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Strategic Environmental Assessment of the Austrian Integrated Network Infrastructure Plan

Environmental Report – Draft for Public Consultation

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Introduction

The integrated Austrian network infrastructure plan (NIP) is prepared on the basis of § 94 ff of the Renewable Energy Expansion Act [EAG]. The NIP is an overarching strategic instrument that identifies the fundamental requirements and objectives of network planning in the electricity and gas sectors for a cross-sectoral energy transition with the goal of climate neutrality. In the NIP, the various high-level energy transmission infrastructures for electricity and gas are considered in an integrated manner for the first time on the basis of common assumptions and quantity structures.

This integrated network infrastructure planning enables a cost-efficient and targeted expansion of transmission capacities in the electricity sector and supports measures for a suitable restructuring of the gas infrastructure. This approach should also enable improved coordination of efficient and demand-oriented network expansion with the expansion of facilities for the generation and storage of electricity and gas from renewable sources.

Energy generation and demand, transport requirements for electricity, gas and hydrogen as well as suitable flexibility and storage solutions are presented. Generation is represented by the identification of land potential for the application of renewable energy. In the electricity sector, the transmission network is considered, and in the gas sector, the transmission network and network levels 1 to 2, as well as the development of a hydrogen infrastructure.

As part of the preparation of the Integrated Network Infrastructure Plan (NIP), a Strategic Environmental Assessment (SEA) is carried out in accordance with section 95 EAG (Strategic Environmental Assessment and Public Participation). The SEA examines whether and, if so, to what extent the planned measures of the NIP are likely to have a significant positive or negative impact on one or more environmental areas. The results of this environmental assessment are documented in this environmental report.

1 Contents and environmental goals

To achieve climate neutrality, a transformation of the energy system is required to achieve a complete substitution of fossil energy sources with renewable energy sources. In the course of the necessary transformation, there will be major changes in the area of energy use. Since electrical energy is produced renewably and can be used in a very versatile way and usually with particularly high levels of efficiency, the trend towards electrification of energy applications will continue. As a result, electricity consumption will increase significantly in parallel with the phasing-out of natural gas, petroleum products and coal, which means that the expansion of electricity generation from renewable energy sources will be particularly important. The NIP presents these requirements for the future energy infrastructure, embedded in an overall view of the energy system, by means of merging generation and consumption centres for a cross-sectoral energy transition.

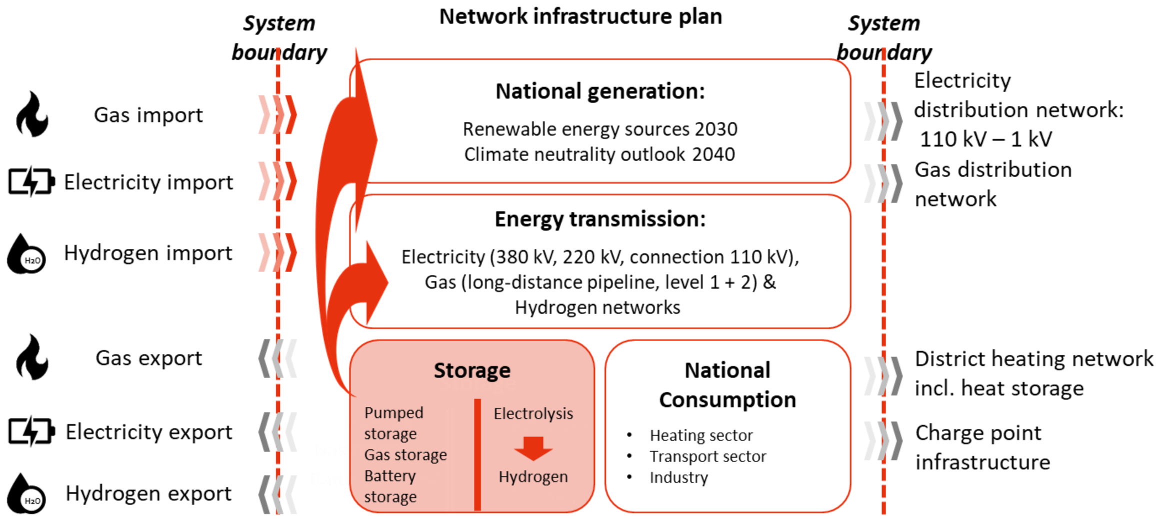
The infrastructure requirements planning for the electricity and gas sectors, which were previously based on separate assumptions, are considered in an integrated manner for the first time. In the NIP, sections of the transmission network are identified in which overloads or network bottlenecks can occur with the assumed future generation and consumption developments. Transport requirements between regions are derived from the analysis. The identified network bottlenecks and transport needs indicate that appropriate measures must be provided by the transmission system operator when preparing future network development plans in order to ensure sufficient energy supply.

By taking a holistic view in the NIP, interactions and synergies between energy sources, generation and consumption sectors are utilised in the planning of infrastructure.

The NIP thus serves as a basis for demand-oriented network development as well as for in-depth and coordinated energy space planning. The plan draws a systemic overall picture of the future demands on the energy system and creates an informative work on the energy transition (BMK [Federal ministry for climate protection], 2023).

In the electricity sector, the NIP looks at the 380 kV and 220 kV networks, including the 110 kV connection, and in the gas supply sector it looks at the transmission network and network levels 1 and 2, as well as the future need for a hydrogen infrastructure.

Figure 1 System boundaries of the NIP (BMK, 2023)



In accordance with its legal mandate, the Integrated Network Infrastructure Plan follows the following principles (Article 94 (2) EAG):

- For the long-term and continuous maintenance of security of supply, an early and ongoing modernisation of the energy infrastructure, primarily through improved coordination of network expansion with the expansion of facilities for the generation and storage of electricity and gas from renewable sources, should be sought.
- By taking a holistic view, specific interactions and synergies between energy sources, generation and consumption sectors are to be utilised in the planning, construction and operation of infrastructure.
- In the course of planning the required energy infrastructure, the environmental assessment pursuant to § 95 shall be carried out and, in particular, aspects of soil, water and nature conservation, spatial planning and transport shall be given greater consideration.
- In terms of affordability and competitiveness for households and businesses, the costs of energy infrastructure should be proportionate to its benefits.
- In order to increase the acceptance of measures for the construction of the required energy infrastructure, all interested parties should be involved in the planning process at an early stage and receive appropriate information.

1.1 Goals and environmental objectives of the NIP

- From 2030 onwards, 100% of total electricity consumption is to be covered by renewable energy sources on a national balance sheet basis. This supports the goal of climate neutrality in 2040.
- Promoting the generation of electricity from renewable sources.
- Promotion of plants for the production of renewable gas.
- The expansion of the energy infrastructure is carried out in line with demand, with foresight and in the long term to achieve climate neutrality and to ensure security of supply.

1.2 International and national environmental protection goals

The environmental report shall set out the objectives of environmental protection set at international or Union or Member State level that are relevant to the NIP and how these objectives and any environmental considerations have been taken into account in the preparation of the plan[1].

The NIP prioritises targets related to climate protection, in particular the achievement of climate neutrality. The SEA Directive (SEA Directive as well as the EAG) also lists other protected resources and interests (human health, biodiversity, fauna, flora, soil, water, air, landscape, material assets and cultural heritage) that may be affected by likely significant positive and negative environmental impacts. Therefore, in addition to the environmental objectives anchored in the EAG (see chapter 1.1), a number of important international and national standards[2] are consulted, the objectives of which serve to derive environmental objectives for the protected resources concerned. These environmental objectives are taken into account as a basis for assessing the environmental impacts of the NIP.

1.2.1 Biodiversity, flora, fauna

- UN Convention on Biological Diversity with the objectives of conserving biological diversity and using its constituents sustainably, and halting the loss of biodiversity

[1] Annex 1, Part 2 (EAG)

[2] Selection

- Flora-Fauna-Habitat Directive (92/43/EEC) with the essential objective of conserving and restoring biodiversity
- Birds Directive - Directive 2009/147/EC aiming at the permanent conservation of the wild native bird species in the territory of the European Union and, in addition to their protection, regulating their management and exploitation
- EU Biodiversity Strategy for 2030 with the aim of putting Europe's biodiversity on the road to recovery by 2030
- Austrian Biodiversity Strategy 2030+ with the goal that by 2030 30% of endangered native species and biotope types should be in good condition or developing positively; 30% of the country's territory should be under protection
- Nature conservation laws of the federal states with the aim, among others, of protecting and sustainably using the landscape including its animal and plant species

1.2.2 Population, human health, settlement development

- Regional planning laws of the federal states with the aim, among others, of developing the settlement structure while taking into account the economical use of energy and increased use of renewable energy sources as well as climate protection targets
- Improve spatial planning programmes of the federal states with the goals of sustainable use of nature and landscape, preservation of biological diversity, promotion of climate protection or resource efficiency, among others
- Masterplan ländlicher Raum [master plan for rural areas] (2017) calls for soil-conserving settlement development under priority 5 "land use"
- EU Environmental Noise Directive (Directive 2002/49/EC) and Federal Environmental Noise Act [Bundes-LärmG] with the objectives of preventing, avoiding or reducing harmful effects, including annoyance, caused by environmental noise

1.2.3 Ground

- EU Soil Strategy (COM (2021) 699 final): Member States should set their own ambitious national, regional and local targets for reducing net land use by 2030 by 2023 in order to make a measurable contribution to the EU's target of net zero land use by 2050
- "Caring for Soil is Caring for Life" (EC 2020c) - Soil Health and Food Mission Board of the European Commission to ensure that 75% of soils are healthy for food, people, nature and climate by 2030 and net sealing is zero

- Soil Charter (2014) with the aim of stopping large-scale land take and sustainably protecting soil as a resource
- Support the objectives of the Bioeconomy Strategy (2019): soil sealing in Austria is to be massively reduced by 2030
- Global Sustainability Goal UN SDG 15.3. (2015) Target: to achieve land degradation neutrality worldwide by 2030
- Alpine Convention and Protocols, in particular the Protocol on Soil Protection with the aim, among others, of using land sparingly (land use)
- Soil protection laws with the essential goals of qualitatively and quantitatively safeguarding and preserving the ecological soil functions
- According to the government programme 2020-2024, the land consumption should be kept as low as possible and the annual growth should be reduced to 2.5 hectares/day or 9 km2 per year by 2030. The soil function assessment is also explicitly stated
- Forest Act 1975 with the objectives of preserving the forest and the forest soil, ensuring that the forest is treated in such a way that the productive power of the soil is preserved and its effects are sustainably assured and ensuring sustainable forest management

1.2.4 Water

- EU Water Framework Directive (Directive 2000/60/EC) [WRRL] and Water Act 1959 [WRG] with the objectives of achieving good ecological and good chemical status for surface waters and good quantitative and chemical status for groundwater
- EU Action Plan "Pollutant-free air, water and soil" COM(2021) 400 final
- National Water Management Plan [NGP 2021] with the main objectives of maintaining and restoring functioning water systems and promoting sustainable use of water as a resource

1.2.5 Air

- EU Air Quality Directive (2008/50/EC) and Immission Control Act for Air [IG-L] as well as associated ordinances to the IG-L with the objectives of avoiding, preventing or reducing harmful effects of air pollutants on human health and the environment as well as maintaining and improving the air quality
- Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants (NEC Directive)

1.2.6 Climate protection & energy transition

- Revision of Directive (EU) 2018/2001 (Renewable Energy Directive, RED III) with the aim of increasing the share of energy from renewable sources in gross final energy consumption to 42.5% within the EU by 2030
- Regulation (EU) 2023/857 (Effort Sharing Regulation) with the aim of reducing Austria's greenhouse gas emissions by 48% in 2030 compared to 2005
- Directive (EU) 2023/059 (ETS Directive) with the aim of reducing emissions from sectors covered by the EU ETS by 62% compared to 2005
- Regulation (EU) 2018/1999 (Governance Regulation) with the aim of meeting the European Union's (EU) energy and climate targets for 2030
- UNFCCC (Climate Change Convention): United Nations Framework Convention on Climate Change with the aim of reducing greenhouse gases and taking precautions against climate change
- Federal Act on the expansion of energy from renewable sources (Renewable Energy Expansion Act - EAG), BGBl. [Federal law gazette] I 181/2021 with the targets of 100% renewable electricity in 2030 and climate neutrality in 2040
- Government agreement 2020-2024 with the goal of achieving climate neutrality in 2040
- Austrian strategy for adaptation to climate change (2017) with the aim of precaution against and adaptation to climate change

1.2.7 Tangible assets and cultural heritage

- Monument protection act with the aim of permanently preserving monuments and material cultural assets in their variety and diversity: Prerequisite is their historical, artistic or other cultural significance
- UNESCO - Convention concerning the protection of the world cultural and natural heritage, aimed at promoting the protection and conservation of cultural heritage worldwide

1.2.8 Landscape

- Nature conservation laws of the federal states with the aim, among others, of protecting and sustainably using the landscape, including its animal and plant species, as well as the spatial planning laws and spatial planning programmes of the federal states

- Forest Act 1975 with the objectives of preserving the forest and the forest soil, ensuring that the forest is treated in such a way that the productive power of the soil is preserved and its effects are sustainably assured and ensuring sustainable forest management

1.3 Relationships with other relevant plans and programmes

The NIP is related to other existing infrastructure-related plans and programmes. In particular, the following plans and programmes that were included in the preparation of the NIP are mentioned by way of example:

- TYNDP - Ten-Year Network Development Plan of the European Transmission System Operators for Electricity (ENTSO-E)
- TYNDP - Ten-Year Network Development Plan of the European Transmission System Operators for Gas (ENTSOG)
- Network development plan (§ 37 ElWOG 2010) - NEP
- Coordinated network development plan (§ 63 GWG 2011) - KNEP
- Long-term and integrated planning (§ 22 GWG 2011) - LFiP
- Climate and energy programmes/strategies of the federal states
- Hydrogen strategy for Austria

By taking an integrative view of the entire energy system, including these plans and programmes, synergies could be identified in the NIP. Cumulative effects become visible where, for example, consumers or producers are located in particularly high density. Cumulative environmental impacts are presented and assessed in chapter 5.

By considering the contents of the NIP in terms of its positive and negative environmental impacts, the environmental report takes into account all plans and programmes integrated in the NIP in an indirect way.

Other relevant plans are:

- National clean air programme 2019 per § 6 of the air emissions act 2018
- Spatial planning programmes of the federal states
- National energy and climate plan

2 Study framework

2.1 Study area

The scope of application of the NIP is the federal territory of Austria. Thus, the basic demarcation of the study area is formed by the national border. Any cross-border impacts will be considered in the course of the investigations for the environmental report. If necessary, cross-border consultations shall be carried out in accordance with Article 96 EAG.

For the different project types of the NIP (national renewable generation and energy transmission), a different approach is chosen for the delineation of the study area (see also chapter 2.3).

For the renewable energy sources, area potentials (Federal Environment Agency, 2023) are available at district level in the form of GWh/a, but the distribution of the plants to specific locations is not known. Hydro-power projects are tied to river courses. Energy transmission projects are characterised by transport requirements between regions.

2.1.1 Study areas for energy transmission

The NIP identifies sections in the electricity transmission network, the gas transmission network and network levels 1 and 2 for gas in which network congestion may occur with the assumed future generation and consumption developments. Transport requirements between regions are derived from the analysis (see Figure 2, Figure 3 and Figure 4). The identified transport requirements identify those regions in which the network operator must provide for suitable measures to ensure sufficient energy transport when preparing future network development plans. The increase in transport capacities should be developed and determined by the respective network operator in accordance with the 'NOVA' principle (network optimisation before expansion) in the course of its network planning.

