that directs all following policies and activities related to renewable energy, including the establishment of solar farms.

The NPPF functions at an advanced level by transforming these national objectives into formulated planning policies. It serves a crucial function in linking ambitious policy with practical execution at the local level, offering direction for planning decisions across the United Kingdom.

- Legal Weight and Enforceability: These rules have significant legal authority: The Climate Change Act, as the primary regulatory measure, is legally binding and sets mandatory targets for decreasing emissions that necessitate the establishment of renewable energy sources, such as solar farms. The National Planning Policy Framework (NPPF), while without legal enforceability, has substantial impact on planning decisions and appeals.
- Recent and Pertinent: These policies embody the most recent political ideas for advancing renewable energy sources. The incorporation of the Net Zero provision in the Climate Change Act (2019) is the latest nationwide undertaking to tackle climate change, therefore intensifying the need for solar energy. The NPPF has recently been modified in 2021 to align with evolving objectives, namely by reinforcing emphasis on sustainability and renewable energy.
- Relationship and Synergy: The selected rules demonstrate significant relationships. The emissions reduction goals established by the Climate Change Act require the use of renewable energy, which is then encouraged by the planning strategies of the NPPF.

## 2.3 Policy Drivers for Biodiversity Protection in the UK

The rapid growth of solar farms, driven by national climate targets and supportive planning policies as well as the declining cost of solar panels and solar energy relative to that derived from fossil fuels, has created both challenges and opportunities for biodiversity. In response, several key regulations have emerged to guide the integration of biodiversity improvement measures into solar farm development and management. Three regulatory instruments stand out as particularly crucial: the Environment Act 2021, the National Planning Policy Framework (NPPF), and the Planning Guidance for the Development of Large-Scale Ground Mounted Solar PV Systems. The laws and regulations are significant due to their hierarchical structure, extensive coverage, and possible applicability to solar farm development. They establish a strong framework that guides decision-making at both the national and Local policy level while the planning guidance publication addresses the site-specific implementation level.

### 2.3.1 Environment Act 2021

The Environment Act 2021 is a significant law in the UK's efforts to conserve and improve the environment. It demonstrates the country's dedication to tackling urgent environmental issues in the 21st century. The UK Government, led by then-Prime Minister Boris Johnson, proposed this Act, which obtained Royal Assent on November 9, 2021. The Department for Environment, Food & Rural Affairs (DEFRA), headed by Secretary of State George Eustice at the time, provided substantial involvement.

The act is remarkable due to its scope, covering several environmental concerns such as air and water quality, waste management, and biodiversity protection. The UK's first significant environmental legislation in more than twenty years, it follows the enactment of the Environmental Protection Act 1990 and the subsequent adoption of EU environmental regulations, from which the UK has now separated after Brexit.

Two crucial provisions within the Act are especially pertinent for the improvement of biodiversity, notably in relation to solar farms.

#### 2.3.1.1 Biodiversity Net Gain (BNG)

Biodiversity Net Gain is an innovative strategy for development schemes that seeks to ensure that the natural environment is left in a quantifiably improved condition compared to its previous one. The policy requires a least 10% enhancement in biodiversity value for new developments, including solar farms (Crosher et al., 2019).

The implementation of BNG in solar farm development involves several key aspects:

- **Baseline Assessment:** Developers have the responsibility to undertake a comprehensive assessment of the site's biodiversity value before starting development. The evaluation generally uses the Biodiversity Metric 4.0, which is a standardised instrument developed by Natural England in 2021. The metric measures the worth of biodiversity in 'biodiversity units' by considering characteristics such as species diversity, quality, and importance of the ecosystem.

- **Impact Calculation:** The potential impacts of the solar farm on existing biodiversity are then calculated, again using the Biodiversity Metric. This includes both direct impacts (e.g., habitat loss due to panel installation) and indirect impacts (e.g., changes in hydrology or shading effects).
- **Enhancement Planning:** Developers must incorporate biodiversity upgrades into their plans that will lead to a minimum 10% increase in the value of biodiversity, based on the initial evaluation and impact calculation.
- **Long-term Management:** Importantly, the Act mandates the preservation of biodiversity benefits for a minimum of 30 years. This requires the implementation of comprehensive, enduring strategies and the allocation of guaranteed financial resources for the continuous maintenance of habitats.
- **Offsite Compensation**: If the steps taken on the site are not feasible or not enough to achieve the desired 10% improvement, developers have the option to adopt measures off the site or buy biodiversity credits. Nevertheless, the Act highlights the need to give priority to measures that may be implemented on-site, wherever feasible.

#### 2.3.1.2 Local Nature Recovery Strategies (LNRS)

Local Nature Recovery Strategies refer to a specialised method used to restore natural environments, aiming to create a comprehensive network of habitats across the country that are rich in animal populations. The Environment Act 2021 mandates that all English local authorities must create these strategies, with each strategy specifically targeting a specified geographical area. Implications of LNRS for solar farm construction are complex and diverse:

- **Spatial Mapping**: Each LNRS must include a map of the strategic areas, identifying existing areas of biodiversity importance and potential opportunities for habitat creation or enhancement and contribute to wider landscape conservation.
- **Statement of Biodiversity Priorities**: This indicates the region's priority objectives in terms of biodiversity, which cover the potential for restoring or improving biodiversity and broader environmental advantages.
- **Supporting Sustainable Development:** It helps to ensure that new infrastructure projects and land use changes are aligned with biodiversity objectives, rather than obstructing them.

- **Collaborative Development:** it is to be jointly produced by local authorities, environmental organisations, landowners, and other stakeholders through collaboration.
- **Integration with Planning:** The plans will provide information and be included into local planning decisions, including those related to the construction of solar farms. Demonstrating alignment with LNRS may become an important factor in securing planning approval sustainable development projects.

### 2.3.2 National Planning Policy Framework (NPPF)

While we have already discussed the significance of the NPPF in encouraging the advancement of renewable energy, it is essential to highlight its specific provisions that are relevant to biodiversity. The 2021 version assigns higher significance to biodiversity in the decision-making process for planning.

According to Paragraph 174 of the Ministry of Housing, Communities & Local Government (2021), the objective of planning and decisions should be to enhance the natural and local environmental conditions by minimising harmful effects and achieving favourable results for biodiversity. This aligns with the requirements of the BNG and creates a consistent policy framework.

Furthermore, Paragraph 180 mandates that local planning authorities must adhere to the idea that if a development would result in substantial damage to biodiversity and that damage cannot be prevented, sufficiently reduced, or compensated for, then planning approval should be denied.

In the context of solar farm projects, these regulations imply that the planning process must include biodiversity concerns from the beginning. According to Baker. J et al. (2019: 5-8), the focus of the NPPF on biodiversity net gain has pushed solar farm developers to consider ecological conservation as an integral part of project design, rather than an optional feature.

#### 2.3.2.1 Green Belt Policy

Since the 1950s, the Green Belt policy has been a key element of English urban planning, playing a vital role in protecting the environment and, consequently, in controlling development initiatives, particularly in the design of renewable energy installations around large cities.

Covering almost 13% of England's whole land area (Mace et al., 2020), the Green Belt is very relevant to our study due to its widespread distribution across the counties involved in the project. As per the Surrey County Council (2023), around 73% of the area in Surrey is formally designated as Green Belt land. The adjacent counties of Berkshire and Buckinghamshire also possess significant Green Belt regions, accounting for 35% and 48% of their respective territories (Official source: Ministry of Housing, Communities & Local Government 2020).

The broad scope of the Green Belt policy significantly influences land use choices, particularly those pertaining to the establishment of development projects.

According to the NPPF, the primary goals of the greenbelt are to reduce urban sprawl, prevent the merging of adjacent towns, protect the countryside from encroachment, maintain the historic character of towns, and promote urban revitalisation (Ministry of Housing, Communities & Local Government, 2021). For the preservation of open spaces and rural landscapes, these objectives are of prime importance. Within the context of solar farm development, the Green Belt policy functions as a major regulatory instrument. It guarantees that initiatives involving large-scale renewable energy are thoroughly assessed within the wider context of environmental conservation.

## 2.4 Planning Guidance for the Development of Large-Scale Ground Mounted Solar PV Systems

Besides policies and national planning regulations, specific comprehensive guidelines have been developed to address the unique challenges and benefits presented by solar farms. The "Planning Guidance for the Development of Large-Scale Ground Mounted Solar PV Systems," published in 2013 by BRE National Solar Centre in collaboration with Cornwall Council, provides detailed recommendations for enhancing biodiversity in solar energy project development.

This article was often mentioned during meetings with planning officers from Runnymede Borough Council (RBC). It emerged during a critical time when the UK was seeing a significant surge in renewable energy investments, particularly in the field of large-scale solar photovoltaic (PV) projects.

Due to its comprehensive and pragmatic recommendations, this guideline quickly became an indispensable resource for both planning authorities and applicants. According to Antonia, planning officer at RBC, during our meeting on the 11th of July 2024, LPAs have begun suggesting that applicants consult this paper to increase the chances of their applications being approved. To improve the robustness of their planning applications, developers should ensure that their projects adhere to the suggested procedures outlined in the guidelines. This would demonstrate their commitment to attaining renewable energy goals and advocating for environmental accountability.

The assertion emphasises the potential of solar farms to offer significant benefits to biodiversity, as long as they are properly designed and managed. It includes measures such as:

- Conservation and improvement of current ecosystems
- Establishment of novel habitats, namely grasslands abundant in species
- Installation of bird and bat cages
- Application of suitable land management practices, such as conservation grazing strategies

The advice states that solar farms, when suitable land management is implemented, have the potential to sustain a diverse range of plants and animals. In fact, solar farms may often surpass the biodiversity value of the area prior to development (BRE, 2013).

This guidance also emphasises the need of implementing long-term management strategies to guarantee the preservation of biodiversity advantages during the useful lifespan of the solar farm and beyond. These findings are consistent with the notion of "permanence" in biodiversity net gain, as specified in the Environment Act 2021.

The selection this regulatory framework was made based on comparable criteria. This methodology ensures consistency in the analysis and facilitates a deeper understanding of the interplay among several policy areas in shaping the development of solar farms.

- Hierarchical Importance: The chosen regulations constitute a hierarchical structure that comprehensively cover the policy environment. The primary purpose of the Environment Act 2021 is to set legally binding national goals for the enhancement of biodiversity. The NPPF functions at an advanced level by transforming these national objectives into systematic planning principles. The Planning Guidance for Solar PV

Systems provides accurate and practically applicable recommendations. This tiered approach ensures that the analysis covers the complete spectrum of regulatory impact, from broad national policy to precise and operational suggestions.

