Are Science-Policy Interfaces a Complex Relationship for Scientists?

The Role of Scientists in the German Energy Transition

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The Role of Scientists in the German Energy Transition

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Abbreviations

BEE	Bundesverband Erneuerbare Energien National association renewable energies
BMBF	Bundesministerium für Bildung und Forschung Federal Ministry for Education and Research
BMWi	Bundesministerium für Wirtschaft und Energie Federal Ministry for Economy and Energy
BMUB	Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
EEG	Erneuerbare Energien Gesetz Renewable Energy Sources Act
FONA	Forschung für Nachhaltige Entwicklung Research for Sustainable Development
GHG	Greenhouse gas
OECD	Organization for Economic Co-operation and Development
RES	Renewable Energy Sources
SPI	Science-policy interface
WUR	Wageningen University and Research Centre

Abstract

How do scientists involved in science-policy interfaces (SPI) of the German energy transition interact with policymakers, what role do they play in interaction, which normative beliefs do scientists have about their role and does the actual role of scientists match with their normative beliefs? This Master thesis attempts to answer these questions through in-depth interviews with German scientists focusing on two concepts: the way participation in SPIs looks like and the way knowledge is generated and used. Scientists in science-policy interfaces often faced a dilemma where they needed to find a balance between providing a full range of policy options while being relevant, credible, neutral and legitimate in the policy process. By describing and analysing the actual and normative role of scientists in SPIs, I can contribute to the debate on how scientists' knowledge is related to the actual role played in interaction with policymakers. Empirical data were collected between October and November 2015. Coding was applied to analyse and compare in-depth interviews, revealing that the role of scientists in interaction with policymakers is dependent on structural features and processes of SPIs, that the normative role perception strongly determines the actual role and that normative role perceptions and actual roles often not agree. I argue that a mismatch between actual and normative role increases complexity for scientists, because it reflects the dilemma. I therefore conclude from my findings that scientists often do not have a chance to choose their own role. The SPI design and the intention behind science-policy interaction strongly influence the role of scientists. Therefore, they often find themselves in a highly complex situation when interacting with policymakers. Two-way or multidimensional interaction in new, modern forms of research for complex societal issues and multifaceted ambitious goals require a shift from traditional, so far identified descriptions to novel roles for scientists.

Keywords:
Science-policy interface; role of science; knowledge brokering; scientific policy advice; energy transition

Introduction

Energy transitions for sustainable development

Approximately 88% of the worldwide energy that is currently consumed by humanity comes from oil, natural gas and coal (Cunningham & Cunningham, 2011). This addiction to these fossil fuels leads to serious geopolitical, economic and environmental problems such as climate change, air pollution and water pollution. And even though coal reserves are thought to be huge, environmental scientists estimated conventional oil and gas resources will be depleted in approximately 50 years at current consumption rates (Cunningham & Cunningham, 2011). In addition, the Intergovernmental Panel on Climate Change (IPCC) warned in their Fifth Assessment Report that high levels of greenhouse gases (GHG) were extremely likely to have caused global warming and changed the Earth's climate during the last half-century and that these eventually have serious impacts on people and the ecosystems (IPCC, 2014). Therefore, a transition towards more sustainable sources of energy is urgently needed. Fortunately, that is likely happening. Sustainability has become a major strategy in handling natural resources. In terms of energy needs, renewable energy sources (RES) have come more and more into focus, since they are considered to be the future regarding sustainability aspects and environmental friendliness (Jacobsen & Delucci, 2009). In Asia, where GHGs emissions are the highest, China has set the milestone in using RES and therefore becoming less dependent on Middle Eastern oil (Cunningham & Cunningham, 2011). Moreover, many OECD countries are currently undertaking transformations in their energy systems in order to achieve CO_2 emission reduction. This has large implications for policymaking and politics and environmental governance (Monstadt, 2007).

In Europe, Germany has been the spearhead of development and application of RES (Sühlsen & Hisschemöller, 2014). This is most visible in the transition of the production of electricity. In March 2011, the Fukushima nuclear disaster led to the political decision of taking the seven oldest nuclear power plants in Germany directly off the grid; thus accelerating the energy transition (in German often referred to as the "*Energiewende"*, Renn, 2015; Strunz, 2014). Germany had a gross energy consumption of 576 TWh in 2014, major sources being coal (46%), RES (27%) and nuclear energy (16%)[1]. According to the Ministry for Economy and Technology, the German Energy Concept (EEG 2014) targets a 35% generation of the total energy supply from RES by 2020 and of 80% by 2050[2].

[1] Retrieved from https://www.destatis.de/DE/ZahlenFakten/Wirtschaftsbereiche/Energie/Energie.html;jsessionid=E2EB660EFA3B45C1DBF747417BE34A4A.cae2. Accessed on May 13, 2015.

[2] Retrieved from http://www.bmwi.de/DE/Themen/Energie/Erneuerbare-Energien/eeg-2014,did=680290.html. Accessed on April 13, 2015.

Participation in environmental governance

The German energy transition creates an important shift from a fossil-nuclear regime to a RES-regime affecting politics, industry and society and it provides new opportunities in the energy system and energy efficiency (Hohmeyer & Bohm, 2015; Strunz, 2014). In the domain of political science, governmental steering was first thought to be the key in governance or 'governing' a wicked problem (Mayntz, 2009). Yet, this traditional image of governance is contested and shifted towards a more bottom-up or non-hierarchical approach of coordination. Hogl *et al.* (2012b) describe that shift from government to governance as a process in policymaking, where participation of non-state actor groups increased and therefore changed the emphasis from command-and-control regulation towards a co-operative and self-regulatory approach. This implies that traditional approaches of public decision-making for complex environmental and sustainability problems are cross-examined (Renn, 2008). The system of democracy calls for a more participatory, collaborative and network-like approach (Newig & Kvarda, 2012). But what exactly does this mean?

Newig and Kvarda (2012, p. 30) describe participation as "*the involvement in collective decision-making processes (…)* which is *closely connected to citizen or public involvement (…) and public-private partnerships and joint decision-making."*. Participatory approaches in governance were introduced, because environmental problems became too complex to be solved only by governmental actors. Emancipation, democratic legitimacy, transparency and effectiveness probably increase by integrating a diversity of (local) knowledge, expertise and values (Koontz, 2006; Reed, 2008). Different scholars also argue that the durability and quality of decisions may be better when involving stakeholders (Beierle, 2002; Fischer, 2000). This seems logical, since a decision-maker cannot be an expert on all different kinds of fields. It is often the case that experts come from science, since knowledge concentrates there in various disciplines, specific topics or technologies. Many scholars address the need for scientific knowledge in complex decision-making and participatory stakeholder settings as a crucial ingredient for clarification of highly technical and complex knowledge (*inter alia* Fischer, 2000). Furthermore, Johnson *et al.* (2004) stated that concentrating on scientific knowledge sources could make an investigation and verification in uncertainties and assumptions possible in order to establish a more thorough understanding. Yet, a decrease of uncertainty due to more research is also widely disputed. Examples from the IPCC have shown that more research cannot directly be correlated to a decrease of uncertainties, because new findings might raise new questions and uncertainties (Beck, 2012). Obviously, the German energy transition is a complex process, where a lot of sectors and actors need to work together to achieve ambitious targets (Loorbach & Rotmans, 2010; Schafhausen, 2013). In order to achieve targets and to make the energy transition politically feasible, current renewable energy technologies need to be improved and investigated. That implies that the German government needs to invest in engineering, research and development of technology. Additionally, the energy transition also depends on social innovation; hence, socio-economic research is important to make the energy transition affordable in monetary terms and in societal

acceptance (Koster & Anderies, 2013). Consequently, participation in complex processes will tend to follow more interdisciplinary and transdisciplinary approaches than disciplinary approaches.

Even though German politicians have agreed on a general objective, the transition is still a highly controversial debated topic due to many divergent voices from contrasting political parties, from different scientific disciplines and from different groups of society. Additionally, policymakers still have open questions to address central matters of the energy transition and possible policy and governance strategies are still unclear. These uncertainties describe a complex process that policymakers cannot answer alone. Cooperation in form of an on-going dialogue with science institutions and other important stakeholders is needed to successfully achieve the set targets.

Research Problem

In complex societal issues and complex ambitious goals like the German energy transition, scientific knowledge is a crucial factor in designing possible policy options. But scientists often face a dilemma between choosing to only inform policymakers or to support the political process. On the one side, scientists could determine the optimal objective and policy option, but this would lead to a scientification of policy. This kind of policymaking is derived from evidence-based knowledge. Scientists are part of the decision-making process by providing scientific evidence-based knowledge to policymakers. It is strongly contested though and considered as utopian (Geden, 2015). On the other side of the coin, policymakers could also use scientific experts to legitimate objectives and political means on which politicians have decided. Policy-based evidence making is very much detested as well and scholars talk about a politicization of science (Pielke, 2002; Sarewitz, 2004; Pielke, 2004; Geden, 2015).

All things considered, political legitimation is the central problem in a science-policy interface (SPI). Legitimation is a necessary foundation of policymaking (Renn, 2015). Therefore, policymakers always aim for legitimation in scientific policy advice. Although scientific advice should not be the rationale for legitimation, scientists need to understand that legitimation is always a by-product of advice (Brown, 2009). So the dilemma for scientists is the balancing act between maintaining an independent position to provide a full opportunity of choices and at the same time making sure that the advice is regarded as relevant and useful by policymakers. Scientists deal with a balancing act because in reality policy-relevant scientific advice is sometimes not neutral and reliable and inversely credible and reliable scientific knowledge sometimes is not able to answer policy-relevant questions (Edenhofer & Kowarsch, 2015a). Geden (2015) states that the value of knowledge is often determined by its utility. Additional fundamental criteria for scientific knowledge in policymaking are (1) scientific credibility, (2) neutrality and legitimacy and (3) policy relevance or salience (Cash *et al.*, 2003). This provokes the crucial question whether scientists are allowed to have a subjective opinion in science in general and whether this can even be considered possible. Scientists make value-based judgments in their daily professional life. And as complex decision contexts are inevitably loaded by value conflicts and inherent uncertainties, it is very hard for scientists to isolate neutral

advice from advocacy in interaction with policymakers. Thus, a problem evolves in how scientific knowledge is seen nowadays in deliberative public policymaking for the German energy transition.

Research Objective

The German energy transition has led to the development of novel transdisciplinary networks due to participatory policymaking approaches and the interaction between policymakers, scientists and the public. In a wider context, science-policy scholarship contemporary debates on how scientists can be policy-relevant without being policy-prescriptive. Specifically in this thesis, I would like to contribute to the debate on how the role of scientists in science-policy interfaces (SPIs) is shaped and whether new roles can be expected. I do this by looking specifically on interfaces between science and policy in the German energy transition and investigate the role of individual scientists in those networks. My focus is on the course of interaction between scientists and policymakers and how knowledge generation and use occur. Different role models of science have been acknowledged theoretically by various studies (Backstrand, 2003; Pielke, 2007; Hoppe, 2009; Turnhout *et al.*, 2013; Edenhofer & Kowarsch, 2015). Spruijt *et al.* (2014, p. 23) reviewed the current state of scholarship on roles of scientists as policy advisers and concluded that most theoretical papers *"lack empirical verification of theories (…), but describe a hypothetical normative situation that "should be" achieved rather than the current situation that can be investigated empirically."* It is therefore discussed how roles of scientists in SPIs are formed and whether novel roles can be expected. It is also debated whether normative ideas about the role of science matches reality and whether scientists have a full influence on which role to play (Huitema & Turnhout, 2009). This thesis aims to address this gap by exploring how German scientists act in reality in SPIs and whether that role is in line with their normative beliefs about their (or science's) rightful role.

Therefore, a first objective of this research is to conduct a network analysis in order to describe the evolvement, the current structure of actors and dialogue platforms in the German energy transition. The first objective can be seen as a pre-study to facilitate to answer the following research questions and to find suitable subjects. The second objective of this research is to get an understanding of the actual role of scientists in SPIs in the German energy transition by investigating their interaction with policymakers.

Research Questions

The main research defines the pre-study and includes a network analysis. This question is:

Which transdisciplinary networks exist, who are key scientists and what are current relations between policymakers and scientists in science-policy interfaces in the German energy transition?

The main research question of the follow-up study addresses the scientists' perception of science-policy interfaces and includes:

How do German scientists involved in science-policy interfaces in the German energy transition interact with policymakers?

Its sub-questions are:

- What actual role do scientists take in science-policy interfaces and why?
- What normative beliefs do scientists have about their role in science-policy interfaces and why?
- Does the actual role of a scientist match with his normative beliefs?

Outline of the thesis

Chapter 1 discusses the theory that underpins the thesis before **Chapter 2** presents the methodological approach done in collecting the data for the thesis. Before this part, the chapter also addresses the pre-study. It describes selection criteria for interview subjects, current trans-disciplinary networks and SPIs and it gives the necessary background information needed to understand how SPIs in Germany have taken shape. **Chapter 3** moves on to describe interviewees' experiences with participation in SPIs and how they interact with policymakers and other SPI members. **Chapter 4** focuses on how interview subjects generate and use knowledge and if they experienced a general learning process in SPIs. In **Chapter 5** normative role perceptions and real roles of interview subjects are described and compared. Additionally, the SPI type, in which interview subjects participate, is classified. **Chapter 6** moves on to conclude how interview results answer the research questions and what the thesis results mean in the light of current literature. I will address the limitations of this thesis as well as its importance in reality and for future research.

Chapter 1. A Theoretical Framework on Scientific Policy Advice

Before this thesis starts describing the methodology and analysing any data, the theory that underpins the analysis of the interview data will be explored and how these have had a bearing on the conceptualization of the research presented. Pregernig and Böcher (2012) stated that the practice of SPIs faces a *'dual challenge'* of trying to combine scientific knowledge with political decision-making in the most successful way, while guaranteeing the democratic legitimacy of science in society. Especially, normative principles and their implementation in real settings of scientific policy advice cause serious problems. Huitema and Turnhout (2009) found a significant difference in what scientists perceive which roles should be performed in SPIs and their performance in reality. They indicated a difficulty for scientists to achieve or maintain a certain role in practice. This finding therefore suggests an analysis of the role of science in SPIs to be always two-fold, because an analysis must examine real-world practices and normative principles for advisory settings. Consequently, I divided the theoretical framework into two sections: From current literature, there are different analytical role models for scientific policy advice to help to analyse the role of scientists in the interaction with public policymaking in the German energy transition. The empirical-based role models from literature are followed by an overview of normative perspectives on the role of science in policymaking. Three fundamental, normative theories underlying the phenomenon of scientific policy advice are presented that shaped my understanding of how SPIs are designed.

Analytical role models for science-policy interaction

In the following, I give a brief overview of the relevant analytical role models that were discussed in past literature. The overview is not intended to provide a complete list of roles; I intend to deliver a rather well chosen selection in order to explore what kind of explanations other authors gave for scientists' role in SPIs in practice.

In a review on the role of scientists in policymaking, Spruijt *et al.* (2014) concluded from examining literature from the past ten years that a scientist's role is influenced by (1) the type of issue (simple or complex), (2) the type of knowledge an expert inherits, (3) the core values of an expert, (4) the organization in which a scientist works, (5) the changing beliefs of scientists and (6) the context of an issue. The type of issue and a consensus on values are incorporated into the role model of Pielke (2007). Pielke (2007) focused on understanding the different choices scientists have to position themselves in relation to policy and politics. Based on the work of Ezrahi (1980), Pielke's model is divided by two different viewpoints: (1) the view of science, whether knowledge is transferred by the linear model or by a stakeholder model, and (2) the view of democracy, based on either the Madison theory or the Schattschneider theory of democracy. According to Pielke (2007), political consensus and scientific uncertainty vary together.

If the decision context is characterized by a value consensus and low uncertainty, then he assumes that the basic assumptions of the linear model apply and scientists in the SPI can take the role of the *Pure Scientist* or *Science Arbiter*. The linear model is the most traditional model of science-policy interaction, also called the knowledge transfer model. It assumes that scientifically produced knowledge is transferred unilaterally to the policymaker, who uses this knowledge for problem solving (Pregnerig & Böcher, 2012). Knowledge transfer or exchange happens between the knowledge producer (the researcher) and knowledge user (the policymaker) and interaction between science and policy is considered to be one-dimensional, linear and one-way: the linkage between scientists and policymakers is best described with the phrase 'speaking truth to power' (Price, 1981; Beck, 2012). A Pure Scientist ideally focuses on curiosity-driven, fundamental research and is absolutely not involved in policymaking. He provides the current state of knowledge to the policymaker and has a very limited to non-existent interest in their accomplishments. Pielke (2007) argues that a Pure Scientist is in reality normally not found, since research funding basically always needs justifications for an expected societal benefit. A scientist can also take the role of a Science Arbiter, which implies limited interaction with policymakers. A Science Arbiter accepts that policymakers have specific questions that require an expert judgement. However, he prefers to stay out of politics and avoids normative questions. A Science Arbiter always intends to optimize scientific authority and independence by limited and restrictive interaction with policymakers.

If the decision context is characterized by a lack of value consensus and high uncertainty, then scientists face the question whether to expand or to reduce the possible policy options. In the case they decide to reduce the scope of options, they take the role of an *Issue Advocate* who sympathizes with a certain political agenda or interest group based on his own values and ideologies. The Issue Advocate seeks to have a close relationship with the decision-maker and endeavors a participation in the decision-making process. On the other hand, if the scientist chooses not to reduce the scope of possibilities, he designates himself to the role of the *Honest Broker of Policy Alternatives*. In this role, he seeks explicitly to integrate scientific knowledge with stakeholder concerns by including them in the research process. The ultimate goal is to present different policy options. Knowledge Brokers fully engage with policymakers to communicate existing knowledge and to realize their policy questions and knowledge demands. This is also the limitation of an Honest Broker, since he is not engaged in the process of knowledge generation, but takes an in-between position between knowledge production and use.

The combination of these different notions of democracy and science deliver a simple and straightforward abstract basis for four idealized roles for scientists in decision-making. Yet, Pielke's model is strongly contested by other scholars in the field of analytical role models. Weingart (2015) disagrees with Pielke (2007) from an ethical perspective by saying scientists can and must only play the role of an Honest Broker in SPIs. He concluded because of indeterminable scientific uncertainties the legitimation of science in policymaking is limited to a mere provision of options. The intention for increased transparency in science-policy interaction requires a development of political options to enhance scientific credibility. Weingart (2015) defined transparency as an important factor in interaction to prevent scientists from becoming advocates. In turn policymakers are responsible for reducing the scope of

options to come to a good decision. Even though Weingart (2015) appreciates like Pielke (2007) an interdisciplinary approach in knowledge *"gathering"* in the Honest Broker role to combine different knowledge, perspectives and experiences, Weingart (2015) reduces science-policy interaction to a minimum, since he believes science must have boundaries in order to get not to powerful.

Turnhout *et al.* (2013, p. 355) reasoned that Pielke's typology is an *'oversimplified, stylized and static representation of what the experts that play these roles actually do.'*. They differentiated the roles that scientists can play according to the different degrees of interaction between knowledge producers and users. Turnhout *et al.* (2013) scaled Pielke's roles regarding interaction between knowledge producers and users from limited to intensive interaction and argued that Pielke (2007) basically forgot one role. Even though the Honest Broker role describes more interaction between knowledge producers and users, he is still very distant and only offers different knowledge-based political options to knowledge users (policymakers or practitioners) without really engaging them and without really being involved in SPI processes. In contrast to Weingart (2015), Turnhout *et al.* (2013) do not argue for boundaries in the relation between scientist and policymaker. They argue for the exact opposite by proposing another role on the spectrum with more intensive interaction. They called this role participatory knowledge producers or knowledge brokers. They defined knowledge brokers to have three main repertoires: (1) **supplying** relevant expertise to knowledge users, (2) **bridging** knowledge between the different actors and domains, and (3) **facilitating** the incorporation of knowledge to define possible solutions for the problem. Basically, Turnhout *et al.* (2013) addressed the demand for new, more interactive roles of science in democratic policymaking. And therefore they set a milestone in the debate whether new roles for scientists in SPIs can be expected. However, they concluded that even scientists in intensive interactions with policymakers, still might continue to use the linear model to a substantial extent because two repertoires contained a fairly traditional role for scientists. This finding is in line with what Bäckstrand (2003) calls an unresolved issue. She addressed the need of reshaping the role of science in policymaking towards a participatory paradigm in science-policy interaction because of a perceived scientization of politics. However, Bäckstrand (2003) could not offer a universal explanation for the role of science in decision-making, since participation is strongly dependent on the context of the political problem and she explained that scientists will continue to struggle to find *"a balance between traditional scientific inquiry and participatory expertise and between technical and deliberative approaches"* (ibid., p. 39) in scientific policy advice. Thus, Bäckstrand (2003) and Turnhout *et al.* (2013) recognize the unresolved issue as a discrepancy between a participatory turn of scientific expertise and the rather traditional role of scientists in SPIs; and therefore add to the finding of Huitema and Turnhout (2009) about a discrepancy between the perception of scientists which roles should be performed in SPIs and their performance in reality.

