HELMHOLTZ ZENTRUM FÜR UMWELTFORSCHUNG UFZ

EnergyLandUse

Book of Abstracts

UFZ EnergyDays 2018

“Energy Landscapes of Today and Tomorrow”

24-25 September 2018, KUBUS Leipzig

www.ufz.de/energydays2018

Introduction

The Helmholtz Centre for Environmental Research – UFZ welcomes you to the EnergyDays 2018 in Leipzig! The conference has been initiated to provide a platform to debate challenges and recent progress in research on renewable energies and on the transition towards decarbonisation with a certain focus on impacts and governance architectures in a landscape framework.

EnergyDays 2018 aims to understand the regional, national and European effects and trade-offs which are associated with new technologies and other system elements of energy transitions in their economic, ecological and social dimensions. The conference will foster the exchange between land-use-oriented energy research at the UFZ and the national and international scientific community.

The UFZ EnergyDays 2018 are organised by the IP EnergyLandUse. Please visit our Homepage for further information.

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24th and 25th of September 2018, KUBUS Leipzig

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HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

Keynote Speakers

Professor Dr. Christina von Haaren, Leibniz University of Hannover

Christina von Haaren has been professor at the Institute of Environmental Planning, Leibniz University of Hannover, since 1998. Her main research areas are in the fields of landscape planning, nature conservation and agriculture as well as impact mitigation regulation. Christina von Haaren has been member of different boards and committees for the German Federal Government (e.g. German Advisory Council on the Environment (SRU) at the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 2000-2008; Commission “Soil Protection” of the Federal Environmental Agency for the 4th period of appointment, January 2015 to December 2017). Currently, she is member of the Supervisory Board of the Helmholtz Centre for Environmental Research (UFZ).

Professor Dr. Michael Rodi, University of Greifswald

Michael Rodi has held the Chair of Public Law, Financial Law, Environmental and Energy Law at the Faculty of Law and Political Science at the University of Greifswald since 1999. He is chairman and managing director of the Institute for Climate Protection, Energy and Mobility (IKEM), Berlin, which is associated with the University of Greifswald. His research focusses on climate protection law and policy, law of sustainable energy and transport, as well as fundamental issues of tax and subsidy law. Michael Rodi is author of various reports commission by the European Commission and German ministries.

Abstracts

Session A1: Energy Landscapes I

***Sessions coordinator and chairperson**: Christina von Haaren[1]*

[1] Institute of Environmental Planning, Leibniz University Hannover, Germany

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***Venue:** Hall 1CD*

Schedule:

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15:00 – 15:05	*Welcome Address*	Christina von Haaren (IUP)
15:05 – 15:25	*Modeling Landscape-Related Conflicts of Renewable Energy in Switzerland*	Felix Kienast (WSL)
15:25 – 15:45	*Balancing Climate Protection, Renewables and Landscapes – Multilevel Politics in Saxony*	Gerd Lintz (IOER)
15:45 – 16:00	*Discussion*	
16:00 – 16:20	*The Potential of Landscape Development through Direct Current*	Sandra Sieber (RWTH Aachen University)
16:20 – 16:30	*Discussion*	

Modeling Landscape-Related Conflicts of Renewable Energy in Switzerland

Felix Kienast[1]

Co-Authors: Marcel Hunziker[1], Anna Hersperger[1], Boris Salak[1], Ulrike Wissen[2], Reto Spielhofer[2], Nica Huber[3], Victor Schinazi[4], Tyler Thrash[4], Urs Steiger[5], Adrienne Grêt-Regamey[2]

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[3] *ETH Zürich, Chair of Forest Ecology, Zürich, Switzerland*
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In many densely populated areas different types of land use, including electricity production, compete directly for little available space. Here, the production of renewable electricity often collides with provisioning, regulating and cultural services of the landscape. In this paper we operationalize the landscape service approach and generate conflict maps between three renewable energies (wind; PV; forest biomass) and six competing ecosystem services (ES). We then applied an optimization tool (Marxan) to evaluate, assess, and quantify the trade-offs between ES provisioning and wind electricity production. Expressing different ES in comparable units and evaluating the costs to the system when these are lost versus the benefits gained from wind electricity production generated an output of possible solutions. When compared to similar studies modeling wind electricity output that avoid negative interaction with ES, the current results using the optimization tool Marxan suggest a solution requiring 13.5% fewer turbines in order to produce the same amount of energy. In a project follow-up the landscape types that bear the highest workload of renewable energy in the foreseen energy transformation are selected to perform a visual assessment/acceptance study involving the public. With sophisticated methods of virtual visual-acoustic simulations, vistas have been generated that represent scenarios of wind and PV. The vistas will then be evaluated by the public with physiological and cognitive measurements in the laboratory, as well as with a Swiss-wide representative survey. In the latter we will test acceptance not only on the basis of visual and acoustic stimuli but also based on attitudes towards the environment, previous outdoor or living experiences in the presented landscapes and previous experiences with renewable energy. Results should yield acceptance levels by the public for renewable energy in various landscape types.

Balancing Climate Protection, Renewables and Landscapes – Multilevel Politics in Saxony

Gerd Lintz

Leibniz Institute of Ecological Urban and Regional Development (IOR), Dresden, Germany

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On the one hand, it is necessary to reduce energy production on the basis of fossil fuels in order to mitigate climate change. On the other hand, in the eyes of many, alternative energy production from renewable sources impairs landscapes – particularly in the case of wind energy. Also taking into account other ways of mitigating climate change such as a reduction in energy consumption, the political and planning system is expected to achieve a satisfying balance. While research has hitherto focused on the often low local acceptance of wind farms, there has been little systematic investigation on how this attitude actually feeds into policy-making and planning.

Against this backdrop, the presentation reports on preliminary empirical results from an ongoing qualitative case study on the course and causes of erratic decision-making regarding the setting of targets for an increase of renewables by the Saxon Government in the Energy and Climate Programme 2012 adopted in March 2013. This programme has to be directly implemented in regional spatial planning, which is charged with selecting the areas required for wind farms. Originally, two months after the Fukushima disaster of March 2011, the Saxon state premier announced a significantly increased target for the expansion of renewables. However, opposition grew within the coalition government, among citizens' groups and the municipalities forming the regional planning associations (the planning association Oberes Elbtal/Osterzgebirge had already refused to sufficiently implement the former targets). After an almost two-year process of political struggle and weighing, the expansion target finally set in the above-mentioned programme was notably lower than the target previously announced by the state premier.

The investigation particularly draws on the literature of environmental policy integration, extended to include the challenge of a twofold environmental policy integration. Additionally, the concepts of multilevel governance and implementation are introduced to the discussion.

The Potential of Landscape Development through Direct Current

Sandra Sieber

RWTH Aachen University, Department of Landscape Architecture, Aachen, Germany

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The increase of renewable energies – as a new part of the traditional energy system – is also a challenge for the existing network infrastructure. Inflexible transmission and distribution systems have to change into flexible smart grids. Direct current (DC) grids could possibly enable this flexibility. While DC high voltage grids offer the possibility of an efficient energy distribution over long distances (national and transnational), DC medium and low voltage grids could afford an efficient use of energy, especially renewable energies, over short distances without the repeated conversion from AC voltage to DC voltage and vice versa.

