

Linking Renewable Energy Projects at Municipal Level with NECP Planning and Reporting

Supporting the Transformation Process

Susanne Geissler¹, Abraham Arevalo-Arizaga¹, Daniel Youssef², Hartmut Dumke²,
and Elias Grinzinger²

¹ SERA Institute for Sustainable Energy and Resources Availability, Austria

² TU Wien, Institute of Spatial Planning, Austria

*Correspondence: Susanne Geissler, s.geissler@sera.global

Abstract. Regarding the National Energy and Climate Plan (NECP) according to EU Governance Regulation, there is a disconnect between the federal and municipal levels that hinders effective planning and reporting, especially in the area of renewable energy sources (RES) where availability depends on the regional spatial conditions. The project transFORMAT-LINK addresses this challenge based on case studies and stakeholder discussions. Main results are (1) the LINK-Guideline for municipal development concepts/plans to support RES project implementation and NECP planning and reporting; (2) the LINK-Software prototype for developing and monitoring municipal development concepts/plans according to LINK-Guideline. This contribution presents an overview of preliminary results, with a focus on minimum requirements for municipal development concepts/plans under the regional spatial planning laws and how they will facilitate the implementation of renewable energy projects.

Keywords: Renewable Energy, Spatial Planning, Municipality Development

1. Introduction

The European Climate Law [1] sets ambitious targets for the reduction of greenhouse gas emissions and thus emphasises the essential role of renewable energy. With the importance of renewable energy sources for achieving energy and climate targets the fact that their availability is spatially dependent, and the associated challenges posed by the division of tasks within Austria are coming to the fore. The usability of renewable energy sources depends on the area and is therefore subject to spatial planning, which is regulated at provincial and municipal level, while planning and reporting with regard to the use of renewable energy and the reduction of greenhouse gas emissions is carried out at federal level by means of the NECP. Looking at the Austrian NECP 2019 [2], spatial planning was mentioned as a very important instrument, but no specific measures in terms of facilitating renewable energy projects were described. In reality, potential renewable energy projects can fail for various reasons such as the resistance from the population or, more generally, due to specific local conditions [3]. The key question is therefore how to improve the existing situation with a view to creating a favourable framework for renewable energy projects at the municipal level, while at the same time establishing a better link between the federal NECP plan and local spatial planning policies, in particular with the aim of enabling realistic planning on the basis of which meaningful reporting can take place.

This question is addressed by the project transFORMAT-LINK which is presented in this contribution according to the following structure: chapter 2 provides more detail on the legal framework conditions, chapter 3 gives an overview of the project set-up including objectives, methods, and envisaged results, chapter 4 presents the main results in more detail, chapter 5 takes a closer look at the aspect of minimum requirements for municipal development concepts, and chapter 6 concludes this paper.

2. Legal framework at EU, federal, state and municipal level

The NECP is a strategic document based on the EU Governance Regulation [4] outlining how each EU member state intends to contribute to the EU's overall energy and climate targets. Austria, like all EU member states, is required to develop its NECP in alignment with EU regulations and directives. This means that Austrian spatial planning legislation must also be consistent with the objectives and strategies outlined in its NECP. For example, if the NECP sets ambitious targets for renewable energy deployment or energy efficiency improvements, Austrian spatial planning legislation may need to prioritize land use or zoning policies that facilitate the development of renewable energy infrastructure or energy-efficient buildings. From a bottom-up perspective, spatial planning can inform the NECP about the realisable potential for renewable energies. However, there is currently the problem of a missing link between the legal matters, as shown in Figure 1 in the form of an overview and explained in more detail in the following sub-chapters.