- The Environment Act 2021, being the main law, has significant legal weight and enforceability. It sets mandatory requirements for biodiversity net increase and has considerable practical importance. The NPPF has substantial impact in shaping planning choices. While the Planning Guidance lacks legal authority, it is widely recognised and frequently utilised in planning applications and decisions, therefore having significant practical impact.
- Recency and Relevance: They embody the most recent policy concepts aimed at enhancing biodiversity: (i) The Environment Act 2021 conforms to the latest national obligations for conserving biodiversity. (ii) The NPPF has recently been modified in 2021 to align precisely with evolving goals. (iii) Despite being published in 2013, the Planning Guidance remains a standard that uniquely concentrates on improving biodiversity in solar projects.
- The Environment Act 2021 enhances the biodiversity net gain responsibilities, which are reinforced by the National Planning Policy Framework's emphasis on environmental improvement, therefore demonstrating robust interrelationships and synergy. This Planning Guidance provides pragmatic approaches to achieve the biodiversity objectives specified in the higher-level policies.

## 2.5 Critiques

### 2.5.1 Critiques of the Climate Change Act

Despite being significant legislation in the UK's efforts to tackle climate change, the Climate Change Act is not immune from criticism. Diverse stakeholders and academics have identified two main areas of disagreement:

1. **Concerns Regarding Feasibility**

The feasibility of the goals set by the Climate Change Act, particularly the commitment to achieve Net Zero emissions by 2050, has been questioned. The critics argue that the objective is impractical, especially considering the limited timeframe at hand. Helm (2019) contends that attaining the goals will require a significant reform of the UK's energy infrastructure, transport networks, and industrial processes to rapidly decrease carbon emissions.

The Committee on Climate Change (CCC) plainly stated in its 2022 Progress Report to Parliament that the UK is currently not making adequate progress towards meeting its fourth and fifth carbon budgets. Moreover, the nation is also failing to achieve the more ambitious sixth carbon budget, which aligns with the Net Zero goal (CCC, 2022).

Furthermore, this pattern of insufficient progress has persisted in the following years. The CCC's 2023 Progress Report highlighted that although the UK has achieved some progress, especially in sectors such as renewable energy production, the overall rate of development is still insufficient. Significant deficiencies in policy implementation were identified in the study, particularly in areas like as construction, transportation, and agriculture (CCC, 2023).

Most recently, the 2024 Progress Report, which was released in June 2024, reiterated similar concerns where the UK is still not progressing as planned to achieve its medium-term carbon goals. The study emphasised the pressing necessity for stronger policies and expedited execution in all areas to close the disparity between aspirations and realisation (CCC, 2024).

### 2. Ambitious Objectives Lacking a Well-Defined Plan of Action

Although the Act establishes high objectives, it has faced criticism for lacking a sufficiently comprehensive plan for attaining these ambitions. According to Lockwood (2021), the Act prioritises the establishment of goals rather than the exact strategies and actions required to achieve them. The absence of a well-defined implementation plan might result in ambiguity for companies and local authorities as they strive to synchronise their activities with the country's climate objectives.

In addition, the Act's carbon budgets, which are revised every five years, do not specify how emissions reductions should be allocated among different sectors, between urban and other areas, or provide specific policy solutions. The lack of policies accompanying the 'target-setting' method has been identified as a possible vulnerability in the United Kingdom's climate plan (Fankhauser et al., 2018).

The Environment Act 2021, while its significant contributions to environmental conservation, has also received several critiques, notably about its impact on solar farms and biodiversity.

### 3. Insufficient specificity on solar farms

One major critique of the Environment Act is that its rules, namely those pertaining to Biodiversity Net Gain (BNG), are not specific to renewable energy projects but are applicable to all types of development projects. Although this wide range of applications guarantees thorough coverage, it may not sufficiently address the distinct difficulties and possibilities posed by solar farm developments. Randle-Boggis et al. (2020) contend that solar farms have unique potential to improve biodiversity, which may not be adequately accounted for by generic biodiversity net gain (BNG) standards.

### 4. Imbalanced Emphasis on Plant Life Compared to Animal Life

Critics have raised concerns about the Environment Act's approach to biodiversity, namely in relation to development projects such as solar farms. They argue that the Act's focus on protecting vegetation may be excessive, perhaps leading to a lack of attention towards the preservation of animal species. This disparity is apparent in several facets of the Act's execution and is acknowledged not just in scholarly literature but also by professionals in the area.

This focus on flora might result in substantial deficiencies in the preservation and improvement of biodiversity. According to Bateman and Zonneveld (2019: 267), habitat-based techniques are limited in their ability to assess species with specialised needs or those that rely on landscape-scale processes adequately. This is especially pertinent for solar farm projects, since they might have an influence on a variety of species or change the dynamics of local wildlife in ways that may not be fully reflected by studies that focus just on vegetation. The frequency of this problem is also supported by first-hand observations made by local specialists in ecology.

During our discussion July 8$^{th}$, 2024, Andy, the ecology expert at Runnymede Borough Council, emphasised this specific issue, noting that when referring to biodiversity, the focus is mostly on plant life. This candid acknowledgement from an active practitioner highlights the degree to which wildlife is frequently disregarded in evaluations of biodiversity and measures for its preservation. In addition, Andy drew attention to a significant deficiency in the collection of data on animal populations. He pointed out that there had been no revisions to the animal census since the 1990s. The absence of current data on animal populations significantly impedes the capacity to make well-informed judgements about the preservation of wildlife and to appropriately evaluate the effects of development initiatives on local fauna.

5. **Reduction of intricate ecosystems to too simplistic representations**

The Biodiversity Metric has faced criticism for its oversimplification of intricate ecosystems, despite its intention to establish a uniform method for quantifying biodiversity. Maron et al. (2021) contend that attempting to quantify biodiversity as a single number is inadequate in capturing the complexities of biological systems and may result in undesirable consequences. The metric's emphasis on acreage and general habitat types may not sufficiently include elements such as ecological connectedness, species interactions, or ecosystem services.

### 2.5.2 Critiques of the National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) has a distinct and perhaps confusing position in the UK's regulatory framework for the construction of solar farms and the promotion of biodiversity. In contrast to other programmes that are clearly categorised as either supporting solar farms, such as the Climate Change Act, or increasing biodiversity, such as the Environment Act 2021, the NPPF encompasses both domains. The simultaneous undertaking of these two roles, with the intention of achieving a well-rounded approach, frequently leads to inconsistencies and intersections that can impede the progress of both solar farm construction and biodiversity conservation efforts.

1. **Inconsistent Goals and a Lack of Clear Direction**

The NPPF's endeavour to simultaneously promote the advancement of renewable energy and safeguard the environment sometimes results in uncertainty. Paragraph 158 of the Ministry of Housing, Communities & Local Government's guidelines states that LPAs should grant approval for renewable energy developments if their impacts are deemed acceptable or can be made acceptable. On the other hand, Paragraph 174 highlights the importance of safeguarding and improving biodiversity. The absence of explicit prioritisation might result in divergent interpretations and implementations of the policy.

The NPPF's terminology is often imprecise, including expressions such as "where possible" or "if appropriate," which allows for subjective interpretation. Cowell (2017) highlights that this ambiguity might result in a situation where there is inconsistency in decision-making regarding renewable energy planning. This can lead to different outcomes for similar projects, depending on how NPPF is interpreted by the different LPAs. This aspect may well be changed after the current consultation (see Appendix).

### 2. Potential Political Influence

The NPPF functions as a guide for LPA planning committees responsible for making decisions on development applications. Nevertheless, these committees, often consisting of elected individuals, may be vulnerable to political influences that may not necessarily coincide with the most effective environmental decisions. Dockerty et al. (2016) found that local planning decisions can be influenced by local committee members' perceptions, which might possibly eclipse the wider environmental advantages. This susceptibility to local political dynamics may result in policies that prioritise immediate public opinion above long-term environmental objectives.

### 3. Policy of the Green Belt: Misaligned Priorities

The NPPF's strategy for Green Belt land poses specific obstacles for solar farm development and raises questions concerning its efficacy in supporting genuine ecological advantages. The longstanding main objectives of the Green Belt, as encapsulated in the NPPF, are to control the expansion of large urban areas, prevent the merging of neighbouring towns, protect the countryside from encroachment, preserve the unique character of historic towns, and contribute to urban revival (Ministry of Housing, Communities & Local Government, 2021, Paragraph 138).

Notably, the stated objectives do not specifically encompass ecological or biodiversity preservation. disparities between the goals of the Green Belt and ecological considerations might lead to unintended negative outcomes. Dockerty et al. (2016: 274) argue that the Green Belt policy, although intended to preserve the integrity of open spaces, does not consistently facilitate the enhancement of biodiversity or ecosystem services.

Paradoxically, it might inadvertently preserve landscapes with little biodiversity, such as strictly regulated agricultural regions, while restricting the growth of solar farms that could enhance local natural variety. NPPF permits development on Green Belt land on the condition of "very special circumstances" (VSC), however the precise criteria for these circumstances are not well specified. The absence of clear understanding, along with the required availability of resources to support VSC, usually advantages bigger and more well-funded initiatives. Rydin et al. (2015: 147) noted that planning negotiations tend to bias preference towards developers with more resources, hence possibly marginalising smaller community-led renewable energy projects.

## 2.6 Current State of Biodiversity on Solar Farms

The exponential growth of solar farms around the United Kingdom, although crucial for attaining renewable energy goals, presents significant obstacles for the preservation of local wildlife. Furthermore, the limitations of policy frameworks contribute to worsening the situation. Emerging research has revealed a multitude of critical issues that demand the attention of researchers, legislators, and solar farm operators.

The principal obstacles are the relocation and fragmentation of habitats. The study conducted by Montag et al. (2016) revealed that while solar farms may result in a general rise in biodiversity, specialist species frequently encounter adverse consequences. Ground-nesting bird species, such as skylarks and lapwings, showed reduced population densities in solar energy installations compared to areas without such facilities. A study conducted by Harrison et al. (2017) found that the existence of large-scale solar systems could limit the movement of wildlife, resulting in an isolation of populations and a reduction in genetic variability. Their study, carried out in southern England, revealed a 50% reduction in the movement of small animals over the boundaries of solar farms in comparison to surrounding open areas.

The installation and operation of solar panels can significantly influence the surrounding microclimates and soil conditions. The extent of this impact is closely related to the height of the panels above ground level. In this context, the "height" refers specifically to the distance between the ground and the bottom edge of the solar panels. Dupraz et al. (2011) provide valuable insights into this relationship. Their study found that solar panels installed with their bottom edge at a height of 2.5 metres or lower caused a reduction of up to 50% in the amount of photosynthetically active radiation (PAR) reaching the ground beneath them, compared to areas without any solar panels. This reduction was most pronounced directly under the panels, whereas the spaces between the rows of panels showed no significant effect on PAR levels.

An additional finding of that study was a significant association between panel height and variations in soil temperature. More precisely, panels placed at elevations ranging from 1.5 to 2.5 metres led to an average reduction in soil temperature of 3-4 degrees Celsius during the summer months in comparison to unobstructed regions. By contrast, panels with heights of 3.5 m or greater had minimal impact on soil temperatures.