Edenhofer and Kowarsch (2015b) criticize the Honest Broker role of Pielke (2007), because they argue that even the Honest Broker of policy alternatives feels not responsible for practical consequences of a public policy decision due to missing interactive evaluation of taken decisions. They describe the role of scientists as "*cartographers*" or "*mapmakers*" (ibid*.,* p. 63), because scientists reveal in interaction with stakeholders possible objectives and political means in the form of pathways. In

order to detect all quantitative and qualitative practical consequences, broad ranges of methods and new forms of research approaches (creative and interdisciplinary) are helpful. Policymakers act as "*navigators*", because they are responsible for implementation of the preferable pathway. They argue that the intention behind science-policy interfaces is to allow for a broader and more salient range of knowledge to be produced, exchanged and taken into account in decision-making processes. Knowledge comes not only from different scientific disciplines, but also from different groups of society and therefore becomes more and more transdisciplinary. Good decision-making will become more apparent when other knowledge holders are included in the assessment process and therefore increase the legitimacy of political means and its acceptance in society. Consequently, Edenhofer and Kowarsch (2015) propose the Pragmatic Enlightenment Model (PEM) as another form of scientific policy advice in public decision-making. It has one important feature that differentiates this model from other existing models, which is the idea of a feedback loop between the practical consequences of implementation and the initial objective (Edenhofer & Kowarsch, 2015b). Therefore the PEM follows an iterative process where actual learning between SPI actors can take place and therefore goes beyond the scope of an Honest Broker defined by Pielke (2007). With this feedback loop it goes beyond the Honest Broker, because SPI interaction according to the PEM does not end after the moment of decision-making. As high uncertainties in complex societal issues are no rarity, long-term issues such as the German energy transition require "*trial-and-error policymaking*". Edenhofer and Kowarsch (2015b, p. 63) put it: *"Mistakes in policy-making can occur, and from them, society as a whole can learn (…)"*. Even though the role of Edenhofer and Kowarsch (2015) as a cartographer is still rather ideally and normatively described, the PEM clearly stands for another way of thinking about SPIs in general. Accordingly, they contribute to the debate by arguing new emerging roles can be expected.

Normative perspectives on the role of science in policymaking

While the previous section concentrated on the different analytical models of science in public policymaking, this section discusses now different thinking modes behind scientific policy advice. These three approaches descend from normative modes of thinking about the role of science in policy. The decisionist theory is based on Max Weber's understanding of science in policy and decision-making (see Weber, 1972). The technocratic approach is still today often followed in scientific policy advice and implies a linear, policy-prescriptive advice setting. Last but not least, the democratic-pragmatic theory is similar to the newest thinking modes of participatory public decision-making and generally tries to overcome weaknesses from the two previous approaches by increasing dialogue and interaction between science, policy and stakeholders. An overview of the most important characteristics is provided in table 2. I used characteristics from these three theories to construct the dimensions for coding of the interview data and to scale sub-dimensions. Those characteristics are described in the end of the chapter.

Decisionist theory

In the decisionist theory, policy decides on future objectives while science tries to rationally identify the best means to achieve the set objectives. Then the executive organ of government implements those means. On the first sight, this theory seems to be simple and convincing (Edenhofer & Kowarsch, 2015a). In case of the German energy transition, the German government decided nationally to remove nuclear power generation from electricity production and to transform the energy system towards renewable energy sources. According to the decisionist theory, engineers and economists therefore have the task to explain to policymakers how to achieve as effectively as possible the set objectives. However, this theory also possesses its pitfalls. The theory presumes that the determination of objectives and means can be clearly divided. But a division of objectives and means is difficult, because every political mean has its consequence, whether desirable or not (Edenhofer & Kowarsch, 2015a). And in case of an undesirable consequence, it poses the question if the set objective will make sense and will be acceptable.

The above-mentioned situation gives a simple example to illustrate the shortcoming of the decisionist theory on the basis of the German energy transition. German decision-makers have decided to transform the energy system from a fossil-nuclear towards a RES regime. Therefore, one target is to drop out of nuclear power generation in 2020 and coal energy in 2050. This also serves international bigger targets namely to reduce CO_2 levels in the atmosphere and to stay underneath the 2°C line projected by the IPCC. There would be also many positive side effects, of course. But for illustration of undesired side effects, I would like to particularly stress negative outcomes. In order to satisfy estimated raising energy demands from industry and society, either other energy sources need to be used in the meantime to fill the gap or RES need to be faster implemented. In the first scenario, a possible political mean could be to implement energy from biomasses, which is assumed to be more sustainable than fossil fuels. Yet, an undesirable consequence of the use of biomass is the threat for ecologically important forest areas and due to higher competition for agricultural area, food prizes could eventually increase. This in turn would be negative for other sustainability goals (Edenhofer & Kowarsch, 2015a). In the second scenario, speeding up the extension of RES means higher costs for building the right infrastructure. These higher costs would bear the consumer. For extensive users of energy, for example the steel industry in Germany, higher costs mean a loss in profit and it could be economically more beneficial to move production to foreign countries with less production costs. Consequently, people would lose their job. Is an energy transition then still be acceptable? Or in other words, makes a decisionist theory sense in view of the consequences?

The decisionist theory unfortunately does not provide answers how to handle positive and negative side effects of means and hence, leaves no room for a sensible and critical debate about political objectives. Value judgements are handled the same way as objectives: decision-makers appreciate courses of action according to their sense of taste.

Technocratic theory

Due to the fact that political contexts become more complicated and problems more and more complex, it seems reasonable that scientists determine political objectives and the optimal solution for complex problems, since they possess objective knowledge to bring rationality into political contexts. This is the fundamental core of the technocratic theory. In contrast to the decisionist approach, the technocratic theory assumes that objectives and means must be the decision of scientists, since they have an in-depth understanding from scientific knowledge to determine the optimal strategy. Of course, 'optimal' means here that scientists make use of their neutral and unbiased knowledge, free from any value judgements. The task of politics is simply implementing those means to reach the objective. Technocratic expert advice is often intertwined with the linear model, since in both – theory and model – knowledge is transferred in a linear way from science to policy.

As I said in the introduction, the technocratic theory is still a common phenomenon in today's policymaking (Pielke, 2007; Sarewitz, 2004). Even in international science panels such as the IPCC (Beck, 2012). There is one big problem with the technocratic theory, which is legitimation (Hogl *et al.*, 2012a). Do scientists have the right to decide about how fundamental problems of the general public are being resolved? Taking a simple example like smoking. Even though it is significantly proven that smoking has serious impacts on human health and that it can lead to cancer, people are still allowed to smoke. To elaborate the previous example from the German energy transition, infrastructure of the energy grid needs to be improved to fill the arising energy gap. Let us assume that scientists would come to the conclusion that the current electric-line system needs to be strengthened by hundred new power poles. These poles are placed in people's neighbourhoods, because this would be the optimal location to transport electricity. Therefore, people would have to move or just live with a power pole next to their door. Do then scientists design an optimal policy pathway that is ethically justifiable for the common good?

The difficulty in a technocratic theory is also the fact that moral or ethical arguments do not stand a chance against rational, well-thought-out scientific judgements, because scientists often tend to present their solution with no serious alternative (Edenhofer & Kowarsch, 2015a). Hence, the technocratic theory also leaves out room for meaningful discussions about values, since factual knowledge and values are strictly divided. Like the decisionist theory, it ignores undesirable and unintentional consequences of political means after their implementation. Additionally, scientists can hide behind the technocratic system. First, in case of failure, scientists are able to maintain their autonomy and authority by shifting responsibility towards policymakers due to a bad political implementation. Second, scientists can make misuse of the technocratic model by hiding their own interests behind optimal political means without alternatives (Edenhofer & Kowarsch, 2015a). Thus, scientists act as stealth issue advocates (Pielke, 2007). Equally, policymakers also often ask for legitimation of their political means using scientific undermined data (Pregnerig & Böcher, 2012). From this viewpoint, the decisionist and technocratic theories show fundamental weaknesses in a modern deliberative,

democratic society. Therefore, scholars have concentrated on other ways of thinking in scientific policy advice. Among others, Dewey (1927) can be considered as the father of a democratic-pragmatic theory and his philosophical pragmatism has contributed to an understanding of the role science plays in society.

Democratic-pragmatic theory

Like mentioned, the democratic-pragmatic approach tries to overcome weaknesses from the decisionist and technocratic approach. The foundation of this theory is to bring policy, society and science together for a systematic deliberation about objectives, political means and their practical consequences, because it is also assumed that a linear knowledge transfer does not comply with reality. Knowledge transfer is more diffuse in policy processes with full engagement of important actors and a fully integration of stakeholder's concerns. Scientists act as knowledge brokers in theses processes (Pielke, 2007; Turnhout *et al.*, 2013). First point in the pragmatic theory is the assumption that factual knowledge cannot be divided from values. On one side, terms like development, costs, impacts (and others) that are often used in scientific assessments contain a normative connotation. Also problem definitions and the description of policy pathways include many normative terms, because it would be impossible to describe a socio-political problem with merely value-free words (Edenhofer & Kowarsch, 2015a). On the other side, every scientific assessment implicates statements with an epistemological value judgement. Or in other words, every assessment consists of a scientific judgement on existing knowledge to provide credible answers to policy-relevant questions. Therefore, it is argued that epistemological value judgements are basically not different from ethical value judgements in their ontology (Putnam, 2002). According to the pragmatic theory it is wrong to say epistemological value judgements are objective while ethical value judgements are not (Edenhofer & Kowarsch, 2015a). Putnam (2002) conceded that there is no value-free science and hence no factual knowledge without values. Consequently, scientific policy advice inevitably contains value judgements from scientists; scientific facts alone cannot discover the best political mean (Kowarsch, 2015). This facilitates the possibility also to discuss values in political contexts rationally by critically analysing and comparing practical side effects of objectives and means (Edenhofer & Kowarsch, 2015b).

Table 1. Characteristics of decisionist, technocratic and democratic-pragmatic theory

Theory	Identification of socio-political objectives	Identification of means/ consequences	Nature of relationship between science and policy	Learning process
Decisionist	Policy	Science	Linear	Linear
Technocratic	Science	Science		No learning
Democratic-pragmatic	Policy, Science, Public	Science, Public	Interactive and fully integrated	Multidimensional learning

In order to illustrate this context, I take the above-mentioned thought experiment of the German energy transition. Like shown in the example, undesired side effects of means can have a negative effect on the legitimation of political objectives. Additional power poles for RES are placed in neighbourhoods where people live. Even though the neighbourhood would be economically seen the most efficient location, it has a negative impact on people's welfare in this area, which is often neglected because welfare values cannot be expressed in monetary terms. Additionally, planting power poles in high-population areas bear the risk of serious accidents due to storms and bad weather events. The public would contest political legitimation, since they consider their security above the political objective to restructure the energy system. Thus, even though undesired side-effects of political means would be built on ethical value judgements of a small group of the population (the residents of this area), they would still count the same weight as an argument based on science and factual knowledge. In the past context of the German energy transition, there is, for instance, also a large debate about the location of wind turbines and residents complaining about disturbances.

According to Dewey, in order to fully assess political objectives, all actors have to ask themselves the critical question whether we decide on means and their practical co-effects that would undermine own value convictions. For Dewey this question is central to rationally and objectively discuss political objectives. Building on this pragmatist viewpoint of how policy objectives and means can be scientifically evaluated, it seems clear that the public or stakeholders need to be involved in dialogues between scientists and policymakers, since scientists cannot be aware of all socially relevant objectives and means-consequences (Edenhofer & Kowarsch, 2015b). In conclusion, the essential elements of the democratic-pragmatic theory are the objective-mean interdependency through practical consequences, researching for alternative policy pathways and the public and deliberative discourse about socio-political problems (Edenhofer & Kowarsch, 2015a). Consequently, political objectives need to be revised when consequences undermine common value convictions. Due to this systematic, intensive interaction between science, policy and public, all actors are involved in an on-going multidimensional learning process. Compared to the other two theories, there is only limited learning happening (decisionist) or no learning at all (technocratic).

Transforming theory into a framework

From current literature it is thus known so far that scholars presented very different analytical role models for scientists in SPIs. It was found that literature on roles in practice in empirical studies is very scarce (Spruijt *et al.*, 2014). As a consequence, normative perspectives about science-policy interaction obviously influenced scholars' thinking. Hence, the analytical models for roles in practice turn out to be very differently explained. Pielke (2007) presented four idealized roles for scientists, whereas Turnhout *et al.* (2013) argued that Pielke basically ignored to include a role that is based on an increased participatory science-policy interaction. Therefore, they introduced a knowledge broker role to address the demand for new roles of scientists in SPIs. Edenhofer and Kowarsch (2015), however, recognized the importance of

participation in early decision-making stages and combined that with a democratic-pragmatic viewpoint to create a role for scientists called *"cartographer"*. A scientist acting as a cartographer explores in collaboration with stakeholders a wide angle of objectives and political means and their practical consequences. The cartographer role is basically the most innovative role, since knowledge is generated and exchanged in a broader and more significant way and learning between SPI actors go beyond the decision-making process. Those roles are very helpful to compare actual roles of scientists and to give their SPI role a specific name. It is also useful put them in order of past literature to explain why they take on a certain role in practice.

As scientists in SPIs have difficulties to achieve or maintain a certain role in practice (Huitema & Turnhout, 2009), the analysis of scientists' role in practice is not very easy to determine. Normative viewpoints play a big part in shaping that role in practice. According to the finding of Huitema and Turnhout (2009), I structured the analysis of interview data into an analysis that a) examines actual (real-world) practices and b) examines normative viewpoints about the role of scientists. In my opinion, it is highly important to look at both sides to fully understand what actually determines the role of a scientist in interaction with policymakers. The above-explained normative role perspectives can be seen as a principal guidance that shaped my understanding of science-policy interaction. In my opinion and derived from literature (Bäckstrand, 2003; Pielke, 2007; Turnhout *et al.*, 2013; Spruijt *et al.*, 2014), the role of a scientist is dependent on two concepts: a) the way **participation** in SPI looks like and b) the way **knowledge** is generated and used (Table 2).

Participation is very much dependent on the level of engagement of a scientist. High level of engagement is seen in vivid discussions, in interactive communications between SPI actors, in shared negotiations with multiple stakeholders and so on. Low levels or none engagement is exactly on the other side of the extreme and describes no or linear communications. Participatory policymaking also involves other non-political actors to actually form a decision. So the degree of involvement into decision processes is also influencing the role of a scientist. Is he in Pielke's words a pure scientist providing mere scientific knowledge, an honest broker that provides options or is he really shaping the process to form a decision in a full integrative way like in the democratic-pragmatic approach? The last dimension of participation focuses on the interaction of scientists with other SPI members. I categorized interaction with the help of background theories and role models and therefore developed three broader typologies that largely emerged from the data set. The first is the scientist as silent observer and is related to the technocratic approach of scientific policy advice. He gets problems and questions from other SPI members and produces and delivers factual knowledge, but he is further not integrated into processes. Therefore, I called it silent observer, since figuratively he sits in his ivory tower and looks down from top-down onto the policy process and gives technocratic advice on how difficult questions and problems can be resolved. The second sub-dimension is a scientist acting as expert respondent within the SPI. Here, the scientist is convinced to make SPI negotiations successful by providing all kind of scientific data. The paradigm of 'speaking truth to power' figuratively is a quite strong attitude distributed among the members. Scientific facts give credibility and authority to possible policy options that the majority of the SPI has to accept or not. Scientists tend to present options with no alternative or with some

other optimal alternatives according to their own point of view and are therefore related to the decisionist approach. I called the last sub-dimension the active participator. In this typology scientists and other SPI members do not follow a strict role division, because SPI members jointly develop certain political pathways and in a systematic dialogue deliberate about desired and undesired consequences. This typology is related to the pragmatic approach of scientific policy advice. Scientists, public and societal representatives critically assess those pathways while making values as transparent as possible. Therefore, a scientist is not regarded as a knowledge producer anymore, and other SPI members as knowledge users, like in the other two typologies.

The second concept affecting the role of a scientist is knowledge in a SPI. Especially, knowledge generation and use are important. The core of policy advice is explained as transferring relevant knowledge to policymakers, who use that knowledge in order to make solid and robust decisions. However, expertise can be seen quite differently in SPIs. According to literature, a strict separation between knowledge producer and knowledge user, namely scientist and policymaker (or other stakeholders), often does not prove to be a true division anymore. In principle, scientists can also act as a knowledge user and policymakers as knowledge producer, since SPIs basically function as large transfer centres for ideas, opinions and knowledge. Knowledge is a feature that every actor in a SPI possesses. A pluralisation of advising actors has been developed from a governance perspective, which calls for a participatory turn in scientific expertise (Bäckstrand, 2003). Science is certainly still an important supplier of factual knowledge, but in the past science has often overestimated its role in knowledge generation that they can reasonably play. It is said that the role of scientists is limited due to knowledge gaps (Wagner, 2015). Therefore, the how of knowledge generation and use is a critical determiner for the role of science in SPIs. For instance, the way a scientific assessment is designed and the problem is formulated regulates knowledge generation and use to a great extent. In technocracy, science is responsible. From a decisionist understanding, policymakers come up with a question and science provides the method to answer that question. From a democratic-pragmatic understanding, science, policymakers and stakeholders together jointly deliberate about the question and the method.

The role of scientists in SPIs is consequently divided into two concepts namely participation and knowledge. Participation is categorized into three dimensions like engagement with policy processes, involvement in taking policy decisions and interaction with SPI members. Those dimensions are again divided into different sub-dimensions, which are derived from normative perspectives about the role of scientists. The same is done for the concept of knowledge. Dimensions that determine knowledge in SPI are the way research is designed and problems are formulated, the way knowledge is generated in a SPI, the way knowledge is used in a SPI, whether scientists divide between facts and values in their knowledge or research data and whether a learning process is taken place in the SPI (Table 2).

Table 2. From concepts to dimensions to sub-dimensions for coding using a normative theory perspective

	Concepts	Dimension	Normative Theory	Sub-dimensions
Role	Participation	Engagement	Technocratic →	None
			Decisionist →	Some
			Pragmatic →	Full
		Involvement in policy processes	Technocratic →	None
			Decisionist →	Providing extra options
			Pragmatic →	Fully integrated
		SPI Interaction with other members	Technocratic →	Silent observer
			Decisionist →	Expert respondent
			Pragmatic →	Active participator
	Knowledge	Assessment design & Problem definition	Technocratic →	Solely Science
			Decisionist →	Policy question, scientific design plan
			Pragmatic →	Jointly deliberation
		Knowledge generation	Technocratic →	Disciplinary, Unilateral
			Decisionist →	Interdisciplinary, Bilateral
			Pragmatic →	Transdisciplinary, Integration of all actors, Co-production
		Knowledge use	Technocratic →	Linear & unilateral
			Decisionist →	Two-way interaction & bilateral
			Pragmatic →	Diffuse/ Brokering & multilateral
		Fact-Value distinction	Technocratic/ Decisionist →	Strict division of facts & values
			Pragmatic →	Acceptance of values in scientific knowledge
		Learning process	Technocratic →	No learning process
			Decisionist →	Unilateral, linear
			Pragmatic →	Multidimensional

Chapter 2. Science-Policy Interfaces in Germany (Network Analysis), Methodology and Sampling

Chapter 2 covers the method that was used for this Master thesis. But before describing the methodology of the follow-up study, I am going to describe current science-policy interfaces in the German energy transition. Key scientists in German science-policy interfaces were identified and contacted to participate in semi-structured interviews. My interest was therefore not on the general structure of the German science-policy networks, but more on the detailed individual level. Names will however not be specified for reasons of anonymity. The description is followed by an explanation of the data collection and data analysis of the follow-up study.

