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Spatial planning for wind and solar developments and associated infrastructure

Leon Bennun, Claire Fletcher, Aonghais Cook, David Wilson, Ben Jobson, Rachel Asante-Owusu, Annie Dakmejian, Qiulin Liu

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Acronyms

CIA	Cumulative impact assessment
CSBI	Cross-Sector Biodiversity Initiative
ESIA	Environmental and social impact assessment
ESMAP	Energy Sector Management Assistance Program
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GBF	Global Biodiversity Framework
GIS	Geographic Information System
Ha	Hectare
IBAT	Integrated Biodiversity Assessment Tool
IFC	International Finance Corporation
IFI	International Financial Institution
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
LCOE	Levelised cost of energy
LSP	Landscape-scale èlanning
LULC	Land use and land cover
MSP	Marine Spatial Planning
MW	Megawatt
NASA	National Aeronautics and Space Administration
NDC	Nationally Determined Contribution
NG	Net Gain
NGO	Non-governmental organisation
NPI	Net positive impact
PS6	IFC Performance Standard 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources
REDZ	Renewable Energy Development Zones (South Africa)
SDG	Sustainable Development Goal
SEA	Strategic environmental assessment
SESA	Strategic environmental and social assessment
TBC	The Biodiversity Consultancy
UNESCO	United Nations Educational, Scientific and Cultural Organization
WDKBA	World Database of Key Biodiversity Areas
WDPA	World Database of Protected Areas
WEF	World Economic Forum
WWF	World Wide Fund for Nature

Glossary

Critical Habitat	Areas of high biodiversity value including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes (IFC, 2012a).
Levelised cost of energy	The lifetime average cost for the energy produced and is used to evaluate and compare the cost of electricity production from different locations (and different technologies, as relevant (World Bank Group, 2021).
Modified Habitat	Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands (IFC, 2012a).
Nationally Determined Contribution	National climate action plans by each country under the Paris Agreement. A country's NDC outlines how it plans to reduce greenhouse gas emissions to help meet the global goal of limiting temperature rise to 1.5°C and adapt to the impacts of climate change. The Paris Agreement requires that NDCs are updated every five years with increasingly higher ambition, taking into consideration each country's capacity (UN, n.d.) .
Natural Habitat	Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition (IFC, 2012a).
No Net Loss	The point at which adverse impacts on biodiversity are *balanced* by measures taken through the application of the mitigation hierarchy, so that no losses remain
Net Positive Impact	The point at which adverse impacts on biodiversity are *outweighed* by measurable outcomes from actions taken in accordance with the mitigation hierarchy to achieve sustainable biodiversity gains.

1 Introduction

Green Beaujolais wind farm. Photo: Gaëtan Bernard/Capa Pictures

1.1 The renewable energy transition

The need to transition to a lower carbon, nature-safe, renewable energy-based economy is more urgent than ever (WWF & BCG, 2023; WWF & TBC, 2023). The Paris Agreement (UNFCCC, n.d.) sets a stringent target of limiting global warming to 2°C above pre-industrial levels by 2050,[1] emphasising the necessity of urgent, rapid, and extensive renewable energy adoption to achieve such target. Delays in implementing low-carbon energy solutions as part of the transition from fossil fuels to renewable energy will severely hinder progress towards this goal.

In parallel, the recently adopted Kunming-Montreal Global Biodiversity Framework[2] (KMGBF) sets an overall vision of achieving full recovery of nature by 2050, and aims to halt and reverse biodiversity loss by 2030 to sustain a healthy planet, whilst delivering benefits essential for human well-being and economic prosperity for all people.[3]

These global climate and nature goals highlight that the transition to low-carbon energy cannot occur in isolation, nor in a vacuum – achieving them both requires combining efforts to reduce greenhouse gas (GHG) emissions with biodiversity conservation and ensuring they are mutually beneficial (action on climate is not necessarily inherently good for biodiversity (Dunne, 2022). Furthermore, access to energy remains a critical challenge in many countries, subjecting many people to a life of poverty. Addressing this challenge through the rapid deployment of renewable energy is paramount – in 2023 at the halfway point for achieving the 2030 Sustainable Development Goals (SDGs) the world is currently not on track to achieve SDG 7 – ensuring access to affordable, reliable, sustainable and modern energy for all (IEA, 2023a; IEA et al., 2023; Roser, 2020). All of this implies the need to transform the

1 To achieve the Paris Agreement goal, greenhouse gas (GHG) emissions must peak before 2025 at the latest and decline 43% by 2030. However, global GHG emissions continue to increase, for various reasons (IPCC, 2023a).
2 For further information, please see: https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf
3 For more details on global goals for biodiversity, see Bennun et al. (2024).

way societies are operating to address the current biodiversity and ecosystem collapse and work towards a just and nature-positive future.[4]

In many countries, wind and solar energy are now cheaper and more secure than fossil fuels (Ember, 2023; IEA, 2023b). The expansion of renewable energy must facilitate increased access to energy in developing countries as they improve the living standards of their populations (Rao et al., 2019). Additionally, although the focus of the transition is on the generation of the renewable energy to support the decarbonisation of the electricity supply, it must also support other sectors, such as heating and transport, as they move away from reliance on fossil fuels (Colmenar-Santos et al., 2019; Gielen et al., 2019; Rosenow et al., 2022). However, whilst large-scale decarbonisation of global power infrastructure is essential to meeting climate goals, it must not happen at the expense of nature (Gasparatos et al., 2017; TNC, 2021) – especially as this would likely reduce the efficacy of decarbonisation efforts. As a consequence, measures to avoid impacts on wildlife and habitats are often seen as a key non-cost measure in leasing and consenting decisions (TNC, 2023). Effective spatial planning is key to this.

1.2 Purpose and scope

This technical note focuses on spatial planning for wind and solar development with respect to biodiversity.[5] It is intended primarily for government planners responsible for the long-term sustainable roll out and/or expansion of renewable energy and associated infrastructure (e.g. grid infrastructure and facilities such as ports) at regional, national, and sub-national levels. For developers and lenders/investors, this technical note could also help illustrate how these actors could play a role in spatial planning in certain contexts (e.g. emerging markets, providing resources, and supporting governments to identify appropriate areas for development).

Spatial planning can pose practical challenges in terms of resources, co-ordination, data generation and analysis, and political implementation, all of which can appear daunting, especially for emerging market countries with limited funding and technical capacity. However, even relatively simple spatial planning exercises can significantly help to improve biodiversity outcomes and enable scaling-up of renewables (for example, see Dhunny et al. (2019) and Goodale & Milman (2019)). The key to effective spatial planning is to begin the process before major project investments are made (WEF, 2016). Different approaches to strategic planning exist, with different levels of effort and various spatial scales. There are also several component assessments/tools that feed into and inform strategic spatial planning.

Hence, this technical note aims to:

- emphasise the importance and benefits of robust strategic spatial planning in terms of the renewable energy transition, global goals for climate and nature, and the planning and development cycle;
- clarify and explain the main existing approaches to spatial planning;
- distinguish the different component parts of/inputs to spatial planning that inform the overall assessment and planning outcomes, as relevant for biodiversity;
- provide high-level guidance on the broad spatial planning process, in terms of sequencing, roles and responsibilities, and key outputs; and
- indicate how effective spatial plans can be developed even in resource- and data-constrained situations.

4 Note that the KMGBF does not specifically include the term 'nature positive', and there is no single agreed definition for this concept – several are in use (for example, S. zu Ermgassen et al., 2022). IUCN is developing a quantitative methodology to help companies, governments and civil society assess opportunities and risks, set targets, measure progress and deliver nature-positive impacts (IUCN 2022).

5 In addition, government planners, lenders, and developers will also need to consider potential impacts on ecosystem services and peoples' well-being and livelihoods.

Asian fishermen rowing in the rivers of the solar photovoltaic district Photo: Jeson/AdobeStock

2 The importance of spatial planning

2.1 Spatial planning for a nature-safe energy transition

As renewable energy projects proliferate worldwide, policy makers, practitioners, and conservationists are recognising the need for timely and coordinated strategic spatial planning that responds to the accelerating transition to renewable energy, whilst balancing the reduction of GHG emissions with the need to minimise local biodiversity and human well-being impacts. Many of the potential impacts of wind and solar projects on biodiversity are well established (Bennun et al., 2021) and, as the industry matures, increasingly understood.

In general, the broad spatial distribution of biodiversity is reasonably well documented in publicly available global datasets at different spatial scales indicating, for example, biogeographic regions, ecosystem or habitat type and extent, location of key habitat features, modelled indicative habitat suitability, species range maps, verified point records of species occurrence, or the boundaries of globally important protected areas. However, the available spatial biodiversity data are biased towards the locations of most sampling effort. In global terms, terrestrial and marine systems are mostly unsampled, while taxonomic biases pervade (Hughes et al., 2021). To achieve global climate goals, the renewable energy sector will need to expand into many new areas, some of which are likely to be less well-studied, such as emerging market countries where the available biodiversity baseline may be poor. Many areas of high value for biodiversity are yet not well delineated. In addition, the accelerated pace of the renewable energy transition is taking place against a backdrop of landscapes which are increasingly modified by human activity,[6] with renewable energy potentially adding to that pressure (Kennedy et al., 2019).[7]

6 A global map of human modification indicates that 95% of the Earth's surface has some indication of human modification, and 84% shows evidence of multiple modifications. For more information, please see: https://gdra-tnc.org/current/.

7 While the total area used for renewable energy, and overlap with important areas for biodiversity, may be low (Dunnett et al., 2022), there is already evidence of encroachment on protected areas (Rehbein et al., 2020).

Poorly located energy developments continue to fragment and destroy natural habitats (WWF & TBC, 2023)[8] and its potential impacts on biodiversity could be large.[9] Thus, if not properly planned, the renewable energy sector has potentially significant implications for biodiversity conservation.

The key for spatial planning for renewable energy is that it is carried out at an ecologically appropriate landscape or seascape scale. In general, there is an urgent need to transform development planning from the level of individual projects to scenarios at these larger scales, while supporting integrated solutions for achieving economic, social, and environmental goals, as well as incentivising mitigation actions for long-term landscape or seascape resilience (WEF, 2016). Striking this balance will be essential for a nature-safe energy transition.

Spatial planning is increasingly a tool for resolving conflicting demands on space,[10] and spatial planning for renewable energy development in particular has two key advantages compared to planning for development in other sectors:

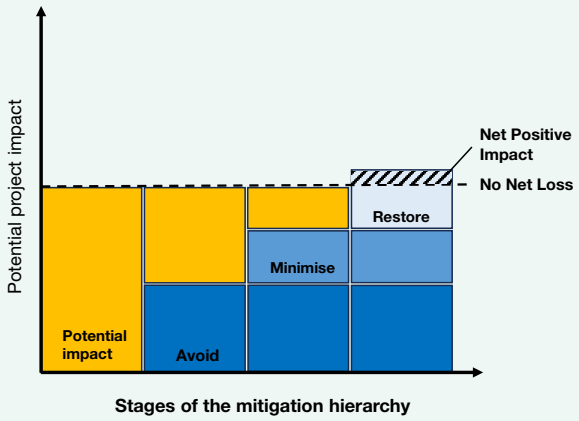
- Renewable energy targets are clear: With respect to global climate goals, the broad extent of the renewable energy roll out and expansion required is clear. Countries have been able to establish (or will be able to establish) clear goals for developing the sector at a national level, to contribute to achieving targets like Nationally Determined Contributions (NDCs) (He et al., 2022);[11]
- Renewable energy resource areas are defined: Areas suitable for wind and solar development are already relatively well defined by the available renewable energy resource in a country (Oakleaf et al., 2019), and evidence suggests that targets can be met through the development of already degraded land (Baruch-Mordo et al., 2019).[12]

These advantages mean that governments can focus spatial planning for renewable energy on these resource areas, with an understanding of the target capacity to be achieved. The work required to identify and map environmental and social features that might be sensitive or susceptible to the potential impacts of renewable energy development can be focused on these resource areas. Mapping physical and technical constraints, and socio-economic[13] considerations will also contribute to understanding the development potential of an area (see Section 3.3.3). Therefore, governments can from an early stage begin to evaluate balanced, low-conflict, and just scenarios for achieving the necessary extent of development on the ambitious timeline required to achieve global goals (WWF & TBC, 2023). This ranges from considering the strategic benefits of concentrating on specific areas to advance national renewable energy development (i.e. 'top-down'), to evaluating more organic development scenarios that are potentially more fragmented, but otherwise more responsive to specific localised impacts and needs (i.e. 'bottom-up'). Spatial planning solutions are more likely to be successful if they are contextual and adaptive (Meyfroidt et al., 2022).

2.2 Spatial planning and the mitigation hierarchy

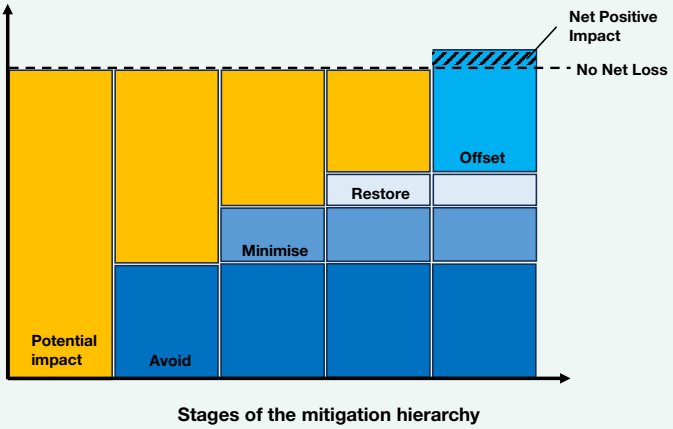
From a biodiversity perspective, a key tool for spatial planning is the mitigation hierarchy, a well-established sequential and iterative framework of four actions: avoid, minimise, restore, and offset (Bennun et al., 2021; CSBI & TBC, 2015). Applying

8 Over 17% of large-scale (greater than 10 MW) wind, solar, and hydropower projects globally currently operation within important conservation areas (Rehbein et al., 2020).
9 The total area predicted for renewable energy to deliver 2050 targets is estimated at 1.33 million km^2 (Jacobson et al., 2019)
10 Noting that spatial planning is a culture- and context-influenced process that can be more complex or less complex, depending on the range of aspects considered and the administrative level (Metternicht, 2017).
11 This may be an iterative process informed by spatial planning to understand what is feasible.
12 Studies by The Nature Conservancy and WWF show that the world can source up to 17 times the amount of energy required by current global targets from converted land alone (Baruch-Mordo et al., 2019).
13 Spatial planning should incorporate early, transparent, and inclusive stakeholder engagement tailored to suit local norms and cultures (World Bank Group, 2021) and including the principle of free, prior and informed vonsent (FPIC) by rights holders, or the organisations they nominate to represent them (see WWF & TBC, 2023). It should include meaningful dialogue and feedback or there is a risk of undermining legitimacy and credibility of, and trust in, the process (World Bank, 2024).



Relative project mitigation requirements in areas of low biodiversity value, where it could be possible to achieve biodiversity No Net Loss, and potentially Net Positive Impact, through actions at the site level.