Figure 2 Electricity demand corridors transmission network 2030 (BMK, 2023)

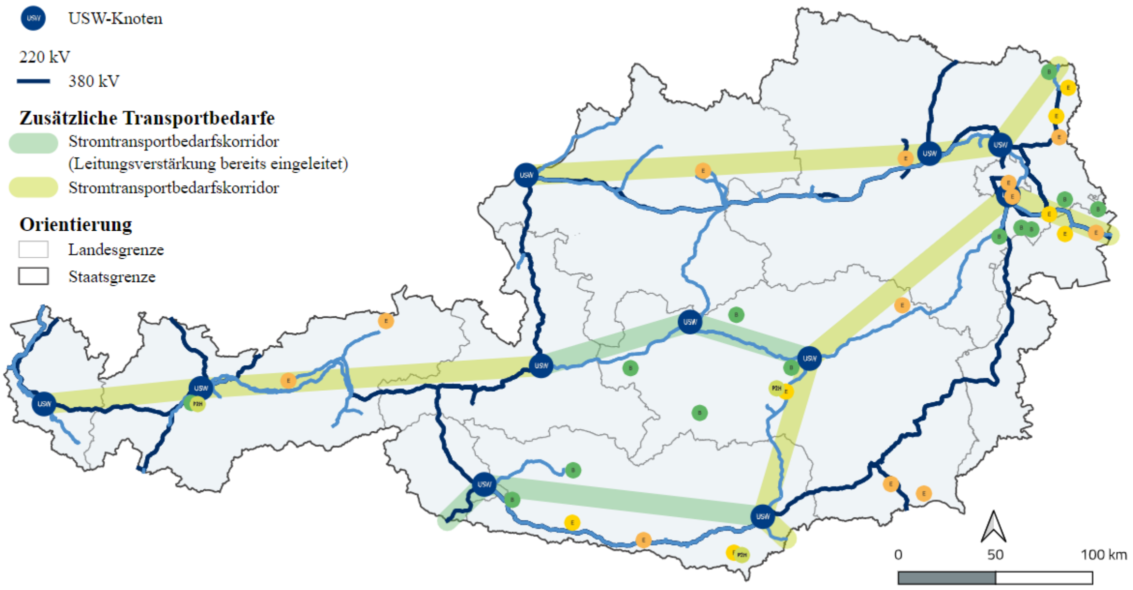


Figure 3 Gas network and hydrogen network 2030 (BMK, 2023)

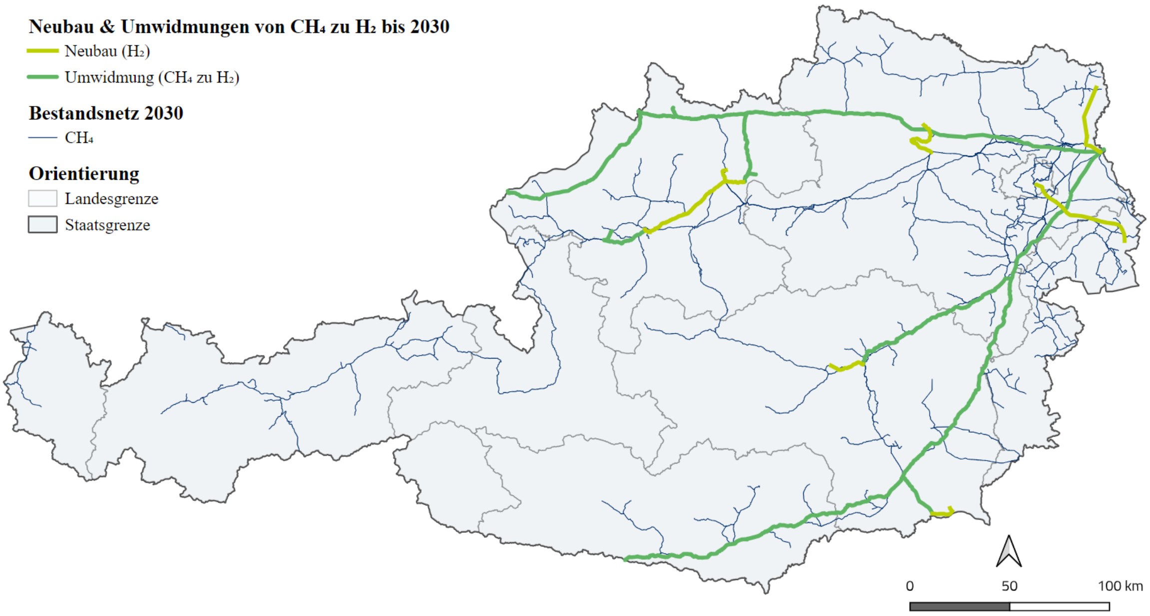
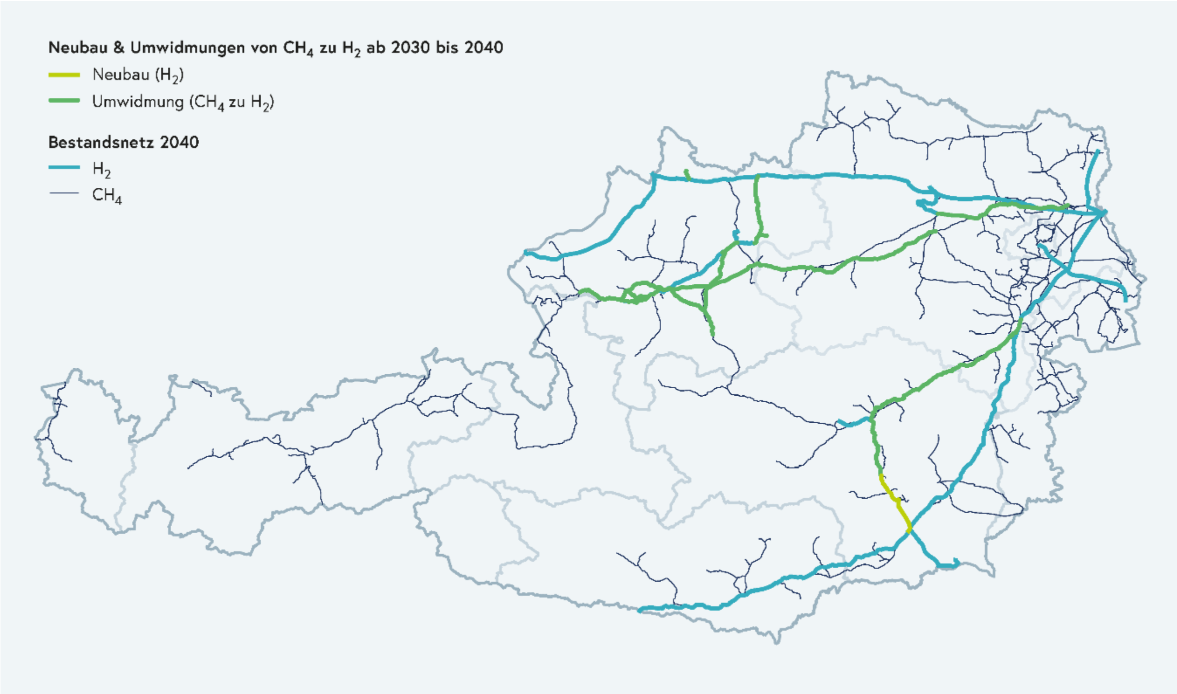


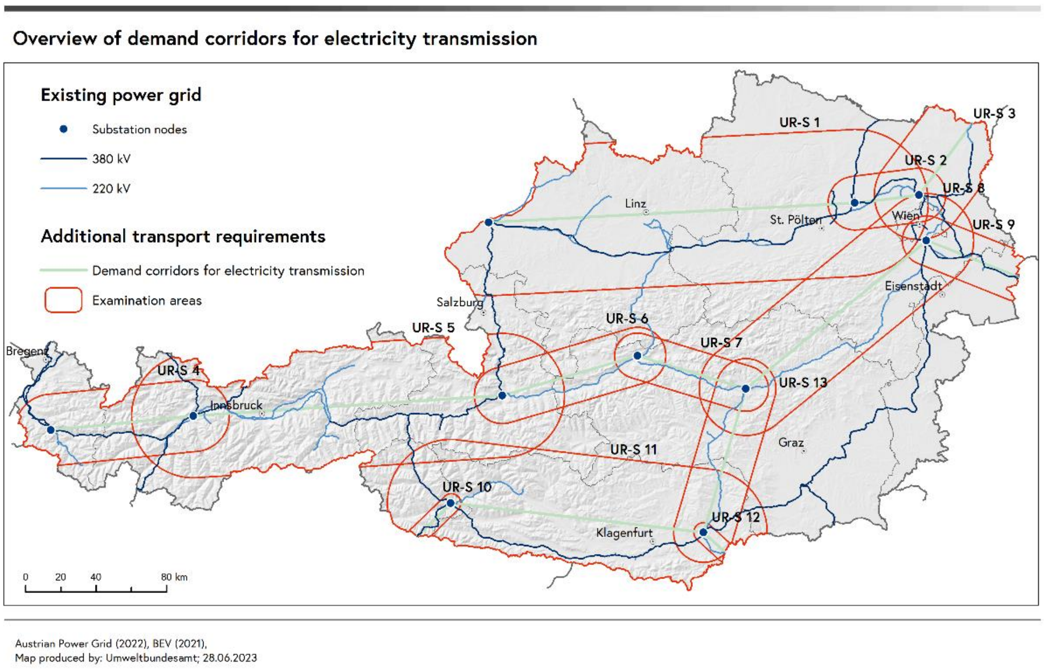
Figure 4 Gas network and hydrogen network 2040 (BMK, 2023)



For the electricity and gas transport demand corridors (incl. hydrogen), based on the experience from Germany[3], a study area with a length-to-width ratio of 2.5:1 is selected for each corridor[4]. In order to reflect the different Austrian topography and to include existing line routes, the rigid length-width ratio was deviated from in eleven of the total of 20 study areas and the study area was changed accordingly.

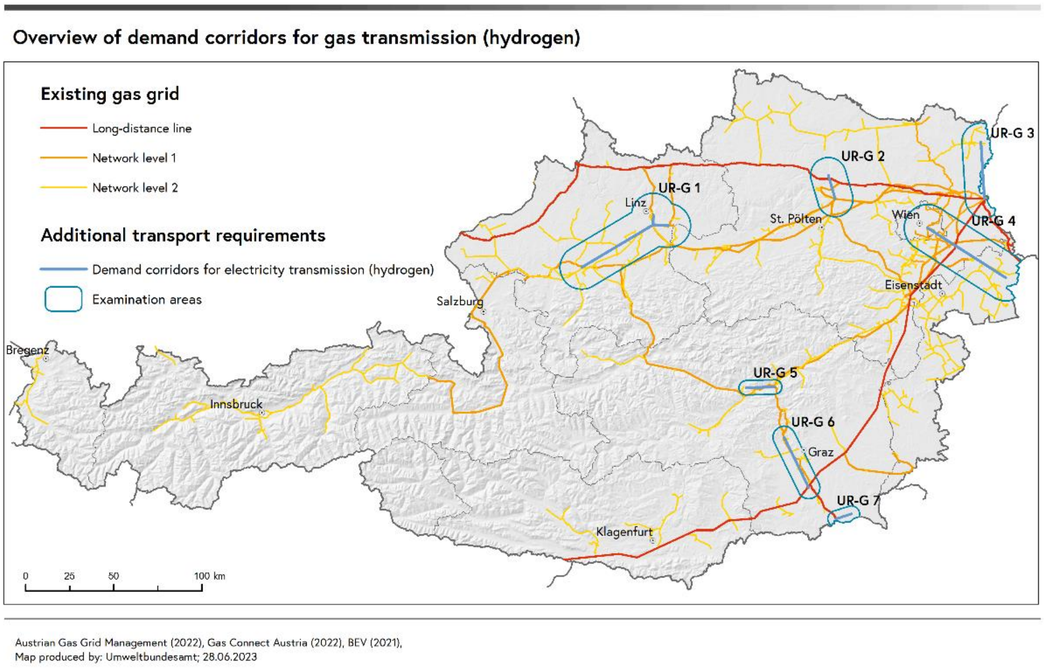
[3] In Austria, there is no experience and no meaningful literature on this.
[4] Federal Network Agency (2021)

Figure 5 Overview of the study areas for electricity transmission demand corridors



These study areas were defined for those transport needs that require a new pipeline construction. For pipelines that are reallocated for future hydrogen transport, no new construction is required and a qualitative consideration is carried out (see chapter 5.1.2.5).

Figure 6 Overview of the study areas for gas transport demand corridors



2.1.2 Study area for renewable energy sources

For hydropower plants, an Austria-wide analysis is carried out. For wind energy and photovoltaic ground-mounted installations, the whole of Austria is defined as the study area without exclusion areas (nature, species and water protection as well as technical exclusion criteria). For photovoltaic (PV) plants on buildings, biomethane and biogas plants, biomass plants and electrolysers, the entire federal territory is considered as the study area.

2.2 Study period – timeframe

The NIP considers a time frame up to 2030 with an outlook towards the goal of achieving climate neutrality by 2040. This environmental report refers to these periods.

2.3 Aspects and depth of assessment

The subject of this SEA is the national renewable energy sources and energy transmission (electricity network levels: 380 kV, 220 kV; gas network levels: Transmission, Level 1 + 2 as well as hydrogen network).

The NIP shows potential areas (Federal Environment Agency, 2023) for the renewable energy sources wind energy, photovoltaics, hydropower and biomethane. For the area potentials of renewable energy sources, data is available at district level in the form of GWh/a, but the distribution of the plants to specific locations is not known. Hydro-power projects are tied to river courses. Energy transmission projects are represented by transport demand corridors between regions. The different methodological approach results in a different depth of assessment between the yield from renewable energy sources and the energy transmission infrastructure in terms of their area-based representation.

2.4 Assessment method

2.4.1 Basics

Possible causes of environmental impacts were assigned to the project types of the NIP (National Generation and Power Transmission) in the Scoping Document. In this way, it was determined which environmental impacts should be considered further down the line. The following causes of environmental impact were used (Sommer, 2005):

- Land use and/or sealing
- Use or design of nature and landscape
- Water use, water withdrawals
- Use of other resources (e.g. soil)
- Terrain change, fragmentation, separation or barrier effects, erosion, compaction, loosening
- Changes in hydrology (incl. drainage, diversions)
- Route cutting/clearing
- Additional traffic routes / traffic excitation
- Visual, aesthetic changes
- Electromagnetic fields

- Accidents or failures
- Landslides, mudflows, avalanches, floods
- Noise emissions, vibrations
- Air pollutant emissions
- Liquid emissions
- Waste and residues
- Accumulation and interaction of environmental impacts (cumulation and synergies)

Derived from the possible causes of environmental impacts, the **protected resources affected by** the NIP (according to SEA Directive and EAG) were identified:

- Biodiversity, fauna and flora
- Population, settlement development, human health
- Ground
- Water
- Air
- Climate
- Tangible assets, cultural heritage
- Landscape

Environmental objectives derived from national and international guidelines (see chapter 1.2) serve as the basis for assessing the significant positive and negative environmental impacts and for determining the conflict risk of the NIP. The following environmental objectives were formulated in summary form and assigned to the protected resources affected (see Table 1).

Table 1 Protected resources and assigned environmental objectives

Protected resources	International/National requirements	Environmental goals
Biodiversity, fauna, flora	• UN Convention on Biological Diversity, Biodiversity Strategy • Flora-Fauna Habitats Directive (Directive 92/43/EEC) and Bird Protection Directive (2009/147/EC) • Nature conservation laws	• Halting the loss as well as conserving and restoring biodiversity • By 2030, 30% of endangered native species and biotope types should be in good condition or developing positively. 30% of the country's land area should be protected

Protected resources	International/National requirements	Environmental goals
Population, settlement development, human health	• Federal Environmental Noise Protection Act [Bundes-LärmG] • 1999/519/EC: Council Recommendation on the limitation of exposure of the general public to electromagnetic fields (0 Hz-300 GHz) • UNFCCC (Climate Convention)	• Increasing the quality of life • Reduction of negative health impacts • Avoidance, prevention or reduction of harmful effects of climate change on human health and the environment
Ground	• Soil protection laws of the federal states (of Austria) • Federal programme 2020-2024	• Qualitative and quantitative safeguarding and preservation of ecological soil functions • Sparing use of land
Water	• EU Water Framework Directive (Directive 2000/60/EC) • WRG (BGBl. 215/1959 in its current version)	• Good status of ground and surface waters • Good ecological potential and good chemical status of artificial and heavily modified surface waters • Systematic improvement and no further deterioration of the water status • Preventing the deterioration and protecting and improving the status of terrestrial ecosystems and wetlands directly dependent on water bodies with regard to their water balance and in physico-chemical terms
Air	• EU Air Quality Directive (RL 2008/50/EC) • Air Pollution Control Act [IG-L] and associated ordinances	• Maintaining and improving air quality • Avoidance, prevention or reduction of harmful effects of air pollutants on human health and the environment
Climate	• EAG • Federal programme 2020-2024 • Paris Agreement from the UNFCCC (Climate Convention) • Fit-for-55 package incl. ESR (Regulation (EU) 2023/857)	• Climate neutrality by 2040 • 100% renewable electricity from 2030 • Reduction of greenhouse gas emissions • Preparedness for and adaptation to climate change

Protected resources	International/National requirements	Environmental goals
Tangible assets, cultural heritage	• Monument Protection Act	• Permanently preserve monuments and material cultural assets in their variety and diversity
Landscape	• Nature conservation laws of the federal states	• Protection and sustainable use of the landscape including its animal and plant species

2.4.2 Indicators

With the help of indicators, the past development (trend of the last years) and the current state (status) of the affected protected resources and thus the impacts on these protected resources can be presented. Environmental indicators should, as far as possible, include threshold values or measurands to describe significant environmental impacts. In selecting the indicators, attention was paid to their informative value in relation to the NIP as well as to the availability of data.

For the different project types of the NIP (national renewable energy generation through renewable energy sources as well as energy transmission) and due to the knowledge of their local location, a different approach is also chosen for the selection of indicators and a distinction is made between Austria-wide indicators and geographically differentiated indicators.

Austria-wide indicators are used to assess significant positive or negative environmental impacts without reference to area. An area reference is not possible in particular if the future locations of the projects are unknown. In the case of the NIP, this concerns the renewable energy sources of wind energy plants, ground-mounted and building-based PV systems, biomethane and biogas plants, biomass plants and electrolysers.

Table 2 Protected resources, environmental goals and Austria-wide indicators

Protected resources	Environmental goals	Austria-wide indicators
Biodiversity, fauna, flora	• Halting the loss as well as conserving and restoring biodiversity • By 2030, 30% of endangered native species and biotope types should be in good condition or developing positively. 30% of the country's land area should be protected	• Status and trends of selected species groups (fish, bats, insects) • Birds (Farmland Bird Index) • Status and trends of ecosystems (forests, moorlands) • Dissection of wildlife corridors
Population, settlement development, human health	• Increasing the quality of life • Reduction of negative health impacts	• Noise immissions • Electromagnetic fields – consideration by means of area category
Ground	• Qualitative and quantitative safeguarding and preservation of ecological soil functions • Sparing use of land	• Accumulation of pollutants in the topsoil or exceeding of guide values • Land use and soil sealing • Consideration of the soil function evaluation (in accordance with Austrian standard L 1076) in the selection of suitable areas (avoidance of installations on high-quality agricultural soils)
Water	• Good status of ground and surface waters • Good ecological potential and good chemical status of artificial and heavily modified surface waters • Systematic improvement and no further deterioration of the water status • Preventing the deterioration and protecting and improving the status of terrestrial ecosystems and wetlands directly dependent on water bodies with regard to their water balance and in physico-chemical terms	• Number of water bodies or proportion of water body lengths in very good and good condition with regard to chemical/physical indicators per GZÜV [water condition monitoring ordinance] and QZV Chemie OG [quality objectives ordinance for surface water chemical make-up] • Number of water bodies or proportion of water body lengths in very good and good condition, or with highest or good ecological potential with regard to biological indicators per GZÜV and QZV Ökologie OG [quality objectives ordinance for surface water ecology] • Groundwater quality per WRG and WRRL

Protected resources	Environmental goals	Austria-wide indicators
		• Groundwater quality per WRG and WRRL
Air	• Maintaining and improving air quality • Avoidance, prevention or reduction of harmful effects of air pollutants on human health and the environment	• Immission concentration of air pollutants • Dust precipitation
Climate	• Climate neutrality by 2040 • Reduction of greenhouse gas emissions • Preparedness for and adaptation to climate change	• Greenhouse gas emissions • Contribution to the implementation of the recommendations for action for the energy industry
Tangible assets, cultural heritage	• Permanently preserve monuments and material cultural assets in their variety and diversity	• UNESCO World Heritage Sites, consideration by area category
Landscape	• Protection and sustainable use of the landscape including its animal and plant species	• Land use and soil sealing • Protected areas • Dissection of wildlife corridors

Geographically differentiated indicators – or specific area categories – are used if there is at least a rough area reference, such as for the electricity and gas transmission demand corridors (energy transmission projects).

