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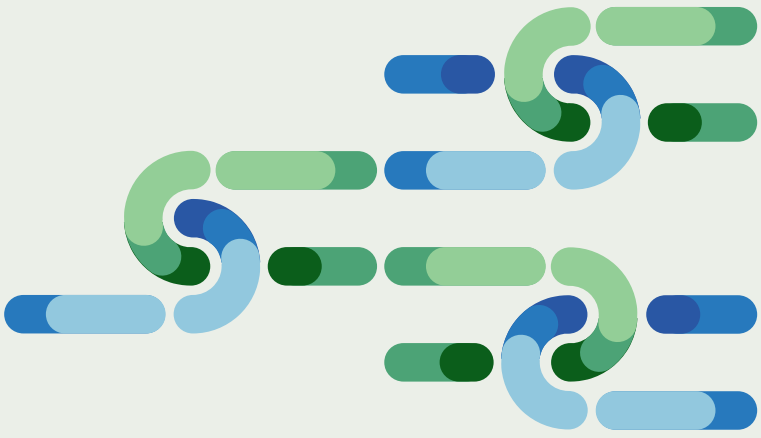
D.2.4.1. Green and Blue Infrastructure-network: Land use conflicts for renewable energy production and other threats

Pilot Region: Trilateral transboundary pilot site (Austria-Italy-Slovenia)

Mapping report outlining GBI network elements and areas of land use conflicts for renewable energy production and other major developments that may threaten GBI connectivity function



This project is co-funded by the European Union through the Interreg Alpine Space programme.

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D.2.4.1. GBI-network Land use conflicts for RE production and other treats. Pilot Region: Trilateral transboundary pilot site (Austria-Italy-Slovenia)

Mapping report outlining GBI network elements and areas of land use conflicts for renewable energy production and other major developments that may threaten GBI connectivity function.

Activity 2.4 Case Studies 3rd step: Identify unsuitable locations/mitigation measures for impact assessment of renewable energy systems and other major developments that may threaten GBI connectivity function

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Klagenfurt, March 2025

Reference in AF: D2.4.1

This project is co-funded by the European Union through the Interreg Alpine Space programme.

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EXECUTIVE SUMMARY

The PlanToConnect project aims to develop an Alpine spatial planning strategy for ecological connectivity in collaboration with relevant stakeholders. This report focuses on the trilateral transboundary pilot area (Austria-Italy-Slovenia) where E.C.O. is carrying out a case study on the integrated planning of a Green and Blue Infrastructure (GBI) network. The report specifically addresses land use conflicts arising from renewable energy installations and other infrastructural developments that could jeopardise the GBI network. This report has the following objectives:

- assessing potential impacts of infrastructures on ecological connectivity,
- evaluating criteria for unsuitable locations,
- mapping land use conflicts and
- suggesting mitigation measures.

The report focuses primarily on potential threats and current pressures in the renewable energy sector. Other threats are not assessed in detail. Existing pressures and anticipated threats in the pilot region are identified and highlighted. There are currently pressures from transportation infrastructure, hydropower plants (river permeability) and urban/industrial development in certain parts of the pilot area.

In the protected areas of the pilot region, such as the Triglav National Park, the Natura 2000 areas and the protected areas in the Prealpi Giulie Nature Park, there are restrictions on wind turbines and solar energy. An environmental impact assessment (EIA) must be carried out for project ideas within Natura 2000 areas. However, these assessments only take into account the direct impact on species or habitats listed in the Habitats Directive or the Birds Directive. This does not mean a general restriction. The Julian Alps Biosphere Reserve also contains restrictions on development, at least in the core area and in the buffer zone. In the Dobratsch Nature Park, in addition to the strict nature conservation areas, renewable energies like solar panels are not definitively excluded.

Mitigation and compensation measures for renewable energy installations, especially wind and solar energy, are outlined. For solar installations, these include permeable fences for the movement of wild animals, escape openings for wild animals and extensive agricultural use. Specific regulations do not yet exist. The development and maintenance of extensively used species- and flower-rich grassland is also being discussed in Austria.

Large parts of the trilateral transboundary pilot site (Austria-Italy-Slovenia) lay within protected areas or within forests. Both can be considered rather unsuitable for RE development. Restrictions are in place and EIAs must be conducted, because the pilot area is of extraordinary international importance in terms of wildlife habitat core aeras.

In addition, there are several ecological corridors that are currently used for the movement of wild animals. They must also be safeguarded in the future. The forested border area (Austria, Italy, Slovenia) is currently not under strict protection, but must also be considered an area of international importance for connectivity. There is a risk that the north-south connection will be cut, especially the bottleneck in the municipality of Arnoldstein (AT).

Transport infrastructure and power lines as well as railroads and some industrial development already exist in the rather small valleys. Although the pilot region is huge, it is recommended to consider the development of RE very carefully and to place RE on a small scale and rather close to existing industrial sites in order to avoid conflicts. There is a big need of collaboration for spatial planning with the ecological sector.

Austria

As far as the development of renewable energies is concerned, there are currently no large installations planned. The nature park label does not impose any general restrictions on the development of renewable energies, but at least consideration is given to ecologically important areas. However, there were project ideas mentioned by the observers on the Austrian side (e.g. for windmills) in the year 2023. Due to a recent referendum in Carinthia, the province where the Dobratch Nature Park is located, no large wind farm projects will be realised in the alpine parts of Carinthia in the next decades. The Federal Office for Spatial Planning has drawn up a plan of suitable areas, most of which are far away from the pilot region.

In addition, small ground-mounted solar installations on agricultural land are currently the subject of intense debate and several projects are in the planning stage. It must be avoided that they are placed in the corridors, especially because there are bottlenecks in connectivity. Even small, ground-mounted solar panels could significantly affect the bottlenecks in the corridors and pose a major hazard. These installations are most likely to be fenced in, which will affect connectivity. Exclusion zones for unsuitable locations and buffers to relevant infrastructure (solar, hydro, wind and transportation) are compiled in this report.

The real pressure is on the waterways: The river Gailitz (IT, AT), the Drau (AT) and the Gail (AT) are currently being exploited for hydropower. Fish ladders have recently been built on the Gail and Drau. They are still missing on the other rivers, and the tributaries pose a constant risk to small-scale hydropower generation.

Italy

For Italy, general criteria for unsuitable sites are defined on the basis of ecological value and protection status. Exclusion zones for unsuitable sites and buffers to relevant (solar, water, wind and transportation) infrastructures are compiled. The Prealpi Giulie Nature Park is part of the bilateral, transboundary UNESCO Julian Alps Biosphere Reserve. Industrial development is restricted within the biosphere reserve, at least in the core and buffer zones. For the transition zone, certain possibilities are upheld and environmental impact assessments are required there. It must be ensured that these developments will take place outside the ecological corridors and other ecologically important areas that are not under strict protection. In the pilot region, however, the north-eastern part of Italy lies outside the Julian Alps biosphere reserve and the area east of Tarvisio is particularly important for the

connection to Austria. Additionally there are some parts where in the Val Canale where bear accidents occur frequently on valley crossings. There transport infrastructure is a barrier and improvements to connectivity should be considered. Specific exclusion zones for both wind power and solar power plants were not mentioned during stakeholder consultation. The report includes maps showing individual and aggregated exclusion zones with corresponding buffers for both wind and solar energy. These maps illustrate areas where renewable energy development would conflict with ecological connectivity.

Slizza River and Fella River (IT) are used for waterpower – improvements on fish permeability need to be made.

Slovenia

Within the Julian Alps biosphere reserve, industrial development is partly restricted and requires environmental impact assessments. Exclusion zones for unsuitable sites and buffers to relevant (solar, water, wind and transport) infrastructures correspond in particular to the core zones and buffer zones. The transition zone of the biosphere reserve is intended to support sustainable development as defined by the UNESCO programme. Therefore, major developments for renewable energy production are not expected and were not mentioned in the stakeholder consultations. However, there may be some suitable sites for solar energy installations in some areas of the Sava Valley in the transition zone. There is still some possibility for other renewable energy development in the transition zone, especially near the urban parts of the Park (e.g. Jesenice, Lesce, Radovljica). It must be ensured that these developments will take place outside the ecological corridors and other ecologically important areas that are not under strict protection. General mitigation measures are then proposed to maintain ecological connectivity at the regional level. On the Sava River (SL), two sites are indicated for the improvement of fish passage and permeability.

REPORT

1 Introduction

The aim of the Interreg project PlanToConnect is to develop and test an Alpine spatial planning strategy for ecological connectivity in cooperation with stakeholders in pilot areas. Proposals for the adaptation of spatial planning systems and territorial policies will be developed.

According to Lahner (2024) several objectives are tackled during the PlanToConnect Project (see also PlanToConnect reports *D1.1.1*, *D1.3.1*):

Objective 1: To prevent the inner Alpine area (perimeter of the Alpine Convention) from becoming a biological island and to preserve the remaining open passages. The method is a consideration and more detailed analysis of the "connectivity areas" from the ALPBIONET2030 project.

Objective 2: Preserve existing highly permeable landscapes in the regions/ maintain the connectivity of the regions and meet the EU target of protecting 30% of the landscape area. The methodology is to identify SACA1 areas that are not protected.

Objective 3: Identification of ecological links important for the creation of a coherent alpine network for a true transnational ecological network. The methods are:

- Elaboration of an alpine ecological network based on network theory, identification of potential ecological connections.
- Identification of its "minimum spanning tree" and "centrality" and adding "connectivity areas" identified by the ALPBIONET2030 project.

Objective 4: To conserve the existing ecological linkages by spatial planning, to lower the risk of getting linkages lost by urban and infrastructural development and to restore potential corridors by connecting GBI elements. The method is the evaluation of urbanisation threat for regional ecological linkages and identification of bottlenecks or pinch points of potential regional linkages.