Pre-study: Network Analysis

In the pre-study, I am going to describe what kind of networks exist, what the current structure is and current relationships between policymakers and scientists in science-policy interfaces. The reasons for a pre-study were to get an overview of the development, the structure and the different actors in the German energy transition. The pre-study was additionally important, since I needed to identify interview subjects for further inquiry. Therefore, a pre-set list of selection criteria guided the network analysis.

Selection criteria of interview subjects

Interview subjects needed to be scientists with a current focus on designing, implementing or controlling an approach of resolution in the German energy transition for policymakers. They should have been active with the conduct of research aimed at improving the progress of the energy transition. This means that they were either studying the technical, environmental or societal angle of the German energy transition. Furthermore, renewable energy experts from associations were also subjects of interest. Here, I am referring to organizations, which already have a clear mission that is supporting the development of renewable energies or the German transformation towards RES, and therefore commission scientists to research for possible problem solutions. Secondly, subjects should obviously work in an environment, where they were encountering SPIs, or experienced working in SPIs recently, or would have done so in the near future. The underlying idea was that they should have experienced working in SPIs or have reflected on their role and thought about the interaction with policymakers or stakeholders and participatory research. An indirect prerequisite therefore was also that they possessed exclusive and relevant expert knowledge to be involved in science-policy interfaces in the first place. Thirdly, subjects should have been part of a transdisciplinary panel, which was not an absolute requirement, because it was rather difficult for me to determine this before. It would have been an advantage. It meant that they exchanged knowledge not only with policymakers, but also with peers and other stakeholders and also had

experience with participatory research design. As the German energy transition turned out to be obviously a complex and dynamic process, I recognized that it was impossible to be solely solved by traditional policy approaches, science or a linkage between just those two actors. Instead it called for transdisciplinary research. From this point of view, scientists as subjects for this research also would consider the social value or social responsibility of science in their research, when incorporating societal goals into their research objectives, in order to make certain of contributing to a desirable innovation process.

Data collection

The enumerated selection criteria were considered when I searched for information of the current network in the German energy transition. I got most information from official Ministries' websites, from institute websites and from websites focusing on the energy transition. Search terms like 'German energy transition', 'science-policy interfaces', 'committees energy transition', specific research institutes names or names of scientists, etc. were used, often also a combination of these. Via links on the Ministries' websites I came to most of the institutes participating in panels and dialogue platforms. Information was also gathered from peer-reviewed articles that addressed issues and various topics of the German energy transition. Though, most of the article information was not addressing actual science-policy interactions; they dealt more with technical, environmental or societal research topics and were less practical. On the research institute websites I especially looked for departments directly related to energy transition, energy in general or climate policies. In this way, I was able to see whether they were involved in conducting research or whether they had an internal panel for the German energy transition.

Science-policy interfaces in the German energy transition

The network analysis revealed a complex and dynamic environment of the German energy transition with a lot of actors and networks involved. Actually, the topic first aroused forty-five years ago. Due to the energy crises in the 1970s, the relevance of renewable energy sources came into focus in industrialized countries in the mid seventies. Unfortunately, this focus had not last for long, because it shifted quickly towards novel nuclear energy thought as clean and cheap. It took more than twenty years to restart the public debate about renewable energy sources and for the first detailed analysis of renewable energy supply scenarios by the European LTI-research group (Hohmeyer & Bohm, 2015). But researchers worldwide thought it would be impossible to reach a 100% renewable energy supply, until nine different studies provided detailed description in 2010 suggesting a 100% renewable electricity supply for the future. The results were a milestone in history of the renewables in Europe; because RES opponents were taken their basis of arguments and they gave public actors the feeling that society is ready to manage an energy transition towards RES. Since the announcement of the energy transition in 2011, the German parliament has actively fostered research programs engaging in innovation and technology development to help to transform the energy system and

to achieve agreed goals. Therefore countless different networks, transdisciplinary platforms, committees, advisory organisations, change agencies, citizen initiatives (and a lot more) have been established. This research especially focused on the cooperation between scientists and policymakers. So-called interfaces where scientists, policymakers and other stakeholders meet to communicate, exchange ideas, and jointly develop knowledge to enrich policy and decision-making and/ or research were picked out to study the role of scientists in these interfaces. A SPI is characterized to involve exchange of information and knowledge leading to learning, and ultimately influencing decisions in the policy cycle. Key features of a SPI are its reason for operation (goals), how a SPI is set up (structure), how key function are carried out (processes), the preparation and presentation of outputs and the level of impact (outcomes) (Young *et al.*, 2013).

Actors and networks in the German energy transition are interrelated and it is often the case that one actor is part of several different networks. In order to reduce the complexity of the system, I concentrated on the biggest or more important networks and actors. Generally, it can be concluded the bigger and more important networks are, the more regular SPIs happened. On the part of politics, there are three German ministries particularly involved in the German energy transition. First of all, there is the Federal Ministry of Economic Affairs and Energy (BMWi), which is promoting energy reforms especially for security of supply and affordability of renewable energy, cost effectiveness, and energy and economic efficiency respectively[3]. Secondly, the Federal Ministry of Education and Research (BMBF) promotes the energy transition in Germany by supporting fundamental and applied research in order to develop new technologies and innovations[4]. Thus, it is closely collaborating with universities and science institutions. Thirdly, the Federal Ministry for the Environment, Nature Conversation, Building and Nuclear Safety (BMUB) contributes to promote an energy transition by fostering broader projects such as global climate protection and more local projects such as extending energy efficiency or local storage of produced energy[5]. Together, those ministries form the political institutions with an executive function to enforce policies regarding the energy transition. The German government is currently supporting research and innovation development for the energy transition. Therefore, they launched a research-funding program called Forschung für Nachhaltige Entwicklung (FONA), which means Research for Sustainable Development. The focus is on a close combination of research and innovation funding (translating research findings into concrete technical and social innovations) and is therefore more application-oriented[6]. Additionally, FONA was introduced particularly to support inter- and transdisciplinarity in the current science system during the energy transition. FONA funding especially supports research that is designed to find applicable knowledge for decision-making. Deputies responsible

[3] Retrieved from http://www.bmwi.de/DE/Themen/Energie/Energiewende/gesamtstrategie.html. Accessed on April 20, 2016.
[4] Retrieved from https://www.bmbf.de/de/energiewende-565.html. Accessed on April 20, 2016.
[5] Retrieved from http://www.bmub.bund.de/themen/klima-energie/. Accessed on April 20, 2016.
[6] Retrieved from https://www.bmbf.de/de/forschung-als-motor-der-energiewende-858.html. Accessed on May 8, 2015.

for the FONA program are especially present in SPIs to develop research questions in cooperation with scientists and stakeholders from economy, public administration and society.

In 2013, about 180 universities and 120 research institutes were actively involved in projects for the German energy transition[7]. In order to keep track of research funding and research projects and to increase transparency, the BMBF established a platform called 'Landkarte der Energieforschung' (Map of energy research). The map shows all involved science institutions and universities that are conducting research for the energy transition and thus getting funding from the German government. All involved science institutions are listed on this website and a table provides an overview of these actors with their ascribed budgets. Major science institutes are the Fraunhofer association (39%), the Helmholtz association (46%), the Leibniz association (9%) and the Max-Planck-institute (6%)[8].

In the following, I am going to describe important SPIs that were looked at in the follow-up study. Interviewees were invited from the following SPIs. Figure 1 provides an overview of the network.

Due to the intended transdisciplinary character of cooperation, the national **science panel Energiewende** (**'Forschungsforum Energiewende'**) was established to bring important actors within the energy transition together. The goal is to improve efficiency in all evolving processes and projects, to improve legitimacy for political action and to improve transparency by involving representatives from all different sections of the population. Together, they have the possibility to discuss and assess scientific scenarios for the energy transition and thereupon based policy recommendations for politics[9]. The leading board of the expert panel consists of three policymakers, four representatives from NGO's and industry and one scientist from the IASS. There are nine further plenum members from respectable research institutes.

Another transdisciplinary entity is the TPEC led by the IASS. Established in 2012, it pulls together important stakeholders from research, politics, business and society[10]. TPEC means **Transdisciplinary Panel on Energy Change**. The panel is basically quite similar to the expert panel; however, TPEC focuses more on transdisciplinary aspects like knowledge sharing and mutual learning across different fields of research, stakeholders and across countries. The task of the IASS is carrying out research for the German Energiewende as well as mobilizing knowledge for global energy transitions. Several topics related to energy transition such as market mechanisms, renewable energy sources, participation and social acceptance are divided in three different working groups with the aim to transfer gained knowledge to politics and private entities. The TPEC team consists of nine researchers working for the IASS in Potsdam.

[7] Retrieved from https://www.bmbf.de/de/energiewende-565.html. Accessed on April 12, 2016.
[8] Retrieved from www.bmbf.prodata.de. Accessed on July 28, 2016.
[9] Retrieved from http://www.acatech.de/forschungsforum-energiewende. Accessed on April 20, 2016.
[10] Retrieved from http://www.iass-potsdam.de/de/forschung/energie/plattform-energiewende. Accessed on April 20, 2016.

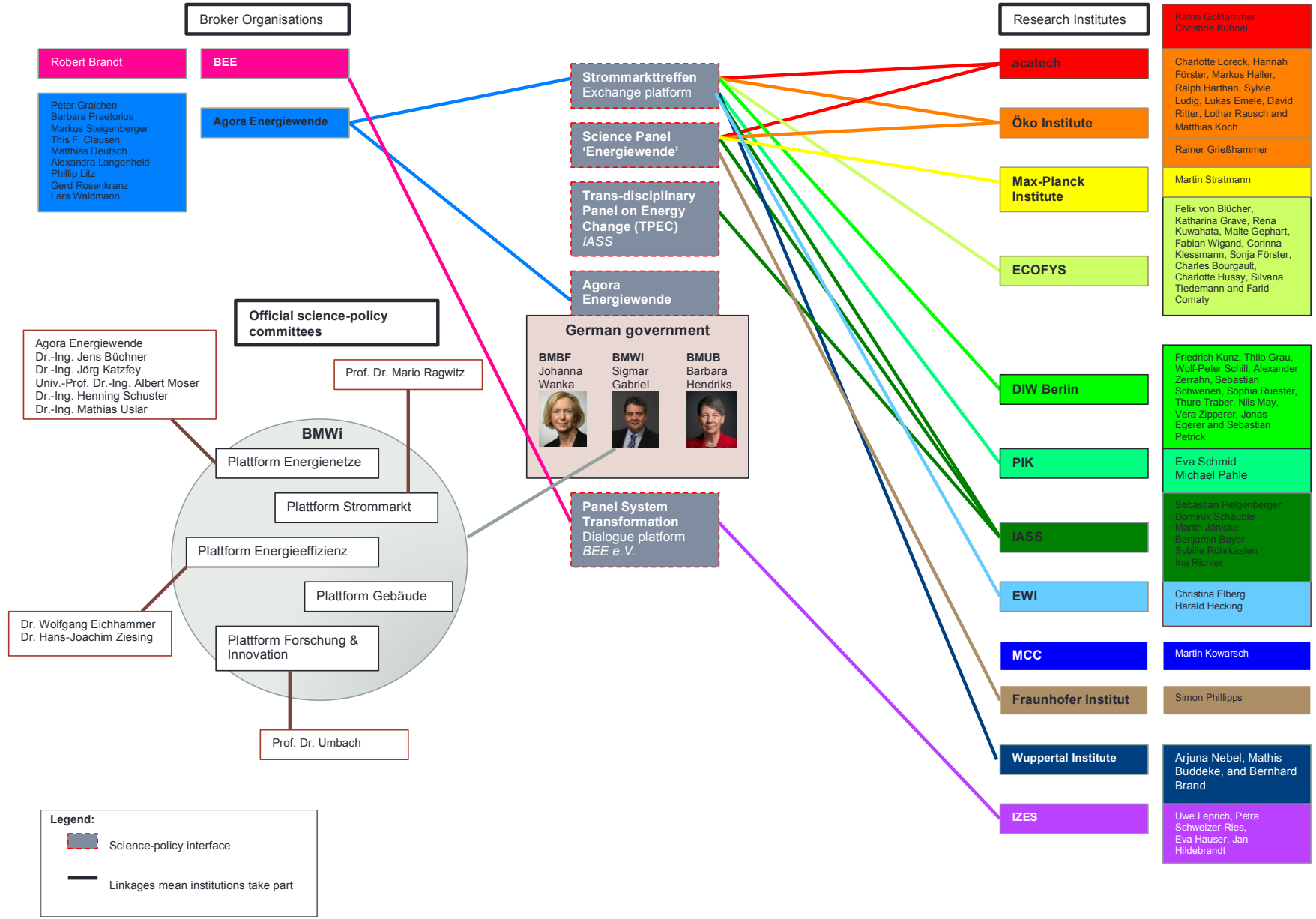

Figure 1. Overview of science-policy interfaces in the German energy transition

A further transdisciplinary think-tank association is **Agora Energiewende** with a main function to develop scientifically based and politically feasible approaches for the energy transition in Germany[11]. Main funders are Mercator Foundation and European Climate Foundation. Their objective is to promote renewable energies in Germany by analyzing, understanding, discussing and assessing various courses of action. The association is divided into two sections: a team of scientists conducting research and developing studies and the Council of Agora, where key stakeholders come together to discuss approaches and exchange knowledge supported by scientific expertise.

'**Strommarkttreffen'** (literally translated into English means 'energy market meeting') is a rather informal transdisciplinary network. Young professionals from politics, research, industry etc. meet every month to discuss important evolving matters around the energy transition in Germany[12]. There are several different groups of stakeholders represented: scientists, policymakers, NGO representatives, industry deputies, union member, etc. In total, 'Strommarkttreffen' has about 500 members working for different institutions and with diverse, interdisciplinary expertise.

The interface **System Transformation** of the BEE is a discussion platform for the member organizations of the BEE and industry experts to present intermediate stages and results to policymakers and other stakeholders in the energy industry[13]. The main objective of the BEE is to advocate for RES in general and therefore they launched the platform to address specific problems of past or current events and to find appropriate policy pathways to integrate RES in the current energy system. The dialogue is about different research studies from different research institutes that describe how the transition could look like and explain concrete policy recommendations for the future.

Follow-up study: Scientists' perception of science-policy interfaces

Research design and data collection

The purpose of the thesis was to conduct a descriptive and exploratory research in order to fulfill the described objective and the resultant research questions. My research questions called for a descriptive exploration of the reasons how scientists interact with policymakers in science-policy interfaces. A qualitative research approach was taken to generate rich, detailed data that leave the participants' perspectives intact and provide multiple contexts for understanding the role of scientists in SPIs. The objective of the data collection method was to interview experts, who are able to reconstruct reality of SPIs and reflect on their own experience in having dialogues with policymakers. Data collection in form of semi-structured interviews was conducted during October and November 2015 to collect

[11] Retrieved from https://www.agora-energiewende.de/en/about-us/frequently-asked-questions/. Accessed on April 20, 2016.
[12] Retrieved from http://www.strommarkttreffen.org. Accessed on April 20, 2016.
[13] Retrieved from http://www.bee-ev.de/home/politik/plattform-systemtransformation/. Accessed on April 20, 2016.

personal experiences of scientists in interaction with policymakers. Before the real interview started, a pre-test of interview questions was conducted to assess the comprehensibility of the questions, the interest and attention of the interviewee for the questions and during the interview, the continuity of the whole interview, the impact of the interview structure and the time needed for the interview. The pre-test was conducted with a German lecturer from the department of Environmental System Analysis at the WUR.

An interview guide with pre-formulated questions gave directions during the interview, but there was enough space for probing questions to intensify certain topics or explore potentially relevant topics that were not part of the pre-defined interview questions. The questions were open questions, formulated in such a way that the interviewed person felt at ease and thus answered in detail and constructively. The interviewee was instructed to especially focus on their direct experiences in their answers, without distinguishing between right and wrong. This instruction was made because otherwise interviewees would get too quickly to normative standpoints, where they would explain an 'ought-to-be' situation instead of focusing on real interaction.

Sixteen subjects were identified as suitable in the pre-study according to the previous described selection criteria. The identified subjects were contacted before via mail to participate in this research. An official letter was drafted (Appendix I.) in order to lend the invitation greater significance. The purpose of the sample was not representativeness, but to explore in-depth scientists' diverse and various beliefs and opinions about their own positioning in science-policy interfaces in the German energy transition. For reasons of feasibility, the number of respondents was restricted to a maximum of 10 people. Non-random sampling was applied, as the network analysis did not result in a lot of possible subjects. Interview subjects were handpicked to study the most interesting and important cases. Once, the snowball strategy could be applied, because one previous interview subject indicated another relevant scientist for further inquiry. In total, nine interview subjects from five different SPIs were eventually interviewed (Table 3). The interviews were conducted from home via telephone calls and were recorded with a cell phone. After that, I transcribed each interview with the help of Microsoft Word and the recording app of my phone. I kept attention to capture every word said during the interview, but not how interviewees answered the questions or framed replies. For reasons of anonymity, I made an agreement with the interview subjects not to indicate their names. Instead, I gave each interview a number (e.g. INT 1 or Interviewee 1) to differentiate between the interviewees.

Table 3. Interview subjects divided over the different SPIs

	Science-policy interface					
Subjects	**Strommarkttreffen** *Informal network*	**Science Panel Energiewende** *BMBF/ acatech*	**TPEC** *IASS*	**Agora Energiewende** *Agora*	**Panel System Transformation** *BEE dialogue platform*	**Other National or international interfaces**
Interviewee 1 (INT 1)					X	
Interviewee 2 (INT 2)	X					
Interviewee 3 (INT 3)						X
Interviewee 4 (INT 4)		X				X
Interviewee 5 (INT 5)	X					
Interviewee 6 (INT 6)		X				
Interviewee 7 (INT 7)			X			
Interviewee 8 (INT 8)			X			
Interviewee 9 (INT 9)				X		

Data Analysis

Obtained data from qualitative interviews was analyzed by using a constant comparative method between different elements in the data set. A constant comparative method enabled me to compare discovered phenomena and developed concepts with other similar or divergent phenomena and concepts within each interview, but also between the different interviews. In light of the research questions and a first view on interview data, I posed generative questions. First assumptions were build on role models from past literature and therefore, generative questions were: How does science-policy interfaces in the German energy transition look like? How do scientists deal with policymakers from the German government departments? How do scientists generate knowledge or expertise to solve the complex energy transition? How are studies conducted that are developed for answering complex problems related to the energy transition?

The first research question addressed the actual role of scientists in SPIs, whereas the second research question addressed the normative role of scientists in SPIs. The interviews were coded according to the theoretical framework that acted as a zoom lens to focus on specific parts of the answers. Coding facilitated to develop a tentative coherence and interrelationships of each interview. Due to a two-fold analysis of actual role and normative role of a scientist, I carefully selected the phrases where interview subjects explained a direct experience to describe their actual role, and phrases where they explained a normative perspective to describe how science-policy interaction should be ideally. Found phrases in each interview were also compared to each other in order to detect inconsistencies within an interview. With the help of these codes an extensive and systematic analysis of the interviews was possible. Concepts of the role of scientists, their dimensions and sub-dimensions were explained in the former theory chapter. The reason to categorize dimensions into sub-dimensions was to be capable of doing a systematic comparison between the different concepts. It is essential to mention that sub-dimensions were scaled and related to the normative part of the theoretical framework (see again Table 2). Two tree diagrams provide another overview of the dimensions and their sub-dimension (Figure 2 and 3).

