Developing an integrated value-based institutional framework for analyzing nexus governance challenges – the case study of Germany

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Zusammenfassung

Globale Entwicklungen, wie die Auswirkungen des Klimawandels oder eine steigende Weltbevölkerung, erfordern ein integriertes und ganzheitliches Management natürlicher Ressourcen, das deren vielfältige Vernetzungen berücksichtigt. Der Ansatz des Food-Energy-Water Nexus rückt diese Verwobenheit ins Zentrum. Das Ziel der vorliegenden Arbeit ist es zunächst, den Nexus-Ansatz auf politikwissenschaftlicher Ebene zu operationalisieren, um dadurch eine Analyse der Politikintegration zwischen Landwirtschafts-, Wasser- und Energiepolitik zu ermöglichen. Im zweiten Teil der Arbeit wird der neu entwickelte Analyserahmen auf das Fallbeispiel Deutschland angewendet.

Die Grundlage der methodischen Entwicklung bildet das Institutional Analysis and Development Framework, das sich auf zentrale Institutionen, Akteure und weitere ausgewählte Elemente fokussiert. Dieses wird durch zwei Konzepte erweitert. Die Erweiterung mit einer Werte-Dimension ermöglicht es, zugrundeliegende Werte und damit einhergehende Wertekonflikte in den einzelnen Politikfeldern zu ermitteln. Dieses werte-basierte Framework wird dann durch das Konzept der Environmental Policy Integration ergänzt. Dadurch können zwei neuartige Analyserahmen entwickelt werden, die die unterschiedlichen Ebenen der vertikalen und horizontalen Politikintegration in Bezug auf den Food-Energy-Water Nexus abbilden.

Im zweiten Teil der Arbeit wird die neu entwickelte Methodik auf das Fallbeispiel Deutschland angewendet. Die Analyse zeigt sieben verschiedene zentrale Herausforderungen in Bezug auf die Nexus-Governance. Diese gliedern sich in Herausforderungen, die alle Politikfelder gleichzeitig berühren, sowie jene, die eine Verbindung zwischen ausgewählten Politikfeldern betreffen. Die Analyse zeigt auch, dass die Herausforderungen untereinander stark miteinander in Verbindung stehen und auf unterschiedlichen Politikebenen adressiert werden müssen. Aus diesen Ergebnissen werden acht zentrale Politikempfehlungen abgeleitet.

Abstract

Global megatrends, such as the impacts of climate change and global population growth, require an integrated and comprehensive management of natural resources that accounts for the various interrelations that exist between them. The food-energy-water nexus focuses on these interrelations. The main contribution of this thesis, firstly, is to operationalize the nexus concept for political analyses in order to adequately analyze policy integration between agricultural, water and energy policy. Secondly, the new developed analytical framework is applied to the case study of Germany.

The Institutional Analysis and Development Framework serves as the basic methodological framework. It focuses on central institutions, involved actors as well as further determining factors. The basic framework is extended in two ways. Firstly, a value dimension is added, which allows to identify underlying values and associated value conflicts in the respective policy fields. Secondly, the value-based framework is extended by the concept of Environmental Policy Integration. This allows for the development of two novel analytical frameworks that capture the different levels of vertical and horizontal policy integration related to the food-energy-water nexus.

In the second part of the thesis, the newly developed methodological framework is applied to the case study of Germany. The analysis identifies seven different key challenges related to nexus governance, each affecting different linkages between policy fields. Overarching challenges that include all policy fields simultaneously are establishing sustainable development as a guiding policy principle, climate protection and biodiversity conservation. Challenges that affect linkages between selected policy fields are: water pollution from agriculture, sustainable production of bioenergy, energy consumption in agriculture, and energy consumption from wastewater treatment plants. The analysis also shows that the challenges are strongly interrelated and that they need to be addressed at different policy levels. Eventually, eight key policy recommendations are derived from these findings.

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10JN[1]	10 years sustainable development "made in Germany". The national strategy for sustainable development
AbwV[1]	Waste Water Ordinance
AgrarZahlVerpflG[1]	Agricultural Payments Commitments Act
AgrarZahlVerpflV[1]	Agricultural Payments Commitments Ordinance
APKlima[1]	Climate Action Program 2020
BDS[1]	Federal Biodiversity Strategy
BImSchG[1]	Federal Immission Control Act
Biokraft-NachV[1]	Biofuel Sustainability Ordinance
BiomasseV[1]	Biomass Ordinance
BioSt-NachV [1]	Biomass Electricity Sustainability Ordinance
BMEL[1]	Federal Ministry of Food and Agriculture
BMU[1]	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BMWi[1]	Federal Ministry for Economic Affairs and Energy
BNatSchG[1]	Federal Nature Conservation Act
CAP	Common Agricultural Policy
CAQDAS	Computer-assisted Qualitative Data Analysis Software
CDU[1]	Christian Democratic Party
DAS	Federal Adaptation Strategy
Destatis[1]	Federal Statistical Office
DirektZahlDurchfG[1]	Direct Payments Implementing Act
DirektZahlDurchfV[1]	Direct Payments Implementing Ordinance
DüG[1]	Federal Fertilizer Act
DüV[1]	Fertilizer Ordinance

[1] These abbreviations refer to the German document title or name of organization. For more information on the documents refer to Tables 7-10.

EAP	Environmental Action Program
EEG 2017[1]	Renewable Energy Act 2017
EEV[1]	Renewable Energy Ordinance
EIA	Environmental Impact Assessment
EnKonz[1]	Energy concept – for an environmentally friendly, secure, and affordable energy supply
EnWG[1]	Federal Energy Act
EPI	Environmental Policy Integration
ESD	Effort Sharing Decision
ETS	European Emission Trading Scheme
EU	European Union
EW nexus	Energy-water nexus
FAO	Food and Agriculture Organization of the United Nations
FB 2004[1]	Perspectives for Germany. Our strategy for sustainable development. Progress report 2004
FB 2008[1]	Progress report 2008 on the national strategy for sustainable development: For a sustainable Germany
FB 2012[1]	National strategy for sustainable development. Progress report 2012
FDP[1]	Liberal Democratic Party
FE nexus	Food-energy nexus
FEW nexus	Food-energy-water nexus
FW nexus	Food-water nexus
GBEL[1]	Green book on nutrition, agriculture, and rural areas
GHG	Greenhouse gas
GrwV[1]	Groundwater Ordinance
IAD framework	Institutional Analysis and Development framework
Ind06[1]	Sustainable development in Germany. Indicator report 2006

Ind08[1]	Sustainable development in Germany. Indicator report 2008
Ind10[1]	Sustainable development in Germany. Indicator report 2010
Ind12[1]	Sustainable development in Germany. Indicator report 2012
Ind14[1]	Sustainable development in Germany. Indicator report 2014
Ind16[1]	Sustainable development in Germany. Indicator report 2016
IntEKP[1]	Integrated Energy and Climate Program
IntUP[1]	Integrated Environment Protection Program
IPCC	Intergovernmental Panel on Climate Change
itv	Interviewee
IWRM	Integrated Water Resources Management
KP 2000[1]	National Climate Action Plan
KSG[1]	Federal Climate Protection Law
KSP 2050[1]	Climate Action Plan 2050
MDGs	Millennium Development Goals
MLG	Multi-Level Governance
NAPE[1]	National Action Plan on Energy Efficiency
NB 2016[1]	Nitrate report 2016
ND[1]	Nitrates Directive
NGO	Non-Governmental Organization
NHS 2002[1]	Perspectives for Germany. Our strategy for sustainable development
NHS 2016[1]	German Sustainable Development Strategy. New edition 2016
NRW	North Rhine-Westphalia
OGewV[1]	Surface Water Ordinance
PBnE[1]	Parliamentary Council for Sustainable Development
PD	Pesticides Directive
QCA	Qualitative Content Analysis
RNE[1]	German Council for Sustainable Development

SDGs	Sustainable Development Goals
SES	Socio-Ecological System
SPD[1]	Social Democratic Party
StsA[1]	State's Secretary Committee for Sustainable Development
UN	United Nations
UNEP	United Nations Environment Programme
WFD	Water Framework Directive
WHG[1]	Federal Water Act
WWN[1]	Guide on sustainable development 2005: Balance sheet and perspectives

1. Introduction

1.1. Motivation

Anthropogenic climate change is one of the grand challenges of the 21st century. Its impacts put major pressure on the availability and access to essential natural resources, such as water or land. Extreme weather events, droughts and temperature rises increasingly endanger the basis of human life (Lenton et al. 2019, p. 592). Simultaneously, a growing world population additionally raises the pressure on natural resources through a continuously growing demand. The concept of planetary boundaries developed by Johan Rockström et al. (2009) presents a safe operating space for the use of natural resources. They defined nine critical ecological areas, including climate change, land use change or ocean acidification, in which transgressing the boundaries would have severe consequences for humanity and nature. The safe operating space is defined as a green zone below the boundary. Transgressing this zone by overuse means reaching a zone of uncertainty with increasing risks (yellow) followed by a zone beyond uncertainty with high risks (red) (Rockström et al. 2009, p. 472). Steffen et al. (2015, p. 6) concluded that in the areas of climate change and land-system change humanity has already transgressed the boundaries, currently operating in the yellow zone of increasing risks. In the area of biogeochemical flows dealing with nitrogen and phosphorous pollution, and in one part of biosphere integrity – genetic diversity – humanity has even begun to operate in the red zone of high risks. The researches provided no policy implications on how to reach the safe operating space by simultaneously fostering sustainable development globally. They, however, made perfectly clear that the "Earth is a single, complex, integrated system—that is, the boundaries operate as an interdependent set" (Steffen et al. 2015, p. 8). Against this background, several related challenges must be taken on at once and in a holistic manner (Steffen et al. 2015, p. 8).