Objective 5: Connecting ecological protected areas to avoid their fragmentation and possibly increase the size of existing protected areas by creating a kind of "buffer zones". The method is to use "potential corridors" of the ALPINE PARKS 2030 projects as a local level outcome, identifying potential links < 2.5km between SACA1 areas.

As part of the PlanToConnect project, E.C.O. is carrying out a case study on the integrated planning of a GBI (Green and Blue Infrastructure) connectivity network in the pilot area. "Trilateral transboundary pilot site (Austria-Italy-Slovenia)". The design of a GBI network for connectivity in the pilot region was developed and described in report D2.3.1Priority areas for conservation and restoration were identified there. These areas form the basis for the integration of ecological connectivity into planning tools.

Ecological connectivity in the pilot region is considered in terms of safeguarding existing corridors between the three countries and improving cooperation between the most important protected areas in the three countries. Bottlenecks for connectivity should be alleviated. In addition, protection gaps in forest habitats and open grasslands should be closed and connectivity barriers removed. Habitat enhancement measures should be taken to improve functional connectivity in the area (see report D2.3.1).

This report (D2.4.1) addresses the land use conflicts arising in particular from renewable energy installations and other infrastructural developments that could jeopardise the GBI network for connectivity in the trilateral pilot region. The objectives are:

- to assess the potential impact of renewable energy infrastructures or other infrastructures that could jeopardise the GBI network for connectivity,
- to asses criteria for unsuitable sites for the various types of infrastructures with a focus on renewable energies,
- to map the land use conflicts for the production of renewable energy and
- to suggest possible mitigation measures.

This report covers all spatially relevant infrastructures that have already had a negative impact on connectivity (pressures) as well as those that pose a threat to connectivity in the future (threats)[1].

As a thematic boundary, this report focuses on renewable energies and excludes urban/industrial development and infrastructures. While agricultural land use also has an impact on ecological connectivity (see report D1.2.1), it is not addressed in this report as it is mainly determined by market conditions and agricultural practices. Spatial planning and its instruments have virtually no mandate and no steering influence.

This report is organised according to the following chapters: Chapter 2 briefly describes the pilot region. Chapter 3 deals with the methodological approach used in the pilot region. Chapter 4 shows the main pressures and threats to ecological connectivity in the pilot region (results). Chapter 5 discusses the factors militating against major developments / renewable energy installations (exclusion zones) in the pilot region. Chapter 6 describes the possible mitigation and compensation measures for the existing and planned infrastructures in the pilot region.

[1] Pressures are factors that have affected habitats and species, threats are factors that are anticipated to be likely to have an impact in future (European Environment Agency 2020).

2 Pilot region: Trilateral transboundary pilot site (Austria-Italy-Slovenia)

The pilot area in the border triangle between Austria, Slovenia and Italy comprises the recently recognized bilateral UNESCO Biosphere Reserve Julian Alps (in Slovenia around the Triglav National Park) and the Julian Pre-Alps (Italy). To the north, on the Austrian side, the Dobratsch Nature Park connects to the Karawanken in the east and the Carnic Alps in the west. Separated by the Gailtal valley, which is connected to Italy via the Slizza/Gailitz river, the Dobratsch with its steep southern slopes offers habitats that can also be found on the other side of the border.

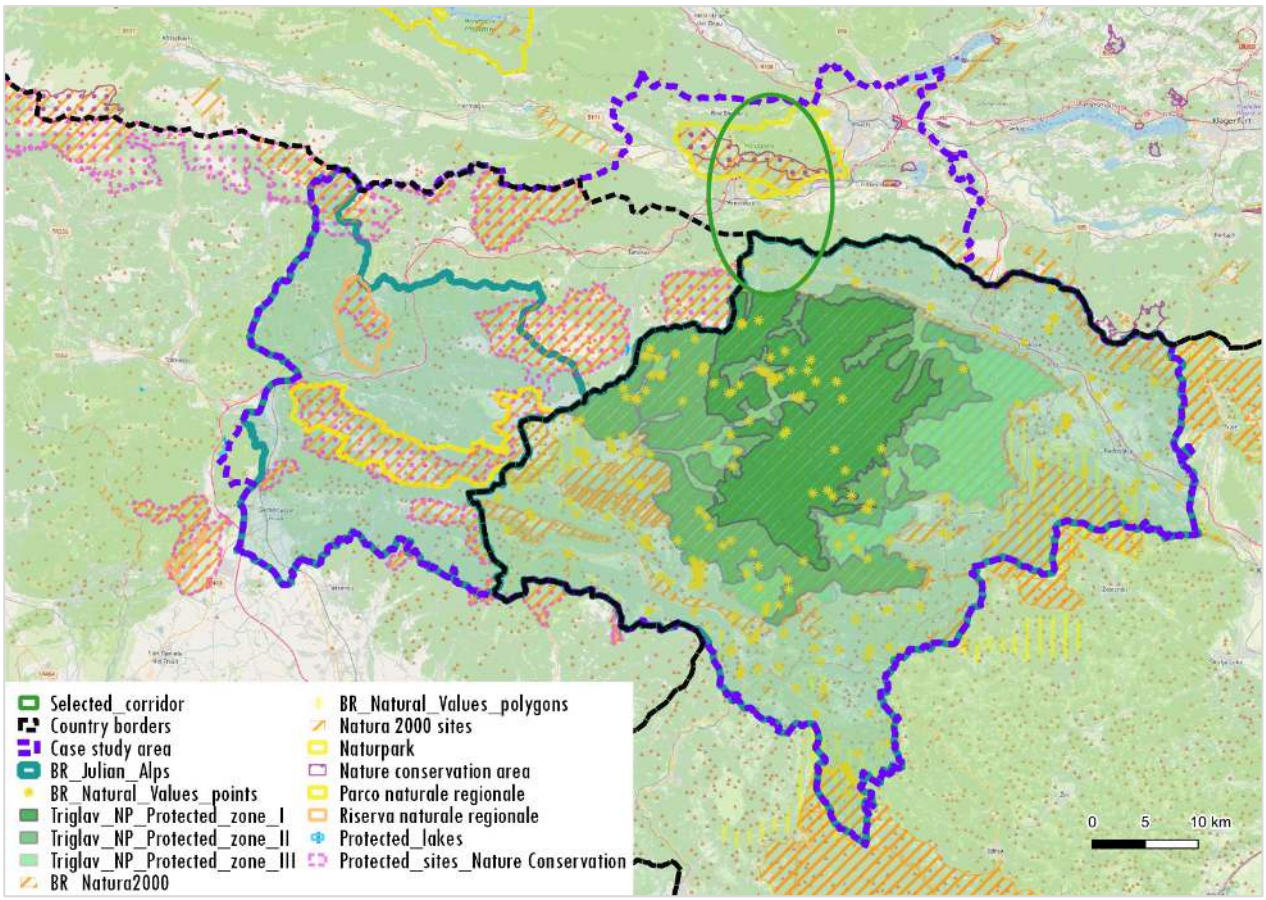

Figure 1: Overview pilot region with legally protected areas. (Selected corridor highlighted in green).

Although the pilot region still offers large natural areas with varying degrees of protection on the mountain slopes, there are bottlenecks in connectivity, especially for the northern connection to Austria and for crossing the valley floors. Transport infrastructure and urban/industrial development are located in the rather narrowl valley bottoms in all three countries. These infrastructures are a major obstacle to the connection. Although there are large natural areas in the study area, these bottlenecks need to be addressed and taken

into account in further planning to enable the connection of these core areas in the future. The Dobratsch Nature Park (AT) is an important link in the ecological corridor system that connects the Balkans and the Karawanken with the Hohe Tauern / central Eastern Alps. However, the “nature Park" in Carinthia is more of a label for sustainable tourism than a strictly protected area. Strict protected areas for the long-term protection of the connecting corridor to the Julian Alps biosphere reserve are therefore not available. Although the area north of the biosphere reserve consists mainly of forest and therefore currently functions as a connecting area, there is a need for action to improve the protection status for the long-term existence of the corridor and to avoid barrier effects in the future. While the mountain areas are mainly used extensively as forests, the valley areas such as the Gailtal (AT) and the (peri-)urban area of Villach (AT), the Val Canale (IT) around Tarvisio or the Sava Valley (Si) are used intensively. In addition, the valley floors, apart from the part between Wurzenpass and Coccau (IT), are under constant development pressure (economic/industrial development and changes in land use and settlement development).

The Triglav National Park and the Prealpi Giulie Natura Park represent an important core area (SACA 1) that is currently well connected. The two parks already work together as a bilateral UNESCO Julian Alps Biosphere Reserve. The biosphere reserve consists of a fairly strictly protected core zone (without human use), a buffer zone (in which traditional use in terms of habitat conservation takes place) and a transition zone (in which sustainable use is to be achieved in the communities of the reserve). The biosphere reserve is a model region for sustainable regional development and therefore also a promising basis for careful handling of upcoming projects in the municipalities (for further description see D 2.3.1). The transition zone extends to the border with Austria and Italy.