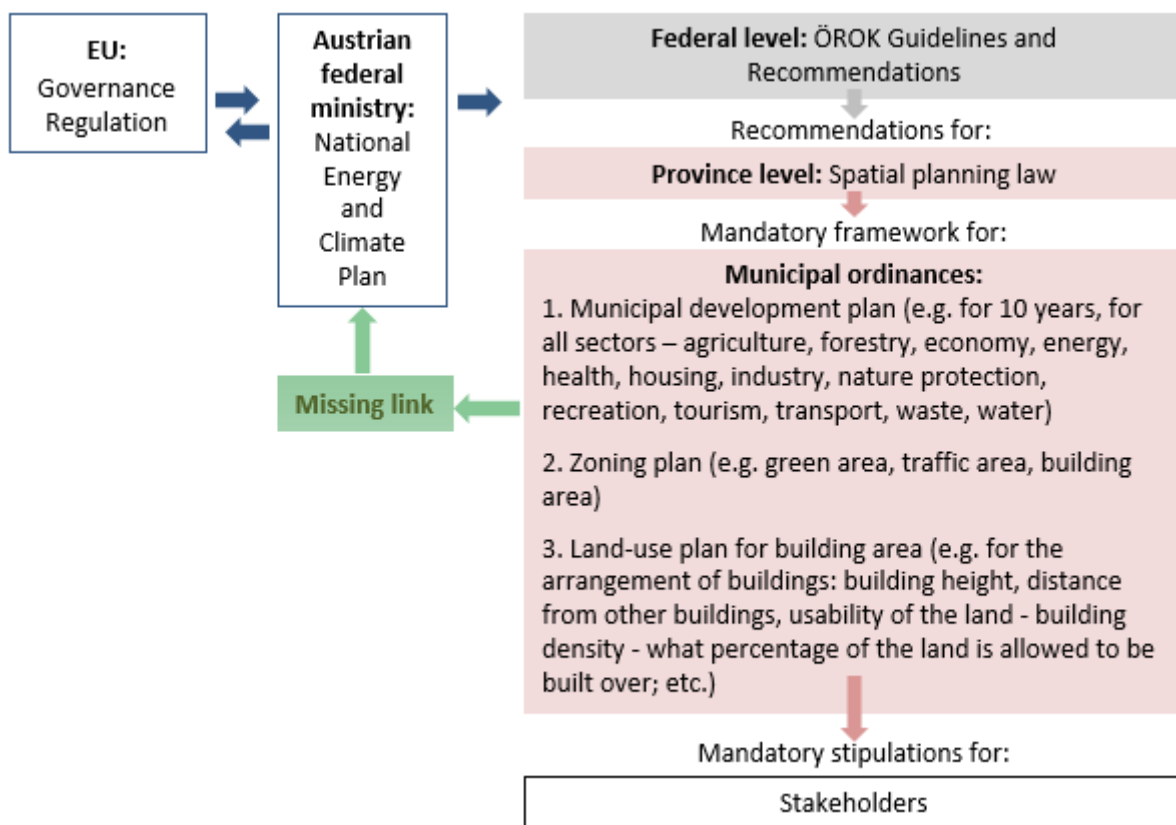


Figure 1. Spatial planning has an impact on the realizable renewable energy potential and is regulated at province level and municipal level. There is no clear link with the federal level of NECP planning and reporting. (Source: based on Geissler et al. [3])

2.1 NECP according to Governance Regulation

The EU Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action sets out the legal framework for the implementation of the EU's energy and climate policy. The National Energy and Climate Plan (NECP) is the key policy instrument to ensure that the objectives of the five dimensions of the Energy Union are achieved by 2030, with a view to long-term improvements by 2050. In this context, the NECP serves as a tool for coordination between different policy areas, including energy, climate, environment, and spatial planning. The NECP contains the binding national targets, measures and implementation strategies. The degree of target achievement is reported and revised at regular intervals.

In Austria, the revised version of the first NECP 2019 was published for consultation in summer 2023. The new version must be finalized and submitted to the EU Commission by June 2024. Overall, further efforts are required to achieve the targets, and renewable energy systems are becoming increasingly important. The federal government is responsible for reporting to the EU on the progress made towards achieving the targets. However, the actual realization of renewable energy projects is significantly influenced by the authorities of the federal states and, in particular, the municipalities. Looking at the Federal Constitutional Act, which defines the division of competences between the federal government and the nine provinces (or federal states), it becomes clear that there is no direct legal responsibility for spatial planning at federal level: Article 118 (3) states that the municipality has competence within its own sphere of action for the management of certain matters listed in the Act, including local spatial planning.

The strategies and measures set out in the Austrian NECP with regard to energy spatial planning therefore remain vague, and it is to be expected that the challenges in relation to the local implementation of policies and measures will even increase after the finalization of the NECP 2024.

2.2 Regional and municipal legal framework

The spatial planning laws of the Austrian provinces set the framework for the content and the formal aspects of spatial development at the provincial level as well as for local development. This includes provisions for the municipal development concept (also called spatial development plan, or similar, depending on the phrasing of the respective legislation, but with the same intention) which provide the framework and specific provisions for zoning plans and land-use plans for building areas. The spatial planning laws contain mandatory minimum requirements and possible contents that go beyond the minimum requirements. In addition to the spatial planning laws there are many other legal provisions such as sectoral development plans at regional level and a multitude of substantive legal acts which are also relevant in this context [5]. The Austrian Conference on Spatial Planning (ÖROK), as an association of the provinces, the federal government and the municipalities, has a coordinating role in spatial planning and provides recommendations and guidelines for the provinces, and the overall strategies at federal level, which provinces should adhere to in their regional laws [6].

With reference to Figure 1 it is emphasized that at municipal level, there are three legal instruments which must be in line with supra-local legal instruments such as regional energy concepts stipulated by the respective province:

- **Municipal development concept:** It provides a long-term plan for the development of the municipality and covers all sectors of the economy, including nature protection. The terminology for this instrument differs in the provincial laws, it is also referred to as a spatial development plan or similar, although the intention and scope are the same.
- **Zoning plan:** It divides the entire municipal area by defining the possible uses for the individual areas by means of dedication and making them visible. There are usually three categories, namely building area, traffic area and green area, such as meadows

and pastures, which are then further subdivided. The approved zoning plan forms the basis for the land-use plan.