To mitigate these challenges, a major societal transformation is necessary that profoundly reconsiders the way we currently use, produce and consume natural resources (WBGU

2011, p. 1). Also, in 2015, the global community took two significant steps towards such a transformation. The United Nations (UN) agreed on limiting global average temperature rise well below two degrees until the end of the century, as laid down in the Paris Agreement (United Nations 2015a). In addition, the UN adopted the Agenda 2030 for Sustainable Development (United Nations 2015b). This UN resolution aimed at addressing the most pressing global societal challenges, mainly through seventeen Sustainable Development Goals (SDGs). Among these goals, several goals address climate and environmental concerns, such as “climate action” (SDG 13), “life below water” (SDG 14), or “life on land” (SDG 15). Additional goals refer to the management of basic natural resources necessary for human life, such as food and nutrition (“zero hunger” (SDG 2)), safe drinking water (“clean water and sanitation” (SDG 6)) and a secure energy supply (“affordable and clean energy” (SDG 7)). In contrast to the preceding agreement, the Millennium Development Goals (MDGs), which mainly addressed the situation in developing countries, the SDGs apply to all UN member states, including industrialized countries. Furthermore, the SDGs are intended as a holistic framework that should be reached as a whole (United Nations 2015b). This means that no goal should be achieved at the expense of another. This, however, can be seen as a paradox since obvious trade-offs between the different goals exist. How can food production for feeding a growing world population (SDG 2) be increased without compromising SDG 6 on water? Water resources are immensely under stress due to the impacts of climate change. Food production, however, demands high amounts of water for irrigation (Lal 2015, p. 48). Reaching SDG 2 could thus negatively affect the efforts for reaching SDG 6. The only solution for such trade-offs can be the implementation of management approaches that, at least, take these interconnections into account and that try to avoid strong negative side-effects. In the best case those management approaches are designed in a way that creates synergies, which help to reach several goals at once. Integrated governance approaches are necessary to account for these interrelations. One concept that specifically focuses on these interrelations is the food-energy-water nexus (FEW nexus) concept. Its emergence mainly dates back to a conference in Germany in 2011:

the “Bonn2011 Conference: The Water, Energy and Food Security Nexus – Solutions for the Green Economy” (Hoff 2011). The conference was held in preparation for the UN World Summit on Sustainable Development 2012 in Rio de Janeiro and mainly dealt with the issue of a safe water, energy, and food supply in developing countries. In the conference’s background paper the nexus is described as an approach that addresses “externalities across sectors” and thus fosters a more efficient use of natural resources (Hoff 2011, p. 5). The novelty of the nexus was to shift the focus from single resource sectors or policy fields towards their interconnections. This concept thus provided a promising new perspective on problems with natural resources (Allan et al. 2015, p. 301). Until then and mostly till today, the management of natural resources, such as water, food or energy carriers, and their related policy fields have mainly been organized in separate silos (Leck et al. 2015, p. 454). Many countries still pursue single, sectoral policy approaches in dealing with these resources, such as an energy policy separate from water management, or an agricultural policy separate from climate policy. Those approaches often emerged due to a historically grown sectoral institutional setting and sectoral mandates (Al-Saidi and Elagib 2017, p. 1137). However, regarding the complex challenges we currently face, single policies are no longer appropriate, especially in terms of natural resources management. An ever-increasing water demand for agriculture or burning fossil fuels for growing electricity demands, for example, do not comply with the intention to combat climate change or to foster sustainable development. The nexus concept can thus help to adopt a more integrated view on current problems with the management of natural resources and to develop more integrated governance approaches (Zhang et al. 2018a, p. 627).

Mainly since 2011, the nexus concept has also found its way into research and science. The concept had appeared in numerous variations and has been applied to a vast number of resources management issues in developing as well as industrialized countries. Most of the research that is concerned with the nexus takes a rather techno-economic perspective, analyzing resource flows or technological innovations (Albrecht et al. 2018, p. 2). Meeting planetary boundaries by fostering human development at the same time, however, is rather

a societal and political challenge than a technical one. As a report of the European Union (EU) on nexus research stated in 2015: “The knowledge gap is not so much in the existence of technologies, but in technology transfer and especially in institutional gaps, lack of coordination and need for institutional changes’” (Rodriguez et al. 2015, p. 30). Thus, the governance of the nexus is the real challenge (Stein et al. 2014, p. 3) and requires more research on the socio-economic implications of the nexus approach. Even if this stream of nexus literature has grown since this statement, some significant research gaps regarding successful governance of nexus-related challenges have remained (Weitz et al. 2017, p. 165).[2] Research on socio-economic approaches is needed that incorporate the basic idea of the nexus concept to explicitly consider resource interrelations by being able to handle the complexities of these issues at the same time. Furthermore, they should be transferable to different case studies in order to allow comparative studies and thus enable case specific as well as general derivations (Albrecht et al. 2018, p. 20). Two key aspects that need further investigation on the way to more integrated policy approaches are: firstly, how policy integration should be designed with regard to the nexus concept (Weitz et al. 2017, p. 172), and secondly, the role that institutions play for successful governance (Villamayor-Tomas et al. 2015, p. 736). This thesis takes up these aspects and contributes to filling these research gaps by developing a framework to analyze nexus-related governance challenges. The framework is based on institutional analysis on the one hand and incorporates a theory on policy integration on the other in order to capture the basic idea of the nexus concept. The resulting novel framework allows researchers to both understand how policy integration looks like in terms of the nexus and to examine specific political challenges that cross sectoral boundaries or policy fields. Additionally, the framework includes a dynamic perspective, which addresses institutional change processes and thus developments over time. The framework can be used for all policy levels. In this study, it will be applied for a temporal analysis of nexus governance challenges on the federal level in Germany. Its open

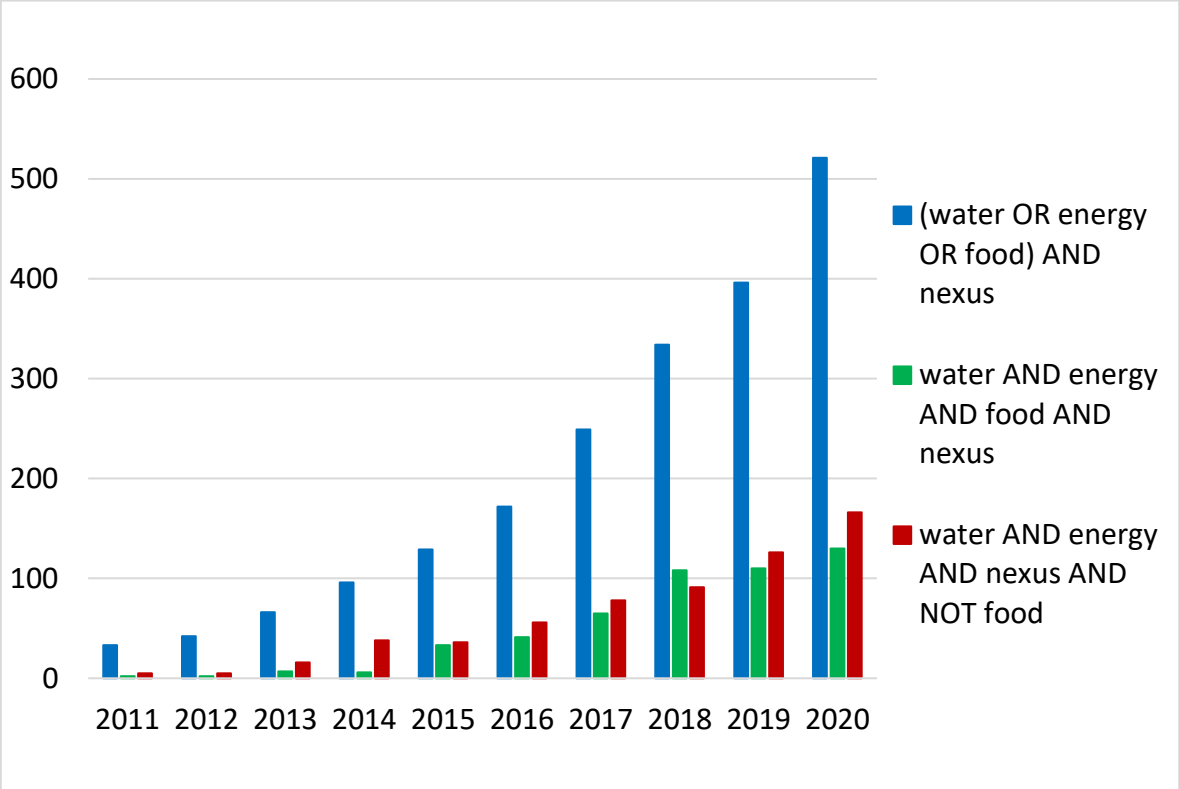
[2] A more detailed description of how the nexus concept emerged on the international level as well as a deeper analysis of existing research on the nexus concept is included in section 2.

structure makes it also transferable to other case studies and thus allows comparative analyses.