Hence, the height of panels also exerts an impact on the growth of plants. An investigation conducted by Adeh et al. (2019) and published in "Scientific Reports" revealed that solar arrays placed at heights of 1.2 m led to a significant 90% reduction in biomass output directly beneath the panels. In contrast, arrays situated at a height of 2 m only had a 30% decrease in biomass growth.

The degradation of soil is an extra severe obstacle. In an extensive five-year study conducted by Davidson et al. (2019) on solar farms in the UK, it was found that the areas encompassed by solar panels had a notable decrease in organic matter content, with losses potentially reaching 15%. Furthermore, there was a significant decrease in soil microbial activity, ranging from 30% to 40%. Such modifications can trigger a chain reaction in plant ecosystems and the organisms that depend on them.

A frequently ignored issue is the impact of polarised light reflection that arises from solar panels. Horváth et al. (2009) highlighted the possible effects on several animal species. Solar panels can be mistaken for bodies of water by avian and chiropteran species, leading to accidents. In their research, Greif et al. (2017) found that bats were 50% more likely to approach shiny and polished surfaces that reflected polarised light.

Henderson et al. (2017) analysed the impacts of a substantial solar farm in England. The investigation uncovered a substantial incidence of avian mortality, especially among species that frequently reside in aqueous environments. The findings of the study indicate that the solar farm is accountable for around 1,000 avian deaths per year. The primary factors contributing to these fatalities were instances of accidents with the solar panels and the phenomenon of mirror-like glare. While this was a single-site study, emerging evidence from both the UK and abroad suggests a more nuanced picture, with site-specific factors playing a critical role in determining ecological outcomes.

The broader ecological impacts of solar farms on wildlife, including birds, bats, and general biodiversity, have been studied to a growing extent. Harrison, Lloyd, and Field (2016) highlighted both potential risks and opportunities for enhancing biodiversity through solar farm developments. SEUK (2024) summarise the latest evidence on ecological trends in the UK and related expertise. Similarly, Jarcuska et al. (2024) identified variability in biodiversity and species abundance effects – both positive and negative – on Slovenian solar parks that were designed purely for electricity generation. Hence outcomes could be considerably enhanced with biodiversity factors included in future design. These findings are complemented by studies such as Dupraz et al. (2011), which underscore the importance of design considerations—such as the height of panels above ground—in shaping environmental impacts (see also SEUK 2022).

The influence on insects also can be significant. Research conducted by Száz et al. (2016) revealed that a substantial percentage, reaching up to 90% of some aquatic bug species, were attracted to solar panels. As a consequence of their decision to deposit their eggs on the panels instead of in the water, these insects eventually experienced unsuccessful reproduction. Amphibians experience similar perplexity, which has the capacity to disrupt their reproductive cycles and locomotion (Egri et al., 2012).

This literature analysis has examined the complex correlation between the expansion of solar farms and the preservation of biodiversity in the United Kingdom. Furthermore, it has highlighted the possibility of enhancing ecological circumstances while simultaneously recognising the challenges faced. The analysis of important policy frameworks such as the Climate Change Act, NPPF, and Environment Act 2021 reveals that the regulatory environment, while supportive of renewable energy expansion, often lacks specific provisions for protecting biodiversity in the context of solar farms.

The next part will outline the methodology employed to deepen the analysis of these significant issues, with the ultimate objective of facilitating the development of solar farms that serve as both sustainable energy sources and habitats for thriving ecosystems.

# Chapter 3: Methodology

This research employs a diverse range of qualitative and quantitative methods to investigate the feasibility of enhancing biodiversity in solar farms.

The selection of a mixed-methods approach, including online research, interviews with pertinent experts, and on-site learning, was driven by the complex nature of the research questions and the need to fully understand both policy contexts and practical situations. This approach facilitates the incorporation of data from several sources, therefore enhancing the dependability and accuracy of the findings.

The research strategy was influenced by the recognition that biological diversity in solar farms is often inadequately and non-optimally preserved. Therefore, a thorough analysis was required to understand the challenges and opportunities for improvement. This study involved comprehensive online research, 11 interviews with important participants, involvement in two pertinent events, and four on-site visits. The trips encompassed a two-day engagement with the administrative premises of Runnymede Borough Council, an observation of a functioning solar farm, and an examination of two prospective solar farm locations now in the developmental phase.

Implementing this methodological approach presented several difficulties. Coordinating meetings with the many participants, some of whom are actively involved in the production and have demanding schedules, was a difficulty. Furthermore, the coordination of on-site inspections required careful planning and faced occasional logistical challenges.
Another significant ethical difficulty that emerged was the need to strike a compromise between the necessity to collect comprehensive data and the necessity to maintain confidentiality limits, particularly in cases involving planning applications and ongoing projects. As a consequence of confidentiality considerations, obtaining contact information of candidates and solar farm owners/managers proved to be challenging. These limitations were duly considered and handled in the investigation and reporting of findings.

Notwithstanding these challenges, the mixed-methods approach provided an effective and holistic basis for addressing the study questions. The utilisation of pertinent material, first-hand accounts from stakeholders, and direct observations from on-site visits enabled a comprehensive examination of the complex interplay between policy, practice, and biodiversity results in solar farm ecosystems.

The subsequent sections will describe each selected method, revealing the rationale behind their selection, the process of implementation, and their collective contribution to the achievement of the research goals.

## 3.1 Research Design

The present study's research design implemented a predominantly exploratory strategy, taking into account the complex and constantly evolving nature of biodiversity management on solar farms. The selection of this approach was made in order to provide an understanding of the research topic, considering the many aspects of policy, practice, and ecological elements. The research method evolved gradually, with efficient guidance from the supervisor and in collaboration with project partners. Implementing this approach ensured that the study remained grounded in actualities while maintaining academic criteria.

The set of methods was deliberately designed to systematically build upon each other in an iterative fashion.

- Online research provided the foundation for gathering vast amounts of data and constructing a robust academic knowledge base. In addition to the meticulous scrutiny of planning applications for the development of solar farms.
- Afterwards, the collected data was refined and examined through discussions with relevant experts, therefore assuring expert validation and contextualisation.
- Conducting on-site inspections and visiting the offices of Runnymede Borough Council and different solar farm sites enabled direct observation and verification of the results obtained in previous stages. These inspections facilitated an improvement of understanding regarding practical implementations and limitations.

The use of this iterative approach enabled the continuous enhancement of the study focus. In particular, the findings derived from the online research phase had a significant impact on the development of questionnaires and interview guides for following stages. The adaptability of the research methodology enabled the incorporation and comprehensive investigation of emerging subjects and issues.

Although no particular theoretical framework was explicitly selected, the research design was inherently shaped by systems thinking, a comprehensive approach that acknowledges the intricate relationships among different elements such as policy, technology, ecology, and human decision-making, especially in relation to solar farms and biodiversity (Checkland, 1981; Meadows, 2008). Systems thinking offers a conceptual structure for comprehending the interactions of various components within a larger, dynamic system, rather than in isolation.

To mitigate these biases, the study actively engaged a diverse group of stakeholders, including solar farm operators, ecologists, and planning authorities, to guarantee a comprehensive representation of viewpoints. Triangulation of techniques was adopted as a precautionary measure to mitigate any individual biases that may arise from any one data collecting approach.

Alternative methodologies, such as comprehensive surveys of persons seeking planning rights, were considered but ultimately abandoned due to constraints in acquiring a sufficiently high sample size, primarily because planning authorities and partners voiced apprehensions over anonymity.

The subsequent sections will provide a comprehensive explanation of each technique used, elucidating their implementation and their combined contribution to achieving the study goals.

## 3.2 Online Research

The online research component is divided into two main domains: academic research and planning application research. Both played a vital role in enabling a comprehensive understanding of the subject matter and directing subsequent research phases.

### 3.2.1. Academic research

- **Sources and research strategy**

The online study utilised a diverse range of sources, including academic databases for primary research on renewable energy and biodiversity in solar farms, government websites for documentation of policy frameworks and planning applications, and reports from environmental and ecological firms obtained through Google Scholar, JSTOR, and Web of Science.

The search approach was initiated by adopting a reading list suggested by the supervisor and relevant colleagues. Upon completion of the initial analysis, a bibliography was compiled and then reviewed to identify areas of uncertainty or areas that need more investigation. To ensure comprehensive coverage, further searches were focused on these designated areas. Keyword searches were conducted using the terms "biodiversity," "solar farms," "planning applications," and "biodiversity net gain."

- **The inclusion criteria for selecting sources were as follows**

An assessment of the reliability of sources was conducted by closely examining the authors, publishers, research projects, and creditors. The rigorous filtering process ensured the reliability and relevance of the gathered data.

- **Period Considerations**

Although no specific time frame was defined for source selection, reasonable measures were taken to avoid include outdated material, given the dynamic and often evolving character of the field.

- **Equipment and Structuring**

Various tools were utilised to handle the internet research process effectively:

  - Microsoft Word and OneNote are used for the purpose of notetaking.
  - EndNote was utilised for the purpose of managing references.
  - Microsoft Excel was used for analysing and visualising data.
  - Gantt chart for coordinating and managing cooperation with partners.

- **Integration with Other Research Phases**

The use of online research was essential in enabling the development of the literature review and identifying areas of ambiguity that need more scrutinization. It enabled the development of questions for meetings and interviews and assisted in the planning for on-site visits.

Moreover, it provided a comprehensive understanding of the subject matter, therefore enabling the achievement of research goals.

- **Unexpected discoveries**

A number of unforeseen patterns arose during the internet investigation:

  - Policy gaps regarding biodiversity management on solar farms, highlighting a need for more specific guidelines.
  - A striking scarcity of current and comprehensive census data on animal species and insects in solar farm environments, with many assessments relying on outdated information from as far back as the 1990s.

- **Challenges**

Conducting online study presented some challenges. This investigation was conducted simultaneously with university classes and project activities, which imposed significant time constraints. Paywalls imposed restrictions on access to some publications, requiring careful use of available resources. Moreover, the rapid progress of solar farm technology and the enforcement of biodiversity management rules necessitate ongoing validation of the precision and validity of information.

### 3.2.2. Review of Solar Farm Planning Applications

- **Databases management systems and scope**

A total of six databases of Local Planning Authorities were examined in this study, namely Runnymede Borough Council, Woking Borough Council, Guildford Borough Council, Sevenoaks Borough Council, Reigate and Banstead Borough Council, and Royal Borough Councils of Windsor & Maidenhead.

An examination of the planning databases of Ealing and Hounslow Borough Councils revealed no pertinent applications.

A total of 30 applications underwent meticulous evaluation, with a particular focus on the period from 2013 to the present.

The chosen timeframe was strategically designed to ensure that the study included the latest trends and methodologies in the advancement of solar farms.