Due to the energy transition, the traditional power supply is changing from a rigid hierarchical “tree structure” with clearly separated producers and consumers to a bidirectional “rhizome structure” with smart-connected producers, consumers and prosumers. This change will affect the landscape as well. A case study carried out by the Department of Landscape Architecture (as part of FEN Research Campus) has shown that the main effects of DC are in the fields “supply of renewable energy and network capacity”, “district planning in regard to energy” and “electro mobility”. In these fields, DC could have an impact on the townscape and the landscape. In conclusion, it can be said that DC could have a very important but indirect influence on the visual level of landscape, namely through the possibility of promoting renewable energies and e-mobility. The vision is to establish urban neighbourhoods with a higher proportion of renewable energies and heavy reliance on electro mobility due to meshed DC lines.

Finally, DC offers a great potential for the energy transition at the local level. The current objective of large-scale electricity production requires a large-scale power transmission. Could a small-scale renewable energy supply with a stronger focus on the settlement lead to alternate forms of energy landscapes?

Session B1: Bioenergy

***Session coordinator and chairperson**: Daniela Thrän[1,2]*

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[2] Department of Bioenergy Systems, German Biomass Research Centre (DBFZ), Leipzig, Germany

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***Venue:** Hall 2AB*

Schedule:

Time	Presentation	Speakers
15:00 – 15:05	*Welcome address*	Daniela Thrän (UFZ / DBFZ)
15:05 – 15:20	*Assessing the GHG Performance of Regional Biogas Systems Using a Life Cycle Approach*	Katja Oehmichen (DBFZ)
15:20 – 15:35	*Including Soil Impacts Within a Regional Life Cycle Assessment*	Indrani Kar (DBFZ)
15:35 – 15:45	*Discussion*	
15:45 – 16:00	*Heat Sales Potentials for Bioenergy Plants in Germany*	Michael Steubing (UFZ)
16:00 – 16:15	*Techno-Economic Analysis of a Stand-Alone Power-to-Liquid Concept*	Maximilian Decker (For-schungszentrum Jülich)
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Assessing the GHG Performance of Regional Biogas Systems Using a Life Cycle Approach

Katja Oehmichen[1]

Co-Authors: Sinèad O'Keeffe[2], Uwe Franko[3], Daniela Thrän[1,2], Jaqueline Daniel-Gromke[4]

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While EEG bonuses have had a strong role in determining what is potentially used in biogas plants, they are still generally planned and built according to available feedstocks (Appel et al., 2016). This has resulted in distinct regional differences (Daniel-Gromke et al., 2018). Understanding the regional factors influencing biogas systems is crucial to determine the Greenhouse gas (GHG) mitigation potential of biogas. Therefore, the aim of this presentation is to show how RELCA the “Regional Life Cycle Inventory Assessment” approach (O’Keeffe et al., 2016), was used to model the climate mitigation potential of over 400 biogas plants in the region of Central Germany. Thus, helping to compare their mitigation performance as a function of energetic output (CO2eq/kWhel) and a function of land input (CO2eq/Hainput). Furthermore, the potential role GHG credits and size can have on the mitigation performance of the regional biogas systems was also assessed.

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Appel, F., Ostermeyer-Wiethaup, A., Balmann, A. 2016. Effects of the German Renewable Energy Act on structural change in agriculture – The case of biogas. Utilities Policy, 41, 172-182.

Daniel-Gromke, J., Rensberg, N., Denysenko, V., Stinner, W., Schmalfuß, T., Scheftelowitz, M., Nelles, M., Liebetrau, J. 2018. Current Developments in Production and Utilization of Biogas and Biomethane in Germany. Chemie Ingenieur Technik, 90(1-2), 17-35.

O’Keeffe, S., Wochele-Marx, S., Thrän, D. 2016b. RELCA: a REgional Life Cycle inventory for Assessing bioenergy systems within a region. Energy, Sustainability and Society, 6(1), 1-19.

Including Soil Impacts Within a Regional Life Cycle Assessment

Indrani Kar[1]

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Soils are unquestionably an essential component of the global ecosystem and will be at the fulcrum of a biobased economy (i.e., the use of biomass resources for the production of healthy foods, materials, chemicals, fuels, and energy) (Garrigues et al., 2012). Therefore, maintaining healthy and functioning soils is a fundamental requirement for not only global sustainability (Vidal Legaz et al., 2017), but also for a biobased economy in order to ensure security of a sustainable biomass supply (Dale and Ong, 2014).

Life cycle thinking has the potential to make the connection, between biomass products (food, fodder, energy) and the environmental consequences to soils in which they are grown (Garrigues et al., 2012; Vidal Legaz et al., 2017; Brandão et al., 2011; Milà i Canals et al., 2011). However, the inclusion of impacts to soil functions has been challenging due to the spatial dependency of such impacts and the contrasting global approaches of life cycle assessments (LCA).

One of the biggest challenges is to find the appropriate level of complexity and comprehensiveness for assessing impacts to and from soil which can fit to life cycle approaches – this needs to come from a compromise between oversimplified and overcomplicated descriptions of the multiple functions and properties of soils (Garrigues et al., 2012).

Therefore, the aim of this presentation is to propose an approach of how to deal with the simplification of this complexity.

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Brandão M., Milà i Canals L., Clift R. (2011): Soil organic carbon changes in the cultivation of energy crops: Implications for GHG balances and soil quality for use in LCA. Biomass and Bioenergy. Vol. 35(6): pp. 2323-36. DOI: 10.1016/j.biombioe.2009.10.019

Dale, B.E., Ong, R.G. (2014): Design, implementation, and evaluation of sustainable bioenergy production systems. Biofuels, Bioproducts & Biorefining. Vol. 8: pp. 487-503. DOI: 10.1002/bbb

Garrigues, E., Corson, M., Angers, D., van der Werf, H., Walter, C. (2012): Soil quality in Life Cycle Assessment: Towards development of an indicator. Ecological Indicators. Vol. 18: pp. 434-442. doi: 10.1016/j.ecolind.2011.12.014

Milà i Canals L., Azapagic A., Doka G., Jefferies D., King H., Mutel C., Nemecek, T., Roches, A., Sim, S., Stichnothe, H., Thoma, G., Williams, A. (2011): Approaches for Addressing Life Cycle Assessment Data Gaps for Bio-based Products. Journal of Industrial Ecology. Vol. 15(5): pp. 707-25. DOI: 10.1111/j.1530-9290.2011.00369.x

Vidal-Legaz, B., Maia De Souza D., Teixeira, R.F.M., Antón A., Putman, B., Sala, S. (2017): Soil quality, properties, and functions in life cycle assessment: and evaluation of models. Journal of Cleaner Production. Vol. 140: pp. 502-515. http://dx.doi.org/10.1016/j.jclepro.2016.05.077.

Heat Sales Potentials for Bioenergy Plants in Germany

Michael Steubing

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To make the energy transition possible it is essential to also make a shift towards a renewable heating supply. Bioenergy plants are able to provide renewable electricity and heat at the same time which is one major advantage of bioenergy in comparison to other renewables. They therefore take a crucial role in covering the German heat demand with non-fossils fuels. However bioenergy plants and heat sales potentials are not evenly distributed across Germany. To exploit the full heat potential of these facilities spatially high resolution data of potential heat sinks in is necessary.

