ACRP

Final Report – Activity Report

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1 Project Data

Short title	TransWind	
Full title	The transition of the Austrian energy system to a high penetration of wind energy - A participatory integrated assessment of the social acceptance	
Project number	B286276	
Program/Program line	ACRP 5th Call for Proposals	
Applicant	University of Natural Resources and Life Sciences, Vienna Patrick Scherhaufer, Institute of Forest, Environmental and Natural Resource Policy	
Project partners	None	
Project start and duration	Project start: 01.09.2013	Duration: 28 months
Reporting period	from 01.09.2013 to 31.12.2015	

Synopsis:
Trans*Wind* assessed the key patterns of social acceptance of wind energy in Austria on the basis of a participatory integrated assessment including modelling and visualisation efforts. In order to ensure acceptance, decision-making processes have to be reformed, justice sustained and thereby both input and output legitimacy enhanced. All of these factors need to be taken into account when engaging stakeholders and civil society in decision-making processes about the future wind energy infrastructure in Austria.

2 Technical /Scientific Description of the Project

2.1 Project abstract

Social acceptance is considered to be a decisive factor for the development of wind energy. Surveys repeatedly show that while people support wind energy in general, specific wind farm projects often cause local opposition. Local resistance against wind energy cannot be explained by singular issues such as simple cost-benefit calculations, the public support for renewable energy sources, the implementation strategy of the developer, the number of wind turbines installed, the intensity of the turbine noise, the protection of local birds and animals, or the "not-in-my-backyard"-effect, although a very dominant influence seems to be the specific value of the landscape, the familiar surroundings and the habitat. Hence, the acceptance of wind energy depends on a complex set of individual and societal indicators, perceptions and preferences rooted in institutional and socio-political arrangements.

The project's approach was based on the concept of social acceptance (Wüstenhagen et al. 2007), which is composed of socio-political, market and community acceptance. Wüstenhagen et al. investigated spatial planning and financial procurement systems to assess socio-political acceptance, market innovation, consumer and investors behaviour to explain market acceptance, procedural and distributional justice and trust to contribute to the understanding of community acceptance. The three levels of acceptance do interact, have main actors associated and are influenced by their interactions and contributing expectations.

We recur to this triangle model because it provides a broad holistic framework widely recognised not only in a scientific but also in a practical context. Trans*Wind* established a conceptual and methodological reliable participatory integrated assessment in order to test various factors of social acceptance. On a macro scale the integrated assessment was based on semi-structured interviews, participatory workshops and a group discussion (WorldCafé) with the experts from our stakeholder group, an estimation of the theoretical wind area potential in Austria and a participatory modelling approach to analyse the levelized cost of electricity (LCOE). On the community level focus groups, semi-structured interviews and presentations/tests of visualisation tools were conducted. Both the integration of results from the macro analyses to the community scale and the use of a mixed-method design ensured the inter- and transdisciplinary character of Trans*Wind*.

This approach is needed to gain new, practical and relevant insights, which could not have been obtained merely from scientific or interdisciplinary sources. The conceptual framework of Trans*Wind* therefore aimed at integrating in a systematic way the analytical perspectives of the scientists and their approaches with the preferences and perceptions of the persons concerned about the issue (stakeholders) through establishing a reference group, holding workshops and organising interviews and focus groups. The assessment was complemented by a GIS based modelling tool (Where the wind blows - WTWB), which allowed the participatory assessment of optimal locations for wind power, depending on the spatial distribution of wind resources. Inputs from the reference group were summarized in a criteria catalogue to define three scenarios (min, med and max) for potentially suitable wind turbine sites. These three scenarios were complemented by a fourth scenario that reflects the wind energy potential with suitability zones for wind energy already defined by Austrian federal states. For all potential locations we calculated the levelized cost of energy generation (LCOE) to derive wind energy supply curves for each scenario of potentially suitable wind

turbine sites. Under the assumptions of the min scenario, only 3.5TWh of wind energy could be produced at relatively high costs of 96 to 243 € MWh-1. Thus, it would not be possible to meet the wind energy targets of 3GW installed capacity (equivalent to about 6.3TWh assuming current capacity factors) of the Austrian Eco-Electricity-Act 2012. The med and max scenario would allow for further expanding the wind energy share at reasonable cost of about 95 EUR MWh-1 even if electricity demand keeps steadily rising. The modelling results raised our understanding of the related costs and benefits and served as a basis for the case study selection.

In the case studies, Trans*Wind* worked with interactive 3D visualisation tools based on latest visualisation developments to provide real-time and realistic visualisations for discussing and assessing different planning strategies and siting processes related to the visual impact on the landscape. Our research on technologies for 3D modelling in the context of Wind turbine visualisations has shown that different concepts and methods exist. The simple image visualisations (static images) are state of the art in planning processes but they are increasingly criticised as there is no easy way to prove their reliability and the number of viewpoints is very limited. From a cost perspective it is still the most efficient technology and the images can be easily shared in reports, presentations or websites. Interactive 3D visualisations allow users to change their viewpoints interactively depending on personal motifs. Therefore, personal fears and expectations can be addressed which may lead to more objective discussions and exchange of opinions during planning processes. During the project, two very new technologies entered the stage: Augmented reality (AR) and Virtual reality (VR) applications. Both are driven by the fast spread of mobile phones and may provide some additional insights in the visual impact of wind turbines. Nevertheless there are still some technological barriers that leads to positioning errors or unrealistic views due to the missing masking of 3D objects by real world objects (in AR) or are lacking quality due to low screen resolutions of mobile phones (in VR).

Through the research in the case studies and the preferences expressed by the stakeholders of the reference group Trans*Wind* identified different and sometimes contrasting patterns of social acceptance, which enhanced our understanding about the economical, political, ecological and social feasibility of wind power plants. Our empirical results showed that all interview partners and focus group participants consider vertical and horizontal cooperation and coordination across different political levels and parties (stakeholders; experts; local to regional decision makers; citizens) to be important. The problem is that the process of interaction between these actors is often conflictual. Different factors could be highlighted explaining this divergence. Such factors can be seen in the conflict of interests, rationales and beliefs which strengthen the problems of coordination and cooperation. Furthermore, any wind energy project is characterised by the basic systemic conflict between nature conservation (protection of wildlife, habitat and landscape) and narratives of ecological modernisation (e.g. climate protection or energy transition). These moral concepts (core beliefs) and policy cores (general beliefs and perceptions in a specific policy field like wind energy) of the participants are unlikely to change. Only the so called secondary aspects, which relates to the implementation of a policy (e.g. instruments, concrete actions), are most likely to change and are subject to learning processes.

Solutions for local wind energy projects can only be found in coordinated processes of cooperation taking into account all patterns of social acceptance. In order to ensure acceptance, decision-making processes have to be reformed, justice sustained and thereby both input and output legitimacy enhanced. All of these factors need to be taken into account when engaging stakeholders and civil society in decision-making processes about the future wind energy infrastructure.

2.2 Contents and results of the project

The activity report covers all work packages from 1 to 6:

- Managing inter- and transdisciplinarity (WP1)
- Integrating stakeholders (WP2)
- Modelling of wind power potentials (WP3)
- GIS analysis and development of interactive visualisation tools (WP4)
- Local case studies (WP5)
- Dissemination, knowledge transfer and evaluation (WP6)

2.2.1 Managing inter- and transdisciplinarity (WP1)

Trans*Wind* meets the challenge of knowledge integration through the following tasks and milestones:

Milestones (M) within WP1:

Task	Description	Status
M1.1	Project implementation plan	Completed
M1.2	Knowledge transfer and dissemination plan	Completed
M1.3	Kick-off and monthly project meetings for quality and progress control	Completed
M1.4	Interim and final project reports	Completed

A first internal meeting was organised before the project actually started. At this meeting the essence of inter- and transdisciplinary work was presented in order to strengthen the cohesiveness of the group of researchers. As the project team is composed of scientists with different backgrounds (economics, political and social sciences, landscape planning, resource management, and engineering) we first discussed and agreed upon a common language and a set of methods which allow integrating the different disciplinary backgrounds. In addition a list of potentials stakeholders was discussed. On basis of this list the selection of the reference group was started (see section 2.2.2).

In the kick-off meeting the project implementation plan was developed. The project leader acts as the core communicator and is responsible for the management of the inter- and transdisciplinary research.

Fixed project meetings (32 within 28 months) followed by detailed minutes helped us to manage the quality and progress of the project and provided room for coordination and problem-solving. This institutionalised way of communication is strongly linked to the commitment of all researchers to work closely together, to invest sufficient time and resources into the project and to act flexible and openly.

In addition a project website was established, which guarantees transparency and the dissemination of results to the public. The website contains a project description, the team members and participating stakeholders, the tasks of the reference group (see section 2.2.2), the results from the different work packages and a list of publications and reports. It is available on http://www.transwind.boku.ac.at/ (in German).

As Trans*Wind* depends on an institutionalised way of communication and participation, high attendance rates are an important attribute legitimising the project's interactions and participatory undertakings:

	1st Workshop	Online questionnaire	Interviews	2nd Workshop	Ballot about one topological indicator	3rd Workshop
Attendance / response rate*	96.43% (n = 28)	82.14% (n = 28)	100.00% (n = 28)	89.29% (n = 28)	50.00% (n = 28)	48.15% (n = 27)

* in relation to the participating organisations of the reference group (n=27-28)

2.2.2 Integrating stakeholders (WP2)

In order to meet the requirements of both scientific rigor and practicality the stakeholder process in Trans*Wind* takes into account the following guiding principles: openness defined as taking the perceptions, beliefs and ideas of stakeholders seriously, transparency defined as stating clearly who is able to participate, when and on which level of co-determination, iterativity defined as an ongoing information sharing process through the various dissemination and participatory activities and institutionalisation defined as a long-term engagement where a core office is responsible for the management of the inter- and transdisciplinary research.

Milestones (M) within WP2:

Task	Description	Status
M2.1	Built-up a reference group with stakeholders	Completed
M2.2	Organise two participatory workshops and one scenario workshop	Completed
M2.3	Case selection	Completed
M2.4	Qualitative assessment of the social acceptance of wind energy	Completed
M2.5	Establish guidelines for various user audiences	Completed

Before the project started the researchers discussed a list of potential stakeholders, which could contribute to the research of Trans*Wind* and represent a supra-regional interest in the sector of wind energy. In the first project meeting we agreed upon the following selection process:
Based on a literature review and an online research we first identified 64 individuals who have a stake in the deployment of wind energy. These persons were contacted per e-mail and asked to specify the most relevant actors (organisations or individuals) in the field. We received 199 nominations (response rate 46.88%) and allotted them to four different categories: politics/administration; interest groups (supporters or opponents of wind energy); wind energy enterprises and electricity providers; regulatory bodies. The organisations with the most entries (absolute numbers) in the four groups were contacted and invited to the first workshop, where the reference group was constituted.
This selection process has two advantages: All stakeholders were already informed, when the project officially started. Therefore the capacity to work with the group could be used at the beginning of Trans*Wind*. Secondly, although the reference group is much bigger than in the project proposal suggested, it better reflects the needs of the community to create a discussion forum.

The reference group of Trans*Wind* contains 27-28 organisations (or 33-34 individuals) drawn from a wide range of sectors such as practitioners, experts, civil servants, policy-makers, lobbying groups, wind energy enterprises, environmental NGOs, representatives of the civil society, labour and trade unions (see a complete list of the members of the reference group in Annex B).[1] The aim of the reference group is to provide feedback at various stages of the research process (see Figure 1), to provide a forum for critical discussion and to guarantee a long-term and institutionalised form of participation.

PHASE 1 (September 2013 – April 2014)

In the first moderated stakeholder workshop the aims of the project and the development of wind energy in Austria were presented, the reference group was constituted, the rules of communication and decision-making were fixed, and the levels of co-determination (from *information* to *consultation* and *co-decision-making*) were declared. This approach was necessary in order to make the participatory processes of Trans*Wind* transparent and conceivable for the stakeholders. As a consequence, the members of the reference group knew from the beginning how much time they should invest and how they could influence the research project. The second half of the workshop was dedicated to a World Café. In small groups, four subject areas were discussed: a) political barriers and benefits; b) siting and planning options; c) future impacts of wind energy; d) social acceptance and justice. The group discussions were moderated and recorded (see a detailed description of the first workshop in Annex C) and contributed to the qualitative assessment of the social acceptance of wind energy.