The study focused exclusively on ground-mounted solar panel installations located in rural or peri-urban areas. This criterion was established to ensure the relevance to the objectives of the study and to maintain consistency among the samples.

The national register of large-scale renewable planning applications (accessible HERE) was not incorporated as a complementary data source due to its lack of granularity and specific regional relevance to the study area. While the register provides a comprehensive overview of planning applications at a national scale, it does not consistently detail localized factors such as site-specific ecological considerations, Green Belt restrictions, or the decision-making processes of individual local planning authorities.

These localized insights were critical for this dissertation, which focused on the nuances of planning applications within specific borough councils. Additionally, the national register's broader scope risked introducing data outside the defined geographic and regulatory context, potentially diluting the study's focus and comparability. Future research could, however, explore how national-level data might complement localized findings by aligning relevant entries with the specific characteristics of the study area.

- **Information Extraction and Analysis**

The review procedure entailed the extraction and analysis of diverse pivotal components from every application, for instance:

  - Comparisons and contrasts among the submitted documents supporting the applications.
  - Reports by planning officers that specifically highlight the rationale behind their decisions to either approve or reject a proposal.
  - Quantitative data, such as the sizes of solar farms and number of panels
  - Specifics on the installation of panels, namely the height of ground-mounted panels.
  - Geographical data, particularly focussing on rural and peri-urban areas.
  - Companies overseeing the various initiatives.

The data from the applications were predominantly organised and analysed using Microsoft Excel. In order to increase the depth and presentation of findings,

- **Observed Patterns & Trends**

Several significant patterns were identified during the review:

  - Similarities in the justifications for either approval or rejection across various applications.
  - The frequent reference to the preservation of Green Belt areas as a crucial consideration in the process of making decisions.
  - Ensuring conformity in document prerequisites among various Local Planning Authorities (LPAs).

- **Research Implications**

This analysis of planning applications provided useful insights into several facets of the research:

  - It clarified the complexities of the planning application procedure.
  - Identified crucial policies on which Planning Authorities depend for making decisions.
  - The analysis offered a more accurate understanding of the distribution of solar farm applications across different councils.
  - Furnished details regarding application fees and related expenses.
  - Identified efficient approaches that increase the probability of application acceptance.

- **Challenges**

The process presented several significant obstacles. Initially, finding the required information in the databases proved difficult due to variations in interface design and arrangement among different LPA implementations. Gaining access to some databases of borough councils necessitated acquiring approval, which required assistance from project partners.
A particularly difficult task was the need to meticulously examine many documents, often amounting to hundreds of pages, that supported each application. To ensure the thorough

collection of all relevant information, this work required intense attention to detail and a significant time investment.

Furthermore, the task of determining relevant applications was complex. The incorporation of solar farm applications among several other construction applications required a rigorous selection process to identify the most relevant ones from a database of hundreds of other applications. It was important to have a perceptive capacity to quickly identify key indicators of solar farm plans among a multitude of planning documents.

A comparison study was conducted on proposals submitted in different municipalities. The precise results obtained from this comparison will be presented in the results section of this paper.

## 3.3 Interviews

The second essential element of this study approach was a series of interviews, 11 in total, carried out with the different stakeholders engaged in solar farm development and biodiversity management. While all the interviews were interesting, not all of them were immediately pertinent to the project. However, the most informative were those conducted in person with Planning Officers and ecologists at Runnymede Borough Council, during which participants provided valuable information and important documents.

The interviews were conducted with an average frequency of 1 to 2 per week, over the whole research period. This rigorous technique facilitated an extensive and profound investigation of the topic. The participants consisted of a wide variety of stakeholders:

- Planning officers.
- Specialists in ecology.
- Developers specialising in solar farms.
- Representatives from energy companies.
- Members of environmental organizations.
- Individuals applying for planning permission.
- Other professionals with expertise in the subject.

- **Selection Process**

The research supervisor meticulously chose and organised the majority of the meetings and interviews, ensuring a strategic and thorough representation of important stakeholders, even though a personal initiative was sometimes required to schedule certain interviews with solar farm owners.

- **Interview Format**

A combination of structured and semi-structured interviews was used, following the flexible approach advocated by Galletta (2013). This adaptability facilitated the gathering of reliable data during the interviews and enabled the examination of distinctive perspectives or occurrences that arose during the discussions.

- **Topics and themes**

The interview topics were customised to match the specialised knowledge of each participant; however, they may be broadly categorised into 3 main groups:

  - Discussions related to the policy framework.
  - Discussions related to renewable energies.
  - Discussions related to procedures for submitting planning applications.
  - Discussions related to biodiversity and ecology.

The flexibility in the choice of topics allowed each interview to fully utilise the interviewee's specialised expertise and experience. a strategy supported by King et al. (2018) in their work on qualitative interviewing.

- **Duration**

The duration of the interviews ranged from 30 minutes to 1 hour, providing ample time for detailed conversations while being mindful of the participants' time limitations. The data were gathered using a combination of notetaking and audio recording, allowing for the instant collection of important information and the option to subsequently analyse talks in detail.

- **Challenges**

Although the language barrier presented a slight difficulty because English in not my native language, it did not cause any substantial problems. The primary difficulty lay in the coordination of interviews and the efficient allocation of time, especially when several interviews overlapped with academic commitments and other research activities.

- **Data Analysis**

The analysis of interview data consisted of meticulous examination of audio recordings and thorough evaluation of notes recorded during the interviews. This procedure facilitated the recognition of significant themes, patterns, and distinctive perspectives among the many stakeholders that were questioned.

- **Complementarity with Online Research**

The interviews demonstrated their exceptional time efficiency as a data gathering approach, sometimes providing more important material in a 30-minute session than a whole day of online research. Furthermore, the material collected was exceedingly dependable, sourced straight from experts in the respective subject. This direct and personal understanding enhanced and frequently provided additional details or explanations to the data collected via internet investigation. However, it is important to recognise that, as warned by Oltmann (2016), there is always a potential for selective disclosure or specific bias being shown on statements by interviewers, which was taken into account throughout the analytical phase.

- **Surprising Discoveries**

Even if they are not directly connected to the study objectives, a very remarkable and surprising component of the interview procedure was the participants' exceptional degree of commitment and promptness. Participants showed a robust dedication to the project, frequently offering more elaborate and perceptive information than first expected.

## 3.4 On-site Learning and Site Visits

The third essential element of the study process was doing on-site learning by strategically visiting pertinent stakeholders.

These trips offered extremely useful direct views and opportunities to interact with important individuals and examine important papers.

- **Sites visited**
  - Runnymede Borough Council offices (2 days)
  - The South Hill Energy Solar Farm (Oxford).
  - Two solar farm sites that have recently been granted planning permission in Runnymede: Twynersh Meadows, Chertsey and Parkside, Wick Lane, Englefield Green, Egham.

- **Site selection**

The choice of places was deliberate and driven by certain goals. Runnymede Borough Council, as a crucial collaborator in the project, was an obvious selection for expanding on-site learning. The council proposed arranging visits to two recently authorised solar farm locations under its control. The functioning solar farm near Oxford was suggested during a stakeholder interview because of its exceptional beneficial effect on biodiversity, making it a great example to research.

- **Purpose and Activities**

The main objective of these trips was to get extensive, direct knowledge about the practical elements of solar farm creation and operation, as well as to comprehend the processes involved in planning and obtaining approval. Activities differed depending on the location:

Activities at the Runnymede Borough Council offices include browsing and analysing important papers, as well as conducting interviews with pertinent staff members.

When assessing solar farm locations, interviews were organised with the staff present, as well as a collection of audio and video data of the site, and careful observation of the layout and environmental characteristics.

- **Tools for collecting data**

Multiple instruments were utilised to guarantee thorough data gathering:

  - Camera and phone for capturing audio, photo and video content.

- ArcGIS for cartography and geospatial analysis.
- Conventional tools for recording notes

- **Support**

A planning officer from the Borough Council accompanied and gave insights during the visits to the two newly approved sites in Runnymede.

Southill energy ecologist assisted the visit of their solar farm, providing unvaluable information about the site biodiversity commitments.

- **Duration**

- The visits of the offices of Runnymede Borough Council were for a duration of 4-5 hours per day, for a total of 2 days.
- The recently authorised sites in Runnymede took around 30 minutes each to complete.
- The operational solar farm in Oxford took 3 hours to complete.

- **Challenges**

The main obstacle encountered was the organisation and permission procedure for site visits, which necessitated thorough conversations and planning.

Although interviews with landowners and farmers were planned to gain firsthand insights into solar farm planning and management, confidentiality and GDPR constraints prevented this.

In the absence of direct interviews, planning application records and policy reviews provided robust secondary data for understanding stakeholder perspective

To address this limitation, future studies could explore anonymous survey methods or collaborate with intermediary organizations to facilitate interviews while maintaining confidentiality.

- **Integration with Other Research Phases**

The on-site learning component was crucial in complementing and augmenting the other research approaches utilised. Being personally on site had several distinct benefits:

- Having direct contact with key personnel, such as planning officers, site managers, and other important persons, allowed for direct interaction that gave nuanced insights that may not have been obtained through remote interviews or document analysis.
- Document accessibility to significant papers that may not have been accessible online or through alternative means.
- The physical presence at the solar farm sites and potential locations was essential for gaining a comprehensive visual and geographical knowledge of the projects. By directly witnessing the solar farms, a more thorough understanding of their size, arrangement, and surrounding environment was obtained.
- Being physically present at the site provided the chance to see and comprehend directly the specific local circumstances, such as the nearby land usage, possible biological pathways, and community environments. These aspects are crucial in evaluating the impact of solar farms on biodiversity.

## 3.5 Ethical Considerations

The study meticulously examined and tackled the ethical concerns, guaranteeing that every facet of the project complied with rigorous ethical principles.

- **Institutional approval and project context**

Before the commencement the study project obtained specific ethical approval from Royal Holloway, University of London (RHUL). The first project meeting was a comprehensive debate in which all project members achieved a consensus on ethical issues, including confidentiality and consent procedures.
As part of this procedure, every collaborating organisation joined a Memorandum of Understanding (MoU) that regulates these ethical concerns and details the management of sensitive information. This Memorandum of Understanding guarantees a uniform process for securing data, protecting participant rights, and implementing ethical research methods among all involved organisations.

- **Managing Confidential Information**

The study faced various instances involving sensitive data:

- All research materials were referenced and all copyrights are protected.

- No images including identifiable persons were utilised or archived.
- Due to the need for confidentiality, access to personal information and contact details of planning applicants was restricted. Some project partners were constrained in sharing information about ongoing projects due to commercial sensitivity.
- The researcher followed the guidelines provided by supervisors and respected the boundaries imposed by data owners and project partners in all such circumstances.