To generate this data we identified heat sinks in the housing sector as well as in the commercial and the industrial sector on a national scale and quantified them. Based upon this data it is possible to give information about heat sales potentials of bioenergy plants on a local scale. Furthermore it can be useful to identify regions where investments in local heating networks seem useful.

Techno-Economic Analysis of a Stand-Alone Power-to-Liquid Concept

Maximilian Decker[1]

Co-Authors: Felix Schorn[1], Remzi Can Samsun[1], Ralf Peters[1], Detlef Stolten[1,2]

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In order to accomplish the 2050 CO2 reduction goals of 80-95 %1990, set by the EU-Commission, a complex redesign and coupling of the different energy sectors is inevitable. With new technologies like electro mobility based on fuel cells and battery systems being on the rise and bringing high potentials of CO2 reduction for individual transport, modes of transportation such as heavy duty- or air traffic will still be dependent on liquid fuels, due to the need for high energy densities.

In addition to biomass-based fuels, electrofuels based on renewable power are a promising option for integrating climate friendly energy sources into the fuel sector. The process utilizing renewable H2 - produced via water electrolysis - and CO2 - from biogas plants, industrial exhaust gases or air - to produce a synthetic fuel product (electrofuel) is referred to as Power-to-Fuel (PtF). Its advantages include applicability in the existing infrastructure and vehicles (as a drop-in or base fuel), and being a storage option for surplus renewable energy. While most reactors for fuel synthesis are already state of the art (Methanol, Methane, Fischer-Tropsch), fuel production prices are still high due to the dependency on the costs of hydrogen, hence costs for renewable power. Before blanket coverage of renewably produced hydrogen is introduced, a concept for the implementation of Power-to-Fuel-systems into the existing market is needed.

This contribution will show a methodology and a resulting analysis for the design and operation of a stand-alone PtF-system consisting of renewable power production, electrolysis unit, hydrogen buffer storage, CO2-source and fuel synthesis plant. The analysis will show production costs for Methanol and Fischer-Tropsch production for different case studies, demonstrating the impact of e.g. system location, plant size, storage system or operation dynamics on the overall system economics.

Session A2: Energy Landscapes II

***Session coordinator and chairperson**: Felix Kienast[1]*

[1] Swiss Federal Research Institute WSL, Switzerland

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***Venue:** Hall 1CD*

Schedule:

Time	Presentation	Speakers
17:00 – 17:05	*Welcome address*	Felix Kienast (WSL)
17:05 – 17:25	*Challenges of Future Energy Landscapes – A Nature Conservation Perspective*	Jens Ponitka (BfN)
17:25– 17:45	*Land-Use Conflicts through Climate Protection and Adaptation: Is Multifunctionality a Solution?*	Alexandra Unger (University of Oldenburg)
17:45 – 18:00	*Discussion*	
18:00 – 18:20	*Proposals for a New Market Design to Support Sector Coupling*	Holger Wiechmann (EnBW Energie Baden-Württemberg AG)
18:20 – 18:30	*Discussion*	

Challenges of Future Energy Landscapes – A Nature Conservation Perspective

Jens Ponitka[1]

Co-Author: Sarah Böttner[1]

[1] *Department of Nature Conservation and Renewable Energy, German Federal Agency for Nature Conservation - BfN, Leipzig, Germany*

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Germany's *Energiewende* characterized by a widespread expansion of renewable energy systems has shown various effects on nature conservation issues such as landscapes, certain species or other legally protected goods. There is an urgent need to develop decentralized renewable energy provision to prevent human interference with the climate system, but in the same manner we also need to protect nature and to safeguard humanity's natural life-support systems.

In this presentation/paper we discuss this field of tension from the specific perspective of nature conservation and landscape management, as the decentralized expansion of renewable energies have led to new conflicts, risks and impacts on habitats, landscapes and to disturbance of species and bird and bat mortality. Besides the need for climate protection measures we need to safeguard biological diversity, the performance and functioning of the natural balance and the diversity, characteristic features and beauty of nature and landscape, as well as their recreational value (BNatSchG) also within the energy transition. It is an enormous challenge for all actors (e.g. government, regional planning, project developers, local approval authorities, scientists) to adequately integrate nature conservation concerns. Based on an overview of nature conservation targets, the effects of renewable energy generation and the review of selected trends and ongoing research (BfN research programme), we describe and derive requirements, measures, approaches, challenges and further research needs for an energy transition that is compatible with nature conservation targets.

We conclude that, rather than dealing with the consequences of unwanted side-effects, nature conservation in its entirety (biodiversity and landscape) needs to be included in energy transition efforts at an early stage. Therefore research, technology development, public involvement and a widespread, critical discussion and academic debate are essential.

Land-Use Conflicts through Climate Protection and Adaptation: Is Multifunctionality a Solution?

Alexandra Unger[1]

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In many German regions, land-use pressure is still very high. New growing demands by climate protection and climate adaptation – the "new kids on the block" (Harvey, M. & Pilgrim, S. 2010) - have recently contributed to this. Land consumption affects both urban and rural areas, albeit with different characteristics.

Rural areas serve as sites for energy production (energy landscapes) and supply cities. This leads to rising prices for land with corresponding negative effects on other land uses. The increase of energy landscapes impacts nature and landscape as well as residents' acceptance of renewable energies.

Ongoing urbanization, in turn, causes high demand for land and increasing densification in cities. Consequently, more and more urban functions are being transferred to the surrounding area (e.g. water management, waste disposal, recreational areas), which results in an increased vulnerability of cities regarding climate change. At the same time, nature-based solutions - the favored adaptation strategy - are associated with additional land demand.

These challenges can only be met through an integrated approach. Multifunctional land use is identified as a major way forward. In rural areas, considerations include the combination of agriculture, water management, and biodiversity, but also the combination of renewable energies with other land uses. In cities, discussions focus on the combination of climate adaptation with biodiversity, recreation and leisure and the dual use of certain infrastructure systems. The relocation of certain functions back into the cities (e.g. urban energy production, urban gardening, peri-urban agriculture) can only be achieved by multifunctional land use. However, the benefits of multifunctionality result not only from more efficient land use, but also from intelligent, resource-saving links and couplings of different land uses, especially at the individual property and neighbourhood level.

The presentation will use the example of the northwest Lower Saxony (Germany) - a growing region with considerable land-use conflicts - to show that the systematic realisation of benefits of multifunctional land use is context-dependent (space, technology) and often fails due to the existing legal and institutional framework conditions. Last but not least, there is often a lack of a common understanding of multifunctionality.

Proposals for a New Market Design to Support Sector Coupling

Holger Wiechmann

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The German energy transition and the associated expansion of renewable energies have already laid the foundation for Germany's decarburization. Now the sectors heat, cold and transportation are also to be included.

Currently, many are talking about sector coupling, but what exactly that means and what final energy levels are being spoken about is often unclear. The starting point here is the current national final energy demand of about 2,500 TWh/a. Electricity accounts for just over 20% of this. In order to achieve reasonably realizable RE targets, this current final energy demand must be at least halved. Also, the "remaining" final energy requirement of about 1,200 - 1,400 TWh (including storage losses) must first be generated with RE. For example, about 200 GW onshore, 75 GW offshore and 400 GW PV are required for this, or a correspondingly different production-side composition. These figures are in dramatic contrast to the current politically desired expansion goals. Examples include the current 15 GW offshore expansion cover or the 52 GW PV expansion cover.