In WP3 Trans*Wind* established an online questionnaire, which was also presented at the first stakeholder workshop. The survey aimed at assessing the general attitude towards wind energy and preferences for future expansion, defining areas that should be excluded from wind power production, setting distance limits and collecting reasons for excluding those areas (see section 2.2.3 for the results of the survey). 23 out of 28 member organisations, i.e. 82% of the reference group, completed the questionnaire.

PHASE 2 (April 2014 – November 2014)

In spring 2014 we organised 28 semi-structured interviews with representatives of all member organisations of the reference group. The interviews were conducted face-to-face and lasted from 57 to 104 minute. They were based on an interview guidebook (see Annex F), recorded and literally transcribed. The aim of the interviews was to deepen various aspects of social acceptance from a stakeholder's point of view. They provided us with a thorough overview about the planning and siting decisions and related conflicts or problems addressing different aspects of social acceptance. The analysis (coding and examination) of the interviews is elaborated in "qualitative assessment of the social acceptance of wind energy" (see below). An additional side-effect of the interviews was to foster the cohesiveness within the group of stakeholders and to motivate them to contribute to the research of Trans*Wind* and to take part in the workshop(s).
In the second workshop (see the minutes in Annex D) the results from the online questionnaire were presented and discussed (see also section 2.2.3). On the basis of the survey and a literature review, the research team established a criteria catalogue, were different types of topological restrictions and distance limits to technical infrastructure and protective areas were compiled (see Table 1). The aim of the catalogue was to introduce a minimum, medium and maximum scenario for the theoretical wind area potential in Austria. During the workshop the stakeholders were able to evaluate the spatial, technical and topological parameters and distance limits again (didactic tool: matrix and glue dots) and to suggest new criteria (e.g. tourism; development of urban areas). This was followed by an intense discussion and a revision of the criteria catalogue (for more details see section 2.2.3). As the discussion took much longer as expected, the following parts of the workshop agenda (introduction to the modelling approach, wind deployment scenarios, criteria for case study selection) were cancelled. At the end of the workshop the participants agreed that the

[1] In December 2014 the Austrian Alpine Assocītation (Österreichische Alpenverein) withdrawed from the reference group.

medium scenario, where no consensus could be found among stakeholders, should be elaborated by the scientific team of Trans*Wind*.
After the workshop one topological indicator (working with sea levels or timber lines) were put to a vote (because an agreement in the workshop was not possible to find) and the final version of the matrix (with a minimum and a maximum wind deployment target) was approved.

According to the literature, some of the most dominant indicators influencing the acceptance of wind energy are the specific value of the landscape, the familiar surroundings and the habitat (Wolsink 2007). Therefore the case study selection should account for the importance of tourism, wood land and the alpine scenery in Austria. In addition wind energy is not only restricted to the topological area of lowlands (in the Eastern parts of Austria), but could also be employed in tableland, intermediate shelf and alpine areas. As a consequence, the case study selection reflects two scenarios: a) the repowering of existing wind turbines and further concentration of wind sites in the East; and b) the diversification of wind farms throughout the country.

A preliminary list of potential (primary and secondary) attributes for the case study selection was sent to the stakeholders of the reference group and the feedback (four written statements) was incorporated (*consultation process*).
The workflow of the case selection included two steps. The first step was based on the following list of (primary) attributes:

- Theoretical wind area potentials of med scenario (see section 2.2.3)
- Topology of Austria (lowlands, tablelands, foothills of the Alps, alpine areas)
- Wood land (municipalities with more than 80% or less than 10% wood land in relation to the municipal area)
- Importance of tourism (high, low, no information)
- Structure of urban development (dispersed settlement, rural or urban character)
- Austrian federal states (“Bundesländer”)

According to this pre-selection, about 35-40 municipalities were chosen and the following questions (secondary attributes) were specified:

- Is the municipality a climate and energy model region?
- Is there a wind farm constructed or planned?
- Has the municipality potentials for repowering?
- Is there a citizens’ group active opposing wind energy?
- How could the public participate when the wind project was planned and constructed (conflictive situations)?
- Who is operating the wind farm?

The case selection resulted in a sample of 24 Austrian municipalities which represents the primary and secondary attributes according to a most different case design. In approval with the members of our reference group (consultation process including two written and three verbal statements) the list was grouped and prioritised according to the requirements of scenario a) and b) (see above) and six different focal points:

- Summer tourism (**Sankt Gilgen**, Ratten, Arriach, Himmelberg)
- Winter tourism (**Hinterstoder**, Bad Mitterndorf)
- Wood land (**Bärnkopf**, Gutenbrunn, Dorfstetten, Draßmarkt, Königswiesen, Zemendorf-Stöttera)
- Repowering (**Parndorf**, Neusiedl am See, Weiden am See)
- Local protests and conflicts (**Himberg**, Wiesmath, Schwarzbach, Bromberg)
- Alpine area with a high level of technical and economical potential of wind energy (**Fischbach**, Langenwang, Haag, Haidershofen, Weistrach)

(*bold are the finally selected case studies*)

PHASE 3 (November 2014 – November 2015)
During the research in the local case studies we informed the group of stakeholders by means of written updates (e-mails) about the processes of negotiations (first contacts with mayors and local councils, assignment of a common understanding), methods (visualisation courses, focus groups, interviews) and implementation (local workshops) (see section 2.2.5 for a detailed description of the local case studies).

PHASE 4 (November 2015 – March 2016)
In the third and final participatory workshop the results from WP3 to WP5 were presented and discussed with the members of the reference group. The feedback was used to make some of the conclusions more comprehensive (see the minutes in Annex E for an overview of the feedback). The stakeholders were informed about the design of the local case studies and the implementation of the workshops (see 2.2.5 for more details). In addition they were able to test the visualisation course developed for the local case studies and judge the different technologies with the questionnaire (see 2.2.4 for more details). At the end of the workshop, the stakeholders evaluated the project and its participatory efforts verbally. They were informed about the plan of the project team to organise a public event (after the official end of the project) in order to disseminate the results to a general public (see 2.2.6), about their possibilities to review the final project reports (*consultation process*), to co-produce a guideline dealing with the social acceptance of wind energy in Austria (Annex I) and to take part in an online questionnaire evaluating the stakeholder process (see 2.2.6 and Annex H). Due to a lack of time, first results from the qualitative assessment of the social acceptance (analyses of the interviews and focus groups) could not be discussed. However, the stakeholders had the chance to review this part based on the prepared presentations, which were attached to the minutes.

Qualitative assessment of the social acceptance of wind energy
Social acceptance is considered to be a decisive factor for the development of wind energy. Surveys repeatedly show that while people support wind energy in general, specific wind farm projects often cause local opposition. Local resistance against wind energy cannot be explained by singular issues such as simple cost-benefit calculations, the public support for renewable energy sources, the implementation strategy of the developer, the number of wind turbines installed, the intensity of the turbine noise, the protection of local birds and animals, or the “not-in-my-backyard”-effect, although a very dominant influence seems to be the specific value of the landscape, the familiar surroundings and the habitat. Hence, the acceptance of wind energy depends on a complex set of individual and societal indicators, perceptions and preferences rooted in institutional and socio-political arrangements.
The project’s approach was based on the concept of social acceptance, which is composed of socio-political, market and community acceptance (see Figure 2).

Wüstenhagen et al. (2007: 2684-2686) investigate spatial planning and financial procurement systems to assess socio-political acceptance, market innovation, consumer and investors behaviour to explain market acceptance, procedural and distributional justice and trust to contribute to the understanding of community acceptance. The three levels of acceptance do interact, have main actors associated and are influenced by their interactions and contributing expectations.
We recur to this triangle model because it provides a broad holistic framework widely recognised not only in a scientific but also in a practical context. In *TransWind* we assessed social acceptance with the following mixed method design (see Figure 3): On a macro scale the integrated assessment was based on semi-structured interviews, participatory workshops and a group discussion (WorldCafé) with the experts from our stakeholder group, an estimation of the theoretical wind area potential in Austria (see 2.2.3) and a participatory modelling approach to analyse the levelized cost of electricity (LCOE) (see 2.2.3). On the

community level focus groups, semi-structured interviews and presentations/tests of visualisation tools (see 2.2.4 and 2.2.5) were conducted. Both the integration of results from the macro analyses to the community scale and the use of a mixed-method design ensured the inter- and transdisciplinary character of *TransWind*.

TransWind conducted various qualitative and quantitative methods (workshops, interviews, focus groups, questionnaires, modelling) assessing the concept of social acceptance. Instead of offering solely a scientific description and explanation of social acceptance, we opened the discussion to interested stakeholders (civil servants, developers, representatives of NGOs and lobbying organisations, public authorities, citizens as well as technical experts) and work together with them in order to identify the patterns, drivers, management barriers and opportunities of social acceptance. Hence identifying and prioritising the factors contributing to the triangle of social acceptance were co-determined by the non-scientific participants in the project and formed an integral part of the participatory integrated assessment.
Two research questions guided our assessment:

1) What are the patterns and determinants of social acceptance of wind energy in Austria?
2) How do the perceptions about the social acceptance differ between expert judgments, stakeholder views and citizen concerns?

In this assessment we framed social acceptance not only as a management task. We go beyond the widely recognised normative assumption that “acceptance” is good and “resistance” is bad. We were interested in reasons how to implement and why to not implement a project. In line with this approach we conceptualised citizens as active agents in the process of decision-making and not as disturbance factors, which have to be convinced to follow the energy transition. Hence our perception of social acceptance is determined by aspects advocating wind energy and by important elements of opposition at the same time.

Methods and data:
The analysis is based on 28 semi-structured interviews with the experts from our stakeholder group (representatives of energy providers, national and regional administrations, protectors of environmental law, NGOs, environmental organisations, trade and labour unions, planning offices, renewable energy lobbying groups), 8 focus groups (composed of 34 local decision makers and 32 citizens) and 8 semi-structured interviews with citizens and decision-makers from the local case studies and one WorldCafé, which was conducted during the first stakeholder workshop. The interviews and focus groups tackled the issues of governance, acceptance, participation and justice during the planning and siting process of wind farms. Both the interviews and the focus groups were using a comprehensive guidebook, which consists of key questions relevant to the research questions (see Annex F + G). The qualitative data was analysed regarding different forms of participatory methods, planning options, technological potentials and ecological constraints. For analyses, the software Atlas.ti was used and a coding scheme was established. The codes were derived from the interview guidebook (deductive method) and supplemented in an inductive way. This iterative method guarantees that all patterns of social acceptance were collected. The qualitative content analysis is based on the protocol of the WorldCafé and the transcripts from the interviews and focus groups.

Patterns of social acceptance and non-acceptance of wind energy:
In the core of our analyses rest the preferences and values of stakeholders, local to regional decision-makers and citizens on the jurisdiction, political and social parameters, ecological constraints and technical feasibility of wind farms. The following patterns of social acceptance and non-acceptance were prioritised by our respondents. Hence this is not an

exhaustive list. The focal points are a result of the sample and represent the stakeholder's interests.[2]

- *Effects on the landscape scenery*: Our interview partners and focus group participants mentioned the landscape scenery as the most important impact on social acceptance. People have a perception of industrialised landscape scenery caused by more and more visible wind turbines. In addition they regard wind turbines as a limitation of the recreational function of the local environment. The irritation is caused by the visibility of the turbines itself, the rotating blades and the navigation lights. In addition wind turbines on hilltops or on mountain backs are highly visible and alter the perception of the landscape scenery tremendously (especially in alpine land). In contrast some participants emphasized habituation effects. People in their young days are getting used to energy landscapes and do not regard wind turbines as a negative impact on landscape at all.
The not-in-my-backyard (NIMBY) effect was only put forward sporadically. It is used much more as a metaphor concealing other concerns about wind energy.