Area categories[5] (see **Annex 1**) serve as indicators of the environmental characteristics of the area under study. The area categories are attributed certain typical characteristics such as the presence of natural habitats or legal stipulations such as a prescribed protection status. They should be able to represent environmental characteristics well and be suitable for mapping potential conflicts (triggered by causes of environmental impacts) with the environmental objectives.

Examples: The "Natura 2000" area category serves as an indicator for environmental properties of the protected resource "Biological diversity, fauna and flora" and the area

[5] Area categories are also referred to as geographically differentiated indicators.

category "Settlement area" as an indicator for the protected resource "Population, settlement development".

The selected area categories are based on geodata available throughout Austria.

Table 3 Area categories as indicators for environmental properties and the protected resources they represent

Area category	Protected resources illustrated					
	Biodiversity, fauna, flora	Population, settlement development, human health	Ground	Water (GW + OFG)	Tangible assets, cultural heritage	Landscape
Natura-2000: EU bird sanctuaries	x					x
Natura-2000: Flora-Fauna Habitat areas	x		x			x
Protected resource flora-fauna habitat occurrences outside Natura 2000	x		x			
Nature reserves	x		x			x
National parks	x		x			x
Protected natural monuments areas	x					x
Protected landscape areas	x					x
Landscape protection areas	x					x
Nature parks	x					x
Wilderness areas	x					x
Biosphere reserves: Core zone	x					x
Biosphere reserves: Maintenance zone	x					x
Biosphere reserves: Development zone	x					x

Area category	Protected resources illustrated					
	Biodiversity, fauna, flora	Population, settlement development, human health	Ground	Water (GW + OFG)	Tangible assets, cultural heritage	Landscape
Wetlands of international importance per the Ramsar Convention (Ramsar sites)	x		x			x
Habitat connectivity	x					
Running waters	x			x		x
Standing waters	x			x		x
Water protection areas (protection zone 1)				x		
Valuable agricultural production areas		x	x			
HNV Farmland	x		x			
Arable land			x			
Grassland			x			
Forest	x		x			
UNESCO World Heritage Sites: Natural Heritage Sites	x					x
UNESCO World Heritage Sites: Cultural Heritage Sites of Austria					x	x
River floodplains (recent floodplains)	x			x		x
Wetland inventory	x		x			x
Moorland conservation catalogue	x		x	x		x
Settlement area zoning (closed development)		x				
Farmsteads and loose hamlets outside closed settlement areas		x				
Industrial area zoning		x				

2.4.3 Geographically differentiated assessment of conflict risks

Only in the case of energy transmission projects are the conflict risks relating to and spanning the different protected resources considered in a geographically differentiated manner. The assessment is carried out in the following steps:

- Conflict risks related to individual causes of environmental impacts: The conflict risk is determined individually for each cause of an environmental impact arising from a project. The conflict risk is identified for each selected area category and each relevant protected resource.
- Conflict risk related to a protected resource: The risk potential for a protected resource in relation to a land use category then results from the highest individual value determined for a cause of environmental impact (maximum value principle).
- Conflict risk for the land use category: The overall conflict risk of the land use category across all protected resources ("conflict risk across protected resources") results from the highest individual value determined for a protected resource.
- The geographically differentiated presentation of conflict risks is carried out using a network (50 m x 50 m) in the study areas. For each network cell in the respective study area, it is known which of the area category(ies) used is/are included.
- The classification of conflict risk follows a four-part scale and assigns low (1), medium (2), high (3) or very high (4) conflict risk to the respective network cells of the study areas.

2.4.3.1 Identification of conflict risks related to individual causes of environmental impacts

For each energy transmission project, each selected area category and each protected resource, the risk class is determined individually for all relevant causes of environmental impacts. The evaluation is based on sensitivity, significance and mapping accuracy (Table 4):

- Sensitivity: Describes the extent of the response of protected resources to the causes of environmental impacts by project types of the NIP
- Importance: Refers to the legal and social value of the area category
- Mapping accuracy: Represents how suitable a land use category is to map a potential conflict

Table 4 Explanation of the evaluation classes sensitivity, significance and mapping accuracy

Evaluation classes	Assessment levels		
	High	Medium	Low
Sensitivity	The properties represented by the area category are very sensitive to the potential environmental impact of the NIP project types.	The properties represented by the area category are sensitive to the potential environmental impact of the NIP project types.	The properties represented by the area category are not very sensitive to the potential environmental impact of the NIP project types.
Meaning	The area category is protected in a special manner in Austria and/or is given special social recognition.	The area category is protected in an average manner in Austria and/or is given average social recognition.	The area category has no special protection status in Austria/or is socially underappreciated.
Mapping accuracy	The land use category maps the spatial and environmental characteristics and the associated potential conflicts very clearly and accurately.	The land use category does not represent the spatial and environmental characteristics and the associated potential conflicts in a completely unambiguous and precise manner, so that differentiated characteristics are possible upon closer examination of the real conditions.	The land use category only represents the spatial and environmental characteristics and the associated potential conflicts very inaccurately, so that greater deviations are possible when the real conditions are examined more closely.

The assessment is carried out for each energy transmission project and considers each protected resource affected, each area category and each possible cause of environmental impact.

The three individual assessments on sensitivity, significance and mapping accuracy are combined into a conflict risk per possible cause of environmental impact:

In a first step, sensitivity and significance are combined via an evaluation matrix (Table 5).

Table 5 Merging of the sensitivity and significance evaluation classes.

Evaluation classes		Sensitivities		
		Low (1)	Medium (2)	High (3)
Meaning	**Low (1)**	1	1 or 2	2
	Medium (2)	1 or 2	2	2 or 3
	High (3)	2	2 or 3	3 or 4

The mapping accuracy then determines the higher or lower value in the evaluation matrix or leads to the removal of the conflict risk:

- Exactly: Decisive for the higher value
- Not quite clear and precise: Decisive for the lower value
- Only very imprecise: Removal of the conflict risk from consideration

The result is a four-level conflict risk class:

- Very high conflict risk (conflict risk class 4),
- High conflict risk (conflict risk class 3),
- Medium conflict risk (conflict risk class 2),
- Low conflict risk (conflict risk class 1).

Examples:

- Sensitivity "High (3)", significance "High (3)" and mapping accuracy "Accurate (3)" results in conflict risk class 4.
- Sensitivity "High (3)", significance "Medium (2)" and mapping accuracy "Not quite clear and accurate (2)" results in conflict risk class 2.
- Sensitivity "Medium (3)", significance "Medium (2)" and mapping accuracy "Only very inaccurate (1)" leads to the removal of the conflict risk from consideration.

2.4.3.2 Determination of the conflict risk related to the protected resources

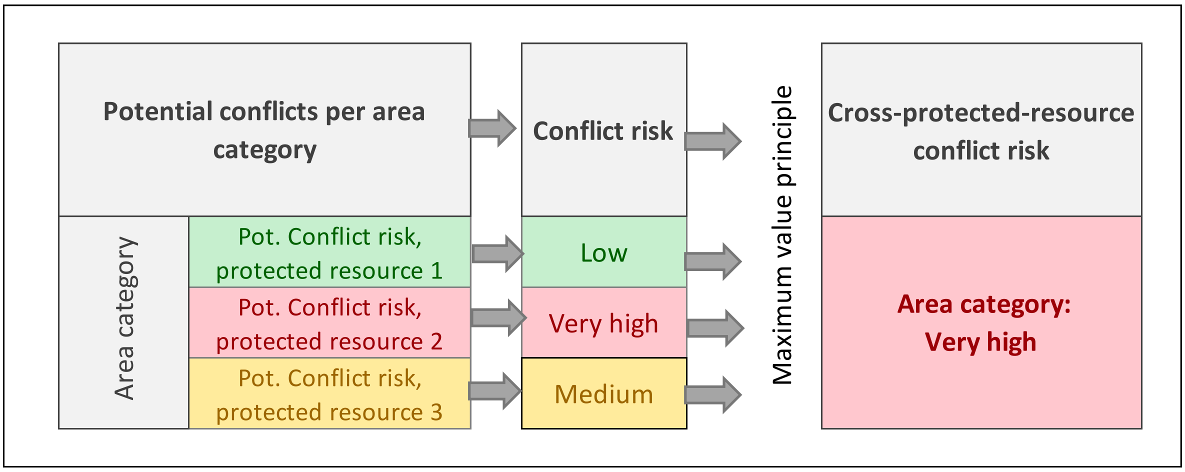
After assessing the individual conflict risks, the conflict risks of all potential conflicts of a land use category that could be assigned to the same protected resource are aggregated to a conflict risk related to the protected resource (in accordance with the maximum value principle).

Konfliktrisiko	Starkstromfreileitungen	Gasleitungen Neubau
SG Biologische Vielfalt, Fauna, Flora	sehr hoch	sehr hoch
SG Landschaft	sehr hoch	sehr hoch

2.4.3.3 Determination of the conflict risk for the area categories

The overall conflict risk of the land use category is determined for all protected resources ("conflict risk across protected resources") and results from the highest individual value determined for a protected resource (Figure 7).

Figure 7 Determination of the conflict risk for the land use category (cross-property conflict risk)



If area categories overlap, the highest value again determines the value (in accordance with the maximum value principle).

2.4.4 Environmental impact

Just as for the presentation of the current environmental status, an approach corresponding to the project type and depending on the knowledge of their local situation, is chosen for the assessment of the environmental impacts caused by the different project types of the NIP (renewable energy sources as well as energy transmission).

2.4.4.1 Energy transmission environmental impact

By overlaying the area categories, the conflict risk per study area (for electricity and gas transport demand corridors including hydrogen, see chapter 2.1.1) can be represented. The 50 m x 50 m network cells used allow the following statements:

Conflict risk density in the study area: This results from the sum of the measure-related conflict risk of all network cells in the study area, in relation to the total number of network cells or size of the study area.

The **length of the measure** represents the second parameter for the cross-protective-resource assessment, as it is assumed that longer projects can generally cause more environmental impacts than shorter ones.

Conflict-prone areas that already appear as "obstructions" (e.g. "cross-cutting obstructions") at the level of this SEA are also taken into account. These are areas from the highest conflict risk class, which cross the study area without any gaps. In the resolution accuracy of the geographical representation (network cells of 50 m x 50 m), this gives an indication that there is an area of very high conflict risk for a pipeline. Areas of very high conflict risk may indicate significant environmental impacts from electricity and gas transport demand corridors incl. hydrogen.

2.4.4.2 Environmental impact – Renewable energy sources

For project types related to renewable energy sources or the associated facilities, the environmental impacts are considered qualitatively with the help of Austria-wide indicators.

As a first step, the **trend of the last years** and the **status of** the Austria-wide selected indicators are presented and evaluated. The trend represents a view of the past and is defined as the development of an indicator in the last years. The status corresponds to the current state of the environment, which has been influenced, among other things, by the trend in recent years (see chapter 3).

Trend in recent years

The trend (the development of an indicator in recent years) is assessed using a five-point scale (seeTable 6):

Table 6 Development of the trend of Austria-wide indicators in recent years

Evaluation grades	Development of the trend of Austria-wide indicators in recent years
+	Positive
(+)	Slightly positive
0	Unchanged/negligible
(-)	Slightly negative
-	Negative

Status

The status (current state of an indicator) is also assessed in five levels (see Table 7):

Table 7 Scale for assessing the current status of Austria-wide indicators

Evaluation grades	Status of Austria-wide indicators
+	Good/Inexpensive
(+)	Fairly good / fairly inexpensive,
0	Mediocre
(-)	Fairly poor / fairly unfavourable
-	Poor/Unfavourable

Zero option

According to the SEA Directive and the EAG, the "relevant aspects of the current state of the environment and its likely development in the absence of implementation of the plan or programme[6]" – thus also a zero option without implementation of the NIP – must be included in the environmental report. The evaluation of the zero option is carried out in comparison to the **status** of the selected Austria-wide indicators.

[6] SEA Directive, Annex I lit. b; EAG, Annex 1, Part 2, lit. 2

The zero option is the **WEM scenario** ("with existing measures"), which assumes the implementation of the measures adopted by the end of 2021 (see chapter 4.2). It is assumed that due to the implementation of the existing measures per the WEM scenario (= zero option WEM), significant impairments of the environmental status will occur in 2030/2040. These effects of the zero option on the selected Austria-wide indicators are subsequently used as the basis for a comparison of variants in relation to protected resources in the alternatives assessment, the development compared to the status of Austria-wide indicators. The evaluation of the zero option WEM in comparison to the status is carried out using the following evaluation scale (see Table 8).

Table 8 Development of Austria-wide indicators under the zero option WEM 2030/2040

Evaluation grades	Development of Austria-wide indicators under the zero option WEM 2030/2040
+	Positive
(+)	Slightly positive
0	Unchanged/negligible
(-)	Slightly negative
-	Negative

Environmental impact

As a classification for the description and assessment of the environmental impacts of the variants assessed, the trend of the last few years as well as the status - the current environmental state - of the Austria-wide indicators was presented (see above).

The future environmental impacts on the affected protected resources are assessed on the basis of the development of selected Austria-wide indicators under the zero option (=Scenario WEM) and presented in assessment matrices. The assessment matrices contain the affected protected resources, the indicators, their development under the assumption of the zero option (= WEM scenario) as well as an assessment of the possible significant impacts due to the implementation of the NIP (see chapter 5). The comparison of variants in relation to the protected resources (see chapter 4.4) is carried out using the same 4-level evaluation scale (see Table 9).

Table 9 Scale for the assessment of environmental impacts and the comparison of variants in terms of protected resources

Evaluation grades	Possible effects
↑	Positive effects
⊡ (↔)	No/negligible impact
↓	Negative impact
↑ to ↓	Positive to negative effects
nr	not relevant

3 Current environmental status and relevant environmental problems

3.1 Summary of trends in recent years and current status of Austria-wide indicators

Some or all indicators are in a negative state, particularly for the protected resources biodiversity, fauna and flora, soil and climate.

Table 10 Trend and status of Austria-wide indicators

Protected resources	Indicators to determine the achievement of objectives	Trend in recent years	Current status
Biodiversity, fauna, flora	Status and trends - Fish	(-)	-
	Status and trends - Birds (FBI)	0	-
	Status and trends - Bats	(-)	(-)
	Status and trends - Beetles, butterflies & grasshoppers, dragonflies	(-)	-
	Status and trends - Woodlands	0	(-)
	Status and trends - Moors	(-)	-
	Dissection of wildlife corridors	(-)	(-)
Population, settlement development, human health	Noise immissions	0	0
Ground	Accumulation of pollutants in the topsoil or exceeding of guide values	0	(-)
	Land use	-	-
	Soil sealing	-	-
	Consideration of the soil function evaluation (in accordance with Austrian standard L 1076) in the	(+)	(-)

Protected resources	Indicators to determine the achievement of objectives	Trend in recent years	Current status
	selection of suitable areas (avoidance of installations on high-quality agricultural soils)		
Water	Number of water bodies or proportion of water body lengths in very good and good condition with regard to chemical/physical indicators per GZÜV [water condition monitoring ordinance] and QZV Chemie OG [quality objectives ordinance for surface water chemical make-up]	(+)	+
	Number of water bodies or proportion of water body lengths in very good and good condition, or with highest or good ecological potential with regard to biological indicators per GZÜV and QZV Ökologie OG [quality objectives ordinance for surface water ecology]	(+)	(+)
	Groundwater quality per WRG and WRRL	(+)	(+)
	Groundwater quality per WRG and WRRL	0	+
Air	Immission concentration of air pollutants	+	(+)
	Dust precipitation	0	0
Climate	Greenhouse gas emissions	-	(-)
	Contribution to the implementation of the recommendations for action for the energy industry	0	0
Landscape	Landscape protection areas	0	0
Tangible assets, cultural heritage	UNESCO World Heritage Sites	Consideration by means of area category	

Development of the trend of Austria-wide indicators:
+ = Positive, (+) = Slightly positive, 0 = Remaining the same / negligible, (-) = Slightly negative, - = Negative
Current status of Austria-wide indicators:
+ = Good/favourable, (+) = Fairly good / fairly favourable, 0 = Moderate, (-) = Fairly poor / fairly unfavourable, - = Poor/unfavourable

4 Alternatives assessment

According to the SEA Directive and the EAG, the environmental report must contain a description and assessment of the reasonable alternatives and their environmental effects. In addition, a zero option, which describes the probable development of the current environmental status if the plan is not implemented, is also to be presented. The environmental report therefore deals with various scenarios or alternatives for future energy production. The aim of the alternatives assessment is to identify and select a planning variant that is as environmentally friendly as possible. First, an assessment of the environmental impacts of the defined scenarios or alternatives is carried out. Based on the preliminary assessment, the alternative that is most suitable in terms of achieving the 2040 climate neutrality target and the impacts on the other environmental aspects is subjected to a more detailed environmental impact assessment (see chapter 5).

