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Governing the Green Energy Transition through Transformative and Collaborative Planning – the Case of Burgenland's Regional Concepts for Energy Development

Raffael Koscher, Gernot Stöglehner, Alexandra Jiricka-Pürrer

(DI Raffael Koscher, BOKU University, Institute of Spatial Planning, Environmental Planning and Land Rearrangement, Peter-Jordan-Straße 82, 1190 Vienna, raffael.koscher@boku.ac.at)
(Univ.Prof. Priv.Doz. DI Dr. Gernot Stöglehner, BOKU University, Institute of Spatial Planning, Environmental Planning and Land Rearrangement, Peter-Jordan-Straße 82, 1190 Vienna, gernot.stoeglehner@boku.ac.at)
(Assoc.Prof. Priv.Doz. DI Dr. Alexandra Jiricka-Pürrer, BOKU University, Institute of Spatial Planning, Environmental Planning and Land Rearrangement, Peter-Jordan-Straße 82, 1190 Vienna, alexandra.jiricka@boku.ac.at)

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1 ABSTRACT

The transition to climate neutrality, which attempts to accelerate renewable energy generation, requires trade-offs due to the diverse demands on land use. As a consequence, early consideration of potential conflicts and transparency on the selection of type and location of energy generation, storage and distribution is key. Due to our poly-crises, we urgently need to reflect not only the necessity to orientate towards climate-neutrality but also the need to promote species and biodiversity conservation at the same time. Particularly, relevant aspects for biodiversity such as the connectivity can only be sufficiently treated at supra-local planning levels, while other indicators deserve a detailed consideration at local level (tiering).

The relevance to consider trade-offs and alternatives based on sufficient data and information by stakeholders becomes particularly evident at the regional level. The Austrian federal state Burgenland is often listed as a role model for energy transition at regional level and excellence in balancing trade-offs at earlier planning stages. Before starting with the first wind turbines in 1997, the regional self-supply share for electricity was at 1,5 %. Only 16 years later, in 2013 there was more electricity generated than used on an annual basis, evolving to up to 239 % in 2024. For 2030, the goal is to generate more clean energy (including energy for heat and mobility) than is used on an annual basis. This transition process is guided by a constantly evolving planning approach starting in 2002 which is strongly based on integrating diverse perspectives from multiple actors involved in planning.

This paper aims to describe the formal and informal involvement of stakeholders together with the planning approach as well implications for the consideration of biodiversity and landscape aspects. As a preliminary study, it examines the extent to which the planning approach affects the quality of the basis for decision-making and conflict minimisation with focus on biodiversity and landscape. In this context we investigated whether this iterative and collaborative planning approach with direct interlinking of SEA with zoning planning leads to a more comprehensive consideration of decision-relevant data bases and also to greater acceptance of local decision makers and citizens. Based on case study research and document analysis, the paper highlights achievements of this planning approach and outlines points for improvement. Our investigations serve as a pre-study for the Biodiversa+ project BIOGAIN, which deals with transformation towards biodiversity net-gain in strategic spatial planning for renewable energy development through a strongly transdisciplinary research approach and investigating the role of novel AI supported data collection and analysis in diverse planning contexts.

Keywords: Collaborative Planning, Green Energy Transition, Biodiversity Net Gain, Regional Governance, Urban Planning

2 INTRODUCTION

To tackle the challenges of decarbonisation and – as an important part of it – the transformation of the energy system is one of the most challenging tasks we face at present. Challenges refer to conflicting objectives regarding land uses leading to implications on e.g. biodiversity, human health, recreation or food security. The role of spatial planning is amongst others to provide land for energy generation facilities like wind park and PV installations and balancing trade-offs at the same time. The few experiences and fast technical development of wind turbines and PV-systems make this task challenging with the need to create a 'learning process' that can improve over time. Particulary, interrelationships between diverse types of renewable energy developments and consequences for biodiversity are still underresearched.

With experience in strategic planning for renewable energy systems since 2002, Burgenland is Austria's pioneer state in this field of spatial planning. It was the first federal state in Austria, where wind power development took place at large scale and where spatial effects were addressed in a systematic way. Due to its rapid growth and expected land use related conflicts, the development of the energy sector became a spatial planning issue.

In Burgenland the energy transition claims a huge amount of space (3.000 ha zones for PV, 9.500 ha zones for wind parks), which is not directly comparable to any other spatial planning tasks with a comparable demand of land before. Impacts on biodiversity have become particularly relevant with regard to connectivity, particullarly when energy production meets linear infrastructure such as railway or highway infrastructure. Sandfort et al. (2025) demonstrated that renewable energy developments affect established animal corridors as they provide the reliable distance from settlements. This is particularly relevant as suitable spaces are challenging to find in case of extensive renewable energy expansion. Both the installation of power plants as well as the mitigation and compensation of negative impacts has required intensive amounts of land. In order to coordinate this, site selection processes and facilitate them with the appropriate data a large number of actors has been involved. Consequently, knowledge transfer and acceptance became crucial elements of the planning processes.