Figure 1 Relative mitigation effort in an area of *low* biodiversity value *Source: Authors.*



Relative project mitigation requirements in areas of higher biodiversity value. In these cases, potential impacts are likely to be greater and offsets (actions beyond the project boundary) are likely to be required to achieve biodiversity No Net Loss or Net Positive Impact. Offsets are inherently difficult, uncertain, and costly, and should only be used as a last resort. Opportunities for offsetting may be limited. Ideally, high biodiversity value sites would be avoided entirely through early planning.

Figure 2 Relative mitigation effort in an area of *high* biodiversity value *Source: Authors.*

the mitigation hierarchy in full implies an overall goal for biodiversity of no net loss (NNL)[14] or net positive impact (NPI,[15] also called Net Gain). Hence, the mitigation hierarchy is essential for planning the sustainable roll out of renewable energy in line with the GBF vision and mission.

Avoidance and minimisation measures **prevent or reduce** impacts, while restoration and offset measures **remediate** impacts that have already happened. Preventative measures are preferable from an economic, social, and ecological perspective for regulators, lenders, and other stakeholders. Planning for avoidance of the highest value and most sensitive areas for nature and people is fundamental. Avoidance is the most effective mitigation measure available to government planners and developers alike. For example, significant impacts can often be avoided entirely through the way such as careful site selection during the early planning phase (e.g. avoiding siting development in Legally Protected Areas (LPA)[16] and Internationally Recognised Areas (IRA)[17], or productive farmland, or avoiding important migratory bird flyways[18]) and preferentially selecting previously converted sites (e.g. degraded agricultural land or other types of modified habitat (Bennun et al., 2021).

Figures 1 and 2 illustrate the different implications in terms of implementing the mitigation hierarchy for development in areas of low biodiversity value versus areas of high biodiversity value. In general, the potential impacts of development are expected to be lower in areas of low biodiversity value, with consequently lower, or less complex, mitigation efforts required to achieve NNL and NPI. The opposite is true for development in areas of high

14 The point at which adverse impacts on biodiversity are balanced by measures taken through the application of the mitigation hierarchy, so that no losses remain.

15 The point at which adverse impacts on biodiversity are outweighed by measurable outcomes from actions taken in accordance with the mitigation hierarchy to achieve sustainable biodiversity gains.

16 LPAs are defined by IUCN as 'any clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values' (Dudley, 2008).

17 IRAs are sites of recognised importance to biodiversity conservation, although they are not always legally protected. World Bank and IFC standards define IRAs as UNESCO Natural World Heritage Sites, UNESCO Man and the Biosphere Reserves, Key Biodiversity Areas, and wetlands designated under the Convention on Wetlands of International Importance (Ramsar Convention) (IFC, 2012a; World Bank, 2016).

18 For further information, please see: https://datazone.birdlife.org//sowb/spotflyway

biodiversity value: potential for adverse impact is greater, and therefore the mitigation action required to achieve NNL and NPI is likely to be more complex, challenging, costly, and uncertain.

2.3 Spatial planning and project-level permitting and development

Spatial planning at the government level offers benefits for governments and developers alike for developing projects in those planning areas. It helps place development plans and different spatial units (e.g. of land or sea area) into their larger economic, social, and ecological contexts to better inform planning decisions (WEF, 2016). While it does not replace the need for individual developer-led site level assessment, spatial planning offers several advantages over what can be achieved through conventional impact assessment (Kiesecker et al., 2010). The baseline data collected by governments[19] can give early insights into potential biodiversity risks associated with a development area. It is therefore important that these data are made available to developers, to enable them to make informed decisions about site selection with the best avoidance and mitigation potential (WWF & TBC, 2023).[20] In terms of the regulatory approvals process, this baseline data can inform and streamline the scoping process for project-level environmental and social impact assessment (ESIA), which has benefits for both developers in preparing scoping and regulators who review them. It can also include information that improves company and regulatory efforts to assess cumulative impacts (WEF, 2016.

Spatial planning can reduce uncertainty for regulators and developers regarding biodiversity risks and the feasibility of mitigation options for a development in an area, including the need for offsets or compensatory approaches. Robust strategic spatial planning processes with early stakeholder engagement increase transparency, both between regulators, developers, and other stakeholders, and for developers engaged in competition for development sites. This can help avoid conflicts throughout the planning and development process, since key stakeholders are likely to continue to engage at key points as planning progresses and moves towards individual project development. Overall, these advantages can potentially speed up approvals,[21] bringing efficiencies and reducing the overall associated costs of the process.

Beyond government-led spatial planning at a strategic level, further developer-led assessments remain fundamental to determining the appropriateness of individual projects. ESIA is a core requirement in all cases. Other inputs include early biodiversity risk screening, especially in high biodiversity value areas, informed by government outputs, and work to align with lender standards (see Figure 3 and Section 3.4).

19 Potentially supported by international financial institutions.
20 Developers winning auctions to develop projects could pay for these data when a licence is granted (WWF & TBC, 2023).
21 For example, at present, the consents and development process for offshore wind in the UK can take around 12 years, onshore wind in Spain can take around 10 years, and utility scale solar in France commonly takes around four years (ETC, 2023).

3 Overview of existing approaches to and components of spatial planning

Raposeras wind farm. Photo: Used with permission of Eni Plenitude

Key existing overarching spatial planning and assessment processes are shown in Figure 3, with a broad indicative planning and development timeline, relevant spatial scale, and the typical lead stakeholder at each stage. These processes are Strategic Environmental Assessment (SEA) at the region, country, or sub-national scale, and Landscape-Scale Planning (LSP) and Marine Spatial Planning (MSP) at the scale of the landscape or seascape (see Sections 3.1 and 3.2 for more details). Other key component assessments informing spatial planning processes and providing essential information to support and guide planning decisions are also shown in Figure 3. These include: **biodiversity sensitivity mapping** (government-led or supported/led by International Financial Institutions (IFIs) and/or non-governmental organisations (NGOs); **government-led cumulative impact assessment** (CIA) (potentially supported or led by IFIs); and **other technical feasibility studies and constraints mapping** (see Section 3.3 for more information).

Full-scale spatial planning processes like SEA, LSP, and MSP can be time consuming, resource-intensive, and costly processes that may not always be readily accessible in emerging markets experiencing accelerated renewable energy development timeframes to meet climate targets establish energy security, and meet other country priorities (World Bank, 2024). Indeed, there are multiple aspects to consider in addition to biodiversity. Hence, while the component assessments do not in isolation constitute an overall spatial planning exercise, they can stand alone and can be a pragmatic, quicker, and less costly means of initiating spatial planning and ensuring the consideration of biodiversity in the context of accelerating renewable energy roll out.

For example, such assessments can be based on existing biodiversity data (e.g. from global datasets, which could subsequently be supplemented with national- or local-level data) and key stakeholder engagement (see Section 4), and use new, more pragmatic and less resource-intensive approaches to address the urgent need for spatial planning. For instance, guidance on scalable approaches to implementation of CIA by government planners project developers (Bennun et al., 2024), and guidance on sensitivity mapping for early offshore wind spatial planning (World Bank, 2024).

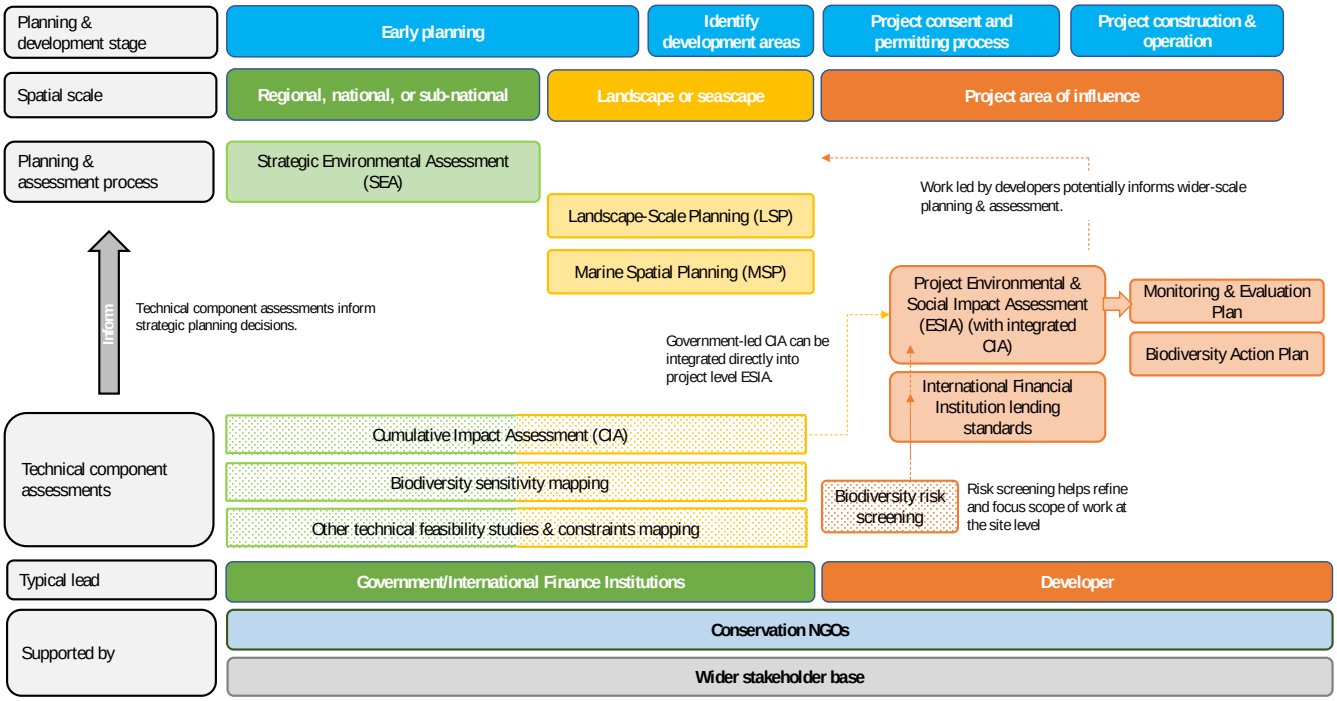


Figure 3 **Overarching existing spatial planning processes and key technical component assessments, with relevant spatial scale, typical lead and support stakeholders, and the broad planning and development process** *Source: Authors.*

Note: This figure is a simplification of processes and assessments that in practice involve significant feedback and adaptive response, some of which is highlighted in the figure.

Spatial planning at the strategic level informed by these component assessments should result in directing development away from the highest value areas for biodiversity, towards areas of lower biodiversity value that also balance social, technical, and economic interests. The outcome is the identification of broad leasing areas, or zones, likely to be suitable for renewable energy development. Within these broad areas, individual project sites can be selected. In its report on offshore wind development in developing markets, the World Bank (2021) outlines how leasing processes can work, giving developers the right to survey and develop a site before constructing and operating a wind farm.

Assessments carried out at the level of individual projects are also represented in Figure 3, including biodiversity risk screening, ESIA in support of the regulatory consents and permitting process, and **work to align with the standards of IFIs** (lending standards). Section 3.4 provides more details.

3.1 Strategic Environmental Assessment

Strategic Environmental Assessment (SEA) (also known as Strategic Environmental and Social Assessment, or SESA) is a systematic process for incorporating environmental and social (E&S) considerations across different levels of strategic decision-making (plan, programme, and policy levels) as early as possible. It can be single or multi-sector, and necessarily carried out on a relatively large spatial scale, usually regional or national, often defined by jurisdictional boundaries. SEA aims to capture the social, cultural, economic, institutional, and environmental contexts within which resource exploitation will take place (IAIA, n.d.).

SEA is generally government-led as part of a regulatory process, as discussed in the example of South African renewable energy development zones (Case study 1). It may involve multiple national jurisdictions, if done at the regional scale, and/or multiple sub-national government agencies. SEA can also be supported by IFIs and NGOs, as

described in Case study 2 (Myanmar) and Case study 3 (Kenya).

There is no single approach to SEA, and it requires a high degree of stakeholder engagement. The scope and process vary considerably between jurisdiction and between individual SEAs. Approaches vary along a continuum from impact analyses and spatial mapping to institutional assessment. SEA is therefore supported by detailed technical assessments, including government-led CIA, and high-level assessments such as biodiversity sensitivity mapping (see Section 3.3.1). The available guidance on SEA is variable. Examples in this regard are provided in the section on further reading.

3.2 Complementary processes to strategic environmental assessment

SEA provides a mechanism for the strategic framing of environmental effects, assessments of alternative options, and potential mitigation measures (European Commission, n.d.). Other overarching spatial planning processes like LSP and MSP that apply at relatively large spatial scales (i.e. beyond the individual project level) can be applied subsequently, or as an alternative to SEA, to achieve similar objectives (see Case study 4).

3.2.1 Set spatial and temporal boundaries for cumulative impact assessment

LSP[22] is a holistic and systematic approach to land use planning and management, for harmonising multiple goals within the same geographic area, assessing land and water potential, and selecting the options that best meet the needs of people while safeguarding resources for the future (FAO, 1993; Metternicht, 2017; WEF, 2016). It is a well-established conservation tool which can aid the implementation of the mitigation hierarchy and has proven effective in cases such as reversing farmland bird declines and grassland restoration (Bigard et al., 2020; Lengyel et al., 2023; Mander et al., 2018; Prach et al., 2015). The appropriate landscape scale for assessment can be defined by biological, watershed, or jurisdictional boundaries (WEF, 2016).[23] LSP may intersect with MSP (see Section 3.2.2) at the terrestrial/marine boundary.

Like SEA, LSP is usually government-led (e.g. by local planning authorities), with the relevant level or jurisdiction(s), depending on the planning area defined (generally not regional or country-level like SEA). LSP can also be supported by IFIs and/or NGOs and requires a high degree of stakeholder engagement. The approach considers both natural and cultural landscapes, and has evolved over time from a relatively closed, top-down process into an integrated, interdisciplinary, multi-stakeholder approach that considers a variety of sustainability factors (physical suitability, economic viability, social acceptance, and environmental suitability (Metternicht, 2017; Trombulak & Baldwin, 2010).

3.2.2 Marine Spatial Planning

MSP is a comprehensive, policy-driven, public process of analysing and allocating the use of sea areas to minimise conflicts between human activities, maximise benefits, ensure the resilience of marine ecosystems, and achieve ecological, economic, and social objectives that usually have been specified through a political process (Ehler & Douvere, 2009; UNESCO-IOC/ European Commission, 2021). It is a science- and information-based tool that can help advance local and regional interests, such as management challenges associated with the multiple uses of the ocean, economic and energy development priorities, and conservation objectives (US NOC, 2013) (see Case study 5). As is the case for SEA and MSP, MSP also requires a high degree of stakeholder engagement.