In addition to the question of seasonal storage (winter-summer heating challenge), short-term flexibility and storage solutions (day-night PV delta or a few days of wind drought) are required to link generation and demand.

But what does this mean for the regulatory framework? Adjustments are definitely needed in the regulatory framework in order to be able to advance sectoral coupling. As long as, for example, only the current EEG levy is normally higher than the retail gas tariff, the sector coupling will not work. A consistent distribution of all energy turnaround costs (e. g. grid costs including grid expansion, storage costs, taxes, etc.) for all energy sources (oil, gas, electricity) paired with, for example, a CO2 emission-oriented allocation key could be a viable option.

EnBW has developed and tested new solutions for an adapted regulatory framework.

Session B2: Wind Power and Sustainability

***Session coordinator and chairperson**: Wolfgang Köck[1]*

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***Venue:** Hall 2AB*

Schedule:

Time	Presentation	Speakers
17:00 – 17:05	*Welcome address*	Wolfgang Köck (UFZ)
17:05 – 17:25	*Integrated Sustainability Assessment and Optimization of Energy Systems*	Claudia Suthardio (INATECH)
17:25 – 17:45	*Czech Wind Power Potential Assessment Based on Austrian/Danish Site Characteristics*	Felix Nitsch (University of Natural Resources and Life Sciences
17:45 – 18:00	*Discussion*	
18:00 – 18:20	*Probabilistic Spatial Upscaling and Aggregation for Power Feed-in of Wind Parks*	Janosch Henze (University of Kassel)
18:20 – 18:30	*Discussion*	

Integrated Sustainability Assessment and Optimization of Energy Systems

Claudia Suthardio[1]

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For solving the issue of climate change, sustainable transformation of the energy system is an important topic. In recent years, scientific research for energy and climate protection has been conducted to support the decision making for implementation of energy transition until 2050. Different models and scenarios for sustainable transformation with the aim to reduce CO2 emissions have been developed.

An energy system is a complex system which should consider different assessment criteria. The political debate often focuses only on climate protection and associated expenses for private households and industry. Other relevant economic, ecological and social indicators such as resource demand, social acceptance, and life cycle emissions of pollutants should also be taken into consideration. Moreover, the government has to consider all of these aspects to develop and implement political measures to foster a transformation towards a sustainable energy system.

This contribution presents first results of the InNOSys project, whose goal is to develop new generic modelling and assessment approaches for energy scenarios, as well as deriving optimized pathways of energy systems in Germany from a sustainability perspective. The main objective of the project is to complete a quantitative sustainability assessment of energy scenarios and optimization of the energy scenario which is technically and structurally feasible.

In this contribution, several existing energy scenarios in Germany will be analyzed and compared systematically. Moreover, sustainability indicators in economic, ecological and social sectors will be defined. The indicators are determined from recent scientific sustainability concepts and national sustainability strategies. Subsequently in the project, a comprehensive sustainability assessment of the existing energy scenarios will be conducted using a multi-criteria assessment method. Specifically, complex and highly developed methods and models of energy systems combined with lifecycle, economic and social analysis will be implemented.

Czech Wind Power Potential Assessment Based on Austrian/Danish Site Characteristics

Felix Nitsch[1,2,3]

Co-Authors: Johannes Schmidt[1], Stefan Höltinger[1]

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Wind power is a promising technology to reduce greenhouse gas emissions in the electricity sector. However, besides climatic limitations such as prevalent wind speeds, further parameters like population density, land use, and protected areas restrict the available sites. Typically, in the assessments of wind power potential, the restrictions are normatively chosen based on legal, technical, or other criteria. We assess in contrast wind power expansion in the Czech Republic considering wind power site characteristics observed in Austria and Denmark. For this purpose, we use spatially highly resolved data on wind turbine deployment in Austria and Denmark and join it with high quality input data from the LUISA terrestrial modelling platform, and the IRENA Global Wind Atlas. In preliminary calculations, we identified a maximum potential area of 1,968 km2 in the Austrian scenario and 1,168 km^2 in the Danish scenario for the Czech Republic which translates to 9,250 MW respectively 5,490 MW of installed capacity. The results show, that the calculated wind power potential only partly meets the capacities as required by recent studies on the decarbonization of the electricity sector. This illustrates the existing challenge of a large-scale installation of onshore wind power turbines in densely populated European areas. A sensitivity analysis examined the impact of the single parameters in a maximum and minimum scenario. As expected, the availability was mainly determined by wind speed, the three land use forms urban areas, agriculture and forests, as well as the population density close to the wind power sites. Protected areas do not seem to significantly limit the potential areas for wind power expansion. The data sets generated in this study can be used in further research to identify and address land use conflicts arising from the expansion of renewable energies.

Probabilistic Spatial Upscaling and Aggregation for Power Feed-in of Wind Parks

Janosch Henze[1]

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Models for analyzing, predicting, or calculating the gross production of renewable energies, such as wind power plants, often do not deal with uncertainties that influence these models. Nowadays, in most of these models, we rely on deterministic outputs, even though uncertainties arise in every step during their application.

By introducing these uncertainties in our models, we have more knowledge about the process under observation. This additional information adds more value to the data analysis process, as we can assess scenarios in more detail. However, this probabilistic perspective also introduces the need for new algorithms that are capable of handling probabilistic data. In this work, we focus on a common problem: upscaling and aggregating the measurements or forecasts of several wind farms to the feed-in of all wind-farms in a region. We formulate this task in a probabilistic way by combining an algorithm introduced by Pinson with an upscaling method. Our algorithm is capable of predicting the probabilistic power production of unknown wind parks based on measurements and probabilistic models of known wind parks, and their geolocation.

Furthermore, the algorithm can use these pieces of information to calculate the total power production of widely distributed wind power plants.

Session A3: Financial and Economic Aspects

***Session coordinator and chairperson**: Gerd Lintz[1]*

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***Venue:** Hall 1CD*

Schedule:

Time	Presentation	Speakers
09:00 – 09:05	*Welcome address*	Gerd Lintz (IOER)
09:05 – 09:25	*Design Options and Policy Recommendations for Community Financial Participation in the Expansion of Onshore Wind Power*	Philine Wedell (IKEM)
09:25 – 09:45	*Cost Driven Wind Turbine Allocation*	Martin Lange (UFZ)
09:45 – 10:00	*Discussion*	
10:00 – 10:20	*An Axiomatic Foundation of the Ecological Footprint Index*	Radomir Pestow (Chemnitz, University of Technology)
10:20 – 10:30	*Discussion*	

Design Options and Policy Recommendations for Community Financial Participation in the Expansion of Onshore Wind Power

Philine Wedell

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The ongoing transformation of the German energy system (*Energiewende*) requires an expansion of renewable energies. Onshore wind power in particular is expected to play a key role in the coming years. According to recent estimates, Germany will need to add 80 GW to its current installed capacity of 50 GW to meet the present electricity demand through renewables. For this reason, local public acceptance of wind energy will become an even more important topic, influencing not only the realization of specific projects, but also the overall success of the *Energiewende*.

