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Planning for renewable energy without conflict: the potential of using sensitivity mapping as a decision-support tool

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ABSTRACT

Expanding the use of renewable energy is a policy imperative, but it must proceed without compromising other vital objectives – such as biodiversity conservation, water management, cultural heritage, and public health – while also actively involving the public. This study emphasises sensitivity mapping as a decision-support tool for integrating diverse political and societal concerns into renewable energy planning. Unlike prior studies, which focused solely on methodological applications, we highlight the utility of sensitivity mapping as a policy-making instrument. Using Slovenia as a case study, we present an example of comprehensive sensitivity mapping at a national scale involving several protection regimes. The findings demonstrate how sensitivity mapping can identify a greater-than-expected potential for conflict-free renewable energy development. However, the study also exposes that there are limits to expanding renewable energy without encroaching on protection regimes, and raises questions about the feasibility of achieving climate neutrality by 2050 at a country-wide level. As sensitivity mapping gains traction across the EU, we underline its potential to enable anticipatory, integrative, and inclusive planning. We also highlight its role in recognising the limits and trade-offs of energy planning, reinforcing the shift of renewable energy expansion from solely a political decision to one grounded in a broader societal consensus.

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1. Introduction

A high consensus exists regarding the urgent need to phase out fossil fuels in order to tackle the CO_2 emissions which are contributing to dangerous climate change. To this end, accelerating the deployment of renewable energy has been widely accepted as a policy priority (IPCC, 2022; IRENA, 2019). In general, this has been broadly supported by the public (Eurobarometer, 2023; European Commission, 2019b; Hamilton et al., 2018). In the European Union (EU), support for renewables has been further reinforced in the aftermath of the Russian invasion into Ukraine in February 2022 as a means of improved energy security and independence from Russia (Mišík, 2022). However, support for renewables is not without its concerns: while, on one hand, the expansion of renewables reaps climate and economic benefits, on the other, it raises potential issues of being incompatible with nature conservation, energy equity, and social justice (Kuzemko et al., 2022). There is also a concern that bolstering renewable energy might not always increase energy sovereignty, and that the political goal of increasing countries' energy sovereignty might threaten the transition towards more renewable energy (Hansen & Moe, 2022). Overall, planning for renewable energy is part of a broader (re)organisation of energy systems, which includes a number of political and societal considerations.

The need for careful planning has become particularly evident in the EU with the emergence of multiple converging policy objectives. Building on its internal strategy, titled the European Green Deal (European Commission, 2019a), the EU has been rapidly increasing its climate targets over the past years, and this has direct implications for increased renewable energy targets. The war in Ukraine has also provided an additional push in this direction. Through a set of regulatory decisions, the EU has moved to fast-track the permission processes for new renewable energy projects, especially for solar and wind technologies. However, while this level of decisiveness for the implementation of renewable energy has been welcomed by investors (WindEurope, 2022), it causes discomfort to some of the other stakeholders, especially when it introduces a conflict between renewable energy and other policy objectives, or when it reduces public participation (Bankwatch network, 2022; Durá-Alemañ et al., 2023; Trouwborst, 2023; WWF, 2022). This is reminiscent of the concerns that the siting of renewables can have a negative impact on nature conservation, natural resources, and landscapes (Osman et al., 2023; Rehbein et al., 2020; Sayed et al., 2021; Serrano et al., 2020; Sokka et al., 2016). It also underscores the necessity for public participation in relation to decision-making for energy systems (Calero Valdez et al., 2018; Kamlage et al., 2024; Lelieveldt & Schram, 2023), particularly if it aims to be conducive to energy justice (Suboticki et al., 2023). While overcoming the potentially conflicting impacts of renewable energy on other regimes and involving the public remain key hurdles for urgent energy transitions, the approaches and tools that make this possible have been poorly explored.

In this study we focus on sensitivity mapping as a decision-support tool in the planning of renewable energy for electricity production. Our objective is to evaluate the potential of this tool, to make advancements within the political ambition to expand renewables, and to involve the public in the planning of renewable energy. This has been done by exploring data from Slovenia on a national-scale in order to identify conflict-free zones for renewable energy development up until 2030. Thus far, the use of sensitivity mapping in the context of planning for renewable energy has been limited in scope and used primarily as a tool for technical energy planning (Collados-Lara et al., 2022; Morkūnė et al., 2020; Nadizadeh Shorabeh et al., 2021). The revised EU Renewable Energy Directive has made this a mandatory approach at the national level across the EU, with the primary intentions of enabling the identification of 'renewables acceleration areas' (or 'go to areas'), and of supporting a faster and simpler process for granting permits (Directive 2023/2413, Art 15c(1)(a)(ii)). Unlike previous studies, we approach sensitivity mapping as a decision-support tool in the context of ambitions for the further expansion of renewables. We examine sensitivity mapping at the conceptual and implementation level and reflect on its usefulness for the planning of renewable energy at a national scale, and possibly also on a regional level. Sensitivity mapping is expected to become more widely used over the next few years in the EU, and likely in other countries as well. Our analysis involves extensive sensitivity mapping on a national scale, incorporating numerous sensitivity categories and stakeholders. As such, it may serve as an illustrative example of what may become a common scenario in the future, and could also have value at various levels of governance.

In Section 2, we lay out the analytical framework of the study. In Section 3 we outline our research method. We present a case study analysis in Section 4, and this is followed by a discussion of the results in Section 5. In the Conclusion, we highlight both the political and participatory potential of sensitivity mapping for the future of energy planning.

2. The analytical framework: the context of renewable energy planning and the potential of sensitivity mapping

2.1. The planning of renewable energy in a political context

Since the late 1990s, the EU has increasingly been stepping up its climate ambitions. This has had direct implications for renewable energy targets (Ahmadov & Van Der Borg, 2019), as well as having an impact on national renewable energy trajectories (Strunz et al., 2021). The evolution of the EU's climate and renewable energy targets shows a notable growth in the past few years, as summarised in Figure 1. A key part of the most recent policy to facilitate the deployment of renewable energy has been focussed on speeding up and simplifying the permit procedures for renewable energy projects (i.e. the process of receiving nationally relevant permissions for locating and constructing renewable energy infrastructures), as well as being focused on siting (i.e. the selection of locations for renewable energy projects).

The EU first attempted to simplify permitting processes in 2018 (Directive 2018/2001/EU), when permitting was associated with lengthy administrative procedures rather than being reflective of any actual siting issues. These efforts were increased due to the Russian invasion of Ukraine (while possibly also being linked to climate-related and economic factors), first through recommendations, and later through legislation aimed at EU energy independence 'from Russian fossil fuels well before 2030' (Directive 2023/2413, Recital 5). The introduction of a set of 'emergency measures' (Regulation 2022/2577) placed a particular focus on renewable energy projects which were capable of being quickly deployed and could achieve a short-term acceleration in the use of renewables (ibid., Art. 1).

Thus far, two policy measures related to siting have been put in place for the acceleration of renewables across member states. The first is a designation of special acceleration areas for renewables in places where countries expect that the renewable energy projects will not have a significant environmental impact (Directive 2023/2413, Art.15c). Subsequent to the former measure is a prioritisation of energy production from renewable sources and their associated processes (such as connecting to the grid, upgrading the grid, and managing storage assets). Until climate neutrality has been achieved, the planning, construction, and operation of renewable energy plants are 'presumed as being in the overriding public interest and serving public health and safety

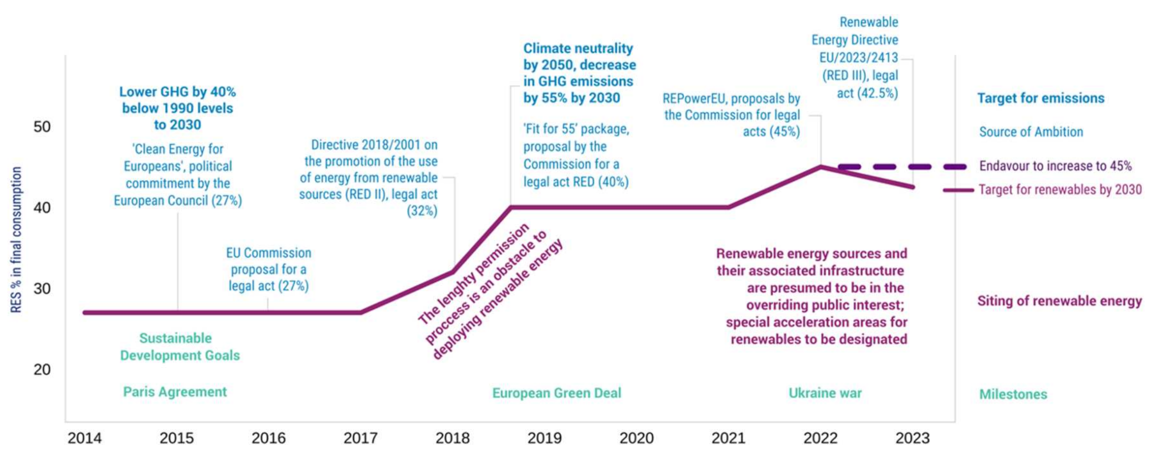

Figure 1. The rising ambition for renewables in the context of climate change targets and geopolitical events, and a reference to the roles of permitting and siting in terms of accomplishing the targets. For references see the text.

when balancing legal interests in individual cases' (Ibid., Art 16f), particularly with regard to the deployment of renewable energy and other policy goals, such as the conservation of habitats, species, and water.

2.2. The planning of renewable energy in societal context

Several obstacles hinder the wider adoption of renewable energy in the EU (ECR, 2023; McKinsey Sustainability, 2023), and these range from regulatory to technical, economic, and societal factors. These factors are largely interrelated and mutually influence each other in our current, complex energy systems, as well as in their aims to transition towards more sustainable and resilient forms (Chipangamate & Nwaila, 2024; Kuzemko et al., 2022). The issue of siting can be framed as an entry point into complex energy systems. The selection of a site is not a single barrier, but is rather an expression of the complex interactions between various economic considerations, regulatory constraints, conflicts with protected areas, public acceptance, and also politics (Taylor, 2023). Ideally, new renewable energy facilities should be built in locations where the potential for electricity generation is greatest, and conflict with other protection regimes is either non-existent or minimised. However, the suitability of specific sites is also dependent on their public acceptance.