MSP is usually carried out at regional or national scale, or at a relatively large spatial scale

22 There are several variations on the term LSP, including land use planning, spatial land use planning, integrated land use planning, participatory land use planning, regional land use planning, and others (see a useful summary in Metternicht (2017)

23 What constitutes a landscape is not necessarily defined by area, but rather by the interacting elements that are relevant and meaningful in a management context (US DOI, 2015).

defined by relevant jurisdictional boundaries (e.g. a country's maritime area), capturing social, cultural, economic, institutional, and environmental contexts. It can also be carried out at smaller scales for specific purposes (Martin et al., 2013). MSP may intersect with LSP at the terrestrial/marine boundary. It is also generally a government-led process that may involve multiple sub-national government agencies, or multiple jurisdictions if at regional scale (i.e. encompassing the marine area of more than one country). MSP processes are also often supported by IFIs and/or NGOs.

Although approaches to MSP vary, it remains the primary tool for considering the inter-relationships between competing activities in the marine environment, and seeks to identify the most environmentally, socially, and commercially appropriate locations for development. It is an effective approach to engage communities, stakeholders, and governments alike to expand marine protections, meet conservation goals, and improve sustainability of economic and non-commercial activities (TNC, 2024a). Further discussion on MSP is given in Further reading. Some examples of MSP in practice are provided in Case study 6.

3.3 Component assessments informing spatial planning

Biodiversity sensitivity mapping, CIA, and other technical feasibility studies and constraints mapping are key component assessments informing spatial planning. They can also stand alone as pragmatic, quicker, and less costly means of initiating spatial planning with early consideration of biodiversity. More detail on these components is given in the next sections.

3.3.1 Biodiversity sensitivity mapping

Biodiversity sensitivity mapping uses available data to identify and map biodiversity features considered sensitive or susceptible to the potential impacts of renewable energy development. This can be refined according to the energy type and the associated potential risk to different biodiversity features.[24] It can be one of the earliest assessments completed to feed into overarching spatial planning, because it can be carried out using existing spatial datasets (see Section 4) and stakeholder engagement, and subsequently be refined or supplemented with primary data collection.

Biodiversity sensitivity mapping can be carried out on a scale reflecting SEA, LSP, or MSP, as well as at more refined spatial scales, for example based on other constraints mapping or technical feasibility studies (e.g. areas of optimum wind or solar resource). It can be a government-led process[25] or led NGOs (see Case study 7), or it may be developed as an academic exercise in some specific contexts. Biodiversity sensitivity mapping is also supported by IFIs (see Case study 8) and with specialist consultancy inputs.

The most useful sensitivity maps for informing renewable energy development are developed as static GIS (geographic information system) layers. They are often grid-based and combine spatial biodiversity data with information on wind and solar resource, as well as economic and/or social constraints to support a realistic identification of appropriate sites for deployment. More user-friendly versions can be hosted online as interactive web tools that can be updated and refined with new data over time. Examples of sensitivity mapping tools and guidance are given in Case study 9.

In sensitivity mapping, identifying the priority biodiversity to focus on can be based on specialist knowledge and pre-determined criteria, such as conservation threat status, project technology type, knowledge about impacts from existing

24 See Bennun et al. (2021) for a summary of key risks to/impacts on biodiversity associated with wind and solar development.
25 There is a growing recognition that sensitivity mapping should be integrated into government-led development planning processes (e.g. Bradbury et al., 2014; Scottish Government Riaghaltas na h-Alba, 2019).

markets, requirements of lending standards, and stakeholder concern. Determining a sensitivity score for a given biodiversity feature to represent in a sensitivity map is generally a categorical or semi-quantitative process (e.g. high, moderate, low), based on the characteristics of the feature that make it sensitive/susceptible to impacts associated with renewable energy development (Allinson et al., 2020; World Bank, 2024). It does not usually consider the likelihood or severity of a specific impact because mapping is carried out before such information is available. Thus, sensitivity mapping can inform the scope of CIA (see next Section 3.3.2) by providing information on biodiversity focus.

Biodiversity sensitivity mapping requires a high degree of engagement with relevant stakeholders, especially where available spatial data are limited, both to improve utility of maps for decision making and identify options for longer-term funding required to maintain the maps.

3.3.2 Cumulative impact assessment

CIA is a process of identifying biodiversity priorities at an ecologically relevant scale and determining their status, which can be informed by the outputs of biodiversity sensitivity mapping. CIA goes further by including the identification of impact thresholds and conservation goals/targets. It can inform single or multisectoral planning.

CIA is usually aligned with available biodiversity baseline information, reflecting the scale of SEA, LSP or MSP (i.e. based on jurisdictional boundaries and other administrative considerations). Ideally, CIA will be led by government, enabling them to deliver conservation outcomes on a much larger scale than project-by-project assessment, and support more efficient and consistent project-level permitting processes by setting impact thresholds, which aids transparency and equitability between projects. It may be supported by IFIs and NGOs, sometimes with specialist consultancy input. CIA is also carried out at the project level as a regulatory requirement, ideally informed by a government-led CIA (see Bennun et al., 2024).

There is no single agreed approach or method for CIA (either at the government or project level). From this perspective, IUCN and TBC have produced a guidance on biodiversity CIA for wind and solar development (Bennun et al., 2024), outlining pragmatic and scalable approaches to CIA for government planners, as well as for project developers who can utilise an existing government-led CIA, or need to develop a project level CIA in the absence of government-led CIA. The guidance is particularly designed to facilitate an 'entry' into CIA at the government level and show how CIA can be approached even in data-poor contexts where the available biodiversity baseline information remains limited, especially where regulatory requirements are still emerging, and/or resources and capacity are limited as well as recognising the urgency with respect to the transition.

3.3.3 Other technical feasibility studies and constraints mapping

Several other non-biodiversity studies are also essential to inform spatial planning and focus decision making on feasible areas for development, such as identifying other potential spatial conflicts some of which may be fixed, and others with flexible flexibility in terms of location and potential to coexist with renewable energy development.

Other relevant studies include, but are not limited to: wind or solar resource assessments; identification and mapping of physical (hard) constraints on development (such as pipelines and cables); geotechnical studies; social sensitivity mapping (similar to biodiversity sensitivity mapping); assessment of other uses and users of the space (e.g. traffic, transport, shipping, navigation, oil and gas, aggregates, access issues, defence and national security, aviation, agriculture, fishing and more); and studies of economic viability (e.g. levelised cost of energy, or LCOE, modelling).

These studies should be carried out at a scale reflecting SEA, LSP, or MSP. It is beneficial to carry out other technical feasibility studies and constraints mapping in parallel with biodiversity sensitivity mapping, to focus subsequent decision making on areas likely to be suitable for development. They will ideally be led by government, but could also be supported by IFIs, relevant NGOs or with specialist consultancy inputs.

3.4 Assessments at the individual project level

At the project level, component assessments are developer-led, with input from relevant key stakeholders (e.g. regulators, NGOs, IFIs). They follow on from and can be informed by the spatial planning processes and assessments outlined in Sections 3.1, 3.2, and 3.3. Project-level assessments, including biodiversity risk screening, ESIA, and assessments required to align with the standards of IFIs, provide finer scale information to characterise impacts and inform project-specific mitigation measures (e.g. micro-siting infrastructure away from sensitive biodiversity features to avoid impacts (Bennun et al., 2021). Ideally, the findings of project level assessments will feed back into broader government-led processes, as relevant.[26]

3.4.1 Biodiversity risk screening

Biodiversity risk screening helps refine understanding of biodiversity risks and likely mitigation requirements at a specific project site. It is usually a relatively rapid desk-based GIS analysis based on existing biodiversity data, screened against the project spatial area of influence (i.e. an area capturing the potential direct and indirect impacts of the project). It can inform or influence a developer's decision to proceed with a project in a particular location and can help to evaluate or compare relative biodiversity risk between projects/site options. As for biodiversity sensitivity mapping and CIA,[27] the outcome of biodiversity screening can be refined using specialist knowledge and pre-determined criteria designed to identify the most important biodiversity features to consider in detail (e.g. criteria based on conservation threat status, the project technology type, lending standards and stakeholder concern). Hence, screening informs ESIA scoping and helps design project-specific baseline data collection focused on the most important biodiversity features.[28]

3.4.2 Environmental and Social Impact Assessment

ESIA is a process for predicting and assessing the potential E&S impacts of a proposed project, evaluating alternatives, and designing appropriate mitigation, management and monitoring measures. It is usually the main regulatory instrument for approving projects and enforcing good mitigation practice. Beyond this, permitting processes can require developers to contribute to the protection and restoration of biodiversity, in line with national targets (WWF & TBC, 2023).

ESIA can be informed by the outcome of spatial planning but should be based on the design and engineering parameters of the individual project. ESIA generally consists of: (i) initial screening of the project and scoping of the assessment process (which can be informed by biodiversity risk screening, see Section 3.4.1); (ii) examination of alternatives; (iii) stakeholder identification (focusing on those directly affected) and gathering of E&S baseline data; (iv) identifying, predicting, and assessing the potential E&S impacts of a proposed project; (v) designing appropriate mitigation, management, and monitoring measures; (vi) assessing significance of impacts and evaluating residual impacts; and (vii) documenting the assessment process (ESIA report) (IFC, 2012b). Ideally, ESIA will result in a quantitative assessment of impacts on the biodiversity features identified as priorities,[29] which can subsequently be used to track project level goals like NNL or NPI (see Section 2.2 and Glossary).

26 This requires relevant enabling mechanisms to be in place (see Bennun et al., 2024).
27 See Section 3.3
28 See Section 8 for further reading.
29 For example, through screening and scoping, and in consultation with stakeholders.

3.4.3 Lending standards

International Finance Corporation (IFC) Performance Standards (PS) are used as the international benchmark for E&S risk management by IFIs and Export Credit Agencies worldwide, through adoption of the Equator Principles.[30] These standards are designed to provide proponents with guidance on how to identify risks and impacts, and to help avoid, mitigate, and manage them as a way of doing business in a sustainable manner. IFC PS6, Biodiversity Conservation and Sustainable Management of Living Natural Resources (IFC, 2012a), represents leading practice for biodiversity at the project level. It is designed to identify areas of high biodiversity value based on the conservation principles of vulnerability (threat) and irreplaceability (rarity or restricted distribution). This is carried out at an ecologically appropriate scale[31] which encompasses, and is usually larger than, the project area of influence.

Alignment with IFC PS6 could be compliance based or voluntary as a means of demonstrating good practice. The process requires projects to determine whether the area in which they propose to operate can be classified as Modified or Natural Habitat, and whether that habitat qualifies as Critical Habitat (see Glossary) according to five specified criteria. It can begin with a desk-based Critical Habitat screening using existing biodiversity data and may require primary fieldwork to confirm Critical Habitat status. Projects found to be in Critical Habitat will require a Biodiversity Action Plan designed to achieve a net gain of the qualifying biodiversity features.

30 The Equator Principles is a financial industry benchmark for determining, assessing, and managing environmental and social risk in projects. At the time of writing, there are 130 financial institutions signatories to the Principles.

31 Called an 'Ecologically Appropriate Area of Analysis' (EAAA) (IFC, 2019).

4 Key inputs to spatial planning for biodiversity and renewable energy

Photo: © Ricardo Tomé/The Biodiversity Consultancy

The approach to strategic spatial planning should be proportionate, designed according to the needs, demands, capacities, rules, and institutional structures of the place (e.g. country) in question. It can be adapted to suit varying circumstances.[32] Table 1 captures key inputs and considerations for spatial planning for wind and solar development.

32 Principles of leading practice are summarised in Metternicht (2017).

Table 1 Key inputs to spatial planning for biodiversity and renewable energy

INPUT	SUMMARY
Renewable energy targets and understanding of resource	◆ As discussed in Section 2.1, the key advantages for renewable energy spatial planning over other sectors are an understanding of the available resource and the development targets associated with that. Targets may be defined as NDCs in line with the Paris Agreement and/or via separate domestic policy.
Spatial biodiversity data	◆ Spatial planning is driven by spatial data. Existing biodiversity data could come from online databases, publicly available scientific and grey literature,[33] citizen science, and directly from specialists and other relevant stakeholders. Quality controlled data should be prioritised. ◆ Authoritative existing global and regional datasets include the IUCN Red List of Threatened Species™ (IUCN Red List), the World Database of Protected Areas (WDPA), and the World Database of Key Biodiversity Areas (KBA),[34] and several other resources indicating biogeographic regions, ecosystem/habitat type and extent, location of key habitat features, modelled indicative habitat suitability, species range maps, verified point records of species occurrence. Equivalent regional, national, and local datasets may be available to refine planning. ◆ Land use and land cover (LULC) datasets are also useful and important, providing information about vegetation cover and whether land is natural or influenced by human activity. LULC datasets can be modelled or mapped and are often based on remote-sensing data (e.g. Europe's Copernicus Land Monitoring Service, NASA's Socioeconomic Data and Applications Centre (SEDAC) LULC collection, or India's National Remote Sensing Centre Natural Resources Census. ◆ Non-spatial data may also be relevant in some cases (e.g. for helping to understand and characterise some issues or features) and it may be possible to digitise this information to represent it spatially (e.g. species locations documented in scientific or citizen science reporting). ◆ Spatial data on several other factors will also contribute significantly to spatial planning (e.g. socio-economic, technical, other uses of the space – see Section 3.3.3).
Specialist GIS support	◆ Strong GIS capabilities are fundamental for spatial planning. All relevant spatial data should be collated and managed centrally for consistency and quality assurance, in accordance with good practice protocols for spatial data handling (for example, including establishing data permissions and access conditions, standardising data to a national-level coordinate system, establishing a data structure, and considering data access and dissemination).
Stakeholder engagement	◆ Stakeholder engagement aligned with good practice principles is essential and will inform identification of biodiversity (and other) priorities for spatial planning. ◆ There are likely to be many stakeholders (internal and external) in common between the government and individual project-levels. This could include representatives from multiple different government agencies/departments and relevant statutory bodies, non-governmental organisations and civil society organisations, academic institutions, individual experts and specialists with both field and analytical expertise, Indigenous peoples, local communities and land managers,[35] natural resource planners, groups with special ties to the spatial planning area or specific biodiversity features, and any other representatives with a legitimate interest in relevant biodiversity features or issues. ◆ It is likely to be beneficial to include stakeholders with expertise at local and country levels, as well as international expertise and familiarity with renewable energy technology and project development. ◆ In cases where the stakeholder group becomes very large, which is especially likely for government-led strategic spatial planning, smaller focus or working groups can be considered (e.g. for specific biodiversity groups like migratory birds, or marine mammals, or specific social and socio-economic considerations).

33 Information produced outside of traditional publishing and distribution channels, such as reports, policy literature, working papers, newsletters, government documents, speeches, white papers, urban plans etc.

34 The IUCN Red List, WDPA, and KBA data are available via the Integrated Biodiversity Assessment Tool (IBAT), based on a subscription model.

35 Especially as it relates to land tenure.

5 Typical lead roles and responsibilities in spatial planning

Aerial drone shot of engineers inspecting solar panels
Photo by Monkey Business/AdobeStock_

Spatial planning is a multistakeholder process. Table 2 provides an overview of the typical roles and responsibilities of key actors involved in spatial planning processes, with a focus on biodiversity.

