HELMHOLTZ ASSOCIATION

Alliance ENERGY-TRANS

Book of Abstracts

Conference "Energy Systems in Transition: Inter- and Transdisciplinary Contributions"

9th - 11th of October 2013

Karlsruhe, Germany

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http://www.energy-trans.de

GENERAL INFORMATION

OBJECTIVES

The main objective of the conference is to gain a better understanding about the conditions, dynamics and impacts of energy transitions towards sustainability. Energy systems are understood as complex socio-technical systems that require transdisciplinary methods and a focus on policy and action oriented research.

CONFERENCE VENUE

The conference will be held at the Center for Art and Media (ZKM) and the Staatliche Hochschule für Gestaltung in Karlsruhe.

As a cultural institution, the Center for Art and Media (ZKM) in Karlsruhe holds a unique position in the world. It responds to the rapid developments in information technology and today's changing social structures. Its work combines production and research, exhibitions and events, coordination and documentation.

For the development of interdisciplinary projects and promotion of international collaborations, the Center for Art and Media has manifold resources at its disposal: the Museum of Contemporary Art, the Media Museum, the Institute for Visual Media, the Institute for Music and Acoustics and the Institute for Media, Education, and Economics.

OFFICIAL LANGUAGE

The official language of the conference is English, with exception of the Public event on Wednesday, October 9th 2013 (in German).

EVENTS

WEDNESDAY, OCTOBER 9TH 2013, 7:00 PM – 8:30 PM:

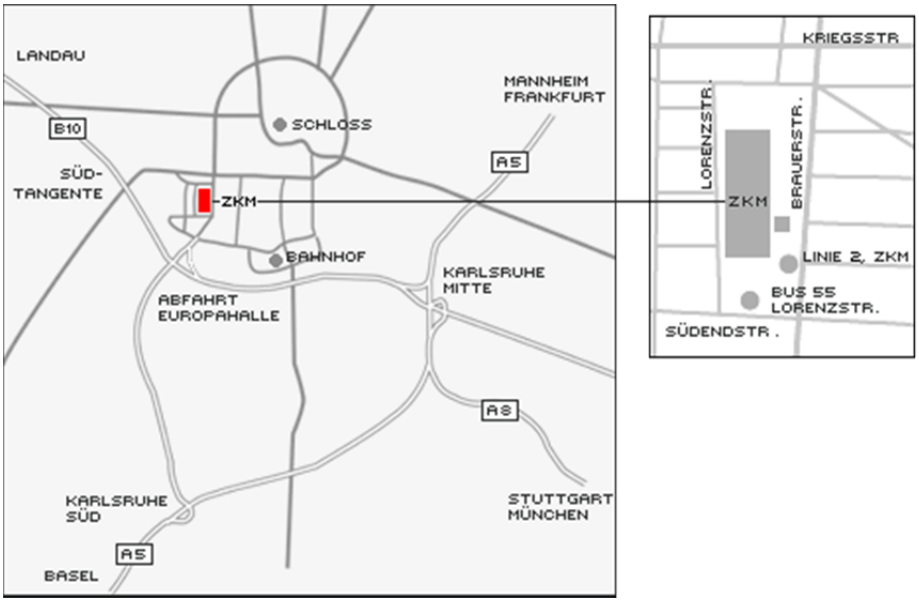
Public event on politics meets science titled "Die Energiewende als Gemeinschaftswerk. Erwartungen an Politik, Wissenschaft und Bürgerschaft" with State Minister Theresia Bauer from the German State of Baden Württemberg, State Secretary Dr. Georg Schütte from the Federal Ministry of Education and Research and Prof. Dr. Gesine Schwan, President of the HUMBOLDT-VIADRINA School of Governance (in German).

THURSDAY, OCTOBER 10TH 2013, 7:30 PM - 10 PM:

Conference dinner at the conference venue and guided tour by the center for art and media.

TRAVEL INFORMATION

The Center for Art and Media (ZKM) is located in the city center of Karlsruhe and can easily be reached by public transport. The exact times of departure are available on the website of the Karlsruher Verkehrsverbund (Karlsruhe Transport Authority). Information about travel data of the German Railway is provided by the Deutsche Bundesbahn.



ADDRESS
Lorenzstraße 19
76135 Karlsruhe

HOW TO REACH THE ZKM

BY CAR
From the North: Highway A5, exit »KA-Mitte«,
take the »Südtangente« direction Landau,
follow the »ZKM« sign.

From the South: Highway A5, exit »KA-Süd«,
follow the »ZKM« sign.

Parking space for 700 cars available below ZKM,
access at Südendstraße.

BY TRAMWAY

Due to construction work in Karlsruhe we kindly ask you to check the current situation for trams and busses on the website KVV Karlsruher Verkehrsverbund.

From the train station, take line 2E
direction »Siemensallee«, get off at »ZKM«
[approximately 200 m from ZKM]

By bus
From the train station, take bus number 55
direction »ZKM/Kühler Krug«, get off at »Lorenzstraße«
[approximately 400 m from ZKM]

ORGANISING COMMITTEE

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Prof. Andreas Löschel	Centre for European Economic Research

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Prof. Miranda Schreurs	Freie Universität Berlin
Prof. Bernhard Truffer	Eawag
Dr. Wolfgang Weimer-Jehle	University of Stuttgart

THE HELMHOLTZ-ALLIANCE ENERGY-TRANS

The conference is organized in context of the Helmholtz Alliance ENERGY-TRANS. The alliance understands the energy system as a complex socio-technical system and, based on this perspective, conducts interdisciplinary research into the systemic interactions of the envisioned energy transition. The main focus lies on the interplay between technical potentials, innovation processes, user behaviour, political and economic conditions (incentives and disincentives), conflicts and management processes. Cross-cutting (i.e. horizontal) activities complement the complex research design as a means to ensure a high level of integration and consistency.

The alliance comprising four centres of the Helmholtz Association, three universities and one non-university research institute. The partners are: Karlsruhe Institute of Technology (KIT, coordinator), Forschungszentrum Jülich (FZJ), German Aerospace Center (DLR), Helmholtz Centre for Environmental Research (UFZ), University of Stuttgart, University of Magdeburg, FU Berlin and the Centre for European Research (ZEW), Mannheim. ENERGY-TRANS is running from 2011 until 2016.

The Alliance is coordinated by the Karlsruhe Institute of Technology (KIT). The spokespersons for the Alliance are Professor Armin Grunwald, Director of the Institute for Technology Assessment and Systems Analysis (ITAS) at KIT and Professor Ortwin Renn, Director of the Stuttgart Research Center on Interdisciplinary Risk and Innovation Studies (ZIRIUS) at

the University of Stuttgart. Helmholtz Alliances are supported by the Helmholtz Association as a means of meeting strategic research goals and promoting structural innovations.

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ABSTRACTS – ORAL PRESENTATION

WEDNESDAY, OCTOBER 9TH 2013

THE PARADIGMA OF RENEWABLES: DIMENSIONS AND INDICATORS OF SOCIAL SCENARIOS

Authors:	Dr. Uwe Pfenning
Institution:	DLR Stuttgart, Department System Analysis and Technology Assessment

Type of presentation	Oral
Session:	***Systemic Perspectives on Renewable Energies***

Research towards the transition of the German energy supply system from fossil and nuclear power resources to renewable energy resources are mostly focus on system level analysis: a) looking for technological innovations in energy generation, storage, supply and distribution systems, b) their economical conditions and consequences and c) participation models bringing in social actors, collective or societal acceptance. Nevertheless participation is a new dimension, reflecting a process of democratization and deliberation for the energy supply system(s), this is not sufficient. Because renewable energy resources is a new paradigma, according to overall changes for every individual, social actors and also system levels. “Energy” comes back to societal and also philosophical items and topics of understanding, consumption, literacy, involvement, legitimation, power, value orientations, and participation.

Thinking about how “Energy” get outside the individual perception, besides daily consumption, analyzing energy-system-biographies is helpful. There were changes after changes (coal, oil, gasoline, nuclear power, renewables), but the structures seem to be the same one: Passive consumers, big companies, governmental frameworks and engagement in research funding, technological innovations without societal reflections and only determined by technological progress in science.

For examples: The centralization of “our” energy supply systems seems to be a logical convention. But it comes out during the Nazi-Regimes and

being establish in the “Reichsenergiegesetz” in 1935. It is a political outcome. Nuclear Power was being establish by high acceptance in society and all political parties in the 70ties after the oil embargo by Arabian Nations during the Jon-Kippur war between Egypt and Israel, regarding the idea to get national independent for the demand of energy by industry and households, the “career” of renewables starting in the 80ties by some individual “first movers and innovators” and becomes a huge societal topic according to climate change and sustainability. Now the discussion focus on economical aspects of individual and societal costs.

Still only agent-based-simulation modeling, participation models and studies towards energy consumption are paying partly attention to social impacts. Szenarios and simulations faced technological applications to estimate resources, technological efficiency and ratios of energy consumption. To contrast these useful technology-szenarios with social scenarios we can work out the integrative aspects, dimensions and indicators how the transition process will be function and could be successful with respect to the relations of science, technology, culture and society. It is an attempt to take a look behind the current scene and to define socio-technological constructs.

Dimensions of Energy Transition	Dimensions of Social Scenarios			
	Philosophy	Sociology	Technology	Economy
Under-standing	Sense	Knowledg e	Innovation	Willing-ness to

				pay
Consumption	Needs	Life Styles	Usability	Budget
Involvement	Interest	Roles	Professions	Subjective benefit
Literacy	Enlightment	Norms & values	Use	Financial impacts
Legitimation	Democratisation	Research and funding	Societal use	Funding / Expenses
Power	Goals / aims	Influence	Decentralisation	Risks and benefits
Value orientation	Sustainability	Socialisation	Conventions, industrial norms	Balancing costs and benefits
Participation	Discourses	Acceptance	Realisation	Individual costs

HOW FAR IS THE GERMAN EXPERIENCE WITH RENEWABLE ENERGIES TRANSFERABLE?

Author: Magdolna Prantner
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Institution:	Wuppertal Institute for Climate, Environment and EnergyResearch Group "Future Energy and Mobility Structures"
Type of presentation	Oral
Session:	***Systemic Perspectives on Renewable Energies***

In line with the overall strategy of sustainable development the EU decided to promote energy production from domestic renewable sources. Within the Renewables Directive 28/2009/EC the EU member states committed to cover 20% of their final energy needs from renewable energy sources by 2020. These 2020-targets involve significant challenges for the member states. Therefore it is necessary to implement successful renewable energy development strategies in each member state in order to reach the overall target of the EU Renewables Directive. The forerunner countries of the European Union have significant experience in the implementation of renewable energy policies. However, how far is this knowledge transferable to the latecomers?

To answer this question the research project analyses comprehensively the development path of the electricity production from renewable energy sources in Hungary and in Germany. The aim is to highlight the broader determining social, political, economic and technical factors in both countries, and analyse the governance of energy transitions. The paper has a particular focus on path dependencies and windows of opportunities along the development path.

The paper shows how the multi level analysis can be applied for the description of a fundamental and rapid transformation process. Therefore the multi-level analysis was extended by the method of Constellation Analysis. The Constellation Analysis is an interdisciplinary concept, which is developed to describe and analyse complex problem areas. Its core idea is the equal ranking of heterogeneous elements and focussing on the relations among them. The combination of the two methodologies contributes to better understanding of the structure of the energy sectors and the motivation and strategies of various stakeholders.

A Dynamic Analysis of Internationalization in the Solar Energy Sector: The Co-Evolution of Technological Innovation Systems in Germany and China

Author:	Rainer Quitzow rainer.quitzow@fu-berlin.de
Institution:	Forschungszentrum für Umweltpolitik (FFU), Freie Universität Berlin, Ihnestr. 22, 14195 Berlin
Type of presentation	Oral
Session:	***Systemic Perspectives on Renewable Energies***

The paper takes a systems of innovation (SI) perspective to provide an analysis of the evolving international technological innovation system (TIS) for solar photovoltaics. The TIS approach is the most suitable for analyzing innovation systems in emergent technology fields, as it explicitly captures the dynamics of change in the system (Jacobsson & Bergek 2011). However, to date, the approach has been applied to analyze national TIS, largely ignoring international influences (Coenen et al. 2012). This may be appropriate in the formative stages of TIS development. However, in more advanced stages of system formation, it becomes increasingly important to capture inter-linkages and dynamic interactions between multiple TIS. To fill this gap in the literature, the paper adapts and applies the TIS framework for the analysis of a co-evolving TIS. This is different from a purely international perspective, as manifested in the sectoral system of innovation (SSI) approach. The SSI approach may be appropriate for the analysis of more established innovation systems, where structures, actors and institutions are more stable (Coenen & Díaz López 2010). An emergent global TIS, however, remains highly susceptible to (policy) developments occurring in individual countries. To capture these dynamics, the concept of a multi-level TIS is proposed. This acknowledges that a global TIS is composed of a number of sub-systems (i.e. TIS) at the national and sub-national levels, which retain a certain degree of autonomy. At the same time, actors and networks are frequently not limited to a single geographic

scale, as has been acknowledged in relational approaches to economic geography (Bathelt & Gluckler 2003; Yeung 2005). They may entertain linkages across multiple scales, often drawing on a physical presence in different localities. Such linkages allow developments in national (or subnational) TIS to exert influences upon each other. The paper draws on this adapted version of the TIS concept to frame the empirical analysis of an evolving global TIS in solar photovoltaics. Based on the system functions outlined by Bergek et al. (2008), the paper traces the dynamic interlinkages between Germany and China, as they have represented the most important drivers of change during the most dynamic period of TIS development. It sheds new light on the process of internationalization in the emergent TIS for solar photovoltaics and highlights how different system functions have been provided throughout this process (considering third countries where appropriate) and how they have shifted geographically as the international TIS has matured. Moreover, the paper demonstrates that not all system functions need to be provided within a single country, an assumption that has been implicitly made by single-country TIS studie.

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A SECOND WIND? BRITISH AND DUTCH OFFSHORE WIND ENERGY

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Type of presentation	Oral
Session:	***Systemic Perspectives on Renewable Energies***
Keywords:	offshore wind energy; system builders; socio-technical transitions; protective space

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Offshore wind power has been positioned as a promising renewable energy resource which could play a major role in transitions towards more sustainable energy systems. This paper focuses on two cases studies: the UK and The Netherlands. The UK can be characterized as a relative laggard in offshore wind energy, but in the past 5 years installed capacity has soared, making the UK the market leader with over half of the total installed capacity in the North Sea in 2012. Conversely, The Netherlands engaged with offshore wind relatively early (e.g. small-scale pilot projects since the mid 1990s) but any momentum was lost: two large-scale parks only materialized in 2007-2008 and were not followed by new ones, leaving The Netherlands at a 3rd position in terms of total installed capacity. This empirical observation - the stark contrast between the recent boom in the UK versus a stagnation in The Netherlands - leads us to the following research question: *how can we explain the difference in recent offshore wind developments between the UK and The Netherlands?*

Sustainable technologies often do not fit well with established selection environments (e.g. in terms of price, performance or consumer expectations) and therefore have difficulties to break out of niches into the mainstream (Smith 2007). Therefore a lot of emphasis has been put on the provision of temporary 'protective spaces' for niche technologies to be tested through real world application and to improve their performance and reduce costs in order to become competitive with existing regime selection environments (Kemp, Schot et al. 1998). Recently, Smith and Raven (2012) conceptualised protective space as being constituted by three interrelated processes: ***shielding*** niche technologies from regime selection criteria; ***nurturing*** the niche technology enabling learning, building of positive expectations and supportive networks and ***empowering*** the niche by achieving changes at the regime level which are favourable for the niche.

Smith and Raven argued that these processes are created through the agency of actors drawing on networks and creating positive narratives to enrol support for the niche technology. Such a conceptualisation goes beyond economic explanations of relative costs as an explanation of diffusion and goes beyond specific policy instruments as an explanation for the observed difference by focussing both on the politics of creating such protective space and what impact this protection has on the development and deployment of the niche technology.

Our cross-case analysis showed that many narratives used to enrol support are very similar and that the kinds of actors involved are also similar (and in some case identical). The most striking contrast is the presence of a pro-active 'system builder' (Hughes, 2000) in the form of the Crown Estate in the UK which is highly involved in nurturing processes (e.g. engaging in learning about cost reduction potentials; working with project developers) as well as shielding and empowering processes (e.g. as a source of expertise for the government and other public bodies). This type of actor is absent in the Dutch case.

We conclude that it is the strong alignment between the three processes under study, facilitated by a 'system builder', which created a more favourable protective space for offshore wind in the UK than in the Netherlands, which in turn explains the difference in terms of deployment between the two countries. Alignment seems to work well when there is a powerful, trusted, interested, professional actor involved who has credibility both with policy makers, public bodies as well as important industry players and can translated and mediate between these two spheres.

	UK	The Netherlands
Nurturing	Learning-by-doing (roll-out) supported by learning-by-innovating to reduce costs. Pilot projects were important in generating lessons (both technical as well as contractual arrangements). Offshore wind advocates built a broad coalition (incl. policy makers and non-departmental public bodies, firms, environmental organisations) sharing positive expectations about the potential for offshore wind	Near-shore pilot project explicitly designed to learn about technological & regulatory challenges, and environmental impacts. Establishment of dedicated offshore wind consortium (energy sector, offshore industry, project developers, research institutes & environmental NGO's). Emergence of shared expectation of "6,000 MW in 2020", which became policy goal.
Shielding	Offshore wind actors first mobilised pre-existing support (e.g. generic research council funding; tax credits; EU funds); then successfully lobbied for dedicated public support schemes (for innovation as well as deployment), and have chosen favourable	Parks constructed in favourable geographic locations. Parks made more interesting for investors by allowing capital support, tax breaks & production subsidies.

	locations for pilots.	
Empowering	Concerted effort towards cost reductions to make technology competitive with other low carbon options (involving DECC, other public bodies, Crown Estate, technology providers, project developers) Offshore wind advocates achieved several institutional changes to the electricity regime to make it more favourable to offshore wind (electricity market reform; transmission connections; streamlining planning)	Changes in licencing procedure from exclusion zone-based licencing to strategic preferred zone-based licencing. Highlighting Dutch offshore companies' involvement in construction of foreign parks & framing offshore wind sector as growth area in broader offshore industry. Making offshore wind part of the 'Top Sector' policy & the 2012 'Innovation Contract Offshore Wind'.

Table 1. Nurturing, shielding and empowering British and Dutch offshore wind power (examples).

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EXPLORING THE TRANSITION POTENTIAL OF RENEWABLE ENERGY COMMUNITIES

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Type of presentation	Oral
Session:	***Systemic Perspectives on Renewable Energies***
Scope:	energy transition, grassroots initiatives
Keywords:	renewable energy communities, energy transition, multi-level perspective, social innovations, case studies

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Transition scholars all agree that the current way of energy production is not sustainable in the long run and without a radical change favoring renewable energy, the negative impacts of climate change and depleting fossil resources cannot be avoided. The literature is less clear about how this future system would look like, who are the agents of this change and how transition can be realized.

The aim of this article is to introduce a special type of social niche (Hielscher et al., 2011), namely the renewable energy communities that can be also drivers of sustainability transition. Exploring the transition potential of such communities provide us opportunity to also take new perspectives into account, which focus not only on the technological, but also social aspects and the agents behind this change. These communities are innovative groups that in contrast to mainstream society are more self-conscious and able to stand up for their needs and realize joint investments, thereby contributing to the spread of renewable energy (Seyfang and Smith, 2006).

We will use the multi-level perspective as an analytical framework for studying renewable energy communities in the transition context (Geels, 2005; Markard and Truffer, 2008), which provides also an opportunity for the further elaboration of the theory by analyzing the complexity and the nature of niches. The question is to what extent renewable energy communities, as socio-technical niches, have the potential to scale up and contribute to energy transition. To answer this question we use the results of comparative case study research, which focuses on four different cases in the Netherlands. We have conducted interviews, as well as analyzed documents, including legislation and policies. The paper provides an overview of the state of renewable energy communities in the Netherlands, both from the demand side and the supply side perspectives, examining all the services, as well as legislation and policies in force that are related to them. In addition, through our cases we illustrate the diversity of communities regarding their locations, size, technologies and motivations.

This paper shows that there is already an increasing number of different local investor groups in the Netherlands, around which a complete infrastructure is building up. It argues that renewable energy communities are not only a few homogenous groups sharing the same values and needs, but there are more and more different communities investing in renewables locally for diverse reasons. Furthermore, technical, legal, financial infrastructure and other services are developing around them. As a result, these communities could survive the valley of death and their embedding into the regime has already started. In case they receive adequate governmental support, they would be able to spread in the regime more easily.

In addition, this paper contributes to transition studies, by focusing on elements that are rarely taken into account, namely: demand side factors as well as the role of civil society in the transition. Furthermore, it aims at elaborating the notion of niches, in order to provide for a comprehensive answer on how social innovations evolve and transform the incumbent energy system. Thus, besides studying the state of renewable energy

initiatives in the Netherlands from the transition perspective, we also con-
contribute to a better understanding of sustainability transitions.

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POLICY MIX CONSISTENCY AND INNOVATION: AN EMPIRICAL ANALYSIS OF OFFSHORE WIND IN GERMANY

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Type of presentation	Oral
Session:	***Systemic Perspectives on Renewable Energies***
Keywords:	Policy mix, consistency, innovation, renewables, offshore w

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In order to succeed in transforming the energy system towards renewable technologies, innovations in these technologies should be fostered by a mix of policy instruments. The term policy mix has been increasingly used in the context of climate policy, environmental policy and innovation policy in recent years, but these existing studies tend to apply a rather narrow policy mix concept with ambiguous characteristics focusing on the combination of instruments only. In a recent paper, Rogge and Reichardt (2013) make a first attempt towards a more comprehensive and interdisciplinary policy mix conceptualization.

In this paper, we test the suitability and usefulness of their definition of policy mix consistency for characterizing policy mixes and their impact on

firm behavior. We do so by analyzing the research case of innovation activ-activities in offshore wind in Germany and how they are impacted by the relevant policy mix and its consistency. Methodologically, we conduct qualitative case studies with power generators and technology providers in Germany (Yin 2009). In order to study the innovation impact of policy mix consistency we adjust the research framework of Rogge et al. (2011) to show the main link between policy mix consistency and innovation, as well as how this link is affected by context factors and firm characteristics (see figure 1).

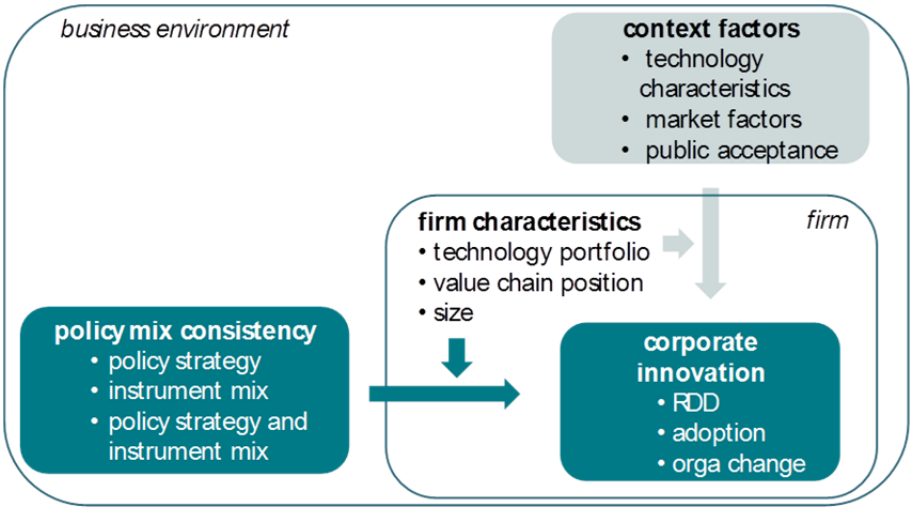

Figure 1: Research framework

Early results indicate a positive link between policy mix consistency and innovation. They also show the need to differentiate between a firm's strategic decision to engage in the emerging technology of offshore wind and case-by-case decisions of concrete innovation projects. While for the former the consistency of the policy strategy appears to be key, the latter clearly depends on a consistent instrument mix which renders the new technology competitive. In addition, weak inconsistencies between policy strategy and instrument mix do not seem to have an effect on innovation activities as long as the policy strategy appears credible and an improvement of the instrument mix can be expected. Our first findings let us preliminarily conclude that the differentiation of three levels of consistency provides useful insights into the mechanisms of the impact of a

complex policy mix on firm behavior and allow for deriving precise policy recommendations.

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OPTIMISING SMART GRID DEVELOPMENT

DESIGN GUIDELINES FOR THE TOUCH POINTS BETWEEN HOUSEHOLDS AND SMART GRIDS

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Type of presentation: Oral

Session: ***Smart Grids: Interdisciplinary Perspectives***

This paper gives an overview of seven Dutch smart grid lighthouse projects, involving households. The authors will describe how interventions were designed and implemented to influence energy related behaviour from a multidisciplinary perspective. Moreover, we will describe household's experiences with these interventions and the effect on behaviour. Valuable design guidelines for the development of smart grids are provided.

Smart grids become increasingly important. The introduction of high electricity consumers, such as heat pumps and electric vehicles, as well as

an increase in the local production of renewable energy, is causing new challenges with regard to balancing demand and supply. If the existing system can be re-invented so that households are able to adapt their demand to renewable energy production, a reduction of the back-up capacity and a more efficient use of the grid can be achieved. This is more sustainable and cheaper than energy storage. This suggests that the energy transition requires social change in addition to new technologies. For this social change to happen, consumers need to recognise and appreciate the (non-economic) added value. To stimulate and facilitate this change, innovations in products and services are essential. To take care that these innovations are successful, it is important to consider the existing context and daily habits in which people consume energy. Additionally, knowledge and understanding of their underlying needs and motivations is essential.

TRANSITIONING SMART GRID RESEARCH IN FLANDERS: THE CASE OF LINEAR

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Type of presentation	Oral
Session:	***Smart Grids: Interdisciplinary Perspectives***
Scope:	smart grids, transition
Keywords:	smart grids, transition, LINEAR, niche management

The proposed contribution analyses the experiences on end-user involvement in LINEAR over the period 2009 -2012. LINEAR is a large-scale smart grid project in Flanders, carried out by a consortium of about 20 partners and lasting 5 years (2009-2014). Although the project was started mainly from the perspective of learning about the technologies needed for smart grid operations, increasingly the project consortium has also been confronted with the social reality of end user involvement. This paper analyses both the expectations about end-user involvement (as held by the members of the project consortium, representing different business interests, universities and research institutes) and the actual end-user involvement as it occurred and evolved in the course of the LINEAR project.

The 'Strategic Niche Management' (SNM) perspective is used as a theoretical framework. This allows us to analyse LINEAR from the point of view of its possible contribution to the ongoing energy system transition. SNM argues that the creation of 'protected niches' allowing for (technological as well as social) experimentation is crucial for promising

innovations such as smart grids to succeed. SNM scholars have identified three processes that play a key role in the successful development of a niche experiment:

i) articulation of visions and expectations;

ii) building of social networks; and

iii) first and second order learning processes.

Regarding visions and expectations, we analyse firstly the motives and rationales of each of the main stakeholders in LINEAR to participate in the project in the first place and the extent to which these rationales are connected to expectations about the changing role of end users in the energy system, and secondly if and how these rationales changed in the course of project. Adopting the SNM multi-level perspective allows us to explicitly take into account possible regime and landscape shifts as an explanatory factor. The focus on the strategies used to build social ties with and between end users over the course of the project allows us to understand how and why end users are encouraged to problematize and change existing habits and routines, and how they responded to such 'encouragement'. Finally, we also analyse the way learning occurred in the course of the project, both on the level of the visions and expectations held by the stakeholders, as on the level of the 'techniques' through which the end users were involved. The empirical data are derived from semi-structured inteviews with representatives of key stakeholders involved in LINEAR.

Conclusions are presented on how this research project – that was not set up and organised from the point of view of transition theory – could be 'transitioned' in possible follow-up projects.

GOVERNING POWER, CONDUCTING DEMAND: RECONFIGURING SOCIAL PRACTICES FOR THE SMART GRID

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Type of presentation	Oral
Session:	***Smart Grids: Interdisciplinary Perspectives***

In the face of challenges of energy security, low carbon transitions and the replacement of aging infrastructure networks, new logics for the development of 'smart' electricity systems are emerging amongst utility providers and public authorities. While often portrayed as a technical matter, orchestrated through the top-down intervention of major corporate or government actors, such shifts in the system of electricity provision also entail efforts to fundamentally reconfigure relationships between providers and consumers, and rearticulate energy practices. In this paper, we argue that understanding the dynamics, politics and implications of systems of electricity provision requires an engagement with the ways in which new forms of 'smart' energy practice are being constituted as the means through which to sustain the 'roll-out' of smart grids.

Drawing on theories of governmentality and of social practices, we argue that the social practices of everyday life critically mediate the ways in which smart grids are being enacted, but also that forms of intervention conducted in pursuit of the smart grid also aim to reconfigure social practices in the creation of forms of 'electricity conduct'.

Through the initial analysis of the first round of findings from an industry-regulator funded project being undertaken by engineers, anthropologists and geographers into the ways in which smart grids are made and reconfigured in the north of England, we consider the different ways in which three smart grid interventions do and do not 'fit' into and around every-day social practices.

The paper draws on three connected studies which trial a new time-sensitive electricity tariff, a 'smart' heat pump installation and domestic balancing of solar PV power respectively to investigate the interactions between new technologies, cultural mechanisms and new forms of knowledge and discourse and their effect on the orchestration of every day energy use and social practices.

Using qualitative data generated from over 150 home energy tours the paper responds to the UK experience of regulator funded innovation in smart energy systems which has emphasised the need for demand side management of infrastructure in which customer flexibility is positioned as a potentially valuable asset for use by network managers to counter two projected trends; the erosion of supply side flexibility through the increased adoption of renewable and nuclear generation and increased demand for electricity powered mobility and heating. Responding to this context we develop and use a practice flexibility framework which considers inter-day, intra-day and locational flexibility and practice curtailment to analyse the ways in which the electricity demanded by social practices may or may not be rendered flexible by the three intervention types.

Our findings suggest that certain practices are rather amenable to the introduction of new knowledge and 'things', and that where this occurs it serves reconfigure the 'constellation' of particular practices. In other instances however, practices remain unchanged by the presence of these interventions and as a result the industry's reliance on demand side management must be re-thought to take greater account of context and community if the promise of the smart grid is to be realised.

THE ROLE OF NATIONAL AND SUPRANATIONAL NON-STATE ACTORS IN THE POLICY COORDINATION OF EU ENERGY REGULATION

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Type of presentation	Oral
Session:	***Governance of Complex Transition Processes***

Following the European Commission's pro-active approach in liberalizing the EU internal energy market - a field traditionally under the domain of Member States and their national energy champions, this paper aims to examine the role of non-state actors at both the national and the EU-level in the policy coordination of EU-level regulatory measures in the field of energy from a multi-level governance perspective.

Despite the transfer of competencies to the supranational level in the energy sector in recent years through the adoption of some major pieces of energy acquis (such as the energy and climate package 2009, the third liberalisation package on energy 2009 and the new energy efficiency directive 2012), most decisions related to the energy mix, in particular the role of gas, renewable energy and nuclear energy are still taken at national level. Therefore, national regulatory authorities and stakeholders still have a key role to play in carrying out energy transition measures and advancing the completion of an integrated, competitive and sustainable energy market.

The governance of energy matters at the supranational level is therefore extremely complex. Moreover, energy policy necessarily overlaps with other fields, themselves regulated at the EU level to a bigger or a lesser extent (internal market, trade, climate policy, EU-external relations, transport, industry, consumer goods, research and development). The inclusion of a broad group of stakeholders in the national and EU decision-making process is therefore paramount for the effective and coherent

coordination of energy legislation. However, participatory mechanisms for involving stakeholders in the domestic coordination of EU energy legislative measures have been underdeveloped so far. On the other hand, energy regulatory authorities have become important inter-mediatory actors linking the concerns and demands of consumers, operators, market participants, trade unions and industrial associations to the opinion formation process at governmental level in Member States and the decision-making at EU level.

This paper develops one case-study: the third liberalisation package on energy that introduced new unbundling provisions for vertically integrated companies with the aim of reinforcing competition on the energy market and ensuring non-discriminatory access to the grid; and further set up new regulatory framework for enhanced cross-border cooperation of TSOs and national energy regulators.