Public acceptance is as important as ever in planning for a rapid and extensive transition to renewable energy sources, but it is often neglected in policy discourses. Policy proposals aimed at the expansion of renewable energy avoid factoring in public acceptance or even participation (e.g. COM/2021/557 final), as this is a complex process with an uncertain outcome, which does not necessarily bode well with the urgency of the action. Academic literature on the topic highlights the importance of public participation in renewable energy planning for reasons of equity and successful outcomes. This means that getting approval for siting locations from the public is both the right thing to do (Lonergan et al., 2022) and conducive to avoiding delays or political and legal actions (Levenda et al., 2021). However, the literature has not engaged as extensively with the strategies and tools that can be deployed to foster the effective participation and acceptance of renewable energy in communities while also accomplishing policy ambitions for the expansion of renewables (for a literature review of strategies, see Sander et al., 2024, Section 3.8).

The socio-environmental impacts of the production of electricity from renewable energy can be both positive and negative, and emerge in the manufacturing, installation, operation, and decommissioning of renewable energy facilities. The impacts relate to several areas. First, there are employment opportunities, implications for health and safety, local infrastructure development, and the livelihoods and well-being of communities (Levenda et al., 2021). Second, there is the security of supply, and the broader security of a country or region (Sheikh et al., 2016). Finally, there are a number of environmental impacts, measured across at least 14 criteria spanning over a facility's life cycle (Sokka et al., 2016). While renewables have a positive impact on the reduction of greenhouse gases from fossil fuel extraction, in certain instances they are in conflict with biodiversity conservation (Harjanne & Korhonen, 2019; Jackson, 2011; Rehbein et al., 2020; Saidur et al., 2011). Depending on the source of the renewable energy technology, the key harms to biodiversity are caused through the following: changes in land use; habitat loss, fragmentation, and displacement; and disturbances or injuries to wildlife (Gasparatos et al., 2017; Gorman et al., 2023). There are also issues with regard to noise pollution and visual impairment, which also impact humans (Saidur et al., 2011). However, while often framed in negative terms, the impacts of renewables on biodiversity can also be appropriately designed and managed to be positive, for example, by providing new habitats for various species (Gorman et al., 2023; Smith et al., 2022).

Apart from the socio-environmental impacts that are easier to measure, other considerations also play a role in achieving public acceptance of renewable energy proposals at both the strategic and project level. These span from the timing and effectiveness of involving the public in decision-making (Calero Valdez et al., 2018; Fast, 2013; Fraune & Knodt, 2017; Lonergan et al., 2022; Stadelmann-Steffen & Dermont, 2021; Susskind et al., 2022) to public values, which can relate to ethical, biodiversity, health, economic, and other concerns and interests (Sovacool, 2009; Susskind et al., 2022), but also include the conflicting attitudes and perspectives of individuals towards the construction of renewable energy facilities (Burch et al., 2020). Perceptions of the socio-environmental burdens of renewable energy differ heavily, not only in terms of the kinds of technology but also according to geographic, cultural, and social contexts (Levenda et al., 2021; Liebe et al., 2017). All of this makes the societal acceptance of renewable energy installations far from a straightforward issue, and one where support for it could be better managed.

Multiple considerations are at play within contextually sensitive decisions over whether and where to place a specific renewable energy installation. The tools and strategies which are particularly promising for sustainability planning have been those that foster multi-functionality and integration (Janßen et al., 2019; Pinarbasi et al., 2019), and/or those that allow scenario development and the consideration of various futures (Blythe et al., 2021; Pereira et al., 2019). One such tool is presented in the next section.

2.3. Sensitivity mapping as an integrative decision-support tool for renewable energy planning

Sensitivity mapping, or sensitivity analysis, is an established method for integrated spatial planning which aims at identifying and avoiding spatial competition. Despite having major potential, the use of sensitivity mapping in energy planning has so far been limited. A typical analysis draws on existing geospatial data and geographic information systems, and is often supported by ecological modelling which provides a systematic framework to determine the potential for significant impacts on the environment by projects under consideration (Gasparatos et al., 2017; González Del Campo, 2017). Intended to be used early in the planning process, sensitivity mapping typically improves strategic planning decisions. It allows for an informed decision-making process which is conducive to transparency, robustness, and the acceptance of decisions (Taha Aljburi et al., 2024), and is contingent on the meaningful engagement of stakeholders and relevant publics during the process.

While it is not a requirement for renewable energy planning under the rules within either the Strategic Environmental Assessment (2001) or the amended Environmental Impact Assessment Directive (2014), both of which advocate for strong public participation, sensitivity mapping has recently became a required step for enhancing the deployment of renewable energy in the context of increased deployment targets for renewables (Directive 2023/2413). Member states have been asked to use sensitivity mapping in order to both arrive at designated 'renewables acceleration areas' and avoid collisions between renewable energy planning processes and nature conservation.

Sensitivity mapping has proven its usefulness in the planning of renewable energy, provided that the spatial and environmental data (species, habitats, etc.) is comprehensive and accurate. When this is possible, experience from the planning of wind and solar energy plants shows that extensive natural and geographical flexibility in site selection allows for the avoidance of sites that would likely be in conflict with wildlife (Katzner et al., 2012; Mc Guinnes et al., 2015; Vasilakis et al., 2016; Donald et al., 2019). Nevertheless, where nature protection regimes are extensive, areas with a low impact can also be very limited in scope (WSU, 2023). Under these circumstances, one possible solution is to make use of technological modifications which are tailor-made and based on continuous monitoring, such as using smaller sized windmills that do not operate during potentially high impact periods (Gasparatos et al., 2017).

Sensitivity mapping for renewable energy typically compiles distributional data on sensitive species and habitats, as well as any other relevant factors. It develops a sensitivity scoring system (such as high, low, or no risk), prepares maps, and interprets the relationship between the sensitivity rating and the risk, all while taking into account any data gaps. The more complete the data input, the more complete the results (ibid., pp. 11–12). Thus, the most appropriate development options can be selected if the following criteria are met: all of the different types of renewable energy (solar, wind, hydro, etc.) are considered in the mapping, planning is done on a spatially large scale, and various protected regimes are included. Sensitivity mapping can operate as a dynamic process over a longer period, and can facilitate an evolving energy system transition. With the implementation of projects, the development of technology, the improvement of data, and changes in legislation, the results of sensitivity mapping can change, and will therefore need to be updated.

Once the results of the process are available, a combination of data and maps also offers an important opportunity for the engagement of the general public. Various scenarios can be drawn up for the future energy system and its implications on ecosystem services (Holland et al., 2018). For example, at the national level, this can lead to considering a few larger power plants versus multiple smaller ones. The results of sensitivity mapping can, if employed properly, present tangible opportunities to citizens, investors, and many other

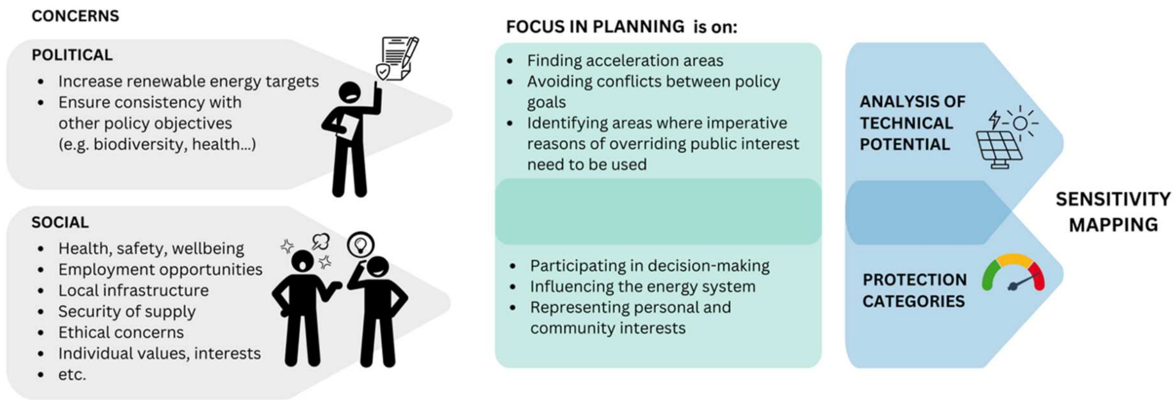

Figure 2. The potential of sensitivity mapping as a decision-support tool for integrating political and societal concerns.

stakeholders, allowing them to understand the implications and trade-offs of certain energy choices, and also to determine any preferred development scenario and design responses to mitigate negative impacts. Reversing the roles in renewable energy planning (i.e. asking where to situate renewables), which is supported by an auctioning system (Grashof, 2019; IFC, 2019), may be an option for finding solutions to non-conflicting (or less conflicting) renewable energy deployment scenarios. Other policies, such as local development or nature restoration, can also help integrate energy planning.

This section maps out the political and societal planning contexts for renewable energy from two perspectives: the challenge of where to situate a facility or infrastructure, and which type of renewable energy to select. Sensitivity mapping has been presented as a decision-support tool that can support both perspectives and, indeed, integrate them for successful renewable energy planning, as depicted in Figure 2.