Table 2 Typical key roles and responsibilities in spatial planning

STAKEHOLDER	KEY ROLES AND RESPONSIBILITIES
Governments	◆ Responsible for the sustainable roll-out and/or expansion of wind and solar development and the associated infrastructure, including establishing an appropriate policy framework and funding spatial planning.[36] ◆ Central leadership and coordinating role in early strategic spatial planning, including facilitating inclusive, transparent, and potentially complex stakeholder engagement (with a mechanism for addressing grievances). ◆ Responsible for collating existing biodiversity data, collecting new baseline data, making these data available to developers (and other stakeholders) to improve transparency and decision making, thereby speeding up the permitting process. ◆ Responsible for identifying biodiversity priorities and establishing conservation objectives at the national level.
International financial institutions	◆ Key role in advocating for and facilitating or leading (funding) spatial planning in the absence of government capacity and resources, especially in emerging markets. ◆ Role may also include supporting governments to establish an appropriate policy framework to enable spatial planning and renewable energy roll out. ◆ Responsible for advocating for and enabling good international industry practice for biodiversity and spatial planning.
Developers	◆ Essential role in supporting government-led spatial planning.[37] ◆ Responsibility to work with governments and with each other to enable information sharing and greater transparency. ◆ Responsible for further site-specific assessments following spatial planning, including biodiversity risk screening, ESIA (including CIA), and baseline studies. ◆ Responsibility to support improvement and adaptation in strategic spatial planning, by feeding in data from the site level.
Non-governmental organisations	◆ Key role in technical assessments supporting strategic spatial planning such as CIA and biodiversity sensitivity mapping. ◆ Key role in supporting project-level technical assessments such as ESIA and lending standards. ◆ Responsible for identifying priority biodiversity values and risks, making data available for spatial mapping, and developing or supporting the development of tools for spatial planning.

36 Strategic spatial planning could be government funded, donor (IFI) funded, or a combination thereof.

37 May even take a lead role, for example, lease awards for offshore wind could be bilateral, in which the developer leads early-stage activities to determine suitable development sites or competitive – whereby the leasing body uses MSP principles to decide broad lease areas within which developers conduct work to identify specific sites. For more information, aee Chapter 3 of World Bank (2021).

6 Case studies

Photo: Birkaybolushikayesi/Pexel.com

Case study 1 Strategic Environmental Assessment for South African Renewable Energy Development Zones and electricity grid infrastructure corridors

SEA was carried out to identify Renewable Energy Development Zones (REDZ) to facilitate the growth of renewable energy in South Africa (Figure 4). The REDZs were identified through a holistic approach, considering technical, environmental and socioeconomic criteria. The first SEA identified eight REDZs for wind and solar photovoltaic energy development (DEA, 2015). The second SEA (CSIR & DEFF, 2019a) identified additional REDZs that specifically targeted previously mined areas where brownfields development could make use of existing infrastructure while also contributing towards rehabilitation of these areas.

The identification of REDZs involved characterising and mapping positive or 'pull' factors beneficial for renewable energy development. These include, for example, the abundance of wind and solar energy resources and access to power corridors and other facilities and complemented by mapping negative or 'push' factors, such as environmental features and areas, which may be sensitive to the development of large-scale wind or solar facilities. Features considered critically important for the environmental constraints mapping included protected areas, forests, critical biodiversity areas and the presence of important bird and bat roosts and feeding sites. Within each REDZ, development is restricted within defined areas of high biodiversity sensitivity. For example, 50-km buffers were designated around endangered Cape vulture (*Gyps coprotheres*) colonies, roost sites and managed feeding sites. Lastly, a prioritisation exercise was carried out to ensure that proposed developments aligned with industrial needs. Two SEAs for electricity grid infrastructure (CSIR & DEFF, 2019b) complemented the SEAs for wind and solar energy. Biodiversity mitigation included planning power line corridors to avoid impacts on sensitive bird species.

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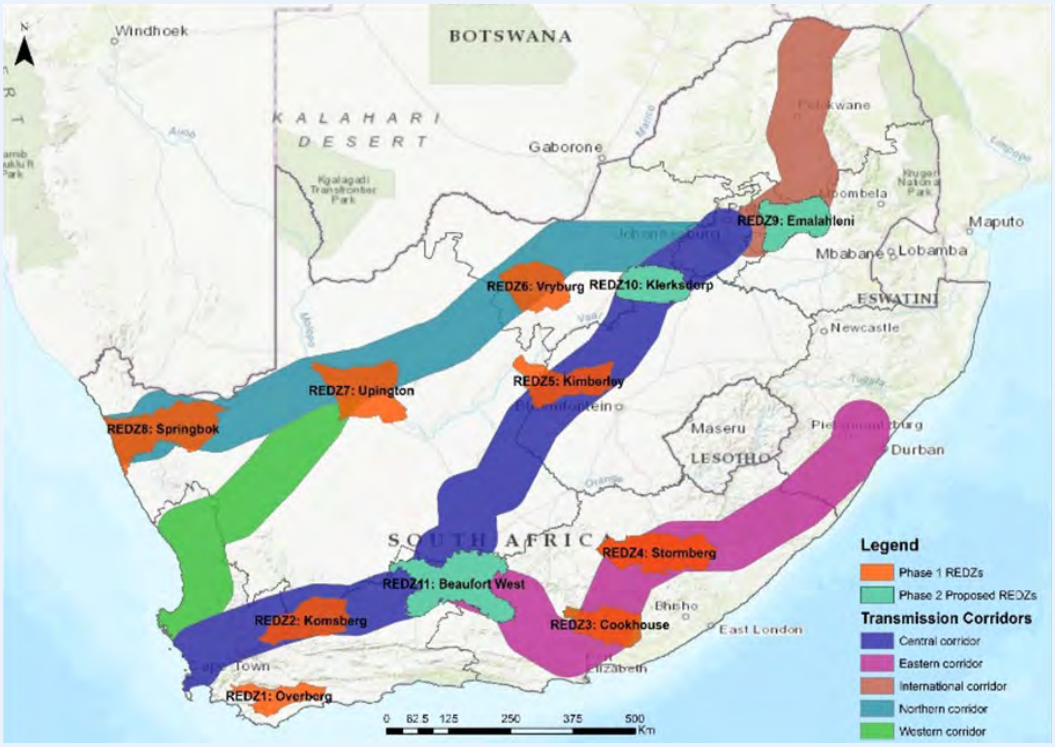

Figure 4 Location of eight existing Renewable Energy Development Zones (first SEA) and three additional zones (second SEA), with electricity grid infrastructure corridors

Source: CSIR & DEFF (2019a, p. 256).

Case study 2 Strategic environmental assessment of the hydropower sector – Myanmar

Lessons can be learned from SEA in sectors other than wind and solar. An SEA for hydropower in Myanmar was jointly prepared between 2016–2018 by the Ministry of Electricity and Energy (MOEE) and Ministry of Natural Resources and Environmental Conservation (MONREC), with the assistance of the International Finance Corporation (IFC) and its development partner, the Government of Australia (IFC, 2020).

The SEA was not developed with a national target for installed hydropower capacity in mind but was undertaken considering the substantial number of proposed projects, knowing that they will play an important role in delivering affordable and reliable energy in Myanmar in the coming decades (Figure 5). There was a vision of the project to result in "sustainable hydropower development based on integrated water, land and ecosystem planning, balancing a range of natural resource uses and priorities to achieve economic development, environmental sustainability and social equity" (IFC, 2020, p. ii).

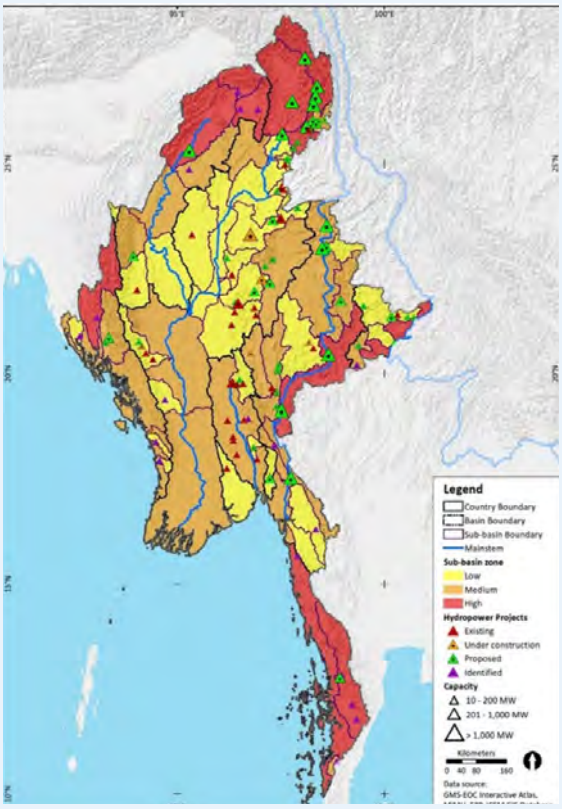

Figure 5 Strategic environmental assessment of Myanmar's hydropower sector

Source: IFC (2020, Fig. 8.5, p. 59).

The main planning principles applied in the SEA include the concepts of 'whole-of-basin planning', 'balanced natural resource utilization' and 'natural resource capacity-based development'. Sub-basins were zones either for potential development or protection based on the evaluation of the following biophysical features:

- Geomorphology: river connectivity and delta/coastline stability; potential sediment production; river flow;
- Aquatic ecology and fisheries: river reach rarity; and the presence of endemic species, Key Biodiversity Areas, Ramsar sites and important wetland areas, confluences, karst geology, and the presence of threatened fish and aquatic organisms; and
- Terrestrial biodiversity: percentage of protected area/Key Biodiversity Areas; and percentage of intact forest (≥80% crown cover).

These biophysical factors were rated and scaled to result in high, medium or low sub-basin zones. Ten high zone sub-basins were found covering 24% of Myanmar, meaning that these areas have critical biophysical processes and values and hydropower development should be limited to smaller scale projects with low environmental and social risks in these areas that would not degrade the biophysical values.

The SEA developed a sustainable development framework (SDF), a project siting tool aimed at balancing hydropower development with basin health by considering environmental and social factors at the basin scale prior to project site selection.

Through the SEA, a national-level GIS database was developed to store information about existing and proposed hydropower projects over 10 MW capacity in each basin and sub-basin. The data include the location of each project, as well as available information on: ownership and development status; baseline conditions; and project technical data.

The project also undertook broad stakeholder consultation, transparently recording comments on the Baseline Assessment Report and Final Report. The SEA methodology and outputs are utlined in the timeline described in Figure 6.

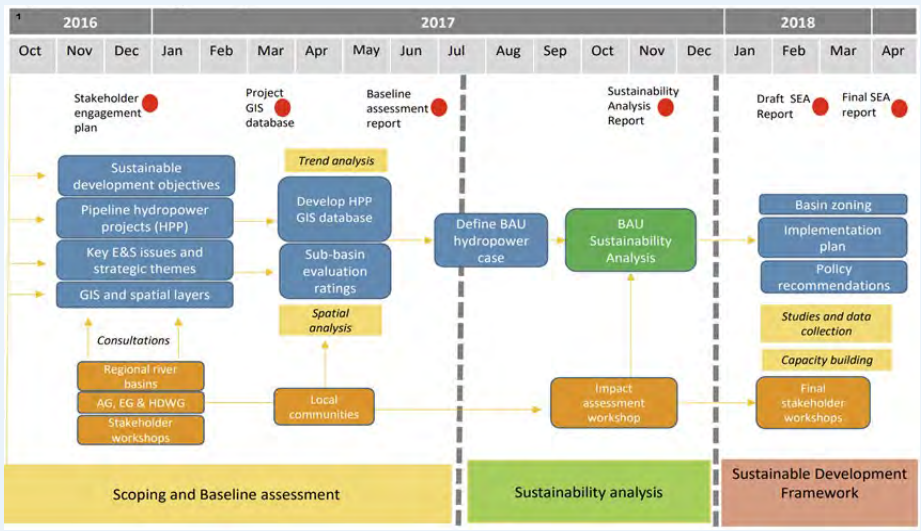

Figure 6 Timeline of the strategic environmental assessment of Myanmar's hydropower sector *Source: IFC (2020, p. 9).*

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Case study 3 Strategic Environmental Assessment for wind energy and biodiversity – Landscape scale vulture conservation in Kenya

An SEA for wind power and biodiversity in Kenya was developed in 2019 by The Biodiversity Consultancy, in partnership with BirdLife International, Nature Kenya, and The Peregrine Fund, supported by USAID through its Power Africa programme implemented by Tetra Tech. The Kenya Ministry of Energy was a proponent.

Whilst it was difficult for the SEA to identify cumulative impacts at the national scale due to the data available and timeframes for the assessment, a potential biological removal (PBR) analysis determined which species had smaller PBR values and consequently were at higher risk of higher population-level effects from wind farm mortality.

The results of the PBR showed that vultures were among the most sensitive receptor species. Through a spatial analysis, a band of areas that were identified as 'Very High' or 'Outstanding' sensitivity could be seen to be correlated with the presence of vulture colonies and tracking data – representing sites that would have very elevated risk for wind farm development. Lower risk areas for development were identified across counties in northern and eastern Kenya.

The Environmental Management and Monitoring Plan (EMMP) of the SEA outlined actions needed to reduce, manage, and monitor adverse biodiversity impacts in the wind energy sector, as identified in the sensitivity analysis of the SEA. One of the recommendations was for aggregated offsets that meet the compensation needs of two or more wind power projects. Aggregated offset interventions should be performed at landscape scale to benefit species of conservation concern that might be threatened by multiple wind farms in Kenya, such as vultures. One suggestion was an integrated anti-poisoning programme for vultures to tackle one of the major causes of existing population declines in vulture species in Africa. An aggregated approach could deliver greater outcomes for wind power developers and vultures overall compared to smaller offsets that are unconnected to one another. Collaboration in the design of a scaled-up approach would also improve efficiency and reduce the time and cost of design, set-up and monitoring. Other offset options that were considered included: supporting conservation conservancies focussed on managing declines of raptors; retrofitting high risk powerlines to mitigate electrocution and collision; rehabilitation and subsequent release of injured birds outside project areas; and captive breeding and release of priority species.

Anti-poisoning measures are already being implemented at Kipeto Wind Farm in Kenya, an operational project near nesting colonies of two Critically Endangered vulture species, Rüppell's vulture (*Gyps rueppelli*) and white-backed vulture (*G. africanus*). Offset measures, in addition to mitigation including shutdown on demand (SDOD) and carcass removal on site, involve a suite of interventions in the wider landscape to reduce human-wildlife conflict and thus retaliatory poisoning of predators. Offset activities are overseen by a multi-stakeholder Biodiversity Committee and implemented by a partnership of four conservation NGOs and the Kenya Wildlife Service.

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Case study 4 European Union Renewable Energy Directive and Renewables Acceleration Areas

To identify candidate areas for accelerating permitting for renewable energy projects, the European Commission (EC) developed a tool to map both energy and environmental data: the Energy and Industry Geography Lab (EIGL) (Figure 7). This geospatial data hub helps to identify lands with a low environmental and social conflict with high potential for energy development.