- *Nature and wildlife conservation*: The second important objection regards negative impacts on protected areas (e.g. Natura-2000, biosphere reserve) and the protection of species, birds and bats. Every siting process for a wind energy project requires on-the-ground surveys regarding the impacts on wildlife and wildlife habitat to receive the environmental permit. The parties who have a legal standing in the environmental impact assessment can assign local screening mechanisms to assess risks and impacts to wildlife. If conflicts are detected by these expert surveys in the permit process, the specific project has to be modified or even stopped. In most cases operators have to implement detection and deterrence technologies or provide compensating areas and measures (e.g. nesting sites, wetlands, and afforestation). In addition, conflicts with the nature and wildlife conservation have a strong veto power in the decision-making process. They are therefore sometimes exploited by citizens' initiatives or action groups, who are against the siting of a wind project. Operators are consequently complaining about the associated planning risks and increased investment costs. They are stressing the argument that the wildlife is already benefiting from wind energy projects by reducing the hazardous effects of climate change or by providing compensation areas. However, the conflicts between nature conservation and climate change are irresolvable. While ecologists highlight that there is no compromise between the two objectives possible, operators frame their performance as already environmental friendly. Still, there is a common understanding that data in the field of bird and bat migration is missing and more (publicly available) research is needed. The recording and use of important bird life areas (IBAs) in various decision-making processes (like the federal suitability zones) is a first attempt to close this gap.
In future a special emphasis should be put on the ecological impacts of wind energy projects in wood land, where so far no comprehensive information is available in Austria.

- *Impact on human ecology*: Our qualitative content analyses show that our interview partners perceived the following most important impacts on human ecology: noise (inkl. infrasound), shadow, ice shedding, and impacts of navigation lights. Turbine noise, shadow effects and ice shedding vary with distance, atmosphere and terrain. The operators argue that due to the Austrian spatial legislation requirements regarding the distance to dwellings most of these impacts of human ecology are limited. The residual impacts have a stake in

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[2] The following items were only relevant for some respondents in our study – therefore they do not allow general conclusions: hunting; community based financial participation opportunities (like community joint venture enterprises or an investment for private equity); the costs of green electricity for households; the necessity of a societal transformation in regard to changes in life-style, consumer or mobility patterns; loss in value of private properties; public acceptance of wind energy (opinion polls); feed-in tariffs.

the environmental permit and are tackled by expert surveys. Measures, which reduce the negative effects, could be a noise optimised operation mode, heated rotor blades, ice shedding warnings, shut-off mechanisms, or a relocation of the wind turbine. However, on the community level the discourse is shaped by revealed emotions and fears linked to these effects on human ecology and often lead to disputes and conflicts. The respondents emphasised infrasound as the most dominant issue in this confrontation. Therefore every siting and planning process should be responsive to these treats, because it often determines the degree of local acceptance.

- *Public participation, trust and transparency:* To engage citizen and local stakeholders in the planning and siting decisions is a decisive moment and task in the implementation process. All respondents agreed that operators have to inform the municipality (mayor and citizen council) and the general public as early as possible. They should be informed about the project's basis conditions, the expected location, the local investments and benefits, the environmental, human and ecological effects and the possibilities to engage in the decision-making process (e.g. to voice an opinion in the environmental impact assessment). Public relations (press releases, newspaper articles), info-days, site inspections and face-to-face contacts were mentioned as appropriate methods of information. These tasks have to be strictly planned and conducted in comprehensible, transparent and trustful ways. Responsible for the management should not only be the operators, but also other entities like citizen initiatives, the citizen council or members of the civil society. Emphasis should be put on local opinion leaders (e.g. secondary residences) as a pivotal group. However informing citizens is not enough to engage them. Local stakeholders should have a say in the decision-making processes and be able to negotiate the quantity, height and location of wind turbines. From the operators point of view, this aims at bringing the project to its appropriate size and dimension and to make it ready for the environmental impact assessment. From the citizens' point of view, they can trust in a transparent process, where their fears and objections are seriously taken into account.
Introducing a public opinion poll ("Volksbefragung") in a municipality could raise the accountability and legitimacy of decision-making. At the same time it does not provide an arena for conflict resolution or fair negotiations. Hence it often leads to a polarisation of local communities. In addition operators seem to be reluctant to this political instrument, because such votes often receive large negative publicity.

- *Distribution of benefits and losses*: The distribution of benefits among the local parties affected by the wind turbine is a delicate issue. First of all operators have to complete contracts with the municipality ("license agreement" e.g. for the use, maintenance and repair of roads) and the land owners (legal provision about the servitude rights). In both cases money is spent (several thousands of Euro per wind turbine and year) to compensate negative effects or economical losses. Some respondents claimed that these payments are used to buy votes or interests. Operators instead assert that this money is an integral part of the siting and planning process and make good economic sense. However, in regard to social acceptance it is very important to distribute and utilise these payments meaningful (e.g. dedicated to specific purposes; mutual fund solutions) in order to reduce enviousness and distrust (e.g. between land owners and the residential population). In addition the parties involved should try to achieve an equal distribution not only within a municipality, but also among the neighbouring communities, which are affected by the wind farm.

- *Energy strategies and political leadership*: Although public support of renewable energy and the discourse about climate change boost the use of wind energy, our respondents assert a lack of political leadership in regard to policy coherence and consistence. There is no common understanding about the development of wind energy from a national to a regional and local perspective and only very little policy coordination across federal state (Bundesländer) boundaries. The Austrian eco-electricity act ("Ökostromgesetz") makes the

renewable energy targets explicit, but without negotiating it with the local to regional administrative levels responsible for the implementation (spatial planning, zoning, requirements regarding distance). On the positive side, four out of nine federal states in Austria have defined suitability and exclusion zones for wind energy to reduce conflicts with local communities and to make the planning for operating companies more reliable (Burgenland with a pioneering role). However, this instrument of political steering was e.g. released too late in the case of Lower Austria and is not legally binding in Upper Austria. There is a general national to local energy strategy missing, where the development of wind energy is embedded and supra-regional planning and siting decisions are taken. In addition most of the respondents state that the introduction of energy efficiency measures and the definition of reduction limits should be an integral part of the energy strategies and would definitely foster the social acceptance of wind energy.
On the community level it is necessary to frame the issue at stake as a regional energy project, which means to communicate why it is important and to link it to other energy measures like the promotion of renewable energy (subsidies), the creation of electric vehicle charging stations or the refurbishment of the street lighting, etc.

- *Impact on tourism:* Compared to the other patterns of social acceptance, the impacts on tourism were surprisingly much less discussed in our study although three out of six case studies were characterized by a middle to high degree of utilization by summer- or winter tourists. Especially the group of operators did not expect many negative effects on the tourist industry. However, as in the Alpine scenery the visibility of wind turbines and the relevance of tourism gain more importance, nature conservationists, local decision-makers and citizens are afraid of damaging the recreational functions of homeland and economical losses e.g. due to declining overnight stays. Hence the impact on tourism strongly correlates with the perception of a landscape for recreation.

- *Economic sustainability:* Wind sites, which received problems in terms of too little distances to dwellings in the past will be removed (dismantling) and others will be replaced by less but more powerful turbines, which increases the total capacity in MW (repowering). After 15 or 20 years of operation, citizens probably will get used to an industrialised landscape scenery. The new turbines have to pass through the approval procedures including an environmental permit, but the respondents do not expect new conflicts with respect to nature conservation or human ecology. The financial distribution from the operators to the municipalities and land owners will be negotiated again. Current examples showed that these sites will get more expensive for wind operators. Consequently, most of the interviewees regarded the process of dismantling and repowering as a win-win-situation. There are only two negative effects – one is an increased visibility. That way, the current distance limits should be reconsidered in the case of repowering. Another concern is about environmental and resource economics. The current support regime (fixed feed-in tariffs for 13 years; afterwards market rate) supports the dismantling of the turbines after this period although the service lifetime is about 20 years. From a financial point of view, the repowering after 13 years makes sense under the current regulation scheme, but it may constitute a waste of important resources.

On the basis of the qualitative assessment (WP2 and WP5) and the major results from WP3 and WP4 Trans*Wind* established a guideline for various user audiences interested in handling the acceptance and non-acceptance of wind energy (seen Annex I). The guideline was critically discussed within the group of stakeholders, revised (principle of consultation) according to these expert opinions (see Annex R) and is published at the project website http://www.transwind.boku.ac.at/ as a key document disseminating the results.

2.2.3 Modelling of wind power potentials (WP3)

In this work package we assessed the Austrian wind energy potential in a participatory modelling approach. Therefore, we included inputs from an online questionnaire, e-mail consultations and two stakeholder workshops into the GIS based modelling tool "WTWB - Where the wind blows" (Schmidt et al. 2013). The model uses data of the Austrian wind atlas (Krenn et al. 2011) and simulates wind speeds on an hourly basis for each hectare in Austria.

Milestones (M) within WP3:

Task	Description	Status
M3.1	GIS model updated	Completed
M3.2	Model parameters aligned with outcome of stakeholder workshop	Completed
M3.3	Model structure (i.e. optimization) updated	Completed
M3.4	Model scenarios run	Completed
M3.5	Model validation by stakeholders	Completed
M3.6	Model scenarios re-run, preparation of input for case study selection	Completed

Participatory modelling approach

To give stakeholders the possibility to articulate their preferences and give inputs at all stages of the participatory modelling process, we conducted an online survey and several e-mail consultations and organized two stakeholder workshops with the members of our reference group (see Figure 4). Federal state authorities, especially those from Burgenland and Styria, contributed with their experience from previous planning processes and their expertise on regional spatial planning laws in the context of wind energy. Wind park developers provided information on the technical restrictions (e.g., the maximum feasible slope). Experts from nature conservation groups highlighted relevant ecological restrictions, such as the type of protected areas that should be excluded.

The results from the online questionnaire revealed priority areas for future wind power production and define minimum distance limits. The majority of the respondents agreed that wind energy can contribute to mitigate climate change (78%), reduce the dependence on fossil fuels (74%) and that it is an economically feasible source of renewable energy (65%). Concerns were raised about the impact on the landscape (65%) and conflicts with nature conservation (48%), especially possible negative impacts on birds and bats (43%). The suitability of different land use categories has been evaluated quite similarly by most stakeholders (Figure 5). However, the suitability of forests is seen very controversially with 12 respondents (52%) assessing forest areas as very suitable or suitable for wind energy and 11 respondents (48%) arguing that they are unsuitable or very unsuitable.

The results of the online questionnaire were summarised in a criteria catalogue (Table 1) and used to define three scenarios (min, med and max) for potentially suitable wind turbine sites.
In the min scenario, we consider several strict restrictions and large setbacks to protected and settlement areas so that all of the stakeholders agreed that no more areas should be excluded as potential sites. This implies that even the most restrictive stakeholders with respect to wind power deployment agreed that such a scenario would be feasible from their point of view. The max scenario was chosen in a way so that the stakeholders agreed that no more areas should be considered to be potentially suitable, i.e., by using lower setbacks to protected and settlement areas (max scenario). This implies that even the stakeholders with greatest interest in wind power expansion agreed that wind power should not be deployed beyond that point. The min and max scenarios represent the lower and upper bounds of the acceptable wind energy potential in Austria from a socio-political perspective, as defined by the stakeholder group. The large bandwidth of the min and max scenario made it difficult to draw conclusions about the potential contribution of wind energy in Austria. To provide a more meaningful estimate within this range we defined a med scenario. Due to the heterogeneity of the stakeholder group, it was not possible to reach consensus on the med scenario. Therefore, assumptions and offset distances of the med scenario are based on

current national and federal state legislations and recommendations by experts and from previous studies. To provide a reference value for our three scenarios, we also calculated the economic wind energy potential for the suitability zones defined by the federal states of Burgenland, Lower Austria, Styria and Upper Austria.