3. Methods

To understand the potential of sensitivity mapping as a decision-support tool, we use a case study approach: a detailed examination of a specific situation within a real-life context which is particularly practical for research (Starman, 2013). Our objective is to explain the opportunities and limitations which result from the introduction of sensitivity mapping, and we selected Slovenia as an instructive case study. To our knowledge, this country was the first to conduct sensitivity mapping at a national level, making it a pioneering experience and useful for other countries in the immediate future. Moreover, the case presented provides a unique example of sensitivity mapping in terms of both the scale and complexity of the analysis. In the first sense, the sensitivity mapping was done at a national scale, which corresponds to the usual perspective for making energy planning decisions, and it took into account multiple regimes, something which should always be factored into energy planning decisions. In the second sense, the sensitivity mapping involved multiple sensitivity categories as opposed to just one, which took this case beyond the minimal standards for sensitivity mapping provided by EU legislative requirements (see Directive 2023/2413, Arts 15(e)–16(a)).

The analysis draws on data from sensitivity mapping carried out in Slovenia in 2023, as well as its concomitant activities[1] (such as an analysis of legal and implementation barriers, and communication activities for renewables deployment) which took place until June 2024. This was combined with an original analysis of data on national and EU energy production, as well as policy documents (also national and EU) and scholarly literature. We provide evidence of the actual results from the process of sensitivity mapping in Slovenia (a causal inference based on what happened) and integrate this with scholarship outside the case study to identify opportunities for a differential use application of sensitivity mapping. The mapping of the potential of renewable energy sources (RES) for electricity production was done across hydro, wind, and solar energy sources (for solar and hydro above 100 kW, and for wind above 1 MW) (Final Report on mapping, 2023). The

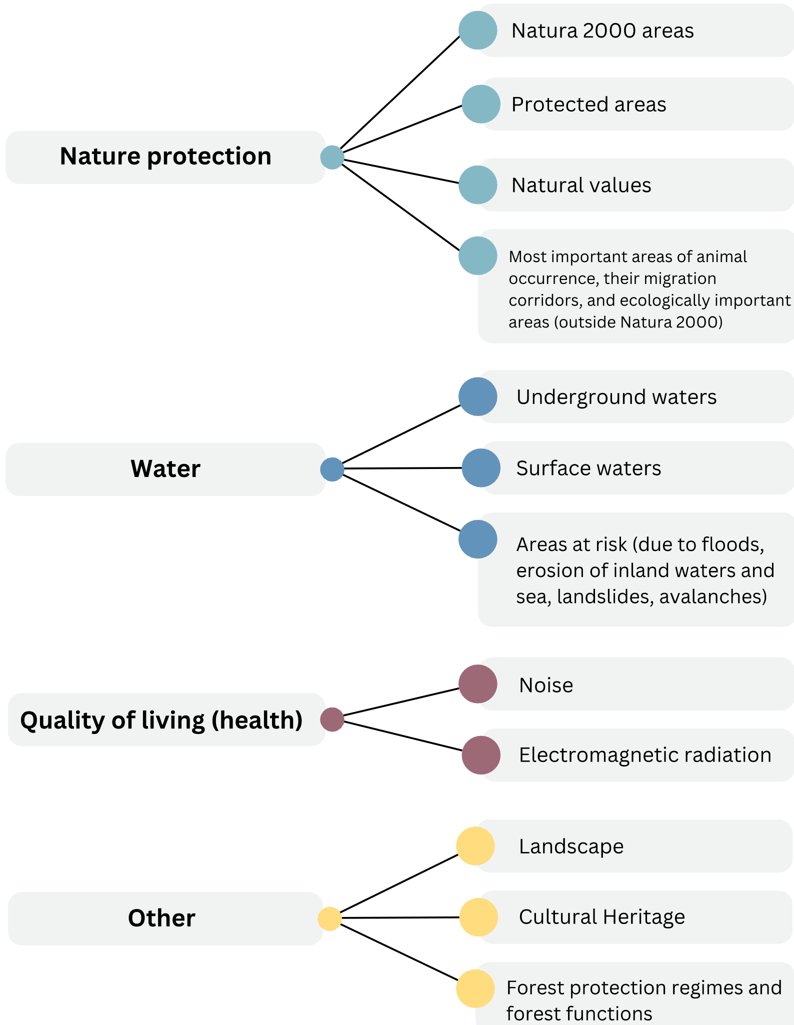

Figure 3. Groups and protection categories covered by the sensitivity analysis. Source: Final Report on mapping, 2023, p. 13.

sensitivity analysis was done for 13 protection categories within four broader groups of protection regimes (Final report on Mapping, 2023, p. 13), as presented in Figure 3. Taken together, the scope of the sensitivity analysis performed in this case goes well beyond any known analyses, which typically focus on the sensitivity of individual species, habitats, or only some renewable energy sources.

4. Case study: how can sensitivity mapping improve planning for renewable energy?

To present the country-wide case study, we first outline a baseline to plan for renewables (4.1.), and then examine how sensitivity mapping contributed to overcoming the identified difficulties (4.2.).

4.1. The difficulties in meeting rising targets for renewables

Slovenia has a long tradition of using renewables for electricity production, relying particularly on hydro-power, which accounts for about third of total electricity production (with nuclear and thermal power accounting for an additional third each). After joining the EU, the country planned to steadily increase its deployment of renewable energy for electricity production, as shown in Graph 1 (Figure 4).

Around the 2010–2011 period, however, while concerns were raised that the expansion of renewable energy, particularly hydropower, could have a significant negative impact on the environment, for the country to achieve its targets it would need to invoke imperative reasons of overriding public interest, meaning that the introduction of renewable energy would also override the goals of nature conservation (NEP draft update, 2011, p. 82). In the years that followed, Slovenia struggled to keep pace with investments in new facilities. This was partly due to the economic crisis and a fall in energy prices, which diminished the economic profitability of renewable energy projects, but also because of failures in realising planned renewable energy projects which either collided with some existing protection categories (nature and water), faced a public backlash, or were stopped by administrative procedures. In 2017, the plans for the 2030 targets proposed a steady increase in hydropower, as well as two scenarios regarding wind and solar: one with an enhanced deployment of wind energy, and the other with an enhanced deployment of solar energy. Plans for hydropower, and especially for large hydropower plants, despite the recognition of a potential conflict with the environment, remained important (ibid., pp. 29–31; Crnčec et al., 2023).

The slow implementation of renewable energy investments, including those in the electricity sector, threatened the achievement of the then upcoming 2020 targets. Indeed, the share of energy from renewables increased by less than one percentage point in the 2010–2019 period. By 2019, the country made the least progress in renewables deployment in the EU since 2005 (Energy Agency, 2021, p. 30). In 2020 the country committed to increasing its share of renewable energy to at least 27% by 2030 (NECP, 2020), which was only an increase of two percentage points compared to the 2020 target (made in 2010), and stood in stark contrast to the Commission's recommendation of increasing the share of renewable energy to at least 37% (European Commission, 2020). Thus, within a decade (2010–2022), Slovenia regressed from a country with a high share of renewable energy to a country with some of the lowest deployments of both solar and wind in the EU.

In justifying its deviation from the more ambitious 2030 target which was requested by the Commission, Slovenia highlighted, among other factors, the fact that almost 38% of its territory was covered by Natura 2000

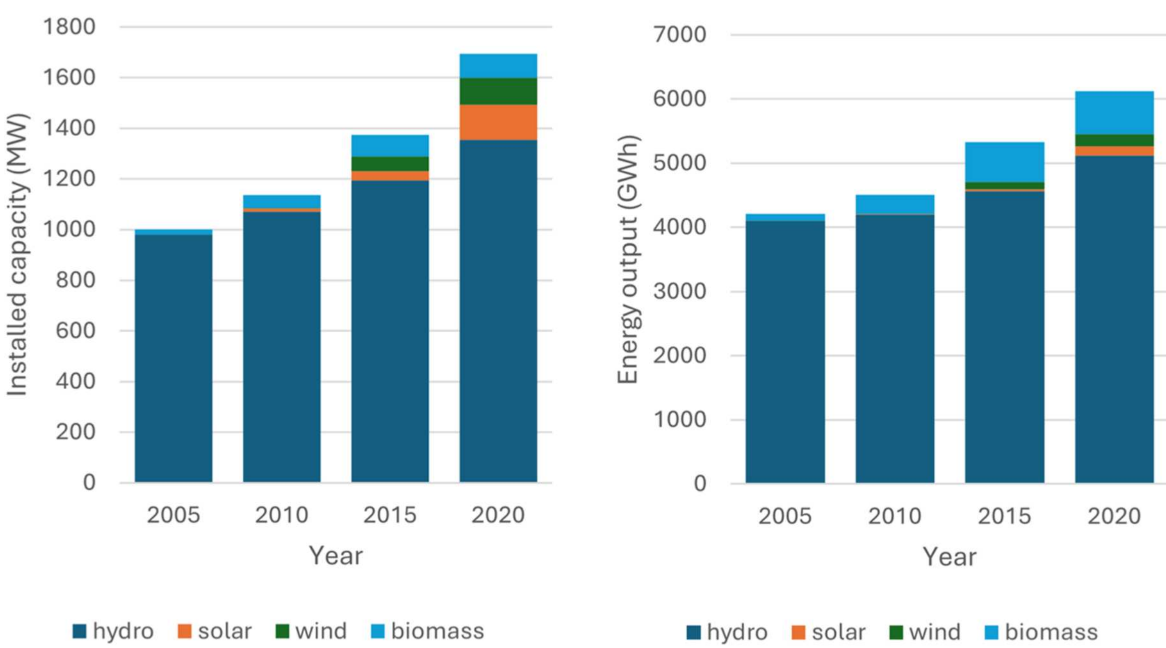

Figure 4. Renewables for electricity generation in Slovenia. Source: our own elaboration based on data extracted from the National Renewable Energy Action Plan 2010–2020, pp. 118–119.

sites, a large part of which were also areas that were very suitable for the deployment of wind and hydropower facilities (NECP, 2020, pp. 48–49). Four large hydropower plants that had been considered for the National Energy and Climate Plan (NECP) (EIMV, ZaVita & Stritih, 2019), had to be omitted from the final version due to the potential for significant negative environmental impacts. The adopted NECP foresaw a rapid deployment of solar energy, while remaining cautious about wind, and significantly downplayed any further deployment of hydropower. To address the risk of a conflict between the deployment of renewable energy and protection regimes, the NECP proposed a more proactive role for the state in terms of identifying and locating acceptable locations for hydropower and wind energy, as well as other renewables (NECP, 2020, p. 86).