4.1 Reasons for the choice of the alternatives assessed

For the alternatives assessment, a zero option (based on the energy scenario "with existing measures" - WEM) and the following three scenarios are considered: The Transition Scenario, which is part of the NIP, as well as the scenario WAM[7] "with additional measures" and the scenario Sector Coupling [SK][8]. Other scenarios dealt with in the NIP either have only minor deviations or consider the gas or electricity sector in isolation and were therefore not included in the consideration of alternatives in the environmental report.

The Transition Scenario, prepared by the Federal Environment Agency together with scientific partner institutions, shows a path for restructuring the energy system by 2040 that continues the current trend of increasing efficiency and electrification or assumes a high level of technology diffusion. The scenario also assumes far-reaching measures in the area of sufficiency. The Transition Scenario represents the most current overall energy

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[7] From the InfraTrans 2040 project

[8] From the InfraTrans 2040 project

scenario, which depicts a far-reaching approach to the 2040 climate neutrality target anchored in the Renewable Energy Sources Act.

The two scenarios WAM and Sector Coupling [SK] originate from the research project "InfraTrans 2040 - Scenarios and Expansion Plans for a Sustainable Economic System in Austria" and build on the impact assessment of the Federal Environment Agency for the National Energy and Climate Plan [NEKP] 2019. The WAM scenario shows the development path if all measures planned and implemented for the Austrian energy system up to 2020 are taken into account. The energy quantity framework in the SK scenario is based on an energy-based analysis of the energy applications in demand in Austria from the WAM scenario. In this scenario, the primary energy demand is minimised and the efficient use of energy is maximised.

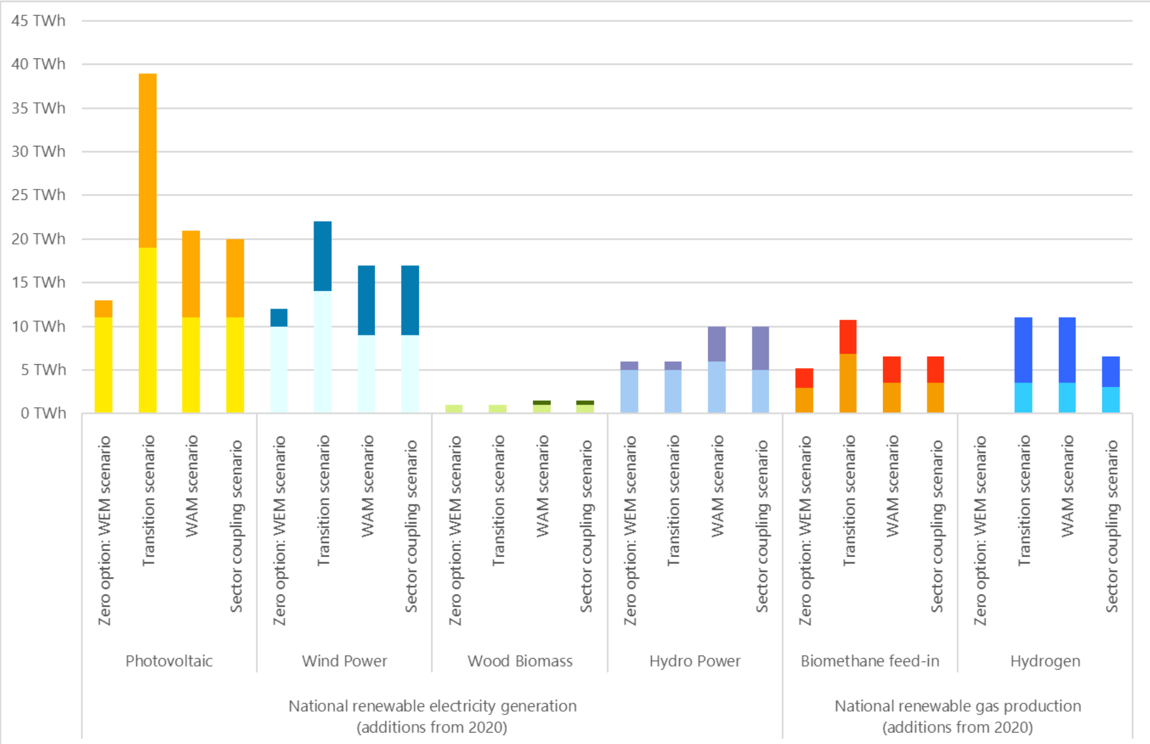
The two scenarios WAM and SK are not sufficient for the ambition of achieving climate neutrality by 2040.

Although the energy quantity frameworks vary in the scenarios described, the analyses of the different scenarios result in the same electricity transport demand corridors for a secure and resilient electricity network that enables the expansion of renewable energies in Austria. In the gas network, there are very similar transport requirements up to 2030, namely mainly a repurposing of long-distance natural gas pipelines for hydrogen transport as well as a minor requirement for new hydrogen pipeline construction. This shows a high resilience of the basic assumptions for the transport requirements as a whole. Differences arise primarily with regard to the period 2030 to 2040 in the gas and hydrogen network. The long-term development of the national methane and hydrogen network beyond 2030 still has uncertainties, as the future amount and distribution of green hydrogen depends on many technical, industrial, economic and regulatory developments. The infrastructure requirements presented in the NIP represent the measures identified in the gas sector in all scenarios. Irrespective of the quantity structures used in the different scenarios, there is agreement across all scenarios in the gas sector on the "no regret" measures depicted in the NIP.

In the alternatives assessment, the environmental impacts of renewable generation are compared, as the same or very similar transport requirements were derived from all scenarios. The environmental impacts of electricity and gas transport requirements are considered in chapter 5.

The following figure provides an overview of the assumptions of the national renewable electricity and gas yield in the scenarios considered in the alternatives assessment.

Figure 8 Overview of the renewable electricity and gas yield assumptions in the scenarios considered in the alternatives assessment. The stacked columns show the total yield in 2030 (lower part) and 2040 (upper part) combined.



4.2 Zero option – WEM scenario

According to the SEA Directive and the EAG, the "relevant aspects of the current state of the environment and its likely development in the absence of implementation of the plan or programme" – thus also a zero option without implementation of the NIP – must be included in the environmental report.

The zero option is used as a frame of reference for the assessment of the likely significant environmental effects of the alternatives considered. The following assumptions were made for the zero option:

To describe the zero option, it is assumed that the development of the selected Austria-wide indicators follows the trend of recent years. The energy scenario WEM ("with existing measures") is used to estimate future energy demand and supply. This document is based on the implementation of the measures adopted by the end of 2021 that are relevant for the energy system, but does not provide for the implementation of any further measures. With regard to the expansion of renewable energy sources, the achievement of the 2030 EAG target is assumed. The continuation of previous developments is assumed, but no additional efforts are assumed with regard to energy efficiency or circular economy. Also not taken into account is CO_2 pricing outside the existing EU emissions trading scheme.

Based on the assumptions of the zero option, both gross domestic and final energy consumption increase by about 6-7% by 2030 and decrease to about the current level by 2040 (+2% compared to 2020). An expansion of renewable electricity generation in the amount of 27 TWh (EAG expansion target) is assumed up to 2030, but after that it increases only slightly. Climate neutrality in 2040 is not achieved with this scenario, fossil energy sources continue to be imported and consumed to a considerable extent (e.g. final energy consumption of coal, oil and gas is still 80% of the 2020 value).

In the WEM scenario (zero option), the majority of the energy system would therefore continue to be based on the use of fossil fuels. Apart from exposure to external supply and price shocks, this continues to have significant negative impacts on the climate as a protected resource, and emissions of air pollutants from the mobility sector also remain at a high level. The extraction and transport of fossil fuels continues to have massive negative impacts on protected resources, especially outside Austria. Beyond the protected resources, considerable economic burdens and locational disadvantages can be assumed. This scenario is therefore of a theoretical nature, especially from a climate perspective - and thus, as a consequence of the massive negative impacts of climate change, also for other protected resources - since legally binding international, European and national climate and energy targets will not be achieved.

Demand in the WEM scenario:

- Electricity: 87 TWh in 2030 and 102 TWh in 2040
- Gas (methane and hydrogen incl. natural gas): 84 TWh in 2030 and 88 TWh in 2040

National renewable electricity yield:

- Photovoltaic: Expansion to 13 TWh by 2030 and 15 TWh by 2040.

- Wind energy: Expansion to 17 TWh by 2030 and 19 TWh by 2040
- Solid biomass: 6 TWh for electricity generation by 2030 and 6 TWh for electricity generation 2040
- Hydropower: Expansion of electricity generation to 47 TWh from 2030 and 48 TWh by 2040

National renewable gas yield:
- Biomethane feed-in: 2.9 TWh by 2030 and 5.2 TWh by 2040.
- Hydrogen: Production of 0.1 TWh in each of the years 2030 and 2040.

It is assumed that due to the implementation of the existing measures per the WEM scenario (= zero option), significant impairments of the environmental status will occur in 2030/2040. These effects of the zero option on the Austria-wide indicators are subsequently used as the basis for a comparison of the alternatives in terms of the protected resources.

Environmental impacts of the zero option – WEM scenario

The protected resources of **biodiversity, flora and fauna** have long been threatened by numerous factors (e.g. loss, alteration or fragmentation of habitats). Climate change further exacerbates these risk factors (BMNT, 2017, Zulka et al., 2022). The expansion of generation facilities and networks potentially increases the pressure on the protected resources of biodiversity, flora and fauna. Due to the continued use of fossil energy and the associated structures, negative impacts on these protected resources can also be assumed in the zero option WEM. In this respect, the consideration of these aspects is particularly relevant in the approval procedures and strategic projects such as suitability zone designations or mitigation measures. If not taken into account, the indicators of the selected species groups and ecosystems as well as the fragmentation of wildlife corridors would therefore develop negatively by 2030/2040 under the described zero option (scenario WEM, no sufficient measures to achieve climate neutrality).

For the protected resource of **population, human health,** a constant status or negligible impacts were assessed on the basis of the noise immission indicator, assuming the zero option.

The **soil** as a protected resource is assessed differently via the indicators of accumulation of pollutants, land use and sealing as well as the consideration of soil function assessments in the status. The negative status in terms of land use stands out in particular. On average over the last three years, 11.5 ha/day of new land has been taken up. Mainly responsible for this are operational areas, residential and commercial areas as well as traffic areas. Land use by energy plants in the broadest sense is not assessed. For the zero option, a negative development for land use is therefore assumed.

Hydropower already has a very high degree of expansion in Austria and accounted for 75-85% of domestic renewable electricity production in the last ten years. According to the risk assessment in the National Hydrological Plan 2021, with regard to the failure to achieve good status per the WRRL, **water** as a protected resource (in this sense specifically surface waters) in Austria is most heavily impacted by hydromorphological stressors (dams, surges, hydropeaking, residual water, obstacles to migration and other structural interventions). Further development, especially in natural stretches, would further increase these stressors and can lead to a failure to achieve the target status or to the loss of vulnerable Red List species. In the case of expansion in accordance with the zero option (scenario WEM), a negative development is to be expected.

For the immission concentration of **air pollutants**, a continuation of the Austria-wide positive trend for PM_{10}, $PM_{2.5}$ and NO_2 is expected with the zero option. The emissions from new biomass CHP plants to be built will reduce in accordance with the current state of the art, thus ensuring compliance with limit values. Increased construction activity can lead to increased dust precipitation locally and for a limited period of time.

The described zero option WEM (-27% CO_2 equivalent compared to 2005)[9] clearly misses national, European and international **climate targets** compared to 2005 in terms of the speed and magnitude of the targeted reductions in greenhouse gas emissions. In the zero option, it is assumed that without the implementation of the NIP, the recommendations for action from the Austrian climate change adaptation strategy for the energy sector cannot be implemented to a sufficient extent either. This concerns, among other things, the close interfaces of the adaptation strategy to the NIP, such as the optimisation of the network infrastructure, the promotion of decentralised energy generation and feed-in, and the optimisation of the interplay between generation and consumption.

[9] Federal Environmental Agency, 2023. GHG Projections and assessment of policies and measures in Austria 2023, Reporting under Regulation (EU) 2018/1999 Submission: 15 March 2023 (draft)

The development of **climate** protection is assessed slightly positively, as a reduction in greenhouse gas emissions is already evident in the zero option (scenario WEM) due to climate protection measures already implemented. However, this reduction is far from sufficient to achieve Austria's binding climate protection targets.

Assuming that there is no guiding spatial planning (e.g. through exclusion and suitability zones) and no targeted use of mitigation measures (e.g. compensation areas), a negative development is assumed in the zero option for the **landscape** as a protected resource due to the impairment of the landscape by the expansion of the (energy) infrastructure (see Table 11).

Table 11 shows the current status of the Austria-wide indicators and their development under the zero option (scenario WEM).

Table 11 Current status and development of Austria-wide indicators under the zero option up to 2030/2040

Protected resources	Indicators to determine the achievement of objectives	Current status	WEM zero option
Biodiversity, fauna, flora	Status and trends - Fish	-	-
	Status and trends - Birds (FBI)	-	-
	Status and trends - Bats	(-)	-
	Status and trends - Beetles, butterflies & grasshoppers, dragonflies	-	-
	Status and trends - Woodlands	(-)	-
	Status and trends - Moors	-	-
	Dissection of wildlife corridors	(-)	-
Population, human health	Noise immissions	0	0
Ground	Accumulation of pollutants in the topsoil or exceeding of guide values	(-)	(-)
	Land use	-	-
	Soil sealing	-	-

Protected resources	Indicators to determine the achievement of objectives	Current status	WEM zero option
	Consideration of the soil function evaluation (in accordance with Austrian standard L 1076) in the selection of suitable areas (avoidance of installations on high-quality agricultural soils)	(-)	(-)
Water	Number of water bodies or proportion of water body lengths in very good and good condition with regard to chemical/physical indicators per GZÜV [water condition monitoring ordinance] and QZV Chemie OG [quality objectives ordinance for surface water chemical make-up]	+	0
	Number of water bodies or proportion of water body lengths in very good and good condition, or with highest or good ecological potential with regard to biological indicators per GZÜV and QZV Ökologie OG [quality objectives ordinance for surface water ecology]	(+)	-
	Groundwater quality per WRG and WRRL	(+)	(+)
	Groundwater quality per WRG and WRRL	+	+
Air	Immission concentration of air pollutants	(+)	+
	Dust precipitation	0	0
Climate	Greenhouse gas emissions	(-)	(+)
	Contribution to the implementation of the recommendations for action for the energy industry	0	0
Landscape	Landscape protection areas	0	-

Current status of Austria-wide indicators:
+ = Good/favourable, (+) = Fairly good / fairly favourable, 0 = Moderate, (-) = Fairly bad / fairly unfavourable, - = Bad/unfavourable
Development of Austria-wide indicators under the zero option WEM up to 2030/2040:
+ = Positive, (+) = Slightly positive, 0 = Remaining the same / negligible, (-) = Slightly negative, - = Negative

As a basis for a clear comparison of alternatives, the status of all indicators per protected resource is summarised and only one assessment score is assigned per protected resource (seeTable 12). In the case of different values, the less favourable value is assumed.

Table 12 Assessment of the development of the environmental status under the zero option WEM (summarised)

Protected resource	WEM zero option
Biodiversity, fauna, flora	-
Population, settlement development, human health	0
Ground	-
Water	-
Air	0
Climate	0
Landscape	-

Development of the protected resources under the zero option WEM up to 2030/2040: + = positive, (+) = slightly positive, 0 = constant/negligible, (-) = slightly negative, - = negative

4.3 Transition Scenario

The integrated Austrian network infrastructure plan presents the energy-economic modelling of the transition scenario. The transition scenario describes a possible transformation of the Austrian energy system on the way to climate neutrality by 2040 and shows how an almost complete phase-out of fossil energy can take place. The framework conditions and measures assumed for this scenario serve to avoid energy consumption, increase energy efficiency, switch to renewable energy sources, reduce greenhouse gas emissions and conserve resources.

The energy consumption and energy supply data for electricity, natural gas, biomethane and hydrogen modelled from the transition scenario also form a basis for the transport requirements presented in the NIP.

In the transition scenario, gross domestic consumption is 314 TWh in 2030 and 260 TWh in 2040. Final energy consumption amounts to 244 TWh in 2030 and 201 TWh in 2040. Electricity consumption increases by around 55%, renewable electricity and hydrogen become important energy sources for the transformation.

The transition scenario involves a strong expansion of the current production capacities of wind and photovoltaics. Based on existing potentials, it is assumed that PV generation will increase tenfold and wind energy generation will triple by 2030 compared to 2020.

Demand in the transition scenario:

- Electricity: 93 TWh in 2030 and 125 TWh in 2040
- Gas (methane and hydrogen): 50 TWh in 2030 and exclusively biomethane and renewable hydrogen amounting to 39 TWh in 2040

Renewable electricity yield:

- Photovoltaic: Expansion to 21 TWh by 2030 and 41 TWh by 2040
- Wind energy: Expansion to 21 TWh by 2030 and 29 TWh by 2040
- Solid biomass: 6 TWh for electricity generation by 2030 and 6 TWh for electricity generation 2040
- Hydropower: Expansion of electricity generation to 47 TWh from 2030 and 48 TWh up to 2040

Renewable gas yield

- Biomethane feed-in: 6.8 TWh by 2030 and 10.7 TWh by 2040
- Hydrogen: Expansion of production to 3.5 TWh in 2030 and 11 TWh in 2040.

The Transition Scenario largely approaches climate neutrality in 2040.