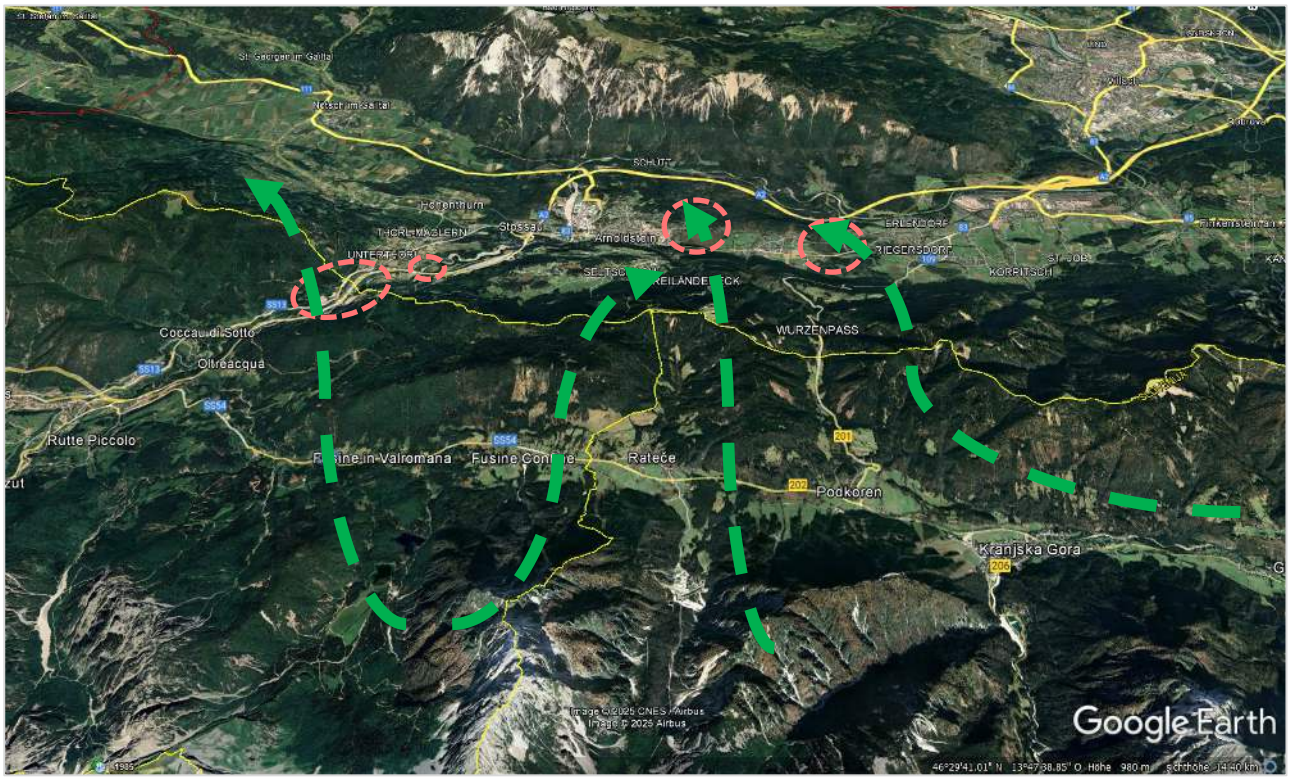

Figure 2: Ecological corridors and connectivity bottlenecks in the border area of the pilot region.

However, there is a need to strengthen cross-sectoral cooperation and governance of parks with the respective national spatial planning and forestry departments to work on common objectives and discuss the role of renewable energies in the transition zone. In addition, international cooperation in spatial planning decisions is required. Initial approaches for better cooperation were addressed in a workshop of the international “regional” connectivity group at a workshop in Bled 2024.

Despite the well-protected core areas in the two nature parks (AT and IT) and the national Park (SI), there is a certain risk of placing (unpopular) renewable energy infrastructure in the very last corner of each country due to the border location. Currently, the border triangle itself consists of forest and will most likely remain so due to the strict forestry laws in the three countries. However, these forested areas are not under special protection in any of the countries. The need for such protection is analysed and discussed in this report.

3 Methodological steps

3.1 Description of the approach/ working steps

Working Step	Description
1 General threats to infrastructures and land use for the ecological networks of the GBI	The first step was to identify which infrastructures, or land uses generally have a negative impact on connectivity. The results of PlanToConnect report D1.3.1 were used for this purpose.
2 Definition of relevant infrastructures	The second step was to identify existing or planned infrastructures in the pilot region that could have an impact on connectivity. For this purpose, threshold values from the EU Environmental Impact Assessment Directive and the Austrian Environmental Impact Assessment Act were compiled and evaluated.
3 Existing pressures and expected major threats in the pilot region	In a third step, all spatially relevant existing and planned infrastructures in the pilot region are compiled on the basis of: • Consultations (observer workshops and interviews with the directors of the three parks) to discuss the emerging developments in the region • References to existing relevant infrastructures by the Regional Connectivity Working Group during a 2024 workshop in Bled (session: Threats and Barriers) • Interviews with planning experts from the pilot area (at municipal or regional level) to identify important infrastructural developments planned for the coming years • Interview with the manager of KEM (climate and energy model region) Dreiländereck • Search for official, publicly available lists of planned projects required to conduct an environmental impact assessment • Mapping approach with spatial data in QGIS. Only data relating to the link in the tri-border region is taken into account.
4 Compilation of general criteria for unsuitable locations	General criteria for unsuitable locations can be found in report D1.3.1.
5 Development of specific criteria for unsuitable locations in the pilot region (exclusion zones)	• Evaluation of the existing protected and ecologically valuable areas in the pilot region in the selected connection corridor. • Evaluation of forest legislation in the pilot region • Consultation with observers and spatial planners • Own expert opinion
6 Mapping the land use conflicts for renewable energy production	Regarding ecological connectivity a map of the exclusion zones for each relevant types of infrastructure was created (using simple overlay functions and proximity tools).

Working Step	Description
7 Possible mitigation and compensation measures	Possible mitigation or compensation measures for renewable energy facilities (existing and planned) in the pilot region trilateral transboundary pilot site (Austria, Italy Slovenia) are proposed referring to the threats report (D.1.3.1) and the report on conflicting land uses (D1.2.1).

3.2 Data used

The following table shows the data used and available for the analysis of the pilot region.

Table 1: Overview of local or regional data used

Data	Source	Description
Austria: planned renewable energy projects at federal level (status 2025)	KAGIS Energy Map of the province of Carinthia	GIS data on project development regarding renewable energy in the KEM Region of Dreiländereck
Austria: planned renewable energy projects in at the Pilot area (Natura Park Dobratsch) (status of 2025)	Interview Protocol	Interview protocol with KEM (climate & energy model region) of Dreiländereck
Austria local level: planned renewable energy projects in relevant municipality	Interview with spatial planner	Interview with spatial planner from relevant municipality Arnoldstein
All 3 countries: Barrier map of pilot region including wind and solar power developments	Observer workshop protocol barriers	Participatory map on discussion on energy development projects during observer workshop 2023
All 3 countries: Barrier map of pilot region including waterpower plants in the pilot region	Expert workshop protocol barrier map (workshop on 4th of April 2024)	Participatory map on discussion on barriers in the pilot area during expert workshop and RCWG workshop in Bled on 4th of April 2024
All 3 countries: restriction zones and known corridors	GIS layers of protected areas and ecological corridors	Compilation of GIS data on protection zones
Italy local level	News on CER	https://www.tecnoandroid.it/2025/01/01/
Areal images	Google Satellite (2025).	Areal image interpretation on satellite data

Data	Source	Description
GIS Data	Data catalogue of three countries	Boundaries Protected areas Ecological corridors Regional Potential linkage (macro model of EURAC)
Slovenia: -Regional level	Regional Development Program of the Gorenjska Development Region 2021–2027	Goals for regional development
PlanToConnect reports	D.1.1.1., D. 1.2.1. D.2.4.1,	Mapping report of UIRS (Region Goriška),

4 Major pressures and threats to ecological connectivity

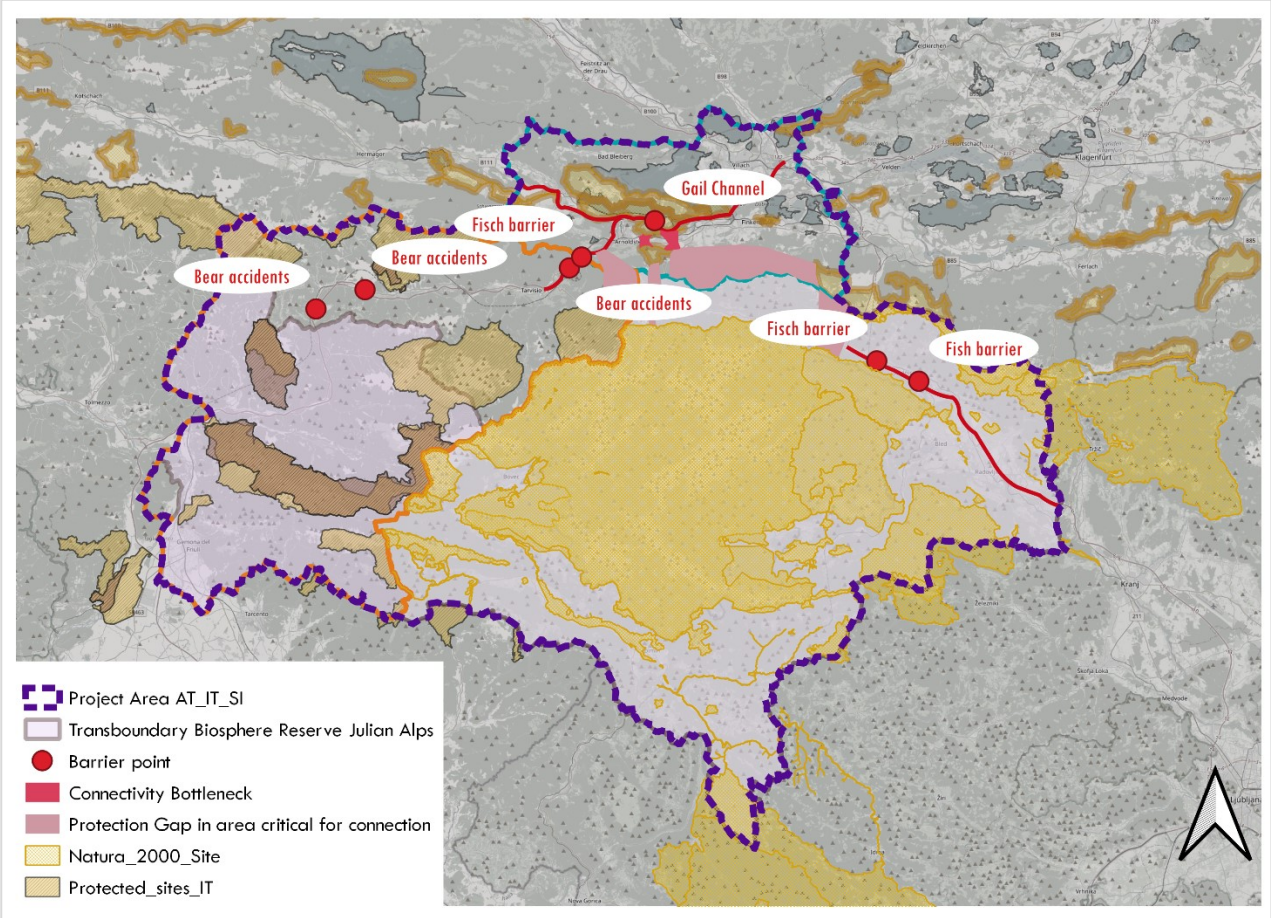

Figure 3: Protected areas and pressures to connectivity in pilot area. No current threats through renewable energy production were mentioned.