Following the increased EU ambition (Fit for 55), EU countries had to increase their national renewable energy contributions to meet the 2030 target (42.5%, with an aspiration of 45%). In its draft for an update of the NECP, submitted in June 2023, Slovenia proposed a target of 30-35%, which was met by the Commission's recommendation of 46% (European Commission, 2024). This proposal demonstrates optimism with respect to the current figures (25% in 2023) (Statistical Office, 2024), but remains significantly below the recommendations of the European Commission.

4.2. Results: the role of sensitivity mapping in the deployment of renewables

Since the NECP (2020) the government has been trying to take a more proactive role in the uptake of renewables through active planning for renewable energy. A concrete step in that direction was the implementation of a project to identify and quantify risks related to the further deployment of renewable energy for electricity generation (Project RES Slovenia) (Inception Report, 2022), and an important part of that was conducting comprehensive sensitivity mapping. The identified risks were scored into grades from 0 to 3 (0-no risk, 1-low risk, 2-high risk, and 3-very high risk of a significant impact on protection categories). The final outcome was the creation of an overlay of various mappings in order to arrive at a detailed and informed basis for decision-making, including the potential designation of special acceleration (or 'go-to') areas for the deployment of renewables at the national level.

The results provided valuable findings regarding the areas with a recognised potential for the production of renewable energy and any corresponding risk to protected categories. Concretely, the analysis revealed that a large share of the areas with the technical potential for renewable energy (especially large hydro and wind facilities) fell into the highest risk category for conflict with existing protection regimes (see Figure 5).

The project concluded that Slovenia has up to 97 TWh/year of production potential from renewable energy sources (RES) from large and mid-size power plants (Final Report on mapping, 2023, p. 17), which is approximately seven times more than the country's total annual consumption of electricity (approximately 14 TWh/year, according to the Energy Agency, 2021, p. 43). It also identified the share of technical potential for renewable energy per energy source (Final report on mapping, 2023), which is summarised in Figure 6.

However, from the overall annual renewable energy technical potential, only 4.3% corresponds to no risk areas, and 1% to low risk areas of significant impact on one (or more) protection categories, with a vast majority of the remaining potential located in areas with high and very high risk of significant impact on one (or more) protection categories (Final Report on mapping, 2023). In no risk areas, only rooftop solar and ground solar have production potential (ibid.). Similarly, in areas of low risk, approximately all of the identified potential is solar. Except for solar energy potential, the vast majority of the identified hydro and wind potential is located in areas of high and very high risk for a significant impact on protection categories. See Figure 7 for the summary.

The study concluded that if the entire no risk production potential of the analysed renewable energy was deployed, the country could increase its share of renewable energy in gross final energy consumption by 7.46 percentage points, i.e. from 21.97% (in 2019) to 29.43%. The deployment of solely no risk potential would thus deliver a higher target compared to the then valid national target (at least 27%), and with the additional deployment of low risk production potential, this could be further increased by approx. 1.73 percentage points, i.e. to 31.16%.

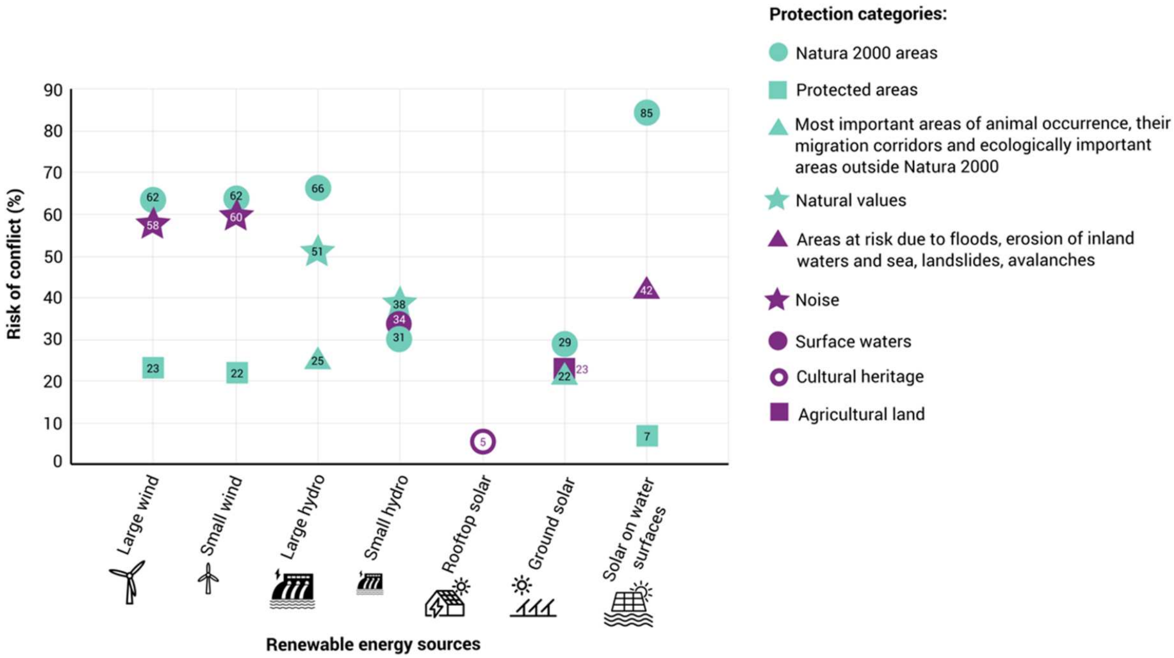

Figure 5. The share of areas with the technical potential for renewable energy which fall into the highest risk category for conflict with existing protection regimes. Note that the values show a share for each category independently, and the risk for a specific source of energy can overlap with multiple categories. Source: prepared based on the Final Report on mapping, 2023, p. 26, Table 14.

This means that the target which Slovenia set for itself in 2020 could be reached within no risk areas; a significant improvement in renewable energy performance can be achieved without the need for interventions in areas of high and very high risk. Nevertheless, the study concluded that Slovenia will not be able to reach the target of climate neutrality by 2050 through the deployment of large RES above 10 MW alone, nor the target of 37%, which was recommended to the country by the commission, unless it makes use of high and very high risk areas (Final Report on mapping, 2023, p. 27–30). It should also be noted that the study has not assessed whether and how the deployment of only some particular technologies (no risk RES) will affect the country's electricity supply security.

Regarding the sensitivity mapping results, to some extent these were only used to engage the public. Prior to the start of sensitivity mapping, the intention was to engage stakeholders in the findings and

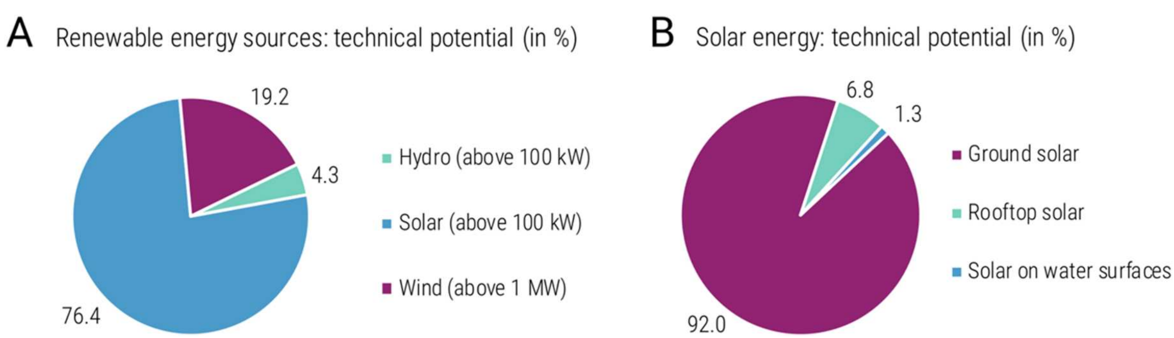

Figure 6. Identified renewable energy technical potential: Total energy potential (a) and the potential of different types of solar energy (b). Source: our own compilation, based on the Final report on Mapping, 2023.

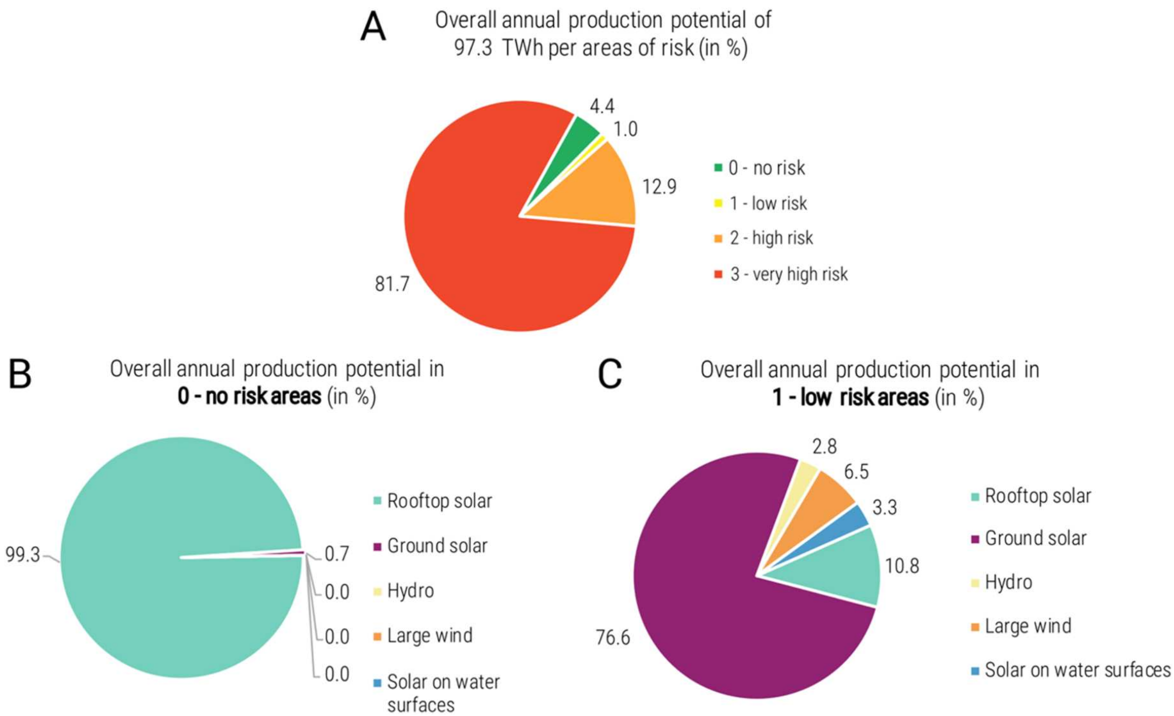

Figure 7. The overall annual production potential per areas of risk (a), the overall annual production potential in 'no risk' areas (b), and the overall annual production potential in 'low risk' areas (c). Source: prepared based on Final Report on mapping, 2023, p. 26.