- **Data Storage and Protection**

Although the data gathered and kept on personal devices was not extremely sensitive, conventional data protection procedures were nonetheless implemented:

- Implement password encryption on all devices that store research data.
- Consistently storing data in a protected cloud storage system.

- **Ensuring the Accuracy and Integrity of Data**

In order to ensure the precision and reliability of the gathered data, we employed many sources to verify and validate the information wherever feasible.

- Comprehensive records were made during interviews and site visits, which were subsequently examined and clarified with participants as needed.
- Consistent meetings were conducted with supervisors to deliberate and authenticate interpretations of data.
- A coherent chain of evidence was meticulously upheld, establishing a direct connection between all findings and conclusions and their basic data sources.

- **Reflexivity and Bias**

During the study process, the researcher constantly used a reflective approach, actively considering the potential impact of personal biases or assumptions on data collection or interpretation. Frequent interactions with supervisors facilitated the questioning of preconceptions and the maintenance of a well-rounded perspective.

- **Limitations and Challenges**

An important ethical dilemma faced was striking a balance between the necessity for thorough data gathering and the requirement to uphold confidentiality protocols, especially in relation to planning applications and active projects. An illustration of this was the challenges encountered in acquiring the contact information of applicants and solar farm owners/managers, mostly because of confidentiality concerns. These constraints were recognised and taken into consideration during the analysis and presentation of the results.

Having defined the methodological framework for this study, we will now focus on the results it has produced. The subsequent chapter presents the findings.

# Chapter 4: Results and Discussion

## 4.1 Results presentation and discussion

To be able to provide theoretical and practical suggestions for enhancing biodiversity on solar farms, it was crucial to separate the two fundamental concepts involved—solar farms and biodiversity—and critically examine the applicable laws that govern each, those related to the renewable energies and their expansion on one hand, and regulations protecting and enhancing biodiversity on the other hand.

The intersection of these two legal frameworks was identified in the NPPF, which functions not only as a directive instrument for local authorities, assisting them in their administration, but also achieving the government's goals as specified in legislations such as the Climate Change Act, which emphasises the shift towards renewable energy and the attainment of net-zero emissions by 2050, and the Environment Act, together with its BNG provisions, which prioritise the protection and enhancement of biodiversity.

For this reason, the primary focus of the research involved a thorough analysis of the NPPF (2021 version), followed by the creation and detailed examination of a database comprising solar farm projects planning applications decided by the NPPF (accessible HERE). These analyses were conducted using the various research methods discussed in the previous chapter.

The first result obtained confirms the criticism highlighted in the literature review, which questions the feasibility of achieving the targets set by the Climate Change Act, specifically the goal of net-zero by 2050. Indeed, the analysis of planning applications revealed a significant number of rejections for solar farm installations, mostly related to the greenbelt preservation, thereby reducing the likelihood of meeting the net-zero 2050 targets. The following pie chart illustrates the different decision percentages of the solar farms' planning application gathered from various (LPA) databases."

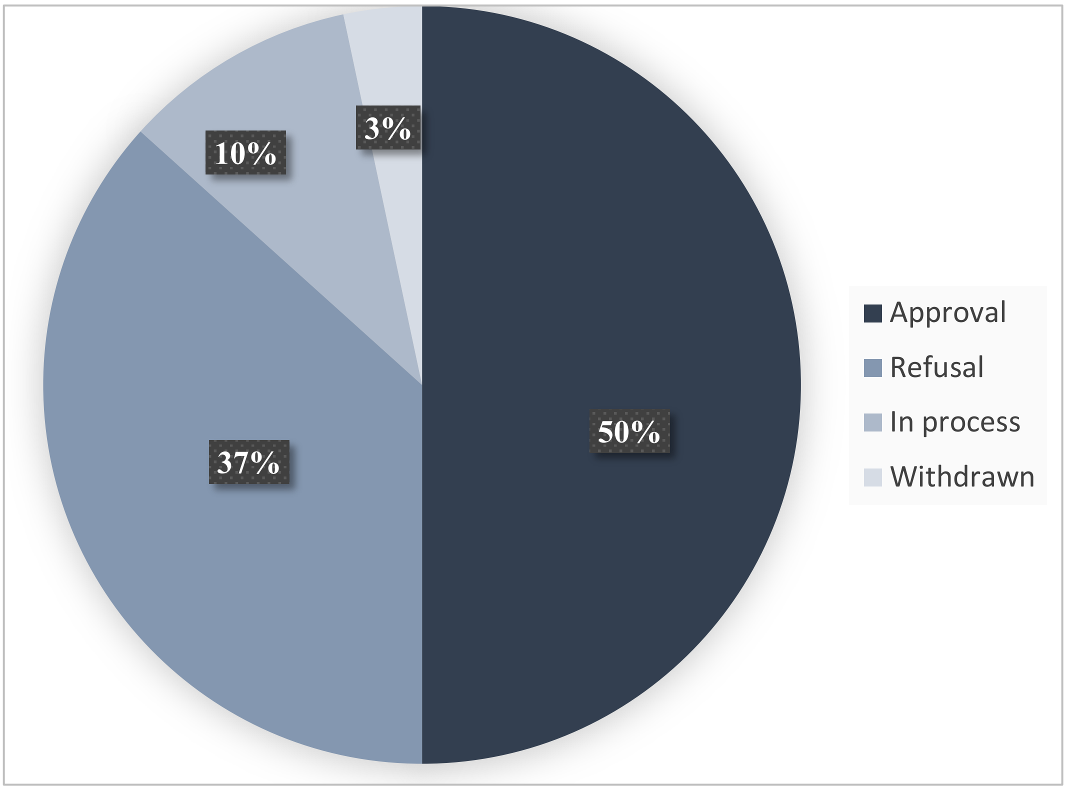


*Figure 1- Distribution of Planning application Decisions for Solar farms*

It indicates that 50% of the 30 applications considered obtained approval, suggesting a reasonable level of success for solar farm projects. In contrast, a considerable percentage (37%) faced rejection, highlighting the significant challenges that were encountered throughout the planning process. Furthermore, the chart demonstrates that 10% of submissions are still being considered, which highlights the ongoing development of this type of proposals and the complicated nature of the decision-making process. Only a small percentage (3%) of applications were retracted by the applicants, indicating potential factors such as changes in project expectations, rising costs or anticipation of negative outcomes.

The total peak capacity that would have been produced by the rejected solar farm projects amounts to 67,175.62 KW. Assuming these farms operate at full capacity for 5 hours each day [1], the daily energy generation would be 335,878.1 kWh. Multiplying this by 365 days in a year, an estimated annual energy generation of 122,598,496.5 kWh, or 122,598.5 MWh when converted to megawatt-hours. Over the typical 35-year lifespan of a solar farm, this would amount to a staggering 4,290,947.5 MWh of clean energy that could have been generated.

The total $CO_2$ emissions that could have been avoided by generating such quantity of clean energy over the 35-year lifespan of the rejected solar farm projects is approximately 3.95 million metric tons of $CO_2$. This estimate is based on the average $CO_2$ emissions from electricity generation in the UK, which is around 0.233 kg of $CO_2$ per kWh**,** according to the UK Government's Department for Business, Energy & Industrial Strategy (BEIS).

To put this into perspective, this is equivalent to the $CO_2$ emissions produced by approximately 850,000 cars driven for a year, raising doubts about its practicality of meeting the targets established by the Climate Change Act,

Moreover, this study is at a very small scale and centred just on solar farms on rural and peri-urban farmland in one particular area, yet it already reveals interesting statistics. Therefore, it is possible to extrapolate these findings to a nationwide level, particularly considering the rather homogeneous results seen in the cities considered, as shown in the following graph.

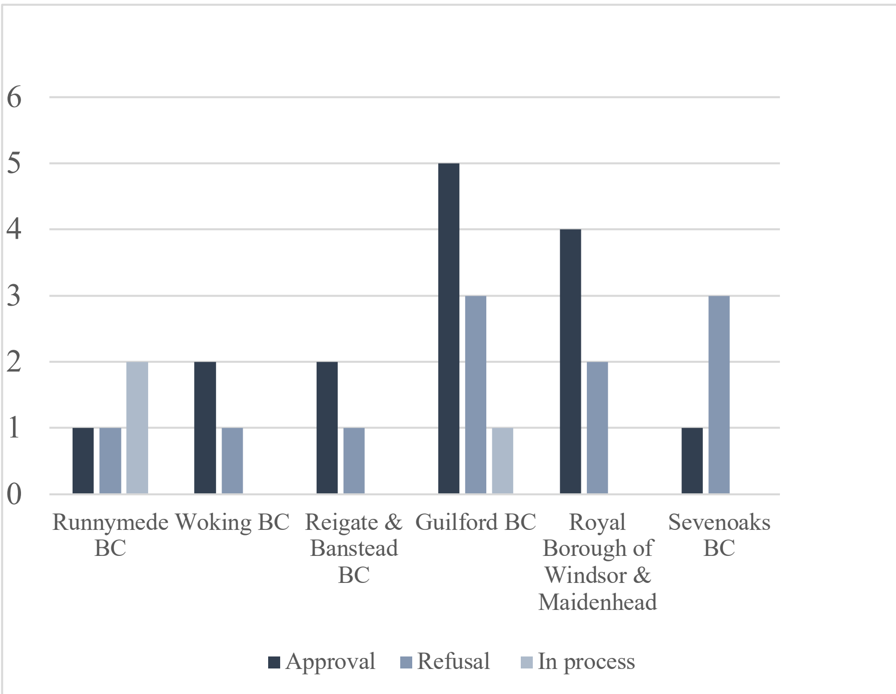


*Figure 2-Variation in Solar Farm Planning Decisions Across Borough Councils*

The bar chart shows the differences amongst councils in terms of both the number of applications and the patterns of decisions. With five approvals, three rejections, and one in-process application, Guildford Borough Council (BC) exhibits the highest level of activity, indicating a strong involvement with solar energy plans in contrast to less positive outcomes for Sevenoaks BC, with three rejections against one permission, possibly indicating problems with the quality of the submitted applications or insufficient guidance.

A total of four approvals and two refusals indicates a favourable outcome for the Royal Borough of Windsor & Maidenhead. Runnymede BC, Woking BC, and Reigate & Banstead BC have lower total application volumes but different patterns of decision-making. Runnymede BC has an equal distribution of approvals, with one approval, one refusal. Two planning applications are still in process. In contrast, Woking BC, and Reigate & Banstead BC both get two approvals and one refusal. the number of applications and outcomes show very modest variances, demonstrating similar difficulties and possibilities across these municipalities.

By analysing the applications more closely, the reasons behind the most frequent decisions almost all converge on "the greenbelt." A graph has been created to illustrate the most commonly cited reasons in these decisions.