Considering the multiple pressures on land and the decline of biodiversity at the same time, a knowledge-based decision-making based on sound biodiversity data as well as learning from monitoring processes becomes key (Diaz et al., 2019). Net-gain policies, introduced by the EU legislation, will even more require a coordinated, strategic planning approach based on usable data and well-organized data sharing processes. Particuluarly then when we target biodiversity net-gain planning, the transparency between the rational ground for decision making and the value-tradeoffs becomes essential.

Based on the analysis of the strategic spatial planning process for renewable energy development in Burgenland so far, this paper reflects the formal and especially the informal involvement of diverse groups of actors in the integrated planning approach with SEA in light of their contribution to biodiversity data sharing as well as knowledge transfer. Against the background of planning theories – the collaborative planning approach (Healey, 1997) and the rational-collaborative planning model (Stoeglehner, 2010) – we discuss the implications of the integration of actors and their role and knowledge contribution.

Core research questions are i) which actors are involved throughout the strategic spatial planning process for renewable energy development in Burgenland so far and ii) how far their involvement influences the data sharing and knowledge transfer in the field of biodiversity and landscape. Finally, we want to discuss as a preliminary study, how far the experiences from Burgenland can provide a basis for learning in a transformative planning approach which focuses not only on compensation but also on the advancement of biodiversity in light of a net-gain planning approach.

Based on case study research including observations of one author and reflexive dialogue with the other authors, combined with document analysis, the paper highlights achievements of the planning approach taken in Burgenland and outlines relevant needs for improvement. Finally, we discuss entry points for additional data deriving from novel sources such as AI supported automated data collection. Our investigations serve as a pre-study for the EU-Biodiversa project BIOGAIN, which deals with transformation towards biodiversity net-gain in integrated spatial and energy planning through a strongly transdisciplinary research approach and investigating the role of novel AI supported data collection and analysis in diverse planning contexts.

3 BACKGROUND – THEORETICAL CONCEPTS OF PLANNING APPROACHES IN LIGHT OF GREEN ENERGY TRANSITION

Integrated spatial and energy planning has been a highly dynamic planning field with different approaches in all Austrian federal states. To discuss the contribution of formal and informal involvement of different groups of actors we introduce two theoretical planning concepts:

Dating back to the nineties of the previous century Healey (1997) explored planning as a collaborative governance process. According to her approach, planning should be organized as an inclusive, deliberative process that enables collective action across public agencies, private actors, and civil society. In this context, several authors discussed therewith how planning can be reframed away from top-down technocratic control

towards communicative, dialogic practice grounded in public reasoning (Gunton and Day, 2003; Linnenluecke et al., 2017).

The concept after Healey (1997) includes the following key points:

- Communicative rationality: legitimacy and quality of decisions depend on open, inclusive discourse and reason-giving among stakeholders
- Institutional capacity: comprising knowledge resources, relational resources (trust, networks), and mobilization capacity
- Place and path dependency: effective planning engages local narratives and path dependencies to co-produce context-sensitive strategies.
- Strategy-making as iterative: Emphasis on iterative, reflexive 'strategy making' rather than fixed master plans, with experimentation, feedback, and learning.
- Power and inclusion: Process design must recognize power asymmetries and broaden inclusion so marginalized groups can influence outcomes.
- Governance focus: Planning is embedded in multi-actor governance networks; the task is to create arenas and interfaces for negotiation and coordination across sectors.

Several authors discussed the collaborative planning approach over the past three decades and developed it further in different thematic fields and planning contexts (e.g., Van Dijk, 2021 or Conzales and Connell, 2022). Already fifteen years ago, Stoeglehner (2010) introduced the rational-collaborative planning model, which combined the rational (facts, analysis) "level of facts" and collaborative (values, participation) strengths "level of value" as two essential components of planning. This approach outlines the importance of a sound information basis, and transparent aggregation rules to link values and facts (Stoeglehner, 2010).

More recent publications such as Jiricka-Pürrer and Stöglehner (2025) discuss the relevance and challenges of recognizing trade-offs with a focus on strategic planning contexts like integrated spatial and energy planning. In this context, the importance of a sound information basis as well as the risk of unperceived biases related to trade-offs becomes even more evident. Applying a rational–collaborative planning paradigm targets to increase transparency on values, and foster traceable aggregation rules for judging environmental significance.

In the field of impact assessment, a variety of scholars such as Cashmore and Richardson (2013) or Hansen et al. (2013) dealt with power relationships related to collaboration and actors' involvement. Partidario et al. (2023) elaborated further the discussion how decision-makers connect values and facts, influenced by power relation and actor constellations in an environmental assessment.

4 METHODOLOGICAL APPROACH

Our approach focuses on case study research (Yin, 2018), combining observations of one author with document analysis and reflective discurse with the co-authors against the background of planning theory. In the following we explain first our methodological approach for this preliminary study and then summarize the case study area's development in strategic spatial planning for renewable energy development.

4.1 Case study research

Due to his longterm experience in strategic spatial planning for renewable energy development, the first author had the ability to reflect from its personal experience and participation, the development of strategic spatial planning for renewable energy development over more than a decade. His involvement comprised the regional framework concepts as well as detailled examination for wind energy zones as expert reports from 2011 to 2021 as well as the following planning and assessment processes for the ordinance on wind energy zones with its amendments including the respective SEAs. For solar power development he contributed to both the generel guidelines for ground-mounted PV systems including the drafting of the criteria-set for planning and assessment of the zones. Furthermore he was involved in the planning and assessment processes for the ordinance on solar energy zones with its amendments including the respective SEAs.