- Land-use plan: It lays down certain rules for the development of building and traffic areas. It can be drawn up for the entire municipal area, individual districts, or neighborhoods.

The municipal development concept provides the framework for the zoning plan and land-use plan which directly impact on the exploitable renewable potential. There are several guidelines for developing the municipal development concepts, but energy is usually a separate chapter instead of addressing this topic as cross-cutting matter, taking into account possible implications on the zoning plan and on the land-use plan. Figure 2 shows in a schematic way which topics are typically covered in a guideline for a municipal development plan, and how the transFORMAT-LINK project tries to improve the situation: The further developed guideline considers energy as a cross-cutting issue, paying particular attention to ecosystem services, as trade-offs can arise in this area. Furthermore, data and tools are provided to facilitate the preparation of material for discussions with stakeholders and the municipal council. The aim is to contribute to transparency and to achieve greater public acceptance of renewable energy projects.

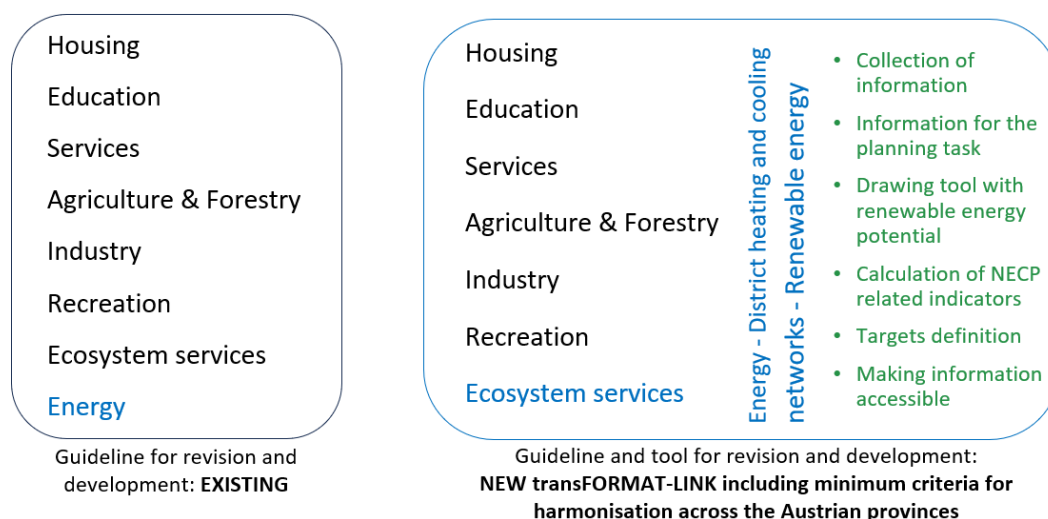


Figure 2. Schematic comparison of guidelines for municipal concept development: status quo and targeted improvements through the transFORMAT-LINK project

3. The transFORMAT-LINK project

This project is funded by the ACRP Program (14th call for proposals) with the duration from 01.10.2022 to 30.09.2024 and is being implemented by a consortium consisting of SERA global GmbH, TU Wien, and Kleboth und Dollnig ZT GmbH. Objectives, methods, and an overview of results are presented in the following sub-chapters.

3.1 Objectives

The project pursues the following objectives:

- Development of harmonized minimum requirements for municipal development concepts in terms of elaboration, criteria for content, documentation and accessibility.
- Development of a method for the revision of municipal development concepts that facilitates the development of renewable energy projects and establishes the link with the NECP.

- Prototype for an electronic database solution for the documentation and monitoring of municipal development concepts.

The project results in the following products:

- LINK-Guideline for the preparation and revision of municipal development concepts to support the implementation of renewable energy projects at municipal level and to facilitate NECP planning and reporting.
- LINK-Digitalization concept/prototype for the digital implementation of the LINK-Guideline: The prototype software consists of functional and model elements to enable real-life testing in the municipalities and thus provides a basis for further development beyond the scope of this funded project.

3.2 Methods

The work builds on the pre-project carried out in 2021 [3] and desk research on similar approaches in European Member States as well as voluntary approaches such as the Sustainable Energy and Climate Action Plan as part of the Covenant of Mayors program.

Furthermore, a municipal case study analysis was carried out in the form of the collaboration with the municipalities Baden bei Wien, Hall in Tirol, Langau, Munderfing, Schwoich, and Werfenweng. Semi-structured interviews were conducted with stakeholders at the municipal, regional, and federal level. A hypothesis-based deductive approach was applied for developing the first draft documents which were further elaborated by means of inductive reasoning based on the case study research and discussions with stakeholders. Procedures were based on methodologies discussed in relevant literature such as Dumke et al. [7] and Schauppenlehner-Kloyber et al. [8].

The project organization in the form of the structure of the work packages (WP) and the links between them is shown in Figure 3.