In a second workshop, six months later, we discussed the criteria catalogue for the scenarios of potentially suitable wind turbine sites with our stakeholder group. The recommendations and comments of the key stakeholders were collected and used to update the criteria catalogue. Experts from regional land use planning authorities argued that current settlements and buildings as well as potential future settlement expansions should be considered. Therefore, we gathered information on land-use plans to include land that was dedicated as a building area as an additional exclusion zone. Our approach to generally exclude or include forest areas was criticized for being too simplistic. Stakeholders suggested that the main function of a forest area (productive, protective, recreational and social welfare function) according to the Austrian forest development plan (Fürst and Schaffer, 2000) should be integrated, and only those areas with prevailing productive function should be considered to be suitable. Another concern that has been raised is whether the defined maximum elevation for wind sites is a proper criterion. Critics argued that using the alpine forest border line instead of the maximum elevation would better reflect topological differences between Eastern and Western Austria. For the integration of the alpine timber line as a new criterion we used results from a study of Kilian et al. (1994). Wind park developers noted that the assumed maximum slope of up to 20°, which we had taken from a previous study on the wind potential in Austria (Prinz et al. 2005), was unrealistically high. According to the wind energy experts in our stakeholder group, it was not economically feasible to build wind turbines on sites that are steeper than 5.7°. Values from scientific literature are usually much higher, ranging from 11.3°, or 20% (Grassi et al., 2012), to 15° (Gass et al., 2013; Winkelmeier et al., 2014) and 16.7° or 30% (Lütkehus et al., 2013). Therefore, we assumed a range between the expert values (5.7°) and the lower values that were found in literature (11.3°). In a third step, the redefined values for the min and max scenario were approved by all of the stakeholders. The contributions and results were collected on our project webpage (www.transwind.boku.ac.at) to encourage continuous stakeholder feedback.

Integration of stakeholder inputs and modelling of the economic potential
The inputs from our reference group contributed to improve the quality and the legitimacy of the results. In total, the 28 experts from the various organisations provided a diverse picture of social, economic and technical barriers that have to be considered for assessing Austria's future wind energy potential. Discussions in the workshops revealed that the definition of the theoretical wind area potential is a key issue that determines the acceptance of wind energy. Therefore, the collection of geographic information to represent the different land use categories was one of our key tasks. To represent their attitudes towards the suitability of different land use categories for wind energy generation, we collected GIS data on land use categories, topology, settlement areas, federal land use plans, protected areas and important habitats and migration routes for wild animals, infrastructure, the regional alpine forest line and the main function of forests. A detailed overview of data-sets and data sources is given in Table 1.
The design of support schemes for wind energy is another important factor for the economically optimal locations for wind power turbines. As the future support scheme for renewable energy in Austria is ambiguous and unpredictable, the implementation of different policy options into the existing optimization model was neglected and allowed us to use more resources for the GIS modelling which was strongly discussed by stakeholders. The economic potential was directly derived by calculating levelized costs of electricity (LCOE) for all feasible locations and generating supply curves based on the different scenarios for the theoretical wind area potential and the future energy demand without using the optimization

model. The following modelling steps were used to derive the supply curves: After modelling the theoretical wind area potential using the available GIS data, the theoretical wind energy potential was calculated by simulating mean hourly wind speeds from the Weibull distributions provided by the Austrian wind atlas.

In the next step, we transformed wind speeds to power production by applying power curves of specific wind turbines. Also, the maximum number of possible turbines was determined by implementing a minimum distance between two wind turbines of 6 times the rotor diameter. In the last step, we calculated the LCOE for all wind sites, applying a wide range of estimates from literature for investment and operation costs, the discount rate and wind turbine lifetimes (Table 2). The supply curves were generated by sorting and summing up the LCOE of all potential wind energy sites.

Scenarios for Austria's energy demand in wind energy share in 2030
Many targets for renewable energies and also for wind energy are defined as a relative share of the final end energy demand. To provide a feasible bandwidth for the end energy demand in 2030 and the resulting wind energy generation we used four scenarios (Table 3). We assume, that in the best case, the demand can be stabilized at the level of 2013, and in the worst case, the demand will continue to grow with the same annual rate of 1.5%, as observed on average in the last 10 years. To reach renewable energy targets for wind power, these scenarios would require an annual wind energy generation between 6.2 and 16.1 TWh for 2030.

Results for the theoretic area and economic wind energy potential
The area of potential wind turbine sites ranges from 74 km² in the min scenario up to 2285 km² and 3305 km² in the med and max scenario, respectively (Figure 6). This is equivalent to 0.1%, 2.7% and 3.9% of Austria's total area, respectively.
Assuming that the best wind turbine locations are utilized first, the LCOEs increase with the installed capacity. The supply curves in Figure 7 visualize the relationship between installed capacity and the marginal LCOE for all scenarios of potentially suitable wind turbine sites. As the potentially suitable wind turbine sites decrease, the corresponding supply curves become steeper. The economic wind energy potential at a given price level varies considerably between the area potentials scenarios.

Under the assumptions of the min scenario, only a total of 3.5TWh of wind energy could be produced at relatively high costs of 96 to 243 € MWh-1. Thus, it would not be possible to meet the wind energy targets of 3GW installed capacity (equivalent to about 6.3TWh assuming current capacity factors) of the Austrian Eco-Electricity-Act 2012. The different area availabilities of the med and max scenario result in only little differences for the LCOE of wind energy production below 25 TWh. Within both scenarios, even ambitious wind energy targets could be met at reasonable costs of less than 100 € MWh-1. The large bandwidth of LCOE results is caused by different assumptions for investment and operation costs and the discount rate.
The Austrian green electricity act of 2012 foresaw a wind energy production of approximately 6 TWh (3 GW installed capacity) for 2020. The marginal baseline LCOE for attaining this target ranges from 86.83 EUR MWh-1 in the max scenario and 87.82 EUR MWh-1 in the med scenario up to 91.20 EUR MWh-1 for federally defined suitability zones. The light-colored areas (Figure 6) indicate the uncertainty range for the marginal LCOE based on the different assumptions for investment and operation costs and the discount rate (Table 3). For the most optimistic assumptions (low investment and operational costs) the marginal LCOE was between 8% and 14% lower than the marginal baseline LCOE. For the most pessimistic assumptions, the marginal LCOE was 16% to 20% higher than the marginal baseline LCOE.
Many targets for renewable energies and also for wind energy are defined as a relative share of the final end energy demand. Thus, the development of the end energy demand

determines the costs for attaining a certain wind energy share. The grey dotted lines in Figure 6 indicate the wind energy generation that is necessary to reach a 10% and 20% wind energy share under different assumptions for the energy demand in 2030. At an end energy demand of 62.0 TWh, i.e., a stabilization of demand at 2013 levels, the marginal baseline LCOE for attaining the 10% target (scenario 1) varied between 86.92 EUR MWh^{-1} in the max scenario and 87.95 EUR MWh-1 in the med scenario up to 91.45 EUR MWh^{-1} for the federal suitability areas. Assuming that feed-in tariffs are calculated based on our LCOE calculation, the annual costs for reaching the 10% wind energy share under a feed-in tariff scheme are 3.8% and 4.9% (23.8 and 30.7 million EUR) lower for the med and max scenario compared to the federal suitability zones. If the end energy demand increases to 84 TWh in 2030, the suitability zones already defined by federal states will not provide sufficient areas to increase the wind energy share to 20% (scenario 4) and even the costs for stabilizing the share at 10% (scenario 3) increase significantly to 110-140 EUR MWh^{-1}. In the med and max area scenario the LCOEs in scenario 4 increase to about 95 EUR MWh^{-1}.

The spatial distribution of optimal wind turbine sites varies significantly for the different area potentials. Figure 8 compares optimal wind turbine locations for the suitability zones defined by the federal states (Burgenland, Lower Austria, Styria and Upper Austria) and the medium area potential. It demonstrates that in the medium area potential, the economical optimal expansion of wind energy takes place in Burgenland, Carinthia, Lower Austria and Styria. The difference between federal suitability zones and the medium area scenario becomes more evident with increasing wind energy shares (scenario 3). In this case, it would be necessary to use the majority of federally defined suitability zones – also those in Upper Austria and Western parts of lower Austria with less favourable wind conditions. In the medium area potential, wind power expansion would concentrate mostly in Burgenland and the Eastern parts of Lower Austria, where already now the majority of wind installations can be found. In the medium area scenario, the total wind energy generation would remain constant in Styria. However, different sites would be selected, which leads to slightly higher average full load hours and a reduction in installed capacity of about 30 MW (or ten 3MW turbines). In the medium area scenario, Carinthia could contribute 2% and 3% to the total wind energy generation in scenario 1 and scenario 3, respectively. The higher availability of sites with good wind conditions in the medium area scenario compared to the suitability zones defined by the federal states leads to higher average full load hours and requires less wind turbines to reach a certain total wind energy production. In scenario 1, the total number of wind turbine installations decreases by 4% and by 9% in scenario 3.

2.2.4 GIS analysis and development of interactive visualisation tools (WP4)

During WP4, four visualisation methods and techniques were identified and evaluated: 1) static images (with video support), 2) Game engines and game engine equivalent technologies 3) Augmented Reality and 4) Virtual Reality visualisations.

1) Static images are a state of the art method to visualize planned wind turbines and to simulate their appearance in the landscape. The method is mostly based on taken photos where wind turbines are retouched using specific software products or image processing software.
2) When it comes to interactive 3D models, specific demands regarding data integration, user experience and modelling efforts appear, which need to be addressed. Therefore we performed a literature and web-based research on existing technologies. One category in this context are game engines that allow users to create own levels within its gaming environment. Some of the most powerful engines such as the Cry engine or the Unity Engine are free for non-commercial or educational use and can provide a very impressive graphical experience. Nevertheless they are mostly designed for smaller levels and have no specific tools and interfaces to integrate large-scale GIS data easily. Therefore the

modelling effort is too time consuming for a systematic use in participation processes. Further, most of these engines have a very high demand regarding processer speed and the graphic card. For architectural purposes, a visualisation suite named Lumion3D exists that provides a very easy to use interface and a high graphical quality. As the largest spatial extent in Lumion3D is 4x4km, it is however not suitable for wind turbine visualisation. The last program we have tested was the Virtual Terrain Project software package (VTP). It is an open source software suite that comes with a builder (VTPBuilder) program, a program for entity management (CManager) and an interactive 3D environment (Enviro). The software looks a bit out-dated but has a very straightforward and logical workflow for the systematic integration and visualisation of GIS data in Enviro. The concepts are comparable to one of the leading landscape visualisation programs named Visual Nature Studio. Regarding the graphical quality it is not comparable with the latest game engines but it provides a realistic 3D environment. VTP has the most efficient workflow for the preparation of interactive landscape models with a large spatial extent.

3) Augmented reality is a concept for an immersive landscape experience where the planned 3D model is overlayed with the real environment using mobile technology. The proof-of-concept has worked, but there still lots of problems and uncertainties such as sensor precision (especially the compass), and missing object masking, which means that the 3D objects are always in the foreground.
4) Virtual reality is a young but booming technology driven by the fast spread of mobile devices. It allows a more immersive view as it isolates the viewer with the VR glasses from the rest of the world. Nevertheless, there still exist technological restrictions such as screen resolution or limited computing resources on the mobile phone.

From the perspective of the technical development process, retouched images (1) are very simple to create. They provide a high level of photo realism. Additionally, these images can be easily implemented in Websites, brochures or in on- and offline surveys. Nevertheless, the level of immersion is very low, and the users cannot change perspectives or parameters easily. Although those images are static, the wind turbine itself can be animated using video animations and the formats are suitable to transfer to different media. More possibilities for interaction and immersion can be provided by producing full 3D models (2) that can be applied to different media. The challenging task in this context is the modelling effort, as normally, wind infrastructure can be seen over long distances due to their size and huge areas have to be visualized therefore. This issue can be partly solved using databases on interchangeable landscape elements and textures as well as a detailed GIS database to enable an efficient workflow. As 3D models are flexible regarding the platform of presentation, it can be used within gaming engines that can generate highly detailed and realistic environments. In addition it can provide highly immersive experiences using latest VR technology. On the other side, the production of content for gaming engines is very time consuming, requires a lot of experience and contains some obstacles to install the content on a computer (e.g. user rights, etc.). Lower level 3D models can be provided using GIS 3D engines (e.g. ESRI City engine, Biosphere 3D) or the 3D options of Google Earth. The final approach to visualize wind power infrastructure is the application of Augmented Reality (3) which means, that 3D models of objects like wind turbines interact with the real environment using the real time camera view of mobile devices like smart phones or tablets.
In addition a database with 3D elements and textures suitable for integration in 3D visualisations was established. Moreover numerous elements and textures were generated and several more were collected and adapted from open source databases. A special focus was set on the variety of different vegetation types, as this seems to be a crucial point for the authenticity of a realistic experience of the natural environment. Vegetation is, however, often neglected in 3D visualisations.

Based on the case study selection (see section 2.2.2), the potential municipalities were screened regarding the availability of open source datasets and through potential sight axis regarding suitable morphologic conditions for 3D visualisation.