The aim of the study is to examine stakeholder involvement at the main stages of the policy-making process (policy preparation and decision-making) in three Member States (Germany, UK and Italy) in order to grasp the national dynamics of policy coordination and to also look at the participation of the relevant umbrella organization during the negotiations at EU-level.

The paper also reflects, in conclusion, on the challenges and opportunities that the EU multi-level system presents for stakeholder involvement in the regulatory decision-making in the energy sector.

THE LEADING GERMAN ENERGY PROVIDERS AND THE TRANSFORMATION OF THE GERMAN ENERGY SYSTEM

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Type of presentation	Oral
Session:	***Governance of Complex Transition Processes***
Keywords:	Energy transition, Energy Providers, Organizational change, Innovation

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In my talk I will present first results of my PhD project in which I investigate how the four big German power companies (E.ON AG, RWE AG, EnBW AG, and Vattenfall Europe AG) position themselves in the changing energy supply system. Since they are powerful actors within the German energy system they wield big influence on the process of its transformation. Their actions have so far not been sufficiently researched from a sociological perspective.

The results I will present are based on the first research row, which implies a large-scale content analysis of annual reports by the companies, press reports, and reports by government agencies as well as the analysis of shareholding networks. The analysis applies concepts from the neo-institutional theory of organizations. Especially the neo-institutional field-theory based on the work on DiMaggio/Powell (1983) and Meyer/Rowan (1977) among others and later modified by Fligstein/McAdam (2012) is appropriate for the object of study. Some additional theories will be used to close the gaps the aforementioned work leaves. These will be the concept of the capability of organizations to adapt to changes in their environment, developed by Dolata (2011), as well as the discussion on “path

dependency” in economic sectors and also in single organizations (For an overview see Werle 2007).

This analysis will provide first answers to the following research questions:

1. Which strategies do the established German energy providers use to defend their leading position and how do these strategies affect the course of the energy transition? Did they begin making organizational changes to cope with the Energiewende? What new or innovative measures have been enacted? Can attempts towards a new coalition building be detected?
2. How did they perceive the decisions made by the Federal Government – primarily as a threat or an opportunity? How did they react to political regulation? Did they try to take influence on political decisions?
3. To which extent are there differences/similarities between the strategies of the different actors?

These questions are particularly relevant because they deal with organizational inertia – a potential obstacle to the transformation of the whole energy supply system.

In my talk I will provide a comparing reconstruction of the actions of the companies in the time period from 1998 to 2013. On this basis I can offer insights about how, on the one hand, the companies adapt to changes in their environment and, on the other hand, how the companies actively influence their environment on their part.

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CONFLICTS OVER THE EXTENSION OF THE GERMAN ELECTRICITY GRID

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Type of presentation:	Oral
Session:	***Governance of Complex Transition Processes***
Scope:	Transition of the Energy System, Social Movements, Actors, Renewable Energies, Citizens' Initiatives, Electricity Grid Extension
Keywords:	Conflicts over the Electricity Grid Extension, Comparative Case Study, Regional Protests, Strategic Action Field, Challenger-Types and Interdependencies

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Background & Context

Facing the change to renewable electricity production the German federal government is planning a far-reaching extension of the grid for the transmission of energy. Wind power from the northern parts of Germany has to be transported to the industrial centers which are located in the South and the West. Although the share of renewable energies has been increasing for years, the building of new power lines is stagnating. Among the main reasons for this are protests of concerned people who have founded many citizens' initiatives along the planned routes.

Content & Findings

This presentation deals with the protest-actors demanding to modify single routes or the whole plan of grid extension. In this context, "grid extension" is understood as a strategic action field (Fligstein/McAdam 2011, 2012),

where the protest-actors are challenging the plans of government and grid operators. The central task is to find out in which way this field has changed. Therefore it is necessary to look at both – challengers and in-incumbent actors. Here, the role of challengers, especially the regional citizen action groups, is highlighted. Main results are derived from a comparative case study examining six power line projects which are very controversial. The first regional protests started around the year 2005. In each of the cases citizens' initiatives are supported by local politicians and municipalities. The regional actors in this context are called Topic-Challenger. Besides the latter, there two other types of challengers are identified, which have entered the field later on: Concept-Challengers and Acceptance-Challengers. The Concept-Challengers, green and left party, environmental NGOs and critical scientists, are aiming for fundamental changes of the extension plan. The Acceptance-Challengers on the other hand, mainly regional governments and specific industry representatives like wind turbine operators and cable producers, are rather aiming for incremental changes. But the simple presence of a higher number of challenger-actors in the field does not mean that the challenger-position as a whole would have been strengthened. Overall the "challenger-part" of the strategic action field has become more complex. Concerning their aims, interests and orientations of action, there are crucial differences between the challenger-types. In consequence, ambivalences and inner contradictions among the challengers can be observed.

Conclusion

The concept of Strategic Action Fields is basically adequate to examine the actor constellations and potential field developments. To make integrated statements concerning developments of the field as a whole, the actions of incumbent actors, starting from their reactions to the protests, also have to be assessed.

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ANALYZING SOCIO-TECHNICAL SYSTEMS:

METHODOLOGICAL CHALLENGES AND POTENTIAL SOLUTIONS FOR THE INTEGRATION OF INTERDISCIPLINARY WORK ON ENERGY TRANSITIONS

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Type of presentation	Oral
Session:	***Conceptual Approaches of Socio-Technical Systems***

The analysis of the transformation of future energy systems poses theoretical and methodological questions. With regard to theory, there is no approach available covering the complexity of the research object in its entirety. As a consequence, researchers tend to rely on the idea of "Socio-technical Systems", a term which indicates the analyzed system relates to both technical as well as social realities. However, many challenges occur while defining system/environment relations, system boundaries, the relevant elements of the system etc. Also, out of this quandary methodological problems derive for large, interdisciplinary research cluster. First of all, in using a multitude of approaches and methods, in combination with a lack of an overall valid theory, there usually is no commonly shared frame of reference given. This peril threatens to hinder any generation of a synthesis among the participating schools of thought among technical and social sciences. In the end this could lead to a lack of common reference in publishing the single results.

Against this background, the proposed presentation will draw on work carried out in context of the Helmholtz-Alliance ENERGY-TRANS; a research programme that investigates the systemic interactions between technology, organisation and behaviour in the German energy transition. Based on the interdisciplinary scientific analysis, ENERGY-TRANS investigates the interfaces between technical and societal factors that significantly influence the prospects for the envisioned transformation process.

The presentation will map the pros and cons of placing the term socio-technical system at the centre of such an interdisciplinary project. It will discuss whether different explicit or implicit conceptualisations of the "energy system" can be captured in a coherent way. However, one potential solution to the problems mentioned above that we like to explore is not based on definition work, but on carving out a commonly shared scientific problem. This should relate to the overall techno-political issue (consequences of the transformation) and is supposed to be of interest to all included disciplines, although still examined according to the respective theoretical and methodical means varying along the subjects involved. By assessing all projects of the "EnergyTrans"-Initiative individually we like to propose that "volatility" with its different dimensions (e.g. volatility of wind and PV electricity production; volatility in energy related user behaviour) could be such a scientific problem for both social and technical sciences.

TA AND SUSTAINABILITY TRANSITIONS

TOWARDS A SOCIO-TECHNICAL FRAMEWORK FOR ASSESSING FUTURE ENERGY TRANSITIONS

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Type of presentation	Oral
Session:	***Conceptual Approaches of Socio-Technical Systems***
Scope:	The paper aims at identifying core concepts, practical challenges as well as the potential benefits of applying an explicit combination of Technology Assessment and Socio-technical Transition Studies.
Keywords:	Technology Assessment, Socio-technical Transition Studies, energy innovations, prospective knowledge

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Background & Context

The origins of Technology Assessment (TA) and Socio-technical Transition Studies (STTS) can partly be traced back to shared starting points. The STTS literature was based on early work on constructive technology

assessment (CTA), which since the late 80ies argued for a co-evolutionary analysis of technology dynamics and the assessment of its impacts on society (in particular as a response to the so-called Collingridge dilemma). After a phase of parallel development, both approaches developed into quite different directions. STTS focused primarily on better understanding the emergence and reconfiguration of socio-technical systems and sectors. TA on the other side started to focus on issues like uncertainty, non-linearity of technology development, and the existence of a multitude of attitudes and preferences in society. This led to a whole set of different TA brands and approaches. Today, TA and STTS have developed rather complementary strengths for informing sustainable governance of energy transitions.

Content & Findings

The present paper aims at taking stock of these literatures and at identifying productive contact zones for a more explicit mutual re-engagement. A major potential lays in identifying and assessing future socio-technical configurations based on a more explicit conceptualization of socio-technical innovation processes. For TA, prospective perspectives are constitutive for its analytical framings as well as for its political recommendations. In order to accommodate for the existence of a multitude of potential trajectories, context scenarios are often taken into consideration. However, grounding these trajectories more explicitly in socio-technical innovation processes could potentially improve the identification of bifurcation points and other uncertainties. STTS research, on the other side, is strong at identifying core mechanisms of socio-technical transformations. It was formalized based on a multitude of in-depth ex-post analyses. There have been repeated endeavors to apply these concepts also to forward looking contexts (mostly by combining STTS concepts with participatory foresight methodologies). However, there is still no fully elaborated framework for informing policy makers. An exception was the policy approach of Transition Management, which has been implemented as a framework informing the Dutch sustainability policy of the last decade. This concept has however been repeatedly criticized for

being too much oriented at the specific political system of the Netherlands and also for remaining politically rather naïve, bordering sometimes even on a technocratic attitude. Here we see a potential benefit of reconsidering the experiences gained in the different TA traditions, as they are traditionally strongly embedded in real world policy contexts.

Conclusion

Against this background, the paper aims at identifying core concepts, practical challenges as well as the potential benefits of applying an explicit combination of both approaches. In particular, we will discuss in how far this could inform the current German energy transition. This will be accomplished by reviewing the extant literature and by proposing integrative concepts. We will furthermore draw on former research on expected developments of energy storage technologies (fuel cells and batteries for mobile applications) and agricultural biogas for illustrative examples.

CONCEPTUAL APPROACHES FOR STUDYING SECTORAL TRANSFORMATION: THE "ENERGIEWENDE" CASE

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Type of presentation	Oral
Session:	***Conceptual Approaches of Socio-Technical Systems***
Scope:	Theory development, literature review
Keywords:	Large technical systems, multi-level perspecive, technological innovation systems, sectoral change

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Background & Context

When talking about the "Energiewende" we refer to an ongoing process in which the energy sector changes fundamentally, e.g. by substituting fossil and nuclear fuels with renewable energy sources, a substantial increase in energy efficiency and a reduction of energy demand. Such a far-reaching transformation of an established socio-technical system is highly complex because it encompasses technological, institutional, organizational and behavioral changes accompanied and guided by a broad set of policies at different levels. In the case of the energy sector, we expect particular challenges because of its long-lasting, capital-intensive infrastructure, a high degree of technological interdependencies (Markard, 2011) and ongoing changes through market liberalization (Markard and Truffer, 2006).

In the innovation studies literature, the transformation of socio-technical systems has been analyzed from different perspectives and with different frameworks. These include large technical systems (Hughes, 1987; Joerges, 1998), the multi-level perspective on socio-technical transitions (Smith et al., 2010; Geels, 2011), the technological innovation systems framework (Bergek et al., 2008; Jacobsson and Bergek, 2011) and related

approaches (e.g. Smith et al., 2005; Dolata, 2009). So far, the aforemen-aforementioned strands of literature have emerged rather independently although they deal with the same or closely related phenomena and are based on similar ontologies. Scholars have just begun to analyze the differences and complementarities of these approaches (Markard and Truffer, 2008; Weber and Rohracher, 2012).

Content & Findings

In this presentation, we review the contributions of the aforementioned strands of literature with regard to the phenomenon of the “Energiewende” (energy transition). The energy transition is a policy-driven, multi-dimensional transformation that includes organizational, institutional and technological changes on both supply and demand side. In technological terms, it involves many technologies in different stages of maturity and diffusion.

The paper starts with the identification of the core characteristics of such a sectoral transformation. Then, the innovation studies and transitions literature will be reviewed against the background of these characteristics. In a third step, differences and commonalities are analyzed. In the final part, we discuss the implications when studying sectoral transformation with the use of different frameworks:

We will show that each of the different framework holds particular benefits for the study of the energy transition. The multi-level perspective highlights the institutional rigidities in the established sector, the large technical systems perspective directs attention to the systemic nature of the transformation but also to the role of agency in this process and the technological innovation systems approach is particularly useful to understand the dynamics of selected technologies in the broader transformation.

However, to adequately address the energy transition conceptual refinements are needed that embody – in a combined or complementary way – the insights of more than one framework.

Conclusion

Future studies on “Energiewende” issues will generate more balanced insights where they acknowledge the strengths and limitations of the frameworks they are working with, and ideally perform complementary theoretical analyses to come to terms with the complexities of the novel phenomenon.

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DYNAMIC GOVERNANCE, PUBLIC POLICY AND RISK: SOME REFLECTIONS AND NEW CONCEPTUAL CONSIDERATIONS

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Type of presentation	oral
Session:	***Coping with Risk and Uncertainties***
Scope:	Governance and transformation
Keywords:	Dynamic governance, transformation, discursive institutionalism, reflexive capacity, adaptive capacity

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Contemporary social theories such as Ronald Ingelhart's theory of value change and culture shift in advanced societies or the theory of reflexive modernization by Ulrich Beck, Anthony Giddens and Scott Lash assert that modern societies go through profound structural transformations. Such transformations induce new constellations of challenges, problems, risks and conflicts because major changes in society and politics are shifting from established manners, customs and generally accepted modes of behavior to new norms and values. Issues of transformation arise from the complex, multilayered, ambiguous and open nature of societal and political change. This may concern all levels and spheres of political activities and comes along with institutional change that is unavoidably a value-laden, disputed and context-dependent process, which mostly produces unanticipated outcomes. Current transformations are often associated with examples such as the political change in terms of statehood, deregulations through liberalization, the balancing of the complex interplay between societal and economic demands, ecological integrity and resource security in terms of natural resources, energy transitions, the trade-offs between

individual data collection, provision of collective security and fundamental democratic and civil rights, or the change of expert institutions in political advisory services between scientification and democratization. A broad range of norms, values, attitudes, and behaviors unveiled by individuals and groups have become increasingly crucial for transformations in all sectors and at all organizational levels and result in demands for more inclusion and participation, network-based organizational forms and new de-centralized modes of politics which rely on the conceptual ideas of governance.

Research on contemporary governance systems reveals that governmentally driven and hierarchically enforced policies and regulations, i.e. the authority by government is increasingly repelled by new forms of governance that is characterized by a new interplay and collaboration between the state, science, economy, civil society, and the public. A key feature of the new interplay is the emergence of horizontal forms of cooperative and coordinated interaction that take place at multiple levels. Here, state actors are one actor group among others and do not possess anymore the prerogative of developing and setting regulations unilaterally; the government adapts to a new role as co-policy maker and ensures the basic institutional conditions. These new horizontal modes of governance are increasingly employed because they are deemed to be more efficient, respond to the shortcomings of the command-and-control approach, and involve the society in designing political regulations. However, recent studies on the state-of-the-art of governance research concludes that new forms of governance have become increasingly important for the production of collective goods, but their effectiveness and efficiency seems to be limited. Furthermore, governance research has widely studied new governance forms and mechanisms as reaction to transformation and to a lesser extent as authority over transformative and structuring power. The existing literature does not explore sufficiently the ways how governance can set up mechanisms and capacities to handle transformation issues. Hence the following questions can be raised: What kind of governance can be shaped that has adequate power to cope with transformation issues? What kind of public and private capacities and capabilities are indispensable for the handling of challenges, problems, risks and conflicts of transformation? How would a new governance system look alike that is pragmatic and feasible? Can state capacity, stakeholder and public

participation and deliberation, and the involvement of expert organizations reinforce each other in order to achieve a socially and publicly acceptable problem solving capability in terms of transformation issues? How can institutions of a new governance system sustain the rule of law?

We argue that the challenges, problems, risks and conflicts arising from transformations and corresponding institutional change could be steered and handled via a concept of dynamic governance. The conceptualization of dynamic governance relies on three core capacities and mechanisms in terms of inclusiveness, reflexivity and adaptability. Methodologically speaking, the article establishes a causal link between transformation issues and key governance capacities. We conceptualize a normative-prescriptive perspective that key governance capacities can produce dynamic structures and processes of institutional problem solving capability to handle issues of transformation and thus serve as dependent variable. The paper links theory and practice as well as normative conceptualization and institutional feasibility.

For this purpose, we firstly review and reconstruct major concerns that have been only insufficiently studied. First, the scholarly literature does not adequately theorizes institutional reflexivity, flexibility and adaptability in terms of transformation with regard to distinctions between change, stability and continuity. Second, we do not sufficiently know about causes and mechanisms interacting to produce institutional variation and alteration. Third, we do not know enough about institutional processes of reconfiguration and rescaling of public policy, especially with regard to causes and consequences of the transformative and structuring power. Fourth, we have little knowledge and experience of how to align institutional change with political and public support for the necessary development of dynamic governance. We reflect these issues from different perspectives of new institutionalism which emphasize flexible and responsive processes of institutional change and the need for sustainable institutional reform.

Rational choice institutionalism relies on instrumental rationality and on micro-level explanations assuming the rationality of actors so that actors' decisions accommodate the consequences of action. Institutions are thus

seen as stable structures of balance due to fixed rationalist preferences of the actors. Historical institutionalism is based on the logic of the path de-dependency which focuses on macro-level explanations of organizational and institutional configurations as established patterns of self-reinforcing historical paths. And sociological institutionalism refers to the logic of appropriateness and sees institutions as socio-culturally constituted norms. These basic assumptions underlying the “older” new institutionalisms represent a more equilibrium-focused and static view that is undermined by the “new” discursive institutionalism with a more dynamic take on change and discourse as explanatory variables.

Discursive institutionalism with the logic of discursiveness relies on the explanatory power of ideas, discourse and deliberation producing institutional problem solving capacity. Similar approaches have been denoted as constructivist institutionalism, strategic institutionalism or ideational institutionalism. The “older” three approaches of rational choice, historical and sociological institutionalism rather neglect the explanatory power of discourse and how to convey ideas of how to handle change. Discursive institutionalism is increasingly gaining ground in governance research. It underscores the thesis that new governance institutions can frame interaction, communication and mechanisms of coordination between political and societal actors as reflexive processes developing and fostering substantive content on how to overcome obstacles and to solve problems. Discursive institutionalism is a dynamic and functional approach that can shed light on particular aspects of inclusive, reflexive and adaptive settings in institutional contexts that provide structures and mechanisms for handlings issues of transformation.

We attempt to glean how the institutional and procedural incapability of current public policy courses and mechanisms can be overcome in the face of challenges, problems, risks and conflicts of transition and transformation. We assume here a dynamic governance perspective in a multilevel system. In so doing, we try to conceptualize a framework for a dynamic configuration consisting of a complex governance regime coordinating multiple levels. It is characterized by active, flexible and extensible structures and functions of authority over transformative power at multiple levels that rely on three major performative capacities.

- *Inclusive capacity* refers to new or revised institutional and procedural structures and mechanisms that enable a coordinative and effective interplay and collaboration of vertical and horizontal configurations and interactions of public and private actors in a multi-tiered system.
- *Reflexive capacity* alludes to a mechanism of reflexivity in order to support an intricate process of discourse, deliberation and evaluation. The actors' perceptions of and reactions to transformation issues affect the situations and contexts they are observing as well as the behavior of actors. Distinctively discursive and deliberative pragmatic learning processes at the policy-science-public interface convey a process of self-reflection, self-interrogation and self-assessment. State, civil-society and economic actors collectively scrutinize and evaluate the ability of the public sphere to accept the outcomes of transformation processes and to tolerate the responsive actions in terms of change and acting under insecurity. The aggregation of discourses through deliberative and participatory processes promises to provide ways and means to advance the very meaning of the challenges, problems, risks and conflicts and shed light on potential problem solving. Different forms and procedures of deliberation and participation can provide platforms where competing arguments and interpretations are exchanged as well as beliefs and values are openly discussed. The opportunity to resolve conflicting cognitive, evaluative and normative expectations lies in the process of identifying reliable consensual cognitive knowledge. Moreover, it would be important to discuss and define collective values, norms and rules that are ethically acceptable and regarded as fair and socially just, when common resources and institutional means need to be activated for achieving common good oriented solutions. In this deliberative and participatory framing, state, economy and civil society actors would be involved to fathom the adequacy, applicability and responsiveness of policy solutions that are deemed socially and publicly acceptable.

- *Adaptive capacity* relates to a systematic approach to organizational and policy learning via institutional structures and mechanisms that are conducive to resolving cognitive, evaluative and normative problems and conflicts. It is about a dynamic process of continuous and gradual learning and adjustment that involves all relevant actors, in particular government, corporate sector, science, and civil society. In practical terms, it is the ability to design or rescale institutional arrangements, mechanisms and processes by which public policy and society can collectively handle the challenges, problems, risks and conflicts arising in times of transition and structural transformation. It requires learning from pros and cons of previous and/or similar path dependencies, rationalizations and pertinence in order to cope with current problems and conflicts and apply these lessons to address newly emerging issues and challenges.

Finally, we will draw conclusions and implications of how this new institutional architecture of dynamic governance with capacities and capabilities in terms of inclusiveness, reflexivity and adaptability can contribute to a new authority over transformative and structuring power and thus to change the existing course of public policy making in the energy sector and how a new governance regime could be shaped that is essentially different in the design and constitutionalization than the traditional organizations and institutions that govern and control the energy system.

RISK GOVERNANCE IN ASSOCIATION WITH DEVELOPMENT OF UNCONVENTIONAL NATURAL GAS RESOURCES: ROLE OF PUBLIC INTERACTION FOR SUSTAINABLE DEVELOPMENT

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Type of presentation	Oral
Session:	***Coping With Risk and Uncertainties***

The International Risk and Governance Council has explored models of risk governance, including regulatory oversight, industry practices and public interaction in association with the management of risks that are inherent in the development of natural gas resources from unconventional reservoirs. Because of the variability within and between countries in political cultures, the assignment and administration of property rights and revenue, and the degree of trust by the public in regulators, science, industry and environmental organizations, there is no single regulatory model that can function comprehensively in all political jurisdictions.

Like all forms of energy production, unconventional gas production is associated with risks as well as benefits. The development of natural gas

from “shales” and other unconventional reservoirs utilizes advanced drilling and completion technologies that are now being deployed on very large scales. While the application of these technologies has allowed access to gas resources that were previously unable to be recovered, the production of gas using these techniques carries additional implicit risks. The magnitude of these risks may vary considerably based on the specifics of the particular development. Risks may be related to inadequacies in technologies or procedures or may be based on the problems with the implementation of appropriate techniques. The more localized and technology specific risks are coupled with water contamination, induced seismic activity, and methane emissions. Methane emissions can increase the overall risk of climate change due to their increased potency relative to other fossil fuels. Other risks are more areally extensive and often found with large scale industrial development including land and nature impacts, nuisance risks (e.g., truck noise, air pollution), wastewater management and community changes associated with development in previously nonindustrial areas.

Comprehensive and effective regulatory systems are required in order to ensure that the risks of unconventional gas production are managed in a responsible manner that benefits the maximum number of different stakeholders. If regulatory systems are inadequate, then irresponsible behavior by developers can damage the environment, impact the health of humans and ecosystems, and inhibit effective and sustainable development. On the other hand, overly restrictive regulatory systems could lead to inefficient and prohibitive business conditions, again resulting in unsustainable development. A crucial component of these evolving regulatory systems is the participation of local stakeholders in the process and the incorporation of their interests, especially those communities of stakeholders that are directly affected by development, into the governance of associated risks. Local communities may vary considerably in their receptivity to the rapid economic changes – as well as environmental risks -- associated with intensive unconventional gas production. Their overall agreement will ascertain the societal legitimacy that is required for the establishment of a political legitimacy for unconventional gas development. Vice-versa, their opposition will undermine most industry or policy plans.

Alternative governance models for managing risks associated with unconventional gas development must be based on scientific and technical

information, take into consideration the economic benefits of development, the global climate impact, and concerns of the effected communities.

Specifically, models include types of public and local community participation that can inform public-acceptance decisions. Collaborative decision-making has been found to be critical for effective interaction between those stakeholders implementing the development and local communities affected by the consequences of the development. A combination of stakeholder's interests with regulatory oversight and industry best practices will result in a more effective governance of development.

ROBUST-DECISION MAKING AND THE RESILIENCE APPROACH AS TOOLS TO DEAL WITH DEEP UNCERTAINTIES IN ENERGY PLANNING

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Type of presentation	Oral
Session:	***Coping With Risk and Uncertainty***
Scope:	dealing with uncertainties, energy transition, design principles
Keywords:	energy system, resilience, robust decision making

Background & Context

The European energy system is expected to be transformed into a low-carbon energy system during the next decades. In particular, the electricity supply shall be based almost completely on renewable energies and the total consumption of energy shall be reduced significantly. This means that the energy system will almost surely look completely different in 40 years. This time scale is shorter than the lifetime of a large part of the infrastructure. Therefore the planning of long-living energy infrastructure faces deep uncertainties about both the technological and the socio-economic setup of the future energy system, which have to be taken into account in one way or another during the planning processes.

These uncertainties are characterized by the fact that it is impossible to estimate either the impacts of different possible developments or their probabilities. Hence, a traditional risk analysis where the risk of a development is the product of its probability and its impact cannot be carried out (cf. Stirling 2003). A common answer to this is the consideration of a set of scenarios, either covering the most plausible developments in an explorative way or describing possible pathways to reach a normative goal (see e.g. Börjeson et al 2006). Still the question remains how to

choose an adequate set of scenarios and how to weigh the outcomes of different scenarios. Furthermore, rare extreme events are typically not covcovered in the consideration of scenarios. In our contribution, we will consider two rather different approaches to this issue, namely robust-decision making and the resilience approach.

Content & Findings

Robust decision making (RDM) was introduced by Lempert et al (2003) in the context of climate change mitigation policies. The key principle of RDM is to trade-off optimality / efficiency of planning strategies for robustness, i.e. for a good performance throughout a large variety of scenarios. These scenarios are meant to represent the whole spectrum of the main uncertainties. Therefore RDM is very complex and thus difficult to apply. It has been applied in the context of infrastructure planning and adaptation to climate change, in particular to water management (Dessai and Hulme 2007). We are not aware of an application to the planning of energy infrastructure though.

The resilience approach focuses on system structures that help to adapt to changing conditions and disruptions. It was originally based on the analysis of ecosystems by Holling (1973) and applied to energy systems by Kahn (1978) as well as Lovins and Lovins (1981). Gleich et al (2010) have suggested to use resilience as a guiding concept for directing system design towards systems that are able to maintain their services in case of turbulent conditions and surprising events. To this end, they suggest to define certain abstract design principles for resilient systems, e.g. the integration of buffers, redundancy, and diversity. An important question in this context is which of the structures to combine and how.

In most applications of planning of energy infrastructure, the uncertainties are too manifold to be addressed by robust decision making. Thus there is need for heuristics that help to identify robust strategies for the planning of energy infrastructure. Two main uncertainties about the design of future energy system concern the penetration of decentralized supply structures, as well as the extent of interoperability of the electricity and gas grids. In

our contribution, we explore how to apply RDM to these two issues in an idealized example. To do so we present a corresponding toy model and a methodology to evaluate the model in order to identify design principles that might be generalized to more complex applications. Such principles can help to concretize resilience as a guiding concept for decision making.

Conclusion

We conclude that RDM and the resilience approach may benefit from each other. On the one hand, the resilience approach helps to identify initial candidates for robust strategies. On the other hand, RDM can be used to identify the most useful combinations of resilient design principles. The final goal is to find resilient design principles for the planning of energy infrastructure that lead to robust decisions, even when the use of the full machinery of RDM is not possible because of its complexity.

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ABSTRACT – ORAL PRESENTATION

THURSDAY, OCTOBER 10TH 2013

THE FORMULATION OF SUSTAINABILITY CRITERIA ON BIOFUELS PRODUCTION AND SUPPLY IN CHINA?

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Type of presentation	Oral
Session:	***Assessing and Monitoring Sustainability of Energy Futures***

China determines to take an energy transition from the fossil fuel dominated energy structure towards a cleaner and more sustainable one, as it was declared and set as a national strategy in the 11th Five Year Plan (2005) and subsequent documents. The renewable energies, including biofuels and other kinds of bioenergy, play an important role in realizing the transition, although their proportion is still trivial compared to the conventional ones. In fact, Chinese government has already initiated a number of pilot projects and promulgated a series of regulatory documents to set rules and guidances for the development of fledging biofuel industry. In the 12th Five Year Plan for Renewable Energy, the government claims that the annual production of fuel ethanol (bioethanol) and biodiesel has reached 1.8 million tons and 0.5 million tons.

In view of such an emerging business, the paper is to address the question of if there are any sustainability standards or criteria on biofuels developed in the law of China. With the mounting research and evidence, the negative impact of biofuels on environment, land use and social well-being has been argued and put on table, which obliges policy-makers to impose sustainability requirements, such as the sustainability scheme implemented in the EU. Thus, the purpose of the paper is to find the sustainability requirements or even criteria, in environmental, social and economic dimensions, imposed on biofuels production and supply. In this regard, two points need to be stated. Considering the characteristic of China's legal

and political system, the official documents entitled as ‘plan’ or ‘guideline’ are of great relevance and importance, although they may have no normative and binding effects. In this sense, the sustainability requirements stated in these documents should be treated seriously and taken into account. Secondly, the sustainability standards or criteria do not need to take the shape of framework legislation or explicitly stated as those in the EU Renewable Energy Directive. Thus, the requirements that are scattered various laws (such as the law on environment or land use) but may have effects on biofuels should also be taken in view.

The finding of the research – whether there are sustainability standards or criteria that have been or are being developed – could be meaningful for the biofuel investors to predict and understand related Chinese policy and law.

TRANSITIONS IN BIOFUEL SYSTEMS AND THE QUEST FOR SOCIAL SUSTAINABILITY: RESULTS OF A DELPHI STUDY

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Type of presentation	Oral
Session:	***Assessing and Monitoring Sustainability of Energy Futures***
Keywords:	biofuels, socio-technical transition, Delphi, social impacts

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In socio-technical transitions, technological change brought about by the introduction of new

features or modifications in a given technical system can engender changes at the social level, influencing the way in which people relate with and perceive technology and how technology directly and indirectly affects people's life. In this paper, ethanol used as a biofuel is taken as a case-study to identify potential social impacts of an intended transition between first and secondgeneration technologies through an expert consultation using the Delphi method. Experts are asked to indicate and analyse main issues that are likely to play a part in the social sustainability of second-generation ethanol, also called cellulosic ethanol, in the future. For that, the study builds on previous research in which a social matrix for the impact assessment of ethanol was designed, and adopts a lifecycle approach where two different technological pathways are compared, highlighting implicated actors. Following the rationale of social impact assessment scholarship, it gives emphasis to the analysis of the experience of social change in poorer regions and to how ethanol transition could foster (or hinder) positive social outcomes for more vulnerable groups. Impacts are

assessed as regards their probability of occurrence, level of reversibility and contribution to wellbeing improvement and poverty reduction, among other criteria. The research aims at informing decision-makers, impact assessment practitioners and the academic community on the possible scenarios, in terms of social trade-offs, that could arise when cellulosic ethanol is commercially available worldwide. While mitigation of major social threats such as food insecurity may be regarded as an advantage due to the use of non-edible crops as feedstock in the production of cellulosic ethanol, other potential benefits of a transition between ethanol generations are less clear. Among others, farmers' adaptation and access to new technologies, shifts in the demand for skilled and unskilled workers, and water security are examples of issues that deserve more attention from the academia and governments.

GETTING A FAIR BALANCE:

CRITERIA AND APPROACHES TO BETTER DISTRIBUTE COSTS AND BENEFITS OF ELECTRICITY SYSTEM RESTRUCTURING

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Type of presentation	Oral
Session:	***Assessing and Monitoring Sustainability of Energy Futures***

The paper aims at developing a more balanced and constructive framing of the challenges posed by a fair energy transition policy. Undoubtedly, negative distributional effects have to be recognised, ana-lysed and counteracted. Nonetheless underplaying the positive ones not only narrows the perspec-tive on the costs of the energy transition policy, but seriously limits the scope of political action to extend its benefits to vulnerable households.