Environmental impacts of the assumed expansion of renewable energies in the Transition Scenario

With regard to the protected resources of **biodiversity, flora and fauna**, assumptions were made for the survey of renewable potentials (on which the Transition Scenario is based) regarding exclusion areas for wind energy plants, PV open space plants and water stretches. These are also presented in the NIP. Exclusion areas are areas in which, for reasons of nature conservation, species protection or water protection, generally no or only limited expansion of renewable energy sources should take place (Federal Environment Agency, 2023). While the NIP completely excludes energy use for protected areas of IUCN categories I-IV (including national parks, wilderness areas, European protected areas, nature reserves), the possibility of a small expansion is assumed in protected areas with a protection status categories V-VI (e.g. landscape conservation areas and biosphere park development zones). Because the Transition Scenario is based on a significant expansion of the energy infrastructure (e.g. in 2040, four times as much electricity will be generated from wind energy and twenty times as much electricity from photovoltaics compared to 2020), the implementation of the corresponding potentials to reduce potentially significant impacts on the protected resources of **biodiversity, flora and fauna** must be based on corresponding mitigation measures and specifications in the concrete approval procedures and suitability zone designations.

Compared to the zero option, the impacts of the transition scenario on the protected resources **biodiversity, flora and fauna** are either negative or positive, depending on the type of implementation. Stronger negative impacts compared to the zero option may result, as the addition of PV plants (plus 73% in 2030, plus 300% in 2040) and wind energy plants (plus 40% in 2030, plus 83% in 2040) is significantly higher in the NIP.

The zero option (WEM scenario) has a significantly higher energy consumption than the Transition Scenario. These considerable additional amounts of energy are generated mainly through the exploration of existing and new oil and gas fields outside Austria and subsequent import. The majority of the potentially serious negative environmental impacts therefore do not occur in the study area of the environmental report and are therefore not explicitly assessed.

For the protected resource **population, human health,** a constant or negligible status was assessed on the basis of the indicator noise immissions, assuming the transition scenario. For the immission concentration of **air pollutants**, a continuation of the Austria-wide positive development for PM_{10}, $PM_{2.5}$ and NO_2 is expected in the NIP, which also results in positive effects on the protected resource of **population, human health**. The emissions from new biomass CHP plants to be built will reduce in accordance with the current state of the art, thus ensuring compliance with limit values. In addition, it can be assumed that the emissions of classic air pollutants - especially from the mobility sector - will decrease compared to the WEM scenario due to the rapid electrification of applications. Increased construction activity can lead to increased dust precipitation locally and for a limited period of time.

In the case of **soil**, the land use will have the greatest effect. Even though the main drivers of land take are operational areas, residential and commercial areas and transport areas, the implementation with land take by renewable energy plants must still be taken into account. It is therefore to be expected that the negative status that already exists will be maintained.

With regard to the protected resource **water**, the NIP excludes stretches of watercourses from the calculation of the residual potential that are legally protected (e.g. regional programmes of the federal states, IUCN I-II), that are not promoted under the Renewable Energy Sources Act and where approval was assumed to be very unlikely from a nature conservation perspective (floodplain strategy, Red List, Natura-2000 sites). This can minimise major negative impacts and is also clearly preferable to a non-sector-integrated planned expansion per the WEM scenario, as the latter does not use synergy effects. In general, however, significant local impacts are to be expected in the case of new construction, which may conflict with the achievement of WRRL objectives. The optimisation potential of existing plants mentioned in the NIP is thus a key factor in achieving the EAG targets and reducing negative impacts on water as a protected resource.

The implementation of the Transition Scenario leads to significant positive environmental impacts on the **climate**. Greenhouse gas emissions are significantly reduced in this scenario. The recommendations for action of the Austrian climate change adaptation strategy for the energy industry, such as the optimisation of the network infrastructure, the promotion of decentralised energy generation and feed-in, and the optimisation of the interplay between generation and consumption, are mapped with the NIP.

In **landscape conservation areas**, changes may occur due to the exclusion criteria set out in the NIP. However, smaller changes in landscape conservation areas are expected than in the zero option.

4.4 Comparison of the alternatives examined incl. zero option

The Transition Scenario largely approaches climate neutrality in 2040. The EU legal targets for 2030 from the Fit-for-55 package are consistently met or exceeded. In the WAM[10] and Sector Coupling [SK][11] scenarios, the climate neutrality target for 2040 is clearly missed. The Transition scenario has a significantly lower final energy consumption than the WAM scenario. For the generation of renewable electricity, the Transition Scenario includes a significantly higher expansion of wind energy and especially PV than the two comparison scenarios (WAM and SK), while the expansion of hydropower is only nearly half as large by

[10] From the InfraTrans 2040 project
[11] From the InfraTrans 2040 project

2040. The amount of biogas in the Transition Scenario is produced domestically and predominantly from waste; renewable hydrogen is largely imported.

Table 13 Environmental assessment of the alternatives presented

Protected resource	WEM zero option	Transition Scenario	WAM scenario	SK scenario
Biodiversity, fauna, flora	-	-	-	-
Population, settlement development, human health	0	0	0	0
Ground	-	-	-	-
Water	-	(-)	-	-
Air	0	0	0	0
Climate	0	+	(+)	(+)
Landscape	-	(-)	-	-

Development of the protected resources in the comparison of alternatives: + = positive, (+) = slightly positive, 0 = unchanged/negligible, - = negative, (-) = slightly negative

In the comparison of the alternatives considered, the Transition Scenario was chosen as the planning variant, as the Transition Scenario shows a possible transformation of the Austrian energy system on the way to climate neutrality by 2040, and thus an almost complete phase-out of fossil energy can take place. The Transition Scenario is the alternative that appears to be the most suitable in terms of achieving the goal of climate neutrality in 2040 and brings the most significant improvements compared to the zero option (Scenario WEM).

The integrated approach in the NIP ensures resource-efficient planning of the energy infrastructure. The coupling of sectors enables the use of synergies between energy sources and thus reduces the consumption of natural resources. The simultaneous consideration of the electricity and gas sectors makes it possible to make optimal use of renewable energy sources and thus minimise the necessary expansion. Local, renewably generated electricity surpluses can be used to decarbonise further sectors. By locating electrolysis plants and other sector-coupling elements in the NIP, it has been ensured that the necessary network expansion can be minimised and the utilisation of renewable production can be optimally utilised.

Compared to the zero option (scenario WEM) and the alternative variants (WAM and SK), a significantly higher electricity generation from wind and PV is assumed in the transition scenario. However, the NIP stipulates that energy use is completely excluded on areas with IUCN categories I-IV (e.g. national parks, wilderness areas, European protected areas, nature reserves) and that only a small amount of development takes place on areas with a protection status of categories V-VI (e.g. landscape conservation areas and development zones of biosphere reserves). With regard to PV, a forced expansion of PV on roofs and façades as well as on already built-up, used and sealed surfaces is assumed. These assumptions are not found in the other variants examined. In the WAM[12] and SK[13] scenarios, almost twice as much hydropower is added by 2040 as in the NIP – with corresponding negative effects.

Implementation of the following measures specified in the NIP is expected to avoid and reduce the more severe negative impacts compared to the zero option, and possibly to have positive impacts at the local level (see also chapter 6):

- Coordination of the locations for the generation plants to the network infrastructure
- Define exclusion areas and suitable areas for the construction of wind energy plants and ground-mounted PV systems
- Encourage the installation of PV systems on roofs and façades as well as on already built-upon, used and sealed surfaces
- Criteria for the exclusion of flowing stretches worthy of protection
- Forced optimisation of existing hydropower plants

Ultimately, climate change mitigation measures reduce the exacerbation of risk factors for **biodiversity, flora and fauna** of the protected resources due to climate change (BMNT 2017, Zulka et al. 2022).

If the avoidance and mitigation measures listed in the chapter 'Measures and Monitoring' are optimally designed, it is plausible that positive impacts can be achieved (locally) by implementing the expansion inherent in the NIP compared to the zero option WEM.

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[12] From the InfraTrans 2040 project
[13] From the InfraTrans 2040 project

5 Expected significant environmental impacts of the NIP

In this chapter, the potential impacts of the different project types of the NIP (national renewable generation and energy transmission) are generally considered and assessed. For the different project types of the NIP (national renewable generation and energy transmission), a different approach is chosen for the delineation of the study area (see also chapter 2.3). However, the specific impacts vary locally and depend on the project. Within the framework of the subsequent approval procedures, appropriate conditions to limit any impacts by means of suitable prevention, mitigation or compensation measures shall be established, if necessary.

5.1 Electricity and gas transmission demand corridors

For the electricity and gas transport demand corridors (incl. hydrogen) and the assessment of the likely significant environmental impacts (chapters 5.1.1 and 5.1.2), based on experience from Germany[14], a study area with a length-to-width ratio of 2.5:1 is selected for each[15]. In order to reflect the different Austrian topography and to include existing line routes, the rigid length-width ratio was deviated from in eleven of the total of 20 study areas and the study area was changed accordingly. These study areas were defined for those transport needs that require a new pipeline construction. For pipelines that are reallocated for future hydrogen transport, no new construction is required and a qualitative consideration is carried out.

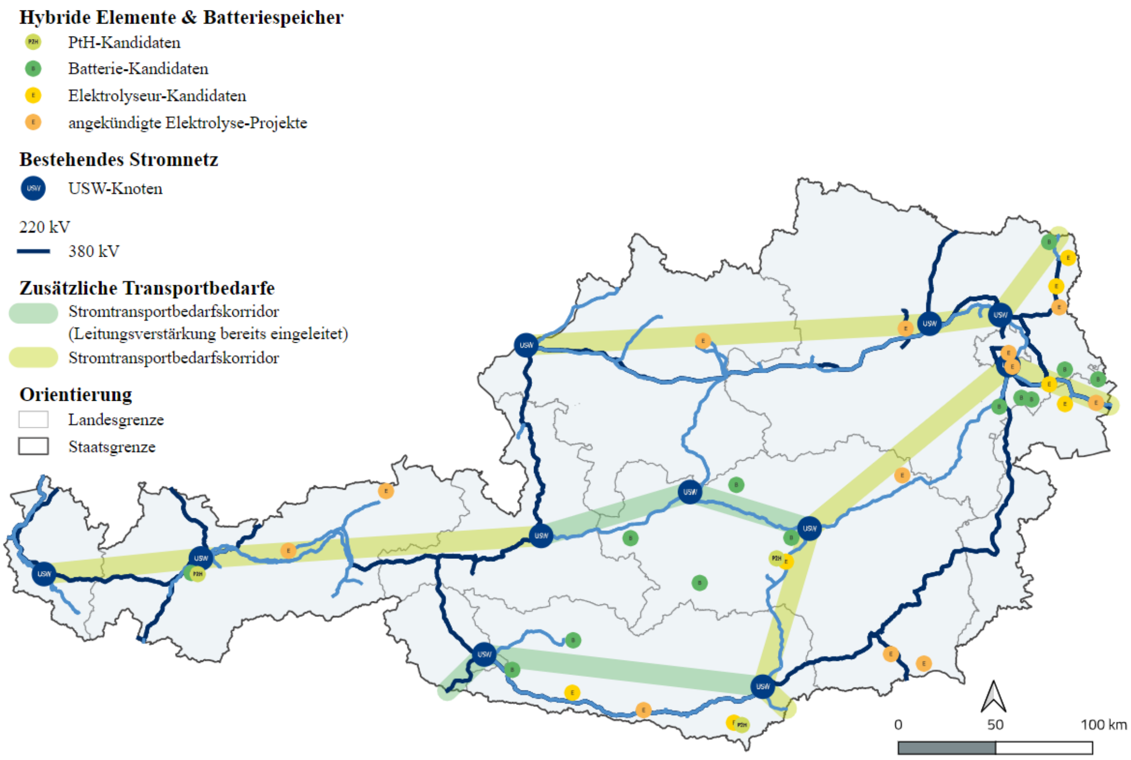
5.1.1 Overhead power lines

The NIP identifies the following electricity transmission demand corridors in the 2030 transmission network (see Figure 9). The electricity network must be adapted to the

[14] In Austria, there is no experience and no meaningful literature on this.
[15] Federal Network Agency (2021)

significantly growing and decentralised renewable electricity generation and the increasing electrification of energy consumption.

Figure 9 Electricity demand corridors transmission network 2030, source: BMK (2023)



For the environmental report, these requirements for the future transmission network result in the consideration of 13 study areas of the electricity transmission demand corridors.

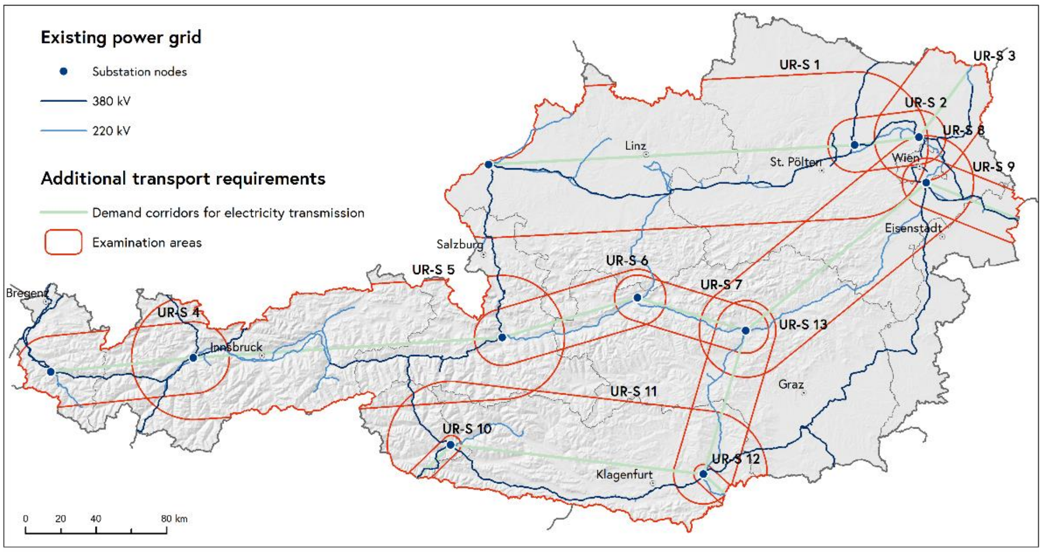
5.1.1.1 Electricity transport demand corridors

The following 13 study areas of the electricity transmission demand corridors were processed (Figure 10).

Figure 10: Overview map of the study areas of the electricity transmission demand corridors (UR-S 1 to UR-S 13) in Austria. The representation of the existing electricity

network contains line projects that will be completed by 2030 according to the 2021 network development plan.

Overview of demand corridors for electricity transmission



Austrian Power Grid (2022), BEV (2021),
Map produced by: Umweltbundesamt; 28.06.2023

The study areas and the methodological approach are described in detail in **Annex 2** to the Environmental Report.

5.1.1.2 Geographically differentiated view

Cross-cutting obstructions, i.e. large-area and possibly barrier-forming areas with a high risk of conflict, are found in 5 of the 13 study areas. These are mainly represented by closed settlement areas of conurbations as well as protected areas per the Flora-Fauna Habitats and Birds Directives. Cross-cutting obstructions do not represent exclusion areas in the sense of concrete route planning, but indicate extensive areas with a high risk of conflict, which must be given special attention in detailed planning.

The study areas covered differ due to the distance spanned, the topology, but also in order to record the existing routes. A comparison of the conflict risk of the study areas can therefore only be made on the basis of the area-weighted mean values. The conflict risk density calculated in this way shows values of 2.22 to 3.01 for all study areas and thus, when considered as a whole, a medium (2) and high (3) average conflict riskTable 14). Higher conflict risk densities are particularly evident in UR-S 4 and UR-S 5, i.e. in the Arlberg and Inntal areas, and are due to the high-ranking natural features in the entire study areas. In both cases, the slope also has a strongly restrictive effect on possible route layouts and thus on the realisable conflict risk. Cross-cutting obstructions are not present in either UR-S 4 or UR-S 5.

Table 14 Overview of the study areas UR-S 1 to UR-S 13 and presentation of area and conflict risk density

Assessment area	Designation	Area (km²)	Conflict risk density
UR-S 1	St. Peter (Upper Austria) – Dürnrohr (Lower Austria)	19,060.2	2.53
UR-S 2	Dürnrohr (Lower Austria) – Bisamberg (Lower Austria)	1,839.9	2.69
UR-S 3	Bisamberg (Lower Austria) – National border (CZ)	3,388.7	2.50
UR-S 4	Bürs (Vorarlberg) – Haiming (Tyrol)	4,269.6	3.01
UR-S 5	Haiming (Tyrol) – Pongau (Salzburg)	14,598.7	2.93
UR-S 6	Pongau (Salzburg) – Weißenbach (Stmk.)	3,351.2	2.75
UR-S 7	Weißenbach (Stmk.) – Hessenberg (Stmk.)	2,169.9	2.58
UR-S 8	Hessenberg (Stmk.) – South-east Vienna (Vienna)	9,235.0	2.72
UR-S 9	South-east Vienna (Vienna) – National border (HU)	1,826.6	2.77
UR-S 10	Lienz (Tyrol) – National border (IT)	322.5	2.63
UR-S 11	Lienz (Tyrol) – Obersielach (Carinthia)	11,926.7	2.57
UR-S 12	Obersielach (Carinthia) – National border (SI)	235.1	2.22
UR-S 13	Hessenberg (Stmk.) – Obersielach (Carinthia)	3,781.8	2.22

The conflict risk values presented are maximum values based on the data used and do not represent a conclusive or even exclusionary assessment in the sense of actual route planning. In the detailed assessment, other non-assessed protected resources may well occur in areas of low (1) or medium (2) risk of conflict and would need to be considered where appropriate. Equally, however, areas with a high (3) or very high (4) risk of conflict are by no means exclusion areas. The presentation of the conflict risk of the study areas is intended to serve as a high-level indicator for detailed planning.

The analysis of conflict risks and conflict risk density suggest that these should be addressed accordingly in expansion measures in the electricity and gas transport demand corridors studied. Particularly in the case of cross-cutting obstructions, the possibility of an adapted route to avoid or reduce potential conflict risks should be examined. Suitable mitigation and compensation measures are required for cross-cutting obstructions in the area of constraint points.