Milestones (M) within WP4:

Task	Description	Status
M4.1	Database on 3D infrastructure	Completed
M4.2	GIS-based visual indicator to assess the visual impact of wind turbines in a landscape	Completed
M4.3	Real-time 3D environments for the case study regions	Completed
M4.4	Validated GIS-based visual indicator based on the input from the questionnaire	Undue

M4.1 Database on 3D infrastructure
The creation of the database on 3D infrastructure was an on-going process by systematically sorting and categorising 3D models as well as textures during the data gathering and 3d modelling process with the goal to develop an dataset for further projects and to optimise the quality of 3D models and textures. The textures are stored as graphics in common formats (JPEG, PNG). The 3D Models are mainly modelled using SketchUp and stored in the open source format OSG (Open Scene Graph). The OSG-Format has the advantage that it comes in a readable text-format and can therefore be automatically adapted and enhanced by applying “search and replace” scripts. With this method we were able to enhance the texture quality and produced optimised models for a better computer performance. This is important, as interactive models consume a lot of calculation power and therefore a stringent optimisation scheme is needed to provide interactive models with a high frame rate for frictionless navigation.

M4.2 GIS-based visual indicator to assess the visual impact of wind turbines in a landscape
GIS-based indicators for the visual assessment of planned wind parks exist and are based mainly on viewshed analysis. The problem in these approaches is that usually the visibility is calculated in a simple visible/not visible scheme (0/1) negotiating aspects of distance and partial masking of wind turbines by relief or forest areas. Therefore we developed a GIS-based calculation model to produce weighted viewshed maps based on different studies addressed landscape impacts of large infrastructure (Brahms and Peters, 2012; Weise et al., 2002; Welsch et al., 2012).

In a first step we developed a weighted viewshed indicator for our medium scenario at Austrian level (see Figure 9). Relief calculations are based on the STRM elevation model with a resolution of 80m. To assess view limitations caused by forest areas, we added forest areas from the JRC forest dataset by adding a constant height of 20m for these areas to the elevation model. Many viewshed analyses consider a 10km radius, but as in many Austrian regions the visibility of wind turbines is much wider (mainly due to the flat plain regions and dispelled agricultural landscapes), we consider a radius of 20km for our analysis.
The weighted viewsheds were calculated per single potential wind turbine and then aggregated over a statistical sum-function to produce a nation-wide map on the visible impact of wind turbines. Based on these findings, we are preparing the calculation model of analysing the current stock of wind turbines in Austria and compare it with potential development scenarios developed in WP3.

M4.3 Real-time 3D environments for the case study regions
Before starting to develop a workflow for the creation of interactive 3d models, we performed a research on available technologies and platforms. The main challenge was to identify technologies that provide a frictionless and in terms of working time affordable framework to

integrate GIS data such as digital elevation models, land use, street data and infrastructure together with 3D models of houses and infrastructure into an interactive environment for the communication of visual aspects of wind turbines in the case study region. We decided to model a total area of 20x20km (according to the viewshed analysis) for each case study and identified core areas with a modelling emphasis depending on the location of the wind turbines in relation to the core settlement areas.
There are several technologies available that allow the development of interactive 3D models based on game engine technologies (e.g. Cry Engine, Unity, Unreal Tournament). The problem in all these technologies is that the automatic integration of GIS data is not or very little considered which means, that building a large scale model is very time-consuming and therefore economically not affordable in participation processes. A software package, that allows the integration of GIS data is provided by the Virtual terrain Project (VTP). A further advantage is that the software is released under an Open Source License which means, that it is provided for free on multiple platforms and can be modified to fit specific demands. Beside the interfaces to GIS data, methods for the automatic creation of 3D houses (block models) based on a given foot plan, a building height and a roof style helps to model a large amount of houses in an affordable time. 3D models are supported in the Open Scene Graph Format (OSG) and can be integrated using point data with X/Y-Coordinates and additional information such as filepath, scalefactor and rotation. The information will be provided using GIS point data within the Shapefile-Format (shp).
Depending on the size and structure of the case study municipalities, the modelling efforts varied very strongly. Table 4 shows the amount of the different entity types used in the case study models. The highest modelling effort is for modelled buildings as there is no potential for process automatisation. But the development of the library for 3D models and textures increased the modelling process significantly.

Virtual Reality models (VR) and Augmented reality
During the project work, two technologies entered a broader market driven by the rapid development of mobile devices such as smartphones or tablets. Therefore we explored these technologies and tested their applicability in the context of large-scale landscape visualisations.
Virtual Reality (VR) seems to be the next “big thing” in the entertainment market, but only little hardware that provides a fully featured VR environment is available in the moment (e.g. Oculus Rift). Nevertheless, smartphones represent a tool that can be transformed into a VR device with little technological expansion by using VR headsets for smartphones. In a basic application, stereo videos and images can be presented and technologically enhanced with head position recognition using the built-in sensors.
Augmented reality is popular since years in product presentation but have not reached a broader spatial context. Smartphones provide GPS positioning, orientation sensors and a camera which means, that the basic information that is necessary to show geo-referenced models (e.g. wind turbines) overlaid with the real environment (using the camera) is technically possible. Problems occur due to issues with the accuracy of the sensors. The GPS provides a position accuracy up to 5m which is enough to provide an accurate positioning in relation to the position of potential wind turbines. The main issues has to do with the orientation sensor, as in mobile phones the orientation is calculated based on movement recognition mainly based on GPS and accelerometer sensor data as magnetic compasses will not work due to magnetic hardware parts in smartphones. This means that the position accuracy is sufficient while the user is in motion, but when the position is constant, the model starts to rotate which means the position of the wind turbines shifts significantly. Another crucial problem is the recognition of the concealment of wind turbines due to the relief, other infrastructure or vegetation elements. This problem can only be addressed by integrating these structures into the 3D model as elements but this works only for small areas.

M4.4 Validated GIS-based visual indicator based on the input from the questionnaire
For the development of the GIS-based indicator on the visual impact, we applied an evaluated model regarding the visual impact estimation based in distance and masking (Brahms und Peter, 2012). Therefore, an additional evaluation of the mapped indicator was not necessary. The arising resources where used in WP1 and WP2 as the inter- and transdisciplinary framework (knowledge transfer, stakeholder participation) became more important than assumed in the application.

2.2.5 Local case studies (WP5)

Based on a multiple set of criteria (see 2.2.2) we selected six potential case study municipalities. In the following step, we needed to find out if the techniques described in WP4 can transport a different level of information to our target group (residents of the case study municipalities) and if so which kind of information is majorly transported. Therefore we developed a workshop setting with a fictive planning project (including a so called visualisation course), which should be tested in four (Bärnkopf, Fischbach, Hinterstoder, St. Gilgen) out of the six case studies. The aim of the two additional case studies was to deepen our understanding about local conflicts and opposition to already developed wind energy projects (Himberg) and about the case of repowering (Parndorf). In both cases we decided that visualisation efforts are not applicable. Therefore we worked with qualitative semi-structured interviews (four in each case study) instead of using the workshop setting and visualisation course.

Milestones (M) within WP5:

Task	Description	Status
M5.1	Moderated focus groups	Completed
M5.2	Qualitative content analyses	Completed
M5.3	Feed-back loops (results from WP2, WP3 and WP4 in relation to WP5)	Completed

The project leader of Trans*Wind* contacted the responsible authorities (principally the mayor) to explain the project's aims and to negotiate a possible commitment of the municipality. In a personal appointment the issues at stake (tasks, responsibilities, and methods) were discussed between the project leader and the mayor and an agreement made. All of our first choices (selection of six municipalities) agreed to take part in the project. To gain the interview partners, the snow ball approach was used. Interview partners were mayors, members of the local councils, representatives of citizen initiatives, nature conservationists and wind energy operators. Participants of the workshops were recruited by distributing a direct mail (leaflet see Annex J) to all households (cf. Table 5) in the municipalities, by advertising the event on local websites and in newspapers and by cover letters to selected decision makers from politics, business and civil society. If the wind infrastructure of the fictive planning project could been seen from neighbouring communities, also representatives of these municipalities were asked to take part in the workshop.

The local case study workshops consisted of four different stages: (1) detailed project description, (2) visualisation course with three different visualisation techniques (static images, interactive 3D model, and virtual reality), (3) survey to evaluate the experiences and handling, (4) moderated focus groups to discuss the social acceptance of wind energy.
In the detailed project description, the project team provided all relevant information about a fictive planning project. Furthermore, also the way that led to the fictive planning project and the selection as case study municipality was transparently communicated within presentations, posters and peer to peer discussions. Then participants were able experience the explained scenarios with three diverse visualisation techniques by themselves. Therefore black cardboard boxes were created to guarantee a level of immersion and therefore a focus on the shown scenario and technique. First, people were able to see the fictive wind energy

project from different selected perspectives within a self-controlled procedure of the state of the art method of static images (Diashow). Second, the scenario was displayed as an interactive 3D model, where test persons were able to decide their point of interest by themselves, but within a rectangle in the size of 20 x 20 km. Third, a preliminary prepared tracking shot was provided to experience with the technology of Virtual Reality. The project team provided technical assistance if needed. After people passed all three stages of techniques, they were asked to take part in a survey that focuses on the handling of the technique and the quality & plausibility of the visualisation itself (the comprehensive results of the survey are documented in Annex K). In the last part of the survey, participants were asked to evaluate the overall performance of the experienced technologies from 1 (very good) to 5 (not sufficient). The results (see Figure 10) show a slight dominance of the interactive 3D model, with 43% evaluating the technology as very good, followed by the performance of the static images (38%) heads up to the performance of the virtual reality technology (37%). Surprisingly the static images and the virtual technology method are close together, although regarding the evaluation of the single variables the static images tend to be clearly favoured. Speaking of time consumption and economic factors it seems that the mature system of creating static 3D images shall be favoured but the interactive 3D model performs better in all quality and trustworthiness oriented indicators (trustworthiness, realism, the assistance of evaluating the landscape scenery and the support of the power of imagination). On the other hand participants favour the static images regarding the handling of the technology (navigation, independent handling and the possibilities for interaction) and the suitability for participation processes. Both technologies perform excellently in the transportation of information which may be rooted in the detailed preliminary project presentation and the transparency throughout at the beginning of the visualisation course.

After the visualisation course, the participants were divided in to a group of “interested citizens” and “local to regional decision makers” and were invited to take part in focus groups (with a maximum of twelve people in each group). The distinction was carried out on the basis of a preliminary stakeholder mapping in each municipality and in approval with the mayor. The reason behind this selection was to differentiate between public and expert opinions. In addition, the participants should be able to raise their ideas, beliefs and attitudes in a trustful atmosphere, where no hierarchy is presumed or expected. The focus groups should provide an open and trustful debate about the advantages and disadvantages of the fictive planning project.

78 participants visited the local workshops in the municipalities. Thereof 66 citizens and decision makers took part in the eight focus groups. A detailed description of the allocation of the participants is presented in Table 6.

Compared to the public relation efforts advertising the local workshops, only a modest number of participants took part in the event. In addition young people, representatives of tourism and decision makers from neighbouring communities were underrepresented. These shortcomings were counterbalanced by very active participants, which attested the format and implementation a high level of expertise and professionalism. The visualization courses were a credible and reliable input for the lively discussions in the focus group. After the workshops, the transcripts of the focus groups and the most important results of the survey (see Annex L) were sent to the participants.

The results of the focus groups and interviews according to the qualitative content analyses are presented in the qualitative assessment of the social acceptance (see section 2.2.2).

2.2.6 Dissemination, knowledge transfer and evaluation (WP6)

According to the responsibilities and claims of a transdisciplinary project Trans*Wind* developed various dissemination efforts and mechanisms of knowledge transfer.