The paper purports that the energy system transformation can only be labelled as socially balanced if it mitigates its costs by increasing the general chances to have a share in its benefits. Energy efficien-cy will be considered the core of a fair balanced transition policy - as energy bills are not only a func-tion of prices, but of both price and the amount of energy used. Reducing consumption and prioritis-ing efficiency measures for consumers who cannot tap the saving potentials out of their own will meet the challenge of energy transition and climate protection on the one side as well as that of mit-igating “fuel poverty” on the other.

In a subsequent step, the paper will test the appropriateness of approaches and instruments, which are prominent in the - partly very separate - discourses on the affordability of energy costs, against the benchmark of the concept of a socially balanced policy of energy transition. The problem of the “financial overload of low income households” (as the term “fuel pov-

erty" so far is not defined for the German context) will be considered as caused by a combination of low income, energy inefficien-cy and prices. According to this problem definition, the paper structures the approaches which are proposes in the discourses and clusters them as price-based, income-based and efficiency based in-struments.

The conclusions will recommend a set of measures for a socially balanced policy of energy transition on the one hand and how to link separate dis-courses in order to activate adequate alliances to pro-mote such measures politically on the other.

INTEGRATIVE SUSTAINABILITY INDICATORS FOR MONITORING THE GERMAN ENERGY TRANSITION ("ENERGIEWENDE")

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Type of presentation Oral

Session: ***Assessing and Monitoring Sustainability of Energy Futures***

The energy system, involving the entire chain of energy production, distribution, storage, usage and disposal, and according technologies, products and infrastructures, is of highest, but ambivalent importance to realize sustainable development. On the one hand, the timely availability of energy, or energy services, is a fundamental precondition for every daily life activities, for production processes, and thus for societal development in general. On the other hand, the running of this system is associated with various such as environmental damages, human health problems, depletion of scarce resources, climate change, or the fact that many people worldwide can´t afford or do not have access to modern forms of energy.. Addressing these and further critical issues simultaneously, requires a fundamental transformation of the energy system. The transformation in Germany, basically by substituting fossil fuels and nuclear power by renewables on the supply side (known as the 'Energiewende') until 2050, requires substantial progress and innovation in energy research and energy policy making as this transformation is not a mere technical, but far more a societal challenge. In this dynamic context, sustainability monitoring is important to provide a basis for defining the sustainability-related goal orientation for the trans-

formation, to assess progress, to identify existing or expectable conflicts between sustainability targets or stakeholder groups and to measure societal satisfaction with the transition process. Recent discussions about energy affordability or poverty resulting from increasing renewable energy costs demonstrate that the apparently broad societal acceptance of the "Energiewende" can crumble if decision-makers are not aware early enough of possible target conflicts and controversies about target weighting and particularly if they do not counteract in time.

Within the Helmholtz Alliance ENERGY-TRANS, a comprehensive tool for sustainability analysis and assessment will be elaborated. A set of indicators and according target values is developed both to assess states or development paths for the German energy system transformation and to support the development of proposals for designing effective, efficient and societally acceptable transformation strategies towards a more sustainable energy future. In this presentation, the selected sustainability indicators, some methodological reflections, and a critical view on first findings about sustainability-related conflicts of goals and interests will be outlined. The presented set of criteria goes beyond those which are already applied by the German government and other (international) institutions in different respects. While these sets predominantly refer to technical, environmental and economic aspects and to quantitative ("objective") data, this tool provides an integrative approach, including highly relevant criteria, such as fairness and distributive issues, security of livelihood, societal self-organization, landscape and cultural aspects, the degree of societal engagement in transition processes (e.g. participation in local co-operatives or private investments in renewable energy plants), or the degree of "subjective" societal satisfaction with the opportunities of participation in planning and decision processes.

SOCIO-TECHNICAL SCENARIOS IN THE CONTEXT OF THE GERMAN ENERGY TRANSITION: POTENTIALS – LIMITATIONS – PERSPECTIVES

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Session:	***Socio-Technical Scenarios in Energy Transitions: Practical and Theoretical Perspectives***

The transformation of complex and dynamic socio-technical systems, such as energy infrastructures goes along with a high degree of uncertainty and incomplete knowledge. This complexity arises because the transition of an energy system is not only a technical process but goes along and interacts with changes in various non-technical factors, such as (new) regulatory regimes, (new) institutions, changes in societal preferences and individual lifestyles. If the transformation additionally aims at meeting sustainability goals in a comprehensive, integrative way, complexity increases even more.

In the last decades, scenarios have become a prominent tool to support decision making in such complex transformation processes. Also for the German energy transition, numerous scenarios have been produced over

the last years. They differ in several respects, such as the assumptions made, the selected thematic or regional focus, or the general methodology applied. This variety reflects well that the term scenario is covering a broad range of different approaches that do all have their specific advantages and disadvantages.

Against this background, this presentation has two objectives: In a first part, it will highlight from a theoretical and conceptual perspective the potentials and limitations of different scenario methods for supporting the German energy transition. It will be argued that the existing scenarios are strongly focusing on technical and economic parameters. But the analysis and governance of energy system transition processes needs to take into account in a more comprehensively way societal and institutional actors and dynamics between the actors as well – in particular if the temporal perspective is 2050. Based on that reflection, in its second part, the presentation will describe scenarios which explicitly take into account such societal dynamics. These scenarios were produced within the Helmholtz-Alliance ENERGY-TRANS, a research initiative mainly characterized by applying a stronger demand-side perspective on the German energy transition. It will be outlined and discussed how these scenarios were developed, how this approach corresponds to the theoretical and conceptual reflections about scenarios, and which will be the next steps in applying these scenarios within the Alliance.

CONTEXT SCENARIOS - A CONCEPT FOR IMPROVING THE ACCOUNT OF SOCIETAL UNCERTAINTIES IN ENERGY SCENARIOS AND ITS APPLICATION IN ENERGY-TRANS

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Type of presentation	Oral and posters
Session:	***Socio-technical Scenarios in Energy-Transition: Practical and Theoretical Perspectives***
Scope:	Improving the consideration of societal/political context uncertainty and complexity in energy scenarios

Keywords: Energy scenarios, societal context scenarios, hybrid scenarios, socio-technical systems, Cross-Impact Balance Analysis (CIB)

Background & Context

Energy scenarios are a widespread approach to explore possible energy futures, to analyze the consequences of policy measures and to describe pathways to desired future states of the energy system. Their guidance is of special importance when strong changes in the energy system are to be expected, as is the case in the outlined course of the German "Energiewende".

In the past the usual focus of energy scenario analysis was on the technical and economical aspects of the energy system. Recently more and more energy systems analysts as well as social scientists became increasingly conscious of the eminent role of the societal context developments embedding the energy system development. Therefore, the conventional approach to represent the societal future merely as a fixed set of framework assumptions of the energy system is more and more considered to be insufficient to address the crucial uncertainty and the rich complexity of societal context conditions and their interaction with the future development of the energy system.

In the research alliance ENERGY-TRANS, a group of energy modelers, scenario analysts and social scientists, following the alliance's central theme of understanding energy systems as socio-technical systems, took up this concern. They decided to apply the concept of "context scenarios" in their scenario projects [1]. Following this concept, model based energy scenario analysis is proceeded by the development of societal scenarios employing cross-impact balance analysis (CIB, [2]) as a method for constructing qualitative scenarios. The resulting societal scenarios are used to inform energy modeling and energy scenario construction about alternative societal futures and - as a consequence - alternative framework conditions for the development of the energy system.

Content & Findings

Three ENERGY-TRANS projects are currently applying this concept:

A) The goal of the project “Technology-Infrastructure Transitions: Potentials of Technologies and Concepts” is to provide characteristic information (e.g. future efficiencies, future costs) on key technologies in the energy sector as a data base to energy scenario construction. However, technology development is subject to societal influences, for instance social technology preferences, availability of educated human resources and financial resources, and energy concepts may be successful in one societal future and necessarily fail in another. This motivated the project team to construct a set of general context scenarios sketching basal international and national developments [3] and also a set of sectoral context scenarios of the special issue of domestic heat consumption technologies. Two multi-level context scenarios including global, national and sectoral factors (in total approx. 50 factors) were used to inform a building simulation model and the energetic effects were calculated [4]. The context scenarios will be used in the next step of the project for developing specific technology pathways of selected industrial technologies consistently addressing the possible variance of societal futures as indicated by the project’s context scenarios.

B) The main objective of the project "Integrated Scenario Building" is the development of advanced scenarios for the transformation of the energy system, under consideration of infrastructure needs on the one hand and social developments that affect the necessary technological implementations on the other hand. To this end, the project will develop societal scenarios comprising fundamental international, European and German drivers of societal development, thus formulating alternative futures representing significantly different context settings for the “Energiewende”. The scenarios will be used to discuss the specific impacts of the alternative futures on the transformation pathway and the prospects of success of the intended transformation. As a proof of concept, a “demonstrator” was developed [1] which illustrates the interplay of (qualitative) societal and (model based) energy scenarios and prepares the implementation of the concept of context scenarios into the current scenario development process of the project.

Currently (August 2013) a series of expert interviews about the selection of the context factors of the project's main context scenario analysis are conducted.

C) The project "Regional Modelling" analyses the possible patterns of the "Energiewende" on a regional level. One urban and one rural region of Germany were selected for an in-depth study of the transformation including the induced changes in energy supply, mobility structures, economic structures and environmental qualities. Just as on the national level analysed by the project "Integrated Scenario Building", the energy transformation pathways on the regional level will depend on the societal developments embedding them, and the project "Regional Modelling" decided to develop societal scenarios consistent with the national and international scenarios of the other projects, but deepening them by societal developments on the regional level. Currently, the scenario exercise of the project is constructing the context scenarios describing the region of South Thuringia. The next steps will be to construct context scenarios also for the second exemplary region of the project (Berlin) and to analyse the implications of the context scenarios using energy, mobility and input-output models.

Conclusions

Whereas all projects follow the same blueprint in their application of the context scenario concept, there are also specific differences between the projects which make a separate context scenario exercise in each project necessary. On the one hand, there are common issues for all projects which should be object to harmonization (e.g. variants of oil price assumptions, variants of national GDP assumptions). On the other hand each project has specific topics which are not shared in the same extent by the other projects (e.g. R&D-activities, local vs. national demographic development). The final step will be to integrate the project's context scenario sets into one set of overarching context scenarios.

The outlined programme will demand a well balanced mixture of coordination and specialisation from three project teams sharing the same vision of an improved energy systems analysis. At the same time, this cooperation

offers a momentum of integration between the widespread research activities and scientific disciplines in the ENERGY-TRANS alliance.

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ENVISIONING AND MATERIALISING ENERGY TRANSITIONS: A COMPARISON OF PUBLIC AND POLICY SYSTEM SCENARIOS

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Type of presentation	Oral
Session:	***Socio-Technical Scenarios in Energy Transitions: Practical and Theoretical Perspectives***

Scenarios have become increasingly important in energy system transition discourse, policy and research. In recent years multiple groups, organisations and institutions have created and documented scenarios, ranging from specified scenario visions to open access tools that offer a basis for the creation of scenarios (e.g. see United Kingdom Energy Research Centre, UKERC, 2011; World Wildlife Fund, WWF, 2011; Department of Energy and Climate Change, DECC, My2050 Calculator; Shell, 2011). Though scenarios have long been utilised in energy system planning, recent developments are characterised by their uptake in the redesign of systems for decarbonisation and greater socio-environmental sustainability. In this regard, much of the existing scenario work has been undertaken through expert modelling or through stakeholder engagement processes, meaning that energy system visions are principally derived from these actor's perspectives. Although wider publics are deeply implicated in multiple aspects of the ways that energy systems are configured (e.g. as producers of energy, as citizens with voting powers, as active protesters or proponents of energy infrastructures), their visions of system transitions are not well documented or understood. Much of the research examining public perspectives on energy system transitions has focused on particular aspects (such as nuclear energy or energy consumption), rather than the system as a whole. In this paper, we seek to bring "public scenarios" into view by pre-

senting findings from an innovative UK based study of public perspectives on whole energy system change, including social, technical and economic aspects. This research involved members of the UK public in creating their own future energy system scenarios using a scenario-building tool. The findings presented in this paper are based on two phases of research: 1) deliberative workshops undertaken with six groups of people (participant n total = 68) across the UK (England, Scotland and Wales); 2) an innovative survey undertaken with a representative sample of the UK public (participant n total = 2441). Through the research analysis we have been able to create a generalised picture of UK public(s) scenarios and the values, criteria and conditions to which these scenarios relate. For this presentation we will explicate these public scenarios and compare and contrast them with existing policy and expert scenarios. The analysis will show where the visions meet and diverge and examine the possible implications for the materialisation of envisioned transitions in the UK context.

DESIGNING BACKCASTING SCENARIOS OF REGIONAL SOCIO-ENERGY SYSTEMS FOR DISASTER-RESILIENT COMMUNITIES

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Type of presentation:	Oral
Session:	***Socio-technical Scenarios in Energy Transitions: Practical and Theoretical Perspectives***
Scope:	Concepts, scenarios or modeling approaches with an integrative perspective on energy transitions
Keywords:	Socio-energy system, Backcasting scenario, Resilience, Community, Fault tree analysis

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1. Introduction

Much effort has been devoted to exploration of a desirable transition of energy systems in existing studies (e.g., [1][2]). The aftermath of the 2011 Great East Japan Earthquake has provided humanity with an opportunity to discuss energy systems, with an emphasis on resilience in the local community. In

Japan, post-Fukushima energy policies are thus being discussed during which several scenarios of nuclear power reduction were presented [3]. From the viewpoint of transforming electricity supply systems, one possible solution might be to develop "microgrids," which enables electricity distribution within the local area by means of distributed energy sources, such as solar panels, storages, and combined heat and power system [4]. However, it is still a challenge to describe holistic future visions and possible transitions of energy systems that would enhance resilience of the local community and, more broadly, the local socio-energy system.A socio-energy system in this paper refers to a system that combines the infrastructure of energy supply to humanity and the socio-ecological components of energy usage, thereby emphasizing a symbiotic relationship between humanity, which heavily depends upon functions and services associated with energy usage, and the surrounding environment (see Fig. 1). Difficulties in designing future socio-energy systems stem from the follow factors that might affect socio-energy systems in the future. These factors include, as depicted in Fig. 1, technological advancement, consumers' lifestyles, institutional design, and economic situations. To overcome these problems, we take a backcasting scenario approach in which multiple stakeholders share various ideas and information and then try to create shared visions. For supporting envisioning resilient socio-energy systems in a systematic manner, we develop a method for designing backcasting scenarios based on fault tree analysis (FTA) [5]. FTA is a deductive approach to determining causes of undesired event (e.g., failure of mechanical elements) using a backward-stepping process [5]. Our method is then ing two problems. One is that desirable visions or social needs on socio-energy systems vary critically with stakeholders, targeted regions, and time

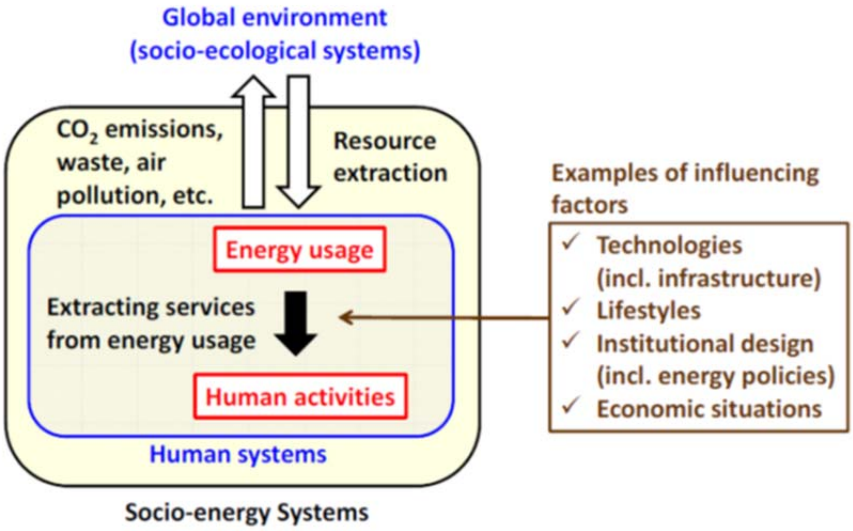

Fig 1 Schematic diagram of socio-energy systems

frame of interest. The other is that there are a large number of unpredictble applied to a case study regarding describing scenarios for resilient socio-energy systems in a Japanese community. Three workshops were organized to write scenarios focusing on socio-energy systems and resilience of Suita City, Osaka, Japan in the following two steps – (i) scenarios of socio-energy systems that lead to bankruptcy of the community and (ii) scenarios of socioenergy systems for a resilient community to avert the bankruptcy described in Step (i). The rest of this paper is structured as follows. Section 2 outlines the concept of backcasting scenarios and energy resilience. Section 3 mentions a method for designing backcasting scenarios based on the idea of FTA. For testing the effectiveness of the proposed method, a case study is illustrated in Section 4. Finally, Section 5 concludes the paper.

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2. Design of Socio-energy Systems and Resilience

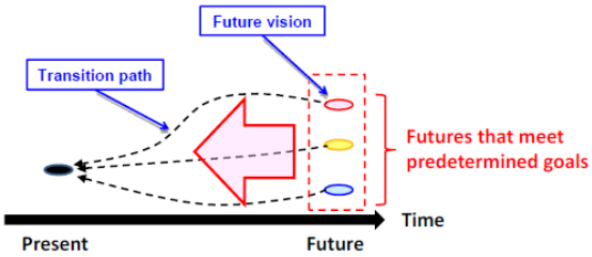

Fig 2 Basic concept of backcasting scenarios

2.1. Backcasting Approach for Describing Energy Futures

A variety of backcasting energy scenarios have been presented by many research institutes across the world. They often aim to drastically reduce CO2 emissions by leveraging various energy technologies, such as nuclear and renewables (e.g., [6]-[8]). As illustrated in Fig. 2, backcasting is a normative approach, which attempts to explore how desirable future visions can be attained [9][10]. Then, transition paths are explored backward from a desirable future vision to the present. Backcasting is often applied to energy scenarios since it is suitable for describing futures that need a drastic change from the present [10].

2.2. Energy Resilience

Resilience, of which concept was originally introduced by Holling [11], is defined as the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks [12]. Toward constructing better energy systems against various risks (e.g., climate change and other natural disaster), there are several related studies regarding energy resilience. UKERC [13] advocates that a resilient energy system can speedily recover from shocks and can provide alternative means of satisfying energy service needs in the event of changed external circumstances. Afgan and Veziroglu [14] mention that energy resilience is the ability of an energy system to provide and maintain an acceptable level of service in the face of various challenges.

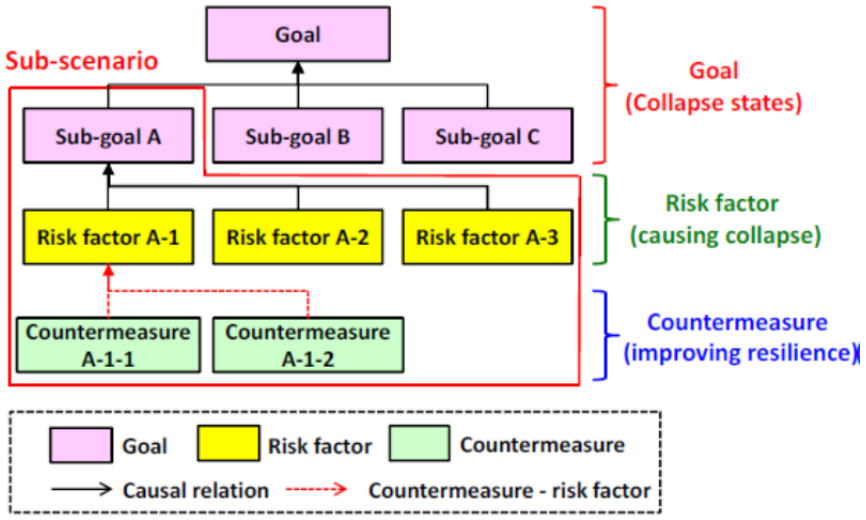

Fig 3 Generating structures of backcasting scenarios

However, there are a couple of difficulties when we apply the conventional concept of resilience in energy contexts. First, resilience can be described as a response to external systemic change [15], but crisis may often come from within the system, and accordingly, endogenous control is necessary in the system recovery. Related to this, second, as energy flow and stock requires large complex systems, it may be less reasonable to ascribe the crisis to a sole transient disruption. Energy as infrastructure can experience enduring shift that finally causes the crisis whereby the system recovery takes time. When current discussions on resilience mainly focus on making a system more resilient to avoid crisis, we redefine the concept of energy resilience in a socio-technical / socio-ecological system so as to include internal and long-term systemic change by focusing more on how to resume (transform or transit) the system at the post-crisis state. In what follows, to tackle with these difficulties, we take a backcasting scenario approach involving various stakeholders so that we can come up with various factors that might degrade or enhance energy resilience.

Item	Descriptions

Demographics	The population is 360,718 (2012). The number of the population will be stable from 2012-2030, while people at age of 65 or more will account for 28% in 2030, increased from 19% in 2008.
Area	36.11 km^2 (population density: 9,990/km^2)
Land use	Urban area: 63%, green space & school: 21%, railway & roads: 8%, others: 8%
Transportation	The railway network is well-developed as there are 14 stations within the city.
Industry	Small-sized companies with less than 10 employees account for 70% (7,496) of all (10,675) in 2006. Most employees (88%) are working in the tertiary industry (e.g., retail sector, service sector, medical sector, education, and restaurant).
Research institute	The city has four universities (including Osaka University) and National Museum of Ethnology.
Medical service	Advanced medical services can be provided by several hospitals, such as Osaka University Hospital and the National Cardiovascular Center.

Table 1 Regional characteristics of City [17][18]

4. An Approach to Designing Backcasting Scenarios for Resilient Socio-energy Systems

In this section, we propose a method for designing backcasting scenarios with a particular focus on resilient socio-energy systems. In order to clarify potential factors that influence the resilience of systems of interest, we integrate the concept of fault tree analysis (FTA) into the method that the authors proposed in the previous study [16]. Our method defines scenario-design processes consisting of the following four steps – (1) problem settings, (2) practicing brainstorming in order to list various factors related to future socio-energy systems, (3) determining whole scenario structure by

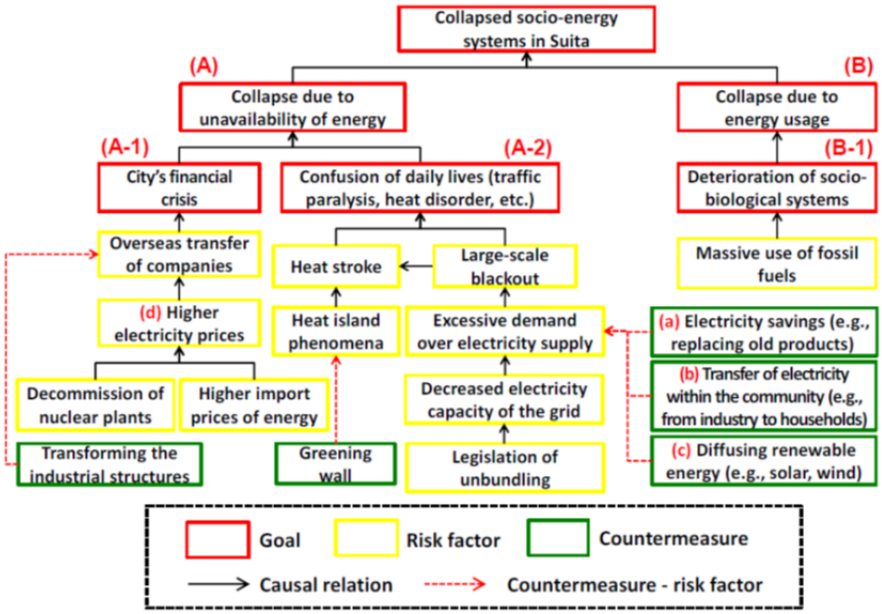

Fig 4 Extracting sub-scenarios using fault trees (not exhaustive)

describing plural storylines, and (4) describing subscenarios by detailing each storyline.

The basic idea of FTA is used to support Step (2) as described in Fig. 3. The procedure of executing Step (2) is as follows. First, we define undesired consequences as goals. Then, we specify external shocks as risk factors that would reduce sustainability of communities, and finally, we try to enhance their resilience by means of risk countermeasures. In Step (3), we identify sub-scenarios by extracting sub-trees beneath each sub-goal (see Fig. 3).

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4. Case Study: Scenarios of Collapsed Socio-energy Systems in Suita City

4.1. Overview

This section demonstrates a case study to show how the proposed method works. Through three workshops involving experts from several academic

Scenario	(A)Collapse due to unavailability of energy		(B)Collapse due to energy usage
	(A-1)City's financial crisis	(A-2)Confusion of citizens' daily lives	(B-1)Deterioration of socio-biological systems
Storyline	This scenario assumes energy will be unavailable for industry for economic reasons. A surge in energy prices and decommission of nuclear power plants result in higher electricity prices, thereby causing the industry to move outside the city. This poses increase in unemployment, financial crisis of the city, and lowering municipal services (e.g., water supply, sewage management, waste management).	The Japanese government legislates ownership unbundling of electricity generation, distribution, and retail operations. This accelerates the diffusion of distributed electricity generation, which makes rather the electricity grid fragile. As a result, largescale-blackout often occurs and hospital services become unavailable. This causes negative impacts on heat stroke patients, etc.	Strong Japanese Yen accelerates mass consumption of fossil fuels, worsening environmental pollution, including air and water pollution\.
Countermeasure	The city introduces policy packages to promote the diffusion of renewable energy with an aim to enhance robustness against energy price increase. At the same time, it makes effort to attract companies that are less dependent on energy (e.g., finance industry).	Electricity generators are installed in industry, hospitals, and offices. When natural disasters hit the city, the commercial and indu trial sectors send electricity to the residential sectors.	The city enacts a law to store eme gency food and water at every s permarket. In addition, it ties agreements on mutual help with other neighboring municipalities.

Table 2 Collapse scenarios and risk countermeasures (not exhaustive)

disciplines (including engineering, political science, public policy, global

system science, and hydrology), we aimed to describe scenarios of resilient socio-energy systems in Suita City in 2030. In this case study, we described several scenarios of "collapsed" socio-energy systems, after which we came up with possible countermeasures to improve resilience by avoiding the collapse or mitigating the damage. Steps (1)-(4) mentioned in Section 3 were applied in the workshops.

Regional characteristics of Suita City are summarized in Table 1. The population of the city in 2012 is 360,718 and the area is 36 km2. It will be faced with aging and the number of citizens at age of 65 or more will account for 28% in 2030, increased from 19% in 2008.

4.2.1. Collapse Scenarios in Suita City, Osaka, Japan

Fig. 4 shows part of the resulting scenario structure of collapsed socio-energy systems in Suita City. The top node means collapsed socio-energy systems in Suita City. The results reveal that there are two collapse patterns, i.e., (A) collapse due to unavailability of energy and (B) collapse due to energy usage. Based on this, we created three narrative scenarios (A-1), (A-2), and (B-1) as depicted in Table 2. Having a look at scenario (A-2), confusion of citizens' daily lives may be caused by large-scale blackout and/or heat stroke that would be accelerated by the heat island phenomena. As elderly people will be increased up to 2030, heat stroke would give more negative impacts on the city. Countermeasures that can be taken by Suita City against large-scale blackouts include (a) electricity savings as a proactive approach, (b) transferring electricity from industry, which often installs electricity generators, to households, and (c) diffusing renewable energy (see Fig. 4).

The participants of the workshop discussed perceptions that each of stakeholders (such as citizens, electricity distributers, politicians, local government, and industry) might have on the described scenarios of collapsed socio-energy systems. The consensus there was that largescale blackout is the largest risk factor and must be avoided. One promising adaptive measure in case blackout occurs is to send electricity generated in the industrial sector to households (countermeasure (b) in Fig. 4). This scheme

would be consistent with the industry's initiatives from the viewpoint of corporate social responsibility (CSR).

One of the remaining issues in this case study is less verification as to how transition paths to the described futures are realized. We thus need to attempt forward-thinking (i.e., thinking from the bottom to the top on Fig. 4) in order to draw paths to attain each of scenarios (A-1), (A-2), and (B-1). For example, if we take a countermeasure (c) to avoid large-scale blackout, another risk (d) might happen. This is because the feed-in-tariff (FIT) scheme is usually adopted to diffuse renewable energy, thereby resulting in increasing grid electricity prices.

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5. Summary and Outlook

We proposed a method for designing backcasting scenarios aiming to clarify resilient socioenergy systems in the local community. The method intends to support systematic scenario writing based on the idea of fault tree analysis (FTA). The results of the case study illustrated that, as shown in Fig. 4, we succeeded in clarifying causal relationships among collapse patterns, risk factors, and countermeasures, and as a result, creating three scenarios in Table 2. The scenario writing enabled to plan various types of measures for enhancing resilience of the community, and helped observe perception gaps among the participants of the workshop. Thus, our scenario-based method appears to be useful for fostering transdisciplinary research processes through co-creation of knowledge on socio-energy systems between science and society. Future issues include (1) describing transition paths of the scenarios as discussed in Section 4.2 and (2) co-designing and implementing the described scenarios in collaboration with the local government and citizens of Suita City.

Acknowledgements

This research is financially supported by Research Institute for Humanity and Nature (RIHN), Feasibility Study "Design and Integrated Assessment of Regional Anthropospheric Energy Systems" (PI: Dr. Yusuke Kishita). The authors would like to extend our sincere gratitude to Prof. Tetsu Sato,

Dr. Terukazu Kumazawa, Dr. Steven McGreevy, and Dr. Hisaaki Kato, all from RIHN, for their fruitful comments in a scenario workshop.

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DOES POLITICAL AND SOCIAL FEASIBILITY MATTER IN ENERGY SCENARIOS?

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Type of presentation:	Oral
Session:	***Socio-Technical Scenarios in Energy Transitions: Practical and Theoretical Perspective***
Scope:	Comparative analysis of four recent German energy scenarios regarding the consideration of political feasibility and social acceptance
Keywords:	Acceptance, Political sustainability, Scenario, Institutions

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Background & Context

Regardless of the fact that the targets of the German “Energiewende” are already enacted into law, there is no uniform concept on how to achieve these goals. Instead, a huge number of different actors are offering competing energy concepts and scenarios to the decision makers. There is a concern that these scenarios are guided by certain interests and neither take into account the social acceptance nor the political feasibility of the concepts. For this very reason, a comparative analysis of German energy scenarios has been carried out in order to identify scenarios which consider political feasibility as well as possible hurdles of social acceptance.

Content & Findings

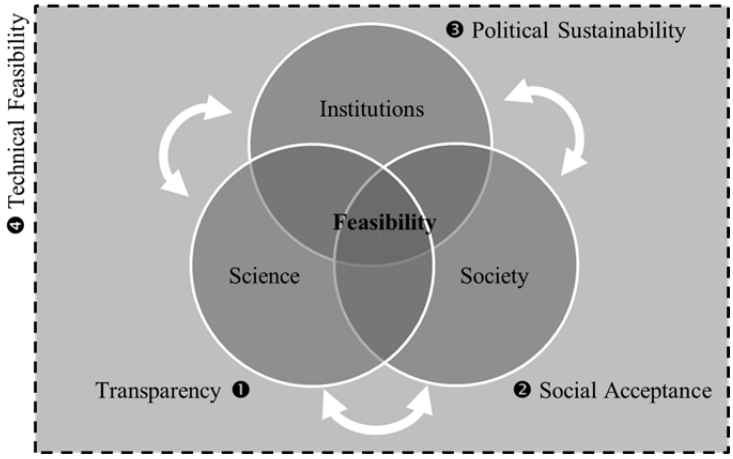
The analysis framework consists of three stages: transparency (❶) from a scientific perspective, acceptance (❷) by the society and political sustainability (❸) from an institutional point of view (see Figure 1).

The analysis of the transparency of the scenarios is intended to ensure that scenarios will not be refused by the scientific community. The evaluation methodology for transparency is based on a SWOT analysis performed by Kronenberg et al. (2011).

Social acceptance has become a crucial success factor for the German "Energiewende". Therefore, a multi criteria analysis of the implementation of social acceptance factors in energy scenarios is conducted. Within this analysis the term social acceptance is used at a societal level (in contrast to local acceptance). The acceptance criteria are derived and operationalized from a representative value tree analysis executed by Keeny et al. (1984). It is assumed that social acceptance can be achieved by balancing the targets of energy policy, and therefore a scenario has to consider acceptance factors for every target area.