4.1 General threats to GBI ecological networks posed by infrastructure and land use

The following table lists the infrastructures and land uses analysed in Report D1.3.1 and assesses their impact on connectivity in the landscape. A distinction is made between structural and functional connectivity (see report D1.3.1).

In addition to the listed land uses, unsuitable agricultural uses and high tourism pressure without visitor management can also affect ecological connectivity, especially in the context of functional connectivity. In areas with connectivity bottlenecks, such land use may be the reason why a potential corridor is not used by sensitive wildlife (such as lynx).

Table 2: Infrastructures and land uses with their impact on connectivity

Sector	Type of infrastructure/ land use	Comments on connectivity
Renewable energies	Hydropower - reservoir (dam)	high impact on structural and functional connectivity, as a lot of land is usually taken up and barrier/fragmentation effects occur
	Hydropower - run-of-river power plants	low impact on structural connectivity due to minimal land use high impact on functional connectivity due to barrier/fragmentation effects in the water body
	Windpower - windmills	ow impact on structural connectivity due to minimal land take partially high impact on functional connectivity due to collisions (birds, bats)
	Solar energy - photovoltaics: Ground-mounted solar modules	Small scale solar modules usually have little impact on structural and functional connectivity, as soil sealing is generally low and the barrier effect is low. The impact depends on the size of the area and the design and especially on the fencing large-scale photovoltaics: high impact due to extensive habitat changes (structural connectivity) and fragmentation effects if fenced in (functional connectivity). Fragmentation effects on large mammals are to be expected from a length of 500 meters.
	Bioenergy - Biomass	Bioenergy plants: Mostly low impact on structural and functional connectivity, as generally little area is taken up and the barrier effect is low. The impact depends on the size of the plant! Change in land management and land use: no general statements possible, as the effects depend on the size of the area, the location and the intensity of biomass production
Energy sector as a whole	Transmission of electricity - high voltage power line	Low impact on structural connectivity due to minimal land use outside of forests Partially high impact on functional connectivity due to collisions (birds)
Transport	Roads/ Highways	high impact on structural and functional connectivity due to generally large land take, barrier effect, wildlife mortality from traffic and impacts from noise, dust and pollutants
Transport	Railway	High impact on structural and functional connectivity due to land use (habitat loss), barrier effects, traffic-related mortality of wildlife and impacts from noise, dust, pollutants and vibrations

Sector	Type of infrastructure/ land use	Comments on connectivity
Urban /industrial development	Urban/ industrial development	high impact on structural and functional connectivity due to land use (habitat loss), barrier effects and impacts due to noise and other pollutants

4.2 Definition of relevant infrastructures

As already described in report D1.3.1 and in **Error! Reference source not found.** the size and design of a particular infrastructure will determine whether it is likely to have a negative impact on the environment. For example, it makes a big difference whether the size of a PV plant is one hectare or 20 hectares.

It is therefore first necessary to analyse which infrastructures generally represent a burden or threat to connectivity and are relevant for spatial planning. It depends on many factors whether such projects will have an impact. The threshold values for projects are defined in the environmental impact assessment laws of the individual countries. For small infrastructure projects that are not relevant to spatial planning, whether or not they have an impact depends very much on the location. (see also Ifuplan, 2025).

The EU Environmental Impact Assessment Directive specifies the projects for which an environmental impact assessment (EIA) is mandatory. These requirements can be interpreted as an orientation for the spatial planning significance of various infrastructures. The EU Environmental Impact Assessment Directive does not specify relevance thresholds for all project types. EU Member States can further specify the need for an environmental impact assessment or a preliminary environmental impact assessment (on a case-by-case basis or by specifying certain criteria such as location, size or type of project).

Austria, Slovenia and Italy define project types in the EIA Act for which an EIA or a preliminary assessment must be carried out. The following table shows the types of projects that are considered spatially relevant and can therefore have a negative impact on the environment and connectivity. While the legislation differs in the three countries, recommendations are given for the selected trilateral core area and the selected corridors. Within the existing protected areas, there are stricter regulations and thresholds (biosphere reserve, nature parks, national park or Natura 2000 sites). An environmental impact assessment is recommended for any project in such protected areas. Particularly in the above-mentioned bottlenecks, any development could have serious impact and should therefore be subject to an EIA.

Table 3: Identification of projects thresholds for spatial planning (expert opinion) for the selected corridor within the pilot region.

	Relevance for spatial planning
Hydropower	Any construction and operation of a hydropower plant Any river canalisation and stream correction work
Windpower (windmills)	Any windmill will have an impact in the quite natural alpine area of the pilot region Screening: Wind power plants with a total capacity exceeding 1 MW also outside the core area.
Solar power (ground mounted photovoltaic systems)	ground mounted photovoltaic system with a size of at least 1 hectare will have an impact in the small valley floors of the pilot region I: Screening: photovoltaic systems with a capacity equal to or greater than 15 MW and 12 MW based on the classification of the area
Biomass (biogas plant)	Biogas plant with more than 1.2 million standard cubic metres of raw gas per year. I: Biomass (biogas plant) It falls under state competence, screening: Thermal plants for the production of electricity, steam, and hot water with a total thermal power output exceeding 50 MW
High voltage transmission line	transmission line with a voltage of 110 kV or more will have an impact in the small valley floors of the pilot region
Roads/ highways	Screening of any new road constructed in the pilot are due to
Railways	railway track associated operating facilities with more than 2000 m²
Skiing area	Screening of extension of skiing slopes within Biosphere reserve (IT.SI) and Natura Park (forest or wetland)
Settlement development	Screening of every new development out of existing urban core areas.

4.3 Existing pressures and expected major threats in the pilot region

The following table lists all spatially relevant projects in the selected corridor connecting the Julian Alps Biosphere Reserve with the Dobratsch Nature Park region (based on the definition of spatially relevant project types, see Table 3. It is based on the knowledge of the workshop participants and is supplemented by an aerial image interpretation. A distinction is made between existing infrastructure (pressures) and planned projects (threats).

Table 4: Overview – Existing pressures and expected major threats in the pilot region trilateral transboundary area (Austria, Italy, Slovenia)

Type of infrastructure/ Land use	Existing (pressures)	expected (threats)	Description
Hydropower - Hydroelectric reservoir (dam)	-	-	
Hydropower - Run-off-River power plant	River Slizza (IT, A) (power station south of Thörl Maglern (A), and several bedload barriers in Italy: (Lago di Predil, Cave di Predil, Rio Freddo, Tarvisio) Gail (A) (Gail canal north of Arnoldstein– - however, a fish pass has already been built and the connection improved) Drau (A) (Villach power plant) Sava (Slovenski Javornik power station) Sava (Hrušica bedload barrier)	Possible small hydropower projects on tributaries. However, none were currently mentioned by the participants and interviewees	In the pilot area there are several dams, bedload barriers and power plants in the rivers Slizza, Drava, Gail and Sava.
Windpower - windmills	Currently there are no windmills existing in the pilot region.	None were mentioned for Slovenia during workshops and consultations. Currently, none were mentioned for Italy during workshops and consultations. However, the area around Tarvisio and the upper Val Canale is not included in the Biosphere reserve. Therefore, project ideas might come up in that area within the next decade.	In Austria, there was a referendum against wind turbines in 2024, meaning that no wind turbines will be erected in the pilot region on Austrian soil in the next few years. There are restrictions on wind power in the Julian Alps biosphere reserve.

Type of infrastructure/ Land use	Existing (pressures)	expected (threats)	Description
Solar energy - Photovoltaics: ground-mounted solar modules	There are currently no large-scale ground-mounted solar installations in the pilot region. There are restrictions on industrial developments within the Julian Alps biosphere reserve. There are also currently no large-scale ground-mounted solar panels in the Dobratsch Nature Park.	In Austria, however, the development of at least small ground-mounted solar modules is currently being driven forward via the KEM region Dreiländereck in Austria. Project development is underway, in particular agri-photovoltaics (parallel use of agriculture and solar panels) is being promoted. In Italy and Slovenia, not a single such project was mentioned during the workshops. However, in the areas outside the boundaries of the biosphere reserve, the development of solar cells will most likely become established in the near future.	Actual trials are not currently known, but could occur in the next decade.
Bioenergy - Biomass	-	-	No existing or planned major Biogas plant
Transmission of electricity - High voltage transmission line	There are high- voltage power lines in the Val Canale, the Gail Valley and the Drava Valley as well as in the Sava Valley east of Jesenice.	In the Gail valley, Verbund Austria plans to close the power line ring around Austria. Therefore, a new power line will most likely be established in the communities of the lower Gail valley.	The power grid must expand in performance in combination with renewable energy. Despite actual attempts in Austria north of the pilot area, additional projects for merchandise lines might arise within the next years to connect the Gail with the Val Canale.
Roads/ Highways	Austria: A2, B111, B100, (B83) Italy: A23, SS13, SS54 Slovenia: A2, (201, 452, 411)	There was no project for increasing the	In the entire northern part of the pilot area there are 4-lane roads (Val Canale, Gailtal from Villach to Thörl Maglern. Sava valley from the Karawanks tunnel to Kranj). Due to the rough terrain, bridges and tunnels wild animals are still able to bypass the highways. However, the secondary road network is heavily