Milestones (M) within WP6:

Task	Description	Status
M6.1	Four working papers finished	Completed
M6.2	Four scientific manuscripts prepared to be submitted to scientific journals	Completed
M6.3	Four presentations at national and international conference	Completed
M6.4	Policy briefs on the basis of the guidelines established in M2.5	Undue
M6.5	Documentation and results from evaluation of stakeholder process	Completed
M6.6	Redesign of the conceptual and methodological approach of Trans*Wind*	Completed (see WP2)

Posters and conference presentations

Schauppenlehner, T.; Scherhaufer, P.; Höltinger, S.; Salak, B.; Schmidt, J. (2014): Den Ausbau der Windenergie sozial verträglich gestalten? Eine inter- und transdisziplinäre Annäherung, Poster, 15. Österreichischer Klimatag, Innsbruck, 2-4 April 2014. (see Annex M)

Salak, B.; Schauppenlehner, T.; Brandenburg, C.; Jiricka, A.; Czachs, C.; Höltinger, S.; Scherhaufer, P.; Schmidt, J. (2015): Bewertung des Landschaftsbildes im Zuge der Errichtung von Windkraftanlagen auf Waldstandorten. In: Bundesamt für Naturschutz (BfN), Naturschutzfachliche Aspekte von Windenergieanlagen auf Waldstandorten in Deutschland, Österreich und der Schweiz. [Naturschutzfachliche Aspekte von Windenergieanlagen auf Waldstandorten in Deutschland, Österreich und der Schweiz, Munich, Germany, JUN 24-25, 2015]

Schauppenlehner, T., Salak, B., Höltinger, S., Schmidt, J., Scherhaufer, P. (2015): Low-cost immersive 3D visualisations for evaluating visual impacts of wind parks using smartphones and free software. In: Leibniz Institute of Ecological Urban and Regional Development, Abstracts. Energy Landscapes: Perception, Planning, Participation and Power.

Schauppenlehner, T.; Salak, B.; Höltinger, S.; Schmidt, J.; Scherhaufer, P. (2015): Application, opportunities and constraints of different landscape oriented 3D visualisation techniques for communication and participation processes of wind energy projects, Poster. In: Aarhus University (Ed.), ECCA 2015 Abstract Book.

Höltinger, S.; Salak, B.; Schauppenlehner, T.; Scherhaufer, P.; Schmidt, J. (2015): Das ökonomische Windkraftpotential Österreichs - ein partizipativer Modellierungsansatz, 16. Österreichischer Klimatag, Vienna, 28-30 April 2015. (see Annex N)

Schauppenlehner, T.; Salak, B.; Scherhaufer, P.; Höltinger, S.; Schmidt, J. (2015): Gewichtete Sichtbarkeitskarten zur Bewertung der visuellen Präsenz und Landschaftsdominanz potentieller Windenergieanlagen in Österreich, Poster, 16. Österreichischer Klimatag, Vienna, 28-30 April 2015. (see Annex O)

Scherhaufer, P. Höltinger, S.; Salak, B.; Schauppenlehner, T.; Schmidt, J. (2015): Zur sozialen Akzeptanz der Windkraft in Österreich. Inter- und transdisziplinäres Arbeiten in Theorie und Praxis, 16. Österreichischer Klimatag, Vienna, 28-30 April 2015.

Salak, B., Brandenburg, C., Schauppenlehner, T., Scherhaufer, P., Schmid, J., Höltinger, S., Jiricka, A., Czachs, C. (2016): Mixed method design as a supportive tool for evaluation of interactive 3D approaches to enhance objectification in wind energy planning processes. Permanent European Conference for the Study of the Rural Landscape (PECSRL), 5-9 September 2016, Innsbruck.

Journal Publications

Schmidt, J.; Lehecka, G.; Gass, V.; Schmid, E. (2013): Where the wind blows: Assessing the effect of fixed and premium based feed-in tariffs on the spatial diversification of wind turbines, Energy Economics, Vol. 40, 269-276. http://dx.doi.org/10.1016/j.eneco.2013.07.004 (see Annex P)

Zeyringer, Marianne; Andrews, David; Schmid, Erwin; Schmidt, Johannes; Worrell, Ernst (2014): Simulation of disaggregated load profiles and development of a proxy microgrid for modelling purposes, International Journal of Energy Research (online first) http://dx.doi.org/10.1002/er.3235 (see Annex Q)

Höltinger, S., Salak, B., Schauppenlehner, T., Scherhaufer, P., Schmidt, J. (forthcoming 2016). Austria's wind energy potential - a participatory modelling approach to assess socio-political and market acceptance, Energy Policy (accepted).

Scherhaufer, P., Höltinger, S., Salak, B., Schauppenlehner, T., Schmidt, J. (submitted): Patterns of acceptance and non-acceptance of wind energy in Austria. A qualitative study of practices, policy-making and environmental justice (part of an already accepted special issue in Energy Policy).

Newspaper reports dealing with Trans*Wind*

Hanak, Sophie (2014): Windparks: Ein gigantischer Nachbar, Die Presse, Online-Ausgabe (15.02.2014) [Print-Ausgabe, 16.02.2014], http://diepresse.com/home/science/1563201/Windparks_Ein-gigantischer-Nachbar

Schröder, Aline (2014): Größer, höher, grüner?, Wiener Zeitung, Online-Ausgabe (03.10.2014), http://www.wienerzeitung.at/nachrichten/europa/europaeische_union/665976_Groesser-hoeher-gruener.html

Complementary dissemination efforts

Trans*Wind* Website: At the beginning of the project, a website http://www.transwind.boku.ac.at/ (available in German only) was established, which contains a project description, a list with members of the research team and of participating stakeholders, the tasks of the reference group, the results from the work packages and a list of publications and reports. The web statistics shows that the webpage had 72 unique visits per month (mean value).

Visualisation – survey results: The most important results of the survey (see Annex L) were sent to all participants of the focus groups.

Transcripts of interviews and focus groups: The focus group transcripts were sent to the participants of each focus group in the municipalities – interview transcripts only after request.

Public event: About 60 people attended the public event held on 7 of March 2016 at the University of Natural Resources and Life Sciences, Vienna. The participants were students, stakeholders from the reference group, researchers from universities and an interested public. The project team presented the results from Trans*Wind* in a nutshell (the presentations can be downloaded at http://www.transwind.boku.ac.at/). Afterwards the participants were invited to take part in the visualisation course and to discuss project details with the project team.

Policy briefs: We discussed the usefulness of policy briefs (milestone 6.4) within the project team and came to the conclusion that due to the contrasting stakeholder views no consensus is possible. We invested the arising resources on various other dissemination efforts (newspaper articles, public event) not indicated in the initial project's application.

Final results: The information of the project results (including the final presentations and the final reports) will be sent to the members of the reference groups, the interview partners, the participants of the focus groups and to other interested parties.

Results from the evaluation of the stakeholder process

All stakeholders from the reference group were invited to take part in an online questionnaire evaluating the transdisciplinary and participatory efforts of Trans*Wind* and its results. The questionnaire contained 31 questions and 15 out of 27 stakeholder organisations responded. The results from only two questions are outlined here (a comprehensive overview of the outcomes can be found in Annex H):

- Question 19 “I grade the integration of stakeholders within the reference group with” Result: 1,71*
- Question 29 “I grade the usability of the project’ results with” Result: 1,87*

*The indicated values represent the arithmetic mean of the participants’ responses from (1) excellent to (5) very poor.

2.3 Conclusions to be drawn from project results

Through the participatory integrated assessment approach Trans*Wind* was able to address the following major needs:

(1) The need to broaden our understanding of the concept of social acceptance through a participatory assessment approach.

(2) The need to link the assessment of subjective and objective parameters for the assessment of wind power projects in an integrative analysis.

(3) The need for information, which reflects the stakeholder uncertainties and needs and is relevant to “real-world” decision-making processes.

(4) The need to gain additional political, technical and economical insights about the integration of wind power into the national energy system.

Trans*Wind* assessed scenarios for Austria’s wind energy potential for Austria in a participatory modelling approach. We included stakeholder perspectives to define criteria for suitable areas for wind energy generation. Our results demonstrate that the Austrian renewable energy target according to the Eco electricity act (2012) of 10% wind energy until 2020 can be met with the suitability zones that were defined by federal states at the current demand levels. However, to successfully continue the transition to a low-carbon electricity system for Austria, higher shares of wind energy may be required after 2020. Our scenarios illustrate that there is a significant trade-off between the acceptability of wind turbine expansion by key stakeholders’ and generation costs. Future legislation (e.g., the required distances of wind turbines to settlement areas) can significantly affect the LCOE of wind energy. More restrictive criteria for wind turbine sites will therefore require higher feed-in tariffs - and more wind turbines - to achieve the same level of wind energy production. Those costs are passed on to the electricity end-consumers, who pay a levy for green electricity. Experiences from Germany show that higher electricity costs can further decrease the acceptance of expanding renewable energies. The challenge for policy makers will be to find the right balance between limiting wind production to sites with minimal negative effects on landscape scenery, human health and the environment and providing enough potential wind turbine sites to allow the deployment of wind energy at feasible costs. Minimizing expansion costs, which directly affect end consumer electricity rates, while ensuring that important land-use restrictions are taken into account to guarantee acceptability, is a delicate act and implies that future expansion targets may have to be adapted according to technological developments (which reduce costs), to changes in social acceptability and to alternative low-carbon technologies. We propose that a continuous process of consultation with important stakeholders on the national level be established to openly discuss these trade-offs. The model developed within this project can be used to assess the impact of various regulations (e.g. tighter restrictions on the minimum distance to settlements or protected areas) on the LCOE of wind energy.

In WP3 we assessed the Austrian wind energy potential in a participatory modelling approach. Therefore, we modified the existing GIS based modelling tool "WTWB - Where the wind blows" (Schmidt et al. 2013) to include inputs from our reference group. To give stakeholders the possibility to articulate their preferences and give inputs at all stages of the participatory modelling process, we conducted an online survey and several e-mail consultations and organized two stakeholder workshops. Inputs from the reference group were summarised in a criteria catalogue to define three scenarios (min, med and max) for potentially suitable wind turbine sites. These three scenarios were complemented by a fourth scenario that reflects the wind energy potential with suitability zones for wind energy already defined by Austrian federal states. For all potential locations we calculated the levelized cost of energy generation (LCOE) to derive wind energy supply curves for each scenario of potentially suitable wind turbine sites. Under the assumptions of the min scenario, only 3.5TWh of wind energy could be produced at relatively high costs of 96 to 243 € MWh-1. Thus, it would not be possible to meet the wind energy targets of 3GW installed capacity (equivalent to about 6.3TWh assuming current capacity factors) of the Austrian Eco-Electricity-Act 2012. The med and max scenario would allow for further expanding the wind energy share at reasonable cost of about 95 EUR MWh-1 even if electricity demand keeps steadily rising.

During WP4 an evaluation of four identified visualisation methods and techniques was done: 1) static images (with video support), 2) Game engines and game engine equivalent technologies and 3) Augmented Reality and 4) Vitual Reality visualisations.
First, the suitability regarding several developed indicators was evaluated (e.g. accessibility, usability, distribution, suitability for different communication strategies etc.). Also a database of landscape elements and textures was generated, to optimise the creation process.

Another topic of WP4 was the development of a GIS based indicator to assess the visual impact of windturbines at a larger spatial scale. A viewshed approach is common in many planning processes, but they are often limited to a simple visible/not visible decision. Therefore we developed a GIS model to calculate weighted viewshed depending on distance and masking effects.

Our research on technologies for 3D modelling in the context of Wind turbine visualisations has shown that different concepts and methods exist. The simple image visualisations (static images) are state of the art in planning processes but they are increasingly criticised as there is no easy way to prove their reliability and the number of viewpoints is very limited. From a cost perspective it is still the most efficient technology and the images can be easily shared in reports, presentations or websites. Interactive 3D visualisations allow users to change their viewpoints interactively depending on very personal motifs. Therefore, personal fears and expectations can be addressed which may lead to more objective discussions and exchange of opinions during planning processes. A problem with interactive environments is that the production costs are very high as many data needs to be gathered in the field and 3D modelling is a very time consuming process. Additionally, most available 3D engines are lacking automatic GIS data processing. Further, interactive models, need fast computers and good graphic cards and needs an installation process to run the model on a computer. Also usage barriers occur as untrained users are often overwhelmed with the autonomous navigation using keyboard, mouse or a joystick. Our approach has shown that there are free tools available that can operate interactive 3d models even on common office computers. The modelling effort can be reduced by developing some automatisms in data processing but needs specific expert knowledge. Depending on the landscape composition, the modelling efforts vary very strong. During the project, two very new technologies entered the stage:

Augmented reality (AR) and Virtual reality (VR) applications. Both are driven by the fast spread of mobile phones and may provide some additional insights in the visual impact of wind turbines. Nevertheless, there are still some technological barriers that leads to positioning errors or unrealistic views due to the missing masking of 3D objects by real world objects (in AR) or are lacking quality due to less screen resolutions of mobile phones (in VR). VR applications require the same modelling efforts than interactive 3D models but can provide a more immersive 3D view.