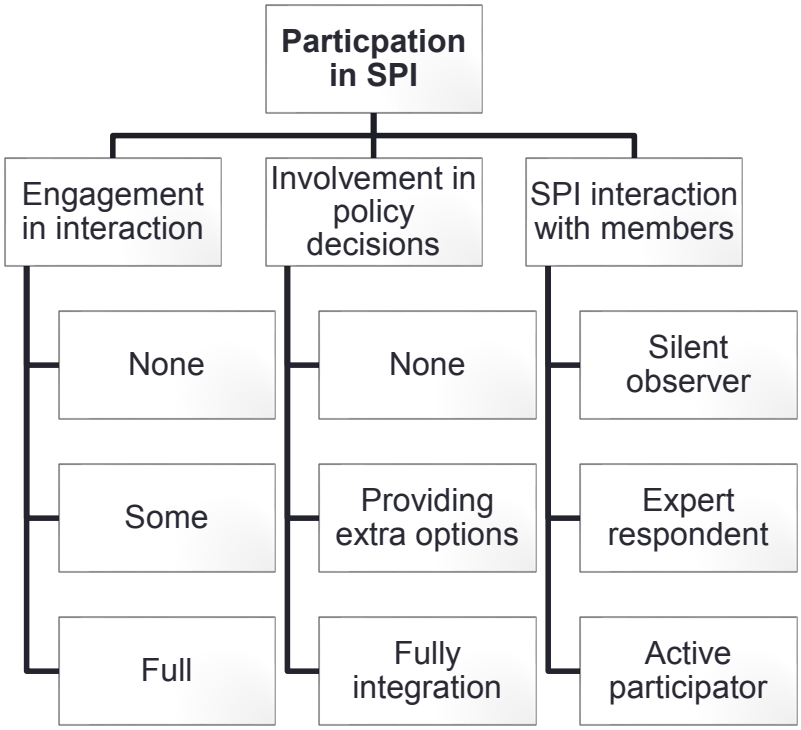

Figure 2. Tree diagram for the role of science

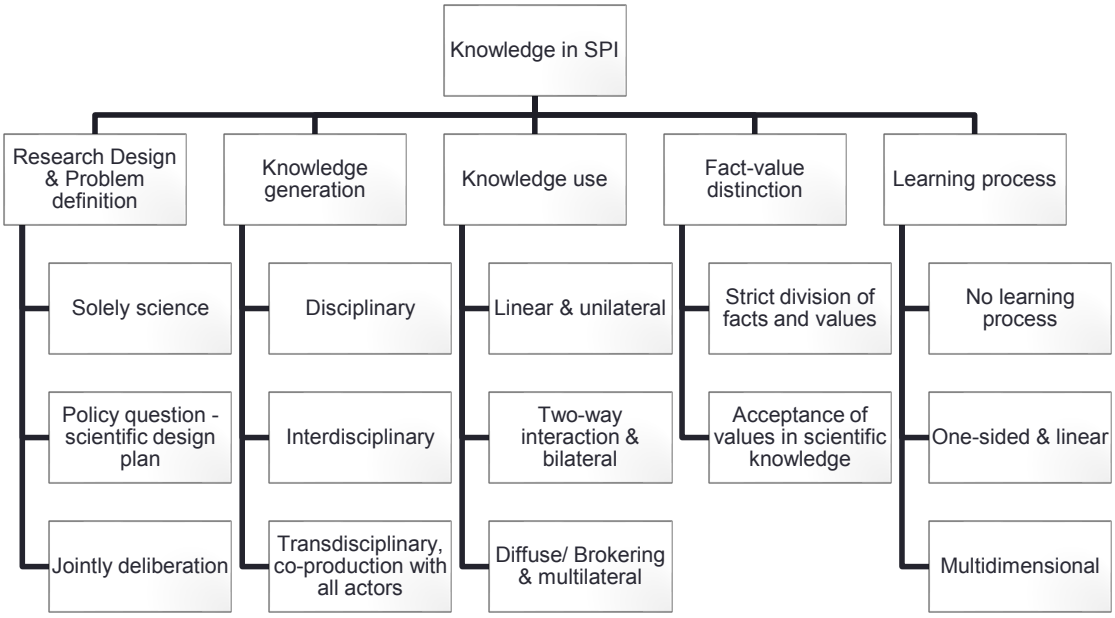

Figure 3. Tree diagram for knowledge in SPI

Chapter 3. Participation in Science-Policy Interfaces

Chapter 3 and 4 cover the results of the thesis and describe what individual interviewees said during the interview conversation. Chapter 3 concentrates on the first concept 'participation', whereas Chapter 4 draws together interview results related to the second concept 'knowledge'. I am particularly focusing on what real experiences of interviewees were to describe their role in reality. Therefore, I made a distinction between those phrases where they directly spoke of experiences, and statements that described an 'ought to be' situation or a normative belief. The interview results for each dimension are explained for every interviewee individually, since I believe to lose deepness of data otherwise. Each dimension starts with an overview how many interviewees are allocated to each sub-dimension, followed by a description about individual explanations and handling of conflicts or dilemmas and it ends with a summary of the dimension in order to pull together points in common.

Engagement (in interaction with policymakers)

The dimension engagement is divided into three sub-dimensions in this analysis. The first sub-dimension is **no** engagement at all, second is **some** engagement and the last stands for **full** engagement in interaction (Table 2 and 4). The sub-dimensions lie on a scale. In total, three interview subjects experienced none engagement in interaction, while two interview subjects experienced engagement to some extent and four interview subjects had experience of full engagement in interaction with policymakers.

No engagement
Interviewees 1 and 6 described none engagement in policy processes. Interviewee 1 explained no engagement, because they simply did not want scientists to be engaged in the interaction with policymakers. Even though Interviewee 1 described an intention to bring practitioners, scientists and policymakers together, they reduced interaction to a minimum level in the BEE's dialogue platform. Instead they placed themselves in the centre of the SPI and interacted directly with all actors from the dialogue platform. Consequently, other actors were unable to directly interact with each other. Interviewee 6 told me during the interview that even though the Ministry of Education and Research (BMBF) consciously set up the science panel Energiewende to create a bridge between science and policy, there was no real interaction between these institutions taking place, and Interviewee 6 could not experience engagement in interaction with policymakers accordingly. The view of Interviewee 6 disagreed with the normative beliefs of Interviewee 4 being part of the science panel Energiewende as well. I will describe this discrepancy directly after the illustration of Interviewee 6. Interviewee 6 further explained the Ministry's intention was to engage scientists in policymakers' interaction, because they wanted scientists to provide options for policymaking that eventually led to policy recommendations with specific courses of action. But instead scientists concentrated on writing evaluation papers of past courses of action that were already taken and they

analysed them on their effectiveness. Interviewee 6 explained several reasons for this interaction failure in the SPI. Interviewee 6 said, due to a very heterogenic composition within the group of scientists, they had difficulties to find common ground. Additionally, there were deep disagreements on the side of policymakers about the responsibility for the German energy transition. On the one side the Ministry for Economic Affairs and Energy (BMWi) wanted to be in control of all related processes; on the other side the BMBF was actually responsible for science policy and distributing research funds. This conflict hindered interaction between science and policy in general, since the BMWi was quite sceptic about the science panel Energiewende and did not want the interface to engage in 'their' policy process. Hence, involved scientists actually did not have a cooperation partner because the BMBF had no power to enforce scientific expertise in designing courses of action and the BMWi was politically powerful but had no intention to cooperate.

Some engagement

Like mentioned, in contrast to Interviewee 6, Interviewee 4 thought different of the interface science panel Energiewende. Interviewee 4 described that he was to some extent engaged in interaction with policymakers. Interviewee 4 participated in the science panel Energiewende in so-called "*Beratungskreisen*" (advice committees) as a scientist to define new relevant research topics. Additionally, he reflected from experience that he often was asked to participate in other scientific committees to directly give policy recommendations. From a normative perspective, Interviewee 4 divided interaction with policymakers in two levels: first, politicians commission studies to analyse certain topics and scientists should apply for those projects. At that point of time, he talked about working on a lot of commissioned studies, and he stated that he was not really engaged in interaction, because interaction rarely happened. And second, policymakers summon scientific committees to advice them on specific topics where required. On the second level, he concluded, there should be more interaction and therefore more engagement of scientists in interaction with policymakers according to his opinion. However, later in the interview he admitted that in reality he had not experienced intensive engagement of scientists in committees between science and policy. That points to a difference in his perception about how interaction in interfaces should be and how reality actually looks like. That concludes that Interviewee 4 seems to be not engaged in real interaction, though according to his normative beliefs he would like to be engaged.

Interviewee 2 experienced to be engaged in interaction with policymakers to some extent. Additionally, Interviewee 2 described that engagement in SPIs can also be an advantage for her, because she had the possibility to exchange knowledge, data and viewpoints with peers, policymakers or other SPI members. Interviewee's 2 determination of the extent of engagement is especially justified by the experience that commissioned studies from policymakers often cannot be utilized for academic purposes. She said conducting applied research for policymakers is conflicting with her reputation as a scientist, because the science community judges her scientific capability on the quantity of scientific papers published. The classical scientific assessment for policymakers lacks a scientific basis, as she put it, and is therefore not qualified for a publication in a scientific journal with a great impact. From a normative standpoint, she explained that she would like to be more engaged in interaction with policymakers, but in reality she was only engaged to some extent

due to the structure of SPIs and the product, namely to deliver a classical scientific assessment.

Interview partner 5 reflected from his experience that he was also to some extent engaged in policy processes. He explained with the help of a past project that interaction with policymakers was always bound by formal contracts to regulate rights and duties of each member. The contract acted as security for both sides, science and policy, and prescribed structural points of the science-policy interface like the sort of advice, the project details and a time frame. The specific content of the project was subject of negotiations between all interface members where he sometimes experienced heated discussions with ministerial employees and he pointed out that in this way he got more engaged into interaction with policymakers than was defined before. He concluded that interaction with policy does not always follow a formal structure, although it was planned before.

Interview partner 7 and 8 work at the same institute and in the same science-policy interface namely the Transdisciplinary Panel on Energy Change or briefly TPEC. During the interview, they both quickly came to the normative standpoint that scientists should only be engaged to some extent in policy processes. They justified their normative view by reflecting from experience. They both considered a certain distance to policymakers and the policymaking process in TPEC. In one experience Interviewee 8 spoke of a balancing process: " *(…) können wir unsere Expertise unmittelbar in den Prozess mit rein bringen und an der Transformation teilhaben. Gleichzeitig aber wird natürlich unsere Rolle als neutraler Partner, der auch für verschiedene Seiten als Ansprechpartner dienen soll, in Frage gestellt*." (Interview 8: … we can include our expert knowledge into the process and participate in the transformation process. But at the same time our role as neutral partner, which shall also serve as contact for different kind of stakeholders is of course contested.) Especially, for reasons of scientific neutrality, objectivity and "*Überparteilichkeit*" (non-partisanship), Interviewee 8 thought, policymakers would perceive scientists as more political-neutral player, when only engaged to some extent into the policy process. He thought that this in turn enhances credibility of his scientific expertise and a trustworthy relationship in cooperation with policymakers. In reality, Interviewee 8 experienced full engagement in interaction with policymakers where he could not maintain that distance to policymakers. From simply giving answers to policy-relevant questions, he stated to have experienced projects where he was asked to act as central player in the process and therefore would have been fully engaged into interaction. Interviewee 7 also experienced quite similar events in reality. He experienced a project with policymakers, where he tried to follow his normative idea of maintaining a distance to the policymaker. However, he eventually experienced policymakers that were overwhelmed with his scientific expertise due to the complexity of the topic that could not be discussed in one meeting. Time and budget that policymakers set were limiting factors, so that only one meeting was scheduled. Interviewee 7 explained that one meeting was simply not enough to communicate study results. Therefore, he was forced to be fully engaged in interaction with policymakers in this project.

Table 4. Interview answers for the different codes for participation in SPIs, presented with their foundation in theory

Dimensions		Theoretical framework		Sub-dimensions	Results on actual experiences									Results on normative beliefs								
					INT 1	INT 2	INT 3	INT 4	INT 5	INT 6	INT 7	INT 8	INT 9	INT 1	INT 2	INT 3	INT 4	INT 5	INT 6	INT 7	INT 8	INT 9
Codes	Engagement	Theoretical Background	Technocratic	None	X			X		X				X								
			Decisionist	Some		X			X								X	X	X	X	X	
			Pragmatic	Full			X				X	X	X		X	X						X
	Involvement in policy process		Technocratic	None	X					X				X			X					
			Decisionist	Providing extra options		X		X	X			X						X	X	X	X	
			Pragmatic	Fully integrated			X				X		X		X	X						X
	SPI Interaction		Decisionist	Silent observer	X					X				X								
			Technocratic	Expert respondent		X		X			X						X	X				
			Pragmatic	Active participator			X		X			X	X		X	X			X	X	X	X

Full engagement

Two interview partners had experiences about full engagement in policy interaction and this matched with their normative standpoint as well. Interview partner 9 described that at Agora Energiewende all scientists of the science-policy interface were fully engaged in the interaction with policymakers. According to circumstances, the topic and relevance, Agora Energiewende had identified all meaningful actors at an early stage in the process; she called it "protagonist" and "antagonist", they were invited to participate in the so-called "*Begleitkreis*" (best English translation is accompanying committee) and were asked to discuss the problem, the resulting question, the research project and which assumptions should be put into the scenario or model. Before the research project started, participating scientists had the possibility to discuss and talk to ministerial employees, other scientists from different disciplines, NGO representatives etc. She defended this SPI structure fostered interaction and engagement. She further explained that interactive SPI processes were their main targets by saying: *"(…) letzlich steht Agora ja für den Marktplatz der Diskussionen und Ideen. (…) Themen auf den Tisch zu packen in eine Diskussionsrunde und zu gucken wo hakt es.*" (Interview 9: (…) in the end Agora means a market place for discussions and ideas. (…) topics are put on the table in discussion rounds and everybody searches for things getting stuck.) She conceded that more engagement of scientists to cooperate with policymakers served the bigger target namely to maintain a stable course for the German energy transition.

The second interview subject experiencing full engagement in interaction with policymakers is Interviewee 3. He said that full engagement started with a thorough problem analysis by using the proverb: *"(…) a problem well put is half solved (…)*" (Interview 3). According to one of his experiences, a representative group of scientists and stakeholders formulated the problem and eventually formulated common objectives, political means and their practical implications. The analysis included common interests that were leading to various options. He explained full engagement on all sides was crucially important, because every SPI participant could deliver his expertise and was able to be part of a larger learning process. In other experiences with direct individual policy advice or more informal SPIs, he said engagement did not exist, because they met for a single time. He said, "wenn man Glück hat, trifft man auf ein sehr interessiertes Gegenüber, aber besonders nachhaltig sind diese Gespräche aus meiner Sicht nicht." (Interview 3: if you are lucky you face an interested opposite, but these meetings have not a real lasting effect according to my view). In general he thought the management of the German energy transition has been a catastrophe so far on the long term (Interview 3: *"Aus einer langfristigen Perspektive muss man sagen, ist das Management der Energiewende bisher eine Katastrophe.*") He therefore also spoke normatively of an increased stakeholder engagement to give advice to society and not only to policymakers. He said, *"(…) wir wollen auch dieses Stakeholder Engagement weiten und Politikberatung im Sinne von man berät die interessierten Mitglieder einer Gesellschaft. Das ist die Zielgruppe (…) und natürlich sind die Regierungen und Politiker ganz zentrale Spieler. Deswegen sollten diese auch immer eingebunden sein."* (Interview 3: we want to expand stakeholder engagement and give policy advice with regard to give advice to the interested members of society. That is the

target group and of course, the government and politicians are real central players. Therefore, they should always be part). But he concluded from other practical examples that commissioned studies from Ministries with none or some engagement were always implicitly steered and controlled. He gave a reason by saying "*weil die* {Politiker} *natürlich in der Studie zum Zeitpunkt der Veröffentlichung was lesen wollen was ihnen in den Kram passt. Das ist kein Geheimnis.*" (Interview 3: because they {politicians} certainly want to read something that suits their plans in the study at the moment of publishing. That is no secret.). He thought only full engagement in interaction of scientists and other stakeholders on the long-term enables policymakers to truthfully represent society.

The extent to which scientists are engaged in interaction with policymakers seems to depend on structural features and processes of SPIs. Interviewee 9, who experienced full engagement in the "*Begleitkreis*", described an interface design that was intended to work with full-engaged members. SPI members of Interviewee 9 were provided with the opportunities to actively participate in discussions and trade-offs. Particularly in interview 6, it became apparent that conflicts on the side of policymakers hindered interaction and engagement of scientists in the interface with policymakers. Policymakers were unable to set up a formal SPI structure with clear defined, shared objectives and common and individual tasks. Therefore, SPI members in the science panel Energiewende had not the possibility to participate in policy discussions. Although Interviewee 4 from the same interface reported some engagement, he might have just meant the delivery of his expertise to policymakers to help them understand the science behind without real interaction. Compared to Interviewee 5, a formal contract does not have to mean that SPI interaction would be planned when put into a formal frame. On the contrary, Interviewee 5 nevertheless reported of vivid discussions with all SPI members and he eventually found himself to be more engaged in interaction than he initially expected. Furthermore, the contrasting view of Interviewee 4 made also clearer that scientists bring in another complexity. The way that they think engagement in policy processes ought to be and his real experiences speak for a gap in perception about normative views and actual practice. In all parts of the interview, interview partner 4 seems to be quite inconsistent about how he experienced engagement and his normative viewpoint about interaction and engagement. It is now unsettled whether misunderstandings between science and policy in the science panel Energiewende has been the case before and therefore interaction between those two never happened; or whether technocratic views were developed from the conflict on policy side and a missing common objective. Interviewee 3 actually brought one fundamental issue to the point, because he referred to the problem of commissioned studies, which is referring to the outputs of a SPI. He thought Ministries implicitly steer and control commissioned studies. Combining his view and the views of Interviewees 7 and 8, it seems evident why 7 and 8 considered a certain distance to policymakers as important and believed their neutrality could be in danger when being fully engaged. From other parts of the interview, I understood that Interviewee 7 and 8 are often working on commissioned studies and this could be an explanation why they did not want to be fully engaged. In contrast to what they think normatively, Interviewee 7 and 8 were also more engaged eventually than they initially planned to be.

Involvement in decision-making processes

Involvement in decision-making processes is divided in three sub-dimensions (a) **no** involvement, (b) **some** involvement by providing extra options to policymakers and (c) **fully** integration of scientists (and other stakeholders) in decision-making processes (Table 2 and 4). The sub-dimensions are again scaled. Two interview subjects described no involvement in decision-making processes, while four subjects described to provide various options to policymakers and three subjects commented to be fully integrated in policymaking processes. The distribution of involvement is similar to engagement. Interview partners experiencing no engagement, tended to experience no involvement and so on. I will come back to this observation in the ending summary.

No involvement

Interviewee 6 from science panel Energiewende saw that there is a fundamental problem in the structure of the science panel Energiewende and therefore she concluded that there is no involvement of scientists in public policy decision-making happening. According to her normative viewpoint, scientists should at least present options to other SPI members. Interviewee 1 from BEE described a static and linear system of interaction. According to his experiences, there was no involvement in policy decisions between scientists and policymakers/ decision-makers, since science had been commissioned to deliver relevant knowledge, his organisation used these facts to support one action proposal and this was handed to policymakers in other panels. Therefore, his normative beliefs matched with what he experienced in reality. He thought that SPI actors must be divided according to their profession meaning that scientists took over the role of knowledge producer, since they were 'the' experts and needed to come up with solutions, policymakers need to be in charge and have to be responsible for making decisions and all other actors are actually involved in a SPI to represent their interests. His organisation's objective was to represent its member organisations and to promote renewable energies and the energy transition. He talked about having internal discussions and workshops with the association members without involving scientists or being involved in the policy process.

Some involvement

The experiences of interview partner 4 from the science panel Energiewende were quite similar, but again inconsistent in his normative beliefs and actual reality. Although, he had interacted with policymakers often directly in interfaces and committees, he pointed out not to be involved in decision-making processes. He stressed a clear line between the tasks of science and policy, by saying scientists should pursue the objectives of science and policymakers should pursue their own objectives. Nevertheless, he talked about presenting scenarios with different options was one of his fundamental tasks in science-policy interfaces. Therefore, I put him in the category (b), being involved in policy processes by providing options, because he clearly indicated to be actually involved in policy processes during the interview. But again, a discrepancy in his perception about what should be and what he actually does in real interaction with policymakers left my interpretation uncertain.

Interview partners 2, 5 and 8 were involved in policy processes by providing extra options and different courses of action to policymakers. Interviewee 8 defined his role in policy processes as initiator for debates about how courses of action could look like. Furthermore, he thought that he played an important part in addressing fundamental matters that still needed scientific examination and finding a solution for complex problems. He explained that direct political requests from ministries or other policy administrations provided a good possibility to apply scientific expertise directly in advice settings. This had enabled him to participate directly in transformation processes. However, he derived from his normative viewpoint again the danger of being dependent and biased, since he feared too close integration in decision-making would threat his neutral position. He said: *"(…) die Wahrung dieser neutralen Position ist wichtig (…) dass wir uns nicht vereinnehmen lassen (…) die Gefahr ist immer da*." (Interview 8: (…) the maintenance of this neutral position is important (…) that we do not let them take us captive (…) the danger is always there.) For him, fully integration of science in decision-making processes posed a danger and he thought it was better to provide options and their consequences.