Furthermore, legislative and political hurdles can hinder the implementation of a socially accepted energy system. This implies social acceptance is a necessary, but not a sufficient condition for a long-term feasible energy system in a democratic society. Notably, the last step of the analysis allows for the permanence of a set of policy measures which can be described as political sustainability (cf. Patashnik, 2003).

Figure 1: Conceptual Framework of the Energy Scenario Analysis



Based on this framework, we carried out an analysis of four recent energy scenarios for Germany. We detected considerable differences between the four scenarios regarding the consideration of economic and environmental aspects. Furthermore, significant potential for improvements is revealed with respect to the integration of political hurdles which notably holds true for the consideration of institutional veto players and the plurality of interests that need to be incorporated.

Conclusion

The results of the analysis should be understood as a contribution leading to a more holistic scenario construction approach in the future. Future energy studies must reflect that concrete technological and political options for realizing a sustainable energy system feature social and political consequences that vary respectively. By considering the identified acceptance factors and the concept of political sustainability, the scenario construction approach will lead to socially feasible and therefore more realistic scenarios than provided nowadays.

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RISKY SOCIETAL EXPERIMENTS OF THE ENERGY TRANSITION: VISIONS OF THE SMART GRID, FIELD TESTS AND THE MASS ROLLOUT

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Session:	***Socio-Technical Scenarios in Energy Transitions: Practical and Theoretical Perspectives***	

To deal with the volatility of renewable energies in production and consumption science and politics promote the possibilities of flexible control through information and communication technologies. Visions of a future smart grid draft scenarios of the coupling of diverse elements such as virtual power plants, cold storage buildings and E-mobility as energy storage and smart meters, smart homes and virtual market places in a liberalized electricity market. Smart grids shall guarantee the stability and flexibility of the energy systems of the future. Many field tests are already being conducted all over Europe – such as in the project “E-Energy” in Germany (www.e-energy.de). Elements of smart grid visions are being developed and trialed concerning their practicality and compatibility in different experimental settings. Due to heterogeneously configured field tests with “test subjects” technoscientific results and learning effects are being created under quasilaboratory conditions. Following the intentions of the involved actors these results shall be transferred into real life situations in the near future in a “mass rollout”.

If one compares this situation to the “system building” by narrow and powerful actornetworks which created the electricity infrastructure around 1900, as described by Thomas Hughes, then one notices: Presently, there is not

a single vision by one central actor or actor-network. Rather, various options are being tested through diverse actor-networks. The shared point of reference for these projects are collective visions of the smart grid. But depending on each field test rather different expectations are being deployed. Accordingly, as a result different products and learning effects are being created. In the case of a mass rollout these would not only face the unpredictable volatility of real life situations but could also become sources of disturbances due to their interactions in the future energy "system".

Based on document analyses and expert interviews with actors of field tests, the paper will address the question in which mode the transfer of the field tests' results could happen. Since it is implausible that there will be a central steering agent, the so called mass rollout will not happen as a planned distribution but rather continue in multiple societal experiments. These will demand further learning processes, adjustments and coordination between different, e.g. regional, experimental settings. From this point of view the transformation toward a smart grid will emerge out of the dynamics of expectations and experiences of heterogeneous actor-networks in the individual field tests. Due to their specific learning effects they could engender pathdependencies, e.g. through cellular solutions, which could become a source for destabilization in the energy "system". Who will control the volatility of these societal experiments?

WHAT ENERGY SCENARIOS TRY TO TELL US – A RECONSTRUCTION OF ARGUMENTS BASED ON ENERGY SCENARIOS

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Session:	***Socio-Technical Scenarios in Energy Transitions: Practical and Theoretical Perspectives***
Scope:	methodology of scenarios
Keywords:	energy, scenario, model, simulation, argumentation,

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Energy scenario studies – mostly based on computer-simulations and published as expert´s reports – are an important source for political decision-making and public debate about the future energy system. One aim of these reports is to describe the available knowledge about potential future developments of the energy system. Since such knowledge is uncertain, nowadays the accepted form to present this knowledge is the scenario-concept. Especially for the topic of energy these scenarios are constructed with help of simulation models.

At first glance the scenario-concept seems to be equally understood by the authors of energy studies – it even seems to be a commonly understood state-of-the-art approach in many scientific domains. Definitions of the concept often explicate that scenarios only represent possible future developments – in contrast to the concept of deterministic prediction which appears to be perceived as generally outdated in many domains. Second, many definitions indicate that scenarios basically represent what-if-statements and therefore only support conditional conclusions. Yet, if one takes a closer look at the argumentation of energy reports, the superficial clarity begins to blur rapidly. Very often it is neither clear what conclusions

are exactly tried to be argued for, nor is it comprehensible which premises are supposed to support them. One special difficulty is that often it is not clear how the computer-simulations are interpreted and how they enter the argumentation.

The talk presents results of an empirical study which aimed at clarifying what authors of energy scenarios studies exactly mean, when they present their simulation results as “scenarios”. More precisely the talk discusses two core arguments which represent the general structure of the argumentations conducted in scenario studies. For both arguments critical premises will be discussed, such as the interpretation of the numerical assumptions, of the numerical results and of the model itself, so that important challenges connected to both arguments will be outlined.

The first argument is called “Series of Possibilistic Predictions”. In this argument two or more simulation runs, diverging by their numerical assumptions, are interpreted as possibilistic predictions for the model’s target system. In this case the conclusion is a conjunction of these possibilistic statements. While the structure of this argument is rather simple and its premises are relatively easy to support, this argument becomes problematic when applied in scientific policy advice – as will be discussed in the talk in more detail.

The second argument is called “Isolation of Effects”. In its most simple form this argument is based on two simulation runs where the second run is a modification of the first in the way that a variation to a limited number of numerical assumptions is conducted. This variation is interpreted as an intervention in the target system, e.g. as a political measure. The difference of the numerical results of the two runs is interpreted as the effect of this intervention. In this case the major challenge is an epistemological one insofar as it is unclear if the first model run is interpreted as a deterministic or as a possibilistic prediction. Depending on this either a rather challenging premise has to be justified in the argument or the conclusion seems to become too weak to address the question that is intended to be answered with this argument.

FOREKNOWLEDGE ABOUT THE ENERGY SUPPLY:

WHICH KIND OF ARGUMENTS CAN SCIENCE PROVIDE?

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Session:	***Socio-Technical Scenarios in Energy Transitions: Practical and Theoretical Perspectives***

Energy systems worldwide have to be transformed capaciously in the next decades in order to reduce global emissions of greenhouse gases (GHGs), especially of carbon dioxide (CO2). In order to make justified decisions with regard to energy consumption and provision knowledge about the future is required. Therefore governments commission scientists, typically economists, to forecast the consequences of different energy scenarios. In my research, I analyze arguments by which decisions in situations of (deep) uncertainty can be justified and which kind of foreknowledge science can provide in order to support justified decisions. The debate about the phasing out of nuclear energy which has been led in Germany in 2010-2011, provides a comprehensive case study in which these questions can be addressed. Although the final political decision was triggered off by the disaster at the Fukushima nuclear plants there had been published scientific reports providing arguments in favour and against a phasing out.

In my talk I shall present the results of an argumentation analysis (Tetens, 2004) of two scientific reports intended to provide arguments with regard to the role of nuclear power for future energy provision in Germany: Schlesinger et al. (2010), which was conducted on behalf of the Federal Ministry of Economics, and Knopf et al. (2011) -on behalf of the Friedrich-Ebert-

Foundation. The main research topics of the both reports were the macroeconomic and climatic effects resulting from the lifetime change of nuclear power plants. These effects were calculated by the means of energy market models. Interestingly, the results of the both reports were politically used in order to justify opposite recommendations: Schlesinger et al. report served to justify the prolongation of the lifetime of nuclear power plants; whereas Knopf et al. was used in order to argue for a phasing out.

The main result of the argumentation analysis is the claim that the methodology deployed in the both reports does not allow to derive relevant political recommendations about the lifetime of nuclear power plants. In order to justify this claim I shall structure my talk as follows:

I shall present which logically valid arguments can be reconstructed from the methodology used in the both studies. A logically valid argument consists of a set of premises from which a conclusion follows. Thus, the reconstruction will allow to explicate the conclusions that logically follow from the assumptions of the reports.

I shall compare the reconstructed conclusions with the recommendations that are stated in the studies. I shall argue that the most of the mentioned recommendations and some of the core messages are actually not supported by the research done there. The mistakes I identify within these studies lie in the fact that the authors wrongly interpret the kind of knowledge gained by the modeling of energy markets.

Finally, I shall derive some lessons from the analysis of arguments in the two case studies. I shall discuss which kind of arguments scientists could provide with regard to the question of future energy provision. I shall also suggest how politically sensitive modeling studies should be designed.

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EVOLUTION OF KNOWLEDGE TENSIONS ON ENERGY TRANSITION NARRATIVES IN AUSTRALIA

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Type of presentation	Oral
Session:	***Socio-Technical Scenarios in Energy Transitions: Practical and Ttheoretical Perspectives***
Keywords:	energy epistemics; energy transition; climate change; Australia

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Elsewhere, the narratives for rapid energy transitions have been unpredictably springing out from various junctures that constantly and frequently change its policy context. Frequently cited examples include (1) the necessity to curb down emissions trajectory which has been blamed for climate change, (2) events including accidents (e.g. Fukushima) and the corresponding public shifts in public opinion (e.g. post-Fukushima nuclear debates), and (3) the development of new energy sources (e.g. shale gas). Throughout these junctures, changes in accepted expert knowledge (including risk assessments and calculations of economic costs of various energy sources especially the myriad models and examples for 100% renewables) contribute to the ongoing knowledge-making and thus policy orientations of energy transition narratives in Australia. Here, I examine the controversies concerning the crucial evolution of these knowledge tensions that shape these narratives. I interrogate the role, credibility and authority of various types and sources of knowledge—experts and forms of expertise—under conditions of strong cognitive and normative uncertainty of the transition discourse. Using an STS lens, I show that the temporal dimen-

sions of knowledge struggles surrounding energy transitions have been influenced greatly by the way climate expertise in Australia is created, formed and shaped.

THE EMERGENCE OF 'HYBRID' GOVERNANCE MODES IN THE UK LOW CARBON ENERGY TRANSITION

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Type of presentation	Oral	
Session:	***Governance of Complex Transition Processes***	

This paper applies insights from an integrative perspective on scenarios for a low carbon energy transition to understanding path dependencies in the governance of the UK energy system.

During the past three decades, the UK and other European countries have pursued the liberalisation of their energy markets in an effort to reduce costs and promote efficiencies. As a result, market liberalisation has become the dominant policy goal and has increasingly influenced the governance framework for energy and other infrastructures. More recently, these governments have developed climate and energy strategies with ambitious targets for greenhouse gas emissions reductions and the deployment of renewable technologies. Achieving these targets, whilst ensuring long term energy security, will require a radical transformation of the energy systems in these countries.

In this paper, we analyse how the energy policy landscape in the UK is evolving to meet the challenges of a low carbon transition. We highlight the emergence of a new 'hybrid' form of governance that combines elements of the 'market liberalisation' and 'decarbonisation transition' governance modes. This seeks to reconcile the new objective of long term infrastructure investment with existing regulatory frameworks and market structures. Drawing insights from the path dependency literature, we argue that this

new hybrid framework may in fact be inadequate to meet the challenges of the low carbon energy transition in the UK as it is an incremental evolution of previous policies and institutions, rather than a distinct break from the past, or paradigm change, which some argue for (Mitchell, 2008).

This paper draws on the work of the 'Realising Transition Pathways' research consortium which is an interdisciplinary group of social scientists, engineers and economists from a number of UK universities. As part of the project, we have developed and analysed three integrated transition pathways for a UK low carbon and sustainable electricity system to 2050 based on alternative governance framings or logics (Foxon, 2013): Thousand Flowers sees the emergence of a diversity of bottom up solutions pioneered by local actors, while Market Rules and Central Co-

ordination involve a continuation of the centralised electricity infrastructure, although with different roles for government and market actors. In this paper, we apply these ideas and related work by the authors on co-evolution (Foxon, 2011) and branching points (Foxon et al., 2013) to explore in-depth ongoing governance dynamics which are shaping the UK low carbon transition.

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ENERGY TRANSITION BETWEEN AUTONOMY AND REGULATION IN GERMANY'S MULTI LEVEL SYSTEM

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Type of presentation	Oral
Session:	***Governance of Complex Transition Processes***
Scope:	German Energy Supply System; Multi-level-Governance, Federalism
Keywords:	energy transition, federal system, multi-level coordination and cooperation, decentralization vesus comprehensive regulation

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Background & Context

The Germany energy transition is embedded in multi-level governance structures (Hirschl 2008). One common assumption is that a federal system offers opportunities for more flexibility and variety, more progressive and innovative policies, appropriate institutional solutions, better inter- and intra-level policy learning and better best practices diffusion compared to centralist systems.

German federal states are key players in the energy transition process. Some of them have already achieved significant expansion rates in renewable energies. A continued encouragement of decentralised activities seems to be important for an ambitious climate policy. However, the states set different priorities due to different geographical and climatic conditions, population structures, and dependency to individual industrial and energy supply paths. Each state follows own objectives which are not aligned with the federal policy goal of an optimized, secure and affordable power supply. The question arises whether the energy transition process is optimal in

terms of spatial control and costs effectiveness. For this reason, many actors like for example the German Consumer Protection Agency or the German Association of Energy and Water, call for a better coordination between federal and state governments in developing renewable energy and the grids. They consider that the state policies run the risk of hampering an optimization of the overall system by pursuing their individual targets and they see a lack of responsibility for efficient and coordinated multi-level system development. The presentation will address the question whether autonomous states can follow their individual interests and help to implement a consistent, robust and sustainable energy transition policy at the same time.

Content & Findings

Federalism causes a high demand for coordination and an increased complexity of decision-making (Benz 2007; Hooghe/Marks 2003). The responsibilities are blurred, which can cause a lack in transparency and accountability. The German national government is in a considerably weaker position in terms of its influence on the implementation of climate change policy at the federal state level, compared to non-federally organized nation states. Political interdependencies are one reason for limited state control capacities.

In the presentation the interactions and conflicts in the German multi-level system will be outlined with reference to the development of renewable energy. It will be shown in which institutions and committees sub-national energy policies interact with policy making at the federal level and how federal objectives are integrated into the state policies. Moreover, the presentation will give insights into different perspectives of actors with regard to the question to what extend state interventions are required in order to coordinate the energy transition.

Conclusion

The German energy transition takes place in the tension between autonomy of federal states and the need for statewide coordination and agreement (Ohlhorst et al. 2013). A coexistence of ambivalence towards decen-

tralized dynamics on the part of federal politicians and a de facto bottom-up movement can be observed. Restrictions by the federation would run the risk of impairing the states' initiatives. Balancing the range of state planning and control with the need for new quantities and qualities of decentralised activities and coordination is probably one key challenge for an effective energy system transition. The challenge is to find ways of effective problem-solving across levels and to provide for both a better implementation of renewable energy targets which have been developed at a higher level (top-down perspective) and the ability of lower levels to come up with experimentation and innovation (bottom-up perspective).

Although there are distributed management approaches in various areas of regulation, such as rules in energy law, planning law, and environmental law, spatial control only starts at the federal state level and the administrative levels below. But the regulatory approaches of different administrative levels, with different interests involved, are not aligned with the purpose of optimizing and sustainably developing the entire system. This results in a power supply system based on local or regional optimization strategies and partial regulatory measures that are not consistently embedded in a comprehensive regulatory system. Assigning multilevel competencies and tasks for the energy transition seems to be decisive for its performance. The transformation process requires an intelligent integration of centralized and decentralized elements, spatial coordination, cooperation and distribution of tasks.

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ADOPTION AND DIFFUSION OF STATE ENERGY POLICIES: A COMPARATIVE ASSESSMENT

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Type of presentation	Oral	
Session:	***Governance of Complex Transition Processes***	

Sustainability has become central to contemporary public discourse, with far-reaching implications for economic, environmental, and political life, and energy policy represents an important and fast-evolving policy arena ineluctably intertwined with sustainability issues. However, sustainable energy policy initiatives confront political, economic, scientific, and technological challenges, with far-reaching implications in each of these realms. Such efforts remain politically contentious in the U.S. and encounter notable resistance from established stakeholders, so much so that no comprehensive U.S. energy policy has been embraced in the national political arena since the 1970s, despite the growing salience of these issues.

Over the past two decades, however, many U.S. states have taken the initiative to explore and enact innovative, sustainable energy policy initiatives, in their classic role as "laboratories of democracy." States have adopted a variety of renewable energy, energy efficiency, and small-scale distributed generation policies. Although there are discernible trends, there has been great variability across states in policy adoption and design. The disparate influences and policy goals driving these choices invite comparative evaluation. In such an evaluation it is critical to understand how enacted policies compare to alternatives, how and why public officials have chosen to adopt and apply familiar policy instruments in different ways, and

how these state-level policies might lay the foundation for eventual action at a national scale.

The objective of this study is therefore to assess why and how states have adopted the three most prevalent U.S. state energy policies: the renewable portfolio standard (RPS), which sets renewable energy mandates; the energy efficiency resource standard (EERS), which sets energy savings mandates; and net metering (NM), which are protocols that allow customer-owned distributed generation access to the electrical grid. The study poses two related research questions: first, which factors motivate state policymakers to adopt different energy policies, and how these factors differ from one another; and second, whether those factors and their relative influence are affected not just by differences between policies but by differences in design stringency within policies. The first question is important because most past literature tends to consider policy alternatives in isolation from one another, even within related issue areas. A comparative analysis can provide insights on how these policies are situated in relation to one another, and illuminate when and how policymakers' choices may either complement or compete with each other. The second question is important because states have not only adopted different

sets of energy policies in recent years, but have also introduced wide variation within specific policy models. As more states adopt these policies, and the variations in design details become more intricate, the task of evaluating these variations becomes increasingly important, but also increasingly challenging.

Using a multinomial logit model and U.S. data from 1990 to 2009, we employ an event history analysis. Results reveal that more substantive, evidence-based factor involving, for example, economic development and government capacity tend to drive net metering policies, in contrast to the political factors underlying the RPS, with EERS policies situated in the middle of the spectrum.

GOVERNING DOMESTIC ENERGY VULNERABILITY UNDER CONDITIONS OF SOCIO-TECHNICAL TRANSITION

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Type of presentation	Oral
Session:	***Governance of Complex Transition Processes***

The factors that contribute to the rise of energy deprivation in the home are gaining increasing attention among policy practitioners and academic scholars. Understood as a condition in which a household lacks a socially and materially necessitated level of energy services in its residential dwelling (based on Buzar 2007a), domestic energy deprivation has been persistently present – and has often been expanding – in developed and developing countries alike. In the global North, the broader dimensions of this predicament are encapsulated under the notion of 'fuel poverty', and are frequently the subject of remedial or preventative measures implemented by the state; this is particularly true in the UK and Ireland, where, following Boardman's (1991) seminal contribution, an extensive body of research has documented the difficulties faced by households who are unable to afford an adequate level of thermal comfort in the home.

There is little knowledge, however, of the manner in which processes of socio-technical transition affect the extent and depth of domestic energy deprivation. This is particularly true with respect to the low-carbon transitions currently underway across Europe, where the effects of price rises and infrastructural transformation on the extent and depth of domestic energy deprivation have received little policy and academic attention. There is a particular dearth of knowledge with respect to the role of state-led poli-

cies, actions and organisations in producing and mitigating fuel or energy poverty.

Taking into account recent advances in research on social resilience (Gallopín 2006) and procedural environmental justice (Walker 2006) this paper uses an energy vulnerability framework to explore the governance of domestic energy deprivation in the European context. When understood through a vulnerability lens, the lack of adequate services energy in the home – or the propensity to experience a situation like this – can be connected to broader institutional dynamics at a variety of scales. Empirically, the paper is based on interviews with decision-makers in Brussels (focused on EU policy) and the cities of Prague and Paris (focused on regional and urban-level processes). Our overarching aim is to generate a conceptual shift in the mainstream theorisations of domestic energy deprivation and socio-technical transition, by highlighting the micro-level spatial dimensions of resilience and precariousness.

FROM ATTITUDE TO IMPACT WITHOUT STEPPING STONES: VALIDATING BEHAVIOR-BASED ENVIRONMENTAL ATTITUDE WITH ENERGY CONSUMPTION

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Type of presentation	Oral
Session:	***Perspectives on the Role of Energy Consumers***
Scope:	Determinants of individual and group-related behavior with respect to energy consumption of households
Keywords:	attitude measurement, environmental attitudes, energy conservation, pro-environmental behavior, environmental impact

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The German energy transformation critically depends on a 50% reduction of primary energy consumption by 2050. Improving technological efficiency is presented as the prime political strategy to achieve this goal. However, as even most remarkable previous technological efficiency improvements have not resulted in lower consumption, a society wide change in individual behavior is called-for.

Promoting pro-environmental behavior as a means to induce relevant changes in individual environmental impact--such as household energy usage requires a substantial empirical relation between the two concepts. Unfortunately, the bulk of psychological research has failed to include an objective indicator of environmental impact. Concurrently, the evidence that speaks of an overlap between pro-environmental behavior and energy consumption is based on estimated rather than actual consumption data (e.g. Gatersleben, Steg, & Vlek, 2002). As laypersons commonly misjudge

the relative potential of specific curtailment behaviors, there are some who have announced a gap between behavior and impact (Csutora, 2012). Nevertheless, by extending the scope beyond behavior to attitudes, we wish to go even one step further: the challenge to demonstrate an empirical congruence of environmental attitudes and impact seems even more daunting due to the commonly purported attitude-behavior gap (e.g. Gifford, 2011). In our research, we attempt to validate a wellestablished environmental attitude measure originally proposed by Kaiser and Wilson (2004) with actual household energy consumption data.

We employed the General Ecological Behavior Scale to measure environmental attitudes in a sample of 256 adults (mean age: 51 years; 25% female, 75% male). Information on participants' choice of energy plan and their households' annual electricity consumption served as measures of the environmental impact.

We found that environmental attitudes were significantly related to both per-capita and household electricity consumption - even after excluding behaviors directly related to private energy usage from the scale. Furthermore, participants' energy plans (green electricity vs. regular plan) were congruent with the underlying environmental attitude.

Overall, our data supports the validity of behavior based measurement of environmental attitudes and identifies both the widely stressed attitude-behavior gap and the behavior-impact gap as methodological artifacts. These findings aid an approach of deliberate intervention planning to induce relevant changes in consumer behavior in order to take a step towards the envisioned energy transition.

A SPATIALLY EXPLICIT AGENT-BASED MODEL OF THE DIFFUSION OF GREEN ELECTRICITY

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Session:	***Perspectives on the Role of Energy Consumers***

In the SPREAD project (scenarios of perception and reaction to adaptation), the diffusion of climate-friendly socio-technical innovations in the energy sector – specifically switching to green electricity – is modelled using agent-based modelling with a psychologically plausible agent architecture. This architecture is based on theoretical and empirical insights from cognitive, social and environmental psychology and takes account of selected relevant socio-psycho¬logical phenomena, e.g. social norms and cognitive dissonance.

A major goal of the SPREAD project is to gain a deeper understanding about individuals' interaction with their social, technical and economic environment that accompanies the changes in the German energy producing and supplying systems. Using simulated scenarios of the systemic interactions including consumers' behavioural change, we describe and analyse various possible spatially and socially differentiated diffusion patterns.

We use data from lifestyle and marketing research with a high spatial resolution to construct an artificial agent population. The agents are endowed with characteristics that are specific for their milieu group (the lifestyle typology of the SINUS Institute, Heidelberg), e.g. concerning the perceived characteristics of green electricity. In order to capture the social influence

via communication in social networks, data about e.g. the number of communication partners with whom the topic of green electricity is discussed were collected in a survey with subjects drawn from the general public (N = 778).

Depending on the current state of the agent and its social, economic and legal environment, one of three different decision modes is being activated: habitual, heuristic or deliberative decision making. While habitual behaviour is the default mode, the heuristic or deliberative decision modes can be activated by various external and internal triggers, e.g. economical (price changes), informational (media events), social (personal communication in social networks), and psychological (cognitive dissonance between personal values and social norms).

We hypothesize that during the early phase of diffusion of green electricity, it is crucial to break the routine, i.e. to get the consumers just to perceive green electricity as a viable option and to scrutinize the merits of adopting green electricity. However, this will succeed only if green electricity is perceived as providing a veritable ecological advantage and social prestige, at least in the more eco-friendly milieus. The later the phase of diffusion, the more important social heuristics become in the process of spreading. In all phases, social influence can be used as an important means for promoting the diffusion.

Simulation runs are validated against temporally and spatially explicit data about households switching to green electricity. By means of systematic scenario analyses, various futures will be explored: We analyse the sensitivity of innovation diffusion with respect to economic boundary conditions (e.g. development of electricity prices), media influences (e.g. the debate on consumers' contribution to the feed-in gratification) and marketing strategies. Barriers and opportunities for a faster and far-reaching diffusion of socio-technical innovations in the energy sector – and, in consequence, for a comprehensive transition of the energy system – will be identified.

IMPACTS OF THE GERMAN ECO-TAX REFORM ON INDUSTRIAL ENERGY DEMAND AND FIRM PERFORMANCE

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Session:	***Perspectives on the Role of Consumers***

The German Eco-Tax aims at reducing energy demand of both households and industry. We study the impacts of the Eco-Tax on environmental and economic firm performance in the industrial sectors. For that, we aim to make use of variation in effective tax rates over time and individual firms to identify the effects of the tax reform. Thereby we gain important information on how environmental tax reforms impact firm behavior and possibly reduce energy demand.

DO EMOTIONS UNDERMINE OR PROMOTE COOPERATION: A HOUSEHOLD ENERGY DILEMMA

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Session:	***Perspectives on the Role of Energy Consumers***
Scope:	Determinants of individual and group-related behaviour with respect to energy consumption of households
Keywords:	Smart Meters, Cooperation, Domestic Energy Use, Emotions

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Background

Outcomes of many individual environment-related decisions depend on choices of other people. For example, reducing energy consumption at home will make a difference to our environment only if others take the same co-operative actions. Such choices often imply facing conflict between short-term individual (e.g., not paying for house insulation) and long-term public benefits (e.g., efficient energy use is better for environment). Through these lenses many environment-related choices turn into well studied in behavioural economics social dilemmas, such as Public Goods

Games (PGGs). Emotions, such as anger, bias rational choice, especially when one needs to account for the choices of others (Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003). Self-report studies identified that situations, which were appraised by the individual as unfair, provoked anger (Straub & Murnighan, 1995). Subsequently, some negative emotions (anger, irritation, disgust) were shown to cause retaliation (Srivastava, Espinoza, & Fedorikhin, 2009), and led to decrease of cooperation. Our experiment aimed to look whether specific emotions, such as anger, disgust, irritation motivate decisions to cooperate or not in the situation of a PGG.

Procedure and Results

118 participants played a series of repeated-interactions modified PGGs structured around energy use at home. Games were designed to simulate an energy-sharing situation (e.g. a house share) where people interacted around energy use and payment in randomly allocated groups of four. Participants played two blocks of ten games, with different group partners in each block. In the end of each PGG, they had to report their emotions (anger, disgust, irritation, fear, shame, guilt, gratitude, happiness, joy and surprise), on a scale from 1 (not at all) to 6 (extremely). There was an increase in energy use over 20 PGGs of the experiment.

As an index of unfairness, the individual deviation from the average electricity use of three other group members was calculated for each participant on each trial. We examined how this deviation affects subsequent emotions, through the means of mixed-effects random intercept regression. Deviation positively predicted anger, disgust, irritation and fear. The greater the deviation from the group was (the participant used less electricity than their group) the angrier, more disgusted, irritated and frightened they reported to be. Deviation also negatively predicted shame, guilt, gratitude, happiness and joy. With the increase in anger, disgust and irritation, the electricity use on the next trial also increased. Shame and gratitude had the opposite effect on electricity use: the more shame and gratitude participants reported, the less electricity they used on the next trial.

Discussion

Our results have both applied and theoretical implications. When others behave unfairly in a social dilemma, cooperation declines. We showed that the decline in cooperation was motivated by emotions of anger, irritation and disgust, elicited as a response to inequality. Thus, cooperation depended not only on behaviour of others, but also what kind of feelings such behaviour provoked. One of the reasons for such an emotional reaction to behaviour of others could be that individuals did not know what the acceptable norm of behaviour was and what the reasons behind the behaviour of others were. Further research could look whether providing individuals more information as to why others seem to behave uncooperatively or with guidelines of the "normal" behaviour, will have an effect on individual emotions as well as individual decisions.

Our results have broader applied implications for policy-making. Sharing information about private energy use is a topical issue, and presents a social dilemma. Recent initiative by UK government supports the roll-out of smart meters in all houses across the UK by 2019. The smart meters will enable reviewing energy use of household members in real time, and sharing this information with others. The aim of the roll-out is to reduce the energy use through supporting better informed energy decisions of individual users. However, our experiment shows that unwanted emotional reactions, such as anger, might interfere with people's decisions. Without any other means to change the situation or without understanding what can be expected as a normative behaviour, anger can lead to retaliation, and subsequently to increase in energy use.

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UNDERSTANDING AUSTRALIAN HOUSEHOLDERS' WILLINGNESS TO PARTICIPATE IN THE SOLAR DISTRIBUTED ENERGY MARKET

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Type of presentation	Oral
Session:	***Perspectives on the Role of Energy Consumers***
Scope:	Consumer Behaviour
Keywords:	distributed energy, solar energy, technology adoption, environmental values, energy security

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With the exception of some remote communities and small scale trials, for many years cheap electricity, existing infrastructure and reluctance to change at both the political and individual levels have delayed opportunities for distributed energy (DE) to be considered in Australia (Gardner et al., 2008). More recently, however, the rapid rise in electricity prices and concern for reducing greenhouse gas emissions is beginning to motivate change in end-users' engagement with the electricity grid through the adoption of DE technologies. This was particularly evident when the Australian government introduced incentives for energy efficiency and solar photovoltaic (PV) systems which has resulted in a rapid increase in the investment in solar PV nationally. As such we are beginning to see a transformation in Australia's electricity supply. Such transformation motivated this research to investigate the opportunity for new business models for solar distributed energy initiatives in Australia and to test Australian house-

holders' willingness to participate in them. This paper presents the results of a national survey looking into this issue.

The survey was designed based on the findings from six focus group meetings held in Brisbane, Melbourne and Sydney as well as current literature relevant to the topic. The survey questionnaire and online platform were tested through a pilot, with the online survey being completed by 2,500 people across Australia in March 2013. The sample is representative of the Australian population in terms of age, gender and location. The survey aimed to investigate the main determinants of support for solar DE options such as solar hot water, and a range of PV system configurations, including grid connected, with or without battery storage and off grid. The study also explored participants' intention for investing in community PV systems, an option which is currently not prevalent in Australia. Using multiple regression analysis the effect of socio-demographic and attitudinal variables on Australian householders' willingness to participate in the solar DE market was examined. Attitudinal determinants included environmental values and beliefs, energy security and knowledge about the technology. The survey also explored Australian householders' preferred payment and service options for investing in these technologies, such as financing, leasing and the use of load control and demand management technology. Finally, the views of those already participating in the solar PV energy market were compared against those who have yet to invest.

The regression models explored in this survey confirm previous studies which suggest that a person's intention to act in favour or against new sustainable energy technologies is influenced by both demographic and attitudinal variables (Gardner et al., 2008; Islam and Meade, 2013; Palm and Tengvard, 2011). This study has shown that gender, age, pro-environmental beliefs and values, technology awareness and the perception of the benefits and risks of such technology are important determinants on households' willingness to invest in solar technology.

In general, socio-demographic determinants that were significantly associated with support for solar PV options included property type and age. For example, younger respondents or respondents living in a house were more supportive of solar PV systems than others. Attitudinal determinants that were significantly associated with support for solar PV options included the perception of the benefits of solar technology and ascription of consequences. In that regard, respondents who reported a higher perception of the benefits of solar energy were more likely to live outside of capital cities, report higher concerns with energy security and have higher subjective knowledge about solar technologies. In addition, those respondents also reported higher ascription of consequences and responsibility or personal norms (see Values, Beliefs and Norms (VBN) Theory: Steg et al., 2005; Stern, 2000). Finally, householders that have already installed solar panels at home were also more likely to perceive the benefits of solar technology.

In addition to the perception of the benefits of solar technology, the regression results show that respondents who reported higher agreement that climate change and the depletion of energy resources is a problem to society (ascription of consequences) reported higher levels of support for solar PV systems. However, personal norms did not contribute to predicting support for the solar technologies presented in the survey. This is in line with findings that show that the link between personal norms and pro-environmental behaviour is not evident when the behaviour involves high cost investments (Biel and Thøgersen, 2007).