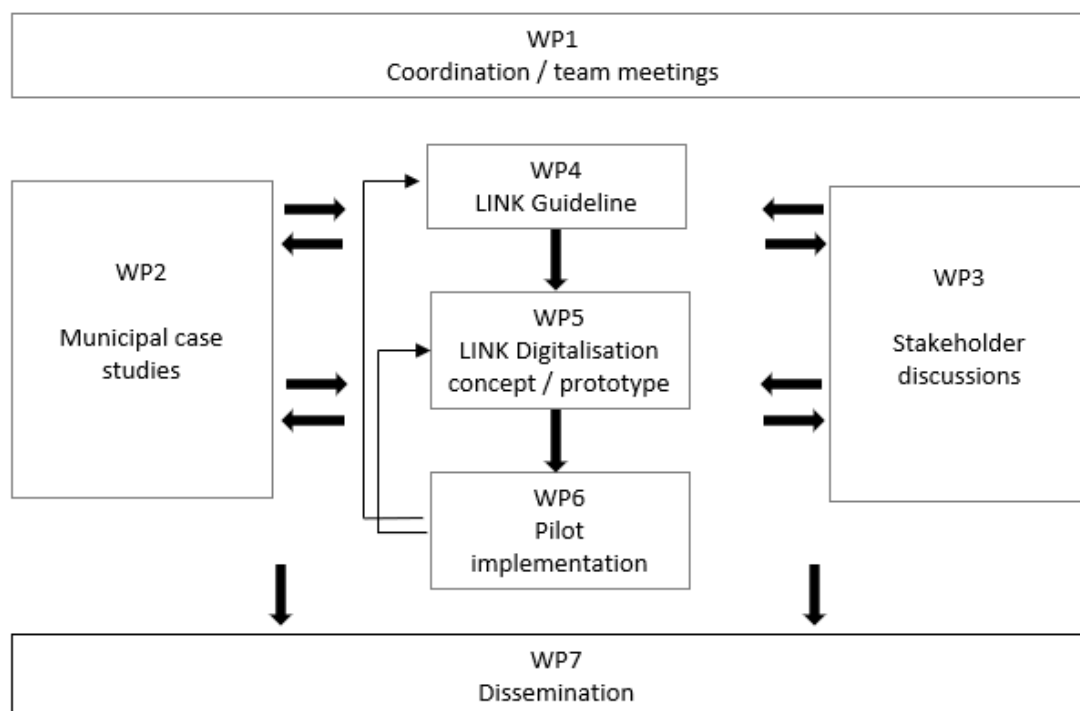


Figure 3. Overview of work packages and the links between them

3.3 Envisaged Results

The project leads to the LINK-Tool as the main result, consisting of the following parts:

- **LINK-Guideline:** Identification and description of criteria including those that should be made mandatory for municipal development concepts to support RES project implementation at municipal level and NECP planning and reporting; including identification of possibly conflicting targets, e.g. protection of biodiversity and improving the conditions for better health, and appropriate balancing mechanisms.
- **LINK-Digitalization concept/prototype:** Concept for documenting and monitoring municipal development concepts according to LINK-Guideline; prototype of software
- **Pilot implementation:** A test run will provide feedback for improving the digital approach and the LINK-Guideline in general. Selected results from the test run are integrated into the LINK-Tool as examples to illustrate processes and results for users.

Furthermore, the following outcomes are envisaged:

- Input for harmonization of spatial planning legislation
- Input for the design of a funding program to support municipalities in implementing measures to actually realize the transformation to sustainable municipalities

A more detailed description of the LINK-Guideline and the LINK-Software is provided in chapter 4 below.

4. Main components of the LINK-Tool: Guideline and Software

The LINK-Guideline consists of six parts with the following contents: (1) Brief description of the NECP and the relevance of municipal development concepts for the NECP. (2) Criteria for municipal development concepts including those that should be binding in all provinces. (3) Procedure for the revision or preparation of municipal development concepts according to the LINK-Guideline (in three steps: status quo survey; analysis regarding criteria and data; processing of the criteria and visualisation of the results). (4) Demonstration of the procedure according to the LINK-Guideline on the basis of pilot projects (description of the initial situation - plan with explanations; result after application of the LINK-Guideline: plan/visualisation plus explanations regarding renewable energy potentials). (5) Documentation and monitoring for municipal development concepts and their step-by-step implementation. (6) Establishing binding force: a degree of bindingness for the application of the LINK-Guideline and how this is to be achieved.

A concept for the digitised implementation of the LINK-Guideline was developed, taking into account (1) reduction of administrative burden, (2) transparency and public access of information, (3) interoperability of data and interfaces. For this purpose, collaboration with giz-mocraft GmbH was established and software development started in November 2023.

4.1 Key features of the LINK-Tool

The LINK-Tool consists of three levels that are aimed – at specific users and are therefore defined as "roles". These are the different access levels depending on the role:

- **Role "Content provider/Editor":** Municipal council, office management, experts: access with login and password.
- **Role "Interested public":** Citizens, associations: access without password. This is the landing page at the same time, as shown in Figure 4.