Type of infrastructure/ Land use	Existing (pressures)	expected (threats)	Description
			travelled, and the death of bears and other wildlife has been cited as a threat.
Railway	There is already a railroad network that runs through the pilot area: A: There are railroads in the Drau and Gail valleys that also connect to the Val Canale (IT). IT: Railway line through the Val Canale. S: Railway from Rosenbach (A) to Jesenice and Kranj through the Sava Valley. Old railroad to Bohinj Jezero.	No extension was mentioned during the workshops	There is an existing rail network in the pilot region. There are no current plans to extend it.
Urban/ industrial development	A: In the municipalities of Villach, Arnoldstein and Finkenstein there is a highly dynamic area in which urban and industrial development continues. IT: Around Tarvisio and the upper Fella Valley (Malborghetto) there is a dynamic area in which urban, industrial and tourist development is progressing.	Expansion of the industrial area around Villach/Arnoldstein. Expansion of the industrial or tourist area around Tarvisio.	No major development plans known, but continuous growth of settlement activity in the valley floor. There is a danger that the settlements in the small valley bottoms will grow together.
Skiing resorts	A: Dreiländereck IT: Tarvisio, Sella nivea SI: Krajnska Gora	Currently no extension mentioned during workshops	No major expansion plans known, leisure infrastructure available, located precisely in the connecting corridor element between Austria and Slovenia. Further development must be monitored (especially the fencing or the functional connection)

The table above shows a number of existing pressures to connectivity in the fairly natural area. The threats are currently unknown, but could arise throughout the pilot region as a result of renewable energy strategies. Careful spatial planning will play an important role in

avoiding the closure of bottlenecks in this pilot region. The three parks will therefore play an important role in communicating the importance of ecological connectivity in the region.

5 Choice of Locations for major developments / renewable energy facilities

5.1 General criteria for unsuitable locations

The general criteria for unsuitable sites are compiled in the following table. They are based on the corresponding chapters of the report D1.3.1.

Table 5: General criteria for unsuitable sites (D1.3.1 – Ifuplan)

	Unsuitable locations
Hydropower	• protected areas (e.g. Natura 2000 areas, nature reserves, …) • natural or semi-natural rivers
Windpower	• protected areas (e.g. Natura 2000 areas, nature reserves, core areas of national parks and biosphere reserves) • European bird protection areas with occurrences of wind energy-sensitive bird species • designated bird migration routes • density centres of collision-sensitive bird species • old natural or semi-natural forests • forested ridgelines because of high collision rates of birds and bats • areas with high perceived scenic quality (landscape quality)
Solar power	• protected areas (e.g. Nature 2000 areas, nature reserves, water protection areas) • areas of high nature conservation value • riparian buffer zones, floodplains • natural watercourses and lakes • soil with very high significance for natural soil functions • agricultural soil with high degree of productivity
Biomass (bioenergy plant)	• protected areas (e.g. Nature 2000 areas, nature reserves, core areas of biosphere reserves, water protection areas) • areas of high nature conservation value

	Unsuitable locations
High voltage transmission line	• European bird protection areas (Important Bird Areas (IBAs) or Special Protection Areas (SPAs)) • wetlands of international importance according to the Ramsar Convention • designated bird migration routes • near large bodies of water and reservoirs • protected areas specifically for landscape (UNESCO World Heritage Sites, Landscape conservation areas, priority areas for tourism) • other protected areas (e.g. Natura 2000 areas, nature reserves, core areas of national parks and biosphere reserves) • old natural or semi-natural forests • water protection areas of zones I and II (no construction of transmission poles in waterways or banks of waterways
Roads/ highways	• protected areas (e.g. Nature 2000 areas, nature reserves, core zones of national parks and biosphere reserves, water protection areas) • areas of high nature conservation value like old-growth forests or wet- and peatland • soil with very high significance for natural soil functions
Railways	• protected areas (e.g. Nature 2000 areas, nature reserves, core zones of national parks and biosphere reserves, water protection areas) • areas of high nature conservation value like old-growth forests or wet- and peatland
Urban /industrial development	• protected areas (e.g. Nature 2000 areas, nature reserves, core zones of national parks and biosphere reserves, water protection areas) • areas of high nature conservation value like old-growth forests or wet- and peatland • existing ecological corridors, especially in bottleneck areas

5.2 Development of specific criteria for unsuitable locations in the pilot region (exclusion zones)

In this context, exclusion zones are areas in which the construction of technical infrastructure is not permitted. Exclusion zones are the most common planning tool to mitigate the environmental impacts of human land use, including the use of RE. Unsuitable locations for such infrastructures are protected areas of various kinds: e.g. Nature 2000 sites, nature reserves, core zones of national parks and biosphere reserves, water protection areas or the developed GBI network for connectivity (including priority areas for conservation and restoration). However, for the definition of exclusion areas it is not sufficient to use only the boundaries of ecologically valuable areas. Many infrastructure projects have far-reaching effects (e.g. wind turbines or roads), so that their positioning directly next to an ecologically valuable area can have a negative impact on it. As described in report D1.3.1, edge effects and barrier or fragmentation effects influence not only the habitats adjacent to an

infrastructure, but also the ecosystems and wildlife habitats in wider areas (see report D1.3.1).

However, many of the infrastructures in the pilot region were already built in the past, before the protected areas were designated. For new developments, distances from ecologically valuable areas should be established to ensure that they are not impacted. These distances depend on the type of area and species present, as well as the type of infrastructure. Two approaches were chosen to answer this question:

- examples of existing standards or guidelines for determining unsuitable areas for a particular type of infrastructure and
- examples of the maximum impact range of infrastructure projects used as buffers around ecologically valuable areas undefined.

There are different buffers for different infrastructures in each country. With regard to the existing standards for our pilot region, we have adopted the corresponding exclusion zones of protected areas for this report. In other parts of the pilot area, different distances apply. The following table lists the unsuitable areas that occur in the pilot region with the proposed buffers. The proposed buffers are based on an assessment of buffers from various sources and our expert opinion - where no values could be found. In addition, any development within closed forests can be considered unsuitable.

Table 6: Compilation of examples for unsuitable locations and their corresponding buffers in the trilateral transboundary pilot site (data mainly for Austria if not mentioned differently).

	Relevant dimension	Unsuitable location	Buffer (m)	Reference
Hydropower	A: Small hydro power plant > 2 MW in area category A (Protected area) or B (Alpine area above 1800 m) A: Huge hydro power plants > 20 MW or 10 MW if length of oxbow is long A: Hydro power chains	The rivers within the core and transition zones of the Biosphere Reserve Julian Alps should basically remain free of such infrastructures. Also, the rivers within natura 2000 sites. For the other natural river parts, impact assessments must be done to define and ensure mitigation measures on aquatic biodiversity. A cumulative effect with existing hydropower plants and bed load	SI, AT, I Determined for each power plant specifically by impact assessment.	Expert opinion and UVP Law Austria

	Relevant dimension	Unsuitable location	Buffer (m)	Reference
Windpower	Small windmills large windmills (> 50 m) Windmills > 30 MW or > 20 Converters with 0,5 MW each.; Windmills 15 MW in areas higher than elevation of 1000m or > 10 Converters with 0,5 MW each. or in protected area category A (protected area)	Natura 2000 areas, nature reserves, national park core zones and biosphere reserve core zones For the other natural river parts, impact assessments should be done to ensure mitigation measures on aquatic biodiversity AT: No wind power may be erected above 1800 m above sea level and in protected areas (biosphere reserves, nature parks, Natura 2000, etc.).	A: Restrictions are given for areas above 1800 m, exclusion zones are biosphere reserves, National Parks, Natura 2000 areas, Nature Parks, wildlife corridors, important bird areas. The State of Carinthia has its own subject area program for this purpose, where green and red zones (with these requirements) are to be designated for the planning and construction of wind energy. SI: For larger wind turbines and wind farms no minimum distance between wind turbines and residential buildings is defined by regulations or act; individual construction/project proposal is subjected to an environmental impact assessment IT: Distance of 3000 meters to protected objects	EIA-Law Austria. National Park law, Habitat and Bird Directive, Environmental Impact Assessment must be done depending on species listed (bats & birds, habitat loss) Regional Planning Law State of Carinthia EIA-Law Italy
		Old, natural or semi-natural forests, forested ridgelines	1500 m/impact on birds and bats	Estimated by Ifuplan 2025, not existing in Austria
		Areas with high perceived scenic quality, Landscape protection area	Visibility from settlement is criteria in Austria Impact assessment is necessary	Purpose of protection must not be contradicted

	Relevant dimension	Unsuitable location	Buffer (m)	Reference
		IT: Prohibited activities according to the regional regulation. The construction of wind turbines or similar is not explicitly mentioned there. However, interventions in the landscape are prohibited. This would probably not be compatible with wind turbines. According to the management plan, the construction of wind turbines in the Riserva Parziale (development zone) is probably also not permitted. In any case, there is no general ban, but a requirement for approval, and construction is probably not possible here due to the landscape protection requirements.		Regolamento del Parco naturale regionale delle Prealpi Giulie
Solar power	Large solar power plants Small solar power plants	Protected zones (national park, Natura 2000 area, nature park, landscape conservation area), ecological corridor Depending on fencing or ancillary use (biodiversity)	A: Restrictions given, exclusion zones SI: If the installation is carried out adjacent to the installation and the furthest point that the installation can reach is less than 1.5 metres from the boundary of adjacent land, the investor must have the consent of the owners of the adjacent land (UIRS, 2025) IT: Distance of 500 meters to protected objects	Own estimation, not yet mentioned in (EIA)- law Austria Own estimation EIA-Law Italy
		Areas with high perceived scenic quality, Landscape protection area	A: visibility from settlement is the criteria	Own estimation Purpose of protection must not be contradicted