The research is timely as it informs the solar industry and policy makers about key determinants in householders' current attitudes and interest in participating in the solar market in a time when most federal and state-based government incentives for solar PV installation in Australia are being removed.

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WHAT DOES THE INDIVIDUAL ENERGY CONSUMER NEED TO DEVELOP AND ACHIEVE ENERGY SAVING GOALS?

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Type of presentation	Oral
Session:	***Perspectives on the Role of Energy Consumers***
Scope:	Interventions to support energy saving activities
Keywords:	energy conservation, stage model of behavior change

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Background

The assumption that an increase in energy prices directly results in a reduction of resource consumption of households is no longer feasible against the background of our knowledge of a bounded rationality. Instead we know from several psychological studies that besides knowledge about prices and other incentives a multitude of factors - motives, competences, explicit and implicit knowledge about saving potentials, as well as objective and subjective constraints - are relevant determinants of energy consumption behaviours in households. An important feature of household electricity consumption is that it is caused by a variety of behaviours. These do not only have different relevance for the total electricity consumption but are also carried out with varying frequency, ranging from every day behavior (use of appliances) to behaviour that is only carried out once within a decade of even lifetime (purchase of more or less efficient appliances; see Garner & Stern, 2002 for a differentiation between so called curtailment

and efficiency behaviours). Thus, given that individuals have the intention to save electricity, in order to reach their goal they first have to be aware of appropriate behaviours, to then choose from a variety of possible behaviours. Intervention strategies and devices to support behavior change (e.g. smart meters) should be based on a thorough knowledge about such behavior change processes. It can be assumed that the relevant change processes can be sufficiently described by psychological stage models of self-regulated behaviour change (e.g. Bamberg, 2007; 2012). Bamberg's model was used to identify and optimize intervention strategies.

Derived knowledge about starting points and measures to support energy saving behaviour

The model assumes that the process of intended behavioural change occurs in a series of distinct stages that each pose a specific task to be completed by the person (e.g. forming the behavioural intention to carry out a specific behaviour). Within each stage, specific psychological variables affect the completion of the task, which marks the transition into the next stage when completed. The stages of change and the respective tasks the model assumes are: pre-contemplation: forming a goal intention, contemplation: forming a behavioural intention, preparation and action: forming an implementation intention & starting to implement a behaviour, and maintenance: keeping up carrying out a behaviour (for details see Bamberg, 2012).

Given the complexity of consumers' motivations, it can be shown that the stages of change model can help design information intervention instruments. Consequently, in accordance with Fischer (2008, p. 101) we argue that computer-based interactive forms of interventions could be a complimentary and an effective tool in the application of such a targeted approach.

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AN INFORMATIONAL CONCEPT OF A SMART METER WEBSITE CONCEPTUALIZED ON THE BACKGROUND OF A STAGE MODEL OF SELF-REGULATED CHANGE

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Session:	***Perspectives on the Role of Energy Consumers***

Smart meters act as the interface between users, energy suppliers and conventional or, more recently, intelligent grids. Together with a persuasive interface design they open up new opportunities to motivate and support energy efficient behavior. A persuasive website and smart phone-app connected to the smart meter was developed using principles derived from the stage model of self-regulated change (vgl. Bamberg, 2013) and presented on the symposium.

The planning and execution of an action is a multi-stage process starting with the formation of an intention, the elaboration of implementation details, and the realization over time. If users are to be successfully motivated to change their behavior, all stages from intention formation to implementation planning and execution should be appropriately guided and supported. In all stages, specific techniques may be set up with the intention to support users to overcome stage-specific obstacles. It is to be expected that users will differ with respect to the stage they are in. Thus he or she should be addressed in a manner specific to that stage. The informational concept of the website could be characterized, amongst other things, by the following points:

- action phase specific concept;

- dynamic reconfiguration of the website, offers of stage-specific information relating to
- the actual stage of action;
- no ”information overload“ with everything that could be of potential interest, but
- information about user’s individual themes, questions and matters of interest;
- the architecture of the website has an interactive logic;
- diagnostic instruments for action stages are integrated;
- underlying knowledge base about general information on potential savings of devices
- and usage patterns, information concerning the household, and information about
- device-specific consumption over time (smart home data)

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REQUIREMENTS FOR PUBLIC PARTICIPATION IN EUROPEAN LAW – A MILESTONE FOR STRENGTHENING PROCEDURAL RIGHTS IN GERMANY

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Type of presentation	Oral
Session:	***Participation and Public Acceptance***

Fair decision-making procedures are a prerequisite for the general public's acceptance of decisions. This fundamental condition is particularly relevant to the current process of infrastructure decisions concerning the energy transition, including decisions on the extension of transmission lines for electricity which have become necessary as a result of the shift towards renewable energies.

So far procedural errors in the administrative procedure related to public participation go unpunished in Germany; unless the concrete possibility of a different decision on the merits can be presented. Thus, a flawed procedure, or even an omission of public participation has not given rise to any consequences in most cases.

The current legal practice can no longer be maintained, as the provisions laid down in the Aarhus Convention and in legal acts of the EU emphasize the importance of the procedural correctness of a decision. At the same time, clear signals have been received from case law of the European court of Justice (ECJ) indicating that the German administrative law needs to take procedural standards more seriously than it has previously.

The paper analyses the procedural requirements of international law (Aarhus Convention) and EU law with regard to infrastructure projects and

demonstrates their possible impact on the planning of the German electricity grid. In a second step, fundamental legal requirements for a fair decision-making procedure are shown to partly address social science discussions about procedural fairness.

THE INTRINSIC VALUE OF PUBLIC PARTICIPATION IN INFRASTRUCTURE PLANNING LAW

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Type of presentation	Oral
Session:	***Participation and Public Acceptance***
Scope:	Potentials and limits of public/stakeholder participation in formal or informal planning procedures with respect to energy-related infrastructure projects

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In traditional German legal thought administrative procedure is attributed only a subordinate, merely "serving" function compared to substantive law. Therefore, the main purpose of procedural and formal legal requirements is to guide the public administration in reaching a decision correct in substance[1]. An intrinsic value is denied to administrative procedure, which becomes apparent when reading § 46 of the German Administrative Procedure Act (VwVfG): the violation of procedural or formal legal requirements is unremarkable as long as the administrative ruling is correct in substance. What is true for administrative procedure in general holds true for public participation in particular. Here as well a function independent of its contribution to the substantive correctness of the administrative ruling is traditionally denied to public participation. Thus the main purpose of public participation is to supply the administration with information in order to broaden its basis for decision-making[2].

However, a fundamental discussion of the function(s) of public participation in infrastructure planning law has only been taking place since the protests against the railway project "Stuttgart 21" arose[3]. One controversially discussed question is how far public participation can contribute to the democratic legitimacy of administrative rulings[4]. To answer this question in the

affirmative means indeed attributing a self-sufficient function to public participation which it does not have in traditional view. Hence, various questions concerning legal doctrine arise. At first: What exactly is the relationship between the traditional informational function of public participation and its alleged legitimating function? Under which circumstances will the legitimating function take effect? Does it affect an administrative ruling in general or just subsidiary? And finally: If public participation does have a self-sufficient function after all, what are the legal consequences of a violation of participation requirements which by no means affect the substantive correctness of an administrative ruling?

These questions will be addressed in the presentation. At first, the legal discussion concerning the function of public participation in infrastructure planning law will be delineated. Assuming that a legitimating function can indeed be attributed to public participation, the question under which circumstances it will take effect will be considered. It will be argued that the significance of the legitimating function of public participation increases to the same extent the material legitimacy of an administrative ruling decreases. This is definitely the case if the ruling – as it is usual with planning decisions – is only vaguely predetermined by substantive law, e.g. if the administration is assigned with an extensive margin of appreciation. In reverse the legitimating function of public participation fades into the background when the administration is bound by substantive law in its ruling. Finally, the presentation will focus on the question of legal consequences which a violation of participation requirements entails. It will be argued that § 46 VwVfG is not applicable if this violation affects public participation in its legitimating function. It is a prerequisite of § 46 VwVfG that the violation of procedural legal requirements can at least potentially affect the substantive correctness of the administrative ruling. On the other hand, § 46 VwVfG is applicable if the violation of participation requirements affect the informational function of public participation.

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[1]Cf. BT-Drs. 6/1173, S. 52; 7/910, S. 65.

[2]BVerwGE 41, 48 (63 ff.); 102, 331 (340).

[3]Of course, the reduction of the significance of public participation to its contribution to the substantive correctness of the administrative ruling has been criticized in the past; cf. only *Debus*, in: Dokumentation zur 32. Fachtagung der Gesellschaft für Umweltrecht, 2009, 185 (188 f.).

[4]Affirmative e.g. *Knauff*, DÖV 2012, 1 (2); negative *Gärditz*, GewArch 2011, 273 (274 f.); differentiating *Gurlit*, JZ 2012, 833 (835).

ENRICHING INFRASTRUCTURAL PLANNING PROCESSES: POTENTIALS AND LIMITS OF PUBLIC PARTICIPATION

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Type of presentation	Oral
Session:	***Participation and Public Acceptance***

The German energy transition challenges conventional infrastructural planning procedures. Latest amendments provide opportunities for expanding infrastructural planning for stakeholder and citizen participation. Stakeholder and public participation are mandatory elements of infrastructural decision making. However, German planning laws do not specify settings or procedures for public participation. This discrepancy between the law and actual planning processes is a serious impediment for fair and efficient decision making. The Helmholtz-Alliance Energy-Trans investigates – among other issues relating to sustainable energy infrastructures – the potentials and limits of public participation in infrastructural planning. The talk will present some preliminary results from a research project funded by the Helmholtz-Alliance Energy-Trans. The presentation will focus on the question of how to match discursive approaches with the legal framework and conditions of success for effective public participation in the planning of sustainable energy infrastructures.

PERCEPTION, EVALUATION AND PREFERENCES: PUBLIC ACCEPTANCE OF ELECTRICITY PORTFOLIOS AND TECHNOLOGIES

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Scope:	Technology acceptance, enery technologies and portfolios
Keywords:	Public preferences, informed decision, electricity technologies and portfolios

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Background & Context

The acceptance of low carbon power generating technologies by the public may affect the feasibility of their widespread deployment. In order to get new insights on the level of acceptance we asked a diverse sample of 130 participants within 15 focus groups German-wide on their opinions, preferences and evaluations of both electricity-generating technology options and a sample of seven future electricity portfolios foreseen for 2035. The study replicated an US study carried out in Pennsylvania. Participants had to judge and rank the options by considering their alternatives, e.g. when disregarding one technology or energy mix they had to favour others. Since knowledge on existing technology options varies, we supplied participants with balanced information material on power technologies (e.g. coal with/without carbon capture & storage, natural gas, nuclear, various re-

newables, and energy efficiency) and their environmental and cost implications by forehand. Participants made informed decisions to rank technologies and energy mixes at several time steps (before focus groups, before discussion, after discussion). The focus groups used a mixed-method design yielding both quantitative and qualitative data.

Content & Findings

The field work delivered results on public preferences, evaluation patterns and information impact. By asking participants to rank technologies and portfolios relative to, in terms of climate protection, equal power plants and energy mixes both German and US studies attempted to simulate the challenges and trade-offs real decision-makers face. When discussing several technologies in relation to each other rather than in isolation participants became aware of the multi-faceted task of creating a real-world instead of an ideal energy future. Main quantitative results presented in this article consist of an electricity technology ranking and an electricity portfolio ranking. The results show considerable differences between US and German participants. While nuclear energy and the carbon capture and storage technology option are high ranking in the USA, German participants clearly favor renewable energies. In Germany this led to the insight that given a credible transformation strategy of the energy system the acceptance of nuclear as bridging technology is higher than that of modern coal plants equipped with CCS. And for the US it could be shown that in the course of pondering the pros and cons of alternative options participants expressed a preference for portfolios including CCS and nuclear power. Overall, from the experiences and findings from our research we see good reasons to plead in favor of studies of technology acceptance that ask informed participants to evaluate alternative options rather than single technologies. Against the background of the German “Energiewende”, findings resulting from such studies may provide highly valuable knowledge for decision-makers involved in conceptualizing, innovating and implementing the future German energy system.

Conclusion

The main findings of our research relate to several issues. First, we observe clear informed preferences on low-carbon electricity generation technologies and portfolios among the German sample. Both technology and portfolio rankings favor unequivocally renewable energies, while fossil fuels and nuclear energy meet less acceptance. Second, socio-demographic variables to some degree explain the spectrum of stated preferences. Age is a predictor with younger participants dismissing the CCS technology and preferring renewable portfolios, while older participants tend to favor fossil fuel portfolios. Low levels of education impacts a low ranking of wind energies. Third, throughout the focus group exercise, participants revealed a high degree of stability of opinions towards technologies and portfolios. Opinion stability manifests in a twofold way: shifting positions between pre- and post-discussion ranking is absolutely rare, and the topped-ranked technologies/portfolios in general improve their score, while the last-ranked technologies/portfolios impair their score. In other words, opinion stability sharpens the contrast between top and worst ranking. However, the case of CCS clearly shows unstable opinions since the CCS technology after the discussion loses considerable support. Fourth, striking differences between the US and German preferences are obvious. While the Pennsylvanian sample favors nuclear energy and CCS, the German sample accepts only renewable technologies and portfolios. The comparison made clear that stated preferences show a country bias, revealing a unique profile of technology and portfolio preferences in the USA and Germany

ENVIRONMENTAL COMMUNICATION EMPOWERS CITIZENS AT THE WIND ENERGY DECISION MAKING PROCESS

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Type of presentation	Oral
Session:	***Participation and Public Acceptance***

The promotion of renewable energy technologies among municipalities requires that special attention to be placed on local dynamics, because they are extremely important in such innovative projects. A lot of effort should be directed on how local societies could best accept the implementation of wind power projects. The dissemination of the results from success stories implemented elsewhere should be high in the communication agenda between governmental/local authorities and the communities. Concerns about the hidden barriers, the problems and the promising perspectives surrounding the use of wind energy in Greece are being directly addressed in this study. Bad characteristics on a local level that have to do with unfairness or threats on the area's biodiversity and the endangered species are sensed and create negative feelings. Nowadays Greece is facing a tremendous economic struggle and the major industries that could bring possible development are the tourism and maritime sectors and they are quite high on the country's agenda. But further development on these business sectors would require increased electricity demand and this route mandates careful consideration for the most appropriate energy source. Communities with limited vision are unwilling to accept technological innovations and can postpone projects for years and for no good reason, just because of inadequate information or because of prior misconceptions (lack of removal of old wind turbines….). Highlighting achievements that lead to upgrading trends must be shared with residents in order to challenge them to try to invest in wind energy.

This presentation focuses on the power citizens hold, when it comes to the decision making on wind turbines planning and implementation, in their home town area. Basically, it covers the theoretical concepts related to the governance of RER from the local communities' perspective and involvement. Also, it illustrates the similarities and differences in two Greek geographic locations when it comes to citizen participation in the decision making process. Finally it analyzes, as case studies, what has been documented, through collected information from media and local town halls sources. The results from the two selected areas in Greece are discussed and the conclusions reveal the empowerment characteristics of the populations on an island (Skyros) and a highland area (Pindos).

The only certainty is that the resulting argumentation of the local communities would definitely create an agony to wind power investors and the inevitable fluctuations in everyone's decisions would determine the final relationship of wind energy installations in desirable Greek locations. The prior history on the addressed issue has taught us that predicting based on all factors associated with the decision making skills is an impossible task. Taking into consideration past experiences and as many lessons the global literature has offered is the most prudent reaction RESs investors can depend on.

Our personal reaction is that if we want to promote state of art environmentally resilient societies, then environmental communication programs should be offered. But these programs, that aim to focus on responsible environmental behavior of citizens, MUST concentrate on strengthening the participants' decision-making skills and critical analysis abilities. The communication programs should be tailored to the needs of each specific community, taking into consideration their unique characteristics, their values, the hierarchy of their priorities and mostly the residents' relationship with the environment.

The present educational system has failed to give us a basic understanding of energy supply options and their impact on society and environment. We have been caught unprepared. Education plays a central role in the promotion of greater public awareness of the technology and the development of consumer confidence in the technology (Jennings, 2009). One of

the most important ingredients is the development of sustainable societies, who recognize that the use of wind energy reduces CO2 emission, mitigates climate change as well as diminishes energy dependency.

The degree of public knowledge regarding wind energy application, the public awareness about the environmental impacts of wind energy and the public attitude towards existing and new wind parks, in view of the NIMBY syndrome are concerns that need to be identified before an environmental communication program is launched. Also it should be exploited why the locals disapprove the wind power implementation and with what specific issues is this resistance associated. Only when these findings are fully analyzed, the reasons that frequently motivate residents to accept wind plans in their area would be revealed. If all these addressed points are incorporated in an educational program, it is certain that a mutual agreement would be reached. Finally, bringing environmental and gender concerns together is a relatively recent phenomenon in the UN's history. Women have a vital role in environmental management and development. Their full participation is therefore essential to achieve sustainable development and this should be taken into consideration when the educational programs are designed. Finally, it is recommended that the educational and communication responsibility is placed on a professional environmental interpreter group that would be in a position to support the role of management authorities in areas where wind energy projects are to be implemented. Taking into consideration the special social settings and biophysical environment the experts would make the wind power approach in Greece a success story.

PARTICIPATION, POLITICS AND ACTOR DYNAMICS IN SUSTAINABLE ENERGY TRANSITIONS

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Type of presentation	Oral
Session:	***Participation and Public Acceptance***

The field of sustainability transitions has a strong theoretical emphasis on the sites and modes of intervention in socio-technical systems, with the intention of informing the purposive 'steering' of the system. Such aspirations have led to the emergence of a growing debate around ideas of reflexive governance. The literature on reflexive governance has raised questions not only about the limitations of modulating an objectified system from the 'outside', but also about the multiple forms of politics which surround any attempt to intervene in the dynamics of complex systems. For critics, questions of power and politics are often obscured in what, it is argued, are optimistic and technocratic transition mechanisms. In addition, the dynamics of participation in and the democratic implications of transitions processes have been underexplored in the literature hitherto.

In order to address this lacuna, this paper develops a more comprehensive and systemic perspective on what it means to participate in socio-technical transitions, with specific reference to sustainable energy transitions in the UK. Through bringing the transitions literature into a more systematic and sustained conversation with participatory and democratic theory we offer a conception of civil society engagement in low carbon energy in terms of diverse, coexisting and interconnected assemblages of participation. We then apply this framework to understand distributed forms of innovation

and agency in UK low carbon energy transitions through analysing a series of case studies based on initial empirical insights from ongoing research as well as the findings of a workshop that brought together international scholars in the sustainability transitions field.

Our comparative analysis of these cases of civil society involvement in low carbon energy transitions – ranging from those orchestrated by formal institutions (e.g. public consultations and open innovation processes) through to interventions that are more organic, spontaneous and citizen-led (e.g. transition towns initiatives, climate camp protests) - highlights the similarities and differences in how these participatory assemblages are mediated and organised, their particular exclusions, the dynamics of their interaction in broader 'ecologies of participation', and the multiple and conflicting temporalities of energy transitions. In doing so, the paper provides a richer account of the unfolding actor dynamics and the multiple ways in which actors contribute to the ongoing reproduction of the system, as well as the many different sites of system innovation. We conclude by sketching out the development of a research agenda that takes seriously the theoretical, methodological and governance implications that are raised by engagement with broader conceptions of socio-technical participation.

STAKEHOLDER PARTICIPATION IN DEVELOPMENT OF SHALE GAS AND NUCLEAR ENERGY PROJECTS IN POLAND

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Type of presentation	Oral
Session:	***Participation and Public Acceptance***
Scope:	Stakeholder participation, nuclear energy, shale gas
Keywords:	participation, experts, fields, boundaries

Since 2009, the Polish government has been carrying out the Polish Program for Developing Nuclear Energy and since 2006 the government has issued concessions for shale gas exploration. Both investments raise interests and various (economic, environmental, social, political) concerns of stakeholders as well as of local publics. Both the nuclear energy and shale gas may be seen as revolutionary projects with a potentially deep impact on various dimensions of social and the economic development in Poland. The nuclear energy development program includes construction of two nuclear power plants in Poland and comes as an answer to the need to reduce the use of coal in Poland's power generation. Shale gas extraction, on the other hand, has been strongly promoted as a chance for gaining a greater independence from foreign gas suppliers and for changing the situation on the Central and Eastern European energy markets in. Thus, both can be seen as ambitious projects for energy transition. One of great chal-

lenges to its success is how to govern this transition at the local and national level.

The paper proposes to examine how participation of stakeholders and local communities is practiced on the national and on the regional level in Poland. The analysis has an exploratory character and is based on data collected through interviews with stakeholders, experts and policy-makers in Poland, on document analysis, as well as on participant observation carried out during various engagement activities in the Pomeranian region in Poland. The analysis will be carried out from the perspective of the technology governance approach which examines how and by whom various risks related to the developed technology are defined and assessed, what kind of structures emerge to govern them, who participates in these structures and how particular decisions are made.

The paper identifies particular problem-areas and topics that open to stakeholder and public participation and concludes that deliberation assumes reconciling logics of different fields of action. Experts, acting in different fields as consultants, have a great structural potential to play the role of translators between different logics of action. However, in practice, as the research concludes, they re-create the existing boundaries between economy, society, technology and science.

CITIES AS ARENAS OF LOW-CARBON TRANSITIONS

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Type of presentation	Oral
Session:	***Bottom-up: The Role of Cities and Regions in Energy Transitions***
Scope:	urban low-carbon transitions, eco-cities, urban energy systems
Keywords:	transition studies, socio-technical change, urban infrastructures

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Background & Context

So far, most analyses of low-carbon transitions have either focused on particular governance levels (e.g. national energy policy), particular functions (e.g. the electricity system) or particular actor perspectives (e.g. supply vs. demand side perspectives). Attempts to manage the transition of such partial systems (such as the national electricity system) underestimate the complexity and interrelatedness of these change processes and draw too optimistic a picture of the capacity to induce and shape radical change through policy interventions.

Cities are an arena where the above-mentioned levels (e.g. urban-global), functional subsystems (e.g. transport-energy) and actor constituencies (e.g. suppliers-users) meet and intersect. Measures to making energy or

transport systems more sustainable create new zones of friction and inconsistency within existing socio-technical regimes and between different sectors. Moreover, different groups of (urban) actors frame the problem of low-carbon transitions quite differently and embed it into different types of socio-political discourse which in turn may also result in conflicts and 'trials of force' between different actor perspectives. Recent actor-network-theory-inspired approaches such as 'navigational governance' (Jorgensen 2012), 'transition mediators' (Jensen 2013) or 'urban green assemblages' (Blok 2013) adopt this more conflict-oriented and actor-based view and conceive of transition strategies not so much as the (participatory) development of transition pathways, but rather through a bottom-up oriented perspective organized around different social arenas where problems of change are interpreted and framed differently and where hence conflicting perspectives come to the fore. While such an approach also provides only partial perspectives, this (unavoidable) partiality is made an explicit starting point for the conception of change strategies towards sustainability. A crucial issue for an assessment of transformative dynamics and identification of promising strategies in such a perspective is the identification of junctions and intersections where such tensions and conflicts arise which open up new opportunities for negotiations and change.

Content & Findings

In our contribution we will apply such a perspective to two exemplary case studies in the cities of Graz, Austria, and Freiburg, Germany. The Graz case is about the conflicts and re-framings taking place in an attempt to construct new hydropower stations (seen as a move to extend the basis of urban renewable electricity generation or as a destruction of a particular habitat), while the Freiburg case is about heat supply options for a low-energy-building district (seen as an opportunity to extend the sustainable district heating system or as a dis-incentive for the construction of energy-efficient passive houses). Both cases share the characteristic that in the processes of socio-technical reconfigurations aiming at greater sustainability, new zones of friction are created, different actor worlds are pitched against each other and visions of more sustainable cities become re-framed and to some extent become an emergent property of situated so-

cio-technical constellations and actor configurations. Moreover, different levels of governance are mobilized in this process, just as new social groups and interests are drawn into the arena. We believe that cities due to their social and spatial density are particular microcosms for such intersections of different lifeworlds and socio-technical systems which makes them a privileged place to study the dynamics of transition processes and its embedding in wider socio-political contexts.

Conclusion

Our case studies of Graz and Freiburg demonstrate that quite far-reaching changes can be achieved in energy infrastructures and socio-technical constellations on a city level. Though not a fundamental system transformation, we see 'regime variations' emerge at a local level which on various counts are significantly more sustainable than the nationally and internationally dominant energy regime and which also facilitate changes beyond the city (advanced standards; model for other cities etc.).

Despite various contingencies and restraints, cities can thus provide a specific and potentially powerful social context for the partial reconfiguration of dominant socio-technical regimes towards greater sustainability. Not least due to the inconsistencies, frictions and malleability of existing regime structures there is often significant room for manoeuvring to stabilise and embed such deviations by local action.

SPATIAL PLANNING, REGIONAL ENERGY AND SUSTAINABLE DEVELOPMENT: HOW ARE THEY INTERLINKED?

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Type of presentation	Oral
Session:	***Bottom-Up: The Role of Cities and Regions in Energy Transitions***

Resource scarcity is strongly connected with land use and its organisation and management. Since we cannot use renewable energy resources endlessly it is even more important to put efforts on reducing energy demand and on using resources in the most sustainable way possible. Spatial planning institutions take a crucial role in deciding where land can be used for which resources and for what purposes. Local and regional authorities have the main power to designate land leading to unfavourable decisions about sustainable land use. This results in a competition between different energy sources, land use for food or energy crops, siting decisions for power generation and agricultural versus living use.

The paper will explore the crucial aspects in regard to scarcity of land and their impacts on energy transitions. In that light it wants to investigate the influence and the possibilities of available regional energy resources to contribute to greater sustainability in the energy sector and it focuses on actors and institutions involved in the socio-technical framework conditions such a transition demands.

Based on a backcasting scenario approach combined with expert interviews, the results of the project E-Trans 2050 emphasize the manifold cross-cutting aspects of governance structures and spatial planning concerning energy transitions. Critical issues are region-specific production of energy and its use, settlement structures and transport system, which all have a determining influence on energy demand. Combining the knowledge of extensive energy use with available energy resources in

spatial planning decisions is a main challenge towards a long term sustainable energy system.

ENERGY DECISION MAKING OF FINNISH CITIES IN THE RISK SOCIETY

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Type of presentation	Oral
Session:	***Bottom-Up: The Role of Cities and Regions in Energy Transitions***
Scope:	Reactions to climate change, individualism, market economy
Keywords:	Cooperation, bioenergy, wind energy, tacit knowledge, renewable energy

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The purpose of this paper is to find out how cities have experienced their role as energy consumers and producers and how they have reacted to the risks created by society itself. The research was done in Finland in the following cities: Vaasa, Imatra, Joensuu and Espoo.

The research questions are: How did cities make their decision on what energy was bought? What are the prerequisites and barriers when making the decision to buy renewable energy? The research was implemented by an empirical approach. City managers who make energy decisions and the provincial government of the area were interviewed to discover how they have reacted to risks and uncertainties that climate change is producing. The cities chosen were cities where renewable energy has been successful or where there has been actions in the city towards low carbon energy production. Vaasa, Imatra, Joensuu and Espoo are all cities where there has been attempts to make energy production more renewable.

During the research it is becoming clearer that the characteristics of Ulrich Beck's (1992) risk society seem to be significant. Some cities in Finland have been in the forefront when making their energy production towards low carbon which is seemingly affected by rising energy prices; for example the city of Joensuu, where oil was commonly used for heating. Rising oil prices forced the decision makers already 10 years ago to search for an energy solution that is local, which increases self-sufficiency and also results in benefits in regional policy. The cities in this research are in different stages of transformation. The research also shows that when interviewing city managers in areas where renewable energy has succeeded there has been cooperation between different actors; the opposite of what Beck described when he wrote about individualism rising in society and leaving people alone with observed risks. There also seems to be indications of tacit knowledge (Polanyi 1998) because there seems to be cross-generational connections in the knowledge of certain areas of energy production.

It seems that cooperation could be the next stage after realizing that action needs to be taken to deal with changing situations and risks. There seems to be a high level of cooperation between companies, city managers and the provincial government in cities in where renewable energy has been a success. Tacit knowledge (Polanyi 1998) also plays a role when energy production decisions are being made.

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HEATING PARIS AND STOCKHOLM: THE URBAN POLITICS OF CHANGING ENERGY INFRASTRUCTURES

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Type of presentation	Oral
Session:	***Bottom-Up: The Role of Cities and Regions in Energy Transitions***

Both existing and new district heating systems are generally viewed, and sometimes effectively used, as instruments for the drastic and rapid reduction of CO2 emissions in urban regional energy provision.

Paris and Stockholm have two of the most extensive district heating systems in Europe. Local governments in the two cities have been strongly involved in the companies providing district heating within their jurisdiction. Furthermore, the related socio-technical systems are currently undergoing significant transformations, within the context of energy transition debates in the two cities.

In this paper, we document the changes that affect these systems and the debates and controversies that surround those changes.

We focus on three areas of debate within a broad urban political economy of infrastructural change:

the spatiality of the infrastructure: intensification vs. extension; and the interconnection of previously independent systems;

technological alternatives locating local centralized systems such as district heating systems between radically centralized electric heating systems and radically decentralized systems such as heat pumps for individual buildings – not to mention low energy buildings;

the governance of district heating systems, the increasing presence of market and financial logics in the management of these systems and their contestation.

Starting from previous work on both cities (cf. Rutherford 2008; Coutard and Rutherford 2010; Rutherford 2013), the paper is based on extensive empirical analysis of:

- the discourses, strategies and actions of the various actors involved in energy systems;
- the projects supported and implemented by these actors;
- the shifting economic, technical and urban configurations involved.

Taken together, these shed light on the contested urban politics of heating provision in the low- or post-carbon city.

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THE SPATIAL DIMENSION OF THE GERMAN ENERGIEWENDE: THE ROLE OF REGIONS AND CITIES

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Type of presentation	Oral
Session:	***Bottom-Up: The Role of Cities and Regions in Energy Transitions***

The transformation of the German energy sector (Energiewende) leads to a massive increase in the use of renewable energy and reshapes the existing institutional and technological energy infrastructures. This socio-technical transition has three spatial dimensions. First, the geography of electricity production and its consumption is changing. The construction of huge wind power plants and the phasing-out of nuclear power stations lead to new energy-producing regions that complement the traditional structures. Second, the geography of Germany's Energiewende shows patterns of uneven development. There is a patchwork of regional losers and winners, often accompanied by huge local differences in adapting to the new preconditions such as the phase-out of nuclear energy. Third, the political geography of energy and its regulations are characterised by widespread processes of re-scaling energy governance. Existing scales of energy governance such as the EU, its member states, or the German federal states (Länder) win competences and power in some areas (centralization), but lose them in others when they are replaced by new scales of energy governance such as subnational energy regions or local energy cooperatives (decentralization). This paper will thus focus on the spatial dimension and dynamics of the German Energiewende, in particular with respect to the role of regions and cities for this transition.

Based on this discussion on the spatial dimensions of the German Energiewende, and in particular the role of subnational authorities, the paper

illustrates the changing geography of energy governance using different empirical examples from Germany. First, villages and communities which have already reached the goal to become energy self-sufficient can be seen as an attempt to use local self-government for small-scale energy transitions that create new economic opportunities, in particular in peripheral regions hit by the economic crisis. Second, the emergence of various so-called energy regions can be understood both as part of the functional regionalisation of governance and as a contribution to regional specialisation driven by the increasing competition between regions. Third, the discussions on "smart cities" demonstrate the urban dimension of energy transitions. Cities that want to develop in this direction do not only aim for a higher degree of energy efficiency (in particular in the built environment) and a higher percentage of renewable energy sources in the energy mix, they also develop new technological solutions (e.g. smart meters) and new forms of energy governance such as the creation of new municipal energy utilities.

Driven by the German Energiewende, the emergence of "energy self-sufficient villages", "energy regions" and "smart cities" represent new spatial forms at subnational scale that constitute both major challenges and opportunities for the governance of the energy sector. The spatial dimension of the transformation of Germany's energy sector is characterised by conflicting trends such as centralisation vs. decentralisation of energy supply, increasing private sector involvement, and reclaiming public ownership of energy utilities. Understanding the geography of energy transitions and the re-scaling of energy governance can therefore contribute to developing more spatially-sensitive and smarter forms of governance capable of dealing with challenges at different scales.