Furthermore, it must be taken into account in planning that there may well be local conflicts in areas that have a low risk of conflict. These must be taken into account when choosing the route and appropriate measures.

5.1.1.3 Impact assessment by means of Austria-wide indicators

Noise emissions are to be expected in the course of the construction phase of overhead power lines, locally for the erection of the pylons, on corridor width sometimes due to clearing. Helicopters may also be used for cable installation. As construction work is only for a limited time, noise impacts on the environment are also only to be expected to a limited extent.

It can be assumed that noise pollution from the activities associated with maintenance and servicing are negligible during the operational phase. However, overhead power lines themselves can also emit noise during operation, depending on the design and weather conditions. This corona noise can be influenced by the number of conductor cables per bundle and the treatment of the conductor cable surface to avoid drop formation with strong surface curvature. The emission level of corona noise is comparatively low, which is why impacts are mainly to be expected in the immediate vicinity of the route. The choice of route therefore has a strong influence on the impact of noise, and a concrete assessment can only be made in individual procedures.

In the area of transformer stations, there is the possibility of further emissions, such as those caused by switching operations or transformers.

When considering the requirements:

- Routing with new buildings as far away from settlements as possible
- Sufficiently high number of conductor cables per bundle
- Treatment of the conductor cable surface to reduce corona noise

It can be assumed that there are no significant noise impacts associated with the construction and operation of power lines.

For the immission concentration of **air pollutants**, a continuation of the Austria-wide positive development is expected in the NIP for PM_{10}, $PM_{2.5}$ and NO_2. The emissions from new overhead power lines to be erected will reduce in accordance with the current state of the art, thus ensuring compliance with limit values. Increased construction activity can lead to increased dust precipitation locally and for a limited period of time. No impact on air quality is expected during the operational phase.

The basic requirements of the electricity and gas infrastructure for achieving climate neutrality are presented within the framework of the NIP. It can therefore be assumed that the implementation of the NIP[16] will have a positive effect on the **climate** in the long term through the reduction of greenhouse gas emissions and through the NIP's contribution to the implementation of the recommendations for action for the energy industry.

Figure 11 Evaluation matrix – overhead power lines

Protected resources	Indicators to determine the achievement of objectives	WEM zero option	NIP Electricity
Population, settlement development, human health	Noise immissions	0	↔
Air	Immission concentration of air pollutants	+	↔
	Dust precipitation	0	↔
Climate	Greenhouse gas emissions	(+)	↑

[16] With regard to energy production from renewable sources as well as energy transmission.

	Contribution to the implementation of the recommendations for action for the energy industry	-	↑

NIP Electricity: Assessment of overhead power lines NIP compared to zero option

Development of Austria-wide indicators under the zero option WEM up to 2030/2040: + = positive, (+) = slightly positive, 0 = remaining the same/negligible, (-) = slightly negative, - = negative

Assessment of impacts in column "NIP Electricity": ↑= positive compared to zero option, ↔= no/negligible differences compared to zero option, ↓=negative compared to zero option

5.1.2 Methane and hydrogen pipelines

The modelling in the NIP results in the following gas network of transmission level and network level 1-2 and hydrogen network 2030 and 2040 (see Figure 12 and Figure 13). The necessary for new pipeline construction for the transport of hydrogen is identified for some sections, as well as the repurposing from a methane network to a hydrogen network. Overall, the analyses in the NIP show that the gas network needs to be adapted to a decreasing demand for methane, to a growing hydrogen economy and to leverage the biomethane potential available in Austria.

Figure 12 Gas network and hydrogen network 2030 (BMK, 2023)

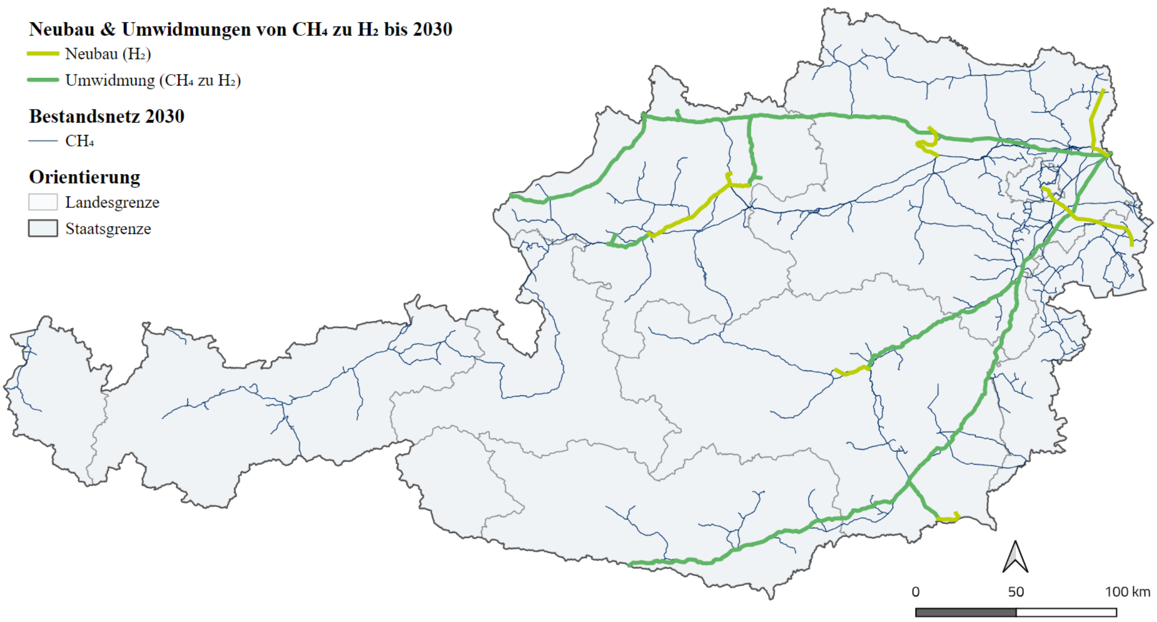
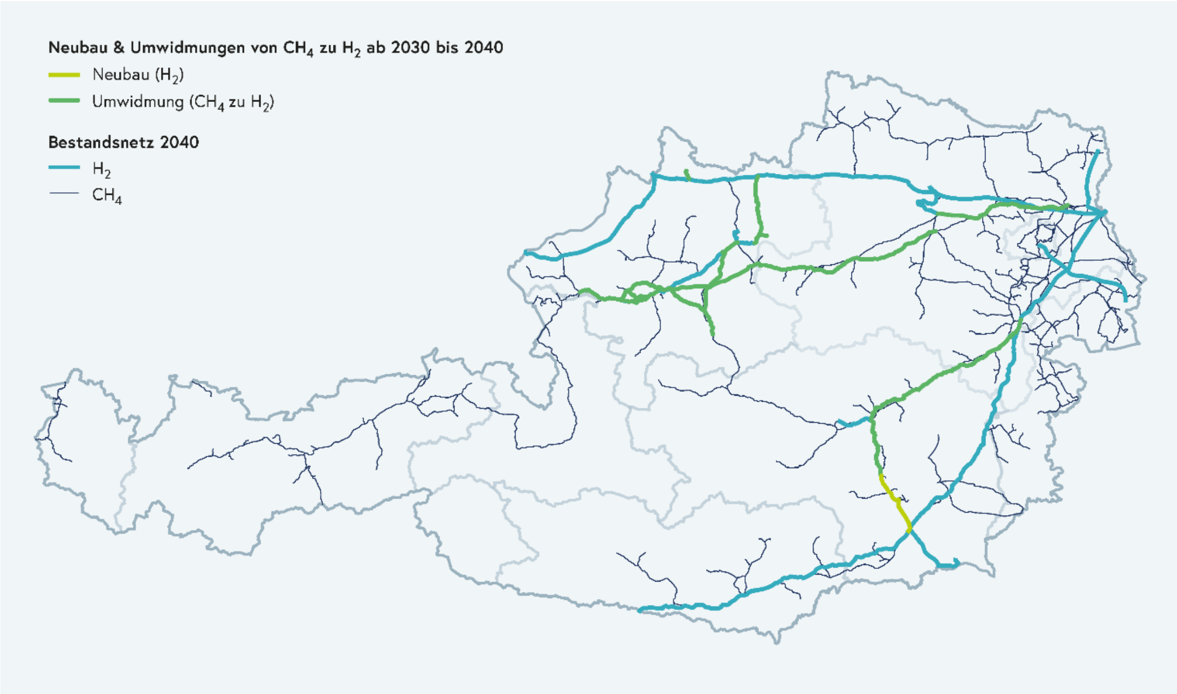


Figure 13 Gas network and hydrogen network 2040 (BMK, 2023)

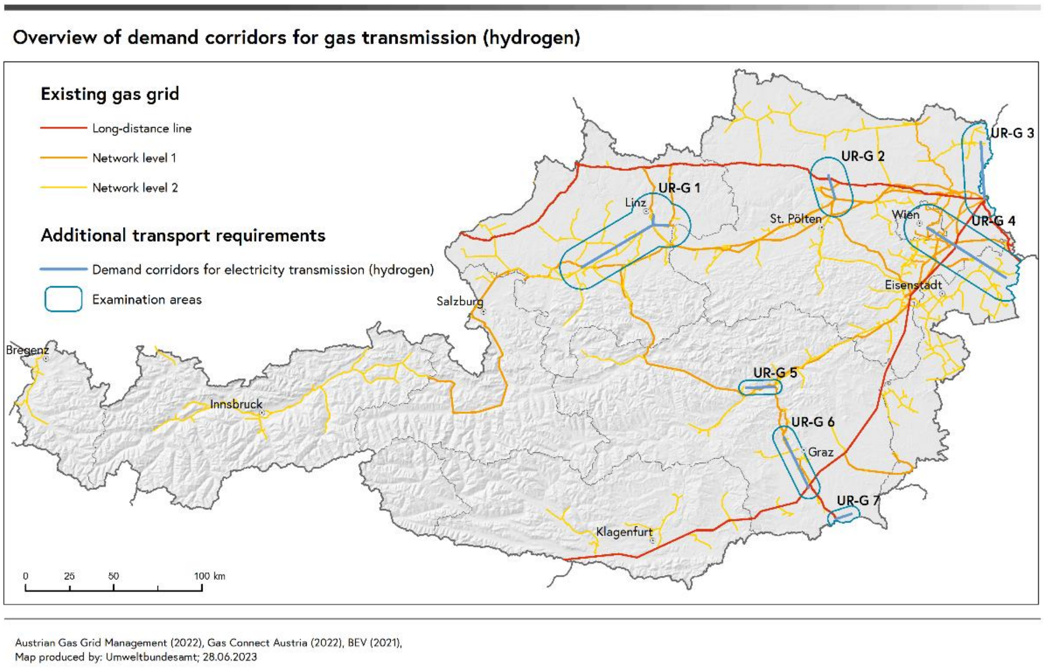


For the environmental report, these requirements for the future gas network of the transmission level and network level 1-2 and hydrogen network result in the consideration of seven study areas of the gas transport demand corridors. Repurposing and conversion of existing pipelines are considered in chapter 5.1.2.5.

5.1.2.1 Gas transport demand corridors

The following seven study areas of the gas transport demand corridors (hydrogen) were assessed (Figure 14).

Figure 14 Overview map of the study areas of the gas transmission demand corridors (UR-G 1 to UR-G 7) in Austria. The representation of the existing gas network contains line projects that will be completed by 2030 according to the 2021 coordinated network development plan.



All study areas and the methodological approach are described in detail in **Annex 2** to the Environmental Report.

5.1.2.2 Geographically differentiated view

Cross-cutting obstructions, i.e. large-area and possibly barrier-forming areas with a high risk of conflict, are found in two of the seven study areas. These are mainly represented by closed settlement areas of conurbations as well as protected areas per the Flora-Fauna Habitats and Birds Directives. Cross-cutting obstructions do not represent exclusion areas in the sense of concrete route planning, but indicate extensive areas with a high risk of conflict that should be given special attention in detailed planning.

The study areas covered differ due to the spanned distance, the topology, but also in order to record the existing pipelines. A comparison of the conflict risk of the study areas can therefore only be made on the basis of the area-weighted mean values. The conflict risk density calculated in this way shows values of 2.16 to 2.64 for all study areas and thus, when considered as a whole, a medium (2) to high (3) average conflict risk (Table 15).

Table 15 Overview of the study areas UR-S 1 to UR-S 7 and presentation of area and conflict risk density

Study area	Designation	Area (km²)	Conflict risk density
UR-G 1	Vöcklabruck – Linz –Enns (Upper Austria)	1,958.2	2.23
UR-G 2	Traismauer – Langenlois (Lower Austria)	597.2	2.56
UR-G 3	Baumgarten – Hohenau an der March (Lower Austria)	655.1	2.57
UR-G 4	Simmering (W) – Nickelsdorf (Bgld.)	1,796.4	2.64
UR-G 5	St. Peter-Freienstein – Bruck an der Mur (Stmk.)	181.9	2.16
UR-G 6	Grafendorf – Gratwein (Stmk.)	523.6	2.39
UR-G 7	Straß – Mureck (Stmk.)	123.6	2.40

The conflict risk values presented are maximum values based on the data used and do not represent a conclusive or even exclusionary assessment in the sense of actual route planning. In the detailed assessment, other non-assessed protected resources may well occur in areas with a low (1) or medium (2) risk of conflict and would have to be taken into account if necessary. Equally, however, areas with a high (3) or very high (4) risk of conflict are by no means exclusion areas. The presentation of the conflict risk of the study areas is intended to serve as a high-level indicator for detailed planning.

The analysis of conflict risks and conflict risk density suggest that these should be addressed accordingly in expansion measures in the electricity and gas transport demand corridors studied. Particularly in the case of cross-cutting obstructions, the possibility of an adapted route to avoid or reduce potential conflict risks should be examined. Suitable mitigation and compensation measures are required for cross-cutting obstructions in the area of constraint points.

Furthermore, it must be taken into account in planning that there may well be local conflicts in areas that have a low risk of conflict. These must be taken into account when choosing the route and appropriate measures.

5.1.2.3 Impact assessment by means of Austria-wide indicators

Noise emissions are to be expected in the course of construction, but due to the limited time of construction work, only a limited impact is to be expected. It can be assumed that the noise emissions are not relevant in the operational phase. In the area of compressor stations, noise emissions may also arise locally during operation, which may have to be dealt with within the framework of individual procedures.

For the immission concentration of **air pollutants**, a continuation of the Austria-wide positive development is expected in the NIP for PM_{10}, $PM_{2.5}$ and NO_2. The emissions from new methane and hydrogen pipelines to be built will reduce in accordance with the current state of the art, thus ensuring compliance with limit values. Increased construction activity can lead to increased dust precipitation locally and for a limited period of time. No impact on air quality is expected during the operational phase.

The basic requirements of the electricity and gas infrastructure for achieving climate neutrality are presented within the framework of the NIP. Assuming the use of green hydrogen and, in the case of domestic production, sufficient green electricity, it can be assumed that the implementation of the infrastructure measures described will have a positive long-term effect on the **climate as** a protected resource through the reduction of greenhouse gas emissions and through the NIP's contribution to the implementation of the recommendations for action for the energy industry.

Table 16 Evaluation matrix - Construction of new hydrogen pipelines

Protected resources	Indicators to determine the achievement of objectives	WEM zero option	Construction of new hydrogen pipeline
Population, settlement development, human health	Noise immissions	0	↔
Air	Immission concentration of air pollutants	+	↔
	Dust precipitation	0	↔
Climate	Greenhouse gas emissions	(+)	↑*
	Contribution to the implementation of the recommendations for action for the energy industry	-	↑

NIP Construction of new hydrogen pipeline: Assessment of construction of new hydrogen pipeline NIP compared to zero option
Development of Austria-wide indicators under the zero option WEM up to 2030/2040: + = positive, (+) = slightly positive, 0 = remain the same/negligible, (-) = slightly negative, - = negative
Assessment of impacts in column "NIP construction of new hydrogen pipeline":↑= positive compared to the zero option, ↔= no/negligible differences compared to the zero option, ↓=negative compared to the zero option; *assuming the use of green hydrogen

5.1.2.4 Underground cable as a possible technology variant

The NIP presents the current status of development and research into the use of 380 kV and 220 kV underground cables. In principle, the use of underground cables in the transmission network is also internationally limited to pilot projects or special cases. Longer-term experience from the operation of 380 kV or 220 kV underground cables is therefore barely available at present (BMK, 2023).

Currently, the use of underground cables in the public high-voltage network is the exception rather than the rule because, among other things, significantly higher investment costs and long repair and downtimes occur in the event of a fault. In the low-voltage network, 83.7% and in the medium-voltage network approx. 66% of the system lengths are already constructed as underground cables, in the 110 kV distribution networks this is a share of just 7%. So far, no 380 kV underground cables are in use in the Austrian transmission network (BMK, 2023).

Underground cables are generally laid at a depth of approx. 1.5 m to 1.8 m in open construction. The route width is approx. 50 m during the construction phase and approx. 25 m during operation, which is to be kept free of vegetation of deep-rooted trees and shrubs and kept permanently clear. The entire ground area of the cable route is permanently available only in a limited form over this width, resulting in cable routes having a particularly negative impact in forest areas.

During operation, highly loaded cables generate heat loss that must be dissipated to the ground surface through the insulation and the soil. In the process, the soil and the insulation are heated accordingly and the soil dries out in the immediate vicinity.

In contrast to overhead lines, no electric fields occur in the vicinity of shielded underground cables. Compared to overhead lines, the magnetic fields of underground cables decrease much faster with increasing distance from the centre of the line, but the magnetic flux density is significantly higher directly above the line due to the smaller distance to the surface (BMK, 2023).