The hub was developed in conjunction with the EC Recommendation on speeding up permit-granting procedures, and REPowerEU proposal to end reliance on Russian fossil fuels and accelerate the green transition. Member States are called to swiftly map, assess, and ensure suitable land and sea areas ('acceleration areas' or 'go-to' areas) are available for renewable energy projects, commensurate with their national energy and climate plans, as well as their contributions towards the revised 2030 renewable energy target and the availability of resources, grid infrastructure, and the targets of the EU Biodiversity Strategy.

With the aim of ensuring a robust spatial planning process for the identification of acceleration areas, a handbook for practitioners was created that considers the potential conflicts of development pathways with environmental, social and cultural values. EU Member States should:

- Identify their 'go-to' areas while avoiding, as much as possible, environmentally valuable areas and prioritising inter alia degraded land not usable for agriculture.
- Limit exclusion zones where renewable energy cannot be developed to the necessary minimum.
- Streamline EIA requirements for renewable energy projects to the extent that is legally possible with binding maximum deadlines for all relevant stages to be undertaken.
- Ensure that the killing or disturbance of wild birds and protected species (under the Habitats Directive) is not an obstacle to the development of renewable energy projects, by requiring

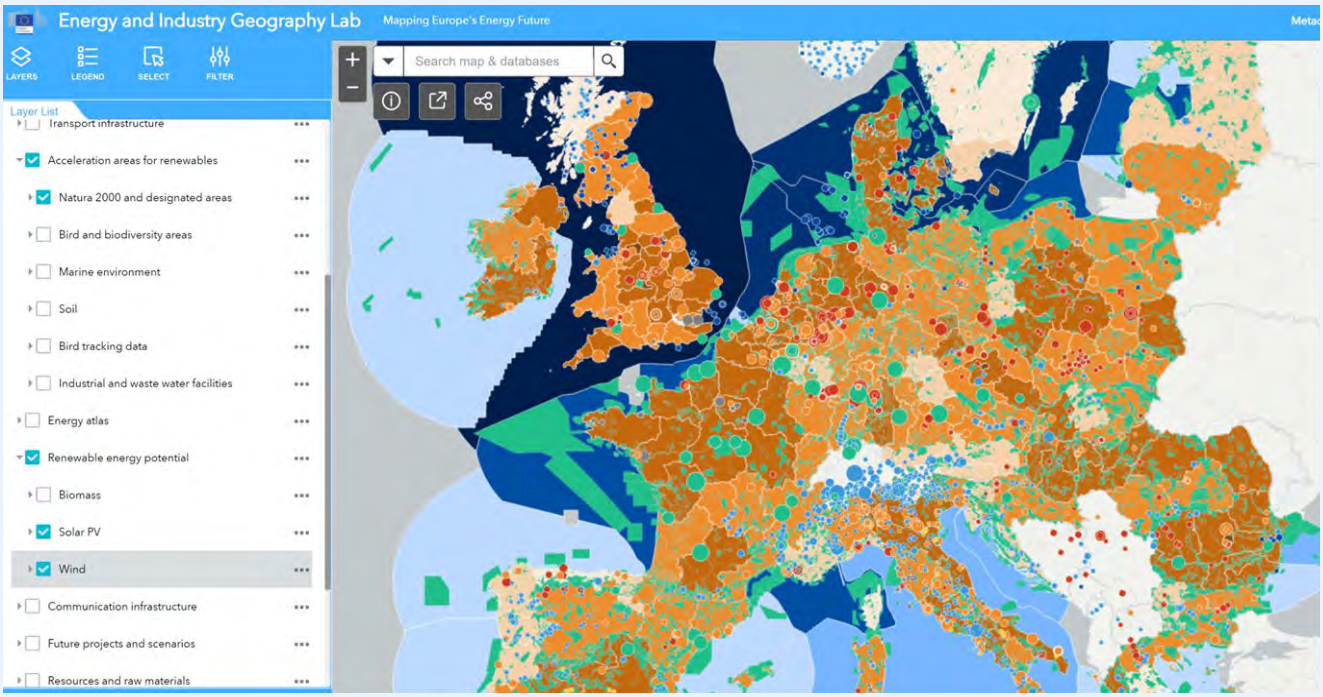

Figure 7 Screenshot of the EU Energy and Industry Geography Lab Tool, with selected data layers turned on (1 February 2024)
Prepared by The Biodiversity Consultancy

projects to integrate mitigation measures to effectively prevent, as much as possible, killing or disturbance, by monitoring their effectiveness and, in the light of the information obtained from monitoring, taking further measures as required to ensure there is no significant negative impact on the population of the species concerned.

- Encourage early public involvement to define spatial plans, promote the multiple use of sites and ensure transparency about where and how renewable energy projects may be built or installed.

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Case study 5 New York State Offshore Wind Master Plan

New York State has developed some of the most ambitious clean energy goals in the United States, including reducing greenhouse gas emissions (GHG) by 40% by the year 2030, and 80% by 2050. New York's marquee Clean Energy Standard is the most comprehensive and ambitious clean energy goal in the state's history and requires that 50% of New York's electricity come from renewable energy sources by 2030. Offshore wind will be a key component – the State has committed to develop 2,400 MW by 2030.

The New York State Offshore Wind Master Plan – Charting a Course to 2,400 Megawatts of Offshore Wind Energy, led by the New York State Energy Research and Development Authority (NYSERDA), sets out the State's comprehensive strategy to reach this goal. The Master Plan outlines how a range of studies were brought together to inform MSP for offshore wind. Since 2016, the State of New York has been conducting research, analysis, and outreach to evaluate the potential for offshore wind energy. The Master Plan is based on a suite of more than 20 studies covering a range of topics related to siting, regulatory, wildlife, commercial, economic, and other important considerations. Specifically, the Master Plan:

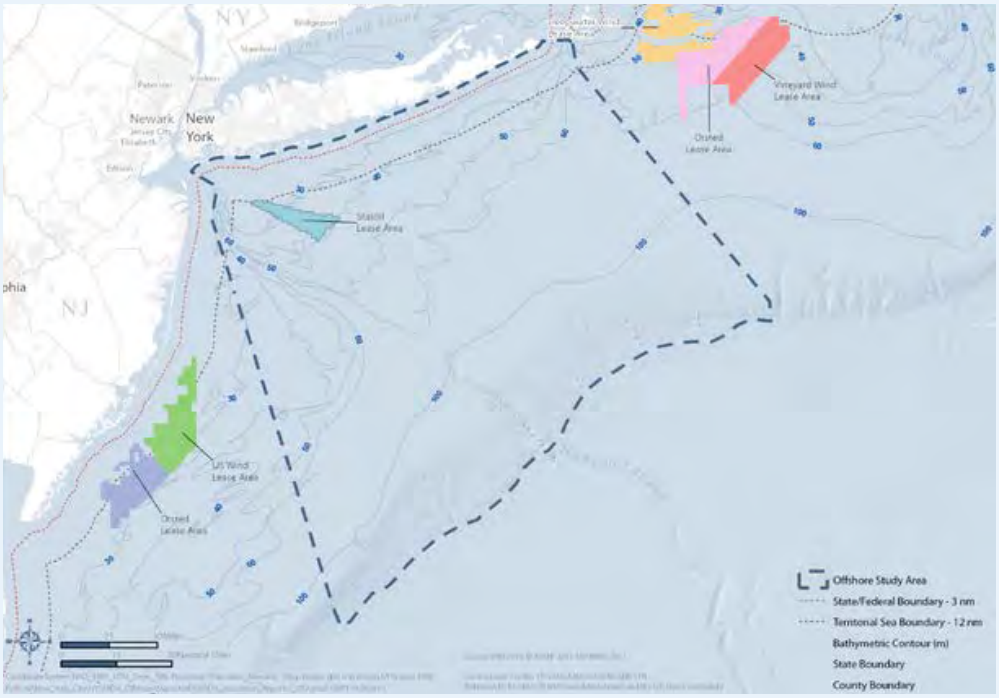

Figure 8 Master Plan Offshore Study Area *Source: NYSERDA (n.d., p. 10).*

- identifies the most favourable areas for potential offshore wind energy development;
- describes the economic and environmental benefits of offshore wind energy development;
- addresses mechanisms to procure offshore wind energy at the lowest ratepayer cost;
- analyses costs and cost-reduction pathways;
- recommends measures to mitigate potential impacts of offshore wind energy development;
- identifies infrastructure requirements and assesses existing facilities; and
- identifies workforce opportunities.

Contributed by: The Biodiversity Consultancy

Case study 4 Examples of Marine Spatial Planning in practice

Sectoral Marine Plan for offshore wind energy, Scotland

Led by the Marine Directorate of the Scottish Government, this sectoral plan identified 15 plan option areas (Figure 9, in violet) for the future development of commercial-scale offshore wind energy[38] in Scotland, including deepwater wind technologies, and covers both Scottish inshore and offshore waters (Scottish Government, 2020). The plan was developed in line with the strategic aims of the National Marine Plan and designed to minimise potential adverse effects on other marine users, economic sectors, and the environment, and maximise opportunities for economic development, investment, and employment in Scotland. The sectoral marine plan aimed to award leases to support offshore wind farms with a total capacity of 10 GW. However, following an SEA and Habitats Regulations Assessment, it was determined that projected cumulative impacts meant that five of the option areas were deemed to be subject to "high levels of ornithological constraint", meaning development can only proceed if scientific evidence can be produced to demonstrate that risk can be reduced to an acceptable level, or that a case can be made in respect of over-riding public interest. For an additional two plan option areas, the need for further strategic regional surveys and scientific research was highlighted. In 2022, Crown Estate Scotland awarded leases for 20 offshore wind farms, at least one in each plan option area, with a total capacity in excess of 27 GW. These projects are currently progressing through the consenting process.

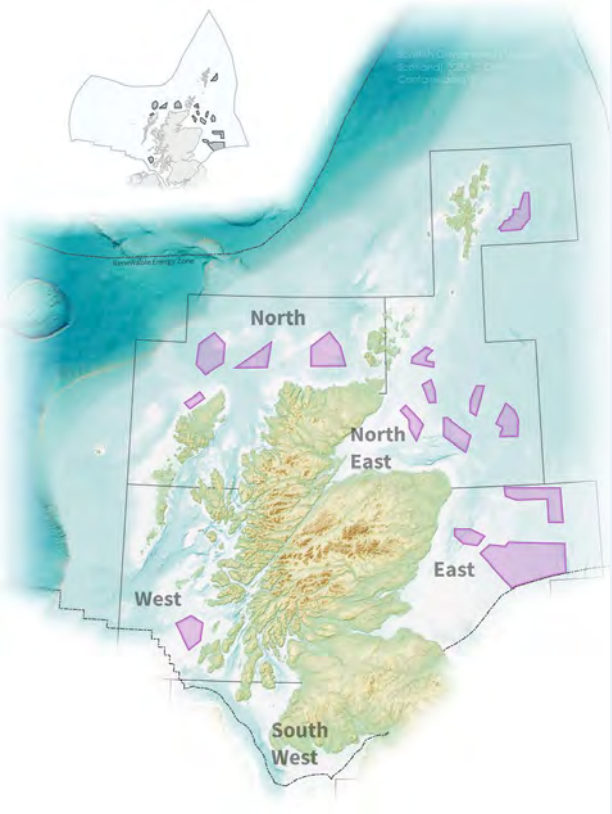

Figure 9 Final Plan options *Source: Scottish Government Riaghaltas na h-Alba (2020).*

The UK Crown Estate's Offshore Wind Leasing Round 4 (see Figure 10) awarded seabed rights for between 7 and 8.5 GW offshore wind energy

38 Defined in the plan as "projects capable of generating more than 100 MW of electricity".

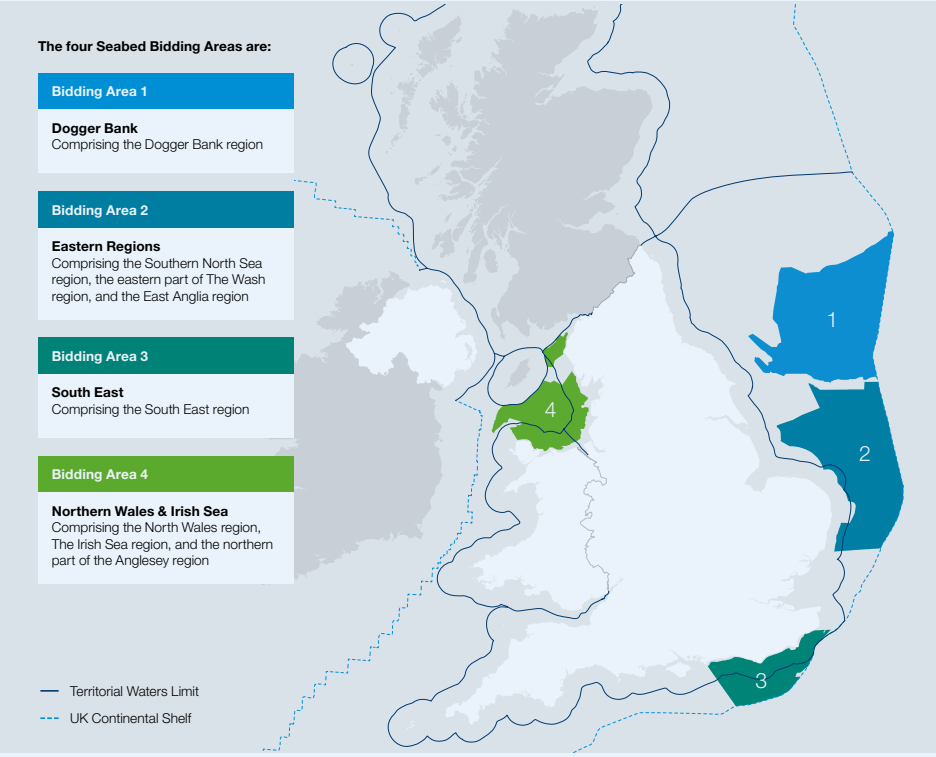

Figure 10 Seabed bidding areas for the Crown Estate Leasing Round 4
Source: The Crown Estate (n.d.)

projects across England and Wales (as well as marine minerals, carbon capture, utilisation and storage, and cables and pipelines). Alongside stakeholder engagement, a resource and constraints analysis were conducted, based on favourable resource areas for fixed offshore wind (up to 60 m depth) with no limitations to the size of turbines and projects, and not considering cable routing and onshore infrastructure. The environmental criteria included environmental designations, such as Sites of Special Scientific Interest (SSSIs), Marine Conservation Zones (MCZs), Ramsar Sites, and confirmed, candidate and potential Special Protection Areas (SPAs) and Special Areas of Conservation (SACs). Additionally, the European Seabirds at Sea (ESAS) database was used to assess gannet, kittiwake, lesser black-baked gull, greater black-backed gull, and herring hull distributions and foraging ranges. Additional criteria included: Ministry of Defence ranges and exercise areas; visual sensitivity within 13 km of shore; overlap with busy shipping routes.

Four areas were identified for leasing (see Figure 10) from a total of 18 characterisation areas. The justification for those areas rejected from this leasing round are discussed in detail in Annex A of the Leasing Round 4 document library. The Crown Estate Leasing Round 5 is currently underway with a set of requirements for bidders to make environmental and social commitments, such as habitat restoration and enhancement, pressure reduction (litter, pollution, prey availability, and others), and data and evidence to improve environmental outcomes.