proposed measures, and link these to key community concerns surrounding renewable energy expansion (Inception Report, 2022, p. 33, 36). However, actual activities during the project included a public poll, a communication strategy with related materials (a set of photo and video material on renewable energy; a website design manual), and capacity building in relevant Ministries, all of which were implemented with the goals of promoting the further deployment of RES, raising awareness on the importance of RES, and minimising the so-called 'not in my backyard' (NIMBY), and 'build absolutely nothing anywhere near anything' (BANANA) effects (Final Progress Report, 2023, p. 14). While the results from the mapping had not been used directly for the engagement of the public until the end of 2024, they were used as an expert bases in the process of drafting an update of the National Energy and Climate Plan (NECP, 2020), which involved the public as well. Furthermore, the high risk of collisions between the intensive deployment of renewable energy and existing protection categories was listed as one of the main nationally relevant circumstances hindering the adoption of a more ambitious national renewable energy target (draft NECP update ver. 4.2, 2024, pp. 62–67). Finally, sensitivity mapping in the future will need to be updated and used to determine renewable energy acceleration areas in the country, a process which should also include the public (The Act on the Deployment of Installations for the Production of Electricity from Renewable Energy Sources). Contrary to the initial approach, which assumed that the expansion of renewable energy was directly linked to public participation in renewable energy planning, the involvement of the public in decision-making which resulted from sensitivity mapping has been much more indirect, as priority was given to informed target setting and the involvement of expert stakeholders.

5. Discussion: the potential of sensitivity mapping for renewable energy planning

In the case which was studied, sensitivity mapping as a decision-support tool demonstrated either direct or potential benefits in the context of advancing renewable energy planning. Based on the case study, we identified specific ways in which this decision-support tool could make a crucial contribution to the process of renewable energy planning through the way it provides novel insights into existing studies.

5.1. Siting renewable energy in areas without conflict and pursuing feasible targets

Sensitivity mapping enables renewable energy planning and expansion without compromising other policy objectives which are protected by existing legislation, and whose significance may also increase (e.g. health, biodiversity, water). This is a significant advance compared to the way renewable energy planning is currently carried out in many countries, including the EU, where targets are set with incomplete evidence regarding their ability to avoid conflict with other protection regimes. This is particularly problematic, as renewable energy targets are often set at the international level, but lead to tensions with their implementation at the local level (Koelman et al., 2022). Rather than using an arbitrary and uniform approach, targets should be set while also considering their potential to be realised without conflict.

The sensitivity mapping performed in Slovenia makes a case for the country to achieve its 2030 renewable energy target in conflict-free areas. The target of at least 27% renewables by 2030 (NECP, 2020) was determined through an expert assessment of the energy potential, but without a comprehensive assessment of the implementation's potential impact on other regimes. The evidence now suggests a higher-than-expected potential in areas which present no risk of conflicts and, in principle, this should be adequate for Slovenia to accomplish its 2030 targets.

The implementation of renewable energy in such areas could help Slovenia break out of the challenging cycle that it has experienced in recent years, where the government set relatively high targets, but often failed to accomplish them in ways that would be acceptable to the public. In some instances of renewable energy projects, the lack of a comprehensive strategic approach to effectively manage climate and energy goals caused civil society to distrust those plans, and created an increased backlash against many renewable energy projects (Huš et al., 2024). This resulted in an increasing deficit of implementation and a loss of internal momentum for renewable energy planning.

With this evidence for the possibility for renewable energy implementation without imposing conflicts on other regimes, Slovenia can start closing the gap between those targets and its results, and the mapping of potential areas for implementation also contributes to establishing viable targets. These do not contradict the ambitious targets, but instead prevent an insistence on using certain conflicting areas, something that can lead to an erosion of trust or a loss of motivation among stakeholders, all of which can hinder rather than advance the intended cause of making advances with respect to renewable energy. Over time, targets can gradually be made stricter (Cattino & Reckien, 2021) and can support an evolving policy on renewables, allowing countries to gradually move in their energy transitions alongside the introduction of other technological developments, such as hydrogen fuels, various means for CO_2 reduction, and other technologies (e.g. Hainsch et al. 2022).

5.2. Supporting targeted policy measures

The results of sensitivity mapping make it possible to more precisely identify policy or regulatory measures that would be the least harmful in terms of existing environmental laws. Such targeted measures may be a better approach than a regulatory change, such as indicating that renewable energy has an 'overriding public interest', something which effectively fragments existing environmental laws and downgrades nature conservation as a policy objective (Durá-Alemañ et al., 2023; Trouwborst, 2023).

In Slovenia, sensitivity mapping has led to the identification of areas with no or low risk that had not been previously recognised, and highlighted regulatory and administrative barriers that impede the implementation of some of these low-conflict solutions. For example, the identification of the relatively important energy potential for photovoltaic (PV) installations coincided with the identification of regulatory barriers to their installation on road land, landfills, agricultural lands, water surfaces, and other areas (Deliverable 4 report 2023). In turn, regulatory adjustments for some of these non-conflict uses have been implemented in the

2023 Act on the Deployment of Installations for the Production of Electricity from Renewable Energy Sources. The Act determined designated areas for PV installations, such as large building roofs, urban parking lots, road and railway areas, electricity production sites, closed landfills, and non-flooded abandoned mines – provided that they comply with spatial regulations. Such interventions which contribute to the deployment of renewable energy without harming other protection regimes are preferable to the deployment of an energy installation in a high-risk area.

5.3. Planning for security of supply and cross border cooperation

Sensitivity mapping does not take into account security supply considerations. In Slovenia, it was found that it would be very difficult for the country to quickly deploy its potential for hydropower and wind energy, so contributions from these technologies to the 2030 targets will not be significant. The focus for pursuing the renewable energy targets is now on solar energy which, however, raises questions regarding security of supply.

In that context, the results of sensitivity mapping at the national and the regional level (e.g. the EU) could also lead to various, less debated policy options, such as transboundary renewable energy planning and exploiting no risk areas, provided that the standards for decisions (the criteria related to protection regimes) are harmonised and justice is ensured. The renewable energy targets may be difficult to accomplish at the same level as certain countries, but may become more manageable at a larger scale. Transnational planning may become a particularly valid option with the rising significance of targets on nature conservation through the EU's Nature Restoration Law (COM (2022) 0304). Countries can pursue regional cooperation and co-investment in renewable energy, or decide to focus on the development of infrastructure at the country level. While this could support security of supply at the level of the EU, it would not do the same at the country level. Solutions in this direction call for a more nuanced engagement with respect to the EU's constitutional values of solidarity, territorial cohesion, internal markets, and sustainable development (Huhta & Reins, 2023; LaBelle, 2024).

5.4. Facilitating participatory decision-making

Participation requires the involvement of different types of publics at different stages. During the development of sensitivity mapping in Slovenia, experts played a key role in identifying non-conflict renewable energy areas. Several provided opinions for spatial planning procedures (various governmental agencies), and investors, NGOs, engineers, and researchers were all instrumental in sharing their data and reviewing the results, all of which ensured a diversity of expertise (Final Progress Report, 2023, p. 5). Involving experts in the early stages is reported to reduce distrust and improve the robustness and acceptance of decisions (Fast, 2013; Lonergan et al., 2022; Susskind et al., 2022). Indeed, the broader consensus among experts that emerged was a welcome development, and it has expanded the circle of participation.

However, in the studied context, sensitivity mapping was not fully exploited for drawing up and openly discussing energy system scenarios. While data from sensitivity mapping is available through a website in a transparent format, the results (maps, interpretations) have not yet fed into societal discussions and public participation in the design of an energy system. This is regrettable because the data can be valuable in gaining stakeholders' trust (Taha Aljburi et al., 2024). However, this requires more than merely making sensitivity mapping results available, or using them as evidence for governmental decisions. A significant improvement in participation could be achieved through scenario development – using data to create diverse scenarios that stakeholders can debate, select, and use as a strategic foundation for planning specific renewable energy projects. This approach could help address both the gap between the widespread and abstract support for renewable energy, as indicated by opinion polls (Eurobarometer, 2023; Mediana and Ernst & Young Svetovanje d.o.o., 2022; Parsifal & Greenpeace, 2023; Sütterlin & Siegrist, 2017), and the lack of concrete follow-through.

A participatory approach requires the role of the public to be understood not only in terms of 'needing awareness raising', or requiring their opinion to be 'steered in the right direction'. Instead, the role of the public lies in their understanding of the rationale for decisions, co-designing them, and assuming co-ownership in the processes of energy transition. This has direct implications for many aspects of existing energy systems, such as the concentration of power and dominance of certain actors, the centralisation of decision-making, and an unequal distribution of costs (Burke & Stephens, 2018; Chmutina & Goodier, 2014). These issues are also directly at play in the energy transition in Slovenia, where these factors have created systemic barriers to change, such as path dependence, system inertia, and institutional lock-in (Tkalec, 2016).