The use of underground cables in high-voltage networks is still at an early stage in terms of practical application over longer distances, even at the international level, focusing on pilot projects and special cases. Long-term experience in the operation of such cable routes in transmission networks is barely available (BMK, 2023). It is therefore not assumed that underground cables will be used extensively at these voltage levels in the next few years.

Possible significant negative impacts from underground cables would be expected primarily on the protected resources of biodiversity, fauna and flora, and soil. The main reasons for this are habitat changes due to land use, clearing and keeping the route free, the occurrence of separation or barrier effects due to the route. Negative impacts are to be expected from the compaction of the soil during the construction and operational phases and the warming of the soil during the operational phase. Soil changes would cause particularly negative impacts in sensitive areas (e.g. moorlands or wetlands). The air as a protected resource may be temporarily affected by dust during the construction phase. No impacts on the protected resource water are expected, nor are impacts due to noise immissions or exposure to electromagnetic fields. As in the case of overhead lines, positive effects can be expected on climate protection, as all the planned measures of the NIP (expansion of renewable energy generation and energy infrastructure) support the goal of achieving climate neutrality in 2040.

5.1.2.5 Gas pipelines: Conversion and repurposing

In the gas sector, the NIP primarily envisages the conversion or retrofitting of existing gas pipelines for hydrogen transport as well as injection points for biogas purified to natural gas quality into the natural gas network. When converting to hydrogen, conversion work is primarily required in the compressor stations and in the installations (e.g. fittings). Before converting natural gas to hydrogen, the technical requirements and approvals of the existing pipes must be checked. Care must be taken that the steel quality of the line pipes as well as the weld seams and insulation comply with the technical guidelines for hydrogen. In principle, it is assumed that there will be replacement of machinery and general replacement of fixtures in the compressor stations.

For the conversion or modification of existing gas pipelines to hydrogen transport, significant impacts on all protected resources are very unlikely.

5.1.3 Summary of impacts – energy transmission

Only in the case of energy transmission projects were the conflict risks relating to and spanning the different protected resources considered in a geographically differentiated manner (seeTable 17). An exception to this is the consideration of noise immissions and the consideration of indicators for the protected resources air and climate.

At the level of the SEA, basically negligible or no impacts by energy transmission projects on the indicators selected for the protected resources **human health** and **air** are to be assessed.

The strategic development of infrastructure in the electricity and gas sectors within the framework of the NIP was developed on the basis of the Transition Scenario. This maps the path to climate neutrality by 2040. It can therefore be assumed that the implementation of the NIP will have a positive effect on the **climate** in the long term through the reduction of greenhouse gas emissions and through the NIP's contribution to the implementation of the recommendations for action for the energy industry.

For all other protected resources, conflict risks related to the protected resources and across protected resources were considered in a geographically differentiated manner. Table 17 shows the assessment of the respective conflict risk for the area categories considered in the SEA. By their very nature, area categories with strict protection status are associated with a very high conflict risk vis-à-vis energy transmission projects.

Table 17 Summary of the geographically differentiated assessment of potential conflict risks for overhead power lines and the hydrogen network

Area categories	Overhead power lines	Construction of new hydrogen pipeline
Natura-2000: EU bird sanctuaries	Very high	Very high
Natura-2000: Flora-Fauna habitat areas	Very high	Very high
Protected resource flora-fauna habitat occurrences outside Natura-2000	Very high	Very high
Nature reserves	Very high	Very high
National parks	Very high	Very high
Protected natural monuments areas	Very high	Very high
Protected landscape areas	Very high	Very high
Landscape protection areas	Medium	Medium
Nature parks	Medium	Medium
Wilderness areas	Very high	Very high
Biosphere reserves: Core zone	Very high	Very high
Biosphere reserves: Maintenance zone	High	High
Biosphere reserves: Development zone	Medium	Medium
Wetlands of international importance per the Ramsar Convention (Ramsar sites)	High	High
Habitat connectivity	Medium	Medium
Running waters	High	High
Standing waters	High	High
Water protection areas (protection zone 1)	Very high	Very high
Valuable agricultural production areas	Medium	Medium
HNV Farmland	Medium	Medium
Arable land	Low	Low
Grassland	Low	Low
Forest	Medium	Medium
UNESCO World Heritage Sites: Natural Heritage Sites	Very high	Very high

Area categories	Overhead power lines	Construction of new hydrogen pipeline
UNESCO World Heritage Sites: Cultural Heritage Sites of Austria	Very high	Very high
River floodplains (recent floodplains)	High	High
Wetland inventory	High	High
Moorland conservation catalogue	Very high	Very high
Settlement area zoning (closed development)	Very high	High
Farmsteads and loose hamlets outside closed settlement areas	High	High
Industrial area zoning	Low	Low

The analysis of conflict risks and conflict risk density suggest that these should be addressed accordingly in expansion measures in the electricity and gas transport demand corridors studied. Particularly in the case of cross-cutting obstructions, the possibility of an adapted route to avoid or reduce potential conflict risks should be examined. Suitable mitigation and compensation measures are required for cross-cutting obstructions in the area of constraint points.

Furthermore, it must be taken into account in planning that there may well be local conflicts in areas that have a low risk of conflict at the SEA level. These must be taken into account when choosing the route and appropriate measures in the (EIA) approval procedure.

5.1.4 Summary of impacts – renewable energy sources

Austria-wide indicators were used to assess significant positive or negative environmental impacts for the renewable energy sources of hydropower plants, wind energy plants, ground-mounted and building-based PV systems, biogas and biomethane production, biomass plants and hydrogen production (electrolysers) (see Table 18).

The different project types (e.g. wind energy, hydropower, PV) naturally have a different impact on the protected resources and on the development of the respective selected indicator.

Common to all project types is the **positive impact** on the **climate** due to the increased share of renewable energies in total energy consumption. The reduction of greenhouse gas emissions as well as a contribution of the NIP to the implementation of the recommendations for action for the energy industry are the reason for the positive impact.

Under the premise that a significant share of the planned expansion of electricity generation is covered by optimising existing hydropower plants, the NIP is to be rated better than the zero option WEM for the protected resource **water**.

Negative or positive impacts are possible for bats and birds due to wind energy: Provided that turbines are well planned in particularly low-conflict zones, negative impacts on **biodiversity** can be reduced compared to the zero option. The intelligent use of the necessary compensation areas to maximise biodiversity also seems expedient. For the protected resource **soil**, negative impacts are to be expected due to land use and no/negligible impacts with regard to sealing.

For PV systems on roofs and façades, only negligible impacts on other protected resources (e.g. **biodiversity, soil**) are expected at the SEA level, as no new areas are taken up.

In the case of PV ground-mounted systems, negative or positive impacts are possible for birds, insects and moorlands: Provided that systems are well planned in particularly low-conflict zones, negative impacts on **biodiversity** can be reduced in comparison with the zero option. In this context, the connectivity of the landscape and the functionality of wildlife corridors can be expected to be negatively affected by ground-mounted PV systems. For the protected resource **soil**, negative impacts are to be expected due to land use and no/negligible impacts with regard to sealing.

Biogas, biomethane and electrolysers are expected to have a negative impact on **soil** as a protected resource due to land use and sealing. Despite the different dimensions of the infrastructures in the NIP compared to the WEM zero option, no or negligible differences compared to the zero option are to be expected on the **landscape** as a protected resource.

It is not anticipated that there will be any impacts on UNESCO World Heritage Sites from renewable energy sources.

It is generally important to carefully consider the above aspects and plan possible prevention, mitigation and compensation measures to minimise negative effects while taking advantage of the positive effects on the climate (see below).

Table 18 Overview of likely significant environmental impacts for renewable energy sources compared with the zero option WEM

Protected resources	Indicators to determine the achievement of objectives	Zero option WEM	Hydro	Wind	Ground-PV	Roof-PV	BioG, BioM, Electr.
Biodiversity, fauna, flora	Status and trends - Fish	-	↑*	↔	↔	↔	↔
	Status and trends - Birds (FBI)	-	↔	↓ to ↑	↓ to ↑	↔	↔
	Status and trends - Bats	-	↔	↓ to ↑	↔	↔	↔
	Status and trends - Beetles, butterflies & grasshoppers, dragonflies	-	↔	↔	↓ to ↑	↔	↔
	Status and trends - Woodlands	-	↔	↔	↔	↔	Not assessed
	Status and trends - Moors	-	↔	↔	↓ to ↑	↔	↔
	Dissection of wildlife corridors	-	↔	↔	↓ to ↑	↔	↔
Population, settlement development, human health	Noise immissions	0	↔	↔	↔	↔	↔
Ground	Accumulation of pollutants in the topsoil or exceeding of guide values	(-)	↔	↔	↔	↔	↔
	Land use	-	↔	↓	↓	↔	↓
	Soil sealing	-	↔	↓	↔	↔	↓

Protected resources	Indicators to determine the achievement of objectives	Zero option WEM	Hydro	Wind	Ground-PV	Roof-PV	BioG, BioM, Electr.
	Consideration of soil function evaluation (in accordance with Austrian standard L 1076) in the selection of suitable areas (avoidance of installations on high-quality agricultural soils)	(-)	↔	↔	↔	↔	↔
Water	Number of water bodies or proportion of water body lengths in very good and good condition with regard to chemical/physical indicators per GZÜV [water condition monitoring ordinance] and QZV Chemie OG [quality objectives ordinance for surface water chemical make-up]	0	↔	↔	↔	↔	↔
	Number of water bodies or proportion of water body lengths in very good and good condition or with highest or good ecological potential with regard to biological indicators per GZÜV and QZV Ökologie OG [quality	-	↑*	↔	↔	↔	↔

Protected resources	Indicators to determine the achievement of objectives	Zero option WEM	Hydro	Wind	Ground-PV	Roof-PV	BioG, BioM, Electr.
	objectives ordinance for surface water ecology]						
	Groundwater quality per WRG and WRRL	(+)	↔	↔	↔	↔	↔
	Groundwater quality per WRG and WRRL	+	↔	↔	↔	↔	↔
Air	Immission concentration of air pollutants	+	↔	↔	↔	↔	↔
	Dust precipitation	0	↔	↔	↔	↔	↔
Climate	Greenhouse gas emissions	(+)	↑	↑	↑	↑	↑
	Contribution to the implementation of the recommendations for action for the energy industry	0	↑	↑	↑	↑	↑
Landscape	Protected landscape areas	-	↔	↔	↔	↔	↔

Zero option WEM, WK (hydropower), Wind (wind energy), ground-mounted PV (ground-mounted PV systems), roof-top PV (roof-mounted and façade-mounted PV systems), BioG BioM Electr. (biogas, biomass, electrolysers)

Development of Austria-wide indicators under the zero option WEM up to 2030/2040: + = positive, (+) = slightly positive, 0 = remain the same/negligible, (-) = slightly negative, - = negative
Assessment of impacts: ↑= positive compared to the zero option, ↔= no/negligible differences compared to the zero option, ↓=negative compared to the zero option* Under the **premise** that a significant share of the planned expansion of electricity generation is covered by **optimising existing hydropower plants**, the NIP is rated better than the zero option WEM.

↓ to ↑: Assuming well-planned installations in particularly low-conflict zones, negative impacts can be reduced compared to the zero option.

6 Measures and monitoring

The Integrated Network Infrastructure Plan is an overarching strategic instrument that shows the fundamental requirements and objectives of network planning in the electricity and gas sectors for a holistic energy transition. Prior to or in the course of implementing the necessary infrastructure and facilities, appropriate measures and instruments shall be applied and further developed in order to prevent, reduce or compensate for possible significant negative environmental impacts.

This also includes corresponding planning at national level and within the framework of concrete project plans. In the case of the measures listed in this chapter to prevent, reduce or compensate for negative impacts, it must therefore be considered that the competence to implement these measures largely lies not with the BMK, but with other responsible parties at provincial level or with the regulatory authority.

In the course of implementing the expected RED III[17] acceleration areas must be designated, whereby mitigation measures must be specified as early as in the area designation plans in order to prevent possible negative environmental impacts. The implementation of an SEA is prerequisite. Against this background, particular emphasis must therefore be placed on the implementation of mitigation measures.

The prevention, reduction and compensation measures of the NIP and examples of further necessary measures are presented below.

6.1 Prevention, mitigation and compensation measures of the NIP

According to the Transition Scenario, a strong expansion of the current production capacities of wind energy and photovoltaics will be necessary. This changeover and expansion for the energy transition is associated with **significant positive effects on the climate**. Without appropriate measures for the energy transition, the climate targets cannot be achieved. **Positive effects** on the protected resource **air** (specifically for NO_2)

[17] Amendment of Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources, decision expected by autumn 2023.

can also be expected from the rapid electrification of applications, especially in the mobility sector.

Significant **negative impacts from** the expansion of renewable energy generation and energy transmission infrastructure are **possible on the protected resources of biodiversity, flora, fauna and soil** (see chapter 5).

Significant negative impacts can be reduced by taking appropriate precautionary measures. The NIP contains a number of principles relevant to environmental protection that can minimise any negative impacts on the protected resources concerned:

- Coordination of the locations for the generation plants to the network infrastructure
- Define exclusion areas and suitable areas for the construction of wind energy plants and ground-mounted PV systems
- Encourage the installation of PV systems on roofs and façades as well as on already built-upon, used and sealed surfaces
- Criteria for the exclusion of flowing stretches worthy of protection
- Forced optimisation of existing hydropower plants and weir structures
- Compensatory areas or mitigation measures
- Requirements for minimising conflicts of use in the course of approval (e.g. refraining from using fencing)

The EAG Market Premium Ordinance and the EAG Electricity Investment Subsidy Ordinance contain ecological requirements for the construction of PV systems on certain open spaces: the following requirements exist for the eligibility of open space PV systems on agricultural land or land in grassland:

- Ensuring that installations can be dismantled without leaving residues,
- The distance between the lower edge of the module table and the ground is at least 80 cm,
- Row distances between the opposing module surfaces are at least two metres.[18]

In addition to the requirements, at least five of the measures listed below must be complied with:

- Preservation of existing biotope structures,
- In the case of fencing, greening of the fence with site-adapted plants of local origin,

[18] This regulation does not apply to innovative photovoltaic systems or to photovoltaic systems with tracking systems.

- Establishment of site-adapted hedges or shrubs of local origin,
- Construction of nesting aids for birds, bats and insects,
- Creation of flowering strips using native seed mixtures,
- Management of the area by alternate mowing with a minimum mowing height of ten centimetres,
- Management of the area in compliance with a mowing frequency of no more than twice a year and a mowing height of at least ten centimetres,
- Grazing of the area without mechanical mowing,
- Greening of the area with regional seed mixtures with at least 15 plant species and wild herbs.[19]

It is important that the full implementation of the eligibility requirements per the EAG is monitored over the entire operating time of the plants and that corrective measures are taken or prescribed by the authorities in the case of deviations.

Ultimately, climate change mitigation measures reduce the exacerbation of risk factors for **biodiversity, flora and fauna** of the protected resources due to climate change (BMNT 2017, Zulka et al. , 2022). If effective nature conservation and biodiversity criteria are taken into account, the switch to renewable energy sources can not only be an effective lever in the fight against the climate crisis, but also against the loss of biodiversity, as stated in the Biodiversity Strategy Austria 2030+ (BMK, 2022).

6.1.1 Measures – Energy transmission

The NIP stipulates that the respective network operator should develop and determine the increase of transport capacities in accordance with the 'NOVA' principle (network optimisation before expansion) in its network planning. This principle is already applied in practice (also in EIA procedures). This reduces the additional land required or the extent of intervention for the network infrastructure, which contributes to a reduction in the negative impact on the environment.

[19] These measures do not apply to installations that are exempt from the deduction per § 6 paras. 2 and 3 (e.g. installations on closed landfill sites), and for innovative installations per § 6 par. 5.

6.1.2 Measures – Hydropower

The NIP specifies criteria to reduce negative impacts on watercourses due to hydropower development (see NIP, chapter 3.2.2.2). This includes the exclusion of flowing stretches particularly worthy of protection (lower limit and upper limit of stretches worthy of protection) and the preferential optimisation of existing hydropower plants before new construction. This approach can be classified as a prevention measure under the SEA Directive: If these measures are implemented, negative impacts on routes worthy of protection can be avoided.

6.1.3 Measures – Wind energy and PV installations

In the NIP, assumptions are made about exclusion areas for the future expansion of wind energy plants and PV plants. These areas should not experience any or only limited expansion of renewable energy sources for reasons of nature conservation, species protection and water protection (see NIP, Chapter 3.2.2.1). While the NIP completely excludes energy use for areas in IUCN categories I-IV (e.g. national parks, wilderness areas, European protected areas, nature reserves), a small expansion is assumed for areas with a protection status in categories V-VI (e.g. landscape conservation areas and development zones of biosphere reserves).

If the definition of IUCN categories I-IV exclusion areas is implemented in accordance with the NIP, this approach is equivalent to a prevention measure per the SEA Directive: No negative impacts are to be expected there. If limited development takes place on IUCN categories V-VI land and certain planning principles and criteria (see chapter 6.2.1) are taken into account, reduced impacts can be assumed.

6.1.4 Measures – Electrolysers

By integrating the planned electrolysers into the network, the routing of the transmission network or network levels 1 and 2 can be optimised (reduced). The integration of electrolysers can be classified as a reduction measure due to the good use of resources and reduction of land use.

6.2 Examples of further necessary measures

The following examples of further necessary measures to avoid or reduce significant negative environmental impacts are not specifically provided for in the NIP, but are already common practice in some cases for implementation at the level of designation of suitability zones or in the subsequent administrative procedures. The implementation of these measures throughout Austria, adapted to the respective local and regional requirements, supports the avoidance and reduction of negative environmental impacts. It is noted that renewable energy generation, storage and distribution technologies are developing rapidly. For this reason, the measures listed here are to be regarded as examples and by no means represent an exhaustive catalogue of measures. This must be taken into account in particular when designating acceleration areas in accordance with RED III.