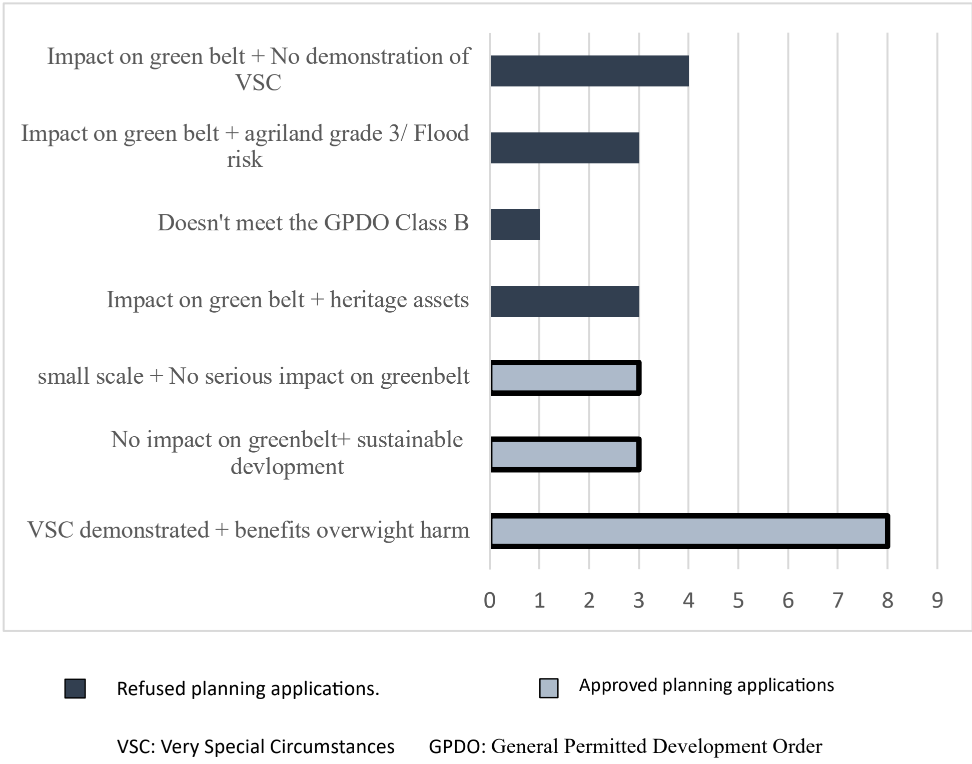


*Figure 3-Frequency of Key Reasons mentioned in Solar Farm Planning*

This horizontal bar chart represents the frequency of the most common reasons mentioned with both refusals and approvals of solar farms planning applications.

Black bars show refusals that are mainly associated with Green Belt concerns. The primary cause for rejection, occurring 4 times, is the combination of impacting Green Belt and failing to demonstrate VSC. This is closely followed by situations in which the impact of the Green Belt is exacerbated by concerns about agricultural land classified as grade 3 or at risk of flooding (3 cases). Equally noteworthy are the rejections based on the combined effect on Green Belt and historical assets, amounting to three cases. Only one instance of rejection is ascribed to failure to comply with General Permitted Development Order (GPDO) Class B regulations, underscoring the need of following precise planning criteria.

In contrast, approvals, represented by white bars, have a distinct pattern. The key determinant for approval is the effective demonstration of VSC, together with benefits outweighing harm caused (8 cases). Furthermore, permissions are issued in situations when projects are of a modest scale and do not significantly affect the Green Belt (three cases), and when there is no serious impact on the Green Belt but also incorporates sustainable development elements (three cases).

While it's true that nearly all of the recorded applications lie within the greenbelt, making the decisions converge inevitably for the same reasons, it's important to note that solar farms require significant space. This need naturally leads to rural or peri-urban locations, which are almost invariably situated within the greenbelt. The following map clearly illustrates the distribution of these solar farm applications.

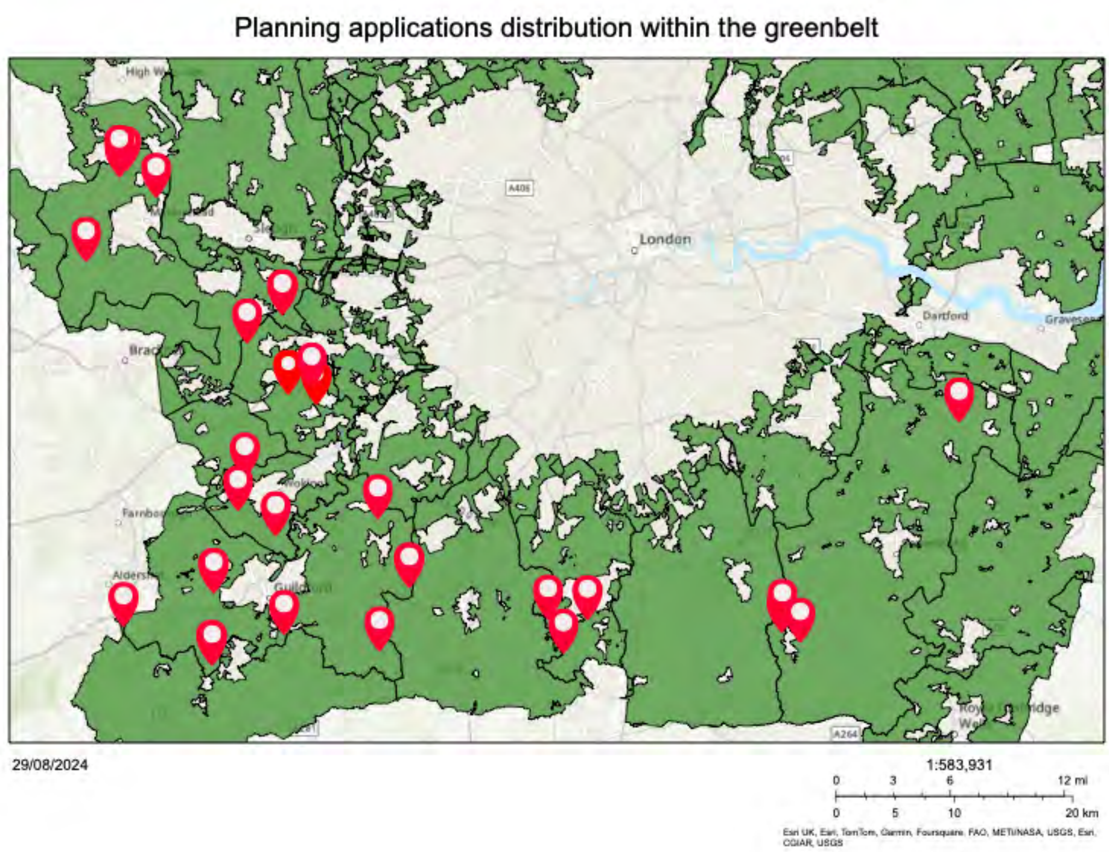


*Figure 4-Map of the planning applications distribution created with ArcGIS.*

The focus of results on the greenbelt is highly significant as it highlights two key points. First, it underscores the importance of the greenbelt and its regulatory protections. This presents a challenge for solar farms because the conservation of the greenbelt is almost always prioritized over any development project unless very special circumstances are demonstrated. Often, modestly funded or poorly advised applications fail to provide the necessary information to increase their chances of acceptance. This, in turn, has an indirect but nonetheless negative impact on the prospects for solar farms and the achievement of Climate Change Act goals. One proposed solution by Local Planning Authorities (LPAs) is the use of pre-application consultations. Although pre-application consultations have shown very promising results, they are not adopted consistently. Figure 5 illustrates the influence of pre-application consultations on the outcome of the planning applications studied and highlights this importance.

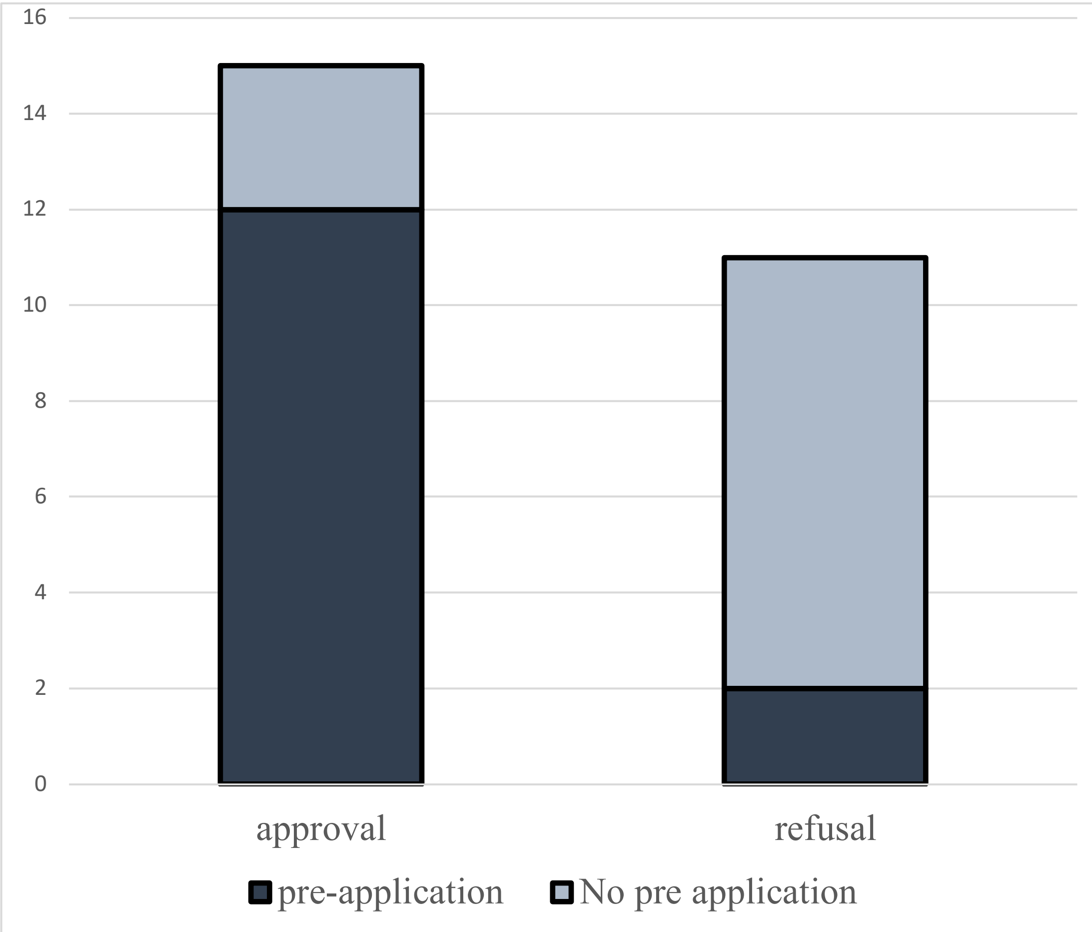


*Figure 5-Impact of Pre-Application Process on Solar Farm Planning Outcomes*

The presented stacked bar chart represents the correlation between pre-application consultations and the outcomes of solar farm planning applications. A clear contrast in acceptance rates is shown by the data between applicants that undertook pre-application procedures and those that did not, highlighting the possible impact of this optional but critical stage in the planning process.