- **Role “Higher-level administration”**, e.g. "NECP reporting" to the specific institutions and authorities involved in the NECP: access with login and password.

The central level is the working level for the municipalities. Here there is access to the checklist for the creation or revision of municipal development concepts, combined with forms for recording ongoing initiatives, access to spatial energy planning data, if already available, or to data that allows for a rough estimate, as well as a simple drawing tool that enables the spatial localisation of potential gains from renewable energies. From this working level, certain information is published for the interested public, and certain information is made available for NECP planning and reporting at federal level.

The LINK-Tool is set up as <https://klexi.at/> as shown in Figure 4. The name is an abbreviation of the German term for climate expert and at the same time an approximation of a German term for a type of rough painting that refers to the definition of spaces the tool offers.

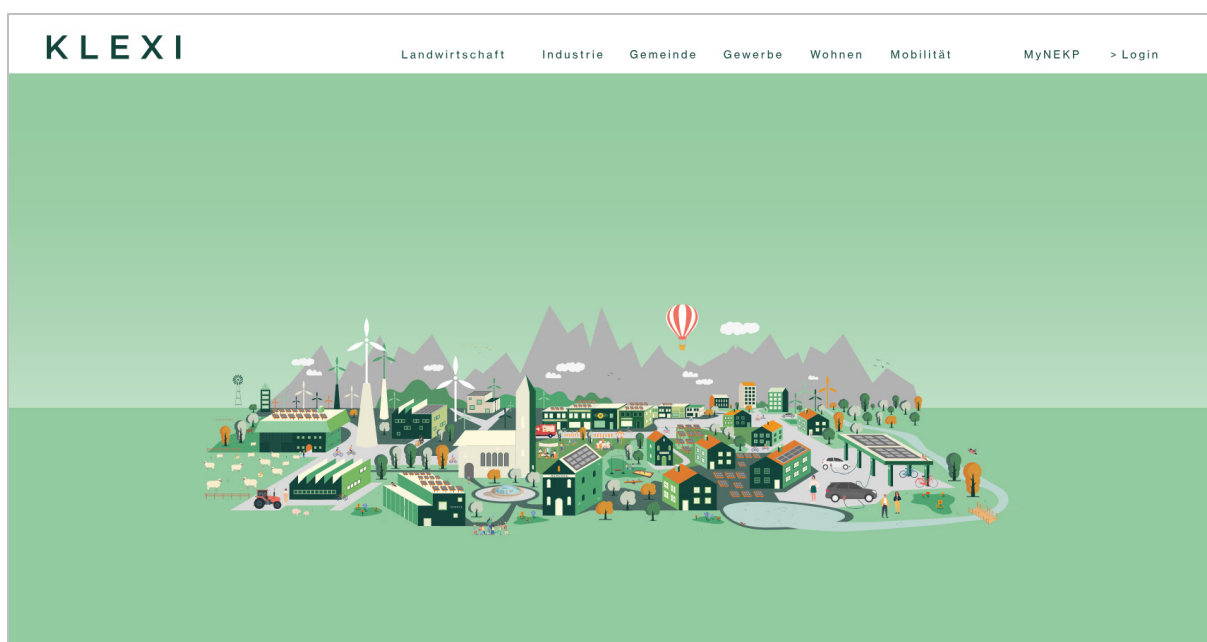


Figure 4. Landing page of the LINK-Tool set up as <https://klexi.at/> (work in progress)

4.2 How to use the LINK-Tool

The tool is designed to be self-explanatory and user-friendly. A great deal of effort was put into the development to have a tool that is very simple to apply, as this is the prerequisite for the possibility of widespread use. The simplicity is intentional to save the administration time and effort.

There is usually an occasion for updating a municipal development concept, e.g. the revitalisation of the city centre, or simply the legal obligation to update the concept at regular intervals. It is possible to get started using the checklist or the drawing tool for localising and quickly estimating renewable energy gains.

A possible workflow would be as follows:

- Go through the checklist to identify possible weaknesses and potential need for action
- At the same time, collect information what has been done so far
- Access information via interfaces to databases
- Use the drawing tool to estimate renewable energy gains

- Make information publicly accessible for discussion to create awareness and acceptance
- Revise existing plans accordingly
- Report indicators to supra-local administration

5. Minimum Requirements for Municipal Development Concepts

The definition of mandatory minimum requirements for municipal development concepts is based on the results of interviews, case studies, research of existing spatial planning laws, and project workshops. They serve to support the realisation of renewable energy projects at municipal level, to facilitate NECP planning and reporting, to identify conflicting objectives, e.g. nature conservation and energy generation, and how these could be balanced.

Ultimately, the aim is to harmonize municipal development concepts in Austria, and to ensure the maximum use of the local socially and ecologically justifiable potential of renewable energy sources. A detailed description is provided in the chapters below.

5.1 Minimum requirements to support renewable energy projects

A municipal development concept affects all areas of life, and many of these planning areas have an influence on energy consumption and the possibility of generating and utilizing renewable energies. This is illustrated by the following example shown in Table 1.