With his background in spatial planning and a professional experience in environmental assessments, he contributed to the analysis of data sharing related to the procedural involvement of different groups of actors.

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Advances of strategic spatial planning for renewable energy development through careful site selection under the consideration of diverse needs and land use demands, is part of his PhD.

In this study his research focuses on the integration of biodiversity data. Due to his past responsibilities in developing environmental reports for the zoning planning in Burgenland for both wind and solar energy, he has the ability to not only reflect the documented outcome (see also 4.2) but also the procedural data collection processes as well as the involvement of different groups of actors.

The last author served as an independent counterpart for reflection with an extensive experience in environmental assessment both from research and practice in other fields of EA, providing structured feedback for the analysis of the planning process in order to question the related stakeholder involvement against the conceptional literature background of power dynamics and decision making in environmental assessments. Both developed this contribution – together with input from the third author – in an iterative, discursive process against the literature background on planning theory as well as literature on power dynamics related to stakeholder involvement.

4.2 Literature-supported analysis of planning documents

As a basis for discussion, the planning documents on strategic spatial planning for energy development in Burgenland have been taken into account.

For wind energy, zoning there are seven regional framework concept dating from 2002 to 2020 with 35 detailed examinations on municipal level, all conducted as expert report. Since the setting of a legal basis in 2022, there is an ordinance with currently 2 amendments and the corresponding environmental reports:

- Festlegung von Windkraft-Eignungszonen 2022. Integrierter Umweltbericht und Erläuterungsbericht. 2022
- Änderung der Verordnung, mit der Windkraft-Eignungszonen festgelegt werden. Integrierter Umweltbericht und Erläuterungsbericht. 2023
- Änderung der Verordnung, mit der Windkraft-Eignungszonen festgelegt werden. Integrierter Umweltbericht und Erläuterungsbericht. 2023
- For solar-PV zoning, there is an ordinance with currently four amendments in power and one in public consultation. The corresponding environmental reports were analyzed for this study:
- Verordnung mit der Eignungszonen für die Errichtung von Photovoltaik-Freiflächenanlagen im Burgenland festgelegt werden. Integrierter Umweltbericht und Erläuterungsbericht. 2021
- Verordnung mit der Eignungszonen für die Errichtung von Photovoltaik-Freiflächenanlagen im Burgenland festgelegt werden. Integrierter Umweltbericht und Erläuterungsbericht. 2022
- Änderung der Verordnung, mit der Eignungszonen für die Errichtung von Photovoltaik-Freiflächenanlagen im Burgenland festgelegt werden. Integrierter Umweltbericht und Erläuterungsbericht. 2023
- Änderung der Verordnung, mit der Eignungszonen für PV-Freiflächenanlagen festgelegt werden. Integrierter Umweltbericht und Erläuterungsbericht. 2023
- Änderung der Verordnung, mit der Eignungszonen für PV-Freiflächenanlagen festgelegt werden. Integrierter Umweltbericht und Erläuterungsbericht. 2024
- Änderung der Verordnung, mit der Eignungszonen für PV-Freiflächenanlagen festgelegt werden. Integrierter Umweltbericht und Erläuterungsbericht. 2026

Additionally, all the insights out of action research and scanning of the planning documents were double-checked with the corresponding entries in the Austrian Spatial Planning Reports (ÖROK, 2005; ÖROK, 2008; ÖROK, 2012; ÖROK, 2015; ÖROK, 2018; ÖROK, 2021; ÖROK 2024).

4.3 Description of the case study area – evolution of regional concepts for energy development in Burgenland

Historically, the federal state of Burgenland was the only region in Austria without any substantial generation of electricity. Until 1997 the share of regional self-supply was constantly below 2 %

(STATISTIK AUSTRIA, 2025a), whereas even the Austrian capital Vienna, which is a federal state on his own, accounts 75 % in average from 1988-2024 (STATISTIK AUSTRIA, 2025b). It is therefore not surprising that the provincial government seized the opportunity to take advantage of the technical and economic development of wind power together with the exceptionally good wind potential in the sparsley populated areas of Northern Burgenland and promoted the first-time-possible generation of electricity in a larger scale within state's borders. Soon after the construction of the first turbines, it became clear, that the dynamic development of wind power needs to be managed on a strategic level (ÖROK, 2005).

4.3.1 Wind power development

In 2002, the first regional framework concept for wind power development ('Regionales Rahmenkonzept für das Nördliche Burgenland') was elaborated. This concept presented general strategies and evaluation criteria as a basis for further approval processes of future wind parks. Furthermore, the area of 13 municipalities was investigated and six suitability zones as well as exclusion zones were designated. (ÖIR, 2002). Soon after the first concept, in 2004 a spatial extension to another nine municipalities was added (Regionales Rahmenkonzept für Windenergieanlagen Im Mittelburgenland und um Eisenstadt, 2004), resulting in then zones for 190 wind turbines (ÖROK, 2005). Both of them had the status of an expert report, without legally binding effect, but served as a technical decision basis in the approval processes (ÖROK, 2008). Since then, a number of revisions and extensions were elaborated.