1.2. State of the Art and research gap

Scientific literature on the nexus concept has been strongly increasing, mainly since 2011. A search for nexus related articles at ScienceDirect revealed that the number of publications related to the nexus concept increased from 33 in 2011 to about 14 times as many in 2020 (521) (cf. Figure 1, blue bar). The way the concept is used within these articles varies greatly, in terms of sector combinations as well as in terms of methods and application. Regarding the different sector combinations, the use of water, energy, and food – as used at the nexus conference in 2011 – only accounts for a rather small part of nexus-related publications (cf. Figure 1, green bar). Basically, no limits exist in using different combinations. Whether climate, environment, carbon, or economic growth, the nexus concept appears in countless variations (e.g. van den Heuvel et al. 2020; Wan Ab Karim Ghani et al. 2019; Yang et al. 2018; Ozturk and Bilgili 2015). The twofold combination of water and energy emerged as the variation that is used the most (cf. Figure 1, red bar).

Figure 1: Annual number of nexus related publications listed in ScienceDirect for the years 2011 to 2020



Source: own Figure. Search at ScienceDirect for (water OR energy OR food) AND nexus in title, abstract, keyword on 16th November 2020 (ScienceDirect 2020b).

However, not only sector combinations differ, but also the methods applied range from techno-economic modeling approaches (e.g. Amjath-Babu et al. 2019) to socio-economic policy analyses (Venghaus et al. 2019). The nature of the nexus concept practically invites researchers from all academic disciplines and research fields. This makes it so difficult to get an overview of ongoing academic research in this field of study. Since the examination of the broad variety of nexus related literature is of such importance for this work, a separate sub-section is devoted to it (section 2.2).

Fact, however, is that the majority of nexus research is still of techno-economic nature. Only 13 percent of all published nexus articles listed in ScienceDirect between 2011 and 2020 are

attributed to the social sciences (ScienceDirect 2020b). This is especially problematic since the increasing challenges related to climate change impacts necessitate new management and governance approaches (Pahl-Wostl 2019, p. 356). In 2017, Weitz et al. (2017, p. 171) identified critical research gaps concerning the governance of nexus-related challenges and found that current nexus literature "identifies barriers to policy coherence and options for overcoming them, but largely reflects a technical-administrative view on governance that distances it from the reality of decision-making processes." Also other nexus review articles identified this gap: Albrecht et al. (2018) called for more transdisciplinary and mixed methods approaches analyzing the socio-political side of the FEW nexus. Simpson and Jewitt (2019) uncovered a need for more analyses on political systems, their power structures and involved stakeholders and Pahl-Wostl et al. (2020) demanded more attention to challenges related to different governance-scales.

To tackle nexus governance challenges the role of institutions needs to be put in focus. As Heikkila and Andersson (2018, p. 309) state: "Public policies are institutional arrangements that set the official rules of the game for society as we work together to provide public goods and solve complex social dilemmas, such as […] sustaining natural resources." Also according to Andrews-Speed (2016, p. 223) institutional analysis is central for any transition in socio-technical systems. A successful governance of nexus-related challenges, first and foremost, is a question of policy integration across several nexus-related policy fields, or in other words between their institutions. In this regard, policy integration results from institutional change or learning processes (Nilsson and Persson 2003, p. 340). Reaching policy integration through learning processes, however, has been a lack in nexus literature, so far and one reason why many practical nexus projects had only limited influence on decision-making (Weitz et al. 2017, p. 17). This study contributes to filling these gaps by providing an integrated framework for institutional change that can be used to analyze nexus governance challenges as well as their state of integration. Beyond that, this study goes one step further by not only investigating institutional change processes themselves but also the reasons for their emergence.

According to many scholars institutions are based on underlying guiding principles or values that influence or determine their design and development (Correljé and Groenewegen 2009, p. 407). Despite repeated remarks on the role of values they are often not further explained in institutional analysis. This study fills a third gap by adding a value perspective to the framework that helps understanding the reasons for institutional change. As a result, a value-based integrated framework for institutional change is developed that can be used to analyze critical nexus-related governance challenges. In order to test the framework, it will be applied to the case study of Germany.

Since its emergence, the nexus approach has been applied to a broad variety of different countries, regions, or cities. In its early years, the nexus concept was mostly applied to African or Asian countries that face problems with the security of water, energy and/or food supply (Gulati et al. 2013, e.g.; Gain et al. 2015; Mirzabaev et al. 2015; Nesadurai 2013). In recent years, the significance of the nexus approach was more and more emphasized for industrialized countries, which may not suffer from supply security (yet) but also face severe challenges regarding an efficient management of these resources (e.g. Zhang et al. 2018b; Villamayor-Tomas 2017; Campana et al. 2018; Price et al. 2018). So far, however, many nexus related publications refer to single nexus challenges; the electricity demand for water supply or the production of biofuels are only two common examples. Those studies focus on one specific challenge related to the nexus. Nevertheless, like the basic idea of the nexus, not only natural resources are interrelated, but so are the different problems associated with them. Political systems usually face several nexus-related challenges at once that cannot be solved in isolation to each other. For this reason, the SDGs were designed as one holistic framework, which explicitly demands the objective not to reach one goal at the expense of another (Yillia 2016, p. 87). Therefore, efforts must be undertaken to capture a variety of critical nexus-related governance challenges as well as their interconnections.

Hence, an overview of critical nexus challenges and how they are interrelated is essential to develop truly holistic solutions. However, research that structurally identifies critical nexus challenges on the national policy level is still a research gap. This also applies for

Germany as a search for journal articles related to the nexus in Germany shows. Table 1 provides an overview of all nexus-related journal articles dealing with Germany listed at ScienceDirect (ScienceDirect 2020a). The search resulted in 37 journal articles, of which 36 were relevant to this study. The articles can be categorized into four different groups either dealing with: a comparative country study between Germany and other countries, the EU context, Germany itself, or the city level within Germany. Most of the nexus assessments for Germany refer to the energy sector (cf. Table 1, x^1) and investigate the nexus between energy consumption and economic growth, for example (e.g. Balcilar et al. 2010; Shahbaz et al. 2018; Cai et al. 2018b). Only a small number of articles relates to the FEW nexus (cf. Table 1, x^4). Those, however, do not provide a comprehensive analysis of nexus-related challenges for Germany. This study fills this gap by providing a comprehensive analysis on nexus-related governance challenges on the federal level in Germany. Germany, currently, executes a profound transition mainly of its electricity system towards low-carbon technologies. This is also associated with several governance challenges regarding the nexus-related policy fields, which not only address critical infrastructures (water, energy, and food supply) (Wróbel 2019, pp. 1625–1626) but are also economically important (agricultural and energy industry). Furthermore, as stated above the nexus-related policy fields are strongly connected to overarching challenges of climate protection or sustainable development. This shows that a successful nexus governance is a matter of national interest. Therefore, an analysis of nexus-related governance challenges on the federal level of Germany is the precondition for designing truly holistic and integrated solutions that support sustainable development pathways.

Table 1: Nexus journal articles related to Germany

Comparative country study	**EU context**	**Germany**	**City**
(Chen et al. 2020)[5]	(Wang et al. 2020b)[2]	(Schlör et al. 2018)[4]	(Böttcher et al. 2019)[2]
(Takaes Santos 2020)[3]	(Alola et al. 2019)[1]	(Schlör et al. 2017)[4]	(von Bock und Polach, Carlotta et al. 2015)[3]
(Aydin 2018)[1]	(Antonelli et al. 2017)[5]	(Märker et al. 2018)[4]	(Friedrich et al. 2020)[2]
(Voltz and Grischek 2018)[2]	(Chini and Stillwell 2020)[2]	(David 2017)[1]	(Gondhalekar and Ramsauer 2017)[4]
(Matthäus et al. 2020)[1]	(Wang et al. 2020a)[2]	(Franz et al. 2017)[4]	(Maaß and Grundmann 2016)[4]
(Huang et al. 2016)[1]		(Jacksohn et al. 2019)[1]	
(Kesikoğlu and Yıldırım 2014)[1]		(Heesen and Madlener 2018)[1]	
(Sharif et al. 2020)[1]		(Galvin 2020)[1]	
(Cai et al. 2018b)[1]			
(Mohmmed et al. 2019)[1]			
(Balcilar et al. 2010)[1]			
(Jammazi 2012)[1]			
(Menegaki and Tugcu 2017)[1]			
(Ajmi et al. 2013)[1]			
(Shahbaz et al. 2018)[1]			
(Destek and Aslan 2020)[1]			
(Chu and Chang 2012)[1]			

Source: own Table. Search at ScienceDirect for (water OR energy OR food) AND nexus AND Germany in title, abstract, keyword on 18th November 2020 (ScienceDirect 2020a). [1]Focus on the energy sector, [2]Water-energy nexus, [3]Bioenergy and biofuels, [4]FEW nexus, [5]others.

1.3. Objectives and outline

As stated above, the main objective of this work is to develop an integrated value-based framework for analyzing nexus governance challenges on the federal level in Germany. In the first, conceptual part of this study the framework will be systematically built through sections 2 to 5. In the second part of the study, the framework will be applied for the case study of Germany (sections 6 and 7). For the sake of clarity, each main section (except for the discussion and conclusion) concludes with a short section summary of main findings.