The results of sensitivity mapping have the potential for creating more inclusive decision-making, which would take into account the knowledge of various stakeholders, and the inclusion of the public is an integral part of the energy transition (Burke & Stephens, 2018; Del Bene et al., 2018; Sorman et al., 2020). However, renewable energy projects are not immune to risk and a system's failure (Attia, 2020; Eitan et al., 2023; Komendantova et al., 2012), or exclusion and injustices (Baker, 2019; Knuth et al., 2022; Scoones et al., 2020). Greater participation in decisions at the strategic level, for example, through scenario planning, could help to overcome some of the potential later obstructions (for example, in the form of permission processes) and improve public acceptance of renewable energy projects. Blockages of projects by the public has been problematic in Slovenia, but it is believed to have been a result of frustration over exclusion, and used as a way to arrest automated decision-making (Huš et al., 2024; Tkalec, 2016, p. 118).

6. Conclusion

Countries and regions are engaged in renewable energy planning as part of mitigating climate change. Decision-makers need to accomplish this transition in ways that are forward looking and informed by evidence (Guston, 2014), as well as being integrative and inclusive (Visseren-Hamakers et al., 2021). This study has outlined the role of sensitivity mapping in contributing to such decision-making. Sensitivity mapping, thus far regarded as a technical tool in energy planning, provides a unique opportunity for a structured consideration of policy concerns and the participation of stakeholders into energy planning, all of which enhance the quality, legitimacy, and typically also acceptability of decisions. Analysing the case of a first-mover country in using this decision-support tool offers a learning opportunity for the energy planning of other countries and regions.

To fully harness the potential of sensitivity mapping as a tool for political decision-making and societal engagement, we advocate for its implementation at larger scales (national or regional), which would encompass multiple energy sources and protection categories, and integrate the results into public debates regarding energy planning. The studied case also demonstrated that, at a country-wide level, attaining a high and ambitious renewable energy target before the 2030s might not be possible without encroaching on some protection regimes. Acknowledging the limits of using some spaces can be unpopular, as it highlights the challenges of the non-conflictual expansion of renewable energy, and this underpins the consensus around a clean energy transition. Nevertheless, it is essential to involve the public in recognising these limits and trade-offs, rather than making renewable energy expansion solely a political decision.

Note

1. The sensitivity analysis was conducted as part of the EU's Technical Support Instrument, which aimed to support Slovenia by addressing renewable energy deployment barriers in the electricity sector under the project 'Facilitating renewable energy deployment in the electricity sector of Slovenia' (RES Slovenia).

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References

Ahmadov, A. K., & Van Der Borg, C. (2019). Do natural resources impede renewable energy production in the EU? A mixed-methods analysis. *Energy Policy*, *126*, 361–369. https://doi.org/10.1016/j.enpol.2018.11.044

Attia, B. (2020). Too Big to Succeed? Africa's Clean Energy Mega-Projects. *Energy for Growth Hub* (blog). https://energyforgrowth.org/article/too-big-to-succeed-africas-clean-energy-mega-projects/

Baker, S. H. (2019). Anti-resilience: A roadmap for transformational justice within the energy system. *Harvard Civil Rights-Civil Liberties Law Review*, *54*, 1–48.

Bankwatch network. 2022. Renewables automatically of 'overriding public interest' – A counterproductive attack on eu nature legislation. November 14, 2022.

Blythe, J., Baird, J., Bennett, N., Dale, G., Nash, K. L., Pickering, G., & Wabnitz, C. C. C. (2021). Fostering ocean empathy through future scenarios. *People and Nature*, *3*(6), 1284–1296. https://doi.org/10.1002/pan3.10253

Burch, C., Loraamm, R., & Gliedt, T. (2020). The "Green on Green" conflict in wind energy development: A case study of environmentally conscious individuals in Oklahoma, USA. *Sustainability*, *12*(*19*), 8184. https://doi.org/10.3390/su12198184

Burke, M. J., & Stephens, J. C. (2018). Political power and renewable energy futures: A critical review. *Energy Research & Social Science*, *35*, 78–93. https://doi.org/10.1016/j.erss.2017.10.018

Calero Valdez, A., Kluge, J., & Ziefle, M. (2018). Elitism, trust, opinion leadership and politics in social protests in Germany. *Energy Research & Social Science*, *43*, 132–143. doi:10.1016/j.erss.2018.05.025

Cattino, M., & Reckien, D. (2021). Does public participation lead to more ambitious and transformative local climate change planning?. *Current Opinion in Environmental Sustainability*, *52*, 100–110. https://doi.org/10.1016/j.cosust.2021.08.004

Chipangamate, N. S., & Nwaila, G. T. (2024). Assessment of challenges and strategies for driving energy transitions in emerging markets: A socio-technological systems perspective. *Energy Geoscience*, *5*(2), 100257. https://doi.org/10.1016/j.engeos.2023.100257

Chmutina, K., & Goodier, C. I. (2014). Alternative future energy pathways: Assessment of the potential of innovative decentralised energy systems in the UK. *Energy Policy*, *66*, 62–72. https://doi.org/10.1016/j.enpol.2013.10.080

Collados-Lara, A.-J., Baena-Ruiz, L., Pulido-Velazquez, D., & Pardo-Igúzquiza, E. (2022). Data-driven mapping of hourly wind speed and its potential energy resources: A sensitivity analysis. *Renewable Energy*, *199*, 87–102. https://doi.org/10.1016/j.renene.2022.08.109

Crnčec, D., Penca, J., & Lovec, M. (2023). Proper in speech, careful in acts. In H. Dyrhauge & K. Kurze (Eds.), *Making the European green deal work* (1st ed., pp. 108–124). Routledge.

Del Bene, D., Scheidel, A., & Temper, L. (2018). More dams, more violence? A global analysis on resistances and repression around conflictive dams through co-produced knowledge. *Sustainability Science*, *13*(3), 617–633. https://doi.org/10.1007/s11625-018-0558-1

Donald, P. F., Fishpool, L. D. C, Ajagbe, A., Bennun, L. A., Bunting, G., Burfield, I. J., Butchart, S. H. M, Capellan, S., Crosby, M. J., Dias, M. P., Diaz, D., Evans, M. I., Grimmett, R., Heath, M., Jones, V. R., Lascelles, B. G., Merriman, J. C., O'Brien, M., Ramírez, I., … Wege, D. C. (2019). Important Bird and Biodiversity Areas (IBAs): The development and characteristics of a global inventory of key sites for biodiversity. *Bird Conservation International*, *29*(*2*), 177–198. https://doi.org/10.1017/S0959270918000102

Durá-Alemañ, C. J., Moleón, M., Pérez-García, J. M., Serrano, D., & Sánchez-Zapata, J. A. (2023). Climate change and energy crisis drive an unprecedented EU environmental law regression. *Conservation Letters*, *16*(3), e12958. https://doi.org/10.1111/conl.12958

ECR (Energy Communities Repository). (2023). Exploring the main barriers and action drivers for the uptake of energy communities: Take-aways from our policy workshop. June 5, 2023. https://energy-communities-repository.ec.europa.eu/energy-communities-repository-news-and-events/energy-communities-repository-news/exploring-main-barriers-and-action-drivers-uptake-energy-communities-take-aways-our-policy-workshop-2023-06-05_en

EIMV, ZaVita, & Stritih. (2019). Osnutek okoljskega poročila: Tehnična podpora za celovito presojo vplivov na okolje za Celoviti nacionalni energetski in podnebni načrt Republike Slovenije. Razpis SRSS/C2019/048. https://www.energetika-portal.si/fileadmin/dokumenti/publikacije/nepn/cpvo/op_nepn_osnutek_nov2019.pdf

Eitan, A., Fischhendler, I., & van Marrewijk, A. (2023). Neglecting exit doors: How does regret cost shape the irreversible execution of renewable energy megaprojects? *Environmental Innovation and Societal Transitions*, *46*, 100696. https://doi.org/10.1016/j.eist.2023.100696

Energy Agency. (2021). Agencija za energijo: Poročilo o stanju na pdoročju energetike v Sloveniji. https://www.agen-rs.si/documents/10926/38704/Poro%C4%8Dilo-o-stanju-na-podro%C4%8Dju-energetike-v-Sloveniji-v-letu-2020/6ef6ecb0-4e1c-4ead-83eb-7da6326cd77f

Environmental Impact Assessment Directive. (2014). Directive 2014/52/EU of the European Parliament and of the Council amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment. *Official Journal of the European Union L*, *124*, 1–18.

Eurobarometer. 2023. Standard eurobarometer 99 - Spring 2023. https://europa.eu/eurobarometer/surveys/detail/3052

European Commission. 2019a. Communication from the commission: The European Green Deal. COM/2019/640 final.