	Relevant dimension	Unsuitable location	Buffer (m)	Reference
Biomass (bioenergy plant)	A: > 200 MW or 100 MW in area category D (settlement)	Protection zones (National Park, Natura 2000 area, Nature Park, landscape protection area), ecological corridor Depending on fencing or side use (biodiversity)	A: Impact assessment needed (EIA) also focussing on emissions.	EIA-Law Austria
		Areas with high perceived scenic quality, Landscape protection area	visibility from settlement is the criteria	Own estimation Purpose of protection must not be contradicted
High voltage transmission line	Austria: 220 kV or more and length > 15 km	Protected areas	Not officially defined	EIA Law Austria
Transport and Railways	Construction of long-distance railway lines or certain frequency. Construction of highways and motorways, change of highway > 10 km	Protected areas	No Buffer defined,	EIA Law Austria Depending on design of each infrastructure
Skiing areas	A: Development of ski areas through the construction of cableway facilities for passenger transport or ski lifts or the construction of ski slopes or snow-making facilities (including water reservoirs), if this means land use with terrain changes of at least 20 ha; depending on the length of the slope; ad also water for snow-making facilities and water reservoirs	Protected areas	No buffer defined; EIA necessary	EIA-Law Austria Depending on surface and design of each infrastructure
Deforestation for any development	Any project with deforestation >20 ha	Protected areas and ecological corridors		EIA-law

Buffers are not defined for all different infrastructure and may be different in the three countries of the pilot area.

Table 7: Buffers to energy infrastructure per country

Type of infrastructure	**Buffers** Slovenia (According to UIRS, 2025)	**Buffers** Italy	**Buffers Austria**
Hydropower	SI Determined for each power plant specifically by the municipal spatial plan.		No minimum distance defined
Windpower	**SUI For larger wind turbines and wind farms** A minimum distance between wind turbines and residential buildings is not set by regulation or law; each individual construction/project proposal is subject to an environmental impact assessment, spatial plans and safety requirements. The typical distance is between 300 and 500 meters, but can be greater for particularly sensitive environments or larger wind turbines. **For wind turbines up to including 50 KW** If the installation is carried out next to the plant and the furthest point that the plant can reach is less than 1.5 metres from the boundary of the adjoining property, the investor must have the consent of the owners of the adjoining property.	**n. A.**	Minimum Distance of 1500 m to residential buildings according to § 5 Abs. 6 Carinthian Wind power regulation
Solar power	**Photovoltaic panels /installations Stand-alone photovoltaic power plants installed on land (up to 1 MW)** Photovoltaic systems up to 1 MW are installed on an existing building or structure constructed in accordance with the regulations for the construction of buildings (hereinafter referred to as 'the structure'), or they are installed adjacent to the structure and their footprint on the property does not exceed 20% of the developed area of the property. If the installation is adjacent to the structure and the furthest point that the installation can reach is less than 1.5 metres from the boundary of the adjacent property, the investor must have the consent of the owners of the adjacent property.	**n. A.**	No minimum distance defined
Transport infrastructure	**Motorways** 40 meters (from the outer edge) **Expressways** 35 meters **Main /trunk road** 25 meters **Regional roads (state roads)** 15 meters **Local roads (municipal roads)** 7 meters	**n. A.**	**n. A.**

	Public paths (municipal) 5 meters **Cycling paths (state)** 2 meters **Cycling paths (municipal)** 1 meters		

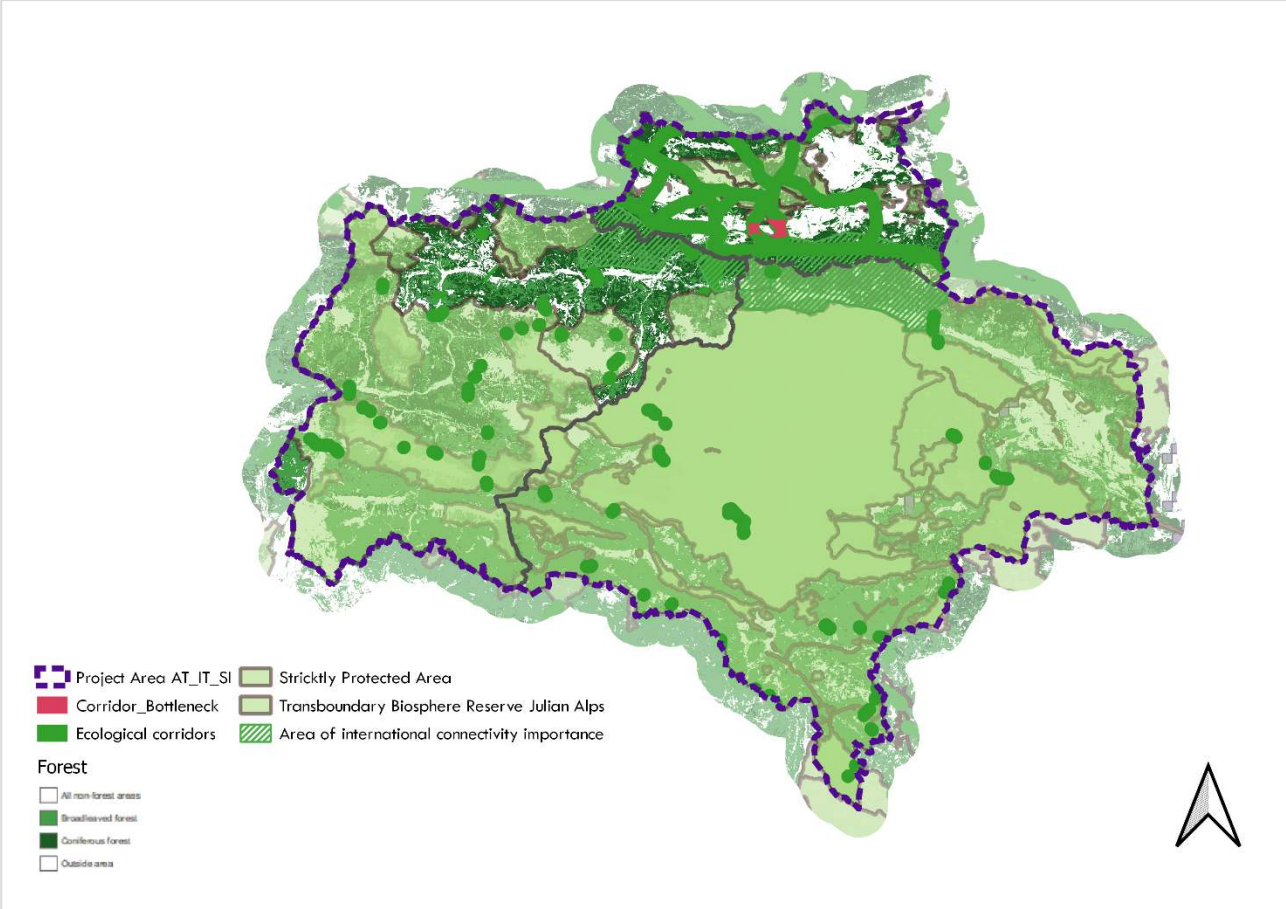

Figure 4: Overview of unsuitable locations in the trilateral transboundary pilot area.

Large parts of the trilateral cross-border pilot area (Austria-Italy-Slovenia) are located in protected areas or in forests. Both can be considered rather unsuitable for the development of RE. There are restrictions and environmental impact assessments must be carried out. There are also several ecological corridors that are currently used for wildlife movement. They must also be safeguarded in the future. The forested border area (Austria, Italy, Slovenia) is not under strict protection, but must also be considered as an area of international importance for connectivity. There is a risk that the north-south connection will be cut, especially the bottleneck in the municipality of Arnoldstein (A). Although the pilot region is huge, it is recommended to consider the development of RE very carefully and to place RE on a small scale and rather close to existing industrial sites in order to avoid conflicts.

5.3 Mapping the land use conflicts for renewable energy production

The following Figure 5 show the exclusion zones for each infrastructure analysed. Because there is a large overlap between the individual exclusion zones, the maps are very similar.

5.3.1 Hydropower

Older hydropower plants already exist in the pilot area. New projects were not mentioned during the consultations with stakeholders. However, small hydropower projects may be planned on the tributaries of the main rivers.

In Italy, Tarvisio was recently mentioned as Italy's first hydroelectric community for renewable energy (CER). The region wants to make the most of its natural resources, such as its numerous waterways and proximity to the Alps. The region has a long tradition in the use of hydropower and is to be further enhanced in the CER.

5.3.2 Windpower

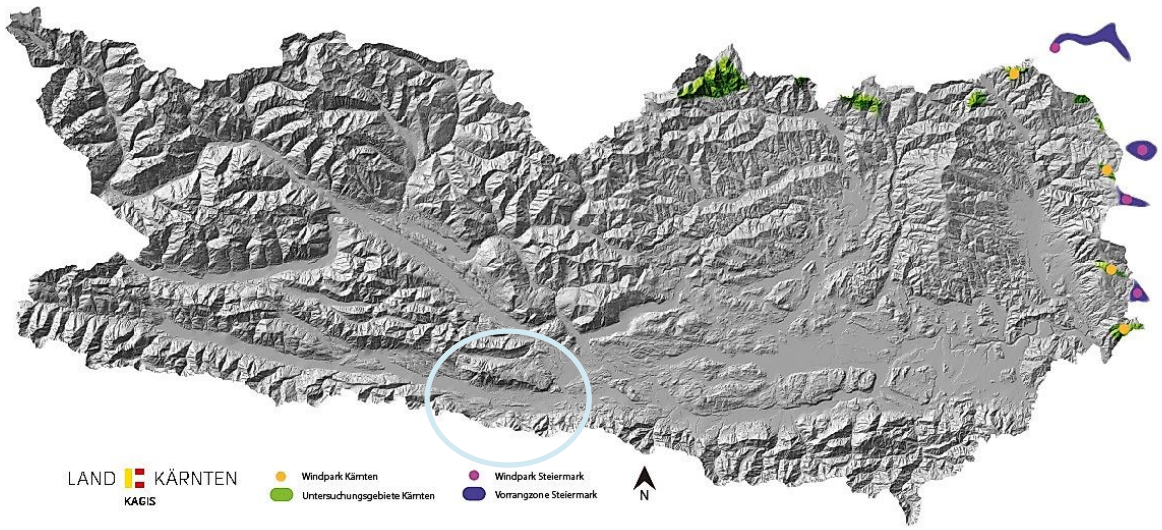

Figure 5: Zones suitable for wind power (windmills – in green) according to the federal government of Carinthia (A) in 2024. Pilot area, Austrian part.