As stated in the sub section above, academic literature uses the nexus concept in many different variations and conceptualizations. In a first step, thus, section 2 is dedicated to the aim of providing the necessary background on the nexus concept. It examines the reasons for and the history of the emergence of the nexus concept on the international level (section 2.1), before the concept is defined for academic purposes (section 2.2). The categorization of different streams of nexus research is used to put this study in the context of ongoing research in this field of study as well as to derive a useful working definition of the concept. The common ground on all streams of nexus research is the focus on the interrelations between different natural resources or resource sectors. Thus, the nexus in its basic idea incorporates a holistic and systemic perspective. To complete the preparatory work for the following development of an analytical framework the nexus concept is conceptualized by the literature on systems thinking (section 2.3). This helps defining the subject of investigation and to set the system boundaries, within which the institutional analysis will be conducted. In this regard, this section lays the groundwork for all following sections.

In this study an extended institutional analysis is conducted in order to properly address the role of institutions and actors and thus being able to adequately analyze nexus-related public policies. The study, thereby, follows a three-step approach throughout sections 3 to 5. In the first step, the basic analytical framework is introduced in section 3: the Institutional Analysis and Development (IAD) framework. In the first part of this section the basic aims and scope as well as the elements of the IAD framework are described (section 3.1). In order to design integrated solutions in the future it is important to understand when, why and

how institutions change. Thus, understanding institutional change processes becomes important. The IAD framework accounts for these interdependencies through feedback loops. Those, however, are not further specified. To gain a deeper understanding of these change processes the IAD framework is combined with social learning, which allows for identifying different types of change processes (section 3.2). By doing so, it can be analyzed how the nexus-related policy fields evolved over time. The result of section 3 is thus an analytical framework for institutional change.

Many different reasons exist why and when institutional change happens. Many change processes occur on a rather superficial level adjusting already existing policies. To reach deeper changes, such as creating new institutions or altering the course of policies, underlying norms and values need to be changed. Usually, institutions are created with a certain purpose supporting specific goals. This purpose is based on underlying values. Controversies concerning these values can induce processes of social learning. For this reason, in the second step, the framework is extended by a value perspective in section 4. Even if the term 'value' has regularly been used by IAD scholars, no detailed definition of values can be found. This research gap is further elaborated in section 4.1 before the value perspective is added to the elements of the IAD framework in section 4.2. These elaborations help to design a value-based framework for institutional change.

However, the main idea behind the nexus concept is to focus on the interconnections between different policy fields and to ask how an efficient and successful management of natural resources can be achieved by simultaneously reaching the SDGs. This means that the nexus-related policy fields need to be integrated in order to account for side-effects and to foster integrated solutions. In its current form the value-based framework for institutional change does not account for policy integration. It may serve as the analytical frame, highlight important system's elements and explain how and when institutional change proceeds. However, it does not show how the different policy fields are interconnected and what current challenges of integration are. Therefore, a perspective on policy integration is needed that fills this gap. In this study, a triangular approach is used

addressing policy integration from three different dimensions: spatial, procedural, and with regard to content. section 5 uses the concept of polycentric and multi-level governance (MLG) to address the spatial dimension (section 5.1.1), the policy cycle to refer to the procedural dimension (section 5.1.2), and the concept of Environmental Policy Integration (EPI) to address the design of policy integration (section 5.1.3). In the second part of this section two different nexus policy integration frameworks are developed that represent different types of policy integration (section 5.2). Section 5 completes the methodological development of this study by adding the *integrated* quality to the framework. The developed integrated value-based framework for institutional change presents a comprehensive toolbox for analyzing nexus governance challenges on any political level. Summarizing its functions, it, firstly, allows an analysis of institutional change within the nexus-related policy fields. Secondly, it provides an approach for examining the values that underlie nexus policies and that determine their design. Thirdly, and, with regard to the nexus most importantly, it can be used to analyze the state of policy integration among the different policy fields. Taken all together, the framework helps to gain a profound understanding of the current nexus governance challenges, their emergence as well as their state of integration.

To test the framework, it is applied to Germany as a case study in the second part of this study. The objective is an analysis of the nexus-related governance challenges on the federal level in Germany. Therefore, firstly, a short background on the case study serves to put it into context (section 6.1). In the following section the research methods are introduced that have been used for the empirical analysis: a qualitative content analysis of central German policy documents (section 6.2.1), and several complementary expert interviews (section 6.2.2). The results of the case study are structured in accordance with the framework development in sections 3 to 5. The first part of the results (section 6.3) presents a value-based institutional analysis of the nexus-related policy fields. It describes underlying values as well as important institutions and social learning processes within their historical development mainly during the last two decades. This analysis not only helps to

understanding how and in what way these policy fields have changed. It also reveals if the underlying values on which the policies are based are similar, compatible or even conflicting. This analysis is important for the elaboration of where policy integration is possible, already exists or is hindered. This will be addressed in the subsequent step (section 6.4). This second part of the results section reveals important nexus governance challenges on the federal level in Germany and analyzes their state of policy integration by means of the two integration frameworks developed in section 5.2. In the third part of the results section the nexus governance challenges are conclusively assessed in detail (section 6.5). These results are discussed in section 7 with the aim of deriving specific policy implications for Germany. The study closes with a conclusion that assesses the suitability of the analytical method developed in the first part of the study and a research outlook (section 8).

2. The food-energy-water nexus concept

In order to develop an analytical framework for analyzing nexus governance, first and foremost, the nexus concept itself needs to be clearly defined for academic purposes. Therefore, in a first step the historical background of the nexus concept is described in section 2.1. This helps to understand the context of its emergence on the international level and thus its original aims and scope. This section will show that, in contrast to many other concepts of resources management, the nexus concept does not originate from academia, but rather from policy and practice. It, however, soon was also used in scientific research in many different varieties. For this reason, section 2.2 provides a categorization of different streams of nexus research in order to derive a working definition of the nexus as an academic concept that will be used in this study. The nexus concept is also characterized by taking a systemic and holistic perspective on resources management problems. To define the system boundaries for the analysis conducted in this study an adequate system's definition is needed. Therefore, literature on systems thinking is used in section 2.3. It allows identifying the critical components of a system and how they interact. This system definition will be the basis for the operationalization through the framework developed in sections 3 to 5.

2.1. Emergence of the nexus on the international political agenda

The Bonn2011 Conference is very often considered as the starting point for the emergence of the nexus on the international agenda. In the conference's background paper, Hoff (2011, p. 13) defines the nexus as follows:

"The nexus approach highlights the interdependence of water, energy and food security and the natural resources that underpin that security – water, soil and land. Based on a better understanding of the interdependence of water, energy and climate policy, this new approach identifies mutually beneficial responses and provides an informed and transparent framework for determining trade-offs and synergies that meet demand without compromising sustainability."

The main idea behind the nexus is to tackle the problem of so-called 'silo-thinking', which describes the fact that currently water, energy, and food are governed and managed in sectoral silos. Often, this is due to historically grown responsibilities, institutions, and processes within the boundaries of policy fields (Pahl-Wostl et al. 2013). However, important interconnections between the different natural resources exist. Neglecting them within a sectoral policy runs the risk of significant side-effects on other sectors and thus of counteracting positive developments (Brandi et al. 2013, p. 2). Originally, the nexus served to address concerns in developing countries. At the Bonn Nexus Conference the nexus was mainly intended as a concept of development policy addressing basic human needs, such as the supply with safe drinking water, enough food, and reliable energy (Hoff 2011, p. 7). It was thus developed as a normative concept (Leese and Meisch 2015, p. 695) and a practical approach for project-based development cooperation. Developing countries face severe challenges to a safe supply with these resources and should thus, first and foremost, focus on universal access as well as a more sustainable and fair use of these resources. However, over time the nexus concept has also become a relevant approach to address many issues also industrialized countries are confronted with, such as a higher global demand for natural resources or the impacts of climate change. Obviously, in industrialized countries these problems differ in scope but they are equally important to solve. Resource challenges in industrialized countries often involve questions of sustainable production and consumption (Brandi et al. 2013, p. 4).

In current nexus research, basically, three different lines of argumentation can be identified explaining its emergence: (1) growing global concerns on the issue of sustainable development, (2) energy and food crises in recent years, and (3) the failure of earlier concepts of integrated resources management (Al-Saidi and Elagib 2017, p. 1132).