A major revision and extension of the regional framework concepts for wind power development was elaborated in 2010 (ÖIR, 2010a; ÖROK, 2012). Not only, the evaluation criteria was adjusted to technical wind turbine development, but also a voluntary strategic environmental assessment was carried out, taking into account the cumulative effects of the planned development and serving as a basis of information for the neighbouring countries Hungary and Slovakia (ÖIR, 2010b). Reflecting one decade of strategic regional framework concepts for wind power development, two insights became clear: i) an assessment of individual turbines needs the broader regional context to be considered, and ii) for a comprehensive assessent of such a major intervention as wind parks, a sound regional basis involving all specialist departments and experts is necessary (ÖROK, 2012). In 2015, the first strategic concept for repowering of wind parks was elaborated, regulating the renewal of old wind turbines (ÖIR, 2015).

From 2002 until 2022, a total area of approximately 8.000 ha was designated as suitability zones for wind power, of which appr. 7.500 ha are to be counted as used. All of them based on the status of an expert report without legally binding effect. It took until 2022 until legal regulation of wind power development in the federal state of Burgenland was passed (Burgenländisches Erneuerbaren-Beschleunigungsgesetz - Bgld. EbBG, LGBl. Nr. 42/2022). Since then, suitability zones as well es exclusion zones for wind power development are continuously assessed in a legally binding process.

As of February 2026, 9 zones with a total amount of appr. 1.500 ha is designated by ordinance, all of which either already have wind turbines installed or are at least in the approval process. Additionally, appr. 8.000 ha of zones based on expert reports still host 415 wind turbines.

4.3.2 Large scale PV development

In the light of strong development pressure regarding ground-mounted PV-installations in the early 2010s, the federal state of Burgenland elaborated a general guideline for PV in 2013, called 'Photovoltaikanlagen auf Freiflächen. Rahmenrichtlinien für das Burgenland' (ÖIR, 2013). The aim of this guideline was to coordinate the spatial requirements of the PV expansion – especially with nature conservation – and thus raise the acceptance of installing ground-mounted PV-systems (ÖROK, 2015). Nevertheless, due to legal and economic development – subsidies for ground-mounted PV had been cancelled and feed-in tariffs had fallen sharply – the expected development did not take place.

In 2020, the guidelines have been evaluated and updated in line with current energy and climate targets and technical innovations. The 'Rahmenrichtlinie Photovoltaikanlagen auf Freiflächen für das Burgenland 2020' (ÖIR, 2020) provided a framework for the process and assessment criteria for zoning, planning, and construction of ground-mounted PV-systems and served as a basis for administrative proceedings in land-use planning and plant approval (ÖROK, 2021).

Based on the guidelines as a technical basis, an amendment of the provincial spatial planning act (Bgld. RPG 2019), announced as Burgenländisches Erneuerbaren-Beschleunigungsgesetz – Bgld. EbBG, LGBl. Nr.

42/2022, set a legally binding basis for further zoning for ground-mounted PV on provincial level. Since then, a number of changes and refinements were set in the spatial planning act. For instance, special rules were elaborated for the direct supply of public infrastructure or industrial facilities, and for large.scale zones, there is no administrative procedure for changes in land-use plan needed on municipal level. Furthermore, since the amendment LGBl.Nr. 107/2024, the regulation also applies to thermal-solar facilities. As of February 2026, 80 zones with a total amount of appr. 3.000 ha is designated by ordinance, of which 2.600 ha are to be counted as used. Currently (February 2026), the fifth expansion of the ordinance is published as a draft bill for consultation and appraisal.

5 IN-DEPTH ANALYIS OF THE PLANNING APPROACH IN BURGENLAND

5.1 Status-quo of the planning and assessment process and analysis of actors involved

Strategic spatial planning for renewable energy development has a long history in Burgenland as sketched in section 4.1. From first informal concepts (ÖIR, 2002) to legally binding zones, the process has undergone a lot of changes, be it in its formal status, its spatial scope or the depth of planning. But still, some key principles remained the same from the beginning.

The process of defining criteria for assessment, examining only certain areas of interest instead of the whole federal state, setting mitigation measures and formulating recommendations for zoning always included relatively broad stakeholder involvement, an extensive discussion and negotiation process, the use of replicable assessment criteria and case-by-case determination of mitigation measures for each zone.

As the whole process started out of a recognized pressure and need, but without a solution already present, a lot of stakeholders from different sides were involved from the beginning.

Although the state's planning department has ever since been the owner of the process, the state environmental attorney turned out as a key player in the whole communication and negotiation process. The major challenge was to coordinate the different requirements and needs from different groups of stakeholders, thus a continuous and trustful communication with the state's nature conservation department as well as with NGOs in the field of nature conservation (like BirdLife or WWF) was crucial.

The political goal for the whole process always has been to foster renewable energy development while keeping acceptance of citizens very high. For rising local support, the municipalities in which the examination zones were located have been involved via their mayors and administrative bodies invited to planning workshops.