Table 1. *Municipal development concept: section "Settlement area" and section criteria*

Criterion	Qualitative sub-criterion	Reason why this is important
Urban development concept	The urban development concept aims to avoid the creation of heat islands.	Heat islands have temperatures up to 5°C higher than the rest of the environment. Passive cooling strategies for buildings such as night ventilation are therefore impossible. The use of cooling appliances becomes more likely. This consumes electricity and heats up the environment even more.
	This is achieved through appropriate surface design: heat storage is avoided, and areas are provided for heat radiation at night.	The avoidance of heat islands is based on two pillars: the use of reflective materials and the provision of open spaces.
Settlement development	Settlement development is carried out in coordination with spatial energy planning.	Spatial energy planning makes the potential for renewable energy visible and usable. Databases are available.
	The following potentials are taken into account: energy efficiency, renewable energy, waste heat, sector coupling.	Energy efficiency involves reducing energy consumption. In addition to renewable energies, waste heat from hot water consumption and industrial processes can also be utilized. Sector coupling in the form of a joint consideration of the housing, services, industry and mobility sectors enables the utilization of efficiency potential.

Basic principles of development: time sequence, time limit	With regard to settlement development, vacant and unrenovated buildings are identified first.	This is a general measure that addresses embodied energy in buildings and the energy consumption related to production and transportation of building materials. In addition, this measure relates to the need to reduce soil sealing and to use land sparingly.
	The potential uses of vacant and unrenovated buildings are clarified with the owners and the need for support from the municipality is determined.	This measure supports the measure listed above.
Vacancies, change of use	A vacancy register is kept.	This measure supports the measures listed above.
	Conversions of use are facilitated.	This measure supports the measures listed above.
Active land and property policy	Buildings that cannot be used anymore by their owners are bought back by the municipality and the land is redeveloped.	In some areas there are single-family homes that are appraised at a low value, are not sold and are no longer inhabited. The municipality can offer the owners the opportunity to buy back the property and redevelop the area.
Sparing use of the land	There is no new zoning of building land.	Reduction of soil sealing has a positive effect on climate change adaptation (microclimate, heavy rainfall events).
	New buildings will only be erected on a site where existing buildings have been demolished.	Same as in the row above.
	Existing soil sealing is reduced: infiltration-capable surfaces are used when renovation work is required on car parks and similar areas.	Same as in the row above.

Renewable energy generation should be taken into account as far as possible when preparing municipal development concepts. Therefore, criteria in the form of a checklist have been drawn up for this purpose, based on the municipal development guideline of the province Vorarlberg [9].

Qualitative sub-criteria have been defined in a way that they can be answered with “yes” or “no”. If so, the corresponding text can be integrated into the description of the development concept. Of course, some sub-criteria will not be applicable to a specific municipality due to lack of relevance, but they provide necessary guidance for those municipalities where the situation requires an appropriate response. Therefore, some of the criteria are labelled as generally applicable criteria, others are informative.

The criteria listed below have been identified as generally applicable criteria.

The settlement area

- The urban development concept avoids the creation of heat islands.
- Settlement development is coordinated with energy spatial planning.
- The spacing rules for buildings take into account the positive and negative effects of shading, such as cooling effects or possible impairment of solar energy utilization.
- Fresh air corridors are preserved or restored to dissipate hot air in summer.
- Heavy rainfall is managed, e.g. through the expansion of retention areas.
- Building owners are supported in renovating their buildings to zero-emission by 2050.
- All municipal buildings have energy performance certificates and renovation concepts.
- The development of the town center facilitates mobility without private cars.
- When designing open spaces, attention is paid to the diversity of species and habitats.

The economic area

- Specifications for commercial and industrial areas include the obligation to use built-up areas (roof, car park) for photovoltaic systems (own systems) or to make them usable (leasing of the area for the construction of systems by third parties).

The open space

- Ecologically valuable areas, biotopes and protected areas are identified and the basis of the assessment is specified. These areas are not available for photovoltaic and wind power plants.

The social space

- The municipality supports energy consumption monitoring and energy production monitoring and the presentation of key figures to raise awareness. To this end, co-operation is being established with community facilities and local supply facilities.

The supply area and the technical infrastructure

- The assessment of energy requirements is based on spatial energy planning.

Transport and mobility

- Pedestrian and bicycle traffic is promoted by minimizing the impact of routes (noise, exhaust fumes, heat/direct sunlight).

Procedural issues

- In the case of renewable energy and energy efficiency projects, regional co-operation is examined and, where appropriate, sought.

The preliminary version of the checklist is available on the project website and will be subject to further revision after the test phase with the pilot municipalities which is planned to be completed until summer 2024.