Interview partner 5 also experienced involvement in advice settings by providing options and their consequences to policymakers. A provision of options belonged, according to his normative beliefs, to one of his core tasks in science-policy interfaces. Here, he also strictly demarcated science from policy by saying, "*(…) aus meiner Sicht ist jede gute Berratung eigentlich immer eine Beratung, die Optionen evaluiert, und andere Formen der Beratung ist keine Beratung sondern Beeinflussung.*" (Interview 5: from my point of view is good advice defined as advice that evaluates options, and every other form of advice is no advice anymore but influence). Consequently, he regards provision of options belonging to science and deciding on certain options belonging to policymaking whereby policymakers eventually have complete responsibility. This shows where he saw the line between science and policy. Therefore he did not follow a fully integrated approach in policy processes. This matched also with his normative standpoint about how involvement should be. He further explained that he saw a difficulty in the interaction with policymakers, because of different evaluation criteria. He explained he made the experience in some projects that scientific criteria mostly had not been crucial criteria for the policy process and sometimes study results could backfire on policy negotiations. He therefore provided study results with a sort of instruction leaflet to make the results more comprehensive and relevant. He said according to his experience policymakers used different evaluation criteria to assess policy recommendations and therefore different positions of science and policymaking emerged in the interface.

Full involvement (by full integration)

The normative viewpoint of interviewee 7 resembles the normative viewpoint of Interviewee 8. He said, *"(…) grundsätzlich die Aufgabe der Wissenschaft ist Handlungsoptionen und deren Konsequenzen zu zeigen*." (Interview 7: the fundamental task of science is to show courses of action and their consequences). Furthermore, he demarcated his position from policymakers by saying *"(…) eine möglichst gute Grundlage hat wertebasierende Entscheidungen zu treffen. Da sehe ich auch nicht mehr die Aufgabe der Wissenschaft drin, sondern das ist Aufgabe der Politik (…) zu entscheiden, welchen Weg man gehen will und mit welchen*

Konsequenzen man dann auch leben möchte." (Interview 7: we do our utmost to deliver a good basis for decisions based on values. I think that in turn is no task of science anymore, but a task for policy to decide which way to go and which consequences are agreeable). In reality, however, he experienced to be fully integrated into the decision-making process. Taking his example described above from the interview, policymakers were incapable to understand the different courses of action of Interviewee 7 in one meeting. Therefore, they wanted him to name advantages and disadvantages of single courses of action and to name the best option. Therefore, he was suddenly fully integrated into the decision process. He reflected on this experience and said he did not feel at ease at that moment, because he planned to only show them the range of possibilities and did not want to have a voice in their decisions. He further explained this was however not possible due to a lack of time. Therefore, he set his normative beliefs aside and presented them the best option according to his opinion.

Other interview partners defined the amount of involvement differently. Interview partner 9 described that employees of Agora Energiewende and their experts had been closely involved in policy negotiation processes about solutions and concrete implementations. She clearly distanced herself from other interview partners. She thought that just the provision of options is often not enough because policymakers or administrational employees then did not really know what to do with the study results. Her normative beliefs about the extent of involvement are also implemented in the SPI settings. Her statement agreed with Interview partner 3, who emphasized science and policy work ideally fully integrated in policy processes. However, the difference here between interview partner 3 and 9 was that interview partner 9 thought scientists should not put themselves in the position to come to concrete policy recommendations, but broker organisations like Agora Energiewende are able to impart the quintessence of studies to policymakers in the form of policy recommendations. She said: *"Wissenschaftler meistens (…) tun sich schwer so ganz basierte Schlussfolgerungen zu ziehen und die Aufgabe machen wir dann und grenzen uns dabei aber auch deutlich* ab." (Interview 9: scientists have often difficulties with drawing concrete conclusions and then we deal with this task and we differentiate us clearly.)

Interview partner 3 reflected from his experience by saying, "(…) es nützt nichts Politikern einzelne Optionen auf den Tisch zu legen und zu sagen, das ist das Beste und das müsst ihr machen." (Interview 3: it is useless to present individual options to policymakers and to say this is the best option and you have to do this). He enumerated several reasons: first, it had not have the desired effect, since a lot of scientists generally follow this kind of advice giving and policymakers get overwhelmed. Second, as a consequence of high quantity, policy recommendations conflict with options from other recommendations and different viewpoints lead to more uncertainty on the side of policy. Last but not least, he said, there is the danger of mutating to a technocrat or an issue advocate in Pielke jargon, since the opinion of one individual is given priority without comparing its representativeness in society. In addition, the given option could cause the opposite effect instead of the prospected outcome. He argued that only in a fully integrated approach in so-called assessments, science, policy and stakeholders are constrained in a multidimensional learning process and scientific advice would be enough legitimized.

Like engagement before, the dimension involvement into policy decisions seems again to be dependent on structural features and processes of SPI. Therefore, the two interview partners, who described no engagement in the interaction with policymakers, also described no involvement in decision-making processes. Furthermore, all subjects describing some engagement also reported some involvement in decision processes namely by providing extra options to policymakers. Last but not least, the two interviewees that reported full engagement also stated to be fully integrated in policy processes. Obviously, engagement or rather interaction in policy processes is likely to be a predetermine factor for involvement. Or in other words, scientists, who are more engaged in policy discussions and trade-offs, are also more likely to be involved in decision-making. Interviewee 6 reported of no interaction with scientists and policymakers at all and if there was no interaction then also no involvement into public policy decision-making, since interaction is therefore logically a prerequisite of involvement. According to statements of Interviewee 1, scientists were also not involved in decision-making processes. Here, I would like to pick up a topic that was mentioned above, namely the problem with commissioned studies. Interviewee 1 talked a lot about commissioning scientists to do a study on a certain topic and he spoke of choosing scientists to match with own concepts. Hence, scientific expertise was used in the BEE dialogue platform to support the BEE's positioning in the interaction with policymakers. Therefore, scientific expertise was likely to function as source for legitimation of the BEE's standpoints. Scientific expertise was thus not planned to be involved in policy processes but rather to function as a source of relevant knowledge in SPI. Interviewee 1 saw himself more in the position to be involved in policy-related processes. This is also likely to be a possible reason why he described a linear and individual SPI atmosphere, since the determined structure of the BEE's platform had not allowed members to mix their roles. I mean here that Interviewee 1 reported on quite static role distributions coming from more traditional role viewpoints. The involved scientist, for example, acted always as a Pure Scientist or knowledge producer, while other interviewees report to also slip into the role of a knowledge user when other stakeholders are involved (Interview 3, 8 and 9).

Again those interviewees with experiencing some engagement did provide different options to policymakers and experienced to be to some extent involved in policy processes. During answering questions regarding their experiences in interaction with policymakers, all of them defined what 'good' policy advice is. Interviewee 7 and 8 again talked about keeping a healthy distance to policymakers in order to maintain an objective position. Interviewee 4 was again quite inconsistent: on the one hand he strictly divided science and politics, on the other hand he emphasized the essential task of science is to deliver options to policymakers. Interviewee 5 thought provision of options would be the only legitimate policy advice. Therefore, next to structural features of SPI, the extent of involvement also appears to be dependent on scientists' understanding of (a) what they define as good advice, (b) what they think policymakers expect from science and (c) what tasks science has in interaction with policy and where those tasks end. For example, Interviewee 7 clearly stated that value-based decision-making is a task that policymakers have to perform. For him, a scientist is not in the position to include value-based knowledge, even if it would be relevant.

Science-policy interface interaction between members

This section focuses on the positioning and SPI interaction between members. It is divided into three sub-dimensions that stand for different typologies of scientists (see theoretical chapter for explanation, p. 22).

Silent observer

According to interviewee 6 experiences about the science panel Energiewende, there was no interaction happening. Consequently, scientists were not able to position themselves in relation to policymakers. She drew the conclusion that even though the interface had the ambition to advice policymakers, *"(…) gibt es sehr viele Wissenschaftler, mit denen geht das nicht (…) und im Akademienprojekt sind durchaus einige (…)*" (Interview 6: there are many scientists, with whom you cannot do this and in the academics project are quite a lot of this kind). As the situation at that point of time suggests, I would assign scientists from the science panel Energiewende to the first typology. Even though interaction was not present, scientists acted to stand above policy, looking down at the policy process and criticized it.

Interaction in the BEE's platform system transformation was quite straightforward and linear. Due to the structure of cooperation between the BEE and scientists, science acted as a body of expertise and delivered knowledge on the basis of the BEE's questions. Basically, the BEE was a commissioner of scientific studies to deliver scientific facts so that they were able to support their proposition to policymakers with scientific factual arguments to give them more weight and persuasive power. Scientists working with the BEE acted as silent observers, since their task was to deliver relevant knowledge without really being in contact with policymakers and decision-makers. In fact, without really being involved in the interface at all, the BEE had taken over this task.

Expert respondent

Interviewee 4 described interaction in science-policy interfaces as bilateral exchange of interests. On the one hand, regarding interests he slipped into the role of an expert respondent. He gave his scientific input that he presented without other alternatives. Policymakers had the possibility to implement this in their policy proposals or not. On the other hand, he described a linear and one-way process in transferring scientific facts, which indicated a more silent observer typology in interaction with policymakers due to limited involvement. Interviewee 2 also described as if she acted as an expert respondent in science-policy interfaces.

Active participator

The experiences of interview partners 3, 5, 8 and 9 reflected every member in a science-policy interface is an active participator. People had the possibility to network, to exchange knowledge and experiences with each other. Additionally, interview partner 8 saw the task of scientists to bring those relevant people together, whereas interview partner 9 thought a broker organisation should be responsible for this task.

Chapter 4. Knowledge in Science-Policy Interfaces

Chapter 4 follows the same structure as the previous chapter and is divided into the different codes I used for analysing the interviews. Dimensions for knowledge are research design and definition of problem, knowledge generation, knowledge use, fact-value distinction in scientific knowledge and lastly the learning process within the SPI. Table 5 provides an overview for this section.

Research Design and Definition of Problem

The dimension research design and problem definition is divided in three different sub-dimensions. The first sub-dimension refers to the **sole responsibility of science** to define the problem and an appropriate research design to generate relevant knowledge. The second sub-dimension circumscribes a **traditional** (leaned on decisionist theory) **task distribution** when science and policymakers work together. Policymakers describe the problem and objective and therefore engage scientists to propose a research design plan accordingly. The third sub-dimension describes a **jointly deliberation** with all important actors in the SPI (also NGOs and industry representatives) to discuss the set objectives in relation to the problem and how research should be designed to answer open questions. Two interviewees in total belong to the first sub-dimension, five interviewees belong to the second and two interview subjects to the third.

Sole responsibility of science
Starting with the first sub-dimension, Interviewee 4 drew from his experiences the conclusion that he as a scientist was responsible for designing studies and research questions, although policymakers sometimes consciously requested scientists in a committee to find solutions for a certain problem. As he strictly divides science from policy, he had the opinion that scientists should execute tasks belonging to the field of science. This matched with the experiences of interviewee 6 from the same SPI namely the science panel Energiewende. She explained that participating scientists thought independently about current problems in the energy transition and designed their own research, no matter whether this was policy-relevant or not. She said, "*Die* {Wissenschaftler} *auch keine Lust haben sich vorschreiben zu lassen, was sie denn bearbeiten sollen. Das ware ja dann eine Einschränkung der Freiheit der Wissenschaft*." (Interview 6: They do not want any prescription from policymakers what to research. This would be a restriction of freedom for science). Hence, the content of research studies in the science panel Energiewende was solely based on the judgement of scientists. Yet, Interviewee 6 explained to rather prefer a system where societal problems would be more deliberatively discussed and SPI actors would listen to each other in order to include every aspect into the research design.

Traditional task distribution
Now I would like to proceed with the second sub-dimension. Interview partner 1 explained that his team sat together to discuss which open questions still existed

among policymakers and how they could be answered. They did not invite any other actors to their discussion. When they reached consensus among each other, then they turned towards science with their questions and scientists helped them to structure the outcomes of the internal discussion. He expressed in the interview a feeling that often scientists are chosen to match with own concepts: *"…passen die wissenschaftlichen Expertisen zu meinem Konzept. und das dem entsprechend auch wissenschaftliche Untersuchungen beauftragt werden.*". (Interview 1: are scientific experts matching with my concept and according to this scientific studies are commissioned.)

Interview partner 2 and 5 described the situation as driven by interests, because policymakers had a certain problem and turned to them and their team for helping them finding a solution based on sound scientific facts. The way Interviewee 2 described the inquiry, it sounded quite centralized and from top-down. Additionally, they told me that they are doing many commissioned studies, whereby policymakers had already formulated problems and objectives in advance. But Interviewee 2 explained that she actually would like to discuss research questions before coming up with a research design plan, but in reality she experienced that policymakers often expect a scientific assessment with a policy-prescriptive recommendation. She often encountered projects with a focus on results rather than a focus on methodology and she said to mostly work on projects individually. Like Interviewee 1, Interviewee 5 also expressed a feeling that policymakers tend to search for scientists, who evaluate policies rather in the same way. He said, "*Politikberatung tendenziell natürlich so stattfindet, dass sich Politiker und Wissenschaftler gerne zusammen treffern, die eine grundsätzlich ähnliche Bewertung von Politiken haben*" (Interview 5: policy advice tends to take place with politicians and scientists, who have a basic similar evaluation of politics). He stated that he would not assume every actor is intentionally biased. Scientists basically have the intention to advice policymakers, not to prescribe specific course of action. But he implied that policymakers influence SPI cooperation from the direct start and that would confirm the suspicion of hiring science to produce results that were initially hoped for.

Interview partner 8 described the design process rather vaguely. Although studies for policy advice settings got commissioned, which is more the traditional way of getting science and policy together, interview partner 8 explained the study design followed new forms of research. He saw himself translating real problems from policy contexts to scientific research questions, and due to transdisciplinary research teams dealing with those questions, he thought that his problem definition and research design was enriched with practical knowledge to better answer direct questions and discuss certain policy pathways in SPIs in theoretical and practical terms. He did not mention a jointly deliberation within the SPI, since policymakers usually directed their questions straight to the department of Interviewee 8, discussed the question with the science team and then they let scientists be free to propose an appropriate plan. Additionally, he explained that due to relative high independency of the IASS from externally funding sources, he was very much free to decide whether to cooperate or not. Interviewee 7 came also from the same SPI as Interviewee 8 and explained as well the independency from external funding sources, which he thinks is the reason for good reputation and trustworthiness of the IASS. Furthermore, he described that due to this good reputation, ministerial employees or politicians regularly inquired directly whether TPEC (SPI of IASS) could do a study for their positioning in the

current debate. All in all, I would count Interviewee 7 and 8 to the second sub-dimension, since other actors are only participating later in the knowledge generation phase.

Jointly deliberation
Last but not least, Interview partner 3 and 9 explained a jointly deliberation about problem definition, research design and research questions was best suited for their interaction with policymakers in SPIs. Interview partner 9 reflected from experience that the design plan always included involvement of relevant actors and that this was very important for the process of linking science with practice. She explained that at Agora Energiewende research institutes in fact proposed a research design and presented their assumptions, but they put their proposal up for discussion within the interface. All interface actors could give feedback and their judgement about the assumptions and questions in the research plan and this feedback was taken to improve the study. Interview partner 3 additionally explained that it was extremely important to include stakeholders in the first phases of an assessment to be able to grasp the problem at its basis and to formulate legitimate policy pathways.

Knowledge generation and use

The following two dimensions are put together, since it was hardly possible to separate both codes in the analysis. The way knowledge was generated often was a consequence for how knowledge was used as well. This means that after a disciplinary, unilateral knowledge generation, a linear knowledge transfer followed and so on. Nevertheless, both codes have their own sub-dimensions that are scaled again. The code knowledge generation has the following sub-dimensions: (a) disciplinary and unilateral, (b) interdisciplinary and bilateral and (c) transdisciplinary, involvement of all actors and a co-production of knowledge. The code knowledge use was built on past models for information transfer and includes a (a) linear, (b) bilateral or (c) diffuse/brokering similar mode.

Disciplinary, unilateral and linear transfer
Interview partner 1 generally had a quite linear way of generating and transferring knowledge. He told me there was also deliberation about intermediate and end results in a so-called "*Word-Café*". That was a kind of workshop where different actors from policy, administration, parliament, associations and enterprises met to discuss study results. His organisation used discussion results as external feedback either for integration in on-going study or to design a new study from emerging questions. This is also a form of knowledge generation, which is not dependent on science. However, later in the interview he said that generated knowledge in studies from science institutions was used to give credibility to arguments with scientific sound information: "*Damit wollen wir auch eben zeigen, dass wir das nicht einfach aus dem Bauch heraus entschieden haben, sondern dass das eben wissenschaftlich fundiert ist.*" (Interview 1: With this we want to show that we have not simply decided on a gut level, but that everything is based on science.) Science acted in the interface as a deliverer of expert knowledge meaning that the team posed questions about a certain topic of interest and science took over the task to produce the

required knowledge and deliver facts. This matches as well with Interviewee 1 perception about the function of science. According to practical examples of Interviewee 2, knowledge generation and transfer also happened more in a linear way between science and policy. Yet, she conceded from normative beliefs that scientists ideally should include relevant actors from society in research process to make it more transdisciplinary and relevant for society.
Interview partner 6 explained in the interview that disciplinary working groups dealt with research topics coming from professors, who sat in the interface's steering committee and deliberated about relevant research topics. The organisation of the interface had actually the intention to arrange interdisciplinary working groups for generating knowledge; yet, structural problems and issues in the SPI processes have not allowed that. Study results were then discussed within the interface and published without integrating feedback from other interface members. Due to a missing commissioner of conducted studies and due to missing interaction between scientists and policymakers to determine policy-relevant topics, knowledge transfer happened in a very linear, one-sided way, as interviewee 6 reflected. Furthermore, she explained that knowledge was not really generated in studies. She concluded, "*Es {Akademienprojekt} ist nicht so wissenschaftlich*." (Interview 6: It {the project} is not really scientific). Scientists in working groups in fact gathered pre-gained knowledge and put that into an assessment to answer questions from the steering committee. Interviewee 6 further described that studies often had no policy relevancy due to this way of generating knowledge. She says, *"(…) das Akademienprojekt hat bis jetzt nichts relevantes gemacht. So lange es nicht relevant ist, kann man Gespräche so viel führen wie man lustig ist, aber das wird keinen Effekt haben auf die tatsächliche Politik*." (Interview 6: the project has not delivered something relevant. As long as it keeps on doing non-relevant studies, you can have endless discussions, but this will not have any effects on actual policymaking).

Interdisciplinary and bilateral transfer
Interviewee 4 explained that his main tasks in an interface with policymakers was twofold: first he produced knowledge by generating scientific facts in commissioned studies and gathered existing scientific facts to keep policymakers updated about current developments. He calls himself "*Faktenlieferant um die Basis solider Entscheidungen zu treffen*" (Interview 4: supplier of facts to be a basis of solid decisions). Second, he defined new courses of action to provide options to policymakers. He emphasized that the second part is not based on facts but on scenarios, so he differentiated between fact-based knowledge with no values and scenario-based explorations with values. He further explained that his expectation from policymakers was to give their input as well by showing concern in discussions and demonstrate political restrictions in order to give scientists a better understanding of contemporary situation. For him, this kind of bilateral knowledge transfer was important, because he was able to deliver "better" facts in interaction with policymakers. Therefore, he claimed the existence of a clear division of tasks: science as supplier of facts and policy for making decisions based on those facts. Consequently, according to his viewpoint only science was responsible to generate relevant knowledge. Later in the interview, he comes back to knowledge transfer admitting that there actually was no real exchange between knowledge.