The developers of wind energy projects and their respective planners also have been involved in an early stage of the zoning process. What seems odd at first sight had the goal to bring in the technical perspective and also some understanding of the economic feasibility of this new kind of large-scale energy projects.

Another important principle has been, that not the whole federal state is the planning scope, but only certain parts of it, with specific interest of realizing projects. Thus, a more detailed planning procedure was possible and also the learnings could be implemented more easily in following processes.

Over the years, the process was evolving and became more and more standardized. After 20 years of strategic spatial planning for renewable energy development, finally in 2022 the legal basis was set for compulsory zoning as a prerequisite for further implementation of wind energy and ground-mounted PV-installations (Burgenländisches Erneuerbaren-Beschleunigungsgesetz – Bgld. EbBG, LGBl. Nr. 42/2022). This marked a big caesura in the development of the planning process, which which led to the current design, which is based on the following nine principles (own compilation based on ÖIR, 2025).

- The federal state's energy strategy is the basis for the whole process
- Planning is limited to specified examination zones with specific project interest
- Involvement of experts (nature conservation, legal processes, water management, cultural heritage, etc.) from administration as well as NGOs
- Early involvement of municipalities, consensus with municipalities
- Coordination of mitigation measures during zoning process with experts, municipalities and project developers

- Interconnection of zonal planning and Strategic Environmental Assessment: Consideration for protected goods already while determination of mitigation measures
- Workshops with municipalities (political and/or administrative representatives) to present and discuss zoning plans
- Zoning plans and environmental report available for public with opportunity to express their opinion before coming into force
- Determination of zoning via ordinance by the federal state (legal requirement for plant approval)

In the zoning process for the use of renewable energy, four phases can be identified: The starting phase to set the scope of the process and identify the examination zones. The planning phase for the detailed examination of all the zones including the coordination and negotiation with all relevant stakeholders. The legislative phase containing the finalisation of the environmental report, the public consultation as well as the required legal processes for the ordinance to come into force. The implementation phase, where the energy plant is approved and constructed with implementation of mitigation measures and monitoring of effects and impacts.

For a better understanding of which actors are involved to what extent in which phase, the following illustration (Fig. 1) gives an overview over the phases and stakeholder involved.

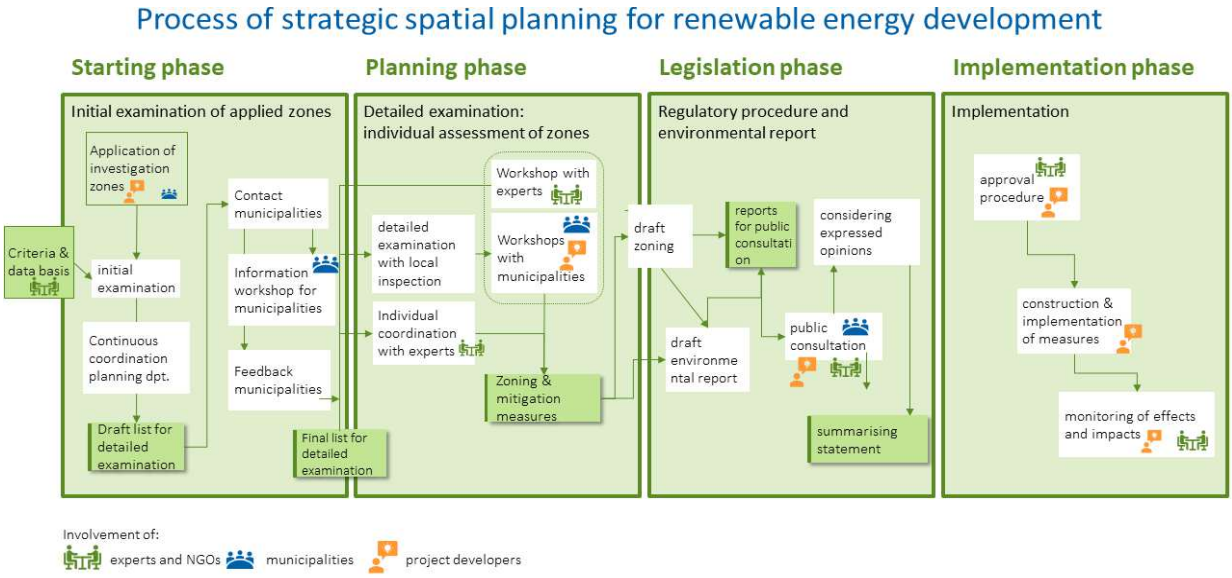

Fig. 1: Phases of the planning process and stakeholder involvement (own illustration based on ÖIR, 2025).

5.2 Reflection in light of the rational-collaborative planning model

According to the rational-collaborative planning model, there are three key aspects which have to be addressed: the 'level of facts', which stands for a well-established information base, the 'level of values' which represents a clear and agreed value system, and transparent rules about how to aggregate these two levels (Stoeglehner, 2010). In the following we reflect on the formal and particularly the informal integration of stakeholders of different groups of actors involved in the strategic spatial planning process for renewable energy development in Burgenland and implications for the consideration of biodivesity and landscape protection goals.