Recent studies have shown that financial participation can have a positive impact on public attitudes toward wind energy projects. Financial participation and/or compensation of the persons affected by wind turbines is one option to boost local acceptance. New policy approaches are needed to strengthen and supplement existing instruments and concepts. Under the current statutory framework in Germany, there is no regulation compelling local community participation in wind energy development, and existing community wind projects have been implemented on the initiative of local citizens (e.g. citizen wind farms).

Our study examines various design options for the direct financial participation of local communities and considers these options from economic and legal perspectives. The focus is on identifying an approach to community financial participation that can reach everyone affected by the turbines. A direct payment scheme is explored, as are tax instruments and the expansion of the existing system of concession fees. The results of the study reveal that a newly implemented special levy (*Sonderabgabe*) at the federal level has the greatest potential to encourage municipal participation in the expansion of wind power. Financial responsibility would lie with the wind turbine operator, who in turn would benefit from the positive effects of increased public acceptance.

Large-Scale Optimization of the Spatial Allocation of Renewable Energy Plants

Martin Lange

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Wind and solar power are the most important resources for renewable electricity (RE) production in Europe. An important prerequisite for the success of the energy transition in Germany and elsewhere is that the expansion of RE sources is carried out cost-effectively, and under consideration of potential social conflicts.

We start from the identification of potential RE plant sites considering physiogeographical, land-use and legal restrictions, as well as site-specific wind speed and solar radiation data for the estimation of energy potentials. Using questionnaires, we estimated the willingness to pay (WTP) for increased distance of RE plants to settlements, and identified prevalent ideas on fairness criteria for RE plant allocation on a national scale. Finally, we optimized the spatial allocation of RE plants for multiple criteria, sequentially or in parallel: (1) electricity production costs, (2) social costs, (3) fairness of allocation, and (4) grid expansion costs.

We found that the optimal spatial allocation largely depends on the future development of photovoltaic investment costs. Under investment costs at the time of the study (2014), wind energy is dominating the solutions. A shift to solar energy occurs under investment costs of 30-40% compared to these costs (expected around 2020). The optimization of the distances to settlements resulted in only a small increase compared to current legal restrictions, due to low WTP. Synchronous Pareto optimization for cost-effective electricity production and fair spatial distribution showed that a maximum of fairness can be achieved with a cost increase of only 0.3 ct/kWh. Inclusion of grid expansion costs resulted in a more even (and fairer) spatial distribution.

With this study we show how physiogeographical, economic and social aspects can be integrated into the optimization of the spatial allocation for RE sources. The results allow us to identify consequences of regulatory measures regarding the energy transition in Germany.

An Axiomatic Foundation of the Ecological Footprint Index

Radomir Pestow[1]

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The objective of this paper is to provide an axiomatic foundation to the concept of ecological footprint indices. For this purpose, we propose five axioms representing general properties which any ecological footprint measure should fulfil. It can be shown that there exists a unique index which is characterized by the given set of axioms. Its functional form is determined and an economic interpretation is given. We find that the proposed index may resolve some important issues discussed in the literature. First, it incorporates a trade component indicating the ecological footprint of economic activities embodied in the trade pattern of a country or region. Moreover, the productivity of land use in energy production as a means to mitigate the pressure on the ecological system is reflected. Finally, from a methodological point of view, there is no longer the need to introduce ecological footprint indices ad-hoc, in particular for the sake of empirical application.

Session B3: Energy Justice

Session Coordinator and chairperson: ***Ludger Gailing***[1]

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Venue: *Hall 1A*

Schedule:

Time	Presentation	Speakers
09:00 – 09:05	*Welcome Address*	Ludger Gailing (IRS)
09:05 – 09:20	*Governing Energy Landscapes. The Need for a Long-Term, Place-Sensitive Perspective*	Sophie Kuppler (Karlsruhe Institute of Technology)
09:20 – 09:35	*British Onshore Wind and Solar Farms: An Energy Justice Analysis*	Philippa Roddis (University of Leeds)
09:35 – 09:45	*Discussion*	
09:45 – 10:00	*"Crop Apartheid" or "Role Model"? Perspectives of Bioenergy Sustainability Certification*	Thomas Vogelpohl (FernUniversität Hagen)
10:00 – 10:15	*Persuasiveness and Awareness of Arguments on Electricity Generating Technologies*	Hawal Shamon (Forschungszentrum Jülich)
10:15 – 10:30	*Discussion*	

Governing Energy Landscapes. The Need for a Long-Term, Place-Sensitive Perspective

Sophie Kuppler[1]

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Energy technologies comprise technical artefacts with a specific location that affect their surroundings. In our paper we argue that ensuring a sustainable energy transition necessitates a thorough understanding of spatial implications as well as provisions for a “long-term governance”. The argument is based on our research on nuclear waste governance.

Technical artefacts of energy technologies can be differentiated in three phases in time. First, there is the siting period often accompanied by protests. Second, there is the installation and operation of the technical artefacts, which have societal and spatial implications that may last even beyond this period. In the third period the lifetime of the technical artefact comes to an end, it needs to be adapted or a different form of infrastructure and governance is needed. We suggest that not only nuclear, but also renewable energy installations are embedded in complex societal processes in all three phases. Those processes cannot be understood without looking at the meaning that is attached to the technical artefacts at their specific locations. Moreover a governance system is needed that can handle their long-term effects, including asynchronicities and failures to ensure that the general aim of implementing an energy supply system that is oriented at public welfare is maintained also in the near and medium-term future. In order to implement such a long-term governance, a thorough understanding of the technical artefacts in their locations and with their spatial implications is needed. Spatial impacts may affect peoples’ identity in this specific place and vice versa may place-identities generate the necessity to adapt governance and/or technical artefacts and institutional arrangements. Here narratives are regarded as a useful tool to analyse existing effects of technical artefacts on place-identity and show possible future developments of the latter.

British Onshore Wind and Solar Farms: An Energy Justice Analysis

Philippa Roddis[1,2]

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As the deployment of renewable energy technologies has increased as part of climate mitigation strategies, so has the topic of public acceptance. Given the decentralised nature of renewable energy systems and their land-intensive production patterns, more people have become exposed to the impacts of energy production. Thus, the public has become increasingly aware of changing energy landscapes in the face of climate change, shifting away from conventional power stations to low carbon energy supplies.

A key way in which public acceptance manifests is the reaction of communities when renewable energy projects are proposed in their local area. This paper explores the spatial distribution of onshore wind and solar farms in Great Britain, and analyses the effect that community acceptance has had on planning applications for these technologies between 1990-2017. It does this by collating data from a UK government planning database, compiling a set of indicators for community acceptance, and testing their association with planning outcomes using binomial logistic regression.

The analysis identifies 12 variables with statistically significant effects: 4 for onshore wind, 4 for solar farms, and 4 spanning both. For both technologies, the visibility of a project, its installed capacity, the social deprivation of the area, and the year of the application are significant. For onshore wind, the project's remoteness, the population density of the local area, its distance to National Parks, and the turbine capacity are significant. For solar farms, the ruggedness of the landscape, the grade of agricultural land, the number of tourist visits to the area, and the project's distance to Special Areas of Conservation (SACs) are significant.

The paper critically reflects upon the results through the theoretical lens of energy justice, considering the implications for (un)fairness, (in)justice and (un)acceptance of renewable energy technologies in the context of Britain and beyond.