Besides the visualisation and communication of case studies we have also developed a GIS based viewshed indicator to evaluate and compare visual impacts of wind turbines at a larger scale. Viewshed analysis is common in planning processes but is often lacking specific weights for distance or masking. Addressing these aspects needs a more complex modelling especially when it comes to large scale analysis (e.g. Austria) as each wind turbine needs to be calculated separately and then joined using raster statistics. Compared to the non-weighted approach, our indicator is based on a more reliable approach as it considers distance and masking of a wind turbine in a landscape. Nevertheless additional information such as protected areas, touristic sites, recreation places, etc. is needed to compare the indicator on with different sites.

Through the methodological approach of Trans*Wind* using quantitative, qualitative and participatory methods, crucial patterns the social acceptance of wind energy could be identified. To better understand the social acceptance and non-acceptance of wind projects, it is necessary to confront different expert judgements about what they regard as important with the preferences and perceptions of citizens and local decision-makers. Therefore, we clustered the statements of selected respondents into a group of i) nature conservationists / ecologists (protectors of environmental law, representatives of environmental organisations); ii) operators / wind lobbying groups; iii) local decision-makers (e.g. mayors, representatives of political parties, the local council, tourism associations, medical scientists); and iv) citizens. Through the qualitative content analyses of the interviews and focus groups, we could categorise the patterns of social acceptance and its perceived importance (see Table 7). Table 7 shows a very coherent picture of interests. For operators, most of the patterns of social acceptance seem to be very import or important, which means that they show an interest in the concerns raised by nature conservationists/ecologists, local decision-makers and citizens at the same time. Nature conservationists and ecologists concentrate on effects on the landscape scenery and aspects of nature and wildlife conservation, where they have the expertise and a stake in the future development of wind energy. On the local level, the perceived importance of most of the critical patterns of social acceptance overlaps. Citizens do only regard energy strategies, the impact on tourism and repowering as less important than their political representatives. However, showing an interest in the patterns of social acceptance raised by others does not mean that there is no controversy or conflicts of actions. Hence solutions for local wind energy projects can only be found in coordinated processes of cooperation taking into account all patterns of social acceptance.

Addressing the different and sometimes contrasting patterns of social acceptance enhanced our understanding about the economical, political, ecological and social feasibility of wind power plants. Our empirical results show that all interview partners and focus group participants consider vertical and horizontal cooperation and coordination across different political levels and parties (stakeholders; experts; local to regional decision makers; citizens) to be important. The problem is that the process of interaction between these actors is often conflictual. Different factors could be highlighted explaining this divergence. Such factors can be seen in the conflict of interests, rationales and beliefs which strengthen the problems of coordination and cooperation. Furthermore, any wind energy project is characterised by the basic systemic conflict between nature conservation (protection of wildlife, habitat and landscape) and narratives of ecological modernisation (e.g. climate protection or energy transition). According to the advocacy coalition framework (Sabatier & Jenkins-Smith 1993; Sabatier 1998) these moral concepts (core beliefs) and policy cores (general beliefs and perceptions in a specific policy field like wind energy) of the participants are unlikely to change. Only the so called secondary aspects, which relates to the implementation of a policy (e.g. instruments, concrete actions), are most likely to change and are subject to learning processes. Therefore we suggest that future projects should focus on aspects of justice and fairness, because they are on the individual level an important motive for action (or in-action) and can be seen as a precondition for acceptance (Rawls 1971; Rawls, 2001; Baasch 2012). The following list highlights how justice and fairness on a procedural and distributional level could be enhanced:

Procedural justice

- The quality of the siting and planning processes in terms of good governance:
    - To inform citizens comprehensively and in a early stage
    - To communicate in a trustful and transparent way
- Participation and openness of decisions:
    - To engage citizens in formal and informal processes and methods of participation
    - To let citizens and local decision makers participate in the negotiations about the quantity, height and location of the wind turbines
    - The use of reliable and trustworthy visualisation techniques, which provides enough possibilities for interaction (cf. the results in WP4)

Distributional justice

- The local diversification of monetary benefits:
    - To distribute compensation payments in a fair and justified way (e.g. balancing between different municipalities; spend revenues on fixed purposes)
- Governance mechanisms and coordination among different levels of policy-making
    - To assess the availability of land and suitability zones in subject to the levelized costs of electricity (cf. the results of WP3) and to adapt renewable energy targets according to these analyses
    - To diversify wind turbines according to the technical and economical potential of wind energy in Austria (cf. the results of WP3) and to link this development to super-regional and regional spatial planning procedures, combining bottom-up and top-down approaches
    - To combine and balance renewable energy production targets with concrete and mandatory energy efficiency measures

In order to ensure acceptance, decision-making processes have to be reformed, justice sustained and thereby both input and output legitimacy enhanced. All of these factors need to be taken into account when engaging stakeholders and civil society in decision-making processes about the future wind energy infrastructure.

2.4 Work and time schedule

All tasks of WP1-WP6 described in the project proposal were successfully completed (see the GANTT for an overview).

The following deviations from the work and time schedule outlined in the proposal were part of an incremental learning process (crucial points of iterativity):

- At the beginning of Trans*Wind* we used the full project title in the communication with stakeholders and other interested parties. Although most of the feedback was positive, we also received critical statements regarding the title of the project: It indicates a bias towards a high penetration of wind energy as the only possible option. As the focus of our project is about deepening and widening the concept of social acceptance and not on how to convince people to foster wind energy, we decided to take a more neutral position. As a consequence we only use the project acronym (Trans*Wind*) in our internal and external communication and declare the project's aims transparently (e.g. at http://www.transwind.boku.ac.at/). This approach allowed us to gain the approval from organisations critical to the development of wind energy in Austria and to compose a balanced reference group (see section 2.2.2).

- The internal evaluation of the first stakeholder workshop (see section 2.2.2) showed that the results from the World Café about the various aspects of community, socio-political and market acceptance should be further elaborated. Therefore we conducted 28 semi-structured interviews with all member organisations of the reference group. This task was not entitled in the project proposal.
- In WP3 an online questionnaire (see more details in section 2.2.3) was developed and presented in the first stakeholder workshop. It was subsequently sent to the stakeholders of the reference group so they could assess land-use criteria for wind energy and set distance limits for wind parks. The results of the questionnaire were discussed in the second workshop, together with other spatial and technical criteria. The stakeholders had the opportunity to judge already existing criteria, to set distance limits again and to suggest new spatial, topological or technical parameters (e.g. settlement development or the alpine timber line). The feedback was in parts contesting the results from the questionnaire. Hence most of the land-use criteria and distance limits were developed in an iterative-loop.
- The second workshop showed that the stakeholder group could only fully agree on a scenario of *minimum* and *maximum* wind deployment in Austria. A medium scenario, as suggested by the stakeholders, was elaborated by the Trans*Wind* researchers (see 2.2.3).
- In WP3 we used more resources for the GIS modelling, which was strongly discussed by stakeholders. The stakeholders were more interested in assessing the suitability of different land use categories than the impact of different policy options. Therefore, the economic potential was directly derived by calculating levelized costs of electricity (LCOE) for all feasible locations and generating supply curves based on the different scenarios for the theoretical wind area potential and the future energy demand without using the optimization model.
- During the project two very new visualisation technologies entered the stage: Augmented reality (AR) and Virtual reality (VR) applications (see 2.2.4). Although both technologies were not fully developed, we decided to work with VR in our case study related visualisation courses. VR seemed to be most applicable for our purpose of local workshops and allows a more immersive view as it isolates the viewer with the VR glasses from the rest of the world. AR, however, has still some technological barriers that leads to positioning errors or unrealistic views due to the missing masking of 3D objects by real world objects.
- We critically discussed the implementation of visualisation courses in local case studies (cf. 2.2.5). Due to our understanding of scientific ethics we decided to use the courses only in areas were wind energy is not actually developed or discussed, but where we detected a technical and economical potential (cf. 2.2.3). Together with the mayors of our case studies we signed a declaration of common understanding and published it on our website. In order to provide an equal distribution of participants in the workshops, we distributed a direct mail (leaflet) to all households in the municipalities.
- The (cost neutral) extension of the project duration (from 24 to 28 months) became necessary because the organisation of local workshops in the four municipalities was more time consuming than originally expected.

- Although the project officially ends in December 2015 the integration of the reference group was prolonged until the project reports and especially the guideline for social acceptance were finalised (consultation process).

Workpackages (WPs)	Months																															
M = milestone W = workshop	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
	09_13	10_13	11_13	12_13	01_14	02_14	03_14	04_14	05_14	06_14	07_14	08_14	09_14	10_14	11_14	12_14	01_15	02_15	03_15	04_15	05_15	06_15	07_15	08_15	09_15	10_15	11_15	12_15	01_16	02_16	03_16	04_16
WP1: Managing inter- and transdisciplinarity																																
M1.1 Project implementation plan		M																														
M1.2 Knowledge transfer and dissemination plan		M																														
M1.3 Kick-off and monthly project meetings for quality and progress control																																
M1.4 Interim and final project reports														M																		M
WP2: Integrating stakeholders																																
M2.1 Built-up a reference group with 15-20 stakeholders		M																														
M2.2 Organise two participatory workshops and one scenario workshop			W1						W2																		W3					
M2.3 Case selection														M																		
M2.4 Qualitative assessment of the social acceptance of wind energy				M						M											M						M				M	
M2.5 Establish guidelines for various user audiences																																M
WP3: Modelling of wind power potentials																																
M3.1 GIS model updated					M																											
M3.2 Model parameters aligned with outcome of stakeholder workshop												M																				
M3.3 Model structure (i.e. optimization) updated													M																			
M3.4 Model scenarios run																M																
M3.5 Model validation by stakeholders																	M															
M3.6 Model scenarios re-run, preparation of input for case study selection																		M														
WP4: GIS analysis and development of interactive visualisation tools																																
M4.1 Database on 3D infrastructure				M																												
M4.2 GIS-based visual indicator to assess the visual impact of wind turbines in a landscape														M																		
M4.3 Real-time 3D environments for the case study regions																M																
M4.4 Validated GIS-based visual indicator based on the input from the questionnaire																																
WP5: Local case studies																																
M5.1 Organise 2-3 focus groups in each case study region																						M			M		M					
M5.2 Coding scheme and analyses of audiovisual tapes and transcripts																							M			M		M				
M5.3 Report on the participants views on the various aspects of community acceptance																											M				M	
WP6: Dissemination, knowledge transfer and evaluation																																
M6.1 Four working papers finished																	M															
M6.2 Four scientific manuscripts prepared to be submitted to scientific journals																												M				M
M6.3 Four presentations at national and international conference								M												M		M			M							
M6.4 Policy briefs on the basis of the guidelines established in M2.5																																
M6.5 Documentation and results from evaluation of stakeholder process																																M
M6.6 Redesign of the conceptual and methodological approach of TransWind																												M				M

3 Presentation of Costs

3.1 Table of costs for the entire project duration

The following table provides an aggregated overview of the costs incurred by the applicant and the project partners throughout the entire project duration, broken down by staff costs, capital expenditure, travel expenses, administrative and material expenses, and third-party costs. It must correspond to the cost accounting form (annexed to the support contract and/or available for downloading under www.publicconsulting.at).

All figures in EURO.
Please add further columns for additional partners or start a new table.