CROSS-ASSET MANAGEMENT AND INFRASTRUCTURE SYSTEM TRANSITIONS: FINDINGS FROM TRAFFIC AND ENERGY SECTOR TRANSITIONS

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Type of presentation	Oral
Session:	***Bottom-Up: The Role of Cities and Regions in Energy Transitions***
Scope:	Motivations, strategies, or expectations of different actors in the energy system, ex-post analysis, urban
Keywords:	Infrastructure management organizations, cross-asset management, urban energy system, infrastructure networks

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Infrastructure management organisations (IMO) are among the most important agents in urban energy system transition (Guy, Graham and Marvin, 1996; Moss, 1998; Schröder, 1993). IMO plan, delegate, execute, control and finance activities to ensure that existing infrastructure networks (including objects like bridges and networks, like cables) provide adequate levels of service for a specified time frame and a certain range of stakeholders (Adey and Jamali, 2012). Cross-asset management comprises a broad range of infrastructure objects and networks simultaneously (Deix et al., 2012). Relevant activities relate to corporate governance, stakeholder management, intervention strategies, life cycle management, and data governance brought in line with asset management policy and strategy.

Only recently, authors in the field of infrastructure management contribute to the literature on infrastructure system transitions (Pel and Boom, 2010; Osman, 2012). Based on two ex-post case studies from the road sector in

The Netherlands, Pel and Boom (2010) suggest that the multi-level perspective (Geels, 2007) – proposed governance guidance from transition research - provides challenges for a better understanding of the role of IMO in infrastructure system transitions.

Based on a review of primary and secondary sources of urban energy transition processes (Hasselmann, 2004; Schott, 1999) and public relation activities, the author suggests that the findings of Pel and Boom (2010) also apply to ex-post analysis of urban energy systems (1880-1914). The reason is that the driving forces in urban energy system transitions were not merely arising from activities of agents that enact transition pathways in niches in relationship with other levels (regime, landscape) (Raven et al., 2012), rather from situations in which agents expect to change levels, enact short-term business operations at all levels, and are rationally processing in response to perceived fragmented semantic governance (Hasselmann, 2011; Lienert, 2013). Ex-post analyses of cross-asset management activities in urban energy system transitions in 1880 to 1914 comprise among other things the substitution of energy sources and distribution networks by alternative sources and distribution networks, centralization and integration of privately owned local power stations, the electrification of trams, and the construction, operation and management of central power plants (Hasselmann, 2004; Schott, 1999).

Ex-post analyses of infrastructure system transitions are potentially useful for understanding the role of IMO in infrastructure system transitions. By assuming stable standard processes in infrastructure system transitions the role of IMOs can be approximated by the multi-level perspective. However, by assuming dynamic and complex situations, theories of the firm (Reihlen and Ringberg, 2013) are more appropriate. That agents change levels, delegate or execute short-term business operation activities at all levels to a large extent and experience ambiguity is among the general daily life characteristics of IMOs regardless of time, space, and sector.

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ABSTRACT – ORAL PRESENTATION

FRIDAY, OCTOBER 11TH 2013

INCENTIVES FOR REDUCING GLOBAL FOSSIL FUEL COMBUSTION:

SOMETHING TO LOOK FORWARD TO

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Type of presentation	Oral
Session:	***Incentives, Instruments and Markets***
Keywords:	Sustainable energy generation and use; global perspective; risks of lead markets; emission permits; efficiency; taxation.

While decreasing in some countries, emissions of fossil fuels are globally increasing. For reasons of climate risks and for sustainability a mechanism is needed to reduce those on a global scale. Permits have been discussed as means to achieve this. However, their current implementations have not been able to deliver, largely due to resistance from some, partially large countries and industrial groups (Gilbertson, Reyes 2009). Therefore it is proposed to increase the attractiveness of permit schemes by redistributing their revenues to the population, on an individual basis and at a global scale. Similar veins of thoughts have been discussed as a “negative income tax” (Rhys-Williams 1942, Friedman 1962, Gerhardt/Weber 1984, Jaeger/Weber 1988). If a permit system with such an income stream were implemented, it would provide:

A reduction in the use of fossil fuels and emissions.

Lower costs than those of other systems, as the price of permits would only rise to the level needed (Dales 1968).

Transparency of the mechanism, as the burden would be designed to achieve the emission objective and the revenues be redistributed to everybody.

An incentive for developing more energy efficient ways of life and related energy consumption and production technologies.

Such a process would embed countries which support a faster transition to sustainability into a global trend; it would reduce the risk of being a first mover lead market. Furthermore, the process would create economic incentives to search for the most efficient sustainable paths, at a global scale. Thus, it would be an efficient global governance process. The proposal could be made known to those who would benefit from it most in the short run, i.e. the poorer part of the world population, via the Internet, traditional media, and, of course, also via oral communication. It could even be communicated and discussed on a novel type of a little regulated high-power wireless Internet (Elsner, Weber 2012) to counter any lack of local networks and any censorship. Such a dissemination and discussion of the concept would reduce the power of rentearning groups, as in OPEC countries. Because it would be beneficial to the poorest part of the population, opposition from affluent actors could be counter-balanced. The process could be supported by globally operating organisations, such as the United Nations, ICANN, the International Telecommunications Society or other NGOs (Noam 2012). The volume of globally necessary emission permits depends on the reduction targets to be set and is unknown because of the nature of the process. Hence the amount available for redistribution is unknown, too. It may be needed to make one payment per year, for efficiency reasons, e.g. via a mobile phone-based payment system. Burden by mid-income earners could be counterbalanced by making purchases of permits partially tax-deductible. In order to increase ecological effects as well as income redistribution effects the implementation of an emission permit redistribution system could be amended with a redistribution system for other permit or rent revenues, and combined with a taxation system with both positive and negative taxes. The author argues on the basis that income distribution has a free variable (Jaeger, Weber 1988), so the design and in particular all rates would be subject to political negotiations. Given the positive social and ecological effects, the majority of the world population would then have “something to look forward to”, as Lady Rhys-Williams put it in her pioneering work (1942).

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PROMOTING MARKET AND SYSTEM INTEGRATION OF RENEWABLE ENERGIES THROUGH PREMIUM SCHEMES – A CASE STUDY OF THE GERMAN MARKET PREMIUM

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Type of presentation	Oral	
Session:	***Incentives, Instruments and Markets***	
Keywords:	Renewable Energies, Market Integration, System Integration, Market Premium, Renewable Energy Sources Act (EEG), Efficiency	

With the share of renewable energies within the electricity sector rising, improving their market integration (i.e. inclusion in the steering and remuneration processes of the electricity market) and system integration (i.e. enhanced responsibility for grid stability) is of increasing importance. To transform the energy system efficiently while ensuring security of supply, it is necessary to increase the alignment of renewable electricity production with short- and longterm market signals. By offering plant operators a premium on top of the electricity market price, premium schemes represent a potential option for achieving this, and have been implemented by several EU member states. The design of such schemes, meanwhile, varies considerably, as well as their importance within national policy mixes for renewable energy support. This paper examines the effectiveness and efficiency of the German market premium scheme adopted in 2012. In Germany, technology-specific feed-in tariffs have proven to be a successful instrument for promoting renewable energies. However, in combination

with priority purchase and transmission rules, they also shield renewable energy producers from price- and quantityrelated market signals both, leading to inefficient production decisions (e.g. supply of electricity even when market prices are negative) and problems for grid stability (e.g. grid congestion). To address this, the Renewable Energy Sources Act 2012 introduced a premium scheme to provide market experience to renewable plant operators and incentives for demandoriented electricity production. Plant operators can now choose between feed-in tariffs and market premium scheme on a monthly basis. The latter covers the difference between the feed-in tariff a plant would be entitled to and the average market value of the electricity generated; moreover, producers receive a management premium intended to cover additional costs resulting from their direct participation in the market. By selling electricity when demand – and therefore the market price – is high, producers can earn revenues above the average market values used in calculating the market premium, thereby improving their income relative to the fixed feed-in tariff. In this way, the market premium is supposed to incentivise demand-oriented electricity production. Building on an evaluation of early experiences, we examine whether the German market premium scheme in its current design improves market and/or system integration, and if it seems suitable in principle to contribute to these aims (effectiveness). Also, potential efficiency gains and additional costs of "administering integration" are discussed (efficiency). While market integration in a strict sense (i.e. exposing renewables to price risks) is not the purpose of the German premium scheme, it has successfully increased participation in direct marketing. However, windfall profits are high, and the benefits of gradually leading plant operators towards the market are questionable. Incentives for demand-oriented electricity production are established, but they prove insufficient particularly in the case of intermittent renewable energy sources. It seems therefore unlikely that the German market premium scheme in its current form can significantly improve the market and system integration of renewable energies. To conclude, we provide an outlook on alternative designs of premium schemes, and discuss whether they seem better suited for addressing the challenges ahead.

INCENTIVE REGULATION AND INFRASTRUCTURE TRANSFORMATION

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Type of presentation	Oral
Session:	***Incentives, Instruments and Markets***

The development of energy infrastructure – including investments and innovations in electricity networks – is a vital part of the Energy Transformation. Yet, up to now incentive regulation of the networks has notably aimed at reducing the costs of existing networks. This contribution analyses whether and how the regulation of electricity networks can tackle these new objectives. It is based on Bauknecht (2012)[1].

This question is approached on the basis of integration of distributed generation (DG) in the electricity grid, which is becoming more and more important in many countries. Faced with a range of technical challenges, diverse regulatory approaches are analysed and assessed in terms of the connection and integration of DG as well as grid innovation and transformation. The role of risk and uncertainty plays a key role in this analysis.

The question arises of the extent to which the standard model of competitive electricity markets including the standard model of network regulation is in a position to facilitate the long-term transformation of energy infrastructure. It is often assumed that additional objectives can be integrated in the market and regulatory framework, e.g. with the help of emissions trading. But that is not enough. The long-term development of energy infrastructure in particular and the related risk and uncertainties requires additional approaches to avoid a lock-in effects and to coordinate innovation processes.

The analysis shows how incentive regulation can accommodate the efficient integration of DG as an additional objective. Beyond the incentive mechanism, there are tensions between the standard model and the governance of system transformation, but the two approaches also have some features in common. Incentive regulation explicitly deals with risks and

uncertainties, yet mainly in the short-term. There is scope for this model to incorporate governance mechanisms that are geared towards infrastructure transformation. Further development of the overall regulatory framework is needed – which includes the regulatory authority assuming a new role and, alongside economic incentives to improve efficiency, contributing to the coordination of the long-term development of the energy system.

Two country studies – on the UK and Denmark respectively – show how DG can be integrated in network regulation in practice. The example of the UK demonstrates how incentive regulation can be expanded while the example of Denmark shows how DG can be very successfully set up outside the scope of incentive regulation. In terms of infrastructure transformation, the UK the regulator Ofgem is no longer just a competition and efficiency authority; now it also has the official task of promoting the sustainable development of the UK's energy supply. In Denmark this coordinating role is assumed by the national transmission system operator Energnet.dk.

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A PUBLIC CHOICE VIEW OF THE EUROPEAN EMISSIONS TRADING SCHEME – IMPLICATIONS FOR THE CLIMATE AND ENERGY POLICY-MIX

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Type of presentation	Oral	
Session:	***Incentives, Instruments and Markets***	

In this paper, we analyze the rationale for an energy policy mix when the European Emissions Trading Scheme (ETS) is considered from a public choice perspective. While neo-classical economists hold that the ETS is the first-best policy instrument to promote a transition of the energy sector towards sustainability, we cast a radically different picture: We argue that the economic textbook model of the ETS implausibly assumes 1) efficient policy design and 2) climate protection as the single objective of policy intervention. Contrary to these assumptions, we first propose that the ETS originates from a political bargaining game within a context of multiple policy objectives. In particular, the emissions cap is negotiated between regulators and emitters with the emitters' abatement costs as crucial bargaining variable. Second, we point out that there may be further objectives such as autonomous renewable energy sources (RES) targets or zero nuclear energy generation. These may be economically warranted – e.g. due to externalities arising from fossil-nuclear energy production (long-run risks of nuclear power, oil spills, security of supply) – or simply politically set. Our paper analyzes what these deviations imply for the design of climate and energy policy. To that aim, we devise a framework comprising four possible cases which have to be differentiated for policy analysis (see Figure 1).

		Objectives of regulation	
		Single Objective: Climate protection	Multiple objectives
ETS design	corresponds to a theoretical model	Case A	Case C
	results from a political bargaining game	Case B	Case D

Figure 1: Overview

In case A we first replicate the textbook model where the ETS is efficiently designed and only meant to address climate change. We confirm that in this case, any additional policy is welfare-decreasing. In case B we subsequently demonstrate that if the emissions cap is continuously negotiated, introducing RES support schemes may make more ambitious reduction targets politically feasible. In case C, we refer to the classical Tinbergen rule, which implies that a policy mix is needed to address multiple policy objectives at least cost. Finally, we argue that most likely climate and energy policy operates in a context such as case D, where the ETS is continuously negotiated and multiple objectives are to be attained. Under this case, additional policy-instruments have the strongest legitimation. We show that RES- support may actually improve the overall cost-performance of climate and energy policy as it helps to internalize other externalities than climate change.

In sum, a public choice perspective questions whether the ETS alone may provide optimal climate and energy policy. Our analysis suggests that support for renewable energies 1) contributes to a more effective ETS-design and 2) may even increase the overall efficiency of climate and energy policy if other externalities and policy objectives besides climate protection are considered. Thus, our analysis also shows that a public choice view not necessarily entails negative evaluations concerning efficiency and effectiveness of a policy mix.

REMUNERATION OF RES AND CONVENTIONAL POWER: CONVERGENCE OR CONTINUED DIVERGENCE?

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Type of presentation Oral

Session: ***Incentives, Instruments And Markets***

Scope: Refinancing scheme for renewables

Keywords: Renewable energy policy; remuneration systems; power system integration

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During the last ten years, renewable electricity has grown very fast in Germany. With 25% of the national power demand reached, it is obvious that the system transformation towards a sustainable energy supply has left the phase of introducing renewables to the system. Germany is entering a next stage, where the coexistence of the remaining (and partly necessary) conventional generation and the ever growing share of renewables will play a crucial role. Onshore wind and photovoltaics (PV) have shown to be able to expand much faster than the other renewable technologies, mainly due to significant cost reductions. It has become highly probable that the variable renewables (VRES) onshore wind – to smaller extent also offshore wind - and PV are going to be the pillars of the electricity generation in the transformed power system, maybe even in the entire energy system. Accordingly, the other elements of the system, demand, conventional and non-intermittend RES, need to gradually assume the role of flexibility options and balance the variable power generation of wind and PV.

With the large cost reductions reached, some argue that VRES don't need any support organised by the state any more. However, wholesale power market price analyses show, that VRES have specific disadvantages on marginal-cost-based markets like the current energy-only market (EOM) for electricity, because, whenever VRES generate much power due to favouring weather conditions, price decline. Kopp et al (2012, 247) therefore argue, that "due to the merit order effect, intermittent renewable energy sources, such as wind power and photovoltaic, cannot be financed through power markets alone, even if their full costs fall below those of convention-

al power plants". Therefore, the question emerges: how to remunerate VRES in the coming phase of system transformation?

Currently, there is a call for "market integration" of renewables, in the sense that (V)RES should be confronted with power price signals, just like any other (conventional) power generation technology, and that their investors and operators should bear the associated risks (cp. VKU 2013, Ragwitz et al 2013). Historical institutionalism reminds us to mind path dependencies (Pierson et al 2002). The current system of wholesale power markets based on the marginal costs of power generation was introduced for nuclear and fossil generation technologies that do have significant marginal costs, mainly for fuel. VRES, however, have almost no marginal, but significant capital costs. Therefore, it could be argued that integrating VRES into the current markets just doesn't fit and may slow down the transformation.

The paper will line out the main underlying assumptions about trading of conventional and renewable power and show to which degree they are related to specific generation technologies. Next, the main arguments and goals put forward in favour of the integration of VRES into current electricity markets are lined out and structured. They encompass effects on the dispatch of and investment in VRES, on the costs to be borne by the consumers, on improvements of the system infrastructure and possibilities for learning for later stages of the transformation process. Also perceptions of fairness play a significant role, voiced as a call for a "level-playing field" between RES and conventional generation (VKU 2013, 10).

These general goals are then assessed in light of current policy proposals and the surrounding context of the electricity system, i. a. the remaining stock of conventional generation, and principles of allocating risks (cp. Franke 1987).

The paper concludes that many promises of confronting VRES investors and operators to price signals of an electricity market of the current configuration cannot be proven right or wrong in theoretical argumentation, but need to be tested – to find out, e.g. to which degree revenues of intelligent RES power trading can in fact reduce the burden for consumers (who pay the RES surcharge). The assessment of principles to allocate risks shows

that increasing VRES operator's risks needs further supporting arguments than put forward so far. A poorly realised integration of VRES into the existing power markets can rather hamper than advance the transformation of the power sector, if the necessary pressure on nuclear and fossil technologies to adapt to growing shares of VRES power isn't sustained. The outcome could then be that VRES become flexibility options themselves, used to complement continuously inflexible baseload power.

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DISTRIBUTED ENERGY RESOURCES: AN AGENT-BASED MODEL OF INTERDEPENDENT HOUSEHOLD INVESTMENT DECISIONS IN ELECTRICITY GENERATION

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Type of presentation	Oral
Session:	***Incentives, Instruments and Markets***
Scope:	We present an agent-based modelling approach to address self-organization aspects of investment into distributed electricity generation. Focus of the paper is on small- and medium-scale PV and wind power installations within a smart distribution grid.
Keywords:	Distributed energy resources; investment decisions; prosumers; households; agent-based modelling

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Background & Context

Distributed Energy Resources (DER) are small-scale power generation and storage technologies located close to where electricity is used. They provide a more sustainable electric power system. Through smart electricity grids, DER offer the potential for lower cost, higher service reliability, increased energy efficiency, energy independence and, not least, the use of renewable energy generation technologies at a significant level. However,

most approaches to the issue of DER and Smart Grid deployment apply implicit and largely unfounded assumptions about the participation of actors. Recently, it has been pointed out that these new technical systems are not sufficient for a further low-carbon transition. Distributed investments must be embedded in an adequate institutional framework (Wolsink 2012).

Content & Findings

In this paper we explore the consequences of self-organization of consumers that become producers ("prosumers"), thus building-up a distributed electricity system. Prosumers are consumers who additionally provide electricity from their decentralized generation to the grid. Attention is also given to the institutional, especially the regulatory framework governing the relation between distributors of electricity and the prosumers (Agrell and Bogetoft 2011, Bolton and Foxon 2011). We adopt an agent-based simulation approach to inquire into the spatio-temporal build-up of such a DER infrastructure (DeMaagd and Bauer 2011, Gebetsroither et al. 2006).

Hereby we focus on mutually dependent investment decisions of interconnected households into small- and medium-scale renewable generation (photovoltaics, wind). It is the process of consumers becoming prosumers we are particularly interested in. Other actors—energy suppliers, network operators, regulatory authorities, government agencies—who also take investment decisions are considered as exogenous factors in our model. Decisions are influenced by economic considerations (investment), technical constraints (grid topology and other space-related factors), human factors, social interactions and, not least, institutions (esp. ownership structures and regulatory constraints).

Conclusion

Model development and implementation (in a Repast-based application) is ongoing. First simulations with a basic model show critical dependencies and data requirements for model calibration. A rigid empirical calibration seems necessary to draw conclusions on the institutional and socio-economic factors that stimulate actor investment into DER.

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MARKET FORMATION ACTIVITIES IN THE PROCESS OF TRANSFORMATION OF THE GERMAN ENERGY SYSTEM: THE CASE OF DIRECT MARKETING OF ELECTRICITY GENERATED BY RENEWABLE ENERGIES

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Type of presentation	Oral
Session:	***Incentives, Instruments and Markets***

Due to effective policy support to date, electricity generated by renewable energies already accounts for a relevant share - 20.5% - of the German electricity supply (cf. BMU 2012). As a result, enforced market integration and a more demand-oriented feed-in of electricity from renewable energies are considered as crucial next steps in the process of transformation of the German energy system. In this process of market integration a variety of actors is involved. They develop innovative strategies, business models and services aiming at the realisation of a more demand-oriented feed-in of electricity from renewable energies.

This process of market formation and integration and especially the interplay of innovative actors and institutions will be analysed in this paper. Firstly the paper investigates how different actors have formulated competing ideas on how to organise such a process and then secondly how they actually developed and implemented different strategies and business models. The analysis covers various actor groups and types. The first important actor group which is analysed consists of different types of renewable energy power plant operators, because these actors have to accept to leave the sheltered niche of the EEG and to take market risks. But key-actors of the process of market integration and hence of the analysis are so-called “intermediaries”. Intermediaries are those actors, who actually develop innovative business models and services and try to convince re-

newable energy power plant operators to opt out of the fixed EEG remuneration and sell the electricity on the open market instead.

The actor analysis is led by assumptions derived from the theory of strategic action fields (cf. Fligstein/McAdam 2011), as well as from neo-institutionalist concepts of organisational sociology. Activities related to market integration are interpreted as phenomena of an emergent strategic action field (SAF). In an emergent SAF challenger actors as well as incumbent actors try to set-up and influence field rules and build close coalitions with governance units in order to ensure that the new market is shaped according to their needs.

The empirical work is based on literature review, guideline-based interviews with representatives of the important actor groups and an actor's workshop which has been conducted in order to discuss results of the analysis.

The paper will conclude with some results. It will explain why different actors have developed and implemented what kind of different strategies and business models. Furthermore it will show and explain why only some strategies have been successful. It will demonstrate how the organisation of the new market was backed and supported by the development and implementation of new regulative frameworks. Hence the paper will come to the conclusion, that only those actors successfully organised and co-designed the new market, who managed to establish close coalitions with governance units.

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MAKING SENSE OF COMMUNITY PARTICIPATION SCHEMES IN THE GERMAN ENERGY TRANSITION

WITH A FOCUS ON MUNICIPAL UTILITIES AND ENERGY COOPERATIVES

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Type of presentation	Oral
Session:	***Incentives, Instruments and Markets***
Keywords:	Motivations, strategies, or expectations of different actors in the energy system; cooperative governance structures and processes; “risks and uncertainties”

Social acceptance is a vital prerequisite condition for the Energy Transition to succeed. Fi-nancial participation of citizens has been found to have a positive impact on social ac-ceptance. Moreover, examples of wind power projects which failed due to a lack of local ac-ceptance abound. Thus, community participation schemes might be seen as a risk manage-ment tool, at least from a financial perspective. The same might hold from an economy-wide perspective with regard to the Energy Transition as a whole.

In the contribution, the role, motivations, and strategies of different actors involved in “com-munity participation schemes” – understood from a financial perspective as a contribution of equity capital with according decision and control rights (community participation in a proper sense/community ownership) or other forms of capital like sub-ordinated loans, bonds or saving certificates (community participation in a wider sense) – are analyzed using results from different completed and ongoing research projects. Findings rest on a mixture of different qualitative methods (interviews, document analysis) and descriptive statistics.

First, a typology of community participation schemes, actors involved in these endeavors and their motivations is presented, taking account of different phases of higher community in-volvement in the energy sector in Germany (rural electrification processes in the early 20th century, alternative energy experiments and early implementation in the 1980s and 1990s, and a revival of now EEG-backed citizen participation schemes since the mid-2000s which received further impetus with the (renewed) proclamation of the “Energiewende” in 2011).

Second, the author focuses on municipal utilities as a specific actor and presents findings from research on the role, motivations, and strategies of these utilities with regard to citizen participation schemes which are most often seen as an instrument of customer retention ra-ther than financing strategy, often a response to political pressure. This might explain the choice of the type of financing used in these cases of (mostly) top-down processes.

Third, the recent surge in energy cooperatives as a hybrid institutional arrangement is ana-lyzed against the earlier limited partnership (more precisely: GmbH & Co. KG) model. Factors affecting the path towards one of the models are identified (legal requirements/ charac-teristics, start-up costs, tax advantages, consultants and tax counselors as advisers, role models & institutional path dependence). The cooperative model is used to illustrate one specific mode of governance within the broader range of citizen participation schemes.

Fourth, findings from the previous parts are bound together to present a theoretical frame-work which might be used to understand citizen participation schemes in the German energy transition.

ENERGY DEMAND AND MOTORIZED INDIVIDUAL TRAVEL BEHAVIOR:

EXPLORING REGIONAL DIFFERENCES IN GERMANY

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Type of presentation	Oral
Session:	***Mobility in Context of Energy Transitions***

Aggregate energy demand of motorized individual travel results to a large extent from the volume of travel (vehicle-km) and the composition of the vehicle fleet in terms of vehicle size and technological properties (e.g. powertrain). Both aspects are explained by individual decisions on the form of travel (mode choice, traveled distances etc.) and car ownership (size, technology etc.).

The paper explores regional differences of user behavior on motorized individual travel and car ownership in Germany and how they can explain overall levels of current and future energy demand. The analysis contrasts two distinct area types: rural *(Raumordnungsregion Südthüringen)* and urban *(Berlin)*. Differences between the rural and urban context become evident by the densities of urban infrastructure, mobility supply (especially in public transport with higher service frequencies in the urban context) and through socio-economic disparities (for instance household structures and income) and different travel behavioural patterns. It will be shown that the contrasted regions show distinctive characteristics regarding mobility behavior and car ownership, factors that do have an important influence on transport-related energy demand.

According to studies on mobility the above mentioned spatial categories in general show similar mobility needs, i.e. the mobility rate in either area does not differ significantly (cf. MiD 2008). But within the areas the en route time (trip duration), the daily distances traveled and the modes used differ substantially. Based on existing studies, surveys and literature, the paper identifies a set of most relevant attributes regarding travel behaviour in the regions. These attributes embrace manifold *mobility indicators* (e.g. mobility rates, modal split, distances traveled by trip purposes and socio-economic characteristics, etc.). In a second step and based on these indicators we construct rural and urban mobility profiles as well as of the regional vehicle fleet structures. Our principal research objective is to identify those factors that are able to explain the most important differences between the urban and rural context. Main data sources among others are the representative travel surveys *Mobilität in Deutschland (MiD 2008)* and *System repräsentativer Verkehrsbefragungen (SrV 2008).* In addition we use statistics provided by the *Kraftfahrt-Bundesamt (KBA, Federal Motor Transport Authority)* regarding car purchase and ownership. Based on the profiles, in a third step we assess the implications both quantitatively and qualitatively for current energy demand in the regions and how the profiles might affect the potentials for reducing energy demand in the future.

ELECTROMOBILITY: COMPARING PUBLIC POLICIES IN EUROPE, THE UNITED STATES AND CHINA

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Type of presentation:	Oral
Session:	***Mobility in Context of Energy Transitions***
Scope:	Government policies to promote electrical vehicles
Keywords:	Public policy, electrical vehicles

Advances in battery technology have stimulated renewed interest in electricity as a source of energy to propel motor vehicles. Most large-volume vehicle manufacturers, plus some innovative start-up firms, are now offering either a plug-in electric vehicle (PEV) or a plug-in hybrid electric vehicle (PHEV) for sale to consumers. The interest in plug-in vehicles, and related systems of "electromobility" that involve utilities and municipalities, has been boosted by the enactment of public policies at the regional, national and local levels of government (e.g., R&D subsidies, production subsidies, consumer incentives/rebates, subsidized charging stations, discounted rates for recharging vehicles, compliance incentives for manufactures in regulatory regimes, direct mandates of zero-emission vehicles and privileged access to inner-city parking and HOV lanes on congested highways). There are two basic rationales for governmental promotion of electric vehicle technology: risk management and industrial policy. This paper (1) provides operational definitions of these two concepts, (2) supplies case studies of electromobility policies in California, the USA, China, the European Union, Germany and France, and (3) classifies each political jurisdiction according to whether the current policies are primarily risk

management, primarily industrial policy, or a substantial blend of the two. The paper concludes that the USA, Germany and China are engaged primarily in industrial policy whereas the European Union is engaged primarily in risk management. France and California are engaged in a substantial blend of industrial policy and risk management. The paper documents significant variation in public policy: the pro-electromobility policies of California are more aggressive than those in the United States; the policies in France are more aggressive than those in the European Union. Germany appears to be hedging on electromobility, supporting R&D and small-scale community demonstrations but refraining from large-scale production subsidies and consumer incentives. California is the only political jurisdiction to enact, through its zero-emission vehicle (ZEV) program, a de facto mandate of plug-in electric vehicles. For those jurisdictions that are engaged in industrial policy, the paper urges further inquiry into the ramifications for international trade policy since subsidies of a domestic electric vehicle industry may not be compliant with WTO principles.

PSYCHOLOGICAL FRAMEWORKS TO EXPLAIN REBOUND EFFECTS IN CAR-BASED MOBILITY

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Type of presentation	Oral
Session:	***Mobility in Context of Energy Transitions***
Scope:	Energy consumption of private households in the mobility sector
Keywords:	rebound; mobility; consumer behaviour

Background & Context

Individual road transportation accounts for 82% of mobility-related primary energy demand in Germany (Umweltbundesamt 2012). In line with EU legislation, the average CO2 emissions per passenger car shall be lowered from 142 gram per passenger kilometre today to 130 g/pkm by 2015 – by more efficient driving technology. Consumer behavior can reduce, compensate or overcompensate those technological efficiency gains though. Related to car-based mobility, roughly three forms of direct rebound effects can emerge from consumer behavior: (1) Consumers buy vehicles that are more efficient but bigger, heavier and more powerful than their previous ones, e.g. changing from a station-wagon to a sport utility vehicle; (2) Consumers drive longer distances with their more efficient cars, e.g. changes of modal split in favor of car-based mobility; (3) Consumers adopt more energy-intensive use patterns, e.g. driving faster or with less anticipation.

Content & Findings

The current work defines rebound as the discrepancy between the decrease in energy consumption expected from technical efficiency improvements (engineering savings) and the actual total energy consumption affected by consumer behavior.

Economic theory hypothesizes that efficiency gains lead to gains in money or value on the consumer side, such as reduced costs per kilometre (e.g. Frondel 2012), thereby causing direct rebound effects. Psychological analysis of rebound aims at a deeper understanding of the underlying mental processes and social influences. Therefore, consumer behavior relevant to energy consumption in car-based mobility needs to be investigated within a multi-causal framework. One promising approach is to conceptualise rebound behavior as non-ecological behavior, using the Comprehensive Action Determination Model (CADM) of Klöckner & Blöbaum (2010). In terms of explained variance, the CADM has proved its adequacy to predict ecological, respective non-ecological behavior, such as travel mode choice (ibid.). The CADM names multiple factors that influence ecological behavior: normative processes, affecting habitual and intentional processes, and situational influences, affecting all other components as well. However, in order to depict the human-technology interaction relevant for the total energy consumption level in the context of rebound effects, the CADM needs to be complemented by a technological and a monetary component. Against this background, the technical efficiency improvement and monetary/value gains can be located at the situational level within the CADM. Now, the influence of changes in these two situational factors on the habitual processes could be most relevant to explain the three kinds of rebound behavior mentioned above. Changes in technical efficiency seem to operate as a situational facilitating factor to all three kinds of mobility-related rebound behavior. For example the subjective and objective constraints to drive faster are released leading again to a high level of energy consumption. This phenomenon might be moderated by monetary advantages, as supposed by economic theory, but it can be argued that other psychological phenomena play an important role as well: moral licensing, moral leakening, moral hazard (Santarius 2012) and mental accounting, amongst

others. These well-known phenomena from other fields such as dieting, might play the intermediating role between rebound-specific situational changes and changes in habits and ecological behavior.

Conclusion

A comprehensive theoretical framework is needed for a detailed understanding of psychological determinants of rebound effects. Normative, habitual and intentional processes, situational influences (technical efficiency and monetary gains), as well as psychological phenomena of moral releasing have to be considered. The approach outlined above might lead to a differentiated explanation of the complex human-technology interaction underlying the three forms of rebound effects.

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INTEGRATION OF ELECTRIC VEHICLES INTO THE FUTURE ENERGY SUPPLY SYSTEM

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Type of presentation	oral
Session:	***Mobility in Context of Energy Transitions***
Scope:	technical structural analysis of
Keywords:	energy scenario, vehicle fleet development, integration, of electric mobility

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Background & Context

Electric mobility will play a key role for the transformation of the energy supply in Germany [the “Energiewende”]. A successful market development of plug-in hybrids and battery electric vehicles and a high fleet penetration in the long-term are the most efficient and effective measure for integrating large amounts of renewable energy into the transport sector and for achieving efficiency targets. Possible benefits of and incentives for buying such vehicles are conditioned by their possible technical and infrastructural development pathways as well as their prospects to interact in a positive manner with the power supply system. Managing the charging of electric vehicles enables to reduce peak demand and to use excess electricity especially during episodes with high wind power generation and low overall power demand. Electric mobility can have a significant contribution to climate protection and energy efficiency only if it is driven by renewable power. Therefore the integration of electric vehicles in the future power supply system is important for their success. Different business models and market actors could be part of this transformation, combining strategies for vehicle sales and marketing, charge control and electricity supply.