"Crop Apartheid" or "Role Model"? Perspectives of Bioenergy Sustainability Certification

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On 17 January 2018, the European Parliament (EP) decided to exclude palm oil-based biofuels from the European market from 2020 onwards due to its dubious social and environmental effects. While considered a success by some European observers, this met with less enthusiasm from the Southeast Asia-based palm oil industry. Rather, the latter accused the EP of a discriminatory policy, a "crop apartheid" that actually serves to protect European agricultural products against non-European competition under the guise of sustainability.

Only a few days later, at the "Fuels of the Future" congress organized by the German biofuels industry, sustainability certification of biofuels was praised as a "role model" for the bioeconomy because of its potential to transnationally regulate the spatio-environmental effects of domestic consumption of agricultural commodities beyond territorial borders. Furthermore, the hybrid public-private governance arrangement, through which biofuels sustainability certification is implemented in the EU, should guarantee democratic legitimacy, transparency and accountability on the one hand and link them with the (alleged) effectiveness and efficiency of private regulation on the other.

Putting these two poles of the debate into perspective, the aim of this paper is to critically review the EU sustainability regulation for biofuels based on conceptual literature on the effectiveness and legitimacy of transnational hybrid governance arrangements and their power and justice effects. Against this background, it will then be discussed whether this example of transnational, hybrid sustainability governance can actually serve as a "role model" for the transnational regulation of the spatio-environmental effects of the large-scale expansion of bioenergy and the bioeconomy in general – and thus should be extended to other types of biomass utilization – or whether this would rather perpetuate and legitimize existing power asymmetries in the transnational space in terms of a "crop apartheid" and the exploitation of natural resources of the Global South.

Persuasiveness and Awareness of Arguments on Electricity Generating Technologies

Hawal Shamon[1]

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The energy concept of September 2010, known as the *Energiewende*, provides mainly a nuclear power phase-out, a reduction of the energy demand by using energy more efficiently, and a decarbonization of the energy supply by switching from fossil to renewable sources (Federal Ministry of Economics and Technology (BMWi), 2015). In order to achieve the latter objective of the Energiewende, it will be necessary to expand tremendously technologies based on renewable sources like on- and offshore wind parks, open space and rooftop photovoltaics as well as biomass plants, and, thus, to decentralize the German energy system. Despite the general support for the energy transition among the German population (bdew, 2016; BDI, 2014), the installation of new renewable energy technologies is often confronted with public rejection or protest on the local level. Therefore, the communication of goals, measures and impacts of energy system's changes to the citizens might be a momentous task in order to attain public acceptance of the energy transition. In this respect, we focus in our survey based study on the analysis of the persuasiveness and awareness of numerous pro and counter arguments on selected electricity generation technologies. The survey was administered online to members of a German access panel. The results of our quantitative analyses show that the use of arguments for communicating the energy transition involves some problematic issues that should be addressed in future.

Session C: Ecological Impacts of Wind Power I: Optimal Spatial Allocation

***Session coordinator and chairperson**: Paul Lehmann[1,2]*

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***Venue:** Hall 2AB*

Schedule:

Time	Presentation	Speakers
09:00 – 09:05	*Welcome address*	Paul Lehmann (University of Leipzig / UFZ)
09:05 – 09:20	*German Wind Power Goes into Hiding - Like Outlaws in the Forest*	Katja Bunzel (UFZ)
09:20 – 09:35	*Nature Conservation as Criteria in Wind Energy Scenarios*	Philip Gauglitz (Fraunhofer IEE)
09:35 – 09:45	*Discussion*	
09:45 – 10:00	*Sustainable Allocation of Wind Power in Germany - A Distance-Based Approach*	Marcus Eichhorn (UFZ)
10:00 – 10:15	*Optimal Spatial Allocation of Wind Energy Development in Germany until 2030 - Insights from an Expert Dialogue*	Paul Lehmann (University of Leipzig / UFZ)
10:15 – 10:30	*Discussion*	

German Wind Power Goes Into Hiding - Like Outlaws in the Forest?

Katja Bunzel[1]

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End of 2016, more than 27,000 windmills are spinning across Germany. Given the ambitious target of the German government of a 80% share of renewables in total electricity consumption by 2050, the number of wind turbines will continue to strongly increase. So far, wind turbines were mainly installed on agricultural land. However, in light of ambitious expansion targets and establishment of setback distances to residential areas, forested areas increasingly become focus of wind farm developers. In the last years, rapid progress in wind turbine technology made it economically feasible to locate wind farms in forested areas, e.g. on forested hill tops and ridgelines offering high average wind speeds.

Against this background, we analyzed the policy instruments of the federal states regarding wind turbines in the forest. Our results show that there is no harmonized approach in the sixteen federal states. While some federal states allow or even support the installation of wind turbines in the forest, other federal states aim to keep their forests clear of wind turbines. This finding is supported by our spatial analysis of wind turbine and land use data (1991-2016), where we found that the installation of wind turbines in forested areas is almost exclusively limited to five federal states. In general, since 2011, there is a clear trend of placing new wind farms in the forest, mainly coniferous and mixed forest. While in 2010, only approximately 5 % of the new wind turbines were installed in the forest, the number increased to approximately 24% in 2016.

Nature Conservation as Criteria in Wind Energy Scenarios

Philip Gauglitz[1]

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Germany has set ambitious goals for the reduction of greenhouse gases. An important means to achieve these is the increased utilization of wind energy to decarbonize the energy system. The growth of wind power is bound to changes not only in the electrical system but also in landscape and environment. To assess potential influences, different growth scenarios are developed and simulated. Prospectively, the scenarios have to regard all aspects, not only economics and technics but also nature conservation and social affairs. Specific scenarios that mainly address questions of landscape and nature conservation are developed by the authors in the research project 'Szenarien für den Ausbau der erneuerbaren Energien aus Naturschutzsicht' funded by the Federal Agency for Nature Conservation. Focus of the scenario-modelling is the inclusion of nature conservation as one of several drivers to determine the allocation of wind power plants. Four generic scenarios for the year 2035 are presented; in two of them nature conservation is the main driver of the allocation, whereas in the other two only energy economic drivers are considered. To ensure comparability of the scenarios, all of them have the same general framework consisting of fixed excluded areas, the same method of detail allocation and the same overall expected energy output. The driver nature conservation is integrated as a nationwide comparative assessment of risk levels. Mapping spatially differentiated risk levels for wind energy was achieved in a GIS-based and discursive process. The result provides a criterion to allocate wind power plants to reduce conflicts in high risk areas. Furthermore, using the same spatial distribution of risk levels allows to subsequently rate the scenarios from a conservation perspective. The developed method provides means to analyze trade-offs between relevant drivers.