Ecosystem-based Marine Spatial Planning in the Swedish North and Baltic seas

Symphony is a tool for ecosystem-based Marine Spatial Planning in the Swedish North and Baltic seas (see Figure 11). Symphony calculates how pressures from human activities in the ocean affect nature values in each location in the Swedish sea. The method and associated

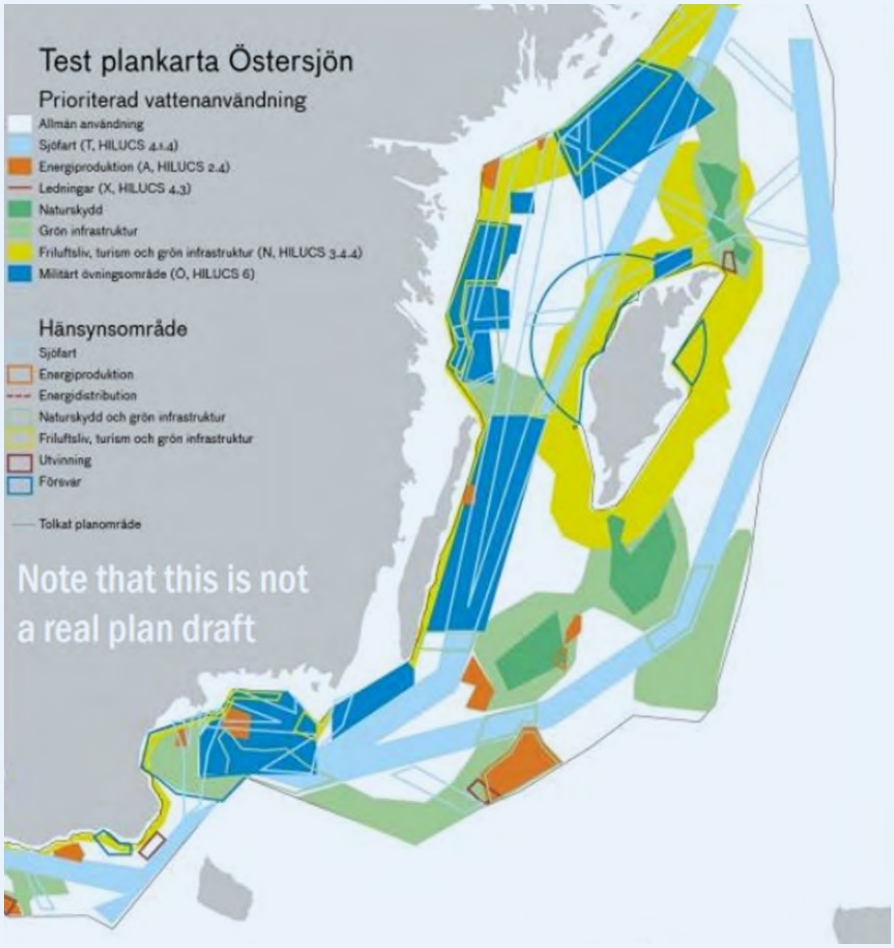

Figure 11 **Example of a geographical scope of the implementation of Marine Spatial Planning.** The map shows the application of Symphony in the North Sea and Baltic Sea. Colour scale indicates level of aggregation of ecosystem components, indicating where ecological values accumulate (high accumulation = yellows/greens). *Source: Swedish Agency for Marine and Water Management (2017).*

application were developed by the Swedish Agency for Marine and Water Management (SwAM) and are primarily used for Marine Spatial Planning purposes.

Symphony includes maps based on 41 environmental pressures, nature values (including 32 different ecosystem components in relation to habitats, reefs fish, birds, mammals and seagrass) and a sensitivity matrix evaluating the vulnerability of each nature value to every environmental pressure. The map includes uncertainties, recognising that some of the nature values included have fewer underlying datapoints than others. The methodology behind the tool has been peer reviewed and published by Hammar et al., 2020).

Contributed by: The Biodiversity Consultancy

Case study 7 The Nature Conservancy Site Renewables Right initiative

The Nature Conservancy (TNC) developed the Site Renewables Right (previously Site Wind Right) initiative to accelerate the deployment of renewable energy in the central United States by promoting the siting of wind and solar projects in areas with low conservation impact across 19 states. The information provided is intended to inform early-stage decision-making and expressly does not intend to replace consultation with federal and state wildlife agencies and tribal governments regarding project siting.

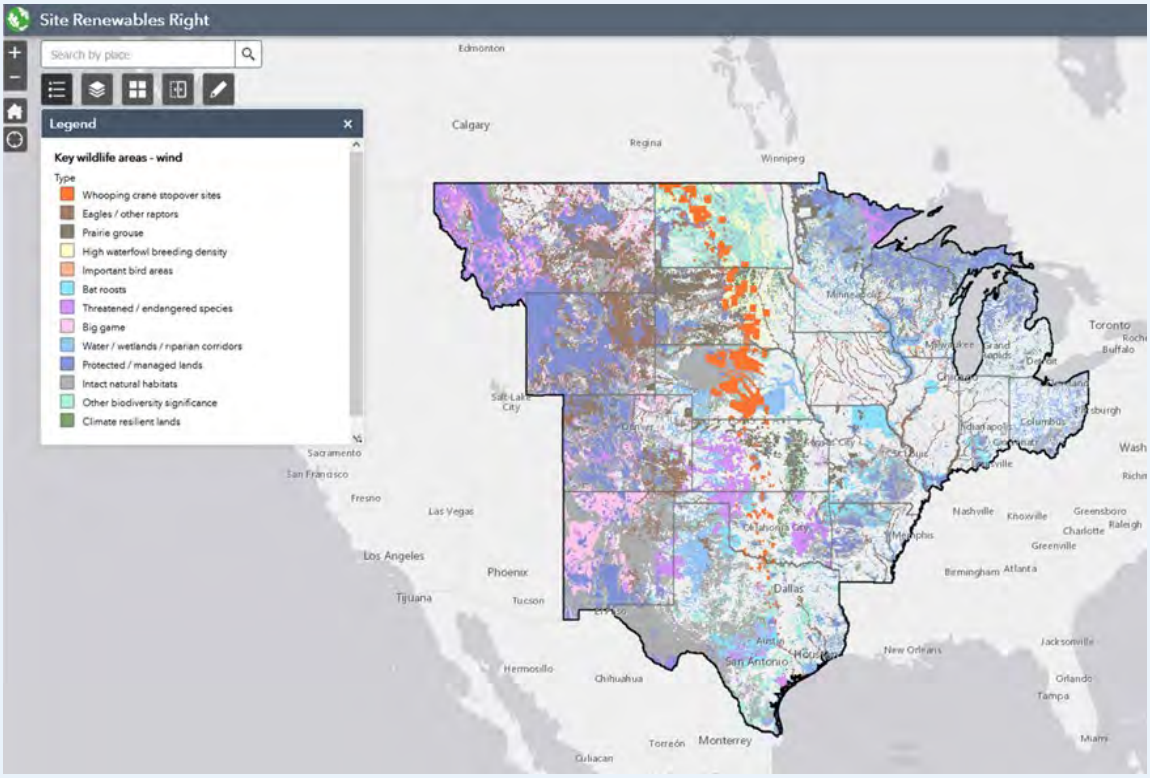

Figure 12 The Nature Conservancy Site Renewables Right map *Source: TNC (2024b).*

The Site Renewables Right web map (Figure 12) (TNC, 2024b) synthesises more than 100 layers of engineering, land use, and wildlife data. The map offers a layer of 'low impact' wind development areas to indicate where spatial information on engineering, wind potential, and land use constraints demonstrates suitable areas for wind energy with low conflict with wildlife and habitats. The map demonstrates that out of more than 90.2 million ha (21% of region) of land where wind energy could be developed based on engineering and land use constraints, a combined area of more than 31 million ha (7% of region) would be low impact. If this area were to be built out, it would contribute up to 1,550 GW of wind energy – equivalent to 8–13 times of current U.S. wind capacity and comparable to the total electrical generating capacity from all energy sources combined. The current map builds upon previous work by TNC in the region (Fargione et al., 2012; Kiesecker et al., 2011; Obermeyer et al., 2011). The map incorporates key wildlife areas for wind (and solar*), including:

- whooping crane stopover sites*;
- big game habitats;
- eagle and other raptor nesting areas;
- water, wetlands, and riparian corridors*;

- breeding waterfowl habitats;
- protected and managed lands*;
- important bird areas;
- intact natural habitats*;
- bat roosts;
- other areas of biodiversity significance*;
- threatened and endangered species*; and
- climate resilient lands*.

Contributed by: The Biodiversity Consultancy

Case study 8 Energy Sector Management Assistance Program Roadmaps for Offshore Wind

The World Bank (WB) Offshore Wind Development Program, co-led by the Energy Sector Management Assistance Program (ESMAP) and International Finance Corporation (IFC), provides strategic analysis of the offshore wind development potential at the national level in emerging market countries, through roadmaps for offshore wind.

ESMAP estimates that there are over 16,000 GW of technical offshore wind potential in emerging markets, highlighting a vast, untapped opportunity. To achieve climate targets with the required urgency and accelerated pace, development must be preceded by rigorous spatial planning for offshore wind, aligned with Good International Industry Practice (GIIP) for people and biodiversity. However, traditional approaches to MSP and SESA in mature markets are sometimes resource intensive, multi-year and costly endeavours, and may not always be readily applicable to emerging markets with the accelerated timeframes to develop the offshore wind sector.

Consequently, through its offshore wind roadmaps, the World Bank has been incorporating principles of avoidance of development in areas of high environmental and social sensitivity into the support that it offers to emerging market countries. To date, roadmaps for countries, including Azerbaijan (World Bank, 2022a), Colombia (World Bank, n.d.), and the Philippines (World Bank, 2022b) demonstrate the implications of early avoidance of areas of highest sensitivity in terms of developable wind resource.

To define potential offshore wind development zones, the range of environmental considerations identified in the roadmaps are reduced to an environmental restrictions layer and an environmental exclusion layer as well as a separate social and technical exclusions layer). These zones are defined as:

- **Exclusion:** Areas of the highest biodiversity sensitivity to exclude from the technical assessment of offshore wind resource); and
- **Restriction:** High-risk areas requiring further assessment of risk during MSP, site selection, and/or ESIA).

Table 3 Digitised spatial data captured in exclusion and restriction zones in the Philippines

Zone	Priority biodiversity value	Available digitaised spatial data layer	Source
Exclusion zone	ALP and ARI	MPAs under the NIPAS/ENIPAS	
		Critical habitats	BMB-DENR
		KBAs, including IBAs and AZE sites	www.ibat-alliance.org
		Ramsar sites	www. ibat-alliance.org
		IMMAs	www. marinemammalhabitat.org
		UNESCO World Heritage Natural Sites	www. unep-wcmc.org
		UNESCO-MAP Biosphere Reserves	www. unep-wcmc.org
	Natural habitats	Coral reefs	www. ihp-wins.unesco.org/layers
		Seagrass beds	www. allencoralatlas.org
		Mangrove forests	www. unep-wcmc.org
Restricted zone	LPAs and IRAs	LMPAs	
		EBSA	www. cbd.int/

For example, Table 3 shows the digitised spatial data captured in Exclusion and Restriction zones in the Philippines Roadmap (World Bank, 2022b). Figure 13 shows these zones in relation to the potential offshore wind development areas identified in the country's roadmap.

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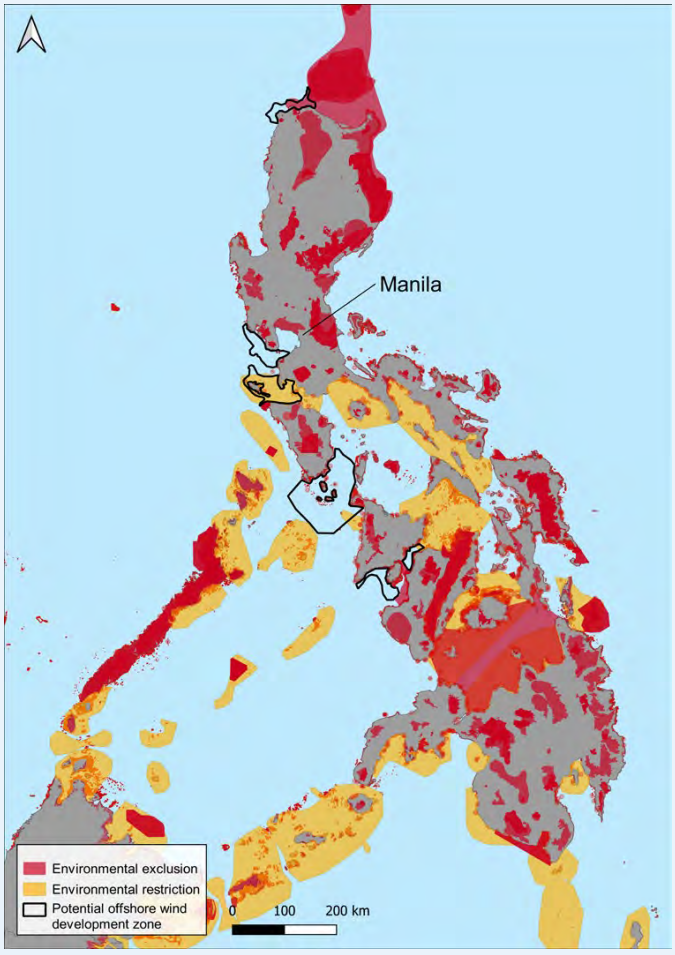

Figure 13 Environmental restrictions and exclusions in the Philippines *Source: World Bank (2022b, p. 68).*

EU The wildlife sensitivity mapping manual (Allinson et al., 2020)

This interactive EU-focused manual provides a comprehensive overview of the datasets, methodologies and GIS resources needed to develop effective wildlife sensitivity mapping approaches. It concentrates on several key wildlife attributes, including all species and habitats protected by the EU Nature Directives, with particular emphasis on birds, bats and marine mammals. The manual includes a theoretical example of a sensitivity scoring system, where species are scored in relation to their sensitivity to a form of renewable energy on a scale of Low/None, Medium, High, Very High, and Extremely High. It gives key recommendations relating to sensitivity analysis and the most suitable data types for sensitivity mapping.

Sensitivity Mapping: Accelerating offshore wind expansion and protecting nature (BirdLife Europe and Central Asia, 2023)

BirdLife Europe and Central Asia and the Renewables Grid Initiative have produced a short video explainer that outlines how sensitivity maps are a powerful tool for protecting nature while facilitating the necessary rapid transition to renewable energy. Watch here.

Avian Sensitivity Tool for Energy Planning (AVISTEP)

AVISTEP is a sensitivity mapping tool providing a detailed spatial assessment of avian sensitivity in relation to different types of energy infrastructure — wind farms (both on- and offshore), photovoltaic (PV) solar facilities, and overhead power lines. The tool provides 'spatial heat maps' (color-coded grid cells) that depict potential avian sensitivity on a scale of low to very high sensitivity. AVISTEP suggests that High sensitivity areas may be unsuitable for development, and Very High sensitivity areas are likely to be unsuitable, and that mitigation measures will be required in both. The tool currently covers India, Nepal, Thailand, and Vietnam with the aim of expanding to other priority countries, such as Egypt, Kenya, and Uzbekistan.