Firstly, many scholars locate the emergence of the nexus within the history of international conferences dealing with the issues of sustainable development, environmental protection, and a secure supply of basic resources, such as water, food, and energy. The Bonn2011 Conference thus stands in line with a number of different conferences, usually starting with

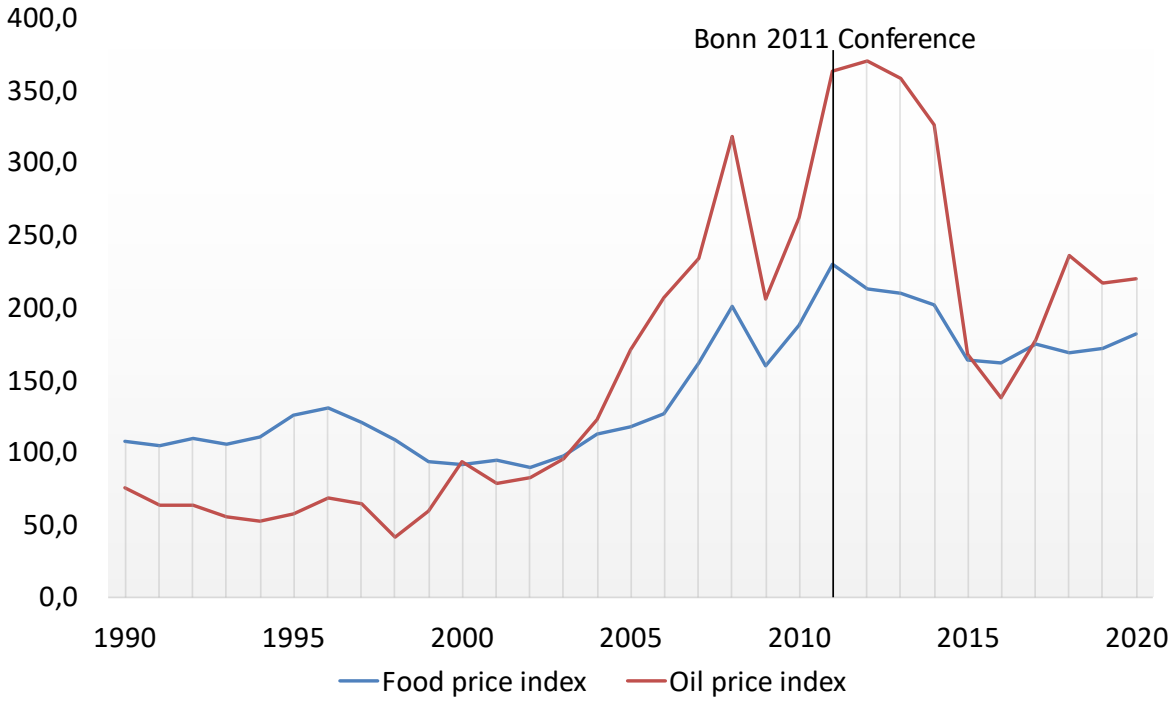
the United Nations Conference on the Human Environment in Stockholm in 1972 (Muller 2015, p. 676). One outcome of this conference was the foundation of the United Nations Environment Programme (UNEP). At that time, for the first time a special focus was put onto global water issues, noticeable, for example, by the UN Water Conference in Mar del Plata, Argentina, in 1977. This conference can be seen as one central stepstone in the development of the nexus. It resulted in an Action Plan that respected and accounted for interlinkages between water and related fields, especially in the case of water needs for agriculture (Muller 2015, pp. 676–677). Ten years later the Brundtland-Report was published. It not only gained a lot of attention in the global north, but also shaped today's idea of sustainable development. In its report, the Brundtland Commission called for an international conference, which was realized in 1992 by the UN Conference on Environment and Development (or Earth Summit) in Rio de Janeiro (Muller 2015, p. 678). Together with the inauguration of the World Commission on Environment and Development and the Intergovernmental Panel on Climate Change (IPCC) the Rio Conference represents the push that environmental concerns received on the international agenda at that time. The Earth Summit is considered as the most important conference on the issue of sustainable development simultaneously addressing the social, environmental, economic, and political dimension. The final agreement, the so-called Agenda 21, also contained a chapter dedicated to water issues, which includes four principles that had been adopted in Dublin one year before. Those Dublin principles emphasized the vulnerability and the economic value of water and called for a participatory management approach while highlighting the role of women (Dodds and Bartram 2016, pp. 8–10). These principles gave rise to the development of the conceptual approach of Integrated Water Resources Management (IWRM), which is seen as one of the predecessors of the nexus concept (Al-Saidi and Elagib 2017, p. 1133). The role IWRM plays for the nexus is described in further detail later in this section. However, the Dublin Principles, in particular, promoted the case of water on the international agenda. The next important step in the history of the nexus can be seen in the adoption of the MDGs in 2001, which included a goal on food and ecological sustainability.

Additionally, during the first decade of the new century the issue of renewable energy sources further emerged on the international agenda, visible, for example, in the establishment of the UN department for Energy in 2004, the Bonn Renewable Energy Conference in the same year, and the foundation of the International Renewable Energy Agency in 2009. Taken together, these developments hint to the fact that the most common nexus sectors, i. e. water, energy, and food, globally gained more and more attention over time. However, they were still mostly treated as separate from each other. Even if some of the more apparent links had already been considered before the emergence of the nexus concept, such as cooling water demands of power plants or energy demand for water purification, these issues were not systematically addressed by integrated solutions on the international policy agenda (Dodds and Bartram 2016, pp. 15–20). This changed through the preparation and adoption of the UN Agenda 2030 and its SDGs in 2015. 20 years after the first Earth Summit, the UN Conference on Sustainable Development (or Rio +20 Summit) was planned for 2012 again in Rio de Janeiro to coordinate global action and pave the way for the SDGs (Harwood 2018, p. 79). Also, the Bonn2011 Conference, organized by the German Government, was held in preparation for the Rio +20 Summit. The conference's main findings were brought into the SDGs process as the official German contribution (The Water, Energy & Food Security Platform 2019). In the final document of the Rio +20 Summit the fields of energy, land and water were emphasized as areas of priority for the SDGs (Brandi et al. 2013, p. 1). This differs from the former MDGs that neither explicitly addressed the field of energy nor land (Brandi et al. 2013, p. 2). In contrast, each nexus policy field is now specifically addressed in the SDGs. The nexus directly links to SDG 2 "zero hunger", SDG 6 "clean water and sanitation", and SDG 7 "clean and affordable energy." By highlighting the role of interrelations and synergies between these policy fields, the nexus further relates to the achievement of a number of other goals, such as "climate action" (SDG 13) or "life on land" (SDG 15) (Rodriguez et al. 2015, p. 83). Additionally, the SDGs especially highlight the need to reach these goals in a holistic and integrated manner. In its first section the Agenda 2030 states: "The interlinkages and integrated nature of the Sustainable

Development Goals are of crucial importance in ensuring that the purpose of the new Agenda is realized" (United Nations 2015b, p. 2). This reflects the objective of achieving the goals as a whole and not to reach one goal at the expense of the others. This necessitates an approach that takes interrelations or possible side-effects into account (Allen et al. 2018, p. 1454). The Agenda calls for integrated solutions in facing the challenges that are covered by the SDGs. Thus, the SDGs incorporate the basic idea of the nexus and implicitly call for a nexus perspective on implementation (Nilsson et al. 2016, p. 320). In this line of argumentation, the nexus concept can be seen as the outcome of a learning curve in global policy-making on sustainable development.

The second line of argumentation explains the emergence of the nexus from a more economic point of view and sees its development mainly resulting from the crises of global food and energy prices in 2007/2008 and 2011 (Al-Saidi and Elagib 2017, p. 1133). Figure 2 shows the development of global food and crude oil price indices between 1990 and 2020. Looking at the price trends it becomes apparent that energy and food prices are interdependent since 2003 reaching a first peak in 2008 and a second one in 2011.

Figure 2: Development of global food and oil price indices between 1990 and 2020



Source: own Figure, based on (statista 2020; FAO 2020), years 2002-2004 = 100.

Between 2008 and 2011 especially the World Economic Forum shaped the discussion on the nexus concept. At its annual summit in Davos in 2008 Indra Nooyi, Chairman and CEO of PepsiCo, stated that "Water sits at the nexus of so many global issues […]" (World Economic Forum 2009, p. 17) and was thus one of the first to speak of the emerging nexus concept. In 2011, the World Economic Forum (2011b) also published the book "Water Security: The Water-Food-Energy-Climate Nexus" in order to bring together different perspectives on the global water challenge. Additionally, in its 2011 Global Risk Report the World Economic Forum selected the water-food-energy nexus as one of the three major global risks (World Economic Forum 2011a). The Bonn2011 Conference took place against the background of the nexus activities by the World Economic Forum and can directly be related to the food and energy price crisis in 2011. Hence, seeing the nexus emerging from an economic point of view seems reasonable as well (Terrapon-Pfaff et al. 2018, p. 410).