Sustainable Allocation of Wind Power in Germany - A Distance-Based Approach

Marcus Eichhorn[1]

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Wind power plays an integral role in the transition of the German energy system. In addition to its positive effects, e.g. reduction of greenhouse gas emissions, wind power also has negative effects on the nature conservation, species protection and human well-being. Therefore, it is important to consider different aspects of sustainability, when identifying locations for wind turbines (WTs). The approach presented here combines environmental aspects, human wellbeing and their respective energetic performance (annual energy production) with a high spatial resolution. The first two aspects are assessed on a distance base, for the latter the respective annual power production is calculated, based on wind speed frequency distributions and technical specifications of the sample WTpau. The approach allows comparing the sustainability of different spatial distribution scenarios of WTs and different wind turbine technologies (state of the art and advanced wind turbines). We applied this approach to four different spatial wind power extension scenarios, which are aiming to fulfil a certain share of the final power consumption in Germany by considering two different wind turbine types. Finally, the respective spatial expansion scenarios are compared in terms of the lowest combined impact and their sustainability performance.

Optimal Spatial Allocation of Wind Energy Development in Germany until 2030 – Insights from an Expert Dialogue

Paul Lehmann[1,2]

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Wind power is widely considered a key technology to decarbonize power generation. Yet, wind power development also produces adverse sustainability impacts. In this paper, we analyze whether and how such impacts may be mitigated by the spatial allocation of wind power development. We look particularly at how the projected wind

power generation for Germany for 2030 of 200 terawatt-hours should be spread spatially. We consider impacts in terms of (1) energy yield, (2) power system integration, (3) nature and species conservation, (4) landscape aesthetics, and (5) distributional fairness.

Previous studies have addressed the issue of optimal siting of wind power by model-based optimization approaches. However, such approaches require quite restrictive assumptions on how to weigh the different sustainability impacts. In contrast, we present results from a management game carried out with practitioners from politics, administration, non-governmental organizations and business. Participants were asked to decide on the spatial allocation of wind power development in Germany in 2030, considering the above mentioned impacts. This exercise provides several insights. First, it reveals which priority practitioners attach to different sustainability criteria. Second, it highlights whether and to what extent trade-offs and synergies materialize between the different criteria. Finally, the discussion shows whether there can be agreement on where to site wind power development, given the multi-criteria decision-problem. Based on these observations, we derive implications for designing the future regulatory framework for wind power development in Germany.

Session A4: Local Energy Systems

Session coordinator and chairperson: ***Thorsten Beckers***[1]

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Venue: *Hall 1CD*

Schedule:

Time	Presentation	Speakers
11:00 – 11:05	*Welcome Address*	Thorsten Beckers (WIP)
11:05 – 11:20	*Citizen- and Community-Designed Energy Landscapes: Multifaceted Benefits, Challenges and Learnings*	Diana Süsser (University of Hamburg)
11:20 – 11:35	*Establishment of Blockchain-Technology-Based Local Decentral Energy Markets*	Karl Holtkamp (PwC Legal AG)
11:35 – 11:45	*Discussion*	
11:45 – 12:00	*Consumer-Oriented TCO Optimization for a Private Prosumer*	Kai Kappner (RTWH Aachen University)
12:00 – 12:15	*On-Farm Energy and Feed-In Tariffs*	Jonathan Cooper (Harper Adams University)
12:15 – 12:30	*Discussion*	

Citizen- and Community-Designed Energy Landscapes: Multifaceted Benefits, Challenges and Learnings

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A transformation towards a sustainable and renewable energy system is necessary; however, it also reveals questions of ecological and social compatibility and profitability. The energy transition leads to physical and social changes in communities and creates new energy landscapes which are not per se accepted. Nevertheless, there are current examples of successful energy communities, which raise the question how an energy transition can be implemented sustainably. Although the societal and political relevance of citizen-designed and community-based renewable energy system has increased, the actual multifaceted benefits but also the challenges and trade-offs are not well understood yet. We address this gap by asking one major question: How do and can citizens actively design the energy transition, and how does this transition transform rural communities and landscapes? North Frisia serves as a case study region where farmers and communities are local actors of the energy transition. In the course of our empirical study, we conducted a regional literature review, two sets of interviews in North Frisian communities (Germany) and a household' survey in one of them. In our talk, we present and discuss two main aspects: (i) the multifaceted benefits and challenges to the people, the environment and regional economy caused by community renewable energy, and (ii) learnings provided by today's perceived trade-offs for the future planning and political design of renewable energy development.

Establishment of Blockchain-Technology-Based Local Decentral Energy Markets

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Project: Elaboration of a White Paper by KIT and PwC on "Establishment of blockchain-technology-based local decentral energy markets"

Target audience: The publication is aimed primarily at political institutions (BMWi, BNetzA, EU) and energy industry associations (BDEW, VKU).

Goals: The publication is intended to identify the necessary regulatory adjustments by means of a use case, insofar as the blockchain technology is used in the German energy industry for business models within the framework of local markets.

Use Case: Local decentralised energy markets that make regionally generated renewable electricity available to a large number of consumers. In addition, local energy markets enable the reduction of balancing energy from upstream grids.

Publication: Volume: approx. 30 pages; language: German and English; joint publication by KIT and PwC. If necessary, an abbreviated version of the publication aimed at the presss to be edited.

Content of the Publication:

Chapter 1: Description of local energy markets
Chapter 2: Efficiency of local markets – why do local energy markets offer more (macro-economic) advantages?
Chapter 3: Current regulatory framework of the German energy industry and the gap on blockchain-technology
Chapter 4: Regulatory objective of a local market based on blockchain technology
Q&A - Key questions and answers in the context of the topic

Preparation of the publication:

- Consultation on the chapter contents (2nd outline level) between PwC and KIT, end of July
- First drafts of the chapters, end of August
- Q & A and finalization, September

Consumer-Oriented TCO Optimization for a Private Prosumer

Kai Kappner[1]

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In the context of the German energy transition, the number of domestic households that cover part of their electricity consumption through generation with their own PV system is constantly increasing. Some even use battery storage systems to store excess power for later use. This increases the degree of self-sufficiency and, according to the provider of such systems, should yield financial advantages for the rising business model of the so-called prosumer.

We analyze the possibilities that arise for prosumers under German market conditions using a developed Consumer-oriented Total Cost of Ownership (TCOC) model and thus determine the economically optimal solution for different domestic household sizes. In order to obtain realistic results, we used real data covering weather (relevant for generation), consumption patterns, investment costs, prices and revenues.

Our research shows that it is financially advantageous for all household sizes to operate a PV system as large as possible (up to 10 kWp). In contrast, our results show that the investment in a battery storage system does not pay off even when government subsidies are taken into account. Regardless of the size of the selected battery storage system and all other influencing variables, economic advantages of such a system do not materialize, although a battery storage system increases the self-sufficiency rate substantially.

On-Farm Energy and Feed-In Tariffs

Jonathan Cooper

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Renewable energy developments in agricultural landscapes are a significant aspect of the decarbonisation of energy systems in a range of countries. Feed-in tariffs have been deployed as financial incentives for investment in such renewable energy developments in a number of territories. This paper develops case studies from two continents in order to examine the role of feed-in tariffs in on-farm energy developments. The Nova Scotia Community Feed-In Tariff (COMFIT) is the world's first example of a scheme which provides financial incentive for the local generation of electricity from renewable resources (such as wind, solar, hydro and bioenergy). Energy infrastructure has, to some extent, resulted in the transformation of the agricultural landscape of this region of Atlantic Canada and there has been a rapid transition in the electricity generation mix there. The COMFIT scheme was closed in 2015 and the full extent of the impacts of its closure are poorly understood. The system of feed-in tariffs operational in the United Kingdom was placed under review in 2015 and since then financial incentives payable have been reduced; it is widely predicted that the scheme is likely to close altogether in the near future. Quantitative and qualitative data are presented in order to explore the views of farmers and other stakeholders in Nova Scotia and the United Kingdom. A tendency for reluctance to be involved in co-operatives and potential barriers to effective communication about such schemes are identified as principal themes among stakeholder views.