5.2 Minimum requirements for managing potential conflicts of interest

The criteria checklist described above serves a second purpose, namely the early identification of potential conflicts of objectives between the use of renewable energies and other objectives, such as landscape and nature conservation. The definition of standardised criteria thus reduces the risk of conflict: when defining the criteria for the content to be covered, possible

conflicts of objectives are taken into account from the outset in order to create scope for resolving them. The aim is to fully utilise the potential of renewable energy.

It is true that the legal framework favors and even demands the construction of renewable energy plants. Nevertheless, resistance at local level can hinder or at least delay projects. Delays also have economic consequences and lead to a reluctance on the part of project developers. Every effort must therefore be made to improve the social acceptance of renewable energy installations, and ensuring transparency with regard to the intended development strategy is a suitable means of achieving this.

With regard to the definition of the minimum requirements for the municipal development concept, this means the introduction of an obligation to make certain information accessible to the population in a simple and easily understandable way. The LINK-Tool, as shown in Figure 4, is available for every municipality and has three working levels, whereby the level without login is aimed at the interested public. The municipal administration works at a level for which a login is required. However, it can also decide to activate certain content for the interested public.

The proposed minimum requirements for the disclosure of information on renewable energy to the interested public based on the LINK-Tool are as follows:

- Presentation of the status quo of renewable energy generation
- Presentation of possible future renewable energy generation
- Visualization of the area and type of planned renewable energy sources
- Presentation of the contribution to the objectives of the climate and energy concept of the province and to the objectives of the NECP

This data should be published at the draft stage in order to support the discussion and consultation process during the creation or revision of the municipal development concept. The LINK-Tool facilitates the generation and display of the required information and thus supports the municipality in complying with such a proposed disclosure obligation.

5.3 Minimum requirements to facilitate NECP planning and reporting

The link between the municipal planning level and the NECP can be established with the LINK-Tool by means of the role "Higher level administration", which can make an essential contribution to the effectiveness of the NECP as a planning and reporting instrument. As described in chapter 4, the LINK-Tool provides for three working levels or roles, and the municipality can grant superordinated institutions access to the data via a login. This applies, for example, to the Federal Environment Agency, which is responsible for scenario modelling in the NECP and is therefore dependent on the data, or the Federal Ministry, which is responsible for drafting the policies and measures, compiling the entire NECP and submitting it to the European Commission. The municipalities can provide the development concept in the form of texts and plans, including the measures to be realized over time. In addition, quantitative indicators can be provided as the information listed in the above chapter is structured to be compatible with the indicators of the NECP.

If the municipality needs financial support for the implementation of individual measures in order to actually make the transition to a sustainable municipality, a sustainable and robust development plan is essential to ensure the coherence of the individual measures supported. The development plan could be a precondition for the approval of funding for individual measures.

6. Conclusions

The project results support renewable energy projects and thus the transformation process at municipal level towards independence from fossil fuels through the LINK-Tool. It provides a checklist for the development or revision of the municipal development concept with a focus on enabling renewable energy projects, a database for the collection and documentation of municipal initiatives in one place, and access to data for the planning task. In addition, the LINK-Tool enables certain content to be made available to the public to raise awareness and promote acceptance, and a reporting function provides a link to higher-level reporting at provincial level (provincial energy and climate strategy) and at federal level (NECP).

The project does not provide a fully functional tool but demonstrates the technical and administrative feasibility of the concept, which was developed on the basis of stakeholder consultations. The stakeholder interviews conducted at the beginning of the project confirmed the hypothesis of this research project that there is a need for such a tool that would increase the quality of the relevant section on energy spatial planning of the NECP in terms of planning and reporting. This is important because if the evaluation shows that the project implementation falls short of the plan, corrective measures need to be taken, e.g. in terms of adjusting legal provisions, providing support to municipalities in terms of professional capacity, or financing of the measures planned in the development concept that meet the minimum requirements set.

Of course, in the stakeholder interviews the view was also expressed that the NECP is strategic in nature, as is planning and reporting, and that the current setup may not be ideal but is justified. However, if you look at the Governance Regulation and the relevant Annex, which sets out the structure for the presentation of policies and measures, it is clear that what we are proposing with the LINK-Tool is not too specific, but in line with the intention of the Governance Regulation.

The minimum requirements are implemented via the LINK-Tool and serve to ensure that the municipal level can be connected to the NECP level via the defined indicators. Furthermore, they are important for the harmonization of the spatial planning laws and procedures of the Austrian provinces, as these provide the framework for the respective municipalities. However, this harmonization is an ambitious goal that can only be pursued with a long-term perspective and therefore requires an alternative that can be implemented in the short or medium term. The minimum requirements could therefore form the structure for a new funding program that complements the KEM [10] and KLAR! [11] programs of the Austrian Energy and Climate Fund. In addition, access to funding for the implementation of measures could be linked to a municipal development concept that meets the minimum requirements, because this would ensure that the individual measures to be financed are part of a consistent concept on the path to independence from fossil fuels.

Overall, the research team is convinced that the LINK-Tool will be helpful in bridging energy policy gaps between the national, federal, regional and municipal levels - soon in Austria, but (due to the high transferability of its design) perhaps also in other countries.