The spatial planning law of Carinthia names exclusion zones for wind farms – such as protected areas (including nature parks), areas over 1800 m and wildlife corridors. In a referendum in January 2025, the majority of Carinthian citizens voted against wind farms in the Alpine region of the province. Therefore, according to the Energy Commissioner, less

than 0.3% of the area is considered suitable for wind turbines. These areas are located in the north-east of the province. The consequence of this decision is that the development of wind turbines (windmills) will be halted for at least the next decade. This means that there is currently no risk for the pilot region

5.3.3 Solar power

In Austria, in the federal state of Carinthia, a new regulation for renewable energies is in the works from 2024. A new photovoltaic ordinance and an energy transition law were presented by the two ministers responsible for spatial planning and energy in 2024 to simplify and accelerate the energy transition. More regional self-sufficiency with alternative energies and the careful use of Carinthian soil are the goals. “Not just a few, but as many people as possible - from small businesses to homeowners and farmers - should benefit from Carinthia's energy transition,” emphasized the provincial governor at a presentation at the Chamber of Agriculture in March 2024. This will enable a faster expansion of renewable energies. The new photovoltaic ordinance will enable a multiple of the previous potential areas. Self-sufficiency, the elimination of zoning procedures, but also the protection of valuable soils are clear priorities of this “Carinthian way”. For example, many photovoltaic systems will no longer require zoning at all in future: “This alone will make well over 3,000 hectares of potential land available for photovoltaic systems without zoning in Carinthia in one fell swoop,” explained the Deputy Governor. This will ensure more dynamism and a boost in the expansion of photovoltaics in Carinthia.

The announced parallel expansion on roofs and open spaces is being promoted: So-called grassland PV systems are now permitted, but require a planning zoning approval procedure and are limited to a maximum of 4 hectares. Valuable agricultural land for food supply is designated and protected from expansion. At the same time, however, agri-PV systems are also permitted “if the area is used for both energy production and agriculture”," explains Gruber. These new provisions are embedded in an energy transition law that aims to accelerate the expansion of renewable energies. Four pieces of legislation (Spatial Planning Act, Building Regulations, Electricity Act and Electricity Industry Act) are being coordinated in order to shorten and simplify procedures.

According to Schuschnig, the decisive factor is that the law stipulates for the first time that renewable energy installations are in the overriding public interest. In future, all renewable energy plants will only require notification under building law and lengthy construction procedures will no longer be necessary with this approach. This also eliminates the need for an impact assessment by the nature conservation authority. The threshold value for the approval requirement in electricity law will also be raised from 5 kW to 500 kW. Double-track procedures will be abolished. In future, it will no longer be necessary to obtain a separate permit under electricity law if, for example, a permit under commercial, waste, water, cableway or railroad law already exists.

However, this approach is being critically observed by the Federal Department for Nature Conservation. The assessment and harmonization with the legislation of the Alpine Convention is currently being undertaken by the Environmental Ombudsman.

In Slovenia renewable energies being considered in the region exist mostly at a strategic level in the Regional development programme of the Gorenjska developmental region 2021-2027 (2023). Objective 5 mentions “Developing a bioeconomy and green jobs based on local natural resources. The area is rich in natural resources (wood, water, solar energy), but there is a clear need for more efficient use of natural resources.

According to the interviewees, no wind power plant projects are currently planned. The entire Slovenian part of the pilot area lies within the UNESCO Julian Alps Biosphere Reserve, where infrastructural development is restricted (core and buffer zone) or at least requires an EIA (transition zone).

For the Italian part, there are regulations according to the Regolamento del Parco naturale regionale delle Prealpi Giulie. There are general prohibitions there. The construction of wind turbines or similar is not mentioned there. However, interventions in the landscape are prohibited. Wind turbines would probably not be compatible with this. Even according to the management plan, the construction of wind turbines in the Riserva Parziale (development zone) is probably not permitted. In any case, there is no general ban in Italy, but a permit requirement, and construction is probably not possible here due to the landscape protection requirements.

5.3.4 Biomass (bioenergy plant)

No large biomass plant is currently mentioned in the pilot area.

In the Regional Development Programme of the Gorenjska Development Region 2021-2027 (2023), forestry with natural resources is mentioned in the context of promoting bioeconomy and green jobs. Wood is mentioned as an energy source.

5.3.5 High voltage transmission line

The expansion of the high-voltage line is planned by Verbund (APG Austrian Power Grid) in the Austrian part of the pilot region. This line will run through the Dobratsch Nature Park north of the Dobratsch in the Drau Valley. A 380 kV power line is planned between Lienz (East Tyrol) and Sielach (Völkermarkt). If necessary, an additional substation is planned along the grid, according to Hafner, 2024.

The Figure 6 below shows the location of the grid (in yellow). The northern part of the pilot area, the Drau Valley, is affected. The Gailtal valley is not affected by this plan, although there could be plans for work on the power line there too.

Figure 6: Concept for 380 kV-Power line according to Austrian Power Grid 2024. Pilot area, Austrian part. Source: APG, 2024

6 Possible mitigation and compensation measures

A list of all possible mitigation and compensation measures can be found in Annex 2. The following table lists possible mitigation and compensation measures for the RE infrastructures in the trilateral cross-border pilot region (Austria, Italy, Slovenia). They are based on the corresponding chapters of report D1.3.1.

Fish ladders have already been installed at the Villach (Drau) and Gail (Gail) hydropower plants.

Table 8: Mitigation / compensation measures for existing and planned RE in the pilot region "Trilateral transboundary pilot site (Austria, Italy, Slovenia) I"

	Project	**Mitigation / Compensation**
Hydropower	There are already existing hydropower plants in the pilot area. No projects were mentioned during the stakeholder consultations	Improve permeability by building fish ladders and natural fish ladders. (Slizza, Sava) Construction of a wildlife bridge on the Gail Canal New projects should include fish passes and sufficient residual flow as well as a concept for sediment transport.
Windpower	No projects were mentioned during stakeholder consultations	Buffer zones to protected areas and corridors Completely avoid placement in important migration corridors or near breeding sites of sensitive species
Solar power	No specific project for large solar power plants was mentioned in the stakeholder consultations. Small solar power plants and agri-PV systems could emerge in the coming years.	Placement of such structures on already degraded land Roofs are preferred. Avoid fences or keep a distance from the ground that is passable for small wildlife. Avoid artificial lighting at night
Transport infrastructure	No projects for new transport infrastructure were mentioned in the workshops. Improvement of existing transport infrastructure	Construction of at least three green bridges for wildlife over the SS13 in the Val Canale to avoid traffic casualties. Improvement of wildlife passed on B100 and B 111 Speed limit on SS 54 (IT) and B83 (A)
All renewable energy projects which require deforestation	All upcoming projects in corridor areas and in bottleneck area.	Assess impact on ecological corridors in the planning phase

Recommendations for all upcoming renewable energy projects in the pilot area:

- In order to avoid conflicts, it is necessary to communicate the importance of the ecological corridors in the pilot area (this will be done in part through the current project) and to show and highlight the corridors on the public maps.
- Designation and establishment of additional protected areas at bottleneck sites
- Planning authorities (local, regional and federal/state) must be informed of the existence of the corridors and are legally obliged to take them into account when planning any infrastructure. Compensatory measures must be taken if the public interest in renewable energies outweighs the interest in nature conservation.

Figure 7: Fish ladder at Drau River (Example at Annabrücke). © Verbund 2024

7 Conclusions

The trilateral cross-border pilot area (Austria-Italy-Slovenia) consists of large natural and protected areas (Julian Alps Biosphere Reserve) and several Natura 2000 areas in Slovenia and Italy as well as the Dobratsch Nature Park with a large Natura 2000 area in Austria.

The land use in the pilot region currently allows for good accessibility, although a macro-regional transport infrastructure is in place. Large parts of the pilot region are covered by forests. As long as these forests continue to exist in the future and the forest laws in the three countries are quite strict, connectivity will be ensured.

The open part of the country is currently dominated by well-structured small-scale agriculture. According to the workshop participants and interview partners, there are currently no efforts to integrate large-scale renewable energy development into the pilot project. However, there is a risk in all three countries that energy efficiency and renewable energy production will be improved and that the pilot region will not be completely spared. Outside the strictly protected areas, such developments will most likely occur in the future. The pilot region consists of large mountainous regions and rather small valleys.

While there are currently no plans for wind turbines and large solar power plants mentioned by the regional connectivity working groups in 2024, small solar power plants and agri-photovoltaic installations could soon become part of the landscape, even in the rather small valleys of the pilot region.

While the habitats of the biosphere reserve are well protected and connected (core and transition zone), the connection to the north and to the Austrian habitats is currently not fully secured. While the landscape is generally very well connected via extensive forested mountain slopes in the area of the border triangle and the Wurzen Pass, there are gaps in protection in the valley floors (e.g. west of Podkoren (SI)). A bottleneck exists above all in the valley floor of Gail (A), where industrial, traffic and settlement development are continuing around this area. The ecological core areas south of the Schütt Dobratsch Natura 2000 site are only connected by two 1000 m wide pieces of semi-natural land (Pöckauer Moos and the forest between the villages of Riegersdorf and Pöckau) in the nature park municipality of Arnoldstein. The municipality is perhaps not yet aware of the importance of this connection.