Compensation areas are an important instrument to compensate for negative environmental impacts of construction projects, e.g. on **biodiversity**. They serve to compensate for negative environmental impacts, e.g. by renaturalising habitats or reforesting them in a near-natural way. Suitable compensation measures must be planned and implemented in accordance with functional, spatial and temporal connections with the construction project. In any case, the aim is to maintain or improve the ecological status quo and to keep the negative impacts on the environment as low as possible at regional level.

The existing guidelines and planning aids for a nature-compatible development of ground-mounted PV systems (BirdLife, 2023, Photovoltaics in the Landscape[20], Criteria for a nature-compatible design of ground-mounted solar systems[21]) can support planning, approval and construction.

With regard to the presentation of the current and concrete impacts on **soil** as a protected resource, it is essential to include the soil functions from a professional perspective. In doing so, the state of the art must be applied in accordance with Austrian standard L

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[20] https://pvaustria.at/wp-content/uploads/PV_Austria_Leitlinie_PV-FFA_final.pdf
[21] https://www.naturschutz-energiewende.de/fachwissen/veroeffentlichungen/kriterien-fuer-eine-naturvertraegliche-gestaltung-von-solar-freiflaechenanlagen/

1076[22]. It is recommended to use the already available soil function assessments of the federal provinces (in accordance with Austrian standard L 1076) for this purpose. These provide information[23] not only on fertility but also on run-off regulation for the respective area, see guides of the federal states[24].

In order to provide project applicants and authorities with a quick and easy overview of Austria's soils of particular agricultural value, the use of the BEAT [soil requirements for nutritional security in Austria] map[25] based on a GIS application with an address search function is recommended.

The use of high-performing soils as defined by the soil function evaluation should be avoided. It is recommended that previously polluted areas be examined as sites, such as areas formerly used for construction, industry or military purposes with a high degree of sealing, as well as built structures, such as contaminated sites, landfills or dumps. Installing systems on field edges and close to existing road networks minimises compaction damage. Combined uses of soils are also desirable.

Plant design and work processes in energy generation plants shall be designed in such a way that the release of environmentally hazardous substances during normal operation is minimised or eliminated.

According to the current state of the art, the "Guidelines for the proper recultivation of agricultural and forestry soils" and Austrian standard L 1211 "Soil protection in the planning and implementation of construction projects" must be applied to all construction measures, or implementation through expert supervision (soil monitoring) must be made mandatory.

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[22] Ground function assessment: Methodical implementation of Austrian standard L 1076
https://info.bml.gv.at/dam/jcr%3Aaed1b6f8-aa98-418b-8529-34534439c975/Bodenfunktionsbewertung.pdf
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https://www.wien.gv.at/umweltschutz/raum/bodentypen.html
[25] https://secure.umweltbundesamt.at/webgis-portal/beat/index.html

6.2.1 Other necessary measures – by project type

Energy transmission
In this SEA, study areas were identified for the electricity and gas transmission demand corridors based on the connection of constraint points. For these study areas, it was possible to show how high the location-related conflict risks would be for the construction of pipelines within these electricity and gas transport demand corridors. From an environmental point of view, areas with a lower risk of conflict are preferable and cross-cutting obstructions should be avoided (see chapter 5). If areas with a low risk of conflict are selected during the planning and construction of electricity and gas pipelines and cross-cutting obstructions are avoided, this procedure is to be classified as a mitigation measure.

Other measures recommended are:

- The bundling of planned power line routes with existing routes or other technical structures, such as high-level transport infrastructure, can help to minimise impacts on the environment, as the impacts take place on sites that are already impacted. However, it is important that when planning such measures, careful consideration is given to whether they actually contribute to a reduction in environmental impacts. In terms of noise emissions, a **route** that runs close to high-ranking transport infrastructure (overhead power lines) can also be advantageous, as masking can be provided by the existing noise pollution.
- In this context, optimisations of already existing route corridors in the area of sensitive spaces (e.g. settlement areas, natural hazard zones) can contribute to reducing negative environmental impacts.
- When designing and erecting the mast foundations, care must be taken to ensure low land consumption (e.g. segmented foundations instead of slab foundations) and the greatest possible protection of the soil during the construction phase in order to minimise the negative impact on soil and land. Optimising the route along existing agricultural or forestry accessways also supports this endeavour.
- To reduce the impact on the landscape as a protected resource, the possibility of lower mast heights, straight cable runs and coloured design of the masts should be examined, and a routing appropriate to the landscape should be provided by adapting to the shape of the terrain.

Hydro Power
In general, the optimisation of existing facilities (or existing weir structures) should be given priority over new construction.

New hydropower plants must be planned, constructed and operated in accordance with state-of-the-art practices. This includes a site-specific assessment of the impacts on locally relevant protected resources and ensuring compliance with the objectives of the Water Framework Directive by implementing appropriate measures.

It is recommended that the following measures be implemented throughout Austria:

- If new hydropower plants are built, they act as obstacles to migration, interrupting the longitudinal watercourse continuum. Therefore, appropriate fish ladders and fish passes are to be provided as a reduction measure to enable especially long and medium distance migratory fish and lake fish species to migrate to the spawning grounds.
- In addition, there must be sufficient residual water to ensure the ecological functions of the watercourse. The impacts caused by hydropeaking are to be reduced by technical measures (e.g. equalisation basins, hydropeaking, river morphological measures, changing the speed of hydropeaking).
- Stretches within the sphere of influence of hydropower plants should be upgraded through structural improvements, revitalisation and other river ecology measures to mitigate the effects of hydrological and morphological pressures.

Wind energy
With regard to the expansion of wind energy plants, there are regional planning specifications for suitability/priority/exclusion zones or criteria catalogues (e.g. wind energy potential, infrastructure, uses, landscape, natural area, ecology, resources) in some federal states.

It is recommended that the following measures be implemented throughout Austria:

- Nature conservation concerns in wind energy development should be taken into account in accordance with uniform criteria during spatial management and in the course of the planning and approval regimes. This includes, among other things, directing the necessary expansion to low-conflict locations. Particularly valuable areas where conflicts arise in the case of wind power use can thus be kept free. It is important to note that birds particularly frequent sites near bodies of water and wetlands, and bats frequent sites in the vicinity of forests.

- Current research data and relevant studies on the environmental impacts of wind energy use and on mitigating risks to protected resources should be centrally collected, processed and made available to all stakeholders.
- In addition, implementation measures that preserve and promote biodiversity should be applied in the planning process of wind farms, as they are explained e.g. in various position papers from BirdLife, the coordination office for bat protection [KFFÖ], the environmental umbrella organisation and National Parks Austria[26]. These implementation measures serve to (1) maintain and improve habitat quality, (2) increase habitats, (3) maintain and improve connectivity between habitats, and (4) minimise mortality or negative impacts on the respective protected resources. Measures can be type-specific and site-specific, for example:
  - Switching off within a defined time window under certain external conditions (e.g. during high migration volumes or increased bat activity, during harvesting and mowing, under certain meteorological conditions)
  - Deterrence through colouring of the wind turbines
  - Deterrence through acoustic bird and bat deterrence
  - "Luring away" species at risk of collision by creating feeding and breeding habitats outside wind farms or measures to make sites less attractive to potential collision victims
- Establishment of projects for monitoring the success of the positive development of biodiversity as well as impact victim monitoring (recording the number of birds and bats killed by collisions with wind turbines) and radar camera technology (recording the number, species and flight behaviour of birds and bats).
- With regard to the impact of noise on human beings, compliance with minimum distances from settlements can help to reduce negative impacts caused by noise emissions from wind turbines (e.g. by complying with noise limits). However, these minimum distances cannot replace the assessment of the actual local conditions. If necessary, sound-optimised operation may be prescribed for the night-time period relevant for the assessment.

[26] BirdLife 2016, 2021a, 2021b; KFFÖ 2022; National Parks Austria 2014, environmental umbrella organisation 2012

Ground-mounted PV systems

In many federal states there are already regional planning specifications for suitable/priority/exclusion zones for the expansion of ground-mounted PV systems or criteria catalogues are applied. The applied criteria of building-integrated PV systems compared to ground-mounted PV systems differ from state to state.

It is recommended that the following measures be implemented throughout Austria:

- Within the framework of zoning planning at cross-regional level (federal state or across federal states), suitability, exclusion and reservation zones are to be designated and an assessment of nature compatibility is to take place in accordance with defined criteria. The published guidelines and planning aids for a nature-compatible development of ground-mounted PV systems (BirdLife, 2023, Photovoltaics in the Landscape[27], Criteria for a nature-compatible design of ground-mounted solar systems[28]) can provide orientation for planning, approval and construction.
- The assessment of areas with regard to their suitability for the construction of a ground-mounted PV systems from a nature conservation and, in particular, bird protection perspective can only be carried out at the local to regional level of the federal states.
- The potential and the more intensive use of sealed areas at state level should be used more, and the preference for ecologically degraded over ecologically valuable areas should be taken into account in site selection.
- Ground-mounted PV systems should generally be implemented using synergies with biodiversity measures. For example, ground-mounted PV systems can serve as a pesticide and fertiliser-free habitat for insects and provide food and reproductive resources, e.g. for pollinators and birds, as well as shelter and microclimatic variations, thus also contributing to the ecological enhancement of areas, such as species-poor farmland. (Montag et al., 2016; Blaydes et al., 2021; Uldrijan et al., 2021). Biodiversity measures should be oriented towards regional nature conservation priorities, as contained in management plans and regional nature conservation models to some extent. Depending on the site conditions, these biodiversity measures include the creation of wet and dry habitats as well as landscape and structural elements, the provision of breeding and nesting aids or the sowing or planting of certified, regional and site-appropriate wild plant seeds.

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[27] https://pvaustria.at/wp-content/uploads/PV_Austria_Leitlinie_PV-FFA_final.pdf

[28] https://www.naturschutz-energiewende.de/fachwissen/veroeffentlichungen/kriterien-fuer-eine-naturvertraegliche-gestaltung-von-solar-freiflaechenanlagen/

- The various conditions and measures in the course of the permits should be checked for adverse effects on biodiversity and habitat and, if necessary, adjusted.
- The most recent research data and relevant studies on the environmental impacts of photovoltaic use and on mitigating risks to protected resources should be centrally collected, processed and made available to all stakeholders.
- Biodiversity monitoring is an indispensable planning and implementation tool, as it makes the success of the measures taken measurable.
- In the ongoing operation of the ground-mounted PV system, the use of synthetic fertilisers or pesticides as well as chemicals and biocides in the cleaning of modules and support frames or even rodenticides should be avoided (Birdlife, 2023).

6.3 Monitoring

Based on the information in the environmental report, necessary monitoring measures with regard to the significant impacts of the implementation of the NIP are to be determined by the Federal Minister in order to, among other things, be able to identify unforeseen negative impacts at an early stage and, if necessary, take appropriate remedial measures. The results of the monitoring shall be taken into account when updating the Integrated Network Infrastructure Plan[29].

Depending on the legal material to be applied for the approval of specific energy transition projects, the execution will lie with the federal government, the federal states, the municipalities or the project operators.

The following questions are particularly relevant for the monitoring measures for the implementation of the NIP:

- Were the planning objectives achieved and the corresponding planning measures implemented?
- Have the assumed environmental impacts occurred and have the mitigation measures been effective?

[29] EAG, § 95 (6)

- Which additional measures or recommendations of the environmental report could be implemented?
- Have responsibilities for monitoring activities been defined?

6.3.1 Target achievement

A key objective of the NIP is to meet the target of 100% total electricity consumption (nationally balanced) from renewable energy sources and to support the achievement of climate neutrality in 2040 by planning the necessary infrastructure.

The measures inherent in the Transition Scenario are important levers for achieving the goal of climate neutrality in 2040 and therefore lend themselves to being reviewed in terms of their impact as part of monitoring measures. The development of energy consumption, the progress in the conversion to renewable energy sources or the reduction of greenhouse gas emissions are to be (further) examined at periodic intervals by means of suitable new or already established monitoring measures.

The expansion of electricity and gas lines in line with demand must be documented in a suitable form, possibly by the network operators when drawing up future network development plans.

The success rate of subsidies for plants for electricity and gas generation from renewable sources should also be presented, e.g. the design and performance of the plants. The funding agencies have corresponding data available for these monitoring measures.

The achievement of the expansion targets for renewable energy generation (e.g. photovoltaic expansion to 21 TWh by 2030 and 41 TWh by 2040) should be reviewed periodically to determine the progress. It is assumed that monitoring in this regard will take place on an ongoing basis. In any case, the expansion targets should be reviewed well before 2030.

6.3.2 Monitoring the environmental impact

In order to determine whether the assumed environmental impacts have occurred, monitoring measures are particularly useful in the following areas, which are related to the achievement of the NIP's plan objectives:

- Development of greenhouse gas emissions
- Implementation of the recommendations for action from the Austrian strategy for adaptation to climate change for the energy industry
- Land use
- Biodiversity monitoring

The development of greenhouse gas emissions or the air quality can be determined at a higher level through existing monitoring mechanisms. Within the framework of existing monitoring measures, greenhouse gas emissions and air quality in Austria are recorded and reported by the Federal Environment Agency (Austrian Air Pollution Inventory).

The land take by energy transition installations could be partly available from remote monitoring data (the European Union's Copernicus Earth Observation Programme). Ongoing documentation of the share of renewable energy production or energy transmission lines in the total land use per year is required.

The design of renewable energy generation and transmission facilities can also promote biodiversity (see chapter 6.2). Within the framework of project approvals, biodiversity monitoring tailored to specific issues can be prescribed by the regulatory authorities, such as the monitoring of biodiversity-friendly measures like the creation of feeding and breeding habitats or the attraction of birds away from wind turbines.

6.3.3 Creation of a monitoring concept for the NIP

It is proposed to establish a monitoring concept in order to best identify unforeseen negative impacts at an early stage and to be able to quickly take appropriate remedial action. This would have to be developed and implemented in close cooperation with the federal states and other affected stakeholders. The concept should contain information on the type, timing, duration and responsibility of the monitoring measures. The results of the monitoring would have to be presented in a separate report and the findings taken into account when updating the Integrated Network Infrastructure Plan.

6.3.4 Existing monitoring mechanisms

The following existing monitoring mechanisms can support concrete implementations of specific monitoring measures:

Biodiversity, fauna, flora

Monitoring per the Flora-Fauna Habitats Directive

The Fauna-Flora-Habitat Directive (Article 17) requires EU Member States to survey the conservation status of all species and habitats for the entire territory of the Member State and to report to the European Commission every six years. This report shall contain, in particular, information on the conservation measures as well as the assessment of the impact of those measures on the conservation status of the habitat types listed in Annex I and the species listed in Annex II, and the main results of the monitoring.

Article 17 - Report Austria (2019)

The Austrian Article 17 Report 2019 (reporting period 2013-2018) includes 71 habitat types with 63 assessments in the alpine region and 54 assessments in the continental region and 211 species with 171 assessments in the alpine region and 174 in the continental region.

Groundwater and surface water

Programmes for monitoring the status of water bodies are prescribed on the basis of the water status monitoring ordinance and applied uniformly throughout the country.

The monitoring programmes are an important water management basis for the preparation of programmes of measures, but also an essential element to be able to prove and evaluate the success of a measure.

By updating the monitoring programmes, longer-term trends in particular can be observed and the accuracy of the predicted environmental impacts can be verified.

Air and climate

Austrian Air Pollution Inventory [OLI]

Within the framework of the Austrian Air Pollution Inventory [OLI], emissions are collected in accordance with international guidelines and reported in accordance with international formats. International reporting obligations exist under the United Nations Framework

Convention on Climate Change (UNFCCC), under the United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution and to the European Union on the Monitoring of Greenhouse Gas Emissions, and under the NEC Directive on the Reduction of SO_2, NO_x, NMVOC, NH_3 and $PM_{2.5}$.

Air quality

The annual reports on air quality contain an overview of the results of the measurement of air pollutants and the exceedance of limit, target or threshold values. PM_{10}, $PM_{2.5}$, nitrogen oxides, sulphur dioxide, carbon monoxide, PAHs, heavy metals in PM_{10}, benzene, ozone and dust precipitation are described.

Climate change adaptation

The second Austrian Strategy for Adaptation to Climate Change was adopted by the Council of Ministers in August 2017 and taken note of by the Conference of Provincial Governors in November 2017. It is the comprehensive guiding document for all of Austria's climate change adaptation activities. Successive steps to implement the strategy are taken on an ongoing basis and documented every 5 years in the form of progress reports. The second progress report was published in September 2021. Based on the findings of the 2nd Progress Report (BMK, 2021) and scientific evidence, recommendations of the National Strategy for Adaptation to Climate Change, which is currently being revised, emphasise that securing a climate-resilient energy infrastructure and taking it into account in the NIP is an essential goal of adaptation to climate change.

Conclusion

The expansion of renewable energy generation, including the corresponding transport infrastructure, is indispensable for achieving the climate protection goals. Climate protection measures contribute to the preservation of our livelihoods. As far as possible, they should be consistent with other important environmental objectives. A lack of decarbonisation of our energy system is not a viable option from an environmental point of view, as the consequences of climate change also have catastrophic effects on all other protected resources.

In addition to climate protection, the environmental goals include halting the loss of biodiversity, restoring 30% of endangered native species and biotope types to a good status, ensuring the quality and quantity of soils, and systematically improving or preventing further deterioration of the status of water bodies. All these important objectives are anchored in international and national commitments.

The analysis in the SEA concludes that the network infrastructure measures presented in the NIP contribute significantly to climate protection. Compared to the zero option and the alternative scenarios (WAM and SK), the transition scenario leads to the lowest environmental impacts. Nevertheless, the expansion of energy production and transport systems can potentially have negative impacts on protected resources. Through coordinated and responsible planning, approval and construction of the future energy infrastructure, any negative impacts that may occur can be significantly reduced, prevented or offset through appropriate measures (see chapter 6.1 and 6.2).

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