Against this background, two aspects will be reflected on in detail: data sharing and knowledge transfer as a contribution to the 'level of facts' as well as the systematic and transparent management of trade-offs related to conflicting interests in terms of laying the ground to the 'level of values'.

5.2.1 Analysis of data sharing and knowledge transfer in the processes with focus on biodiversity and species as well as their habitats (planning and accompanying SEA)

When coming to data, the zoning process faced two major challenges: First, and this was a special challenge in the early days, it was the fundamental question on what effects and impacts can occur when implementing large-scale renewable energy projects, and thus what data is needed for assessments of environmental

impacts. Especially in the beginning, technology was new and developing very fast. Consequently, the list of relevant data and assessment criteria was elaborated step by step.

The second challenge referred to the existence and availability of data linked to these likely impacts. For the known possible effects and impacts, very little data existed ready-to-use, that could have been provided by provincial administration. For example, no state-wide biotope mapping existed. Thus, mutual learning together with institutional and stakeholder-related information, which stakeholders brought in during the process, was even more important in order to enable a corresponding factual and technical data basis. The process design with its broad involvement of stakeholders and different actors was very helpful for this. Thereby, it turned out, that not only the presence in the process is sufficient, but mutual trust is and belief in the process is crucial, otherwise there is a risk, that informal data is not provided. Transparent communication at the beginning of each zoning process and a mutual understanding of each actor's role and contribution possibilities created this confidence in the process.

Although the department of nature conservation in Burgenland had little comprehensive data on biodiversity-related topics, the individual experts have contributed a wealth of personal knowledge and experience on certain sites and special habitats that they contributed to the expert workshops. Sharing of such existing but rather general data often resulted in first assumptions which proved to be useful for further detailed non-site investigation by the planning team and cumulated to the 'zoning data base'. Examples are historical breeding sites or rarely used wildlife corridors.

BirdLife Austria, an NGO working in the field of bird protection, has been involved from the very beginning of the first development concepts, and the planning process can draw on an existing and continuously maintained database of bird observations. In addition, specific studies are being carried out as part of the zoning investigation, in which the existing data is being reviewed and supplemented. In northern Burgenland, where there is a very good existing database, high-quality results regarding birds and their habitats can thus be achieved very quickly. In central Burgenland, this broad database is lacking, meaning that the investigation process is much more complex and the results are nevertheless not as comprehensive as in the north, with many years of records. The results of the specific studies are fed back into the BirdLife-database. While different levels of citizens science and NGO data became evident across the planning scope, birds are overall still very well researched and monitored in contrast to other avian animals where less data derives from public sources and citizen science. While bird protection proved to be very important in the responsible designation of suitable areas for wind farms right from the start, it took 15 years for bat protection to be considered equally important. Bats are now the second most important species group to be included in the detailed studies.

Another important source of information were the workshops with the mayors of the respective municipalities. They knew their area best and had the opportunity to contribute their perceptions and experiences. Although most of them have not been experts in the field of biodiversity or nature conservation, they knew the history of the places and often provided important clues on specific habitats, which fostered transdisciplinary knowledge transfer that helped to put the right focus on the detailed investigations.

By involving project developers at an early stage of zoning planning and establishing good relations with them, helped to view and consider their research data e.g., deriving from monitoring of earlier energy projects or which they collect during preliminary studies for detailed plant planning and submission for approval. Although often being very detailed. nevertheless, it was crucial to check the developers' data for reliability and validity.

To sum up, the situation and handling of data in the zoning planning process in Burgenland has been highly heterogenous: General comprehensive mapping of habitats and biotopes was initially missing and planners profited strongly from informal expert knowledge queried during the workshops. Yet. a systematic structure to collect and process this information was missing. Data on bird protection was – at least for some parts of the federal state – existing in a comprehensive database maintained by the NGO BirdLife. This information was used as a baseline. As the planning and environmental assessments investigated further data during the planning process, a loop existed when this data was fed back into the database. For bats, no comparable database or continuous monitoring has existed. In this case the planning process benefited even more from, informal networks during the collaborative and iterative planning process. Data on connectivity like wildlife corridors was initially spread across different provincial and federal agencies and therefore sometimes

difficult to access. Thus, data management and sharing became as relevant as the data collection itself. Based on previous experience in the zoning process, first attempts have been made to continuously build up a database containing this information.

5.2.2 Systematic and transparent management of trade-offs

Strategic spatial planning for renewable energy development has from its beginning faced two, partly controversal objectives. On the one hand the generation of renewable energy as a contribution to achieving climate change migitation goals has been in the public interest. At the same time, Burgenland needed to safeguard nature conservation interests, which are particularly relevant due to highly valuable bird habitats like in the national park Neusiedlersee and European legal requirements linked to the habitat and bird directives across the country. Thus keeping a balance beteween all the differing, often competing claims on the use of space has been an intrinsic challenge throughout the planning process.

In order to minimize conflicts and trade-offs in zoning planning, the impact asssessment experts and planners therefore needed to select carefully the criteria needed based on the known impact chains at the planning time/stage and the available data. While the rational basis was set according to the data and its rational interpretation, the weihging of thecriteria was part of the collaborative negotiation process.