Cost category	**Eligible total costs according to contract**	**Cumulative costs during the project term** Total costs for the consortium*	**Applicant** Costs incurred during the project term from - to	**Partner 1** Costs incurred during the project term from - to
Staff costs	217.959	227.789,84	227.789,84	
Capital expenditure	0	0	0	
Travel expenses	12.000	4.704,29	4.704,29	
Administrative and material expenses	1.000	987,59	987,59	
Third-party costs	0	1.803,36	1.803,36	
Total	**230.959**	**235.285,08**	**235.285,08**	

* Sum total of costs incurred / cost category of the applicant and all partners

3.2 Statement of costs for the entire project duration

Overall, in budgetary terms the project is almost in line with the originally planned costs according to the contract. The costs incurred in the Trans*Wind* project for the entire duration of the project are stated in the table above. The total costs of the applicant amount to 235.285,08 Euro. The personnel costs were higher than originally planned and amount to 227.789,84 Euro compared to 217.959 Euro in the project proposal. The extra personnel costs incurred by the applicant BOKU University have been partly covered by cost reclassifications (see below). The travel costs amount to 4.704,29 Euro and were lower than originally planned due to the fact that only a few stakeholders wanted to refund their travel expenses for the participatory workshops and focus groups. The administrative and material expenses amount to 987,59 Euro and were mainly used for leaflets, for plotting posters and for renting notebooks for the case study workshops. Third party costs amount to 1.803,36 Euro and included mainly the transcription of expert interviews and focus groups from the case studies, which iinitially should be done by the project staff.

3.3 Cost reclassification

In sum we have mainly reclassified travel costs to personnel and third-party costs of the applicant. The reclassifications were necessary because an internal evaluation of the first stakeholder workshop (WP2) has shown that the results from the World Café about the various aspects of community, socio-political and market acceptance should be further elaborated. Therefore we conducted 28 semi-structured interviews with all member organisations of the reference group. This was not entitled in the project proposal. The extension and the necessary cost reclassification (see cost plan) linked to it was requested to ACRP and officially accepted in writing on January 20, 2014.

Cost plan:

	Costs	Reclassified from
Staff costs for conducting and analysing 28 interviews	€ 5.788,75	10 hours from WP1 20 hours from WP2 20 hours from WP5 75 hours in-kind contribution
Staff costs for transcribing 28 interviews	€ 1.984,12	Travel Costs in WP2 and WP5 (attendance of stakeholders)
Travel costs	€ 670,88	Travel Costs in WP2 and WP5 (attendance of stakeholders; attendance of scientific team at case studies)

The working hours taken from WP1, 2 and 5 to conduct the interviews did not affect the originally proposed research in the respective work packages.

4 Utilization

All dissemination activities within Trans*Wind* can be found in the following table and at http://www.transwind.boku.ac.at:

Title	**Medium**	**Date & Location**
Scientific Dissemination		
Conference presentations & posters		
Den Ausbau der Windenergie sozial verträglich gestalten? Eine inter- und transdisziplinäre Annäherung, Poster (Schauppenlehner, T.; Scherhaufer, P.; Höltinger, S.; Salak, B.; Schmidt, J.)	15. Österreichischer Klimatag	2-4 April 2014, Innsbruck, Austria
Bewertung des Landschaftsbildes im Zuge der Errichtung von Windkraftanlagen auf Waldstandorten (Salak, B.; Schauppenlehner, T.; Brandenburg, C.; Jiricka, A.; Czachs, C.; Höltinger, S.; Scherhaufer, P.; Schmidt, J.)	Naturschutzfachliche Aspekte von Windenergieanlagen auf Waldstandorten in Deutschland, Österreich und der Schweiz	24-25 June 2015, Munich, Germany

Low-cost immersive 3D visualisations for evaluating visual impacts of wind parks using smartphones and free software (Schauppenlehner, T., Salak, B., Höltinger, S., Schmidt, J., Scherhaufer, P.)	Energy Landscapes: Perception, Planning, Participation and Power	16-18 September 2015, Dresden, Germany
Application, opportunities and constraints of different landscape oriented 3D visualisation techniques for communication and participation processes of wind energy projects, Poster (Schauppenlehner, T.; Salak, B.; Höltinger, S.; Schmidt, J.; Scherhaufer, P.)	The European Climate Change Adaptation Conference (ECCA) 2015	12-14 May 2015, Copenhagen, Denmark
Das ökonomische Windkraftpotential Österreichs - ein partizipativer Modellierungsansatz (Höltinger, S.; Salak, B.; Schauppenlehner, T.; Scherhaufer, P.; Schmidt, J.)	16. Österreichischer Klimatag	28-30 April 2015, Vienna, Austria
Zur sozialen Akzeptanz der Windkraft in Österreich. Inter- und transdisziplinäres Arbeiten in Theorie und Praxis (Scherhaufer, P. Höltinger, S.; Salak, B.; Schauppenlehner, T.; Schmidt, J.)	16. Österreichischer Klimatag	28-30 April 2015, Vienna, Austria
Gewichtete Sichtbarkeitskarten zur Bewertung der visuellen Präsenz und Landschaftsdominanz potentieller Windenergieanlagen in Österreich, Poster (Schauppenlehner, T.; Salak, B.; Scherhaufer, P.; Höltinger, S.; Schmidt, J.)	16. Österreichischer Klimatag	28-30 April 2015, Vienna, Austria
Soziale Akzeptanz von Windkraftanlagen (Scherhaufer, P.)	Die Energie der Alpen	22-23 October 2015, Garmisch-Partenkirchen, Germany
Mixed method design as a supportive tool for evaluation of interactive 3D approaches to enhance objectification in wind energy planning processes (Salak, B., Brandenburg, C., Schauppenlehner, T., Scherhaufer, P., Schmid, J., Höltinger, S., Jiricka, A., Czachs, C.)	Permanent European Conference for the Study of the Rural Landscape (PECSRL)	5-9 September 2016, Innsbruck, Austria
Journal articles		
Where the wind blows: Assessing the effect of fixed and premium based feed-in tariffs on the spatial diversification of wind turbines (Schmidt, J.; Lehecka, G.; Gass, V.; Schmid, E.)	Energy Economics	2013.
Simulation of disaggregated load profiles	International Journal for	2014.

and development of a proxy microgrid for modelling purposes. (Zeyringer, M.; Andrews, D.; Schmid, E.; Schmidt, J.; Worrell, E.)	Energy Research	
Austria's wind energy potential - a participatory modelling approach to assess socio-political and market acceptance (Höltinger, S., Salak, B., Schauppenlehner, T., Scherhaufer, P., Schmidt, J.)	Energy Policy	Accepted.
Dissemination to stakeholders and the general public		
Stakeholder workshops		
1st stakeholder meeting	Workshop	27.11.2013, Vienna, Austria
2nd stakeholder meeting	Workshop	19.5.2014, Vienna, Austria
3rd stakeholder meeting	Workshop	19.11.2015, Vienna, Austria
Case study workshops		
"Windenergie polarisiert" (1)	Workshop (Visualisation course and focus groups)	16.6.2015, Bärnkopf, Austria
"Windenergie polarisiert" (2)	Workshop (Visualisation course and focus groups)	29.6.2015, Fischbach, Austria
"Windenergie polarisiert" (3)	Workshop (Visualisation course and focus groups)	24.9.2015, St. Gilgen, Austria
"Windenergie polarisiert" (4)	Workshop (Visualisation course and focus groups)	6.11.2015, Hinterstoder, Austria
Newspaper articles		
Windparks: Ein gigantischer Nachbar (Hanka, Sophie)	Die Presse	15.2.2014 (online) 16.2.2014 (print)
Größer, höher, grüner? (Schröder, Aline)	Wiener Zeitung	3.10.2014 (online)
Public events		
Final project presentation *("Windkraft polarisiert: Ergebnisse aus einem transdisziplinären Forschungsprojekt")*	Public event	7.3.2016, BOKU, Vienna, Austria
Presentation of the visualisation course at „Lange Nacht der Forschung"	Public event	22.4.2016, BOKU, Vienna, Austria
Guideline		
Guideline for various user audiences interested in handling the acceptance and	Guideline	April 2016

non-acceptance of wind energy ("*Leitfaden zum Umgang mit der sozialen Akzeptanz von Windkraftanlagen*")		

In addition Stefan Höltinger, who was one of the main researchers in the Trans*Wind* project, is finishing his doctoral dissertation in June 2016. Höltinger et al. (submitted) describes the outcome of the participatory modelling approach in Trans*Wind* and is an important article in his cumulative thesis.

Oliver Pichler, master student at the University of Natural Resources and Life Sciences, completed his master thesis under the supervision of the Trans*Wind* project leader Patrick Scherhaufer. The master thesis investigated and compared the process of establishing suitability areas for the use of wind energy in different Austrian federal states.

5 Outlook

In Trans*Wind*, we have been focusing on identifying main barriers for the further expansion of a single technology, i.e. wind power production. While the stakeholder process and the case studies were very valuable in providing insights with respect to the expansion of large, landscape-sensitive infrastructure, the process has also shown that stakeholders and participants of local focus groups are, in many cases, opposed to discussing single technologies. They are rather inclined to assess options for the whole electricity system, including additional low-carbon generation technologies and energy efficiency measures. In that way, trade-offs and synergies between different technological options, including demand side measures, can be discussed.

Intermittent production technologies may require new storage plants or transmission lines, which may cause very sensitive interventions to the perceived landscape scenery (e.g. power grid lines or pumped-storage plants). Thus, a locally non-conflictive technology can turn into a highly conflictive one on a regional or super-regional level, when system consequences are assessed. Future projects should therefore aim at assessing low-carbon electricity options with a full electricity system model that allows regarding indirect effects of adding new generation technologies such as necessary changes to the electricity transmission infrastructure.

Integrating such a complex modelling approach with an inter- and transdisciplinary research process is necessarily restricted in the level of technical detail – due to computational constraints on solving such models at a high level of disaggregation, but also due to constraints of what can be communicated to and discussed with stakeholders. However, a systematic way of assessing future energy options and their different impacts in terms of land-use, landscape, costs, and carbon emissions seems to be of high importance to design cost-effective solutions which are accepted by a wide range of stakeholders.

Vienna, 28. April 2016

List of Annexes

As the work of Trans*Wind* depends on an intensive dialogue with the stakeholders of the reference group and is targeted to the Austrian research and policy community, most of its documentation is in German.

Publicly available / Not publicly available (please contact the project leader if you want to have more information)

Overview

- ✓ Annex A: List of References
- ✓ Annex A_1: List of Tables and Figures
- ✓ Annex B: A list of participating stakeholders (in German)
- ✓ Annex C: Minutes of 1st stakeholder workshop (in German)
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- ✓ Annex F: Interview guidebook (in German)
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- ✓ Annex H: Results from the evaluation of the stakeholder process (in German)
- ✓ Annex I: Guideline dealing with the social acceptance of wind energy (in German “Leitfaden zum Umgang mit der sozialen Akzeptanz von Windkraftanlagen”)
- ✓ Annex J: Leaflet to all households in the municipality “Bärnkopf” (in German)
- ✓ Annex K: (Comprehensive) Results of the survey dealing with the quality and plausibility of the visualisation tools and techniques
- ✓ Annex L: (Most important) Results of the survey dealing with the quality and plausibility of the visualisation tools and techniques (in German)
- ✓ Annex M: Poster – Schauppenlehner, T.; Scherhaufer, P.; Höltinger, S.; Salak, B.; Schmidt, J. (2014): Den Ausbau der Windenergie sozial verträglich gestalten? Eine inter- und transdisziplinäre Annäherung, Poster, 15. Österreichischer Klimatag, Innsbruck, 2-4 April 2014. (in German)
- ✓ Annex N: Poster – Schauppenlehner, T.; Salak, B.; Höltinger, S.; Schmidt, J.; Scherhaufer, P. (2015): Application, opportunities and constraints of different landscape oriented 3D visualisation techniques for communication and participation processes of wind energy projects, The European Climate Change Adaptation Conference (ECCA), 12-14 May 2015, Copenhagen, Denmark.
- ✓ Annex O: Poster – Schauppenlehner, T.; Salak, B.; Scherhaufer, P.; Höltinger, S.; Schmidt, J. (2015): Gewichtete Sichtbarkeitskarten zur Bewertung der visuellen Präsenz und Landschaftsdominanz potentieller Windenergieanlagen in Österreich, Poster, 16. Österreichischer Klimatag, Vienna, 28-30 April 2015. (in German)
- ✓ Annex P: Journal article / Schmidt, J.; Lehecka, G.; Gass, V.; Schmid, E. (2013)
- ✓ Annex Q: Journal article / Zeyringer, M.; Andrews, D.; Schmid, E.; Schmidt, J.; Worrell, E. (2014)
- ✓ Annex R: Expert opinions from the members of the reference group about the guideline dealing with the social acceptance of wind energy (in German)

Annex