European Commission. 2019b. *Europeans' attitudes on EU energy policy*. Publications Office of the European Union. https://data.europa.eu/doi/10.2833500568

European Commission. (2020). *Summary of the Commission assessment of the draft National Energy and Climate Plan 2021-2030*. https://energy.ec.europa.eu/document/download/6d18f1f6-849b-4af0-b85d-b78d5387eb87_en

European Commission. (2024). *Commission Recommendation, Assessment (SWD) and Factsheet of the draft updated National Energy and Climate Plan of Slovenia*. https://commission.europa.eu/publications/commission-recommendation-assessment-swd-and-factsheet-draft-updated-national-energy-and-climate-4_en

Fast, S. (2013). Social acceptance of renewable energy: Trends, concepts, and geographies: Social acceptance of renewable energy. *Geography Compass*, *7*(12), 853–866. https://doi.org/10.1111/gec3.12086

Final progress report. (2023). *Facilitating RES Deployment in Electricity Sector of Slovenia (REFORM/SC2021/091) Final progress report*. https://www.energetikaportal.si/fileadmin/dokumenti/podrocja/energetika/res_slovenia/res_slo_final_report.pdf

Final report on mapping. (2023). *Facilitating Renewable Energy Deployment in Electricity Sector of Slovenia, (REFORM/SC2021/091), Deliverable 2: Mapping of RES potential for electricity production across the entire territory of Slovenia*. https://www.energetikaportal.si/fileadmin/dokumenti/podrocja/energetika/res_slovenia/res_slo_mapping_final_report_eng.docx

Fraune, C., & Knodt, M. (2017). Challenges of citizen participation in infrastructure policy-making in multi-level systems: The case of onshore wind energy expansion in Germany. *European Policy Analysis*, *3*(2), 256–273. https://doi.org/10.1002/epa2.1022

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*, 161–84. https://doi.org/10.1016/j.rser.2016.08.030

González Del Campo, A. (2017). Mapping environmental sensitivity: A systematic online approach to support environmental assessment and planning. *Environmental Impact Assessment Review*, *66*, 86–98. https://doi.org/10.1016/j.eiar.2017.06.010

Gorman, C. E., Torsney, A., Gaughran, A., McKeon, C. M., Farrell, C. A., White, C., Donohue, I., Stout, J. C., & Buckley, Y. M. (2023). Reconciling climate action with the need for biodiversity protection, restoration and rehabilitation. *Science of The Total Environment*, *857*, 159316. https://doi.org/10.1016/j.scitotenv.2022.159316

Grashof, K. (2019). Are auctions likely to deter community wind projects? And would this be problematic? *Energy Policy*, *125*, 20–32. https://doi.org/10.1016/j.enpol.2018.10.010

Guston, D. H. (2014). Understanding 'anticipatory governance'. *Social Studies of Science*, *44*(2), 218–242. https://doi.org/10.1177/0306312713508669

Hainsch, K., Löffler, K., Burandt, T., Auer, H., Crespo del Granado, P., Pisciella, P., & Zwickl-Bernhard, S. (2022). Energy transition scenarios: What policies, societal attitudes, and technology developments will realize the EU Green Deal?. *Energy*, *239*, 122067. https://doi.org/10.1016/j.energy.2021.122067

Hamilton, L. C., Bell, E., Hartter, J., & Salerno, J. D. (2018). A change in the wind? US public views on renewable energy and climate compared. *Energy, Sustainability and Society*, *8*(1), 11. https://doi.org/10.1186/s13705-018-0152-5

Hansen, S. T., & Moe, E. (2022). Renewable energy expansion or the preservation of national energy sovereignty? Norwegian renewable energy policy meets resource nationalism. *Political Geography*, *99*, 102760. https://doi.org/10.1016/j.polgeo.2022.102760

Harjanne, A., & Korhonen, J. M. (2019). Abandoning the concept of renewable energy. *Energy Policy*, *127*, 330–340. https://doi.org/10.1016/j.enpol.2018.12.029

Holland, R. A., Beaumont, N., Hooper, T., Austen, M., Gross, R. J. K., Heptonstall, P. J., Ketsopoulou, I., Winskel, M., Watson, J., & Taylor, G. (2018, July). Incorporating ecosystem services into the design of future energy systems. *Applied Energy*, *222*, 812–822. https://doi.org/10.1016/j.apenergy.2018.04.022

Huhta, K., & Reins, L. (2023). Solidarity in European Union law and its application in the energy sector. *International and Comparative Law Quarterly*, *72*(3), 771–91. https://doi.org/10.1017/S002058932300026X

Huš, K., Kvac, B., Petek, A., & Simoneti, M. (2024). *Premagovanje ovir pri uvajanju vetrne energije v Sloveniji*. https://focus.si/publikacija/premagovanje-ovir-pri-uvajanju-vetrneenergije-v-sloveniji

IFC (International Finance Corporation). (2019). *Local benefit sharing in large-scale wind and solar projects*. https://www.commdev.org/wp-content/uploads/2019/06/IFC-LargeScaleWindSolar_Web.pdf

Inception Report. (2022). *Facilitating Renewable Energy Deployment in Electricity Sector of Slovenia, (REFORM/SC2021/091), Inception Report (final version)*. https://www.energetikaportal.si/fileadmin/dokumenti/podrocja/energetika/res_slovenia/res_slo_inception_report.pdf

IPCC. (2022). Climate change 2022: Impacts, adaptation and vulnerability. In H.-O. Pörtner, D. C. Roberts, M. Tignor E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama (Eds.), *Contribution of working group ii to the sixth assessment report of the intergovernmental panel on climate change*. Cambridge University Press. https://doi.org/10.1017/9781009325844

IRENA (International Renewable Energy Agency). (2019). *Global energy transformation: A roadmap to 2050*. International Renewable Energy Agency.

Jackson, A. L. R. (2011). Renewable energy vs. biodiversity: Policy conflicts and the future of nature conservation. *Global Environmental Change*, *21*(4), 1195–1208. https://doi.org/10.1016/j.gloenvcha.2011.07.001

Janßen, H., Göke, C., & Luttmann, A. (2019). Knowledge integration in marine spatial planning: A practitioners' view on decision support tools with special focus on Marxan. *Ocean & Coastal Management*, *168*, 130–138. https://doi.org/10.1016/j.ocecoaman.2018.11.006

Kamlage, J. H., Uhlig, J., Rogall, M., & Warode, J. (2024). Shaping energy landscapes: Public participation and conflict resolution in wind power, grid expansion, and biogas transformation fields. In K. Berr, L. Koegst, & O. Kühne (Eds.), *Landscape conflicts. RaumFragen: Stadt – Region – Landschaft*. Springer VS. https://doi.org/10.1007/978-3-658-43352-9_16

Katzner, T. E., Brandes, D., Miller, T., Lanzone, M., Maisonneuve, C., Tremblay, J. A., Mulvihill, R., Merovich, G. T., & Thompson, D. (2012). Topography drives migratory flight altitude of golden eagles: implications for on-shore wind energy development. *Journal of Applied Ecology*, *49*(5), 1178–1186. https://doi.org/10.1111/j.1365-2664.2012.02185.x

Knuth, S., Behrsin, I., Levenda, A., & McCarthy, J. (2022). New political ecologies of renewable energy. *Environment and Planning E: Nature and Space*, *5*(3), 997–1013. https://doi.org/10.1177/25148486221108164

Koelman, M., Hartmann, T., & Spit, T. J. M. (2022). When tensions become conflicts: Wind turbine policy implementation and development in the Netherlands. *Journal of Environmental Planning and Management*, *65*(3), 375–397. https://doi.org/10.1080/09640568.2021.1885018

Komendantova, N., Patt, A., Barras, L., & Battaglini, A. (2012). Perception of risks in renewable energy projects: The case of concentrated solar power in North Africa. *Energy Policy*, *40*, 103–109. https://doi.org/10.1016/j.enpol.2009.12.008

Kuzemko, C., Blondeel, M., Dupont, C., & Brisbois, M. C. (2022). Russia's war on Ukraine, European energy policy responses & implications for sustainable transformations. *Energy Research & Social Science*, *93*, 102842. https://doi.org/10.1016/j.erss.2022.102842

LaBelle, M. C. (2024). Breaking the era of energy interdependence in Europe: A multidimensional reframing of energy security, sovereignty, and solidarity. *Energy Strategy Reviews*, *52*, 101314. https://doi.org/10.1016/j.esr.2024.101314

Lelieveldt, H., & Schram, W. (2023). Where are the citizens? Unravelling the lopsided nature of stakeholder participation in the Dutch regional energy transition*. *Energy Research & Social Science*, *96*, 102925. https://doi.org/10.1016/j.erss.2022.102925

Levenda, A. M., Behrsin, I., & Disano, F. (2021). Renewable energy for whom? A global systematic review of the environmental justice implications of renewable energy technologies. *Energy Research & Social Science*, *71*, 101837. https://doi.org/10.1016/j.erss.2020.101837

Liebe, U., Bartczak, A., & Meyerhoff, J. (2017). A turbine is not only a turbine: The role of social context and fairness characteristics for the local acceptance of wind power. *Energy Policy*, *107*, 300–308. https://doi.org/10.1016/j.enpol.2017.04.043

Lonergan, K., Gabrielli, P., & Sansavini, G. (2022). *Energy justice analysis of the European Commission REPowerEU plan*. ETH Zurich. https://doi.org/10.3929/ethz-b-000551952

Mc Guinness, S., Muldoon, C., Tierney, N., Cummins, S., Murray, A., Egan, S, & Crowe, O. (2015). *Bird sensitivity mapping for wind energy developments and associated infrastructure in the Republic of Ireland*. BirdWatch Ireland.

McKinsey Sustainability. (2023). Five Key Action Areas to Put Europe's Energy Transition on a More Orderly Path. 2023, August. https://www.mckinsey.com/capabilities/sustainability/our-insights/five-key-action-areas-to-put-europes-energy-transition-on-a-more-orderly-path

Mediana, and Ernst & Young svetovanje d. o. o. (2022). Odnos Javnosti Do Obnovljivih Virov Energije: Poročilo Raziskave s Kvantitativnim Pristopom. https://www.energetika-portal.si/fileadmin/dokumenti/podrocja/energetika/res_slovenia/res_slo_communication_strategy_public_pooling_results.pdf

Mišík, M. (2022). The EU needs to improve its external energy security. *Energy Policy*, *165*, 112930.