The graph shows a notable frequency of pre-application consultations for accepted applications. Among the 15 applications that were approved, 12 had undergone pre-application procedures, while just 3 were authorised without. The significant disparity indicates a robust positive relationship between pre-application involvement and achievement of desired results.

In contrast, of the 11 applications that were rejected, just 2 had received pre-application consultations, while the remaining 9 had not. The inverse correlation between the pre-application procedure and the likelihood of rejection further amplifies its potential importance.

Secondly, this indicates that the NPPF may be missing a key opportunity to better support and achieve higher Biodiversity Net Gain objectives. Indeed, while the NPPF often requires a modest 10 to 20% net gain in biodiversity for development projects as VSC for projects within the greenbelt, more optimistic results—up to 70%—have been demonstrated as achievable, as seen in the Southill Energy Community Solar Farm in Charlbury, Oxford, discussed above in Chapter 2. Similar principles are set out by SEUK (2022).

Installed in 2016, this community-owned project of 4.5 MW spans 45 acres of land. It was designed with a strong emphasis on sustainability and active participation of the community, which positions it as an exemplary example for renewable energy initiatives.

Southill Solar Farm has implemented a comprehensive biodiversity enhancement strategy to achieve a 70% net gain. This includes planting native wildflower meadows to enhance biodiversity between and around solar panels. They've also focused on hedgerow enhancement, planting new hedgerows and improving existing ones, as well as creating a woodland of 60 fruit trees. The farm also installed bird boxes and nests to support the 48 species identified in the area, along with insect hotels for bees and other insects. Grassland management practices were implemented across 30 hectares to maintain diversity. Finally, habitat corridors were established to facilitate wildlife movement throughout the site.

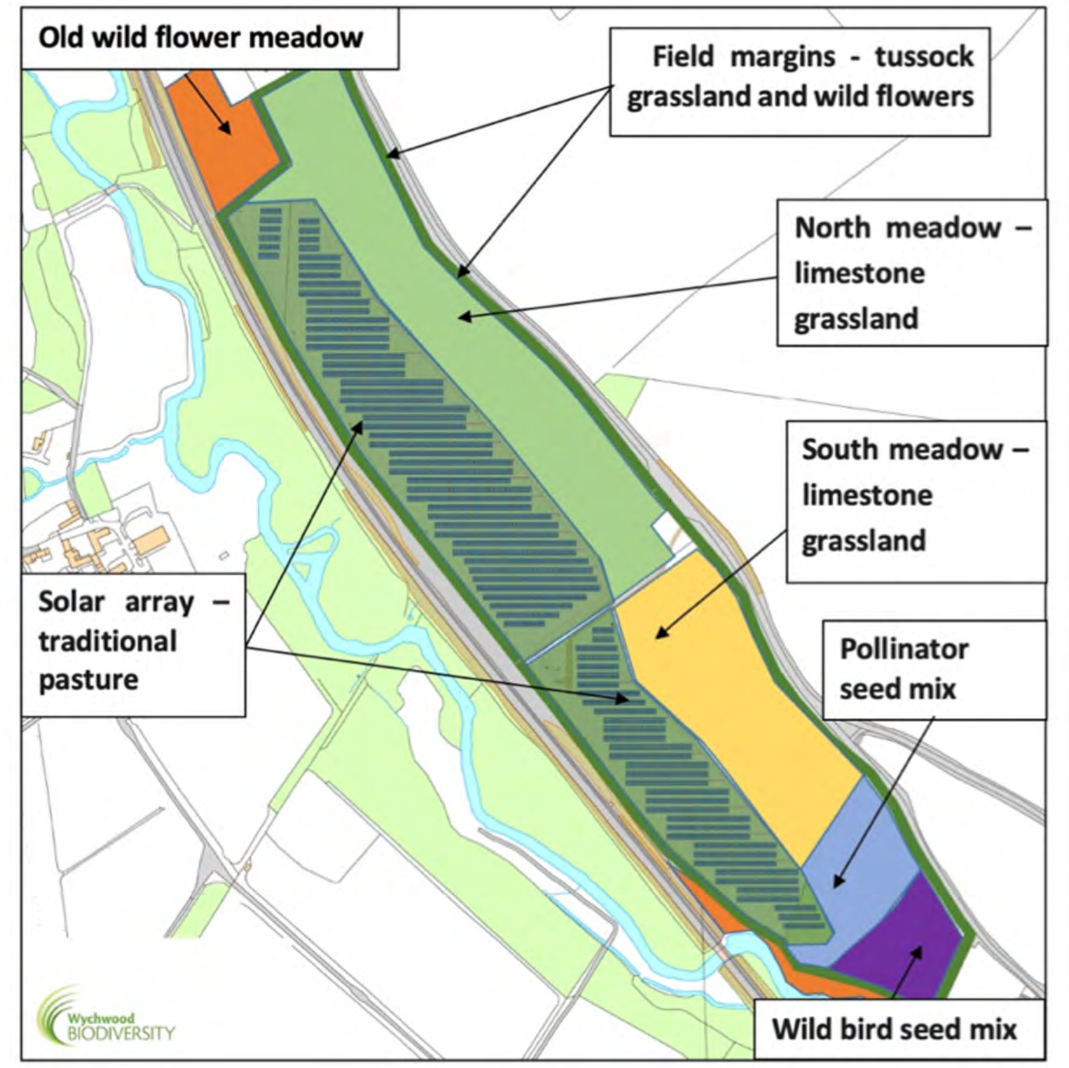


*Figure 6-Biodiversity Management Plan for Southill Community Energy Solar Farm. [From Wychwood biodiversity case study: Enhancing biodiversity at Southill]*

The image presents a detailed site plan that visually illustrates the various habitats formed within the solar farm providing a more comprehensive perspective on the strategies employed to enhance biodiversity.

# Chapter 5: Recommendations

A primary objective of this study has been to develop suggestions for improving biodiversity on solar farms. The ideas presented subsequently have been developed using a thorough methodology that includes examination of important documents such as "Realising the Biodiversity Potential of Solar Farms: A Practical Guide" authored by Wychwood Biodiversity and Naturesave Insurance as well as integrating guidance from ecologists acquired through meetings and interviews about case studies of effective biodiversity projects in current solar farms, therefore assuring a combination of academic understanding and practical proficiency.

## 5.1 Regulatory framework recommendations

- **Recommendation 1: A more precise NPPF**

A more precise NPPF is essential for meeting the objectives set in both the Climate Change Act and the Environment Act, while indirectly improving biodiversity in solar farms. The existing NPPF's broad recommendations, especially about the establishment of solar farms on Green Belt land, allow for varying interpretations that may lead to unanticipated outcomes for solar farm applications. This unpredictability may hinder the achievement of renewable energy goals and, as a result, efforts to mitigate climate change.

To address this, the NPPF could provide more precise definitions of the "very special circumstances" in which the construction of solar farms on Green Belt land may be allowed. Furthermore, the NPPF could provide more explicit instructions on how to reconcile the visual appearance of solar farms with their ecological advantages. This might be achieved by defining precise screening and land management procedures that, if used, would be positively perceived throughout the planning process. Implementing these specific guidelines will not only simplify the authorisation procedure for solar farms but also guarantee that approved projects always include strong biodiversity safeguards, therefore promoting both climate and environmental sustainability goals. The current NPPF consultation might address some of these points.

- **Recommendation 2: Elevate Biodiversity Net Gain Targets for Solar Farms**

The current requirements of a 10% biodiversity net gain for development projects underestimate the ecological improvement potential of these areas. Case studies have demonstrated that well-managed solar farms may attain much higher levels of biodiversity enhancement. This lack of optimism underscores a lost chance in the present strategy towards the preservation and increase of biodiversity.

- **Recommendation 3: Mandate Pre-Application Consultations for Solar Farm Proposals**

Introducing mandatory or strongly recommended pre-application consultations as an integral part of the planning process for solar farm projects would be an important step to improve the quality of proposals and their potential to enhance biodiversity. This proposal seeks to convert the pre-application phase from an optional step to a mandatory and crucial stage in the planning process.

The implementation of pre-application consultations will require developers to actively include planning authorities and pertinent specialists from earlier stages. There are various reasons why this early engagement is so beneficial. Primarily, it enables the detection and resolution of potential issues before to the submission of the official application, therefore enhancing the likelihood of acceptance. Furthermore, it offers developers the chance to obtain professional guidance on biodiversity improvement techniques that are specifically designed for their particular site and project. Professional ecologists can provide guidance to developers on how to optimise biodiversity benefits, sometimes surpassing the minimal criteria and contributing to increased net gain percentages. Moreover, this procedure enables a thorough evaluation of all elements of the plan, guaranteeing that biodiversity concerns are included from the beginning rather than being handled as an after-consideration. Ultimately, obligatory pre-application consultations would result in more resilient, ecologically sustainable projects that are more in line with both planning criteria and biodiversity objectives, benefiting developers, local authorities and the environment.

- **Recommendation 4: Establish Long-Term Partnerships with Local Communities and Environmental Organizations for Solar Farm Biodiversity Management**

The objective of this recommendation is to ensure the continuous and efficient control of biodiversity on solar farms by implementing obligatory long-term collaborations with local communities and environmental organisations. Through the establishment of these collaborations, operators of solar farms may access local ecological expertise, promote community involvement, and guarantee reliable and systematic maintenance of biodiversity during the whole lifespan of the solar farm.

Key aspects of this recommendation include:

1. Ensuring that these collaborations cover the whole operating lifespan of the solar farm, starting with the design phase before construction and ending with decommissioning.
2. Engaging partners in regular evaluation of biodiversity, decision-making at management level, and execution of conservation measures.
3. Promoting community engagement in biodiversity projects, which may comprise educational programs or citizen scientific activities.
4. Consistent reporting on biodiversity results to uphold transparency and accountability.

The implementation of these collaborations could ensure that each solar farm actively contributes to the long-term preservation of local biodiversity, therefore optimising their beneficial effects on energy generation and ecological improvement.