While there existed legally binding standards in some thematic fields, such as the prohibition of killing in species protection or the prohibition of deterioration in Natura 2000 habitats, stakeholders could discuss acceptable trade-offs for other topics such as the landscape appearance or the impairment of the landscape's recreational function only during the planning process. In these context the importance of the rational basis became even more evident.

Because the perception of changes to the landscape is an important factor in the acceptance of wind farms and utility-scale PV-installations (Schauppenlehner et al., 2024), particular attention has been paid to their assessment from the outset. It has proven important to make the necessary information available to the stakeholders involved in a transparent and comprehensible manner, and to design and communicate the assessment schemes in a comprehensible way. In the early stages of wind zoning, the visual impact of wind turbines was determined using dominance analyses (ÖIR, 2010). This is a method in which the proportion of the vertical field of vision occupied by the structures is used as a measure of their dominance. Only, by comparing the ratios of different wind park scenarios, the evaluation could be made understandable for all involved stakeholders.

With the onset of a certain habituation effect on wind power and the technical advancement of wind turbines, this method with its rigid measurements took a back seat and was replaced by qualitative evaluation of 3D visualizations (ÖIR, 2025). This also takes into account the significant development of rotor diameters, as it is now possible to consider not only the absolute height but also the appearance of the entire rotor. By presenting different scenarios and an expert assessment by the planning team, workshop participants (both experts and municipality representatives) could experience and discuss the different appearances. This has proven to be particularly valuable in repowering processes.

For particularly sensitive cases, such as the potential impact on the World Heritage Site Fertö – Neusiedler See, additional independent expertise was sought from BOKU university, which created a 4D-model of the study area in a landscape lab and enabled workshop participants to immerse themselves even more deeply in the modeled scenarios using VR glasses (Bittner et al., 2024). This gave even non-experts a good approximation of a changed landscape and, based on this, enabled them to weigh up the pros and cons.

By far the most frequently mentioned trade-off with PV systems is the large-scale restriction of agricultural usability of the land taken. This issue has been addressed via the conflict criterion 'use of high-quality agricultural land' and corresponding mitigation measures as the restriction to Agri-PV-systems. To gain municipalities' acceptance, it proved crucial to show the possibilities of combined land-use in the planning workshops with the municipality and convince stakeholders about its effectiveness. As agriculture and food sovereignity are important topics, there have been several cases, where municipalities first opposed against a PV-zone but where convicted as they got to know about the possibility of mandatory Agri-PV.

Zones for ground-mounted PV systems occupy large areas and therefore have the potential to cut off important migration corridors for wild animals. This kind of potential conflicts was especially difficult to assess, as the reactions, especially avoidance behaviour, were hard to predict without prior experiences with

installations at this large scale. As a first mitigation measure to reduce fragmentation, most of the zones for solar energy use only allow construction without fences. But still, discussions in workshops and with additional experts did not lead to a clear consent on how large the necessary distances should be. As a consequence, discussed examination zones nearby the internationally significant Alps-Carpathians Corridor have been deferred, and for corridors with minor significance, assumed distances have been set with the requirement of monitoring in order to gain important insights for future zones.

These examples show that knowledge about the impacts and also about the effectiveness of mitigation measures is not only essential in order to anticipate trade-offs or negative impacts, but also for a transparent, collaborative process that can be conducted on an equal footing in order to lead to a consensual value judgement of all involved stakeholders. This is where the data bases outlined in section 5.1.1 in combination with transparent assessment criteria and a proven set of mitigation measures proofed to be essential. For this reason, information workshops were held with municipalities. However, the focus of these workshops was on the process and opportunities for municipal participation, rather than on impacts in general. Often questions came up in the forefront about financial benefits for municipalities for hosting suitability zones or about opportunities for renewable energy communities.

6 DISCUSSION

The process for strategic spatial planning for renewable energy development in Burgenland has undergone many changes since its start almost 25 years ago. Starting with an idea but no specific experience and a high level of uncertainty in the field of biodiversity and landscape a broad stakeholder involvement was one of the first steps, mainly to gather information about the different needs and concerns. This was necessary, as there was no approved criteria set and comprehensive data base for assessment, which would be the precondition for a rational planning process based on objective facts (Stoeglehner, 2010).

Although, the composition of the involved stakeholders has changed over time, and knowledge on impacts and data related to renewable energy development went from individual contributors to the common process, it is still a strong element in the whole process, which not only safeguarded the consideration of different perspectives, but also has served as a strong source for information and data. The process in Burgenland shows that institutional capacity building has been able to develop shared knowledge like pointed out by Healey (1997) and foster confidence in collaboration and relationships. Our research confirmes studies such as Hansen et al. (2013) on the value of informal communication between actors at the micro-power dynamics level in the decision-making process related to the environmental assesssment. Moreover it showcases the organizational arrangements which have allowed mutual learning as in the case of the animal data reintegrated into public data bases.