For the above-mentioned bottleneck area in Austria, immediate attempts should be made to secure the corridor. In order to secure the connection between the Dobratsch Nature Park and the transboundary UNESCO Julian Biosphere Reserve in the future, emphasis must be placed on keeping this bottleneck area free of any development, including energy production.

In addition, the forest area between Thörl Maglern and Arnoldstein in the western part of the Dobratsch Nature Park also has an important corridor function and must be kept open in the future. Due to the A2 highway, the permeability in this area is essentially given under the highway bridges near the river Slizza.

The forest north of Tarvisio on the Italian side of the pilot area is of similar importance for the ecological network. Bear accidents along the SS13 witness to the bottleneck of this bypass for the movement of large mammals. Although the wild animals can pass the A2 highway through overpasses or underpasses, they are then caught up in the traffic on the main road. Wildlife bridges should be built there. Near the Slovenian border, the forest east of Fusine in Valromana must be protected from further development in order to secure the connection to Austria to the north. The wooded area may not be touched anyway, but it is advisable to inform the community about the role of this area for connectivity.

In Slovenia, strictly protected areas dominate the centre of the pilot region. However, the area between Podkoren and Rateče, which represents the physical connection to Austria to the north, lies in the transition zone of the biosphere reserve, but is not under strict protection. It is advisable to communicate the importance and role of this area in safeguarding the corridor to the municipalities. In addition, the forest area north and east of Podkoren along the Wurzen Pass also has an important corridor function.

Renewable energy generation should be kept away from these areas. For small photovoltaic installations on the ground (up to 1 ha), it is recommended to take compensatory measures if they cannot be completely avoided. Such measures can provide a minimum level of permeability (at least permeable for smaller species and red deer) by increasing the distance of fences from the ground. They can also provide biodiversity-rich vegetation (e.g. dry meadows and improved structures for reptiles). To protect the landscape, such installations should be hidden in hollows and by hedges.

As far as rivers are concerned, much can be done to improve river connectivity. The EU Water Directive supports the idea of connected and ecologically intact rivers. Work should therefore be carried out in all three countries within the next decade to improve the permeability of existing hydropower plants. Fish ladders have already been installed on the Drau and Gail rivers.

8 Glossary

Term	Definition
Bioenergy plants	A biomass cogeneration plant (BMHKW) and a biomass power plant (BMKW) generate electrical energy by burning solid biomass. A biomass CHP plant also provides heat, which can be used as district or local heating or as process heat. In the case of pure heat provision, this is referred to as a biomass heating plant (BMHW). Solid fuels (biogenic solid fuel) such as residues from wood processing like sawdust, wood chips, forest wood not suitable for use as timber, straw and waste wood are used as raw materials, but grain can also be burned.
Connectivity" (structural and functional)	"Connectivity comprises two components, structural and functional connectivity. It expresses how landscapes are configurated, allowing species to move. Structural connectivity, equal to habitat continuity, is measured by analysing landscape structure, independent of any attributes of organisms. […]. Functional connectivity is the response of the organism to the landscape elements other than its habitats (i.e. the non-habitat matrix). This definition is often used in the context of landscape ecology. A high degree of connectivity is generally linked to low fragmentation." (EUROPEAN COMMISSION - Technical information on Green Infrastructure (GI), 6.5.2013, Glossary) (Definition of connectivity see also Deliverable 1.1.1, chapter 8)
Fragmentation	Habitat fragmentation refers to a process of environmental change that has a decisive influence on evolution and biodiversity and is also responsible for species loss. It involves the splitting up of the habitat of animal or plant species with the result that genetic exchange between the resulting sub-habitats is prevented. Habitat separation is caused either by geological or climatic processes such as rift valleys or glaciations, or by anthropogenic influence such as deforestation and road construction or other development.
GBI – Green and blue infrastructure	Green infrastructure (GI) is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings." (EUROPEAN COMMISSION - Green Infrastructure (GI) — Enhancing Europe's Natural Capital, 6.5.2013) (Definition of connectivity see also Deliverable 1.1.1, chapter 6)
Hydropower (dams, weirs, run-off-river power plant)	power derived from the energy of falling water or fast running water to generate electricity Hydropower generation including development and use of associated infrastructure (e.g. building dams or weirs, changes of hydrological functioning rivers or chemical and thermal properties of water due to operation of dams and weirs).
Hydroelectric dam	a barrier that stops or restricts the flow of water; used to create energy in the water flow that can be captured by a turbine to generate electricity
Pressures and Threats	Definition by the European Environment Agency 2020 (State of nature in the EU - Results from reporting under the nature directives 2013-2018):

	"Pressures are considered to be factors that have affected habitats and species within the current reporting period, while threats are factors that are anticipated to be likely to have an impact during the subsequent two reporting periods."
Solar PV panel	an arrangement of photovoltaic materials that absorbs and converts sunlight into electricity
Transmission lines	power lines used to move electricity from a generating site (e.g., a power plant) to an electrical substation, which often transforms the voltage from high to low before reaching consumers
Wind farm	Group of wind turbines used to produce electricity

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ANNEXES

Annex 1 Mitigation /compensation (see D1.3.1)

	Mitigation / Compensation
Hydropower	• Upstream and downstream fish passage facilities (fish ladders, bypasses) to allow migration • intelligent turbine design or turbine shutdown on a fixed schedule decreasing turbine related mortality • ecologically effective minimum flow of water • bed-load management • morphological enhancement measures: ➢ improvement of the riverbank structure (unsealing the riverbank) ➢ introduction of gravel banks ➢ introduction of disturbance elements (stones, deadwood) • New hydropower technologies with less environmental impacts
Windpower	• turbine design optimization • switch off systems at times of increased bird/bat activity to prevent/avoid collisions (Automatic anti-collision systems) • unattractive design of the environment at the base of the mast and in surrounding fields for wind energy-sensitive birds (red kites)
Solar power	• landscape-oriented design of the facility, visual integration into the environment: suitable arrangement of the solar panels (e.g. “Solar biotope network”) • sufficiently large (wide) open spaces between the rows of solar panels (sunlit strips at least 3 m wide between the rows) • elevation of the solar panels (panel distance to the ground at least 0.8 m) • no fencing or at least permeable for small and medium-sized mammals (15 cm distance between the fence and the ground), migration corridors as crossing aids for large-scale facilities • development and maintenance of extensively used, species- and flower-rich grassland in the solar park ➢ using seeds from local species or locally obtained mown material ➢ no fertilization, no use of pesticides ➢ up to 2 mowing intervals (use of insect-friendly mower, cutting height 10 cm) with removal of mowed material or/and site-adapted grazing • no mulching
Biomass (bioenergy plant)	• -

	Mitigation / Compensation
High voltage transmission line	• bundling of linear infrastructure, appropriate route alignment • appropriate design of the pylons to reduce fragmentation including spanning above the forest canopy • marking transmission lines to reduce bird collision risk • ecological rights-of-way vegetation management creating and connecting new habitats
Roads/ highways	• appropriate route alignment • traffic management measures: reducing traffic volume or speed • fencing combined with wildlife passages • wildlife passages as overpasses (e.g. green bridge, fauna overpass, multiuse overpass) or as underpasses (e.g. viaduct, fauna underpass, multiuse underpass, small fauna underpass, adapted culverts, fish passage, amphibian passage) reducing the barrier effect and providing a safe crossing • embankments to mitigate noise and provide new habitats for endangered flora species • adapting infrastructure verges • mechanical methods for vegetation control or grazing as alternative methods to the use of chemical substances in the management of green areas • adapting road lighting for mitigating light pollution • noise screens, placing the road between cuttings or earthen mounds, silent pavements for mitigating noise • runoff water management: Retention ponds
Railways	• appropriate route alignment • fencing combined with wildlife passages • wildlife passages as overpasses (e.g. green bridge, fauna overpass, multiuse overpass) or as underpasses (e.g. viaduct, fauna underpass, multiuse underpass, small fauna underpass, adapted culverts, fish passage, amphibian passage) reducing the barrier effect and providing a safe crossing • embankments/ earthworks to mitigate noise and provide new habitats for endangered species • adapting infrastructure verges • mechanical methods for vegetation control or grazing as alternative methods to the use of chemical substances in the management of green areas • noise screens, placing the road between cuttings or earthen mounds, rail noise absorbers for mitigating noise • runoff water management: Retention ponds

	Mitigation / Compensation
Urban /industrial development	• appropriate location of new urban/industrial development (avoid areas of high nature conservation value including ecological corridors) • preservation of large, undissected open spaces, safeguarding inner-urban trees (particularly large/mature trees) • minimizing the road infrastructure associated with urban/industrial development, keeping vehicle speeds low • reducing use of fertilizers and pesticides in maintenance of public and private green • minimizing artificial lighting • good pet ownership to reduce domestic animal damages to wildlife • runoff water management: minimize water runoff into streams • Integration of connectivity elements in zoning plans / optimising connectivity planning and interfaces between regional concepts and municipal planning

PlanToConnect

Mainstreaming ecological connectivity in spatial planning systems of the Alpine Space

Project partners:

Urban Planning Institute of the Republic of Slovenia (SI)
Veneto Region (IT)
ALPARC – the Network of Alpine Protected Areas (FR)
Asters, organisation for the conservation of natural areas in Upper Savoy (FR)
Eurac Research (IT)
ifuplan - Institute for Environmental Planning and Spatial Development (DE)
University of Würzburg (DE)
Salzburg Institute for Regional Planning and Housing (AT)
E.C.O. Institute of Ecology Ltd. (AT)
Fondazione Politecnico di Milano (IT)

Document / report title

D.2.4.1. GBI-network: Land use conflicts for RE production and other threats Pilot Region: Trilateral transboundary pilot site (Austria-Italy-Slovenia)

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Layout
E.C.O. based on UIRS template

March, 2025