Content & Findings

This contribution presents results of an integrative analysis of medium to long-term prospects of plug-in electric vehicles (full electric and hybrid) in a supply system with a high share of renewable energy sources. More information on the methodologies used for this study can be found in [1]. Scenarios for a successful technology and market development of EV were calculated using a model based approach (VECTOR 21), combining the range and promise of technologies, economic development indicators as well as the demand side and customer needs. The final successful market scenario for Germany results in 27 Million of plug-in electric vehicles by the year 2050, thereof 11 Million full battery electric vehicles (BEV) and 16 Million plug-in-hybrids. In addition, user profiles were derived from today's real world driving profiles and used for calculating the resulting electricity demand as well as the grid-connected battery capacity of the vehicle fleet in hourly resolution. As an exemplary result of the analysis, the battery capacity of a small BEV available for load balancing (total battery capacity of 22 kWh) varies between 14 kWh in the late evening and early morning hours down to a minimum of about 3 to 4 kWh by 9 o'clock in the morning. These results are very sensitive to the assumed user profiles, annual mileage and battery sizes. The battery profiles represent a realistic estimation of the available capacity for load-balancing in the power distribution system and were integrated into an energy system model (REMix). This model was applied to simulate optimized charging strategies in a supply system with other load balancing options such as controllable and flexible power plants, pumped hydro storages as well as transmission in the power grids of Europe. The scenario for the expansion of renewable energy use for power generation is based on normative scenario studies described in [2]. The results show that controlled battery charging can reduce the residual peak load (i.e. required installed capacity of back-up power plants) between 3.5 and 4.5 GW and can increase the use of excess electricity of about 4 to 5 TWh per year compared to uncontrolled loading (less than 10% of approx. 54 TWh electricity demand of EV in Germany in 2050). However, the role

of other flexibility options mentioned above appear to have a much higher potential for peak shaving and valley filling in Germany than EV.

Conclusions

The successful fleet scenario and the optimized implementation of controlled battery charging were calculated based on several explicit assumptions regarding future technologies, their costs and performance as well as assumptions about political framework conditions such as promotion schemes and binding targets. The analysis follows optimistic but still realistic long-term pathways for technology development, the individual transport sector and the transformation of the energy system that are documented in [1]. BEV reach a share of 28% and plug-in-hybrids of 34% of the total passenger car fleet in 2050. Important sensitive factors for the fleet simulation are low CO_2 emission targets requiring the implementation of efficiency measures and EV market breakthrough but also a successful development of the batteries regarding energy density, costs and durability. Implicit preconditions for this model based results are a general market and consumer acceptance of electric vehicles and customers choosing their new cars considering primarily total costs of ownership and following statistical consumer profiles without a different attitude towards EV compared to conventional cars. In reality, consumer concerns including price differential, range, recharging infrastructure and speed of recharge may continue to be significant market barriers. On the other side, changing mobility behaviours and expectations about EV could even increase their market success compared to the scenario. The results of the energy system modeling indicate overall economic potentials of a controlled battery charging and set a technical-structural framework also for social studies focussing on behaviour, acceptance and other social responses to facilities and concepts for controlled battery charging. Possible contributions and therefore economic potentials of controlled charging are significant but should not be overestimated. Batteries for electric driving are predominantly the key for the transformation in the transport sector but cannot solve the problem of load balancing in the national electricity supply system alone. Other flexibility options remain much more promising such as hydro power stations, flexible cogeneration plants with heat storages and the extension of the power transmission grid.

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DO FIRST MOVER ADVANTAGES FOR PRODUCERS OF ENERGY EFFICIENT APPLIANCES EXIST? THE CASE OF REFRIGERATORS

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Type of presentation	Oral
Session:	***Energy and Economic Development***
Scope:	Lead market of environmental innovations
	First mover advantages
	Energy efficiency
Keywords:	Household appliances, energy efficiency, refrigerators,lead market, first mover

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Background & Context

Global warming is an important driver for innovation in environmental technologies. Innovations in energy efficiency contribute not only to reach environmental targets, they can be furthermore economically profitable. Private households can e.g. reduce their costs by using efficient household appliances or lighting. It is therefore not surprising that the global market for energy efficiency technologies is expected to become an increasing and important future market.

Content & Findings

Against this background, this paper analyses lead market potentials of different countries for energy efficient household appliances. As an example, we use the case of refrigerators since energy efficiency regulation – and thus responding innovations - diffused already on a global scale and quite quickly regarding this product. As it is common in a globalized econ-

omy, emerging countries have entered the market and have become relevant competitors. On the other hand, markets are saturated in developed countries. The relevant question is if the emerging countries are lagging behind the suppliers from developed countries, or if and how far they are catching up?

In this paper we will apply an indicator-based approach to measure the relevance of different factors. We use in particular the lead market approach for environmental innovations which identified six success factors for such markets: Comparative price and demand advantages, a high reputation in environmental technology (transfer advantage), similar market conditions (export advantage), a competitive market structure and ambitious environmental regulation.

Conclusion

As our results show, Germany has the most lead market potentials for energy-efficient refrigerators, followed by Korea und Italy. Moreover, first mover advantages for energy efficiency innovators can be observed on this market. But they exist only for technology intensive products with high quality. There is also a market offering second mover advantages for producers with lower quality and lower energy efficiency standards.

For environmental and innovation policy in the pioneering countries the tradition of setting ambitious energy efficiency standards has been confirmed to be successful also regarding the international diffusion, these standards spill over to other countries over time, and give the home industry a good competitive position. Especially regarding household appliances more dynamic labels – as have been discussed during the past revision of the EU Energy Label - would be helpful to improve the signaling effects of more energy efficient appliances to consumers.

For firms in countries that do not have sufficient lead market potentials, product innovations must be targeted to fit the preferences of users in the lead market. The screening of the lead market can take on varying degrees

of intensity. A good way for a company to establish ties with a lead market is via producers with long experience.

Our research also needs to acknowledge limitations. As a consequence of our definition of the household appliances industry it needs to be kept in mind that the lead market advantages identified refer to the aggregate sector. It may well be that lead market advantages within a sector vary from one product group to another, or even between individual products. Another limitation refers to the relatively short time series of data available which hampers a comparison of the indicators over time.

DO DEPLOYMENT POLICIES REDUCE TECHNOLOGICAL DIVERSITY? EVIDENCE FROM PATENT CITATION NETWORKS

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Type of presentation	Oral
Session:	***Energy and Economic Development***
Keywords:	Demand-pull policy, Technological diversity, Patent citations, Social network analysis

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To address climate change and other sustainability issues, an increasing number of countries adopt innovation policy strategies that include subsidized demand for clean energy technologies ('deployment policies'), e.g., in form of feed-in tariffs for renewable electricity or investment subsidies to early adopters. Apart from subsidizing diffusion, a central objective is to bring down costs of the technologies. Research has shown that deployment policies can represent strong incentives for innovation, but especially their timing entails trade-offs. Short-term cost advantages for the most advanced configuration created through incremental innovation and economies of scale may render alternative – and potentially superior – designs unattractive. To avoid a premature lock-in, deployment policies should thus be introduced rather late in the lifecycle of the technology. At the same time, technological standardization and so-called "dominant designs" may enable numerous innovations in lower levels of the design hierarchy. Demand-side incentives can therefore be beneficial early on in the evolution

of an industry. So far, very little quantitative empirical research has been carried out on this trade-off.

We use the case of wind energy to analyze technological development in the presence of policy support. We created a database of 30,000 patent families filed globally in the field of wind energy over the last 45 years. We apply social network analysis methodology to the patent citation data in order to identify the core technological 'trajectories', and the relative distance of each patent to other prior and contemporary inventions. Centrality measures calculated for sequential networks are used to measure whether a patent is close to or deviates from the main stream of developments at the time of its application. By linking these results to policy data, we explore the proposition that policy-driven market growth has led to a lock-in of dominant designs from core to peripheral components in a gradual process (e.g., first the three-blade rotor and the horizontal axis, then the generator, etc).

Our results show that innovation in wind energy proceeds along the design hierarchy, i.e., from the design architecture to single components. Rather than 'drying out', however, innovative activity increased even as higher-level components were standardized. Furthermore, we identified the main technological trajectories for wind energy technology development as visible in patent filings. The beginnings and ends of these key development paths – the sources and sinks of the trajectories – were analyzed in detail. Initial analyses of these sources and sinks of technological trajectories indicate that diversity decreased in several confined periods of standardization, i.e., that many sinks can be found in these years. These spikes in sinks tend to fall in periods of high market growth rather than of large market size. High research funding, on the other hand, coincided with increasing technological diversity. Our results imply that (i) deployment policies can be a suitable innovation policy instrument; (ii) that incentives should be designed to establish a predictable, steadily growing market; (iii) that 'boom-and-bust' cycles are to be avoided by any means; and (iv) that complementary research support can help avoiding premature lock-ins.

SWARM ELECTRIFICATION - SUGGESTING A PARADIGM CHANGE THROUGH BUILDING MICROGRIDS BOTTOM-UP

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Type of presentation:	Oral
Session:	***Energy and Economic Development***
Scope:	Rural electrification / Community empowerment
Keywords:	Bottom-up electrification; microgrid; Bangladesh; microfinance

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Background & Context

Discussions on economic development are often centered on two key players of development: the government and the private sector. This approach however, fails to take into account “the crucial third agent, in whose name development is carried out: people organi[z]ed as communities and collectives, people seen not as “beneficiaries” of the state or “consumers” of private services but as drivers of their own destiny, empowered to self-provision basic needs and to govern from below” [1]. This paper suggests a new conceptual approach on rural electrification where a microgrid is built through the people´s own resources from the bottom-up aiming to empow-

er a large share of today´s 1.3 billion people lacking access to electricity. In light of the multiple global initiatives driving rural electrification and sustainable development today, especially the growing importance placed on sustainable energy supply by the United Nations as an important catalyst in the effort towards achieving their Millennium Development Goals, rural energy programs and practitioners around the world have a new opportunity to address the issue of sustainable energy access for all [2]. The authors advocate a bottom-up user-centered concept in the pursuit of sustainable and effective models. For rural electrification strategies, small-scale energy systems can provide rapidly deployable, affordable, and flexible solutions, which can address end-user needs on a highly adaptable basis [3]. Grid-based solutions, on the other hand, can offer great potential to provide stable and sufficient electricity supply for productive uses, which play a key role in bolstering economic development [4]. Here the authors suggest a concept coined as swarm electrification, where individual stand-alone energy systems are linked together to form a microgrid. This approach can be likened to the concept of swarm intelligence, where each individual node brings independent input to create a conglomerate of value even greater than the sum of its parts [5].

Content & Findings

The “Energy for All Case” expects that only 30% of rural areas can be electrified via connection to centralized grids, whereas 70% of rural areas can be connected either with mini-grids or with small stand-alone off-grid solutions [6]. The International Energy Agency (IEA) further argues that "smart grids could enable a transition from simple, one-off approaches to electrification (e.g. battery- or solar PV-based household electrification) to community grids that can then connect to national and regional grids" [7]. This paper is based on these observations and suggests a paradigm change for rural electrification. We advocate changing the mindset of prohibitive last mile cost (centralized perspective) to an end-user perspective and the people´s development capabilities. Under the concept of swarm electrification, end-users act as simultaneous consumers and producers of electricity, so-called prosumers, forming the core nodes of a microgrid that can expand towards and eventually interconnect with national or regional grids.

This paper applies the concept in a case study for Bangladesh. The approach builds on network effects generated through the inclusion of localized economies with strong producer-consumer linkages embedded within larger systems of trade and exchange. Solar Home Systems (SHS), currently consisting of a 20 to 85Wp solar panel, battery, and charge controller, have begun to electrify Bangladeshi rural communities [8]. Two million SHS are already installed through microfinance schemes implemented by so-called Partner Organizations (POs), who are expanding their customer base at a rate of 65,000 systems per month, making Bangladesh the fastest growing SHS market in the world. However, many households do not fully utilize the electricity stored in their battery, resulting in a full battery by midday, limiting the generation potential of their systems [9]. At the same time, some households require electricity beyond what their systems can supply and others cannot afford a complete SHS, remaining trapped in energy poverty. There is a need for more cost effective, reliable and flexible electricity supply. Swarm electrification suggests interlinking multiple households with SHS and households without systems. The resulting network can facilitate trade and increase usage flexibility and reliability. The trade of electricity allows SHS owners to generate additional income through the sale of (excess) electricity and consumption smoothing. The electrification of additional households and businesses has the potential to improve the broader community's social and economic quality of life. With recent advances in information and communications technologies and smart grid technologies, this bottom-up interconnected electrification approach becomes feasible [10]. Moreover, the author´s initial calculations suggest that the process can be designed in a financially mutually beneficial way.

Conclusion

Despite the current trend toward traditional top-down mini-grids, the authors are convinced that the concept of swarm electrification is a better fit to meet the combined goals of universal energy access for all and fostering rural development. The approach does not require a large initial capital investment, or top-down system sizing. Moreover, critical social ac-

ceptance issues can be addressed. In the mechanism presented, the microgrid is based on organic growth, empowering the people themselves to build a critical mass to swarm toward the national grid and to thereby enjoy greater negotiation power with energy utilities.

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FORMULATING A SUSTAINABLE ENERGY POLICY REGIME FOR BRUNEI DARUSSALEM

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Type of presentation:	Oral
Session:	***Energy and Economic Development***
Scope:	Transition Management, Socio-technical regime transition, Fossil fuels dependencies
Keywords:	energy transition, oil and gas, energy policy

Background and Context

Brunei is very developed in economic and social terms as well as having an established infrastructure across the country as a result of extensive petroleum and natural gas fields that are the sources of one of the highest per capita Gross Domestic Product (GDP) in the world. But dependence on oil and gas is not only very environmentally damaging, it also sets the country back in a world that is increasingly concerned with climate change and the need for low carbon solutions. The economy of the country is strictly reliant on the export of oil and gas, with profits responsible for approximately 50 per cent of Brunei's GDP and 90 per cent of exports and government revenue.

The focus in this paper is on changes in a socio-technical system, in this case of decarbonising the energy sector of Brunei. It is not about transitions towards a particular energy future (hydrogen, nuclear, wind) which is a technology-driven approach but about investigating the factors that enable an emergence of alternative sources of energy as part of Brunei's energy mix and policy. This leads into investigating decisions and choices

made at the level of values, deep rooted beliefs, of the landscape that affect the regime and niches pursued as well as finding ways to create niches that can influence the corresponding regime and landscapes.

Content and Findings

Within science and technology studies, theories on transitions are slowly emerging, how the combinations of social and technical systems change from one equilibrium into the next. Drawing on conceptions of socio-technical regimes transitions, I explore the discourses in the policy arena regarding energy issues and their interaction with incumbent technologies in order to inform pathways to move beyond fossil fuels. The Sultanate is governed by a monarchy with several positions within the government taken up by members of the Royal Family. Brunei's unique political and socio-economical structure differentiates the country from its neighbouring South-East Asian countries and hence has led to a development of a hierarchical government structure with many decisions implemented from the top-down with little space for plans to be done otherwise.

In 2006, 6 per cent of the daily production of crude oil was locally refined, while the rest was exported out of the country, 34 per cent to ASEAN (Association of South East Asian Nations) countries which include Singapore, Malaysia, Thailand and others, 17.6 per cent to the Republic of Korea and 16.8 per cent to Australia (Brunei Energy Division, 2007). Due to its substantial hydrocarbon exports, the country of Brunei has been able to achieve a high standard of living, the population especially benefiting from low tariff regimes such as for electricity and water utilities and no personal income tax.Despite the Sultanate's status as a net exporter of oil and gas, the country imports about half of the refined petroleum products it consumes, owing to the country's limited domestic refining capacity and human resource knowledge and expertise in the area. Moving in a direction away from conventional industries is proving to be a challenge for a country that is low on population and (other) primary resources required to augment economic capacities.

Being that oil and gas is the primary source of income for the country, much of the information especially those related to revenue and expenses

are difficult to obtain and not openly discussed as they are politically sensitive matters. The mindset that is often practiced with these matters is to not discuss the future potentials that might affect the oil and gas industry. The governance structure of the country has resulted in a far from transparent government with no or little culture of openness to discuss issues. In many situations but seemingly less in the present, government matters are decided upon without consultations with the public.

Conclusion

The aim is to acquire an understanding of Brunei's current situation as well as the potential visualisation for Brunei in order to motivate and inform practices and innovation of the current energy sector. As an oil and gas producer, the country, though can be of effect, is less concerned about issues that are prominent in Western countries, such as oil price volatility, energy independence and meeting energy demand and hence are more concerned with seemingly more pressing economical concerns of the country to increase local business development and human resources. The strong social and political entrenchment in present energy sources shadows the required recognition of applying transition theories. It is to Brunei's advantage to incorporate policy directions that are designed with a different energy future in mind, one that has the potential to diversify the economy, offer more job opportunities and expand business chances.

ENERGY COOPERATIVES, ENERGY TURN, AND QUALITY OF LIFE

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Type of presentation	Oral
Session:	***Bottom-Up: The Role of Cities and Regions in Energy Transitions***

Energy cooperatives (henceforth "EC") are an increasingly important player for the transformation processes of current energy systems towards sustainability and decentralization. In Germany, there has been a considerable growth in the number of EC in the last years, most prominently for wind and solar power. How ever, recent developments show that EC have also gained importance in the field of energy distribution grids. Research concerning EC is a relatively young phenomenon. Former investigation has concentrated on single fields as management-processes, public acceptance or legal aspects. The newly funded German research project EnGeno focus on the transformation potential and the role of EC for the energy turn connecting micro-, meso-, and macro-level issues. The democratic organisation of EC, related to the source of their financial assets, makes them a special actor for creating public acceptance for system transformations in energy turns. At the same time, being a member of energy cooperatives or even a user of its services may alter one's quality of life.

We conceptualise the link between EC activities and their members' and users' quality of life by combining psychological and economic-philosophical approaches. Methodologically, we rely on a mixed methods design, comprising of quantitative and qualitative analysis.

Traditional economic models focus mainly on self-interest (ego motivation) as the motivation behind behavioural decisions. On the contrary, socio-psychological action models (e.g. Norm-activation model (Schwartz/Howard 1981) and the Theory of planned behaviour (Ajzen 1991)) also acknowledge normative and affective factors influencing behaviour. In the research project, we will identify the motivations and activity barriers for participation in energy cooperatives. Here, we assume the relevance of regional disparities as well as of different motivational structures of energy cooperation members, such as financial gain, energy security, enhancement of community structures. Of further interest are the differences in the pro-environmental behaviour of members and non-members of EC.

Following the Human Scale development approach (HSDA) of Manfred Max-Neef (Max-Neef 1986) as an alternative to neo-classical approaches to explain human behaviour, the motivations for pro-social behaviour of members of EC may be carved out. “Quality of life” is the focus of the HSDA and its matrix of needs and satisfiers offers an alternative model of qualitative growth to conventional development thinking where quantitative growth is key. Following the HSDA, we define quality of life as the potential of individual stakeholders to meet their need through appropriate strategies. This implies the assessment of elements and conditions that inhibit peoples´ possibilities of adequately satisfying their desired personal well-being and collective welfare. EC offer several possibilities to influence strategies to meet the needs of their members and users, ranging from an economic return on investments to more social group creation effects to psychological effects based on identity or self-efficacy. The latter might play a prominent role as people increasingly reject knowledge about global warming etc. due to perceived helplessness. Being member of EC may offer ways to strengthen individuals´ freedom of action to act sustainably that link self- and other regarding goals and thereby increase the overall well-being. With this understanding we can draw conclusions on how organisational and political governance processes in the energy sector should be implemented towards transitions that increase long-term sustainability and immediate quality of life.

FOSTERING LOW CARBON ROUTINES IN EVERYDAY LIFE:

STRENGTHENING A CONSUMER PERSPECTIVE IN ENERGY TRANSFORMATIONS ON A LOCAL LEVEL

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Type of presentation	Oral
Session:	***Bottom-Up: The Role of Cities and Regions in Energy Trasitions***
Keywords:	energy consumption, routines, less energy intensive lifestyle, social inclusion, urban policie

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Cities and urban agglomerations contribute significantly to the overall energy consumption in Germany. Municipal authorities can foster energy transformations by restructuring energy provision, local public transport and other local services. While many cities have set up ambitious targets and schemes for a "greening" of urban infrastructure, the transformation of energy provision still needs to be connected more closely to behavioural adaptations towards low carbon and less energy intensive lifestyles of city dwellers. At the same time, cities have to tackle with increasing social marginalisation and cultural diversity among the urban population.

The contribution takes up the role of green consumption and sustainable lifestyles and links these issues to the transition of urban energy systems. The focus is on the promotion of low carbon and less energy intensive routines among the urban population in the areas of household energy consumption and mobility. Particular emphasis is given to favourable motives and conditions supporting the diffusion of low carbon and less energy

intensive routines as well as to barriers impeding these changes in different social groups.

Our contribution presents results from a broad empirical survey among 2.000 inhabitants of Frankfurt/Main and Munich, two large German cities which are forerunners for innovative climate policies. The survey provides insights into the actual status of low carbon routines within different segments of the urban population. Furthermore it investigates the willingness to change routines in everyday life as well as the readiness to participate in collective initiatives and social networks, promoting the diffusion of low carbon and less energy intensive practices. Drawing on these findings, pioneers, forerunners and other target groups for mainstreaming less energy intensive practices within different segments of the urban population are identified.

These findings will be linked to the results of an empirical analysis on how selected climate policy instruments in Frankfurt and Munich (in particular communication and incentives) are actually taken into account. Against this backdrop, we will discuss some implications on how energy and climate policy instruments on a local level could be better linked to the needs of city dwellers in order to catalyse the promotion and adoption of low carbon routines among the urban population.

The contribution is based on the joint project “KlimaAlltag – low carbon lifestyles in a zero emissions city” (www.klima-alltag.de) funded by the German Ministry for research and Education), and coordinated by ISOE.

LOCAL INITIATIVES AND THE TRANSFORMATION OF THE ENERGY SECTOR

ACTOR-BASED STRATEGIES, ALTERNATIVE CONCEPTIONS AND VARIANTS OF CHANGE

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Type of presentation	Oral
Session:	***Bottom-Up: The Role of Cities and Regions in Energy Transitions***

While the traditional form of power generation and supply is based on centralized structures with large-scale power plants, the objective of a strongly decentralized form of energy supply is increasingly becoming of importance. This upcoming new paradigm of a transformed energy system challenges not only policies at a European, national, and state ("Bundesländer") level. New governance arrangements emerge (Joss 2011) and need to be tested for persistence and functionality.

Based on the current situation and the assumption that the field of energy supply is already unstable and unorganized, the question arises whether there is an opportunity for an alternative path creation (a change towards sustainable energy infrastructures) resulting from local/regional initiatives. In existing regulatory and market frameworks, important technical and institutional innovations for the energy transition have been developed, tested and applied at regional levels. Regions that experiment with sociotechnical innovations and implement new concepts must develop new governance structures under highly uncertain conditions.

The objective of this paper is therefore to analyze specific structural and organizational designs of regionally located governance that has and is being established by the action of actors involved. The phenomena which are studied focus on local initiatives (Solarcomplex

AG, Hegau Bodensee Region/ Regional Innovation agency Regina, Neumarkt in Upper Palatinate region/Verband Abfallwirtschaftsgesellschaft des Neckar- Odenwald-Kreis mbH, Hohenlohe-Odenwald-Tauber region/Bioenergyregion Südschwarzwald plus, Region Southern Black Forest) and conflicts resulting from the development of new governance-arrangements based on vague responsibilities of specific actors such as public-private partnerships and publicly initiated – but legislatively privately organized – outfits. The paper will analyze and compare the aforementioned cases with a focus on actor constellations, actor-based strategies and conceptions. Data will be collected by document analysis and qualitative expert interviews.

According to the theory of strategic action fields as developed by Neil Fligstein and Douglas McAdam (2011/2012) the requirements for structural changes are up to/depending on a collective construction/attribution of threat or opportunity as a starting point of organizational appropriation depending on actors violating field rules with respect to acceptable practices and engaging in “innovative action” in defense or support of group interests. Challengers are able to sense an opportunity to use new methods to advance their position in the field and are thus likely to engage in innovative action and sustain mobilization. Then they slowly begin to institutionalize new practices and rules and use opportunities of intentionally constructing new pathways. (Fligstein/McAdam

2011:10)

The study therefore adds to the understanding of emerging pathways and the role of action of change agents in the context of energy infrastructure transitions. The results will help to (re)construct the specific structural and organizational designs (Dolata 2011) based on the analysis of mobilization processes that are dependent on the action of challenger actors.

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CAUTION: INTERDEPENDENCIES.

ON THE INTERLINKAGES BETWEEN ENERGY POLICIES AND RESIDENTIAL SEGREGATION.

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Session:	***Bottom-Up: The Role of Cities and Regions in Energy Transitions***	

Investment into the building stock is a commonly known driver of neighbourhood change, of dislocations and, thus, of residential segregation. Energy efficiency measures are investments into the building stock. Whereas energy poverty or vulnerability of households is usually discussed as a matter of low income groups living in substandard housing conditions, and refurbishment measures come as a solution to the problem. We suggest looking at both sides of the process: The social and physical structures of a city as a precondition or barrier to energy efficiency measures or RE use on the one hand, and on the other hand to how they might drive residential segregation.

In Germany, the energy efficiency performance of buildings and the use of RE for heating and electricity is encouraged by funding of pilot projects and financial support for retrofitting existing building stock. These policies pronounce social trade-offs. Retrofitting is said to be a classic win-win solution, protecting the climate, upgrading the housing stock for the economic benefit of the owners, and reducing fuel costs for households.

Recently, this win-win assumption is challenged. Scholars see a potential for a new wave of gentrification supported by ecological means, and the association of German housing companies claimed that increased retrofit-

ting attempts would deepen the socio-spatial differentiation of cities. More affluent households could pay for well insulated buildings and enjoy the thermal comfort of upgraded housing stock, whereas underprivileged groups would concentrate in rather unfavorable housing conditions and – on top – suffer from fuel poverty in harsh winters.

Our paper aims at discussing the inter-linkages between retrofitting and RE-supporting policies and residential segregation in Germany, the synergies and conflicts which are to be expected. Recent survey data will be presented which explore these interrelations in the case of Delitzsch, a small town in eastern Germany.

TOWARDS A SUSTAINABLE GRID DEVELOPMENT REGIME? A COMPARISON OF BRITISH, NORWEGIAN AND SWEDISH GRID DEVELOPMENT

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Type of presentation	Oral	
Session:	***Sustainable Grid Developement***	

In several countries worldwide electricity grids are currently undergoing numerous changes, due to the need of decarbonisation, a rising awareness on security of supply and ageing electricity grids. However, for that task social, environmental and economic aspects of grid development have to be taken into consideration in order to sustainably re-design electricity grids. This paper examines the grid development regimes in three countries - Great Britain, Norway and Sweden – and discusses the challenges and opportunities they present for a sustainable grid development . While the electricity grid in both Great Britain and Sweden historically developed in a centralized way, in Norway, grid development was decentral, from local electricity works, through regional coordination into a nation-wide grid. In all three countries, the electricity sector was deregulated in the 1990s, resulting in a shift from state monopoly to private ownership in Britain and a shift towards public limited companies operating under market conditions in Sweden and Norway. But while cutting costs became the major priority in

both Britain and Norway after deregulation, with drastically sinking investments in grid infrastructure, investments fell less drastically in Sweden. Today, however, investment needs are high in all three countries. Accordingly, we examine how need for grid development is argued, framed and legitimated and, namely, how planning processes, regulatory practices and public engagement are implemented in the three countries In this paper we propose that it is crucial to consider the barriers and opportunities posed by the development of electricity grids per se, for the achievement of greener and more sustainable energy systems. We argue that it is important to examine the development of electricity networks as socio-technical systems and, through that, discuss the possibilities

PUBLIC BELIEFS ABOUT HIGH VOLTAGE POWER LINES: A COMPARISON BETWEEN NORWAY, SWEDEN AND UNITED KINGDOM

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Type of presentation	Oral	
Session:	***Sustainable Grid Development***	

Several European countries are currently planning significant new transmission and distribution networks, namely following European directives and policies for tackling climate change concerns, but also for ensuring security of supply, namely through creating European-level electricity networks, among other factors. However, the actual implementation of those policies requires initiatives able to adapt to varying national, regional and local contexts. This becomes very clear if we consider that despite overall public support in several European countries regarding renewable energy and associated technologies, cases of local opposition to the construction of specific projects are frequent. Nevertheless, and while public beliefs and responses to renewable energy infrastructures per se have been often examined in several countries, the examination of beliefs regarding high voltage power lines has been rather neglected so far. This despite the fact that the development of electricity grids is playing a key role in the transition of energy systems to address the climate and energy crises. In this paper we intend to examine public beliefs about high voltage power lines in

Norway, Sweden and UK and discuss how those are entangled with these specific national contexts, but also with more transversal factors, such as regarding perceptions about how the decision-making processes for the construction of high voltage power lines occur, or trust in the transmission system operators. For that, we conducted surveys with representative samples of Norway, Sweden and UK population. Results highlight the importance of examining public beliefs about high voltage power lines per se and also that despite similarities in those beliefs across the three countries, there are also relevant differences that must be taken into account. We discuss the importance of these results for a more sustainable grid development at national and European levels.

PARADOXICAL LANDSCAPES: PERCEPTIONS AND SOCIAL ACCEPTANCE RELATED TO GRID DEVELOPMENT

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Type of presentation	Oral	
Session:	***Sustainable Grid Development***	

Current grid policy in Norway and the UK emphasises the need to minimize visual impacts upon valued landscapes, often by co-localising new grid development (especially overhead lines) with existing infrastructure. This policy draws on the notion that the visual impacts of overhead lines are perceived by the public as less disturbing – thus more acceptable – if they are routed in landscapes already defined as 'modified landscapes'. Currently new grid development projects take place in localities that are different both in terms of how landscapes are perceived by the people living in the areas as well as in terms of the degree the landscapes are affected by infrastructural elements already in place (overhead lines, bridges, railways, motorways). Drawing on analyses of focus group discussions about grid development proposals in different localities in Norway and the UK, this paper will explore local residents' perceptions and social acceptance related to 'alien' and 'natural' landscape elements in light of the following themes: the routing of grids, technology preferences (overhead lines versus undergrounding, pylon design and camouflage measures), as well as

the view on the 'need' for grids. The analysis will draw on theories of representation of technology and landscapes, as well as theories of sense of place and perceptions of paradoxical landscapes.

LEGITIMATE GRID DEVELOPMENT? ON PARTICIPATION AND INVOLVEMENT IN NATIONAL GRID DEVELOPMENT PROJECTS

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Session:	***Sustainable Grid Development***	

In the planning and construction of renewable energy, public acceptance is increasingly considered a key challenge and an important planning issue at both EU and national levels. Public acceptance is of particular relevance within grid development as such infrastructure is increasingly requested in the face of global climate change, while often heavily contested at the local level. In order to deal with the challenge of public acceptance, dialogues with affected local residents are emphasized as a tool to reduce controversy in new grid proposals. How communication between the gird companies, authorities and the local residents is organized varies greatly between countries, both in terms of practical organization and topics raised. Little prior research exists on the actual outcomes of the different ways of conducting participatory measures across countries and how these participatory measures are perceived by the involved local stakeholders. Drawing on an analysis of grid development projects in Norway and the UK (policy documents, applications, interviews and focus group discussions with residents) this paper will explore how different participatory measures are per-

ceived in terms of 'trust', ‘fairness’ and the 'need' for grids. The paper will further address how public concerns in concrete grid projects are reflected in suggested mitigation measures (alternative routing, camouflage measures, economic compensation etc.) in Norway and the UK.