Site Renewables Right

The Nature Conservancy Site Renewables Right map aims to accelerate the deployment of renewable energy in central United States by promoting the siting of wind and solar projects in areas with low conservation impact across 19 states. The map incorporates more than 100 layers of engineering, land-use, and wildlife data and suggests areas for low-impact wind energy development. (See also Case study 7.)

Soaring Bird Sensitivity Mapping Tool

This mapping tool is for wind energy and other sectors, developed by the Migratory Soaring Birds Project – a partnership of BirdLife International, the United Nations Development Programme (UNDP), and the Global Environment Facility (GEF), supported by several national independent organisations working together for soaring seabirds. It is focused on Southern Europe, the Middle East, and North Africa, and on the Rift Valley and Red Sea flyway - the second most important flyway in the world for migratory soaring birds. The tool contains data on 89 species of soaring birds. The principal source of information is BirdLife's Important Bird and Biodiversity Areas (IBAs) dataset, with additional data from soaring bird satellite tracking data and species' range maps, as well as spatial data on protected areas and relevant topography.

Seabird Mapping and Sensitivity Tool (SeaMaST)

SeaMaST is a GIS tool providing evidence of the use of sea areas by seabirds and inshore waterbirds in English territorial waters. The tool is grid-based (3 km x 3 km), and takes a quantitative, more complex approach than others outlined herein, calculating Species-specific Sensitivity Indices and producing maps for seabirds relevant to English waters. The methodology is publicly available (Bradbury et al., 2014) and considered relevant for assessment in other countries requiring management of marine areas for seabirds.

Integrated Environmental & Social Sensitivity Mapping – Guidance for Early Offshore Wind Spatial Planning (SenMap) (World Bank, 2024)

This guidance is an output of the World Bank's Offshore Wind Development Program, co-led by the Energy Sector Management Assistance Program (ESMAP) and the International Finance Corporation (IFC). It is a guide for early-stage environmental and social sensitivity mapping, designed to support government planners in emerging market countries to identify potential areas for offshore wind development with the lowest environmental and social sensitivity. The sensitivity map outputs are intended to help identify broad, potential areas for offshore wind, at the earliest stages of government-led spatial planning and can support planning for avoidance, directing development away from areas where sensitivity is highest. The approach is designed as a proportionate and less resource-intensive entry into spatial planning than wider and full-scale processes like MSP and SEA. It can be standalone and feed into SEA and MSP.

Contributed by: The Biodiversity Consultancy

References

Allinson, T., Jobson, B., Crowe, O., Lammerant, J., Van Den Bossche, W., & Badoz, L. (2020). *The Wildlife Sensitivity Mapping Manual: Practical guidance for renewable energy planning in the European Union*. Final report for the European Commission (DG ENV). Luxembourg: Publications Office of the European Union. https://data.europa.eu/doi/10.2779/065468

Andersen, J. H., Al-Hamdani, Z., Harvey, E. T., Kallenbach, E., Murray, C., & Stock, A. (2020). Relative impacts of multiple human stressors in estuaries and coastal waters in the North Sea–Baltic Sea transition zone. *Science of The Total Environment*, 704(2020), 135316. https://doi.org/10.1016/j.scitotenv.2019.135316

Baruch-Mordo, S., Kiesecker, J. M., Kennedy, C. M., Oakleaf, J. R., & Opperman, J. J. (2019). From Paris to practice: sustainable implementation of renewable energy goals. *Environmental Research Letters*, 14(2), 024013. https://doi.org/10.1088/1748-9326/aaf6e0

Bennun, L., Fletcher, C., Cook, A., Wilson, D., Jobson, B., Asante-Owusu, R., Dakmejian, A., Liu, Q. (2024). *Guidance on biodiversity cumulative impact assessment for wind and solar developments and associated infrastructure*. Gland, Switzerland: IUCN. https://doi.org/10.2305/EHGE6100

Bennun, L., van Bochove, J., Ng, C., Fletcher, C., Wilson, D., Phair, N., Carbone, G. (2021). *Mitigating biodiversity impacts associated with solar and wind energy development. Guidelines for project developers*. Gland, Switzerland and Cambridge, UK: IUCN and The Biodiversity Consultancy. https://doi.org/10.2305/IUCN.CH.2021.04.en

Bigard, C., Thiriet, P., Pioch, S., Thompson, J. D. (2020). Strategic landscape-scale planning to improve mitigation hierarchy implementation: An empirical case study in Mediterranean France. *Land Use Policy*, 90, 104286. https://doi.org/10.1016/j.landusepol.2019.104286

BirdLife Europe and Central Asia (2023, February 20). *Sensitivity Mapping: Accelerating offshore wind expansion and protecting nature*. BirdLife Europe and Central Asia. Retrieved from https://www.youtube.com/watch?v=CugqLNGtWS4&t=3s

Bradbury, G., Trinder, M., Furness, B., Banks, A. N., Caldow, R. W. G., Hume, D. (2014). Mapping Seabird Sensitivity to Offshore Wind Farms. *PLoS ONE*, 12(1), e106366. https://doi.org/10.1371/journal.pone.0106366

Colmenar-Santos, A., Muñoz-Gómez, A.-M., Rosales-Asensio, E., López-Rey, Á. (2019). Electric vehicle charging strategy to support renewable energy sources in Europe 2050 low-carbon scenario. *Energy*, 183, 61–74. https://doi.org/10.1016/j.energy.2019.06.118

Council for Scientific and Industrial Research (CSIR) & Department of Environment Forestry and Fisheries (DEFF) (2019a). *Phase 2 Strategic Environmental Assessment for wind and solar PV energy in South Africa*. CSIR Report Number: CSIR/SPLA/SECO/ER/2019/0085. Stellenbosch, Western Cape, South Africa: DEFF & CSIR. https://redzs.csir.co.za/wp-content/uploads/2020/07/PHASE-2-SEA-FOR-WIND-AND-SOLAR-PV-DEVELOPMENT-IN-SA-MAIN-REPORT.pdf

_____ (2019b). *Strategic Environmental Assessment for the Expansion of Electricity Grid Infrastructure Corridors in South Africa*. CSIR Report Number: CSIR/SPLA/EMS/ER/2019/0076/B. Stellenbosch and Durban, South Africa: DEFF. https://sfiler.environment.gov.za:8443/ssf/s/readFile/folderEntry/29212/8afbc1c772743944017376c3d2c61f70/1595409805381/last/SEA_for_Expansion_EGI_Corridors_SA.pdf

Cross-Sector Biodiversity Initiative (CSBI) & The Biodiversity Consultancy (TBC) (2015). *A cross-sector guide to implementing the Mitigation Hierarchy*. Cambridge, UK: CSBI. https://www.icmm.com/website/publications/pdfs/

environmental-stewardship/2015/guidance_mitigation-hierarchy.pdf

Department of Environmental Affairs (DEA) (2015). *Strategic Environmental Assessment for wind and solar photovoltaic energy in South Africa*. CSIR Report Number: CSIR/CAS/EMS/ER/2015/0001/B. Stellenbosch, South Africa: DEA , CSIR. https://redzs.csir.co.za/wp-content/uploads/2017/04/Final-SEA_Main-Report.compressed-1.pdf

_____ (2016). *Strategic Environmental Assessment for Electricity Grid Infrastructure in South Africa*. CSIR Report Number: CSIR/02100/EMS/ER/2016/0006/B. Stellenbosch, South Africa: DEA, CSIR. https://sfiler.environment.gov.za:8443/ssf/s/readFile/folderEntry/29477/8afbc1c7727439440173b458b51a2620/1596454160198/last/Final-EGI-SEA_Main-Report.pdf

Dhunny, A. Z., Allam, Z., Lobine, D., Lollchund, M. R. (2019). Sustainable renewable energy planning and wind farming optimization from a biodiversity perspective. *Energy*, 185, 1282–1297. https://doi.org/10.1016/j.energy.2019.07.147

Dudley, N. (Ed.) (2008). *Guidelines for applying protected area management categories*. Gland, Switzerland: International Union for Conservation of Nature. https://doi.org/10.2305/iucn.ch.2008.paps.2.en

Dunne, D. (2022, 16 June). *Explainer: Can climate change and biodiversity be tackled together?* Carbon Brief [online article]. https://www.carbonbrief.org/explainer-can-climate-change-and-biodiversity-loss-be-tackled-together/

Dunnett, S., Holland, R. A., Taylor, G., & Eigenbrod, F. (2022). Predicted wind and solar energy expansion has minimal overlap with multiple conservation priorities across global regions. M. Turner (ed.). *Proceedings of the National Academy of Sciences*, 119(6), e2104764119. https://doi.org/10.1073/pnas.2104764119

Ehler, C. & Douvere, F. (2009). *Marine spatial planning: a step-by-step approach toward ecosystem- based management*. IOC Manual and Guides no. 53. Paris, France: Intergovernmental Oceanographic Commission (IOC) and the Biosphere Programme. https://unesdoc.unesco.org/ark:/48223/pf0000186559

Ember (2023). *Global Electricity Review 2023*. London Fields, UK: EMBER. https://ember-climate.org/app/uploads/2023/04/Global-Electricity-Review-2023.pdf. Available in Chinese and Spanish.

Energy Transitions Commission (ETC) (2023). *Streamlining planning and permitting to accelerate wind and solar deployment*. *Version 1, January 2023*. London, UK: ETC. https://www.energy-transitions.org/wp-content/uploads/2023/01/Barriers_PlanningAndPermitting_vFinal.pdf

European Commission (n.d.). *Strategic Environmental Assessment*. European MSP Platform. Retrieved from https://maritime-spatial-planning.ec.europa.eu/faq/strategic-environmental-assessment-sea

Food and Agriculture Organization of the United Nations (FAO) (1993). *Guidelines for Land Use Planning*. FAO Development Series 1. Rome, Italy: FAO. https://www.fao.org/land-water/land/land-governance/land-resources-planning-toolbox/category/details/en/c/1036358/

Fargione, J., Kiesecker, J., Slaats, M. J., & Olimb, S. (2012). Wind and Wildlife in the Northern Great Plains: Identifying Low-Impact Areas for Wind Development. *PLoS ONE*, 7(7), e41468. https://doi.org/10.1371/journal.pone.0041468

Gasparatos, A., Doll, C. N. H., Esteban, M., Ahmed, A., Olang, T. A. (2017). Renewable energy and biodiversity: Implications for transitioning to a Green Economy. Renewable and Sustainable Energy Reviews, 70, 161–184. https://doi.org/10.1016/j.rser.2016.08.030

Gielen, D., Boshell, F., Saygin, D., Bazilian, M. D., Wagner, N., Gorini, R. (2019). The role of renewable energy in the global energy transformation. *Energy Strategy Reviews*, 24, 38–50. https://doi.org/10.1016/j.esr.2019.01.006

Goodale, M. W. & Milman, A. (2019). Assessing the cumulative exposure of wildlife to offshore wind energy development. *Journal of Environmental Management*, 235, 77–83. https://doi.org/10.1016/j.jenvman.2019.01.022

Hammar, L., Molander, S., Pålsson, J., Schmidtbauer Crona, J., Carneiro, G., Johansson, T., Hume, D., Kågesten, G., Mattsson, D., Törnqvist, O., Zillén, L., Mattsson, M., Bergström, U., Perry, D., Caldow, C., Andersen, J. H. (2020). Cumulative impact assessment for ecosystem-based marine spatial planning. *Science of The Total Environment*, *734*, 139024. https://doi.org/10.1016/j.scitotenv.2020.139024

He, J., Yang, Y., Liao, Z., Xu, A., & Fang, K. (2022). Linking SDG 7 to assess the renewable energy footprint of nations by 2030. Applied Energy, 317, 119167. https://doi.org/10.1016/j.apenergy.2022.119167

Hughes, A. C., Orr, M. C., Ma, K., Costello, M. J., Waller, J., Provoost, P., Yang, Q., Zhu, C., Qiao, H. (2021). Sampling biases shape our view of the natural world. *Ecography*, *44*(9), 1259–1269. https://doi.org/10.22541/au.159419540.02222358

International Association of Impact Assessment (IAIA) (n.d.). *Strategic Environmental Assessment*. IAIA. Retrieved from https://www.iaia.org/wiki-details.php?ID=24

International Energy Agency (2023a). *Renewable Energy Market Update Outlook for 2023 and 2024*. Paris, France: IEA. https://build-up.ec.europa.eu/system/files/2023-06/RenewableEnergyMarketUpdate_June2023.pdf

_____ IEA (2023b). *World Energy Outlook 2023*. Paris, France: IEA. https://www.iea.org/reports/world-energy-outlook-2023, Licence: CC BY 4.0 (report); CC BY NC SA 4.0 (Annex A)

International Energy Agency (IEA), International Renewable Energy Agency (IRENA), United Nations (UNSD), World Bank, World Health Organization (WHO) (2023). *Tracking SDG 7: The Energy Progress Report*. World Bank, Washington DC. © World Bank. License: CC BY-NC 3.0 IGO. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2023/Jun/Tracking_SDG7_energy_progress_2023.pdf

International Finance Corporation (IFC) (2012a). *Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources*. Washington DC, USA: IFC. https://www.ifc.org/en/insights-reports/2012/ifc-performance-standard-6

_____ (2012b). *Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts*. Washington, DC, USA: IFC. https://www.ifc.org/en/insights-reports/2012/ifc-performance-standard-1 (also available in Arabic, Burmese, Chinese, Dutch, French, Portuguese, Russian, Spanish, Turkish)

_____ (2012c). *Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources*. Washington, DC, USA: IFC. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/634681491382426076/biodiversity-conservation-and-sustainable-management-of-living-natural-resources-guidance-note-6 (also available in Arabic, Chinese, French, Portuguese, Russian, Spanish)

_____ (2020). *Strategic Environmental Assessment of the Myanmar Hydropower Sector*. Washington, D.C: IFC. https://www.ifc.org/content/dam/ifc/doc/mgrt/sea-final-report-english-web.pdf

International Union for Conservation of Nature (IUCN) (2022). *Towards an IUCN nature-positive approach: a working paper. Summary highlights.* Gland, Switzerland: IUCN. https://www.iucn.org/sites/default/files/2022-10/nature-positive-summary-highlihgts-oct-2022_0.pdf

Jacobson, M. Z., Delucchi, M. A., Cameron, M. A., Coughlin, S. J., Hay, C.A., Manogaran, I. P., Shu, Y., & von Krauland, A.-K. (2019). Impacts of Green New Deal Energy Plans on Grid Stability, Costs, Jobs, Health, and Climate in 143 Countries. *One Earth*, *1*(1), 449–463. https://doi.org/10.1016/j.oneear.2020.01.007

Kennedy, C. M., Oakleaf, J. R., Theobald, D. M., Baruch-Mordo, S., & Kiesecker, J. (2019). Managing the middle: A shift in conservation priorities based on the global human modification gradient. *Global Change Biology*, *25*(3), 811–826. https://doi.org/10.1111/gcb.14549