In fact, these activities in 2008 and 2011 were the first ones that formally spoke of the nexus among the three fields of water, energy, and food – sometimes complemented by the climate sector (Scott et al. 2015, p. 18). References of sub-nexuses, such as e.g. the food-energy nexus, can already be found in programs of the United Nations University in the early 1980s (Al-Saidi and Elagib 2017, p. 1132). Also, the Food and Agriculture Organization of the United Nations (FAO) published a report on the energy and agriculture nexus in 2000 (FAO 2000). However, the emergence of the nexus concept in policy, practice, and research did not begin until the activities of the World Economic Forum and the Bonn2011 Conference (Gain et al. 2015, p. 896). Referring to the World Economic Forum (2011b) and Hoff (2011) the nexus, from the beginning, was and often still is mostly water-centered. This is based on the assumption that water often is not defined as a separate topic, but as a cross-cutting issue important for the other policy fields. Leading to the realization that water concerns need to be considered in the management of the other natural resources (Gupta et al. 2013, pp. 576–577). Rodriguez et al. (2015, p. 27) argue that water is the basis for and the link between all other sectors. Hence, even if the nexus concept claims equal importance among the different resources, water is given a special role (Beck and Villarroel Walker 2013, p. 632). The main argument behind this assumption is the notion that water scarcity is the reason for competing interests in the energy and agricultural sector. Increasing demands for food, changing patterns of nutrition, and increasing biofuel production all stress water resources. Thus, water is seen as the main link between energy and food (Perrone and Hornberger 2014, pp. 52–53). However, due to this water-centrism the nexus debate, for a long time, did not really find its way into the fields of food and energy (Al-Saidi and Elagib 2017, p. 1136). Against this background, the third argument for the emergence of the nexus can be explained. A significant number of scholars argue that the nexus developed because existing concepts of integrated resources management failed (Al-Saidi and Elagib 2017, p. 1133). Especially in light of the impacts of climate change integrated management approaches became increasingly important within the last decade (Pahl-Wostl et al. 2013). However, according to Al-Saidi and Elagib many existing

approaches “failed due to over-idealization as final remedies for integration” (2017, p. 1137). The most prominent example is IWRM (Al-Saidi and Elagib 2017, p. 1133). Within the above-mentioned Dublin principles – that underlie IWRM – water was seen as an economic good, an assumption that was highly contested at that time (Savenije and van der Zaag 2008, p. 296). IWRM was mainly conceptualized by the Global Water Partnership founded in 1996 (Roidt and Avellán 2019, p. 610). One key problem of this concept can be seen in the fact that many issues concerning water management have to be tackled on the local or regional level on which the international Dublin principles had only little influence. For least developed countries in Africa or Asia, however, it was of high relevance since it set a standard for donations regarding international development cooperation. Even if these countries felt the impacts of IWRM the most, they barely played a role in international policy-making (Muller 2015, pp. 680–682). In Europe, the principles of IWRM were implemented in the form of the Water Framework Directive (WFD) (Faby et al. 2005, p. 307). This, however, happened without any specific reference to IWRM. Furthermore, the WFD directly opposed the assumption of water being an economic good (Muller 2015, p. 682). Eventually, the concept of IWRM failed to be implemented properly (Gain et al. 2015). Thus, the most important point of reference is the question if the nexus is a more promising concept for implementation (Kurian 2017, p. 98).

Against the background of the three different lines of argumentation about the emergence of the nexus the question is raised what added value the nexus concept has in the area of resources management. One could argue that the main idea behind the nexus, namely that interconnections between natural resources exist, which need to be taken into account, is not new at all. As mentioned above, already before the nexus officially emerged in 2011, research existed using the term nexus in this context (FAO 2000; Lofman et al. 2002). Additionally, other concepts for integrated resources management already existed without using the term nexus, such as IWRM or land-use planning (Cai et al. 2018a; Fürst et al. 2013). However, those approaches were mostly sector-driven. The novelty of the nexus is its emphasis on the interrelations between the sectors rather than on a specific sector itself

(Stein et al. 2014). Hence, it constitutes a new paradigm in environmental policy. The nexus can thus also be seen as a new impulse on old issues; a new brand for tackling problems of separate management paradigms (Al-Saidi and Elagib 2017, p. 1137). It is thus seen as a promising new driving force to move onto sustainable development pathways by reducing trade-offs and increasing synergy effects (Hoff 2011, p. 5). Whether the nexus also has practical added value and can actually lead to improved resources management depends on its application and implementation. Since the nexus originally has not been developed in academia, but emerged from economic considerations and global resource issues, no common conceptual approach exists. Still, a number of pilot projects could already be realized. The nexus concept has thus shown its strength in realizing small-scale projects on a local level. One weakness, however, is that the nexus has rarely found its way into practical policy-making and administration yet (Simpson and Jewitt 2019, p. 121) This, however, is assumed to be important to prevent the nexus from only being used as a buzzword without considerable results, as is often argued for previous concepts like IWRM (Stein et al. 2014). In fact, Cairns and Krzywoszynska (2016, p. 169) argued that the term 'nexus' has become a buzzword and they warned against using the nexus as an apolitical concept. Since no universally agreed definition of the nexus concept exists (Venghaus et al. 2019, p. 4), in the following section 2.2 firstly, a working definition of the nexus for academic purposes will be derived. This definition will be used to properly conceptualize the nexus concept in section 2.3. Deriving a well-grounded argumentative conceptual approach for the nexus is one of the main contributions of this thesis and is necessary to develop an integrated value-based nexus governance framework in sections 3 to 5.

2.2. Defining the nexus as an academic concept

As mentioned above the nexus was developed as a management concept that has found its way into scientific research. For that reason, nexus research is spread over a wide range of different disciplines and research methods. In contrast to concepts deriving from certain academic disciplines, such as, for example, Environmental Policy Integration (EPI), the nexus

is not bound to a specific theory, method or practice. As already described in section 1.2 many different streams of nexus research emerged in the last years focusing either on technical, environmental, economic, or social aspects. The nexus can be seen as a transdisciplinary research issue that invites researchers from practically every academic discipline. In general, nexus research aims at the identification of new issues and challenges that are not visible by sectoral approaches (Howells et al. 2013, p. 625). Nevertheless, it is often not clear what purpose the nexus follows, or what the overarching goals or guiding principles are (Weitz et al. 2017, p. 166). Because of this broad variety of perspectives on the nexus and the fact that it still is a rather young concept, many different definitions of the nexus exist as well as various ways to approach this concept. The background paper of Hoff (2011) and his definition mentioned above is still used as basic literature and often serves as a starting point (e.g. Albrecht et al. 2018; Benites-Lazaro et al. 2020; Mercure et al. 2019; van den Heuvel et al. 2020). Hoff's definition describes the basic idea of the nexus well but it does not define how to use the nexus in academic research. In order to derive a working definition of the nexus that suits the purpose of this thesis, the first step is to bring light into the jungle of different streams of literature. Against the background of a comprehensive literature review on nexus publications a broad categorization of the different literature streams was developed including the following categories: sector combination, application, analytical perspective and methods. Table 2 provides an overview of the different categories and their specifications and shows the broad variations in this specific field of study. The different categories will be explained in the following paragraphs.

Table 2: Categorization of nexus research

Categories	**Specifications**						
Sector combinations	Water	Energy	Agriculture/ Land/ Food	Climate	Ecosystem/ Environment	Development policy	Security
Application	Regional application		Project application		Sectoral application		Theory application
Analytical perspective and methods	<u>Techno-economic dimension</u>			<u>Political and socio-economic dimension</u>			
	Modeling approaches	Scenario development		Policy analysis	Resources management	Stakeholder analysis	
	Quantitative			Mostly qualitative			

Source: own Table.

Sector combinations

The nexus varies broadly in the combination of sectors. With regard to its emergence the water-energy-food nexus seems to be the original one (e. g. Endo et al. 2020; Larkin et al. 2020; Yu et al. 2020; Simpson and Jewitt 2019). It is, however, only one of many possible and used sector combinations. Concerning the field of natural resources, the sectors addressed the most are: water, energy, land, food, agriculture, climate, and ecological system. They are often combined with a development and security dimension (e.g. Amorim et al. 2018; Endo and Oh 2018; Zhang and Vesselinov 2017; Mahlknecht et al. 2020). Also, many studies on sub-nexuses emerged, such as the water-energy nexus, which proved to be the most frequent sector combination (e.g. Abegaz et al. 2018; Chen et al. 2018; Salehi et al. 2020; Wang et al. 2019; Ahmad et al. 2020). Also, the food-energy nexus (e. g. Cuberos Balda and Kawajiri 2020; Schwoerer et al. 2020) and the food-water nexus (Gephart et al. 2017; Mrozik et al. 2019; Li et al. 2021) are addressed. Most nexus analyses start by appointing two or more sectors that shall be in focus and by defining a geographical or socio-cultural context (Villamayor-Tomas et al. 2015, p. 736). This hints to the fact that the most important aspect of the nexus is its main idea about the interconnections among different sectors. Considered that way, it is not of great importance, which sectors are included.

Application

In addition to the varying sector combinations, nexus research also differs in the area of application. Many articles focus on case studies in specific regions (e.g. Saladini et al. 2018; Wang et al. 2018; Rodriguez et al. 2018; Cuberos Balda and Kawajiri 2020) or river-basins (e.g. Amjath-Babu et al. 2019; Yang et al. 2016; Hennig 2016; Chen et al. 2019). Others apply the nexus to a sector-specific problem from a nexus perspective, such as water supply or electricity production (e.g. Vakilifard et al. 2018; Jin et al. 2019; Price et al. 2018; Lechón et al. 2018). This stream of literature well represents the origins of the nexus as a practical approach stemming from economy and development cooperation.