One of the main characteristics of the zoning process in Burgenland was the timing of an early involvement of different kinds of stakeholders, in order to address general concerns and either resolve them or cancel planning in this area. Similar as pointed out by Partidario and Sheate (2013) multidirectional knowledge transfers among stakeholders at an early time increased the effectiveness of planning and integrated SEA. An important puzzle piece was the transparent communication at the beginning of each zoning process, so that all invited actors knew their possibilites to contribute to the process.

Planning and environmental assessments were set up as a set of incremental and iteraritve processes, concentrated on certain scopes (assessment areas) with specific project interests rather than the whole federal state. This approach triggered activity by stakeholders as the chance of implementation in the near future has been much higher than in case of a general planning concept for the whole federal state and sparked their interest in participation Furthermore, this approach provided the opportunity to deepen the planning into a more detailed level and implement learnings in the following zoning reviews.

The possbility for the municpalities to be involved, to opt out at the beginning of the process and to contribute in developing mitigation measures, together with a recognizable added value for the municipalities, led to highly accepted proecess with hardly any objections or citizens' inititives against individual projects and with wind power as part of the identity of northern Burgenland.

Nevertheless, some of the key concepts of the collaborative planning approach were missing or seem to be only partly implemented, compared to the theoretical framework. Although there is a broad stakeholder involvement, citizens were directly involved only in the legislation phase by having the possibility to express

their opinion during the public consultation. Any earlier involvement of the public has been subject to decision of the municpalities representatives Furthermore, the rather informally agreed process of participation involved the risk, that not all relevant stakeholders were involved or some got marginalized.

Overall, a rational-collaborative planning paradigm has been applied with institutionalized formats to exchange information and produce new data as a basis for planning and assessment. With regard to the rational-collaborative planning model (Stoeglehner, 2010) we see the following interesting aspects in the case of Burgenland's integrated spatial and energy planning processes become evident: The SEA was considered a meaningful and integrated part of the whole process due to its integrated nature which led to streangthening the 'level of facts' in combination with the involvment of stakeholders. No discussions which questioned the necessity of an SEA arised. The environmental objectives and respective mitigation measures could be developed and discussed throughout the planning process to meet examination criteria and to optimize the zones.

In terms of planning alternatives, via the integration of assessment in planning, the iterative process of planning and SEA targeted the development of most environmentally friendly alternatives. The planning process, however, did not allow room to consider system alternatives, as the focused zoning model did not question the clear planning task it pursued.

The incremental and iterative approach of assessing only certain zones with specific project interest thus bears the possibility, that the overarching goal of the zoning process could fade into the background. Moreover, in addition to all the advantages, the close integration of planning and assessment carries the risk of diluting the objectives of the SEA, namely minimzing impacts on biodiversity and landscape considering the whole territory. In this context, again the stakeholder involvement provided a 'corrective' in several circumstances. In the case of Burgenland the power dynamics (Partzsch, 2016) allowed actors, such as the nature conservation department of the federal government, to reiterate the importance of protected species and their habitats.

Finally, for the SEA applied at this scope, the question remained how far species that are currently less endangered will be considered with regard to interelationships between different types of energy generation (in the future). Approaching these questions, however, would prerequisite a diverse governance structure with new planning instruments.

7 CONCLUSIONS

Rational–collaborative approaches that integrate environmental objectives early and require environmentally friendly benchmark alternatives can raise environmental standards in planning. In our study we surveyed the informal integration of stakeholders in light of a rational-collaborative planning approach. Strategic spatial planning for renewable energy development in Burgenland was particularly interesting as it involves strategic long-term development with extensive demand of land with a high potential for conflicts. At the same time energy planning in Burgenland started more than two decades ago with a level of high uncertainty and little existing data particularly in the field of biodiversity and landscape.

Our contribution discussed the strategic spatial planning approach for renewable energy development in Burgenland with regard to the 'level of facts' and the 'level of values' as specified by the rational-collaborative planning model. The examples provided in the field of biodiversity and landscape illustrate the relevance of multi-face stakeholder involvement, which has contributed to both levels and allowed partly even learning of time. It points out advantages of the focus on clearly defined planning scopes but outlines at the same time its limitations.

Taking into account the implementation rate and the perceived acceptance in public, the process for strategic spatial planning for renewable energy development in Burgenland can be accounted successful so far. The informal involvement of different groups of actors lead to improvements in the field of biodiversity and landscape as illustrated in this article. Future research within the Biodiversa+ project BIOGAIN will continue to analyse the perception of these contributions to the planning process by the diverse actors themselves as well as limitations and expectations for improvement including the new abilities to foster data collection and analysis by support of artificial intelligence.

Above all, the reflection on the 'Burgenland model' can provide inspiration but cannot be applied 1:1 to other regions in Austria or internationally. Too different are the prerequisites, on the hand in terms of spatial

conditions and energy potential, but even more in terms of institutional capacities and planning traditions. This connects to challenges of case study research observed in other contexts, when testing of the first outcomes is recommended in other contexts (Yin, 2018). The transferability analysis in combination with additional empirical data collection will be part of the ongoing research in the Biodiversa+ project to identify levers for transformation towards biodiversity net-gain. Thorough analysis of data flows and prerequesits for biodiversity-net gain in combination with governance in strategic spatial planning of renewable energy development will continue this preliminary study presented herewith.

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