Morkūnė, R., Marčiukaitis, M., Jurkin, V., Gecevičius, G., Morkūnas, J., Raudonikis, L., Markevičius, A., Narščius, A., & Gasiūnaitė, Z. R. (2020). Wind energy development and wildlife conservation in Lithuania: A mapping tool for conflict assessment. *PLoS One*, *15*(1), e0227735. https://doi.org/10.1371/journal.pone.0227735

Nadizadeh Shorabeh, S., Argany, M., Rabiei, J., Firozjaei, H. K., & Nematollahi, O. (2021). Potential assessment of multi-renewable energy farms establishment using spatial multi-criteria decision analysis: A case study and mapping in Iran. *Journal of Cleaner Production*, *295*, 126318. https://doi.org/10.1016/j.jclepro.2021.126318

NECP. (2020). *Integrated National Energy and Climate Plan of the Republic of Slovenia*. https://energy.ec.europa.eu/system/files/2020-06/si_final_necp_main_en_0.pdf

NEP Draft update. (2011). Osnutek predloga Nacionalnega energetskega programa Republike Slovenije za obdobje do leta 2030: »aktivno ravnanje z energijo«. 10.6.2011. https://www.energetikaportal.si/fileadmin/dokumenti/publikacije/nep/nep_2030_jun_2011.pdf

Osman, A. I., Chen, L., Yang, M., Msigwa, G., Farghali, M., Fawzy, S., Rooney, D. W., & Yap, P.-S. (2023). Cost, environmental impact, and resilience of renewable energy under a changing climate: A review. *Environmental Chemistry Letters*, *21*(2), 741–764. https://doi.org/10.1007/s10311-022-01532-8

Parsifal, S. C., & Greenpeace (2023). *Poročilo o Raziskavi: Raziskava Javnega Mnenja o Odnosu Državljanov Do Različnih Virov Energije in Postavitvi Vetrnih Parkov*. https://www.greenpeace.org/static/planet4-slovenia-stateless/2023/12/28742c0d-za-splet-porocilo-raziskave_gp-si-2023-dodatek.pdf

Pereira, L., Sitas, N., Ravera, F., Jimenez-Aceituno, A., & Merrie, A.. (2019). Building capacities for transformative change towards sustainability: Imagination in intergovernmental science-policy scenario processes. *Elementa: Science of the Anthropocene*, *7*, 35. https://doi.org/10.1525/elementa.374

Pinarbasi, K., Galparsoro, I., Depellegrin, D., Bald, J., Pérez-Morán, G., & Borja, Á.. (2019). A modelling approach for offshore wind farm feasibility with respect to ecosystem-based marine spatial planning. *Science of the Total Environment*, *667*, 306–317. https://doi.org/10.1016/j.scitotenv.2019.02.268

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

Saidur, R., Rahim, N. A., Islam, M. R., & Solangi, K. H. (2011). Environmental impact of wind energy. *Renewable and Sustainable Energy Reviews*, *15*(5), 2423–2430. https://doi.org/10.1016/j.rser.2011.02.024

Sander, L., Jung, C., & Schindler, D. (2024). Global review on environmental impacts of onshore wind energy in the field of tension between human societies and natural systems. *Energies*, *17*(13), 3098. https://doi.org/10.3390/en17133098

Sayed, E. T., Wilberforce, T., Elsaid, K., Rabaia, M. K. H., Abdelkareem, M. A., Chae, K.-J., & Olabi, A. G. (2021). A critical review on environmental impacts of renewable energy systems and mitigation strategies: Wind, hydro, biomass and geothermal. *Science of The Total Environment*, *766*, 144505. https://doi.org/10.1016/j.scitotenv.2020.144505

Scoones, I., Stirling, A., Abrol, D., Atela, J., Charli-Joseph, L., Eakin, H., Ely, A., Olsson, P., Pereira, L., Priya, R., van Zwanenberg, P., & Yang, L. (2020). Transformations to sustainability: Combining structural, systemic and enabling approaches. *Current Opinion in Environmental Sustainability*, *42*, 65–75. https://doi.org/10.1016/j.cosust.2019.12.004

Serrano, D., Margalida, A., Pérez-García, J. M., Juste, J., Traba, J., Valera, F., Carrete, M., Aihartza, J., Real, J., Mañosa, S., Flaquer, C., Garin, I., Morales, M. B., Tomás Alcalde, J., Arroyo, B., Sánchez-Zapata, J. A., Blanco, G., Negro, J. J., Tella, J. L., … Donázar, J. A. (2020). Renewables in Spain threaten biodiversity. *Science*, *370*(6522), 1282–1283. https://doi.org/10.1126/science.abf6509

Sheikh, N. J., Kocaoglu, D. F., & Lutzenhiser, L. (2016). Social and political impacts of renewable energy: Literature review. *Technological Forecasting and Social Change*, *108*, 102–110. https://doi.org/10.1016/j.techfore.2016.04.022

Smith, P., Arneth, A., Barnes, D. K. A., Ichii, K., Marquet, P. A., Popp, A., Pörtner, H.-O., Rogers, A. D., Scholes, R. J., Strassburg, B., Wu, J., & Ngo, H. (2022). How do we best synergize climate mitigation actions to co-benefit biodiversity? *Global Change Biology*, *28*(8), 2555–2577. https://doi.org/10.1111/gcb.16056

Sokka, L., Sinkko, T., Holma, A., Manninen, K., Manninen, K., Sokka, L., Sinkko, T., & Pasanen, K. (2016). Environmental impacts of the national renewable energy targets – A case study from Finland. *Renewable and Sustainable Energy Reviews*, *59*, 1599–1610. https://doi.org/10.1016/j.rser.2015.12.005

Sorman, A. H., Turhan, E., & Rosas-Casals, M. (2020). Democratizing energy, energizing democracy: Central dimensions surfacing in the debate. *Frontiers in Energy Research*, *8*, 499888. https://doi.org/10.3389/fenrg.2020.499888

Sovacool, B. (2009). Exploring and contextualizing public opposition to renewable electricity in the United States. *Sustainability*, *1*(3), 702–21. https://doi.org/10.3390/su1030702

Stadelmann-Steffen, I., & Dermont, C. (2021). Acceptance through Inclusion? Political and economic participation and the acceptance of local renewable energy projects in Switzerland. *Energy Research & Social Science*, *71*, 101818. https://doi.org/10.1016/j.erss.2020.101818

Starman, A. B. (2013). The case study as a type of qualitative research. *Journal of Contemporary Education Studies*, *64*(1), 130.

Statistical office of the Republic of Slovenia. (2024, November 5). *Renewable energy in the final consumption of energy*. https://www.stat.si/StatWeb/news/Index/13208

Strategic Environmental Assessment Directive. (2001). Directive 2001/42/EC of the European Parliament and of the Council on the assessment of the effects of certain plans and programmes on the environment. *Official Journal L*, *197*, 30–37.

Strunz, S., Lehmann, P., & Gawel, E. (2021). Analyzing the ambitions of renewable energy policy in the EU and its member states. *Energy Policy*, *156*, 112447. https://doi.org/10.1016/j.enpol.2021.112447

Suboticki, I., Heidenreich, S., Ryghaug, M., & Skjølsvold, T. (2023). Fostering justice through engagement: A literature review of public engagement in energy transitions. *Energy Research & Social Science*, *99*, 103053. https://doi.org/10.1016/j.erss.2023.103053

Susskind, L., Chun, J., Gant, A., Hodgkins, C., Cohen, J., & Lohmar, S. (2022). Sources of opposition to renewable energy projects in the United States. *Energy Policy*, *165*, 112922. https://doi.org/10.1016/j.enpol.2022.112922

Sütterlin, B., & Siegrist, M. (2017). Public acceptance of renewable energy technologies from an abstract versus concrete perspective and the positive imagery of solar power. *Energy Policy*, *106*, 356–366. https://doi.org/10.1016/j.enpol.2017.03.061

Taha Aljburi, M., Albahri, A. S., Albahri, O. S., Alamoodi, A. H., Mohammed, S. M., Deveci, M., & Tomášková, H. (2024). Exploring decision-making techniques for evaluation and benchmarking of energy system integration frameworks for achieving a sustainable energy future. *Energy Strategy Reviews*, *51*, 101251. https://doi.org/10.1016/j.esr.2023.101251

Taylor, M. E. (2023). Peril and promise: The challenge of siting renewable energy. *Texas Journal of Oil Gas & Energy Law*, *18*, 42–60.

Tkalec, T. (2016). *Politološki aspekti decentralizacije proizvodnje električne energije: doktorska disertacija* [PhD thesis]. University of Ljubljana, Faculty of Social Sciences. http://dk.fdv.uni-lj.si/doktorska_dela/pdfs/dr_tkalec-tomislav.pdf

Trouwborst, A. (2023). Waking up bats, hazing wolves and draining snake lakes – Exploring the EU habitats directive's prohibition of 'deliberate disturbance'. *Journal for European Environmental and Planning Law*, *20*(3–4), 217–235. https://doi.org/10.1163/18760104-20030003

Vasilakis, D. P., Whitfield, D. P., Schindler, S., Poirazidis, K. S., & Kati, V. (2016). Reconciling endangered species conservation with wind farm development: Cinereous vultures (Aegypius monachus) in south-eastern Europe. *Biological Conservation*, *196*, 10–17. https://doi.org/10.1016/j.biocon.2016.01.014

Visseren-Hamakers, I. J., Razzaque, J., McElwee, P., Turnhout, E., Kelemen, E., Rusch, G. M., Fernández-Llamazares, Á., Chan, I., Lim, M., Islar, M., Gautam, A. P., Williams, M., Mungatana, E., Karim, M. S., Muradian, R., Gerber, L. R., Lui, G., Liu, J., Spangenberg, J. H., & Zaleski, D. (2021). Transformative governance of biodiversity: Insights for sustainable development. *Current Opinion in Environmental Sustainability*, *53*, 20–28. https://doi.org/10.1016/j.cosust.2021.06.002

WindEurope. (2022). Overriding public interest' is essential to the expansion of renewables. October 14, 2022. https://windeurope.org/newsroom/news/overriding-public-interest-is-essential-to-the-expansion-of-renewables/

WSU (Washington State University). (2023). Report to the Washington State legislature: Least-conflict solar siting on the columbia plateau. https://www.energy.wsu.edu/RenewableEnergy/LeastConflictSolarSiting.aspx

WWF. (2022). 'Go to areas' for renewables: Making the puzzle fit. WWF position on the legislative proposal to amend the renewable energy directive as part of 'REPowerEU'.