Table 5. Interview answers for the different codes for knowledge in SPIs, presented with their foundation in theory

Dimensions		Theoretical framework		Sub-dimensions	Results on real experiences									Results on normative beliefs								
					INT 1	INT 2	INT 3	INT 4	INT 5	INT 6	INT 7	INT 8	INT 9	INT 1	INT 2	INT 3	INT 4	INT 5	INT 6	INT 7	INT 8	INT 9
Codes	Research design & Problem definition	Theoretical background	Technocratic	Solely science				X		X							X					
			Decisionist	Policy question, scientific design plan	X	X			X		X	X		X								
			Pragmatic	Jointly deliberation			X						X		X	X		X	X	X	X	X
	Knowledge generation		Decisionist	Disciplinary, Unilateral	X	X				X				X								
			Technocratic	Interdisciplinary, Bilateral				X	X		X						X					
			Pragmatic	Transdisciplinary, Integration of all actors, Co-production			X					X	X		X	X		X	X	X	X	X
	Knowledge use		Technocratic	Linear & unilateral	X	X		X	X	X				X								
			Decisionist	Two-way interaction & bilateral							X						X					
			Pragmatic	Diffuse/ Brokering & multilateral			X					X	X		X	X		X	X	X	X	X
	Facts-Values		Technocratic/ Decisionist	Strict division of facts and values							X	X	X				X	X		X	X	X
			Pragmatic	Acceptance of values in scientific knowledge	X	X	X	X	X	X				X	X	X			X			
	Learning process		Technocratic	No learning process						X												
			Decisionist	Unilateral, linear	X	X		X	X		X			X			X					
			Pragmatic	Multidimensional			X					X	X		X	X		X	X	X	X	X

but interests: "*Es ist eher so ein gegenseitiger Austausch (…) bei den Interessen (…)*" (Interview 4: it is more a mutual exchange about interests). He further stated that he saw committees also as a means to the end, because they enabled him to feed in scientific papers in a linear manner. He stated *"(…) wenn ich aktiv das Gefühl habe, man muss die Sache {politische Entscheidung} nochmal neu ausrichten oder neuen Input haben, dann kann man das auch als Brücke nutzen.*" (Interview 4: when I have the feeling that the whole thing {political decision} needs a new orientation or new input is needed, then I can use that as a bridge).

Interviewee 5 conducted studies in bilateral conversations with policymakers and in interdisciplinary teams with scientists from other institutes. Though, from his interview it seemed that knowledge had been generated in the traditional way: he or his team applied for studies that policy had initially commissioned in order to answer specific questions or design strategies for implementation in the energy transition. He told me that in these studies he wanted to be as independent as possible by portraying a position that had knowledge and cognition at its centre. Thus, a position that was based on factual knowledge, he says, "*das eine gewisse Objektivität in die Debatte bringen kann und andererseits natürlich weil man dann auch nicht die Gefahr läuft vielleicht als Wissenschaftler insgeheim zum Politiker zu werden.*" (Interview 5: that can bring certain objectivity into the debate and on the other side a scientist does not run the risk of becoming a hided politician). Often, he thought that this posed a personal challenge when being in a position of power. In contrast to interviewee 4, who openly used this position, interviewee 5 regarded it critically.

Furthermore, interviewee 5 was quite ambiguous about the inclusion of values. Like mentioned, on the one side, he was trying to generate fact-based knowledge in order to be as independent as possible; on the other side, he stated that model assumptions for policy pathways always contained implicit values. Therefore, the ambiguity allows giving a hint on how interviewee 5 thought interaction should be, while he actually had another normative mind-set about values and facts. He added that he saw a development *"(…) dass die Politikberatung tendenziell natürlich so stattfindet, dass sich Politiker und Wissenschaftler, sagen wir mal die eine grundsätzlich ähnliche Tendenz in der Bewertung von Politiken, gerne zusammentreffen.*" (Interview 5: that policy advice tends to occur with politicians and scientists, who have a fundamental similar tendency to assess policy pathways). Like interview partner 2, Interviewee 5 seemed to be caught in a linear and traditional knowledge generation system, although they would like to be more involved in SPI processes and conduct participatory research.

Transdisciplinary, co-production and diffuse transfer

Interview partner 8 was convinced that transdisciplinary research, a coproduction of knowledge, is the right way to answer policy relevant questions. He thought scientists from different research fields, change agents, interest groups and other relevant groups should be involved and should be given a vital role in generating knowledge. However, he contemplated a role difference between scientists and other knowledge producers, since he felt to bear the responsibility in applying a systematic methodology. He said "*da muss eine Rollentrennung stattfinden. Wenn ich jetzt die wissenschaftliche Arbeit, auf der meine Reputation aufbaut, also systematische Methode, Ergebnisoffenheit, Hypothesen eben von verschiedenen Seiten zu prüfen, dann macht das großen Sinn dass das wissenschaftlich geleitet ist (…)*". (Interview 8:

there must be a role distinction. When I take my scientific work, on which my reputation is built, so the systematic methodology, undetermined results, hypotheses were investigated from different angles, then it makes a lot of sense that this is scientifically managed). All statements considered, Interviewee 8 actually rejects a division between the knowledge producer and user in knowledge generation. A coproduction of knowledge under the supervision of science is for him the right way to generate knowledge in SPIs and that is also what he experienced in SPI projects. In his projects, he therefore also made use of diffuse knowledge transfer strategies and brokered between various actors in the SPI.

Interview partner 9 described a conflict of the energy transition in Germany that although targets had been agreed upon, there was still a management deficit and the question existed how political means should be implemented to reach the set targets. In other words, there was either a problem in generating the right knowledge, or transferring the right knowledge to the wrong receivers, or even though right knowledge had been transferred at the right place, there was still ambiguity about applying knowledge. She explained that Agora Energiewende had found out about the gap existence between knowledge generation, knowledge use and decision-making within the German energy transition. Therefore, she explained, they had decided to design the projects according to new modes of knowledge generation and diffuse knowledge transfer. As many different actors from science, policymakers, advocacy groups, etc participated in the science-policy interface, expert knowledge came from many different angles of society and was concentrated in this nexus. Differently from interview partner 8, interview partner 9 did not think there should be a role division in a science-policy interface, as everybody can take different roles. However later in the interview, she recognized that there is a division between Agora Energiewende and scientists, because scientists borne main responsibility for the conducted research and Agora wrote a summary with the most important points and recommendations for policymakers after having talked to scientists. In this way, scientists had the possibility to protect their credibility and independence and the broker organisation acted as a middleman.

Facts and Values Distinction

This section deals with how interview partners separate values from scientific knowledge in practice. Do they distinguish between factual knowledge and value-based knowledge and maintain a more traditional position by declining values to be included in scientific expertise? Or do they accept values as being part of scientific knowledge and took that into account when giving advice? Due to very divergent opinions in the interviews, I simplified by reducing the code to two dimensions: (a) strict division of facts and values and (b) acceptance of values in scientific knowledge. The dimensions are not scaled this time. In total, three interview partners belong to sub-dimension (a), while the other six interview partners belong to (b).

Strict division of facts and values

According to interview partner 8's experiences an important basis for good policy advice was to be political-neutral meaning that he approached unprejudiced policy relevant questions. He further explained that not anticipating the results played an

important part in the interaction with policymakers. Additionally, the systematic methodology of science was another critical precondition according to his opinion that enabled him to be unbiased. He said, not only searching for the right literature to support your hypotheses, but also to look for other findings to refute hypotheses. He thought open questions from policy were much more valuable than "just doing the happy talk". He used the expression "just doing the happy talk" to explain that scientists had the task in the interaction with policymakers not just to praise all thriving things, but to compare current political conditions with set targets and how different courses of action could like.

Like interviewee 8, interview partner 9 was convinced that interaction in science-policy interfaces was disturbed when own interests are given priority. She said that difficulties in interfaces mostly evolved from deviating from a neutral position. Although she experienced biased positioning in only a few projects, she said that broker organisations like Agora Energiewende had a key function in moderating the interaction: to move discussions from a representation of interests to a rational level, which she defined as scientific facts. Compared to interviewee 8, who thought scientists have the role to moderate such interactions, interviewee 9 thus believed that brokers should perform this task. Hence, according to interviewee 9, neutrality exists and is a core value of scientific knowledge. However, she acknowledged, "*Der Anspruch an Wissenschaft stets neutral zu sein, ist ein Anspruch, der in den seltesten Fällen perfekt gelebt wird*." (Interview 9: The requirement for science to be always as neutral as possible is a requirement that is seldom perfectly accomplished.). Consequently, she acknowledged the discrepancy between her normative beliefs and how it is actually done in reality. Furthermore, she had the opinion that bias in science is bad and biased scientists did not have any perspective on the long term. Therefore, she also experienced turning down moderation of some interfaces, where the public perceived Agora Energiewende as biased and prejudiced towards a certain topic. Instead, external (more neutral perceived) moderators had been hired to lead those interfaces. From experience she learned that this kind of policy advice setting was perceived as most neutral and the public considered somebody more seriously.

Acceptance of values in scientific knowledge

According to interview partner 1, absolute neutrality cannot be reached. Everybody, every scientist, every policymaker and also Interviewee 1 and his team had certain core beliefs and those were always influencing statements and policy advice. So every study was biased in they way that the studies contained strong or subtle tendencies. Interview partner 2 and 6 also doubted the existence of an objective truth. They were convinced that eliminating any values from scientific facts was not possible. Interviewee 2 further normatively argued that making those values and assumptions as transparent as possible, enhanced the quality of debate about specific policy pathways.

Interviewee 4 defined good research as objective and non-filtering any results. He reflected that this was obligatory for cooperating with policymakers, "*Politiker, mit denen ich zusammenarbeite, erwarten, dass ich objektiv gute Ideen oder Forschungsthemen identifiziere.*" (Interview 4: politicians, with whom I interact, expect me to identify objective good ideas or research themes). However, this is colliding with another answer where he described that he filtered scenarios by setting

priorities in order to send a clear message to policymakers. Why did he filter certain scenarios? Did certain scenarios not fit to his worldview or did he consider them to be irrelevant for policymakers? These questions are highly influenced by his internal values and his normative beliefs. From the interview data, it was not really clear why his answers collided with each other. He mentioned several points that could be interpreted as a reason: either he felt to be urged to meet policymaker's expectations, or he wanted to represent his own interests, or he simply filtered scenarios to reduce scientific complexity and make communication with policymakers easier. From my own interpretation, it seems likely to be a reciprocation between those three factors. He explained that he is unable to develop infinite scenarios in general and therefore he only takes the best ones in order to represent the most meaningful technologies and to decrease scientific complexity.

Those interviewees with full and some engagement and a fully integration into policy processes took a more strict view in dividing factual knowledge from value-based knowledge. Interviewee 8 and 9, for example, were to a high extent involved in policy processes, but they defined good policy advice in a rather traditional manner. They thought knowledge based on the current scientific state of the art (facts) enhanced scientific quality, therefore enhanced objectivity and credibility in a public debate that in turn acted as precondition for a trustworthy atmosphere in SPI. Therefore, we can conclude that they considered interaction with policymakers is more difficult when values on scientific side are included. Even though Interviewee 9 acknowledged difficulties with complete value-free scientific knowledge, she nevertheless put much pressure on a neutral position. Even to the point that she had been willing to leave the SPI to provide a deliberation on a rational level as she defined it.

Learning process

I divided the code learning process in following sub-dimensions namely (a) no learning process, (b) linear and one-sided learning process and (c) multidimensional learning process. One interviewee described no learning process at all, five interviewees described a linear learning process and three interviewees stated a multidimensional learning process during working in the SPI.

Interview partner 6 described the science panel Energiewende with no learning process at all. Interviewees 1, 2, 4, 5 and 7 described a linear learning process. Interviewees 3, 8, and 9 speak of a learning process that involves the entire SPI. Interviewee 3 and 8 even speak of a learning process that involves the entire society, since the German energy transition is a national process.

Although a lot of interview subjects wanted to achieve a multidimensional learning process among the actors of the SPI, only three subjects stated to have experienced it in reality. There seems to be a correlation between the extent of learning in SPIs and the extent of engagement and involvement of scientists. Generally, interviewees who experienced a lot of engagement and involvement in policy processes regarded SPI interaction as a multidimensional learning process. Interactions with limited engagement in interaction and involvement in policy processes generally perceived a

more linear, one-sided learning process. Furthermore, it is also likely that learning can be correlated to the research design and problem definition and to the way knowledge is generated.

Chapter 5. Comparing actual science-policy interaction with normative beliefs and type of SPI

Chapter 5 aims to analyse and compare normative beliefs and real-world experiences of each interview subject more deeply. While the two previous chapters mostly concentrated on the description and comparison of the individual dimensions, this section works towards a synthesis of those different descriptions. Three points of interests will be addressed in the following (1) what do subjects think is ideal, (2) what role do they take in practice and (3) what is the type of SPI according to theory. The normative beliefs will be discussed and analysed through the three theories in scientific policy advice. The three theories are (1) decisionist theory, (2) technocratic theory and (3) democratic-pragmatic theory.

I can identify three broad groups by comparing normative interview results with the theoretical background behind the codes. Hence, their normative mind-set can be roughly estimated. Therefore, I added up the answers for the normative results in Tables 4 and 5 from each theoretical dimension. As a result, one interviewee took a decisionist approach in his normative viewpoints and that is Interviewee 1. The second group consists of again one interview subject, Interviewee 4, showing a strong tendency to a technocratic approach in his normative beliefs. And the last group of interviewees inclines to take a more democratic-pragmatic approach in their normative viewpoints, which are Interviewee 2, 3, 5, 6, 7, 8 and 9 (Table 6). Interviewees 2 and 3 are an extreme exemption, since they fully possess a pragmatic mind-set about SPI interaction and did not score on any other approach at all in their normative understanding of the role of science. The handling of scientific policy advice influences the way in which scientists act in interaction with policymakers and therefore determines positioning of scientists in interaction and their role.

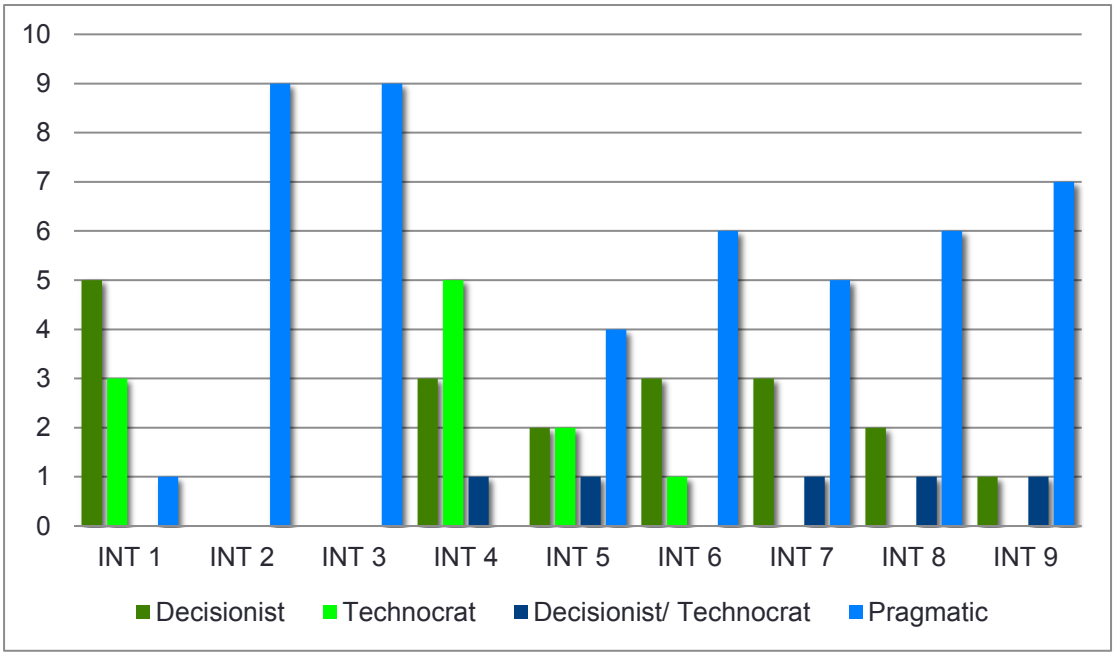

Figure 4. Quantitative analysis of normative beliefs in interaction with policymakers

Normative beliefs from decisionist theory

Interviewee 1 strongly leaned his normative perspective about the role of science on the decisionist theory. In a decisionist approach policy identifies a problem, sets an objective and commissions science to find appropriate political means. Science and policy are two strictly divided authorities and factual knowledge is objective and allows no normative conclusions and value-based knowledge is subjective (Weingart, 2015). Interviewee 1 mentioned several times that policy pathways should be based on scientific facts to enhance objectivity and neutrality. His normative perspective matched with his real experience. According to the experiences of Interviewee 1, the role of scientists in the BEE's interfaces was already determined from the beginning. Interviewee 1 explained that the BEE worked with scientists to give answers to specific questions they had about certain topics. Due to the traditional conduct of studies, knowledge generation was limited to disciplinary problems and formulations of research questions. As a consequence, a scientist cooperating with the BEE had no other chance than to deliver factual knowledge and therefore acted according to a decisionist role model, because the BEE does not expect from them a high engagement or involvement into policy processes. Even though the BEE was a special case, because basically they are not a science institute and they only represent interests from other RE organisations and associations in the German energy sector, they nevertheless play an important role in the German energy transition, since they are present in many other interfaces with policymakers. They used scientific factual knowledge to support their political arguments and consequently let no room for fully integration of scientists in policy decisions. According to the story of Interviewee 1, they positioned themselves in the middle of science and policy and acted as a kind of gatekeeper of information. Interviewee 1 clearly stated to only use scientific facts that are relevant for the current policy context and to restrict knowledge that could harm the development of RES. Therefore, they took a strict issue advocacy position in SPIs. It would have been interesting also to interview a scientist, who was involved in the interface of the BEE in order to understand the interface from both sides. But from the description of Interviewee 1 it seems that a scientist in this interface would have no possibility to take another role, because eventually they were not part of the policy process. The interface of the BEE is characterized as a decisionist form of interaction between science and policy, since scientists are only involved to give answers to specific policy questions. The interface is no platform for dialogue between scientists and policymakers. It is rather a tool for the BEE to contribute to agenda setting in the policy cycle by advocating for their interests and prioritizing emerging issues.

Normative beliefs from technocratic theory

Interview partner 4 had strong normative beliefs that are rooted in a technocratic approach of scientific policy advice. In a technocratic approach science identifies the best socio-political objective and determines optimal political means accordingly, thus science is acting according the logic of facts. Value-based knowledge practically is eliminated in finding optimal political means. He put strong emphasis on the fact that scientists are responsible for science and policymakers are responsible for

policy and agenda setting. Therefore, he ideally strictly divided science from policy as two independent domains of human activity. According to his normative beliefs, the role of scientists in science-policy interfaces is to deliver facts. Interviewee 4 mentioned this point several times during the interview. In interaction, he saw himself as "*Faktenlieferant um die Basis solider Entscheidung zu treffen*" (Interview 4: Supplier of facts to be a basis for solid decisions). He defined interaction between policy and science in the way that policymakers want to be advised and therefore consult scientists. Therefore, he as a scientist has the task to conduct research in order to get more evidence for 'better' decisions.

Furthermore, he openly admitted to interfere in policy decisions where he saw the need for more scientific basis. In the interview, he said to use SPIs as bridge to linearly feed in his scientific expertise. But his normative beliefs did not follow a technocratic approach in reality. Although he described to be not engaged in interaction with policymakers, he provided different options of courses of action to policymakers and accepted values in scientific factual knowledge. He even considered the provision of options as one of his core tasks in science-policy interaction. Regarding knowledge generation and knowledge transfer processes, he mostly acted according to technocratic approaches. But still there are deep discrepancies in his perception about his role in SPIs, because on the hand he stressed to deliver scientific evidence and on the other hand he reduced SPI interaction to an exchange of interests. He talked about his role and defined it as *"Faktenlieferant"* (supplier of facts). But when he talked about his role in interaction with public actors he restricted it to an exchange of interests. Therefore, according to the practices of Interviewee 4, the science panel Energiewende can be classified as a technocratic platform, where participating scientists interact in a one-way flow to speak 'truth (scientific facts) to power (policy)'.

Normative beliefs from democratic-pragmatic theory

Normative perspectives of the rest of the interviewees are rooted in a democratic-pragmatic approach. The democratic-pragmatic approach builds on interdependency between political means and their practical consequences and between factual and value-based knowledge. Edenhofer (2011) therefore stresses that science has the task to enlighten policy about possible political means to achieve the set targets. Interview subjects of this group normatively think that they should be fully engaged in interaction and fully integrated in policy decisions to be able to generate the relevant knowledge for questions of policymakers. Therefore, they ideally would like to act as a knowledge broker (Turnhout *et al.*, 2013) or a cartographer of policy pathways (Edenhofer & Kowarsch, 2015b) in SPIs also to integrate other knowledge holders into the generation of knowledge. The intention is to jointly deliberate in identifying current pressuring research topics. The involvement of non-state actors is considered as important in order to conduct transdisciplinary research, consequently leading to a diffuse knowledge transfer and a multidimensional learning process.