Analytical perspective and methods

Another broad differentiation can be made between nexus research from a rather technical or techno-economic perspective and from a rather political or socio-economic perspective. Depending on the respective research focus and the academic background, methods vary from mere quantitative analyses, such as modelling approaches (e.g. Amjath-Babu et al. 2019; Brouwer et al. 2018; Gonzalez-Salazar et al. 2016; Khan et al. 2018), to qualitative analyses, such as policy analyses (e.g. Portney et al. 2017; Mercure et al. 2019; Pahl-Wostl 2019; Venghaus et al. 2019). The former stream of research mostly aims at the analyses of physical resource flows and interconnections as well as the development of scenarios. Socio-economic approaches, in contrast, focus on the analysis and assessment of policies, policy implications, policy implementation, and the management of natural resources. They often emphasize the participation of stakeholders and point to the people dimension within the nexus (e.g. Larkin et al. 2020; Hoolohan et al. 2019; Ghodsvali et al. 2019). Some articles also apply the nexus in a mere conceptual manner. This stream on nexus research, so far, addresses conceptual and theory-driven aspects of nexus management or governance. It attempts to derive a well-grounded definition of the nexus. In 2016, Al-Saidi and Elagib stated: “Nexus governance is the missing link in the nexus debate” (2017, p. 1137). Since this statement has been made research on nexus governance further increased (e.g. White et al. 2017; Pahl-Wostl 2019; Artioli et al. 2017; Märker et al. 2018; Urbinatti et al. 2020; Weitz et al. 2017). However, Simpson and Jewitt find “that much of the literature appertaining to the WEF nexus to date is apolitical and technical in nature” (2019, p. 121). For this reason, there is still a need for more qualitative assessment of political systems and power structures in order to actually implement a better nexus governance (Simpson and Jewitt 2019, p. 121). The present study complements this stream of literature by providing a nexus definition and conceptualization that serves as a basis for developing an integrated governance framework. In this study, the nexus is seen as a basic analytical concept that needs to be defined context-specifically. This working definition provides the basis for any further analysis conducted within this study. Thus, the focus is set on the basic idea behind

the nexus, an emphasis on resource interconnections that shifts from a single-sector to a multi-sector perspective. Hence, the nexus concept is not bound by any combination of sectors or policy fields. It rather depends on the context of application. Thus, the nexus concept alone does not offer any analytical tools or instruments but provides the frame in which an analysis is conducted (Simpson and Jewitt 2019, p. 117). Hence, the nexus concept needs to be operationalized by other concepts and methods from the social sciences. The next section, therefore, provides a clear conceptualization of the nexus as a concept of systems thinking (section 2.3). By means of this concept the holistic perspective of the nexus can be examined in greater detail. It helps to understand what defines a system and what parts it consists of. The nexus concept sets the focus on resource interrelations and calls for a more comprehensive and holistic perspective. However, it does not define the system's components. Defining the nexus as a concept of systems thinking sets the basis for the operationalization in sections 3 to 5.

2.3. The nexus as a concept of systems thinking

Regarding the varieties within nexus research mentioned above, the question is raised: How can the nexus concept be operationalized in a way that allows for a practical approach in governance research? According to Hoff (2011, p. 40) systems thinking is required for the challenges regarding food, energy, and water management and for supporting the nexus idea. By emphasizing the interconnections between the different natural resources, the nexus – by its core – calls for a systems perspective. Furthermore, the fact that the nexus addresses several policy fields, their interrelations as well as social, political and ecological aspects makes the related challenges very complex. The concept of systems thinking provides an approach to structurally address this complexity (Alcamo 2015, p. 3). It is thus well-suited for the nexus and has been repeatedly used in nexus research (e. g. Terrapon-Pfaff et al. 2018; Laspidou et al. 2020; Zhang et al. 2021). However, most of these research articles use techno-economic approaches, such as modeling or simulation, for their analyses. Still, systems thinking offers a clear definition of a system and its components that is also very useful for the institutional analysis conducted in this study. One of the most

established definition on systems thinking was developed by Donella Meadows: “A system is an interconnected set of elements that is coherently organized in a way that achieves something” (Meadows 2009, p. 11). According to Meadows, the system’s behavior results from the interactions between its various elements, possibly leading to unexpected outcomes and non-linear developments. To emphasize the need for a holistic perspective, Newell et al. (2011, p. 2) state that the performance of a system cannot be improved if the subsystems are optimized separately. Analyses of each of the system’s components or policy fields can offer valuable insights on specific issues. However, in order to avoid or understand unintended side-effects, interactions between the system’s elements need to be taken into account (Newell et al. 2011, p. 2). According to Meadows, a system consists of three central things: (1) elements, (2) interconnections, and (3) a function or purpose, which are organized together to achieve something over time (4 behavior over time). She explains her system concept by using a sports metaphor:

> “A football team is a system with elements such as players, coach, field, and ball. Its interconnections are the rules of the game, the coach’s strategy, the players’ communications, and the laws of physics that govern the motions of ball and players. The purpose of the team is to win games, or have fun, or get exercise, or make millions of dollars, or all of the above” (Meadows 2009, p. 11).

In order to systematically analyze the four components of a system Donella Meadows developed four steps (Meadows 2009, p. 13):

1. Identification of the elements of the systems,
2. Identification of interconnections and relationships between these elements,
3. Characterization of the resulting effects of these interconnections,
4. Characterization of the system’s behavior over time.[3]

[3] The following paragraph is based on Meadows 2009.

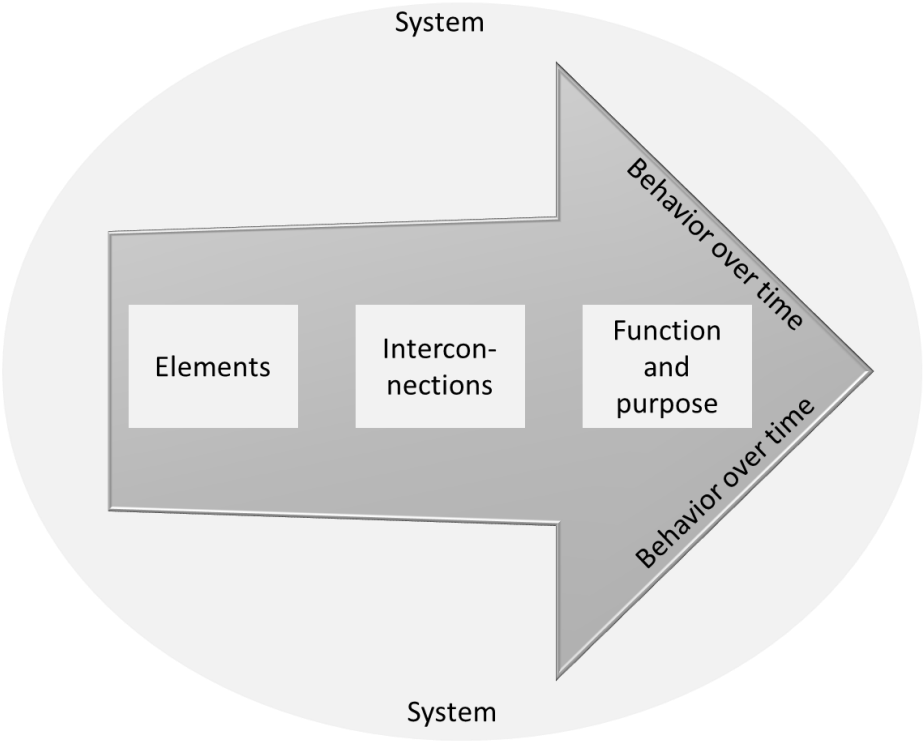
For a systems perspective, in fact, each of the four categories is important. However, changes in those categories have different effects on the system's performance. The first category (step 1) refers to the single components that form the system. Changes in this category are assumed to have the least effect. Even if all players are changed, they still remain a football team (Meadows 2009, p. 16). The interconnections (step 2) describe physical flows (water, energy) or flows of information between the elements (Meadows 2009, p. 14). In case of the nexus, this category foremost refers to the interconnections between the respective policy fields. Every system pursues a certain function and purpose (step 3), that only results from the system's performance as a whole. It is defined by the complex interplay of its components. According to Meadows, the function or purpose is not determined by its goal but rather its behavior, which basically always aims first and foremost at persisting (Meadows 2009, p. 15). The temporal development of the system is captured by the category of behavior over time (step 4). It includes historical conditions, future scenarios, or stock changes whereas the latter refers to changes in the behavior of all elements under varying circumstances (Meadows 2009, pp. 17–19). Donella Meadows emphasizes this last aspect of the system's time horizon and thus adds a temporal dimension to the earlier definition of systems by Barry Richmond (1994). Using systems thinking literature helps to delineate the nexus and to set the systems boundaries by referring to the four categories of function and purpose, elements, interconnections, and behavior over time.

But what kind of system is the most suitable for nexus research? What elements need to be included? According to Dyball et al. (2005, p. 41) all problems concerning environmental management are connected to society. Thus, the ecological and social systems need to be considered in a holistic perspective (Harwood 2018, p. 80) in order to capture and understand the system's dynamics and changes (Newell et al. 2011, p. 3). Therefore, to further specify the type of system that mostly applies to the nexus it is seen as a socio-ecological system (SES) (Norouzi and Kalantari 2020, p. 73). SES are characterized by the interdependence between the socio-economic and environmental or ecological system,

mostly in the form of the use of natural resources (Anderies et al. 2004). Anderies et al. (2004, p. 3) describe an SES as “an ecological system intricately linked with and affected by one or more social systems.” SES are defined as complex adaptive systems in which all system components interact in various ways influencing each other. Those systems are non-linear, interdependent systems that are capable of adapting to environmental changes (Pahl-Wostl 2009, p. 357). Consequently, an SES can never fully be controlled or designed. They are characterized by high uncertainty, a high level of self-organization, and a small number of designed elements (Anderies et al. 2004, p. 2). However, the complexity of SES makes it both necessary and at the same time extremely challenging to take a system perspective (Newell et al. 2011, p. 1). Against this background, the working definition of the nexus concept developed in section 2.2 is extended:

The nexus concept forms a superior analytical concept for the analysis of SES that needs to be defined context-specifically. It refers to SES as systems characterized by a function or purpose, their elements and interconnections over time.