Kiesecker, J. M., Copeland, H., Pocewicz, A., McKenney, B. (2009). Development by design: blending landscape-level planning with the

mitigation hierarchy. *Frontiers in Ecology and* the Environment, 8(5), 261–266. https://doi.org/10.1890/090005

Kiesecker, J. M., Evans, J. S., Fargione, J., Doherty, K., Foresman, K. R., Kunz, T. H., Naugle, D., Nibbelink, N. P., Niemuth, N. D. (2011). Win-Win for Wind and Wildlife: A Vision to Facilitate Sustainable Development. *PLoS ONE*, 6(4), e17566. https://doi.org/10.1371/journal.pone.0017566

Lengyel, S., Nagy, G., Tóth, M., Mészáros, G., Nagy, C. P., Mizsei, E., Szabolcs, M., Mester, B., Mérő, T. O. (2023). Grassland restoration benefits declining farmland birds: A landscape-scale before-after-control-impact experiment. *Biological Conservation*, 277, 109846. https://doi.org/10.1016/j.biocon.2022.109846

Mander, Ü., Kull, A., Uuemaa, E., Mõisja, K., Külvik, M., Kikas, T., Raet, J., Tournebize, J., Sepp, K. (2018). Green and brown infrastructures support a landscape-level implementation of ecological engineering. *Ecological Engineering*, *120*, 23–35. https://doi.org/10.1016/j.ecoleng.2018.05.019

Martin, G., Kotta, J., Aps, R., Kopti, M., Martin, K., Remmelgas, L., & Kuris, M. (2013). Marine spatial planning as a tool for promoting sustainable economic development including tourism and recreation in a coastal area: an example from Pärnu Bay, NE Baltic Sea. *WIT Transactions on Ecology and The Environment*, 173, 393–404. https://www.witpress.com/elibrary/wit-transactions-on-ecology-and-the-environment/173/24479

Metternicht, G. (2017). *Land use planning. Global Land Outlook Working Paper*. Bonn, Germany: United Nations Convention to Combat Desertification (UNCCD). https://www.unccd.int/sites/default/files/2018-06/6.%20Land%2BUse%2BPlanning%2B__G_Metternicht.pdf

Meyfroidt, P., De Bremond, A., Ryan, C. M., Archer, E., Aspinall, R., Chhabra, A., Camara, G., Corbera, E., DeFries, R., Díaz, S., Dong, J., Ellis, E. C., Erb, K.-H., Fisher, J. A., Garrett, R. D., Golubiewski, N. E., Grau, H. R., Grove, J. M., Haberl, H., ... & Zu Ermgassen, E. K. H. J. (2022). Ten facts about land systems for sustainability. *Proceedings of the National Academy of Sciences*, 119(7), e2109217118. https://doi.org/10.1073/pnas.2109217118

New York State Energy Research and Development Authority (NYSERDA) (n.d.). *New York State Offshore Wind Master Plan Charting a Course to 2,400 Megawatts of Offshore Wind Energy*. NYSERDA Report 17-25. https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Publications/Research/Biomass-Solar-Wind/Master-Plan/Offshore-Wind-Master-Plan.pdf

Oakleaf, J. R., Kennedy, C. M., Baruch-Mordo, S., Gerber, J. S., West, P. C., Johnson, J. A., & Kiesecker, J. (2019). Mapping global development potential for renewable energy, fossil fuels, mining and agriculture sectors. *Scientific Data*, 6, 101. https://doi.org/10.1038/s41597-019-0084-8

Obermeyer, B., Manes, R., Kiesecker, J., Fargione, J., Sochi, K. (2011). Development by Design: Mitigating Wind Development's Impacts on Wildlife in Kansas. *PLoS ONE*, 6(1), e26698. https://doi.org/10.1371/journal.pone.0026698

Prach, K., Fajmon, K., Jongepierová, I., Řehounková, K. (2015). Landscape context in colonization of restored dry grasslands by target species. *Applied Vegetation Science*, *18*(2), 181–189. https://doi.org/10.1111/avsc.12140

Rao, N. D., Min, J., & Mastrucci, A. (2019). Energy requirements for decent living in India, Brazil and South Africa. *Nature Energy*, 4, 1025–1032. https://doi.org/10.1038/s41560-019-0497-9

Rehbein, J., Watson, J., Lane, J., Sonter, L., Venter, O., Atkinson, S., Allan, J. (2020). Renewable energy development threatens many globally important biodiversity areas. *Global Change Biology*, 26(5), 3040–3051. https://doi.org/10.1111/gcb.15067

Rosenow, J., Gibb, D., Nowak, T., & Lowes, R. (2022). Heating up the global heat pump market. Nature Energy, 7, 901–904. https://doi.org/10.1038/s41560-022-01104-8

Roser, M. (2020, December 10). *The world's energy problem. Our World in Data*. Licence: CC BY 4.0. https://ourworldindata.org/worlds-energy-problem

Scottish Government Riaghaltas na h-Alba (2020, October 28). *Sectoral marine plan for offshore wind energy*. Edinburgh, Scotland: The Scottish Government. Retrieved from https://www.gov.scot/publications/sectoral-marine-plan-offshore-wind-energy/pages/3/

Scottish Government Riaghaltas na h-Alba (2019). *Development of a 'Seabird sensitivity Mapping Tool for Scotland'*. Edinburgh, Scotland: Marine Scotland, Centre for Ecology & Hydrology. https://www.gov.scot/binaries/content/documents/govscot/publications/research-and-analysis/2020/08/development-of-a-seabird-sensitivity-mapping-tool-for-scotland-final-report2/documents/development-of-a-seabird-sensitivity-mapping-tool-for-scotland-final-report/development-of-a-seabird-sensitivity-mapping-tool-for-scotland-final-report/govscot%3Adocument/Development%2Bof%2Ba%2BSeabird%2BSensitivity%2BMapping%2BTool%2Bfor%2BScotland-%2Bfinal%2Breport.pdf

Swedish Agency for Marine and Water Management (2017, March 23). *Symphony – a tool for ecosystem-based marine spatial planning*. Presentation of the tool Symphony. Göteborg, Sweden. Retrieved from https://www.havochvatten.se/en/eu-and-international/marine-spatial-planning/swedish-marine-spatial-planning/the-marine-spatial-planning-process/development-of-plan-proposals/symphony---a-tool-for-ecosystem-based-marine-spatial-planning.html

The Biodiversity Consultancy (TBC), World Wide Fund For Nature (WWF (Eds.) (2023). *Nature-safe Energy: Linking energy and nature to tackle the climate and biodiversity crises*. Gland, Switzerland, and Cambridge, UK: WWF and TBC. https://wwfint.awsassets.panda.org/downloads/cleanaction_nature_safe_energy_report.pdf

The Crown Estate (n.d.). *Identifying seabed Bidding Areas*. The Crown Estate. Retrieved from https://www.thecrownestate.co.uk/our-business/marine/offshore-wind-leasing-round-4-identifying-seabed-bidding-areas

The Nature Conservancy (TNC) (2021, 9 April). *Smarter Energy Siting Helps Achieve Climate & Biodiversity Goals.* The Nature Conservancy. Perspectives. Retrieved frin https://www.nature.org/en-us/what-we-do/our-insights/perspectives/smarter-energy-siting-helps-climate-biodiversity/

TNC (2024a). *Marine Spatial Planning. TNC's Approach*. Arlington, Virginia, USA: TNC. https://marineplanning.org/overview/tnc_approach/

TNC (2024b, 19 July). *Site Renewables Right. Accelerating a clean and green energy future (updated)*. The Nature Conservancy. Retrieved from https://www.nature.org/en-us/what-we-do/our-priorities/tackle-climate-change/climate-change-stories/site-wind-right/?vu=siterenewablesright

TNC, Clean Energy Buyers Institute (CEBI), & Bain & Company (2023). *Beyond the megawatt. Optimizing impact of clean energy procurement: Growing demand for social and environmental outcomes*. Washington, DC, USA: CEBI. https://www.nature.org/content/dam/tnc/nature/en/documents/Clean-Energy-Buyers-Institute-Report_Optimizing-Impact-of-Clean-Energy-Procurement_Growing-Demand-for-Social-and-Environmental-Outcomes.pdf

Trombulak, S. C. & Baldwin, R. F. (2010). Introduction: Creating a Context for Landscape-Scale Conservation Planning. In Trombulak, S.C., Baldwin, R.F. (Eds.), *Landscape-scale Conservation Planning* (pp. 1–15). Dordrecht, The Netherlands: Springer. https://doi.org/10.1007/978-90-481-9575-6_1

United Nations (n.d.). *All About the NDCs United Nations*. Retrieved from https://www.un.org/en/climatechange/all-about-ndcs

UNESCO-IOC/European Commission (2021). *MSPglobal International Guide on Marine/Maritime Spatial Planning*. Paris, France: Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization and Directorate-General for Maritime Affairs and Fisheries of the European Commission. https://unesdoc.unesco.org/ark:/48223/pf0000379196 (Available in Arabic, French, and Spanish.)

United Nations Framework Convention on Climate Change (UNFCCC) (n.d.). *The Paris Agreement*. UNFCCC. Retrieved from https://unfccc.int/process-and-meetings/the-paris-agreement (Available in Chinese, French, Russian, and Spanish)

_____ (2016). *Report of the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 13 December 2015*. Adoption of the Paris Agreement. FCCC/CP/2015/10/Add.1. https://www.un.org/en/climatechange/paris-agreement (Available in Arabic, Chinese, French, Russian and Spanish here).

UNFCCC (n.d.). *The Paris Agreement*. UNFCCC. Retrieved from https://unfccc.int/process-and-meetings/the-paris-agreement (Available in Arabic, Chinese, French, Russian, and Spanish)

United States Department of the Interior (US DOI) (2015). *Department Manual 600 DM 6: Implementing Mitigation at the Landscape-scale*. Washington, DC, USA: DOI. https://www.doi.gov/sites/doi.gov/files/elips/documents/600-dm-6.pdf

United States National Ocean Council (US NOC) (2013). *Marine Planning Handbook*. Washington, DC, USA: NOC. https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/final_marine_planning_handbook.pdf

World Bank (2016). *ESS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. Guidance Note for Borrowers*. Washington, DC, USA: World Bank. https://documents1.worldbank.org/curated/en/924371530217086973/ESF-Guidance-Note-6-Biodiversity-Conservation-English.pdf

_____ (2021). *Key Factors for Successful Development of Offshore Wind in Emerging Markets*. Washington, DC, USA: Energy Sector Management Assistance Program (ESMAP), World Bank. License: Creative Commons Attribution CC BY 3.0 IGO. https://documents1.worldbank.org/curated/en/343861632842395836/pdf/Key-Factors-for-Successful-Development-of-Offshore-Wind-in-Emerging-Markets.pdf

_____ (2022a). *Key Offshore Wind Roadmap for Azerbaijan.* Washington, DC, USA. License: Creative Commons Attribution CC BY 3.0 IGO. https://documents1.worldbank.org/curated/en/099125006022242537/pdf/P1757160c9ba20078097880a6781b95d5eb.pdf

_____ (2022b). *Offshore Wind Roadmap for the Philippines*. Washington, DC, USA: World Bank. License: Creative Commons Attribution CC BY 3.0 IGO. https://documents1.worldbank.org/curated/en/099225004192234223/pdf/P1750040b777da0c30935a0e2aa346f4e26.pdf

_____ (2024). *Integrated Environmental & Social Sensitivity Mapping - Guidance for Early Offshore Wind Spatial Planning*. Washington, DC, USA: World Bank Group. http://documents.worldbank.org/curated/en/099060424173523666/P1700901ab099e04a1ad5e19ad8ccceea4a

World Bank Group (n.d.). *Offshore Wind Roadmap for Colombia. Final Report*. Washington, DC, USA: World Bank. https://www.minenergia.gov.co/documents/5859/Colombia_Offshore_Wind_Roadmap_VE_compressed.pdf

World Economic Forum (WEF) (2016). *Blueprints for a Greener Footprint: Sustainable Development at a Landscape Scale*. Cologny, Geneva, Switzerland: WEF. https://www3.weforum.org/docs/WEF_Blueprint_for_a_Greener.pdf

World Wildlife Fund (WWF) & Boston Consulting Group (BCG) (2023). *Building a Nature-Positive Energy Transformation: Why a low-carbon economy is better for people and nature*. Washington, DC, USA: WWF. https://wwfint.awsassets.panda.org/downloads/wwf-bcg-building-a-nature-positive-energy-transformation.pdf

zu Ermgassen, S. O. S. E., Howard, M., Bennun, L., Addison, P., Bull, J. W., Loveridge, R., Pollard, E., Starkey, M. (2022). Are corporate biodiversity commitments consistent with delivering 'nature-positive' outcomes? A review of 'nature-positive' definitions, company progress and challenges. *Journal of Cleaner Production*, *379*(Part 2), 134798. https://doi.org/10.1016/j.jclepro.2022.134798

Further reading

SOURCE	SUMMARY	REFERENCE
Strategic Environmental Assessment*		
SEA Good Practice Guidance	Guidance for practitioners on how to conduct a SEA in Australia and New Zealand	EIANZ Working Group (2018)
Strategic Environmental Assessment: guidance	Non-statutory guidance to support practitioners undertaking SEA in Scotland	Scottish Government (2013)
A Guide to Undertaking Strategic Assessments (Environment Protection and Biodiversity Conservation Act, 1999)	Explains the strategic assessment process under the Australian Government's national environment law	Commonwealth of Australia (2013)
Strategic Environmental Assessment Better Practice Guide. Methodological guidance for strategic thinking in SEA	Guidance from Agência Portuguesa do Ambiente (APA) (Portuguese Environment Agency) aimed at public institutions	Partidário (2012)
Strategic environmental assessment (SEA) and climate change	Guidance for practitioners on how climate change issues can be considered in SEA in England and Wales	Environment Agency (2011)
Applying Strategic Environmental Assessment	Good Practice Guidance for Development Cooperation	OECD (2006).
Marine Spatial Planning		
International Guide on Marine/Maritime Spatial Planning	Guide to assist governments, stakeholders, communities and all relevant parties with the practice and design of marine spatial plans	UNESCO-IOC/European Commission (2021)
Marine Spatial Planning: a step-by-step approach toward ecosystem-based management	Guidance aimed at professionals responsible for the planning and management of marine areas and their resources. Especially targeted at situations in which time, finances, information, and other resources are limited. (Intergovernmental Oceanographic Commission and Man and the Biosphere Programme)	Ehler & Douvere (2009)
Biodiversity risk screening		
Industry guidance for early screening of biodiversity risk for offshore wind energy development	Brief practical guidance on early risk screening for projects. Relevant to both project financers and developers and is applicable to developments around the world.	Bennun et al. (2021)
Industry guidance for early screening of biodiversity risk for wind energy development		
Industry guidance for early screening of biodiversity risk for solar energy development		
Biodiversity screening – Industry Briefing Note		The Biodiversity Consultancy (2017)

* The International Association for Impact Assessment is currently developing guidance on SEA for renewable energy

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