Interviewee 2 and Interviewee 3 have deep normative beliefs rooted in the democratic-pragmatic approach. But in contrast to Interviewee 3, Interviewee 2 experienced completely different science-policy interaction in reality. In reality, she

experienced only some engagement and involvement and also designed a research approach that was directed to answer policymakers' questions instead of a jointly deliberation of problem and an interactive approach in knowledge generation. Normatively she was convinced that high amount of engagement and involvement in decision processes would be needed to develop appropriate policy pathways for the German energy transition. Especially transparency needed to be increased in designing those pathways according to her statements. And she was convinced that transparency could only be increased in participatory policymaking. But she recognized that in reality she is very much self-conscious to be caught in a decisionist system of science-policy interaction. Engaging in interaction with policymakers did not always serve her scientific career, because the classical assessment for policymakers lacked a scientific basis and was mostly too applied and therefore not qualified for publishing in a scientific journal. When policymakers rejected her assessment because of undesired outcomes or non-election, she had wasted valuable time and money. She explained that one colleague of her had experienced this and *"es hat ziemlich viel Frust herbei geführt, weil es ist nicht erwünscht dass wir das jetzt von uns aus publizieren. Also als Wissenschaftler ein Jahr lang was zu machen was man dann nicht publizieren darf, ist unpraktisch."* (Interview 2: it led to a lot of frustration because policymakers did not allow us to publish the results. Thus doing research for over a year as a scientist and then being not allowed to publish your results is very unhandy). This discrepancy was also seen in Interviewee 5, who thought differently though about the normative role and his role in practice. Like Interviewee 2, he experienced to answer specific policy questions in commissioned studies, where he worked in an interdisciplinary setting to come up with a research design plan. Instead of multilateral knowledge transfer, he described to experience linear and unilateral use of his expertise by policymakers. Therefore, he experienced the role of a science arbiter in practice, since he is to some extent involved in decision processes and also to some extent engaged in interaction, but transferred his scientific expertise linearly to decision-makers. He talked about a general development that policy advice had the tendency to occur between politicians and scientists, who have a fundamental similarity in their assessment of policy pathways. Decisionist features mostly characterized the SPI in which Interviewees 2 and 5 operate, since interaction between her and policymakers was based on commissioned studies to answer relevant emerging issues that needed scientific expertise.

Interviewee 3 was the only interview subject who really managed to implement his normative beliefs into practice. To be precise, he also had some negative examples about science-policy interaction where he could not implement his normative beliefs, because either policymakers were simply overwhelmed by an overload of scientific expertise or policymakers expected him to mention the best option. But he saw science-policy interaction more holistically, because he stated to expand stakeholder engagement in his projects and give policy advice with respect to advise interested members of society. Therefore, he regarded the German energy transition as a learning process for the whole society. In this learning process, he as a scientist took over the role of a cartographer to conduct transdisciplinary research to meet goals of societal and governmental actors. He therefore went beyond the role of an Honest Broker (Pielke, 2007) or a knowledge broker (Turnhout *et al.*, 2013), because he

made use of new forms of research and intensive participatory approaches in his SPI and also helped policymakers understand the consequences of specific political means.

Interviewee 6 experienced technocratic aspects in interaction with policymakers, although she had normative beliefs going towards a democratic-pragmatic theory. Good policy advice was defined according to her standpoint by full engagement of science to provide options for policymaking leading to expert recommendations. She actually had the ambition to conduct transdisciplinary policy assessments with an intensive interactive approach in knowledge generation and a multilateral transfer of knowledge. From a normative point of view she would belong to an Honest Broker (Pielke, 2007) or a knowledge broker (Turnhout *et al.*, 2013) role. But instead the SPI structure and the design of SPI processes hindered her to do so, because her peers concentrated on writing evaluation papers of past political means. She related non-existent engagement and involvement especially to a failure of management. Although the science panel Energiewende was created to bridge the gap between policy and science, no one felt responsible to steer and manage internal SPI processes. Therefore, the heterogenic group could not be handled and she had difficulties to find common ground with other SPI members. Additionally, the conflict on the policymakers' side was a reason for missing interaction and a determination of policy-relevant topics did not take place so that knowledge transfer happened in a linear one-sided way. Hence, in reality Interviewee 6 took a role that resembles the Science Arbiter type (Pielke, 2007) due to limited interaction with policymakers.

Interviewee 7 ideally thought to take the role of an Honest Broker in scientific policy advice. He divided science and policy in two separate systems and said, " *(…) die Aufgabe der Wissenschaft Handlungsoptionen zu zeigen und deren Konsequenzen (…) sodass die Politik eine möglichst gute Grundlage hat wertebasierende Entscheidungen zu treffen. Da sehe ich dann auch nicht mehr die Aufgabe der Wissenschaft drin, sondern das ist Aufgabe der Politik."* (Interview 7: the task of science is to show options with different courses of action and their consequences, so that politics has a good basis to make a value-based decision. I see that this is no task for science anymore, but a task for politics). Two things can be noticed in this quotation. First, from a normative standpoint he divided factual knowledge from value-based knowledge. And second, he restricted his role in interaction with policymakers to a mere provision of options and did not go one step further. This is a clear sign that he thought like an Honest Broker type, because Pielke (2007) described the Honest Broker in exactly this in-between position between knowledge production and use.

In the interview he went into detail about his perception of the function of science. Interviewee 7 explained that delivering facts is not only his demand for his own work, but he felt that also policymakers expected evidence-based advice to make robust decisions. Even though he stated that normative demands are huge and scientific expertise is never completely value-free in scientific studies for the German energy transition, he stressed transparent value decision help to bring more fairness and clarity in public discussions. He said, "*in dem Bereich glaube ich, dass es keine wertfreie Forschung gibt. (…) es sollte möglichst fakten-und evidenzbasiert sein und möglichst transparent. (…) dann entsteht einfach auch mehr Fairness und mehr*

Klarheit und eine bessere Grundlage für Entscheidungsträger." (Interview 7: in this area I believe that there is no value-free science. It should be fact- and evidence-based and transparent as much as possible. Then there is also more fairness and more clarity and a better basis for decision-makers). Form this point, Interviewee 7 also developed another important argument. He mentioned that every actor in the German energy transition got overloaded with scientific studies, with interests from different groups of society, with opinions or options, generally a huge overload of information, and policymakers are really challenged to still have an overview about relevant information. He said, "Die werden permanent bombadiert mit Informationen und es ist sicherlich schwer dann noch den Überblick zu behalten oder da noch Struktur reinzukriegen was den jetzt verlässliche Informationen sind" (Interview 7: They are permanently bombarded with information and it is certainly difficult not to lose track or to bring structure into the vast quantity to identify relevant information). Therefore, he argued that science also has the duty to bring structure into the debates, show consequences and compare similar studies to see common points and differences. In his real experience he was faced with overwhelmed policymakers and he then took initiative to deliver facts in order to structure the debate.

In general, he was also able to implement his normative ideas, but it sometimes collided with his real knowledge generation and knowledge use. Ultimately, Interviewee 7 experienced to generate knowledge more or less within his interdisciplinary team of colleagues than to link it in participatory knowledge approaches with actors from society. Additionally, he more experienced to exchange generated knowledge bilaterally with policymakers in small meetings. He reported that policymakers underestimated the complexity of his research and scheduled only one meeting for discussion of end results. He explained he got into a dilemma, since policymakers asked him to point out the best option, which made the interaction for him very complex and uncomfortable.

Interviewee 8 was also part of TPEC and had normatively the same attitude as Interviewee 7. Yet, in his practices he was really able to implement pragmatic normative standpoints. This was especially noticed in the way he talked about knowledge production and use. He strictly declined the terms knowledge producer and knowledge user in relation to SPIs. He said, *"der Begriff des Wissensnutzers ist mir immer etwas unangenehm"* (Interview 8: the term knowledge user is always inappropriate). He thought the division in knowledge producer and user is a very traditional form of science and he was convinced that it is not the kind of science an energy transition needs. He valued practical knowledge the same way as peer-reviewed articles from scientific journals and was pleased to integrate knowledge from stakeholders into his studies. Consequently, Interviewee 8 belongs to the group of knowledge brokers because of intensive interactive knowledge generation. He did not see a dilemma for scientists in interaction with policymakers. For him, it was more a weighing up process or a balancing process and he saw that scientists in commissioned studies experience that balancing process more intensively. Interviewee 8 mentioned several roles during the interview, in which he slipped depending on the situation and process. He said he saw himself as an initiator of debates in the policy process to provoke discussions about new emerging topics or problems. Furthermore, he stated that he also took the role of a manager of scientific studies, since he worked with relatively interdisciplinary and transdisciplinary

research teams to examine the research topic from different viewpoints. Resulting from this, he said that he also saw himself in the role of a networker, since his projects and interfaces involved many actors from different fields. Moreover, he thought especially social scientists are in the role of an evaluator and monitor by saying, "*In der Gesellschaft haben sie auch die Rolle einen Spiegel vorzuhalten. Auch als Reflektion beizutragen zu den Prozessen in der Energiewende extrem wichtig*" (Interview 8: In society they have the role to hold a mirror up to the people. Also to contribute to reflect about processes in the energy transition extremely important). Eventually, he mentioned that science acts as a moderator in public debates. Especially in complex, multidimensional learning processes scientific expertise is important according to his viewpoint. He compared the IASS to other think tanks and concluded that the work of both IASS and for example Agora Energiewende are very valuable for the development of the energy transition. However, according to his opinion, such think tanks like Agora Energiewende are to some level perceived as political-biased, and play a slightly different role compared to science institutions like the IASS.

Interviewee 9 belonged to a special case, since Agora Energiewende is already a broker organisation and also positions itself in this way as well. Interviewee 9 perceived the function of science is generally to deliver facts and to inspire debates with factual knowledge. In contrast to Interviewee 8, she saw scientists not in the role of a moderator to structure science-policy debates. She mentioned this was a task of a broker organisation and scientists do not have to place themselves into the centre of discussions. Therefore, Agora Energiewende took the role of a knowledge broker by engaging in decision-making processes to broaden the scope of choices and by integrating scientific with stakeholders' knowledge. Interviewee 9 scored high on a democratic-pragmatic approach in her normative perception about the role of science, which very much matched with her role in practice. The SPIs of Agora Energiewende follow a highly pragmatic approach in interaction between policymakers, scientists and other representatives from society. They have a high level of participation and a multidimensional approach in knowledge generation and use. Yet, it is surprising that Interviewee 9 pursues a rather traditional viewpoint in the distinction between factual and value-based knowledge of science. Objectivity and neutrality of science is according to her very important in policy recommendations even though intensive interaction between SPI actors exists. Due to high lobbyism in the German energy transition, Agora Energiewende feels obliged to face lobbyists with neutral and objective scientific assessments that improve the development of the energy transition and not strengthen their own. Therefore, scientists are quite limited in taking new roles in interaction, because Agora behaves like a supervisor in the SPI.

Table 6. Differences between the normative role perception and the role taken in practice of each interview subject and the type of SPI

SPI		Normative role perception	Role of scientist in practice	SPI type
Panel System Transformation *BEE dialogue platform*	Interviewee 1	Decisionist	Decisionist: Pure Scientists or Science Arbiter	Decisionist approach
Strommarkttreffen *Informal network*	Interviewee 2	Pragmatic	Decisionist: Science Arbiter	Decisionist approach
	Interviewee 5	Pragmatic		
Other National or international interfaces	Interviewee 3	Pragmatic	Pragmatic: Cartographer	Pragmatic approach
Science Panel Energiewende *BMBF/ acatech*	Interviewee 4	Technocratic	Decisionist: Science Arbiter or Issue Advocate	Technocratic approach
	Interviewee 6	Pragmatic	Technocratic: Science Arbiter	
TPEC *IASS*	Interviewee 7	Pragmatic	Decisionist: Honest Broker	Pragmatic approach
	Interviewee 8	Pragmatic	Pragmatic: Knowledge broker	
Agora Energiewende *Agora*	Interviewee 9	Pragmatic	Pragmatic: Knowledge broker with very high amount of participatory knowledge production	Pragmatic approach

This section has shown that although a lot of interviewees had a democratic-pragmatic normative role perception, many subjects acted differently in real science-policy interaction by taking another role (Table 6). Additionally, I noticed that four scientists from same SPIs have either divergent normative role perceptions or (and) experience different roles in reality, although they are part of the same organization and/ or interface. Generally, interviewees had very divergent normative opinions about the function of science and how they experienced their own real role in interaction with policymakers. It was obvious that the normative perception of individual interviewees were strongly influencing their perception of the real role in

SPIs. However, they seem to face difficulties when realizing their normative beliefs in reality. Interviewee 7, for example, felt the need to change his role in interaction due to an extensive overload of policymakers. Therefore, he changed from *"Faktenlieferant"* (fact supplier) to an advocate for a single option. This is in line with what Interviewee 4 and 5 describe that scientists sometimes need to do in science-policy interaction and therefore get interventionist in politics. In contrast, Interviewee 8 really described his real roles in accordance with his activities performed in SPIs. This shows that his perception of his real role is rather less influenced by his normative beliefs about which role to play. It seems to be more dependent on the situation and context of cooperation or dialogue. From interview 9, I can derive that scientists stay in a rather traditional role when a broker organization acts between science and policy. Even though Interviewee 9 described intensive interaction and participation between science and policy, scientists acted more traditionally, because their role was limited to some extent. Interviewee 8 had a broad range of roles, but he was also involved in SPIs without a broker organization. A lot of activities that Interviewee 8 described that a scientist should do, fell into the tasks that Interviewee 9 ascribed for the broker organization in their SPIs.

Regarding the normative role perspectives from literature, there are role descriptions from current literature that match the three normative approaches. Those can be combined with a spectrum of interaction between knowledge production and use (Figure 5). Single elements of Figure 5 are not new; however, looking at normative approaches and their normative attributes (that were used for coding in this research) and roles in practice and the combination of those elements on a spectrum of interaction is indeed innovative. Therefore, a Pure Scientist would theoretically belong to a technocratic approach in scientific policy advice, since interaction with SPI actors is limited and also not desired in order to maintain a large distance from the decision-making process. Science Arbiters are on the edge of a technocratic and decisionist approach. They care very much for a maximization of scientific authority, but understand that interaction with knowledge users is needed to point out good solutions or confusions. The Honest Brokers interact directly with societal actors, but mostly take an in-between position between knowledge production and use, which can be related to a decisionist approach in scientific policy advice. Even though they might be more integrated into decision-making processes by showing possible policy options, they often protect their authority and credibility by keeping a distance to the process. That makes a relationship between an Honest Broker and policymaker or other SPI actor rather linear. Knowledge brokers as defined by Turnhout *et al.* (2013) are *„participatory experts"* meaning that they very closely generate knowledge with immediate knowledge users. The knowledge broker role would better fit into the pragmatic approach due to a high level of multilateral knowledge generation and use and multidimensional learning. But the role does not imply to be highly integrated into decision-making processes in practice and therefore stays on the edge of the decisionist theory. A scientist acting as a cartographer is fully involved into the SPI context and is currently described as the most interactive, practical role in literature. However, a danger will always remain for all roles in practice and that are scientists expressing strong opinions and present themselves as ‚opinion-makers' or ‚public intellectuals' to win debate for their purposes. Pielke's fear of stealth issue advocacy would then demonstrate the truth. But it could also be, like in the case of Interviewee 7, that a scientist normally acting

as an Honest Broker sees himself forced to change to issue advocacy in order to be taken seriously by other SPI actors. This case would confirm the dilemma of a scientist to balance between an independent and credible position while being policy-relevant. Like in the case of Interviewee 4, scientists may slip into roles that take political positions to push certain matters ahead. In the objective, I derived from literature that novel roles in practice can be expected. This thesis unfortunately cannot describe those novel roles. I can support the hypothesis that novel roles can be definitely expected, when science and policy continue to cooperate in scientific policy assessments and scientific policy advice settings. However, my feeling is that role typologies in practice are difficult to define on beforehand in empirical studies. Scientists' roles seem to emerge from the context of cooperation and dialogue between the different SPI partners. Additionally, I think it will be difficult to put empirical results together to generalized role typologies because of a huge diversity in science-policy interaction contexts.

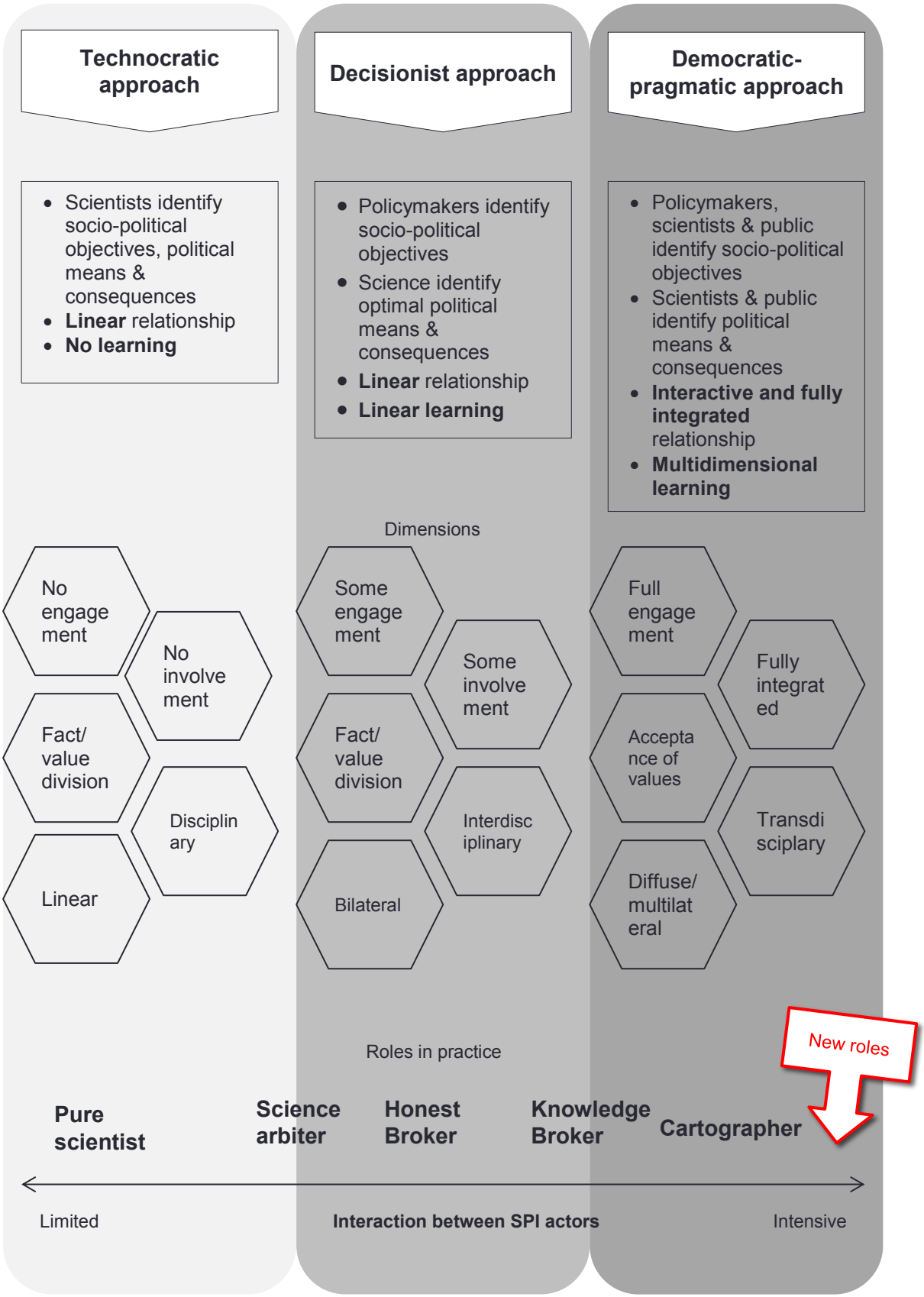

Figure 5. Interdependence between normative approaches and practical roles of science on the spectrum between knowledge production and use (based on Pielke, 2007; Turnhout *et al.*, 2013; Edenhofer & Kowarsch, 2015)

Chapter 6. Conclusions and Discussion

After the nuclear disaster in Fukushima in 2011, the German government has decided on a great shift from a fossil-nuclear regime to a RES regime (Renn, 2015). Even though German politicians have agreed on a general objective, the transition is still a highly controversial debated topic due to many divergent voices from contrasting political parties, from different scientific disciplines and from different groups of society. Contemporary societal issues and multifaceted ambitious goals like an energy transition require scientific knowledge to design possible policy options to resolve issues and achieve set political objectives. But here starts a challenge for scientists, because they have to choose to only inform policymakers or to support the political process. This thesis focused on the balancing act that scientists face in interaction with policymakers. The balancing between maintaining an independent position to provide a full opportunity of choices and at the same time making sure that the advice is regarded as relevant and useful often poses a dilemma for scientists in SPIs. Scientific advice is significantly used to lend political arguments more credibility and legitimacy (Cash *et al.*, 2003). As a consequence, scientists are required to be neutral and objective in their advice. However, neutrality and objectivity assume that advice is only build on evidences, proven facts so to say, which leaves no room for uncertainties in scientific expertise. Nevertheless, uncertainties in complex societal issues and multifaceted ambitious goals like the German energy transition will never be fully eliminated. Consequently, complex decision contexts are inevitably loaded by value conflicts and inherent uncertainties. The consequences of not attending to this problem could be severe for the credibility and legitimation of science in society. On the one side, scientists can become hided activists and use their scientific expertise as political tools (Sarewitz, 2004). On the other side, policymakers relying largely on scientific expertise move scientists into the center of political debates and science institutions can fell prey to the politicization of its assessments (Beck, 2012).