Session C: Ecological impacts of Wind Power II: Policy Responses

***Session coordinator and chairperson**: **Paul Lehmann**[1,2]*

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***Venue:** Hall 2AB*

Schedule:

Time	Presentation	Speakers
11:00 – 11:05	*Welcome address*	Paul Lehmann (University of Leipzig / UFZ)
11:05 – 11:20	*Ecological-Economic Analysis of Instruments to Govern Future Wind Power Deployment*	Felix Reutter (UFZ)
11:20 – 11:35	*Application of Species Conservation Law for Permitting Renewable Energy Projects, Considering in Particular Wind Power Onshore*	Wolfgang Köck (UFZ)
11:35 – 11:45	*Discussion*	
11:45 – 12:00	*Governing Wind Energy Development through Spatial Planning: Insights from the UK*	Richard Cowell (Cardiff University)
12:00 12:15	*Implementation of the Energy Transition as a Challenge for Planning*	Julia Wiehe (Leibniz Universität Hannover)
12:15 – 12:30	*Discussion*	

Ecological-Economic Analysis of Instruments to Govern Future Wind Power Deployment

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In Germany a high increase in wind power generation is planned. Wind power has major benefits compared to conventional power plants, especially as it is climate friendly. However, there are also negative external effects potentially associated with wind power plants. The extent of these externalities largely depends on the spatial wind power plant allocation. The future wind power plant allocation is influenced by regulatory conditions. From an economic perspective policy makers therefore should be aware of the impacts that different regulatory conditions have not only on the (internal) wind power production costs but also on the externalities (external costs) and eventually on the total (i.e. internal plus external) wind power generation costs.

To shed light on this, a spatially explicit ecological-economic modelling approach is applied. The modelling is performed with data for the German federal state of Saxony. Two negative wind power externalities are considered. (1) The red kite, a protected raptor bird, can collide with wind power plants potentially leading to population losses. (2) Residents may suffer from wind power plants in their vicinity, mainly due to noise and visual impairments. In terms of the regulatory conditions, one planning instrument (uniform minimum distance regulations), two economic incentive instruments (spatially differentiated wind power support / obligatory compensation payments), and mixes of these instruments are assessed.

Within the modelling framework a comparative analysis is carried out examining the instruments' impacts on the future wind power plant allocation and the corresponding internal, external and total costs. The main finding of the analysis is highly relevant for policy makers: the modelling results suggest that with respect to the red kite externality uniform minimum distance regulations are recommendable, whereas with respect to the externalities for residents the introduction of economic incentive instruments should be considered to influence future wind power plant siting decisions.

Application of Species Conservation Law for Permitting Renewable Energy Projects, Considering in Particular Wind Power Onshore

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In Germany, the prohibition of killing under species protection law is generally understood on an individual basis. According to consistent case-law, however, it is only considered violated if a significant increase in the risk of death through renewable energy projects can be assumed. Accordingly, a population-risk-related (and not a model-related) approach is applied.

For the application of this approach, a number of species protection criteria have been developed, which include the reproduction rate and the specific behaviour of species as well as the conservation status. All this leads to distance recommendations as well as avoidance recommendations, the observance of which is intended to ensure that the requirements of the killing ban are met.

The case-law emphasizes that although species protection guidelines can provide important indications for determining a significant increase in risk, they always depend on an assessment in individual cases. For this evaluation, the competent authority shall be given a margin of discretion. This is particularly the case because species protection knowledge has not yet coagulated to such an extent that one can speak of a general convention in the sense of a clear state of the art in science. The need to develop a way of dealing with uncertainty has resulted in monitoring measures accompanying the project, the evaluation of which can lead to subsequent improvement decisions.

In order to answer the question whether a significant increase in the killing risk is to be expected from the project implementation, cumulative effects must also be determined and evaluated. Due to the amendment of the EIA Directive 2014/52/EU, this aspect will have to be given much greater importance in the future, as the environmental report will have to provide information on this.

In view of the further expansion forecasts for onshore wind energy, it is to be expected that in future the exemption possibilities provided by species protection law will also play a much greater role onshore.

Governing Wind Energy Development through Spatial Planning: Insights from the UK

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As part of their policies for onshore wind, many countries now use some form of spatial planning to identify areas or zones where development would be acceptable or unacceptable. Despite this common practice, research into the actual effects of spatial planning remains problematic. One problem is that technical research on *how* to map renewable energy resources against spatial constraints, often using GIS, has grown faster than patient analysis of how such techniques get used in practice, and with what effects. Indeed, most social science research on wind energy planning practice examines conflicts over project consenting, giving little attention to how the 'political work' of reconciling renewable energy development with other social priorities gets undertaken at a wider spatial scale, through spatial policies, before individual projects come forward.

This chapter addresses these knowledge deficits by analysing the experience of 'spatial planning' for on-shore wind in the UK, where recurrent siting difficulties for wind farms has prompted policy experimentation. Central to the analysis is a concern to elucidate the *very different governance roles* that spatial planning can perform, and the need to understand how spatial plans – as methodology, process and product – serve to align the constellation of actors around them. This framework is applied to a comparative analysis of the use of spatial planning approaches in England, Northern Ireland, Scotland and Wales, tracing causal links between governance roles and wind energy outcomes. Evidence suggests that spatial zoning can help to expand the volume and steer the locations of wind energy development, but rarely do they circumvent conflicts over landscape change or speed up project consent decisions. In England, such conflicts have led to spatial zoning becoming a tool mainly of locally-driven development exclusion. To grasp how spatial planning systems 'work' and their diverse effects, researchers need to conduct long-term studies.

Implementation of the Energy Transition as a Challenge for Planning

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Within the transformation of the energy system, a human and nature-compatible allocation of the facilities in the area must be ensured so that protecting nature and human needs is guaranteed and as little space as possible is used. Adequate participation of the political authorities at federal, regional and local level as well as the population is important.

It is assumed that the previously unspecific incentives at the national level would continue to activate the local energy potential in a very inefficient manner. At the same time, there is pressure on nature and landscape suspected - as they have become effective in the past through undifferentiated incentives for energy crop cultivation.

If national responsibility is broken down to the political levels they will have to make different contributions to achieving the 2050 target, since the energy potential is spatially unevenly distributed.

The aim of the contribution is to work out which institutions and instruments can ensure that quantities of energy required for the federal goal are actually generated locally. An analysis of current regulation at federal level and the example of the settlement of wind energy in the Hanover region show the challenges of implementation down to the lower planning levels.

Quantitative targets for the overall energy balance of regions (e.g. in federal spatial planning and/or planning for energy production) could therefore be a solution for the nature -optimized allocation of the facilities while fulfilling the energy targets. Using the example of current grid planning, it is shown that it is possible in principle to regulate and partially implement inter-federal interests at the federal level using economic incentive mechanisms and legal requirements. The conditions should therefore also be created at federal level for a nature-compatible implementation of the energy transition.