The missing policy links between the national, federal, regional and municipal levels in executing the NECP goals is a serious and urgent challenge, not only in Austria, but in many European countries. This became clear during the desk research in the first phase of the TRANSFORMAT-LINK project and requires further analyses, which will be addressed in a separate article.

Data availability statement

The following sources are used: Energiemosaik <https://www.energiemosaik.at/intro>, SEP – Spatial Energy Planning <https://waermeplanung.at/>, and other sources such as AGWR (Building registry of Statistics Austria), and EPC database environment ZEUS. Apart from Energiemosaik, the data is not publicly accessible, but the municipalities have access to the data for their own area.

Underlying and related material

Further information and materials can be found on the project website: <https://transformat.at/>.

Author contributions

Susanne Geissler: Writing – original draft. Abraham Arevalo-Arizaga, Daniel Youssef, Hartmut Dumke, Elias Grinzinger: Writing – review & editing.

Competing interests

The authors declare that they have no competing interests.

Funding

This project is funded by the Climate and Energy Fund and is being carried out as part of the "ACRP - 14th Call, 2022" program. <https://www.klimafonds.gv.at/>

Acknowledgement

We would like to thank the municipalities of Baden bei Wien, Hall in Tirol, Langau, Munderfing, Schwoich, and Werfenweng for their excellent co-operation in the project.

References

- [1] European Parliament and the Council, "Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999: European Climate Law."
- [2] Österreichische Bundesregierung, "Integrierter nationaler Energie- und Klimaplan für Österreich Periode 2021-2030, Version 2019: gemäß Verordnung (EU) / des Europäischen Parlaments und des Rates über das Governance-System für die Energieunion und den Klimaschutz." 2019. [Online]. Available: https://energy.ec.europa.eu/system/files/2020-01/at_final_necp_main_de_0.pdf (27 February 2024)
- [3] S. Geissler, P. Wallisch, D. Radlbauer, and A. Arevalo-Arizaga, "Linking the National Energy and Climate Plan with Municipal Spatial Planning and Supporting Sustainable Investment in Renewable Energy Sources in Austria," *Energ.* 2022 15 645, [Online]. Available: <https://doi.org/10.3390/en15020645> (27 February 2024)
- [4] European Parliament and the Council, "Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC,

- 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council: Governance Regulation.”
- [5] ÖROK - Österreichische Raumordnungskonferenz, “ÖROK-Rechtssammlung – Landesrechtliche Grundlagen.” [Online]. Available: <https://www.oerok.gv.at/raum/daten-und-grundlagen/rechtssammlung/landesrechtliche-grundlagen> (27 February 2024)
- [6] ÖROK - Österreichische Raumordnungskonferenz, “Geschäftsordnung.” [Online]. Available: https://www.oerok.gv.at/fileadmin/user_upload/Geschaeftsordnung_OEROK_Stand_2020.pdf (27 February 2024)
- [7] Dumke H., Eder M., Fischbäck J., Hirschler P., Kronberger-Nabielek P., Maier S., Malderle M., Narodoslawsky M., Neber E., Rainer E., Scheuven R., Schnitzer H., Weinhandl M., Weninger K., Zancanella J., Zech S., “EnergieRaumPlanung für Smart City Quartiere und Smart City Regionen (ERP_hoch3): BMVIT, Bundesministerium für Verkehr, Innovation und Technologie,” Graz, Wien, 2017.
- [8] Schauppenlehner-Kloyber, E., Gugerell, K., Radinger-Peer, V., Dumke, H., Youssef, D., Dillinger, T., Fischer, C., Penker, M., Ed., *Selbstermächtigung und Selbstorganisation als Schlüssel für nachhaltige Lern- und Transformationsprozesse in der Region Römerland Carnuntum: Proceedings of REAL CORP 2020, 25th International Conference on Urban Development, Regional Planning and Information Society*. Vienna: Schrenk, M. and Popovich, V. V. and Zeile, P. and Elisei, P. and Beyer, C. and Ryser, J. and Çelik, C, 2020.
- [9] *Leitfaden für Gemeinden für die Ausarbeitung eines Räumlichen Entwicklungsplans (REP) nach dem Vorarlberger Raumplanungsgesetz. Version 2 - Entwurfsfassung, 24.07.2023 (zur Veröffentlichung freigegeben)*. Amt der Vorarlberger Landesregierung, Abteilung VIIa-Raumplanung und Baurecht. [Online]. Available: <https://vorarlberg.at/documents/302033/472283/Materialien+zum+REP.pdf/26d8d348-9837-60df-35fef37cc340822d> (27 February 2024)
- [10] Klima und Energiefonds, “Klima- und Energie-Modellregionen.” [Online]. Available: <https://www.klimaundenergiemodellregionen.at/> (27 February 2024)
- [11] Klima und Energiefonds, “KLAR! Programm.” [Online]. Available: <https://klar-anpassungsregionen.at/klar-programm> (27 February 2024)