This thesis therefore focused on the course of interaction between scientists and policymakers in the German energy transition. In particular, the focus was on the level of participation of scientists in SPIs and how knowledge generation and use occur in SPIs related to the German context. This thesis has covered a wide range of theoretical aspects of scientific policy advice and how scientists experienced their own role in interaction with German policymakers. The aim of this study was to get an understanding of the actual role of scientists in SPIs in the German energy transition by investigating their interaction with policymakers. Therefore, I have systematically looked at different SPIs in the context of the German energy transition and asked the question what role scientists take in these SPIs. The research has collected data in two steps. First, a descriptive analysis provided answers to the question, which SPIs for the energy transition in Germany exist. Second, interview data was collected related to scientists' practices in scientific policy advice and their perception which role they play in interaction with policymakers to investigate the positioning of scientists. Due to the influence of normative viewpoints on the role of scientists in practice, the analysis of interview data was divided into an analysis that a) examines actual (real-world) practices and b) examines normative viewpoints

about the role of scientists. The last three chapters have described the results of the interviews. This chapter focuses on revisiting the findings by interpreting and describing their significance in order to answer the main research question: *How do German scientists involved in science-policy interfaces in the German energy transition interact with policymakers?*

Regarding the actual role, scientists mentioned various roles to play in SPIs according to their experiences. From current literature we know that authors are arguing about the factors that influence the role of scientists and how much scientists and other knowledge holders should be involved in policy processes. From the analysis of interviews it emerged that the role of scientists in interaction with policymakers is dependent on structural features and processes of SPIs. Structural features define how the SPI is set up. Processes in a SPI define the ways in which key functions are executed. Together they seem to determine the extent of engagement in interaction and the extent of involvement in decision-making processes. In turn, these two factors, engagement and involvement, were again important pre-determinants for how knowledge is generated and used. The analysis of interviewed scientists showed that the more scientists were engaged in interaction and the more they were involved in decision-making, the more integrated knowledge generation and the more diffuse knowledge transfer was. Consequently, interviewees that conducted research by integrating knowledge from relevant actors in a SPI, also talked about to experience a multi-dimensional learning process. On the other hand, interviewees that held more on to the paradigm of 'speaking-truth-to-power' experienced less engagement or involvement and conducted studies in a more traditional manner. Consequently, knowledge generation followed a more disciplinary and unilateral (sometimes interdisciplinary and bilateral) approach and therefore knowledge transfer was limited to a linear exchange.

Next to structural and procedural features of SPIs, another very important determinant of a scientist's role is his own normative perception about the function of science. This perception is strongly dependent on the three different theories in scientific policy advice: decisionist, technocratic or pragmatic theory. As expected, all interviewed scientists have many diverse positions in interaction with policymakers. Diverse positioning is matching with the assumption of a balancing act because the findings show a discrepancy between what they normatively perceive their role should be and what their actual role in reality is. Huitema and Turnhout (2009) had already found an inconsistency between a normative role perception and an actual role played in real interaction. This thesis can add to the finding of Huitema and Turnhout (2009). The interviewees that explained to ideally work according to pragmatic features in interaction experienced a more decisionist form of cooperation with policymakers (Interviewees 2, 5, 6 and 7). They often worked on commissioned studies, in which policymakers posed a problem and ordered scientists to find evidences to solve it. Surprisingly, all interviewees explained to acknowledge value-based judgements in scientific knowledge even though a decisionist form of scientific policy advice strictly divides facts from values (Edenhofer & Kowarsch, 2015a). On the contrary, the interviewees, who experienced SPI activities that relate to the pragmatic theory (characteristics for recap: full engagement in interaction, fully integrated involvement into policy processes, co-production of knowledge and diffuse knowledge transfer), tended to limit the function of science to merely delivering

factual knowledge and also strictly divided factual knowledge from value-based knowledge. This finding was unexpected, since pragmatic theory aims to discuss values in political contexts rationally by critically analysing and comparing practical side effects of objectives and means (Edenhofer & Kowarsch, 2015b). The finding might relate to fundamental criteria of expert knowledge in policymaking. Credibility, relevance and legitimacy are attributes that influence the impact of a SPI. Expert advice is significantly used to lend political arguments more credibility and legitimacy (Cash *et al.*, 2003). Scientists that are closely involved in policy processes could be forced to make such a strict division between evidence-based and value-based knowledge in order to be taken seriously and credible by policymakers.

In this research, interview subjects tended to normatively think their role in interaction with policymakers should be going more in the direction of an Honest Broker (Pielke, 2007) or a knowledge broker (Turnhout *et al.*, 2013). Seven interviewees out of nine in total reported that their role as a scientist in SPIs should be facilitating and leading towards new, more interactive ways of deliberating about a societal issue, generating transdisciplinary knowledge and transferring knowledge multilaterally. Mostly, they justified this normative position, because of a multidimensional learning process from which they would eventually benefit. Additionally, three subjects regarded engagement in interaction and involvement in the decision-making process as very important predetermines for cooperation to design policy options. Interviewed scientists probably had this perception, because it follows a new participatory paradigm as Bäckstrand (2003) puts it. Bäckstrand (2003) and Newig and Kvarda (2012) reflected that the participatory turn in scientific expert advice is explained as an opposition to the perceived scientization of policy. Democratic deliberation about certain courses of policy actions is thought to increase the democratic legitimacy of decision-making (Koontz, 2006). As interviewed scientists do not want to be regarded as an advocate for a particular course of action, they consider interactive and participatory approaches in interaction and knowledge generation as quite essential. It is also important for them because they have recognized that political legitimacy is a by-product in scientific policy advice (Renn, 2015) and that therefore a representative presentation of options lends their expertise improved scientific credibility, neutrality and policy salience (Cash *et al.*, 2003). However, it seems to be difficult for five (out of nine) scientists to implement their normative role perceptions in reality, since they reflected to take more traditional roles in interaction with policymakers. Even though interview subjects believed to jointly deliberate about an appropriate problem definition, to integrate knowledge from all relevant actors in their policy advice and to use that acquired knowledge in a diffuse way would be best for the development of SPI cooperation, many subjects did not achieve that position in real cooperation. Often, policy questions directly determined the content of scientific expert advice (Interviewee 2, 5 and 7) and therefore limited knowledge generation to a disciplinary or interdisciplinary approach and knowledge use to a linear procedure. Consequently, the argument that the role of scientists in SPIs is strongly influenced by structural and procedural features of a SPI keeps on coming back. Before the analysis, it was expected that scientists have choices in what role they play in interaction with policymakers (Pielke, 2007). After the interview analysis, it emerged that the SPI design and the intention behind science-policy interaction influence the role of scientists. According to the role model of Pielke (2007), value consensus and the level of uncertainty about a specific

debated issue are determining factors for the role of science in policy and politics. However, my results suggest that also the structure of a SPI influences the role of scientists. SPIs with a high level of engagement and involvement tended to go in a direction of jointly deliberation in research design and problem formulation, a transdisciplinary co-production of knowledge and a diffuse knowledge use. Additionally, interviewees that were engaged and involved to a higher extent stressed a multidimensional learning process. Although Interviewee 9 explained that Agora Energiewende functions as a broker organisation between SPI actors, and therefore limits the development of scientists' roles, Interviewee 9 stressed that they intentionally design projects with participatory settings and high involvement that go beyond the Honest Broker role. In SPIs, value consensus and the level of uncertainty are still important factors for role determination, but they are certainly not enough to analyse a two-way interaction, where scientists' positioning is also influenced by the relationship with policymakers or other SPI members. Importantly, which complex issue eventually has a value consensus and a low level of uncertainty, when a lot of scholars stress the inevitability of value conflicts and inherited uncertainties of complex decision contexts? Even Pielke (2007) acknowledges this fact. Therefore, I argue that the positioning of scientists is also strongly dependent on the intention behind the design of SPIs and consequently the intention how to handle scientific policy advice. Not only the scientist decides on which role to play, but also policymakers influence their role. For example, Interviewee 7 was acting as an Honest Broker, thus providing several options, was nevertheless asked by involved policymakers to present one preferable option and was therefore pushed into the role of an Issue Advocate.

Although policymakers' views and perceptions were not included in the analysis, I can conclude from my findings that scientists often do not have a chance to choose their own role. The SPI design and the intention behind science-policy interaction strongly influence the role of scientists. Therefore, they often find themselves in a highly complex situation when interacting with policymakers, because their role is determined from both sides: science and policy and not like Pielke (2007) explains that they have choices about how to engage with policymakers. Often the dialogue between science, policy and society in SPIs determines the role of a scientist and it seems that the role is emerging from the context of dialogue. I wanted to understand which role scientists play at various interfaces of science and policy in the German energy transition. A lot of different roles emerged during the interviews rooted in various thinking modes of scientific advice in policymaking. Interviewee 8 was very creative in describing his role(s), since he related to each activity another role. He described himself as debate initiator, manager of scientific studies, networker, evaluator and moderator in public debates. Other interview partners (4 and 6) seemed to stick to their most visible role, namely the role of a scientist, because the dialogue between science and policy and the SPI type hindered a participatory approach. On the contrary, the technocratic approach taken in the expert panel Energiewende did not require another role definition of science. Again other interview partners, like Interviewee 2 and 5, would like to be more integrated in policy processes and thus play a more significant role, but somehow find themselves stuck in a decisionist-following system of scientific policy advice. Interviewee 3's role perception was significantly rooted in a democratic-pragmatic thinking mode and he defined the role of science as a cartographer. Turnhout *et al.* (2013) were convinced

that Pielke's typology is an *'oversimplified, stylized and static representation of what the experts that play these roles actually do.'* (p. 355). Although this thesis could not provide novel roles for scientists in SPIs, I can undermine that statement and say that roles of scientists in interaction with policymakers are as diverse as different people in interaction are. Especially in the era of new and modern forms of research for complex societal issues and multifaceted ambitious goals, a two-way or multidimensional interaction requires a shift from traditional to novel roles for scientists. However, and here I also agree with Turnhout *et al.* (2013), roles of interviewees in practice tended to be more rooted in traditional practices of science than in new functions of science. This was seen particularly in the SPI with a broker organization that seemed to limit the development of novel roles for scientists involved.

In the end I can say that a mismatch between the actual role in SPIs and the normative role perception of individual scientists increases the relational complexity for a scientist in a SPI. Some interview subjects reported to experience enormous frustration, others took self-responsibility and the lead in SPIs by interfering in policy decisions, again others saw themselves caught in a traditional science system unable to implement their normative (good-intentional) role perception into practice. This mismatch might also one of the reasons for the dilemma that scientists often face to balance between providing a full range of policy options while being relevant, credible, neutral and legitimate in the policy process. I could observe that interviewees felt uncomfortable when they spoke about objectivity, neutrality and independency in the context of scientific policy advice in the interviews. According to an interpretation of their statements, scientific policy advice seems to be a tensed field on a thin line between mistrust about the honesty and transparency of science and the urgency for policymakers to deal with serious, real issues immediately. Unfortunately, interviews in this thesis have not revealed how interviewees have dealt with the dilemma or their tensions between personal normative roles and their real roles extensive enough to obtain robust results. But this is certainly valuable to study in future.

Limitations

One important constraint represented the limited time available for field research, which also set limits to the amount of interviews that could be arranged. On the one hand, the 9 interviews conducted represent an appropriate selection of important actors in the realm of the German Energiewende, but on the other hand they are unable to represent the whole range of relevant actors in the energy-political system. It was certainly not the objective of the interpretive methodology to come to generalizable results. Rather a careful selection was appropriate. But with fewer interviews, I was also able to go in full depth of every interview to get the most out of them.

Further, it was difficult to gain access to all the interviewees who were considered desirable for answering the research questions. For instance, there was no possibility to talk to policymakers in the identified SPIs or persons working at the Ministries due to its restrictive interview policy. Also, it would have been appropriate to conduct a wider range of interviews with parliamentary members in order to

display the different party positions regarding the dialogue about the German energy transition. This would have been valuable, because the policymakers could have shed light on important factors influencing the role of science in SPIs, since it was found that actual roles are determined in the context of interaction. This means that future research should address the reciprocal influence of normative role perceptions and roles taken in practice of scientists and policymakers alike in order to fully understand both sides.

Another limiting practical factor was that the interviews were conducted in German and translated consecutively into English for the purpose of communicating the research result in the thesis. Therefore, the bias of eliminating aspects of authenticity or other subtleties through the translation process was always present. Finally, due to practical reasons interviews had to be conducted on the phone, although a face-to-face conversation would have been more appropriate for this kind of study. In retrospective, some questions were kind of sensitive and it seemed that interviewees would have felt more at ease when speaking to me face-to-face instead of speaking to a stranger on the phone.

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Glossary

The following terms are key terms in this thesis and therefore a definition is provided. Definitions derived from own understanding, from literature and from definitions in encyclopaedias.

Decision-maker: a person who decides things, especially at a high level in parliament, an organisation or institution.

Energiewende: English meaning is energy transition and is the long-term structural change in the energy system to renewable energy sources as part of sustainable development.

Engagement: the intensive commitment, dedication or effort in a particular situation

Knowledge broker: A Knowledge broker is an intermediary (an organization or a person) that aims to develop relationships and networks with, among, and between producers and users of knowledge by providing linkages, knowledge sources, and in some cases knowledge itself, to organizations in its network.

Knowledge generation: the production and creation of knowledge for complex societal issues or multifaceted ambitious goals

Knowledge transfer: the process of packaging and presenting knowledge for dissemination

Legitimation: the justification of a state to act or the reason why someone is allowed to act or behave in a certain way.

Linear model of innovation: it suggests technical change happens in a linear fashion from invention to innovation to diffusion. It prioritizes scientific research as the basis of innovation, and plays down the role of later players in the innovation process.

Policymaker: a person responsible for making public policy, especially in government.

Political science: Political science is a social science discipline that deals with systems of government and the analysis of political activity and political behavior. It deals extensively with the theory and practice of politics, which is commonly thought of as the determining of the distribution of power and resources.

Politician: a person whose job is in politics, especially one who is a member of parliament or of the government and part of a political party

Post-normal science: a concept attempting to characterize a methodology of inquiry that is appropriate for cases where "facts are uncertain, values in dispute, stakes high and decisions urgent". It suggests that there must be an "extended peer community" consisting of all those affected by an issue who are prepared to enter into dialogue on it.

Scientific policy advice: The interface between science and policy. Scientists have the task to translate research results into practical political questions and vice versa, translate practical questions into research questions.

Science-policy interfaces: the relationship and on-going dialogue between researchers and policymakers with the goal to improve linkages between policy needs and research programmes. The dialogue takes place at all levels - local, regional, national and international.

Stakeholder: A stakeholder is any group or individual who can affect or is affected by the achievement of the organization's objective.

Stealth Issue Advocacy: It occurs when scientists claim to be focusing on science but are really seeking to advance a political agenda. It threatens the legitimacy of scientific advice, as people will see it simply as politics, and lose sight of the value that science does offer policymaking.

Value judgment: A subjective assessment based on one's own code of values or that of one's class.

Wicked problem: A problem that is difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognize.

Appendices

Appendix I.

Invitation letter for the interview

Wageningen, 22.10.15

Anfrage für ein Gespräch

Sehr geehrte(r) ... ,

im Rahmen meiner Masterarbeit würde ich Sie gerne zu einem 30 minütigen Interview einladen, um über Ihre Position an der Schnittstelle zwischen Wissenschaft und Politik zu reflektieren.

Der UN Generalsekretär Ban Ki Moon sagte einmal in einer Rede, dass nachhaltig gewonnene Energien der Schlüssel zu einem globalen Wandel sind: *„Nachhaltige Energie ist der goldene Faden, der Wirtschaftswachstum, gesellschaftliche Gerechtigkeit und eine gesunde Umwelt verbindet.“* (frei übersetzt). Die Energiewende in Deutschland ist ein großes Thema in der Politik, in der Industrie sowie in der Gesellschaft. Der Ausstieg aus fossilen Energieressourcen und Kernenergie, sowie der Übergang in ein Zeitalter der erneuerbaren Energien ist nur durch technologischen Fortschritt möglich. Darum hat die Bundesregierung die Ausgaben für die Energieforschung in den letzten Jahren stark erhöht und die Zusammenarbeit mit Forschungsinstituten und Universitäten weiter ausgebaut.

In meiner Masterarbeit „Kommunikation und Wissenschaft“ würde ich gerne diese Thematik aufgreifen und die Rolle der Wissenschaft in der deutschen Energiewende näher untersuchen: Welche Position nehmen die Wissenschaftler der führenden Institute gegenüber der Politik ein? Inhaltlich ginge es vor allem um den Verlauf der Interaktion zwischen Politik und Forschung und wie der Wissenstransfer von Wissenschaft zu Politik stattfindet.

Für diese Untersuchung bin ich auf der Suche nach Forschern, die momentan mit einem Projekt an der Energiewende beteiligt sind und zeitgleich mit politischen Entscheidungsträgern zusammenarbeiten. Aufgrund Ihrer Erfahrung und Ihrem derzeitigen Stand als Wissenschaftler bin ich auf Sie aufmerksam geworden und würde Ihnen gerne ein paar Fragen diesbezüglich stellen. Alle erhobenen Daten werden vertraulich behandelt und mit absoluter Anonymität in meiner Arbeit verarbeitet. Ich würde mich über eine positive Antwort Ihrerseits freuen.

Mit freundlichen Grüßen,

L. Koch

Larissa Koch
MSc Applied Communication Science & Environmental Sciences

Appendix II.

Question guideline for the semi-structured interview (translated into English)

Issue/ Topic	Possible question	Possible follow up question	Probing
Research profession	Could you describe your background and role as a scientist?	What are your most important activities in your professional life? Which profession would you ascribe to yourself when you think about your daily activities?	Tell me more about that. Why?
Interaction with policymakers	How do you interact with policymakers?	Could you describe the interaction with the help of real examples on the German energy transition? To which extent do you provide advice to policymakers? And in what form? What are your feelings when interacting with policymakers?	Tell me more about that/ *specific situation.* Really? Tell me an *experience/ real example.*
	What do you want to achieve when interacting with policymakers?	What are your goals/ motives? Do you want to fulfil policymakers' objectives?	
	Have you ever experienced a situation where you reduced the scope of available policy options to support the scientifically "better" option(s)?	If yes, please describe such situation.	Really? Can you tell me more …
	Statement: *"Every scientist interacting with policymakers faces the dilemma of remaining scientifically*	What is your opinion on this statement?	Really? Why? Tell me more about …

	independent, while delivering relevant and useful knowledge to policymakers"		
Boundaries in science-policy cooperation	Where are your boundaries in interaction with policymakers?	Have you ever had boundary negotiations with policymakers?	If yes, how did those negotiations look like?
Communication between scientist and policymaker	How do you present research results, if these results were intended to address policy questions? When do you encounter difficulties in communicating with policymakers?	Do you have to consider specific What did you do? What was your reaction? How do you cope with those difficulties?	 Really? Tell me more about *specific situation.*
Outlook on science-policy interaction	What is your perspective on the relation between knowledge producer and knowledge user in the future of the German energy transition?	Why do think that?	