## 5.2 On-site recommendations

- **Recommendation 1: Installation and infrastructure**

The is to engineer and execute solar panel infrastructure that maximises the potential for biodiversity while simultaneously ensuring energy efficiency through the following measures.

a. **Optimal height of the panels:** Establishing a minimum height of two metres for solar panels where practicable is crucial for several reasons, as emphasised by Wychwood Biodiversity and Naturesave Insurance. This height enables the growth of more diverse and taller vegetation beneath the panels, enhances soil ecosystems by improving the distribution of light and water, and generates diverse microclimates that support a broader range of species. Furthermore, this elevation enables more convenient maintenance, such as sheep grazing, which maintains vegetation at an appropriate height to avoid disruption to solar panels and power production. It also enables the management of areas beneath the panels that are inaccessible to mechanical equipment, preventing soil compaction and disturbance caused by heavy machinery at the same time. In addition, it increases the penetration of light into the spaces beneath and between panels, therefore providing additional support for plant growth.

b. **Optimal inter-row spacing:** This emphasises the critical need to maintain a sufficient space between rows of solar panels in promoting biodiversity in solar farms. Achieving appropriate spacing is crucial for facilitating strong plant growth between the panels. Greater distance results in increased sunlight reaching the ground, which in turn supports a wide variety of plant species and contributes to the development of a more complex habitat structure for insects, birds and small mammals.

   The diverse flora not only enriches the total biodiversity of the area but also actively supports the health and stability of the soil. Furthermore, ensuring suitable spacing between rows establishes essential pathways for the move of animals.

   The implementation of deliberate inter-row spacing in solar farms enables the successful integration of energy generation with the establishment of a more permeable and ecologically diverse environment. This transformation of a potential barrier into a biodiversity-friendly landscape that promotes both local wildlife and sustainable energy objectives is achieved.

c. **Incorporate pond installation:** The incorporation of ponds into solar farms is an effective approach to enhance biodiversity by establishing essential aquatic environments. In addition to enhancing the ecological value of the site, these water basins provide vital supplies for a diverse array of animals, including amphibians, insects, birds, and small mammals. Ponds function as strongholds for wildlife, providing potable water, reproductive sites for amphibians, and habitats for aquatic flora and aquatic animals.

d. **Implement a sun-tracking solar panel system:** This approach enables panels to track the trajectory of the sun over the day, therefore most effectively maximising energy generation by maximising available solar exposure. There are several such technologies available; the most appropriate would need to be investigated in each context. These add to the capital cost but also provide notable benefits for the improvement of biodiversity. The motion of panels generates dynamic patterns of light and shadow on the layer of earth below, thereby promoting a more varied microclimate capable of supporting a broader range of plant species. The diverse range of light exposure facilitates the development of both sun-loving and shade-tolerant plants, therefore enhancing the total plant variety on the site. The dynamic fluctuations in sunshine and shadow also contribute to soil health by mitigating the persistent shading of any one region, therefore promoting a more uniform distribution of soil moisture and minimising the likelihood of soil deterioration. Furthermore, the deployment of panels might stop birds' collisions with panels and discourages from constructing nests on the buildings, hence potentially mitigating conflicts between wildlife and solar farm activities. Through the implementation of rotating systems, solar farms may attain a harmonious combination of optimised energy generation and increased biodiversity, therefore establishing a more dynamic and biologically diverse environment that can effectively respond to the requirements of renewable energy generation and local ecosystem regeneration.

**Mitigate glare and polarized light impacts:** The implementation of anti-reflective coatings on solar panels for glare reduction not only enhances the efficiency of energy capture but also mitigates the potential for confusing birds and insects by the "lake effect" mentioned previously, thereby reducing the risk of bird collisions and incorrect egg deposition.

- **Recommendation 2: Biodiversity integration**

Building upon the recommended strategies presented in resources such as the Buglife (2022) guide "Realising the Biodiversity Potential of Solar Farms," this proposal aims to actively improve the ecological value of solar farms by implementing specific measures.

a. **Wildflower meadows:** Strategically establish a variety of wildflower meadows across the property, offering essential homes and food resources for pollinators and other insects. Not only does this enhance the aesthetics of the place, but it also greatly enhances the overall regional biodiversity.

b. **Hedgerow installation:** Install and maintain hedgerows along the external boundary and inside the solar farm. These corridors provide essential habitats, nesting locations, and sustenance for a diverse range of species, including birds and small animals.
c. **Fruit tree integration:** augments the existing biodiversity by introducing an additional layer. These provide habitat for wildlife and perhaps provide communal advantages through the production of fruits.
d. **Apiculture:** Implement distribution of beehives and other insect habitats over the property to provide crucial nesting sites for bees and other insects. This enhances the provision of pollination services and sustains the wider environment.
e. **Biodiversity management**: Establish a systematic timetable for monitoring these key characteristics of biodiversity and adjust management approaches as necessary to guarantee their sustained efficacy.

Through the implementation of these strategies, solar farms have the potential to evolve into highly diverse and versatile environments that not only provide environmentally friendly electricity but also actively enhance the health and resilience of the surrounding ecosystem. This methodology enables solar farms to far surpass the minimal biodiversity criteria, therefore demonstrating the compatibility of renewable energy generation with environment preservation.

# Chapter 6: Conclusions

This research has explored the potential for improving biodiversity in solar farms in the United Kingdom, elucidating associated obstacles and potential advantages. The findings are likely to be relevant in other countries with similar climatic and vegetation conditions. The results emphasize the important role of policy frameworks, namely the National Planning Policy Framework (NPPF), in influencing the outcome of solar farm planning applications.

The examination of planning applications revealed significant findings, indicating that a considerable proportion of rejections were mostly attributed to concerns over the preservation of the Green Belt. This aligns with academic literature, such as Cowell and Devine-Wright (2018), which highlights the tension between renewable energy objectives and the strict regulatory framework for Green Belt land. This trajectory raises questions about the feasibility of achieving the objectives established by the Climate Change Act, notably the aim of reaching net-zero emissions by 2050. Furthermore, the study emphasized the significant opportunity for generating clean energy and reducing $CO_2$ emissions that is being overlooked as a result of these rejections.

The analysis revealed several aspects that need enhancement in existing procedures and regulations, particularly the broad guidelines of the NPPF that encourage interpretation by local planning authorities. This variability echoes the findings of Rydin et al. (2015), who noted how inconsistent decision-making can result from the lack of precise criteria in planning policy. The necessity for more specific standards for assessing solar farm proposals, particularly those located on Green Belt land, remains a pressing concern.

An important discovery identified the beneficial influence of pre-application consultations on the rates of planning approval. These findings indicate that implementing compulsory consultations might greatly enhance the calibre of proposals and their congruence with both renewable energy and biodiversity objectives.

This research also reflects on the existing criteria for biodiversity net gain, which appear underestimated in assessing the potential of solar farms. Montag et al. (2016) highlighted that well-managed solar farms could support a broader range of species compared to traditional agricultural land. Similarly, case studies like the Southill Energy Community Solar Farm demonstrate that far greater levels of biodiversity improvement are attainable, indicating the potential for more ambitious objectives.

As highlighted during the Labour Party's 2024 election campaign, changes to the NPPF that relax some Green Belt restrictions are now being signalled by the new government (see appendix). These reforms could have a significant impact on future solar farm planning applications by creating more opportunities for projects that align with both renewable energy and biodiversity objectives. However, this would require balancing development with careful ecological considerations to ensure sustainability.

The outcomes of this investigation lead to the formulation of various suggestions. These measures include enhancing the NPPF to offer more explicit instructions, raising biodiversity net gain objectives specific to solar farms, requiring pre-application consultations, and promoting enduring collaborations with local populations for biodiversity management.

The on-site recommendations prioritize the optimization of solar panel installation and infrastructure to maximize biodiversity potential. Key considerations include establishing a minimum panel height of 2 metres, where practicable, to facilitate varied vegetation development and wildlife mobility, maximizing inter-row spacing to promote plant diversity, and integrating pond installations to establish aquatic habitats. Additionally, the use of solar panel rotation devices to provide dynamic light patterns could encourage diverse plant development while minimizing glare and polarized light effects to reduce disturbances to wildlife. The integration of wildflower meadows, hedgerows, fruit trees, bee hotels, and other insect habitats around the property is essential for fostering diverse ecosystems.

Consistent monitoring and flexible management are critical to realizing these benefits. By adopting these strategies, solar farms can transition from being merely energy producers to becoming multifunctional landscapes that generate environmentally friendly electricity while actively enhancing the health and resilience of surrounding ecosystems. This transformation aligns with the goals of academic literature and policy initiatives, emphasizing the importance of innovative and adaptive approaches to achieving sustainable development.

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# Appendix: December 2024 Alterations to the NPPF

(available at https://assets.publishing.service.gov.uk/media/675abd214cbda57cacd3476e/NPPF-December-2024.pdf)

The new Labour government launched a public consultation during Autumn 2024 on proposed changes to the NPPF. These centred on selective relaxations to Green Belt protections in respect of how local planning authorities (LPAs) should treat planning applications for renewable energy installations and certain other forms of housing development. The aim is to assist in meeting the UK's net zero targets and housing shortages, particularly for specific housing categories.

Following the consultation, the new version of the NPPF was published on 12th December 2024, superseding the December 2023 version. While various small wording changes have been introduced, the principal changes of relevance to this study include the identification of Grey Belts within the Green Belt, expanded criteria for renewable energy projects, and strengthened strategic collaboration guidelines.

**Relevant Changes To the NPPF**

1. **Grey Belts in the Green Belt**

Paragraph 148 introduces the concept of Grey Belts, areas within the Green Belt already disturbed by development, which are now prioritized for renewable energy projects and affordable housing. This adjustment provides a clearer framework for selecting appropriate sites, reducing the ambiguity previously associated with Green Belt protection.

The prioritization of Grey Belts aligns with the recommendation for more precise guidance in the NPPF. These areas also offer opportunities for biodiversity enhancement, supporting the advocacy for integrating ecological considerations into solar farm developments.

2. **Flexibility in Green Belt Policies**

Paragraph 155 introduces more flexible conditions under which development in the Green Belt may not be considered inappropriate. However, the retention of Paragraph 160 underscores the continued need for developers to demonstrate "very special circumstances," maintaining a significant barrier for most renewable energy projects.

The flexibility supports the recommendation to encourage pre-application engagement, enabling developers to navigate complex requirements effectively and build stronger cases for their projects.

3. **Policy Support for Renewable Energy Projects**

Paragraph 168 now requires LPAs to give "significant weight" to renewable energy proposals, emphasizing their contribution to net zero targets. This replaces the previous focus on community-led initiatives, shifting attention to a broader policy objective. This shift represents a positive development, yet the removal of explicit community-led support may risk diminishing local engagement in renewable projects.

4. **Strategic Collaboration Guidelines**

Expanded guidance on collaboration between LPAs (Paras 24, 27, 28) emphasizes sustainable growth, climate resilience, and integrated planning. However, we believe that collaborating with local organizations remains crucial for fostering meaningful community involvement, as demonstrated in the Southill Solar Farm case.

5. **Mandatory Contributions for Green Belt Development**

Paragraph 156 specifies contributions required from major developments within or near the Green Belt, including affordable housing (Para 157), infrastructure improvements, and green space creation or enhancement (Para 159). The focus on green space improvements directly supports the advocacy for biodiversity-focused designs, ensuring ecological benefits are integral to development projects.