ABSTRACTS - POSTER PRESENTATION

TWO SCENARIOS FOR GOVERNING RAPID ENERGY TRANSITIONS

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Type of presentation	Poster

Recent climate science suggests that response requires steep, quick and complete turn around of our current emissions trajectory. Highlighting reductions that could be rapidly produced from the energy sector, I explore two narratives at which transitions to sustainable energy systems could be governed. These narratives are: (1) militaristic, i.e. state-led, top-down, institutionalized, monocentric debates with particular emphasis on a scenario response that parallels wartime mobilization, and (2) cross-sectoral efforts which include the more bottom-up, polycentric, community-led initiatives that are currently occurring in various locations in the world. I ask four complementary questions. What are the strategies in each of the scenario? By contrasting the rationalities between these two forms of mobilization, what are the unique controversies that these scenarios entail? What are the similarities and differences between these scenarios in terms of: governance aspects, technologies, actors, patterns, processes, infrastructure, and rules? What are the limitations and criticisms of the two scenarios? In the end, I posit the questions: Are there points of intersections between these two scenarios?

CHALLENGES FOR ENERGY SYSTEM STUDIES WITH REGARD TO NEW QUESTIONS ARISING WITH A HIGH SHARE OF RENEWABLE ENERGY USED

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Type of presentation	Poster

In order to support energy policy, potential developments of energy systems in future are analysed by deriving if-then statements via complex scenario analyses. Additionally to the systematic lack of knowledge and uncertainty with respect to future processes, these analyses vary in methodology, coverage, detail and crucial assumptions. Thus, the study results are difficult to interpret and can hardly be compared to each other. Therefore, robust answers to specific questions about the future energy system can barely be derived from them.

In the contribution, the heterogeneity of realised studies is revealed on the basis of a meta-analysis of about fifteen relevant studies on the central question of how much energy storage may be needed in a future energy system fulfilling certain targets with regard to carbon reduction. Despite of the large number of studies, the plurality of the studies is insufficient to lead to robust estimates. The discussion of the studies' characteristics shows that differences in methodologies, considered technologies, assumptions and compilation of results lead to a variety of statements.

In the second part, the design of an interdisciplinary project group is discussed which has been installed at the Europäische Akademie with the purpose to analyse the particular challenges arising with the analysis of future energy systems with a high share of renewable energy used. The

focus is laid on secure energy supply. Based on the characterisation of these new types of energy systems, aims of the project are

- to reveal benefits and limitations of the contribution of scientific analysis of these systems as support to policy,
- to develop guidelines for the interpretation of existing studies and the design and reporting of new studies, and
- to work out recommendations for the improved integration of system-analytical expertise in political advisory work.

LONG-TERM ENERGY DEMAND MODELLING – ANALYZING THE IMPACT OF MYOPIC TECHNOLOGICAL KNOWLEDGE

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Type of presentation	Poster
Scope:	Development of a new methodological concept to consider technological myopia in long-term energy demand modelling
Keywords:	bottom-up analysis, regression analysis, patent analysis, energy efficiency, residential sector

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Background and objective

Increasing energy efficiency is known to be a significant driver for decarbonizing the energy system. To analyze the impact of energy efficiency ex ante usually technology-based models are applied. However, because of limited knowledge about long-term technological progress, the applicability of this approach is restricted for long modelling horizons (Grupp, 1997). The objective of this study is to develop a concept that considers technology myopia in long-term energy demand modelling in the residential sector. To emphasize the added value of this study the concept will be applied to the German residential sector in terms of explorative scenarios up to 2050 focusing on electricity.

Methodological approach

The concept consists of a combination of three well established methodological approaches utilized in futurology: Chronological coupling of a bottom-up and a top-down model based on a system analytical approach including patent analysis as an indicator of innovation. The bottom-up model covers final energy demand by energy appliances for the short- to medium-term horizon (EAM). Because detailed techno-economic parameters are not available in the long run, the top-down model is used for the medium- to long-term horizon, which calculates final energy demand based on energy services (ESM). Thus, in the ESM, energy demand is abstracted from certain appliances. To define the transition between the two energy models, the obsolescence of technological knowledge about certain energy appliances needs to be captured. In order to do so, a patent-based model is applied that quantifies technological progress by appliances using an innovation indicator (KSM). Thus, the heterogeneity of energy-using appliances leads to the effect that the transition period between the energy demand models differ depending on the innovation characteristics (Figure 2).

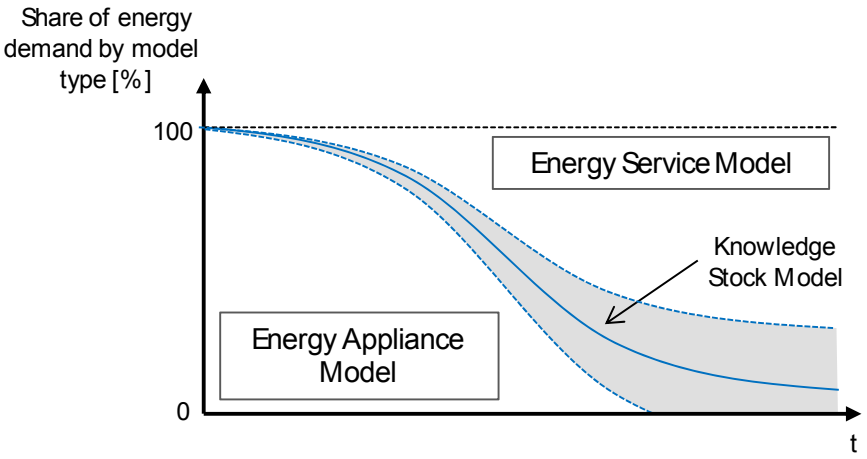

Figure 2: Schematic representation of model interaction under consideration of a differing pace of technological progress of each energy-using appliance

Energy Appliance Model: EAM is based on the simulation method and designed as a vintage stock model. To calculate energy demand the EAM comprises socio-economic (macro-economic drivers) and techno-economic

(detailed stock representation) parameters. EAM is structured by three hierarchical levels: energy appliances (e.g. televisions), technologies (e.g. LCD) and efficiency classes (e.g. A++). Overall, the model captures 32 appliance alternatives. The diffusion process is modelled based on sigmoid growth curves in combination with a multinomial logit approach and different types of distribution functions (Bass, 1969; Tutz, 2000). In a subsequent step EAM results are decomposed by effects (activity, structural and intensity effect) using additive logarithmic mean Divisia Index (LMDI I) to analyze the influencing factors on energy demand change.

Energy Service Model: As techno-economic parameters are not known for long-term modelling horizons, ESM energy demand calculation is abstracted from certain appliances and represented by energy services capturing individual's needs (Gordon et al., 2005). ESM captures 12 energy services. In order to do so the energy-using appliances of EAM are assigned to these energy services. Although, there is just myopic technological knowledge the impacts, for instance, of policies on energy demand need to be implicitly captured in the ESM to provide a consistent scenario design as well. ESM results are calculated based on multivariate regression analysis, whereas the regression parameters are derived from empirical data and EAM results by effect.

Knowledge Stock Model: The knowledge stock per energy-using appliance is the key driver to derive a time span in which calculation of energy demand shifts from EAM to ESM. This time span depends on the appliance specific pace of technological progress. As technological progress cannot directly be measured, backward citations of patent documents that refer to existing patents are used as correlative indicator (technological cycle time indicator; TCT indicator) to draw conclusions about the magnitude of technological myopia (Park et al., 2006). To capture the continuous drop in ability to explain the future state of technology development (obsolescence of technological knowledge) the TCT indicator is transformed into exponential depreciation rates. When coupling EAM and ESM the depreciation rate serves as a weighting factor of the energy demand calculated.

Results and conclusions

The analysis of explorative scenarios investigating the energy saving potentials in the German residential sector showed that ambitious energy

policies are able to decrease sectoral electricity demand on a level of 100.2 TWh by 2050. This is a decline of electricity demand between 2008-2050 of 39.3 TWh (-28.2%). Whereas in the reference scenario just 15.7 % of electricity demand in 2050 is calculated by the EAM, the percentual share even decreases in the HPI scenario down to 1.3%. Hence, the average annual decrease of electricity demand calculated by EAM in the period 2008-2050 is -2.0% in reference scenario and -2.2% in high-policy-intensity scenario. Due to the heterogeneity of energy-using appliances in terms of reinvestment cycles, market entrance and elimination as well as adoption behaviour, the suitability to model energy demand based on a bottom-up approach largely varies. Whereas bottom-up based electricity demand projections for ICT are merely just possible for short-term horizons (<10 years) as already in 2018 50% of electricity demand is only calculated by the EAM, for heating systems the share of 50% is reached in 2034.

The discussion about the chronological coupling of different types of energy demand models in combination with patent indicators illustrates that the modelling concept developed enables a more transparent analysis of energy scenarios than conventional bottom-up studies. There are three advantages of the developed methodological concept: (I) all strengths of bottom-up modelling are retained for the short- to medium term projection horizon, (II) by including an innovation indicator an energy-using appliance specific time horizon can be defined that determines the point in time, when energy demand can no longer be calculated via techno-economic parameters, (III) for the medium- to long-term projection horizon energy demand is abstracted from certain energy-using appliances and represented by energy services, whereas energy demand is still calculated on a high level of granularity due to the decomposition approach.

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Type of presentation Poster

As a PhD student of the Corvinus University of Budapest the economy of the biomass utilization is in the focus of my PhD research. The focal question of my doctoral research is that how could the bioenergy contribute to rural development? Concerning this question it must be clarified what bioenergy means and what kinds of utilizations are available. In my research it is focused on the opportunities of energy production based on biomass, especially second generation technologies and heating applications. I hope my research could support the policy makers to create the suitable position of bioenergy in rural development.

The main aim is to compare the effects on rural development of small and large scale utilization's of biomass as a natural resource of energy. The most important aspects of this analysis are on the one hand the business point of view and on the other hand the socio-economic point of view. From business aspect it is the main question that which is the optimal or effective operation size. First of all it is important to know which potentials of feedstock are available for the biomass utilization. Being aware of potential can be created a CBA (cost-benefit analysis) on the supply chains of utilization technologies which can be compared.

95 Socio-economic aspect is more difficult to determine. It will be based on a quantitative analysis of estimates of stakeholder groups. Four main stakeholder groups will be interviewed about the effects of bioenergy. It will focus mainly on the contributing to rural development and the sustainability of the continuous food and feedstock supply for bioenergy. Very important factor is the long-term "job" effect of the whole bioenergy supply chain as the main actor of rural development. Also important is that what size of bioenergy is estimated by interviewee to contribute more to rural development in long-term.

The research method can be divided into three main parts:

- Description of the regions and the technological side. The research is concentrated on a rural region in Hungary (larger scale: Dél-Dunantúl

as “NUTS 2” region; smaller scale: a “LAU 1” region in Dél-Dunántúl, but it is not defined, yet) which will be described (regional profile, current land use and comparative advantages). The description of available technologies will be based on literature and the practical results.

- Potential analysis. Here will be shown for both of the scales what are the most suitable resources for the utilization and which potential (volume and quality in long term production) can be available in a sustainable energy and food supply – based on the statically dates and the current land use. The most suitable bioenergy feedstocks are the currently not utilized agricultural and forestry residues or by-products and the currently not used croplands as energy plantations.
- Assessment analysis of the stakeholder groups. In this part will be analysed the estimations of the most important stakeholders on the production and utilization sides as well by interviewing: farmers or forestry represents, industrial experts, policy makers and independent researchers.

DEMAND MODELLING BY HYBRID ENERGY SYSTEM MODELS- LINKING THE RESULTS OF PROCESS-BASED BOTTOM-UP MODELS AND MACROECONOMIC MODELS

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Type of presentation	Poster
Scope:	Hybrid energy system demand modelling
Keywords:	Hybrid energy system, industry, physical production, structural change, material efficiency

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Background and Context

Current energy demand and supply modelling methods often use either macroeconomic (top-down) models or technology specific (bottom-up) models to project future energy demand or supply. However, as every model is an abstraction of reality, these models have strengths and weaknesses. Being aware of the advantages and disadvantages of these modelling approaches the current trend of energy demand modelling goes into the direction of hybrid energy demand modelling; but the idea to apply them simultaneously is around for some time (Böhringer, 1998; Böhringer et al. 2006, 2008; Hourcade, 2006; Herbst et al., 2012a and others).

When linking top-down and bottom-up model systems, a few major challenges have to be met, as macroeconomic models deliver economic values (e.g. gross domestic product, gross value added of economic branches, or

income of private households) as results, while bottom-up models need physical quantities (e.g. tonnes of cement, number of employees, or square meters) as inputs for their model runs. Consequently the transformation of the macroeconomic and microeconomic drivers of top down models into physical inputs via standardized causal relationships is the major additional component of a hybrid energy model system in order to achieve accurate and transparent energy demand projections. These hybrid energy model systems open the opportunity to adequately simulate the impacts of general energy or climate policies (e.g. CO_2-taxes or emission certificates) by the top- down model and of sector- or technology-specific policy bundles by bottom-up models in a consistent manner.

Content and Findings

The poster reports on a transformation module between macroeconomic information (stemming from a top down model or from a set of scenario assumptions) and an existing industrial energy demand bottom-up model for the EU-27, Switzerland, Norway, and Turkey up to the year 2035, considering 11 industrial branches as well as selected energy-intensive products (e.g. oxygen steel, electric steel, primary aluminium, secondary aluminium, container glass, flat glass, other glass, cement, paper, chlorine).

This transformation module operates as a “link”, translating monetary and demographic information into physical production for energy-intensive bulk products (Jochem et al., 2007, 2008; Schade et al. 2009). However, implementing such a “link” is not trivial as several challenges (structural change, material efficiency and substitution strategies, saturation effects, quality improvements, capacity changes or limits, and foreign trade of bulk or intermediate products) have to be met and country-specific characteristics have to be considered in the projections (Herbst et al., 2012b).

Conclusions

The contribution reports on recent advances on developing the bridge for energy-intensive industries such as metal production (converting the eco-

nomic data into physical production of oxygen and electric steel, primary and secondary aluminium), pulp, paper, and printing (physical production of pulp and paper), or non-metallic minerals (physical production of cement, etc.) including the endogenous modelling of inter- and intra-industrial structural change and the consideration of trends of higher product quality, saturation, material efficiency, material substitution and stagnation in the per capita consumption of industrialized nations due to rationalization and competitive disadvantages of some of these basic products. The examples show the complexity of the approach, the large data needs and the related mixture of methods for developing such a transformation module for hybrid energy models.

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STAND-ALONE MICROGRIDS WITH CONSUMER-BASED GENERATION AND STORAGE

APPLYING THE CONCEPT OF SWARM ELECTRICITY IN THE DEVELOPING CONTEXT OF NON-ELECTRIFIED VILLAGES IN THE GLOBAL SOUTH

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Type of presentation	Poster
Scope:	Electrification Process in Off-grid Areas
Keywords:	Microgrid,Bottom-Up, Electrification

Background

Currently approximately 1.3 billion people worldwide lack access to electricity and an additional billion people's access is of poor quality. To tackle this issue the UN has launched the "Sustainable Energy for All" initiative whose primary goal is "universal access to modern energy services". Further, the "share of renewable energies in the global energy mix" is to be doubled (United Nations Foundation 2012, 1). Means and ways to reach these goals include solar home systems and wind turbines for individual households but increasingly, along with the global discussion on smart grids, intelligent networks become more and more attractive also for the developing context. The IEA points out that "smart grids could enable a transition from simple, one-off approaches to electrification (e.g. battery- or solar PV-based household electrification) to community grids that can then connect to national and regional grids" (IEA 2011, 22).

Content & Findings

This paper demonstrates an electrification process for off-grid areas in the global south that is bottom up and enhances income generation. More precisely, it is shown how a village situation with a certain number of *isolated units* such as solar home systems (SHS)1 can be transformed into a

microgrid. Network effects in such an *autonomous microgrid* enhance the stability and usage of the provided electricity, allow for income generation, and hence improve the economics and reliability for the households and micro-enterprises. The demand-side orientation of the approach focuses on achieving end-user acceptance as well as providing high quality (stable, reliable, sufficient) electricity service. Further, the microgrid should be able to interconnect with national or regional grids, when the infrastructure extends to the respective area (*grid-connected microgrid*). The evolution of this proposed microgrid process is illustrated in *Fig.1* .

The key idea for this microgrid is that each prosumer (producer and consumer) within the microgrid is connected to the grid via a smart meter and control unit ensuring stability of electricity supply and demand2. In this manner control is realized with distributed intelligent units, thereby applying the concept of swarm intelligence to energy supply. The concept can be named swarm electricity, as advocated by Lichtblick in Germany (Kampwirth 2009). This paper applies the swarm concept to off-grid situations in the global south, resulting in a *swarm electrification process*.

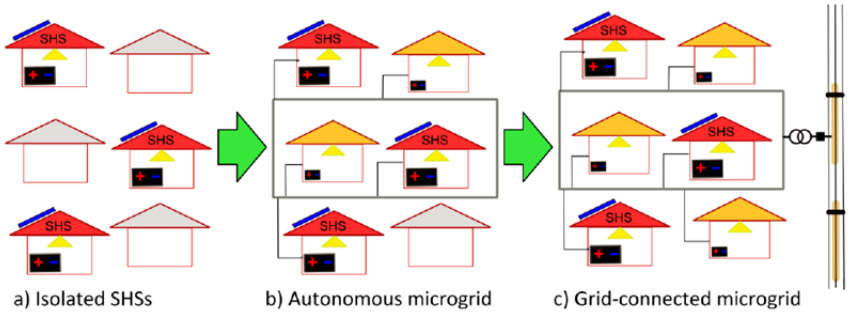

Fig.1: Development of the microgrid in the swarm electrification process (author's own work)

The simulation elaborates on the technical and economic feasibility of this transition and identifies technical details of the equipment needed. Stable and sufficient electricity supply is addressed with a minimum of centralized elements. This will be enabled on the one hand by the fact that each unit is attached to a storage device and on the other hand by taking advantage of the decentralized, bottom-up structure of the network.

The results show that the development process is technically feasible for a village situation starting with 10 units and gradually scaling up. The highly adaptive capacity of the microgrid and the end-user orientation make this community-based approach a very promising option for achieving the key concern of the UN's *Sustainable Energy for All* initiative.

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[1] Solar Home Systems are small and medium (<500 W) sized solar-powered households and businesses that consist of a solar panel, a (lead-acid or other) battery and a control unit.

[2] An example for an intelligent energy access meter is shown by the MESUS project (Boldt 2012)

IN SEARCH OF COHERENCE: THE UNFOLDING INTERDISCIPLINARITIES OF AN ENERGY TRANSITION PROJECT

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Type of presentation	Poster
Scope:	The poster describes the processes of interdisciplinarity that took place within the context of a multi-disciplinary UK energy transition project, *Transition Pathways to a Low Carbon Economy* funded by the EPSRC and E.ON.
Keywords:	Interdisciplinarity, Transition Pathways, Integration

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Background and Context

As the call for papers for this conference acknowledges, the necessity of energy transformation 'requires an effective, efficient and socially compatible integration of technological development, organizational structure and behavioural adaptions.' A more thorough understanding of the possibilities of energy transitions therefore depends upon the integration of technological understandings of energy system change with research that reveals the way in which energy is embedded in the meanings and patterns of everyday life. This paper analyses the practices of interdisciplinarity within a recent energy transition project, providing insights into the practical challenges of integrating different disciplinary knowledges.

The *Transitions Pathways to a Low Carbon Economy* consortium project was launched in 2008 in order to select, develop and analyse a set of potential transition pathways towards a low carbon future for the UK energy system. This task has involved undertaking integrated assessments of the technical and economic feasibility, and social and environmental potential, and acceptability of these pathways, bringing together quantitative and qualitative research methods. Engineers, economists, historians and social scientists have worked collaboratively to generate a set of transition pathways that aspire to be both technically and socially robust. During the process of elaborating these pathways the project has also reflexively explored the ways in which its own interdisciplinarity has unfolded.

Content and Findings

One important insight is that within a complex consortium project interdisciplinarity unfolds in an uneven manner. Collaborative projects can be simultaneously multi-, inter- and trans-disciplinary. Different degrees of integration are achieved in different sites and the impacts and outcomes can be multiple. This view of interdisciplinarity is different to the conventional level of analysis whereby classification is often made at the level of project. Not all knowledge within a project gets integrated, some remains 'orphan'. Our research suggest that the different degrees and types of integration can be usefully understood with reference to the concept of *coherence.* Interdisciplinary coherence is manifested in a number of different ways:

The linkage of different knowledge outputs

Comprehension between participants

The credibility of interdisciplinary outputs

Compatibility between different disciplinary worldviews

Recognising the need for coherence also highlights the fact that interdisciplinarity is something that needs to be constantly managed and, to some extent, forced. Clear, specific processes, interdisciplinary spaces, and integration mechanisms are useful for driving integration, but specific individuals and the working culture of interdisciplinary projects are also important. "Translators" seem to be important in facilitating dialogue and overcoming disciplinary misunderstandings. Developing a common language and un-

derstanding is a critical element of ensuring the coherence of the project, but does not mean that more profound ontological and epistemological barriers are completely erased.

Conclusions

We conclude by reflecting on what implications these findings on interdisciplinarity might have for future integrative transitions projects. Four broad conclusions are developed:

Interdisciplinarity is an uneven process: complex consortium projects can be simultaniously multi, inter- and transdisciplinary. The specific positionality of any given researcher will influence how interdisciplinarity is experienced. However, it should not be assumed that integration of all knowledge is a pregiven goal. This is something that should be discussed and agreed.

Interdisciplinarity can be usefully understood as a search for coherence. This has several dimensions and is something that has to be actively managed through the development of supportive processes, spaces and mechanisms.

Interdisciplinarity creates uncertainty and insecurity, this suggests a need for time to develop the necessary coherence and the processes by which novel outputs can be successfully produced.

Interdisciplinary projects exacerbate the pre-existing difficulties of consortium working, adding an extra level of complexity.

A copy of the full report can be downloaded from:

http://www.lowcarbonpathways.org.uk/lowcarbon/news/Interdisciplinarity_in_Transition_FINAL_REPORT_Dec_2012.pdf

FINNISH ENERGY CONSUMERS IN THE RISK SOCIETY

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Type of presentation	Poster
Scope:	Consumer behavior in the energy market
Keywords:	Consumer behavior, energy market, risk society, individualism, climate change, renewable energy

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The purpose of this paper is to find out how consumers have experienced their role as energy consumers. The research was done in Finland in the following cities: Vaasa, Imatra, Joensuu and Espoo. The cities that were chosen were cities where renewable energy has been successful or there has been actions in the city towards low carbon energy solutions.

The research questions are; How did consumers make their energy purchase decisions? What are the prerequisites and barriers when making the decision to buy renewable energy? The research was implemented by an empirical approach.

The research was implemented by an empirical approach. During the research it is becoming clearer that the characteristics of Ulrich Beck's (1992) risk society seem to have significant relevance. The consumers that were interviewed seemed to react in the way Ulrich Beck described; denial and apathy (1992, 51-84). The level of individualism in the current society combined with intangible information related to risks in regard to energy matters makes the topic difficult and overwhelming for consumers to comprehend and this leads to what Beck (1992) described, denial and apathy. Climate change seems to be unfamiliar to many consumers; this group also included people who claim that the environment is important to them. Some consumers also do not seem to trust energy companies and information related to climate change; this makes energy purchase decisions

especially difficult because there are too many variables to consider. Individualism in society could to lead to transformation because some consumers want to be self-sustainable in response to the risks that society has produced, so individualism seems to lead to solutions for some consumers in contrast to apathy and denial.

Therefore, to promote low carbon energy, energy related decisions should be easy and simplified for consumers. Currently there is excessive uncertainty, contradicting information, distrust and risk. Therefore the characteristics of the risk society and consumer reactions to it seem significant.

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DO ENERGY-EFFICIENT ISSUES MATTER IN EDUCATIONAL FACILITIES?

FIRST RESULTS FROM POST-OCCUPANCY EVALUATION IN THE CONTEXT OF THE GERMAN PROJECT "ENERGY-EFFICIENT SCHOOLS"

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Type of presentation	Poster
Keywords:	Energy efficient school buildings, comfort, indoor climate, behaviour, user interaction

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Individual behaviour with respect to energy consumption as well as acceptance of new and energy efficient technologies are crucial elements in the context of energy transformations in Germany. The most promising target group to address these issues are the very young people. They are the future pillar of our society and therefore, it is of great importance to subject them to energy related topics. This was one reason why the German Federal Ministry of Economics and Technology (BMWi) launched the programme "Energy-efficient schools". The project aims at a zero or nearly zero energy level by using innovative technologies for glazing, ventilation, and lighting in retrofitted or new school buildings. Additional targets are improved learning conditions through a better indoor climate and more comfort for students and teachers. In parallel to technical monitoring the social accompanying research is of special interest: The construction phase should be used as window of opportunity to integrate energy topics into the lessons, to raise energy awareness and to lead to a more energy efficient behavior of the students and their families at home.

For the eight buildings within the programme, post-occupancy evaluation is carried out in parallel to a technical monitoring. To investigate the users' perspective, surveys and group discussion are conducted, taking into ac-

count the status before and after the construction phase. The research focuses on:

- how the installed technologies affect the school's daily life in terms of acceptance, and whether room temperature, air quality, lighting, etc. meet individual needs,
- the fit between energy concept, new technologies and occupants' behaviour,
- the extent to which innovative and energy efficient technologies in school buildings are used to teach the students about energy saving
- the effect of spill-over, that means the question of whether energy related topics or behavior affect the students' life at home.

The first survey, the situation before the construction phase, is finished for seven of the eight buildings, 1,890 students aged between 9 and 19 years and 182 teachers participated. The occupants' ratings after the construction phase have been gathered in four schools.

First results show that the well-being and learning conditions in the new or retro-fitted buildings could be increased in comparison to the prior learning environment. However, the building performances vary in some details. In some cases, the automatically controlled ventilation and lighting systems cause some problems for the users. Communication processes between persons in charge of technical issues and the educational staff should be improved to result in a better understanding and an adequate behaviour. Finally, the automation of procedures does not automatically lead to a higher awareness of energy issues among the students. Group discussions indicated the students' desire for getting more involved in the technical details and monitoring of the energy-efficient issues of the new building. The spillover effect was, up to now, rather low. However, further surveys in retrofitted and new-built schools will create a broader basis of findings about acceptance and use of new energyrelated technologies and concepts.

PUBLIC CONSULTATIONS IN ENERGY PLANNING

AN ARGUMENTATION-THEORETICAL CASE STUDY OF THE GERMAN ENERGY GRID DEVELOPMENT PLAN 2012

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Type of presentation	Poster	

Large energy infrastructure projects should be discussed in public, not only to gain real acceptance, ethical justification and political legitimation, but also to gain knowledge about hidden risks and uncertainties. Can public consultations fulfil these functions? Obviously only insofar the debates they produce can be characterized as rational. Thus, to evaluate or criticize public consultations in energy planning, one should ask if the participants have argued with each other in a rational manner. And to improve such consultations, one should ask how to facilitate a more rational discourse. This paper tries to answer these questions for the public consultations of the German Energy Grid Development Plan 2012. The analysis is based on a year-long observation of these consultations from an argumentation-theoretical perspective. First, three rational deficiencies are diagnosed: the prevalence of irrelevant, intransparent or unjustified arguments for decisions under uncertainty. How can these deficits be explained? Several possible explanations are proposed: power structures and interests, asymmetric information, scarce resources or insufficient argumentative competence in regard with handling risks and uncertainties. It is not the aim of this paper to argue in favour of any of these explanations, since this would go far beyond the scope of argumentation theory. Instead we argue that our main conclusion holds in any case: regardless of what caused the diagnosed deficiencies, some simple remedies against them can be prescribed and maybe even procured by argumentation theory itself. In the final part of the paper we will sketch one such possible contribution of argumentation theory: we will show how argumentation software facilitates rational discourse and how it could be integrated in online participation systems such as Adhocracy.

BEYOND THE GRID – THE CONCEPT OF MICROENERGY SYSTEMS AND ITS IMPLICATIONS FOR POLICY

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Type of presentation Poster

So far, the discussion on how to provide access to modern electrical supply for the 1,3 billion people worldwide, who still remain without it, has focused on the extension of the centralized grids. This view has been challenged recently, for example in the The World Energy Outlook 2011 of the International Energy Agency. In their „Energy for All Case“, a scenario for universal access to electricity until 2030, only 30% of rural areas are connected to centralized grids, whereas 70% of rural areas are connected either with mini-grids or with small, stand-alone off-grid solutions.1

With regard to the planning and governance of energy infrastructures, the concept of a decentralized energy supply on household or community level holds new research challenges for planners and political and social scientists. This includes taking a critical view on political and scientific conceptions of grid-based energy infrastructures, which are widely shaped by Western conditions and perspectives. Centralized, supply-driven approaches to electricity supply are based on the notion that state-owned monopolists or a few big utilities provide ubiquitous infrastructure services. They assume a passive role of customers and thus claim that the provision of infrastructure services is closely linked to and/ or highly regulated by the state. In that regard, they generally focus on the centralized energy systems, thus ignoring the various forms of energy production and consumption (e.g. cooking, heating, use of batteries etc.) detached from the grid.

In many countries of the global South, the path to improving access to modern energy services differs substantially from the historical development path in the west. As a matter of fact, today electrical devices have already surpassed the centralized supply structures in most African countries. In Tanzania, only 5,3 million people had access to the grid in 2009

whereas 17,7 million people owned a mobile phone.2 This highlights a market for off-grid energy systems, which has never been actively advocated in the western world. In Bangladesh, one million households were supplied with electricity from solar home systems in 2011.3 The same holds true for most policy makers. In many developing countries an energy policy focused on centralized structures encounters a barrier in conforming to a decentralized practice of energy use.

In his conference contribution, the author introduces the concept of micro-energy systems, as an approach that takes a user-centered perspective on energy and thus contributes to a better capture of the energy situation in countries of the global South. In the case of Tanzania, he discusses the implications of this approach for policy-makers. Based on the assumption that the provision of decentralized systems requires different infrastructure regimes and forms of organisation, the contribution aims to discuss research perspectives for a more integrated planning and governance of centralized and decentralized energy systems in the global South.

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GOVERNING THE TRANSITION TO SECURE COMPUTERS FOR CONTROLLING ENERGY SYSTEMS

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Type of presentation	Poster
Keywords:	Risks of decentralised energy systems; protection against malware; political processes for securing IT-networks.

In some countries such as Germany it is anticipated that a large number of energy production and storage components will need to be controlled electronically. Also, it is assumed that personal computers or smartphones will be used to control them, e.g. to start a washing machine or to load or unload the battery of an electric car.

Furthermore, the messages from smart meters need to be communicated and processed. For reasons of convenience and costs, it is assumed that it would be desirable that all this co-ordination takes place on the open Internet. Ideally all these computing and communication systems should be highly secure (CPNI 2012 reviews the attack surfaces). This abstract addresses how malware attacks could be prevented, including highly sophisticated attacks as seen with Stuxnet (Falliere 2010) or in attacks on security firms such as RSA (Weber, Weber 2011), based on, among other things, zero-day attacks.

The paper will not address whether the software to control energy systems is robust, or whether other attacks such as denial of service attacks would hinder the proper functioning of energy systems, as this is addressed elsewhere.

It would make sense to design computers in a way that they function properly, i.e. that sensitive applications cannot be attacked. Principles for designing such secure computers are known for years. One can either design computers from scratch (clean slate, assuming the tools to design them have no flaws). However, for consumeroriented control computers, such as PCs or smartphones, compatibility with existing applications is

desirable. For achieving this, a system would be needed which isolates sensitive applications from others. There are various ways to achieve this, and various prototypes and products have been built. However, no existing systems protects reliably against all imaginable attacks. A proper system would need to be composed out of properly specified and built hard- and software. Concepts such as LaGrande (Grawrock 2006) and the use of L4 by the mobile industry (Open Kernel Labs 2012) show that the IT-industry is moving into the direction of providing isolation characteristics. However, this process is taking place only slowly. Governments could support it by:

- Creating legislative incentives for developing better isolation procedures.

- Requesting high-quality isolation for government-procured computers.

- Making the use of highly secure computers mandatory for controlling energy systems.

- Discussing the above mentioned problems and options publicly. At least three issues need to be evaluated when implementing such strategies:

- The costs for the isolation of control applications need to be put in relation to other weaknesses of a future energy system. For instance, the level of evaluation and the use of proofs need to be determined.

- The hardware may be procured from Chinese government-controlled manufacturers. As such hardware might contain Trojan horses, local, more expensive production may need to be considered.

- The usability of such computers needs to be investigated. For instance, user interfaces protecting users against applications which lead to fake updates by using mimicry may need to be used (Weber et al. 2008).

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