Figure 3: Systems perspective of the nexus



Source: own Figure, based on (Schlör et al. 2020, p. 4).

The conceptualization of the nexus concept by systems thinking and its more specific definition as an SES was necessary to clearly identify the object of investigation. It can now be operationalized for any other analysis. Since this study aims at developing an integrated framework for the analysis of nexus governance, in the next section, first, the basic analytical framework is introduced.

2.4. Section summary

Section 2 provided background on the nexus concept. In the first step, the emergence of the nexus on the international level was described before it was examined as an academic concept. In the last step, the nexus was properly conceptualized by using literature on systems thinking and SES for the purpose of operationalizing the nexus for the analysis conducted in this study.

Usually, the Bonn 2011 Conference is seen as the point of origin of the nexus concept. In the conference's background paper, the nexus is described as a new approach that aims at improving water, energy, and food security by explicitly highlighting resource interrelations in order to use synergies and avoid conflicts of interests. The concept thus addresses the problem that the management of these resources, so far, is mostly organized separately. The 2011 conference especially focused on the situation in developing countries and was organized in the context of German development cooperation. Basically, three different lines of argumentation for the emergence of the nexus concept exist. The first one puts it in the context of international conferences on sustainable development starting with the UN Conference on the Human Environment in 1972, the Earth Summit in 1992, and the adoption of the SDGs in 2015. In fact, the Bonn2011 Conference was held in preparation for the Rio +20 Summit 2012 in Rio de Janeiro, which also initiated the SDG process. Eventually, the SDGs incorporated the holistic perspective of the nexus, which is why the nexus can be seen as the outcome of a learning curve in global sustainable development policy. The second line of argumentation describes the nexus as a result of the global oil and food price shocks of 2007/2008 and 2011 (cf. Figure 2). During this time, especially the World Economic Forum focused on the water-energy-food nexus calling it one of the three major global risks in 2011. This shows that the economic dimension is important as well for the emergence of the nexus. The third line of argumentation locates the nexus in the context of integrated management approaches, especially IWRM. Against this background the water-centrism in the early days of the nexus concept can be explained. The nexus is considered as a further development of IWRM, which mainly lacked a proper implementation. Therefore, the nexus can be seen as a new impulse or brand for persistent problems in resources management. However, in order to address these issues by using the nexus it, first and foremost, needs to be properly defined for a scientific analysis since no universal definition for the nexus exists.

Originating from policy and practice the nexus soon also found its way into science and academia. Mainly since 2011 nexus research is steeply increasing and is spread over a broad

variety of disciplines and methodological approaches. The vast number of nexus related articles and the inconsistency with which the nexus is used, at first, necessitate a broad categorization of this research field. By categorizing nexus research lines of differentiation, for example, can be drawn along the following three categories: sector combinations, application, and analytical perspective and methods. When differentiating between sector combinations, the water-energy nexus has become the most prominent one by now, followed by the water-energy-food nexus. Besides, many other sector combinations exist including, for example, climate, environment, or carbon. What they all have in common is the basic idea that interrelations between different resources exist that need to be taken into account. This, however, also means that the actual sector combination might, in fact, be important for the specific research question but is of less importance for a common understanding of the nexus concept. With regard to application the nexus is either practically applied to a specific case study or – although less frequently – as a conceptual approach for management and governance. In the early days of nexus research, the regional focus was mostly set on developing countries, Asia, or Africa. By now, many studies also address nexus issues in industrialized countries.

With regard to the analytical perspective and methods related research articles can be divided into techno-economic or socio-economic analyses. Whereas the first ones mostly use quantitative methods, modeling approaches or scenario development, the latter rather apply qualitative methods, policy or stakeholder analysis. The weakest stream of nexus research focuses on a more conceptual perspective and addresses the questions what successful nexus governance generally means and how it could look like. This thesis can be assigned to this stream of literature and aims at answering these questions. Here, the nexus is understood as a basic analytical concept that needs to be defined context-specifically. The focus is thus set on the basic idea behind the nexus emphasizing resource interrelations. Still, in order to be able to conduct an analysis the nexus needs to be properly conceptualized and operationalized. Doing so is one of the main contributions of this thesis.

In order to clearly conceptualize the nexus literature on systems thinking and SES is used. Since the nexus emphasizes an interconnected and holistic perspective a system understanding seems to be highly appropriate. In this thesis the definition of Donella Meadows is used who describes a system by four categories: a number of elements (1) that interact with each other (2) in order to serve a certain purpose (3) and evolve over time (4). The nexus can be well conceptualized by this systems definition. It helps setting the system's boundaries and defining relevant aspects. For this analysis, the nexus, more specifically, is understood as an SES. SES are defined as complex interacting systems that cannot be understood by focusing on separate elements. Therefore, taking a systems perspective is, in fact, challenging but absolutely necessary in order to be able to analyze nexus governance. Against the background of this system conceptualization the integrated value-based analytical framework can be developed.

3. Basic analytical framework

In this section the basic analytical framework for analyzing nexus governance challenges is developed. It builds on the IAD framework of Elinor Ostrom and colleagues. Its aims and elements are described in the following subsection (section 3.1). Afterwards, the framework is extended by the concept of social learning in order to capture processes of institutional change (section 3.2).

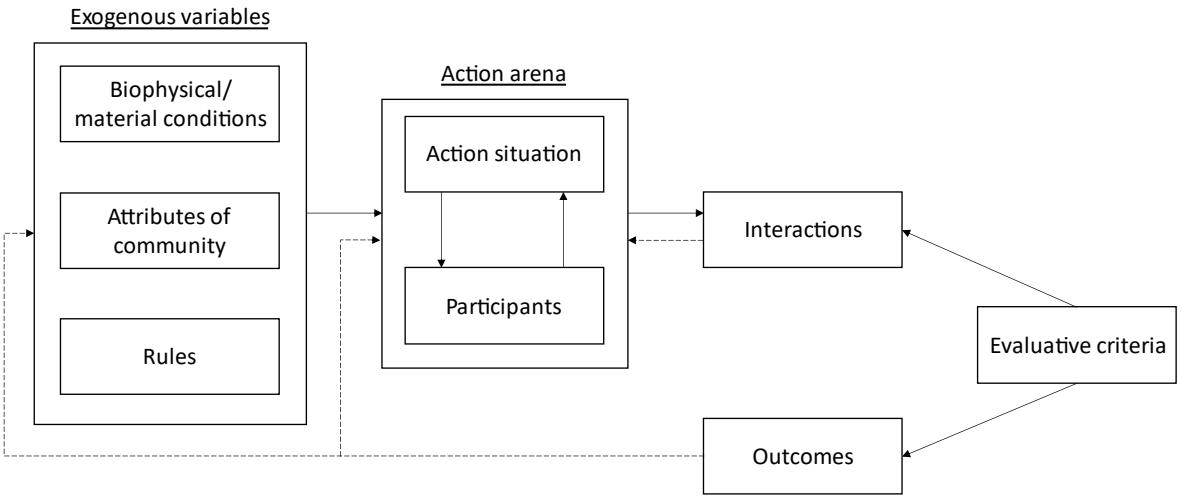
3.1. Institutional Analysis and Development framework

3.1.1. Idea and aim of the framework

Governance can be defined as the interplay of actors and institutions as well as structures and processes (Benz and Dose 2010b, p. 27). Thus, to be able to analyze nexus governance a framework is needed that sets the focus on these aspects. Furthermore, it should be applicable for the analysis of complex SES. For this reason, the Institutional Analysis and Development (IAD) framework is used. It was developed by Nobel laureate Elinor Ostrom and colleagues in order to analyze the role of institutions in collective choice processes (Ostrom 2005, p. 829). The IAD framework is one of the most established frameworks in institutional analysis. The main objective for its development was to help solve problems related to the management of 'common pool resources', such as water, forests, or fisheries (Heikkila and Andersson 2018, p. 310). In general, it can be applied to any kind of social interaction, such as markets, firms, families, or political settings, and to any level of social choice, such as constitutional, policy, or operational (Cole 2017, p. 831). Another feature that makes the IAD framework suitable for nexus research is that it pursues a systems perspective and can be applied well to complex SES (Pahl-Wostl et al. 2010, p. 574). The framework helps to identify system elements important for institutional analysis and their interrelations. This allows revealing critical aspects that need to be considered in the analysis (Ostrom 2011, pp. 7–8). In the last 30 years the IAD framework has been used by a broad variety of scholars to tackle complex political and social issues, for example within single nexus policy fields (e.g. Nigussie et al. 2018; Heikkila 2017; Iychettira et al. 2017).

Since its first development in the 1980s the framework continuously evolved and was modified over time (Cole 2017, p. 830). The IAD framework basically divides systems into three parts: (1) the exogenous variables, (2) the action arena including the action situation and the participants, and (3) the resulting interaction patterns, outcomes, and their assessment (cf. Figure 4).

Figure 4: IAD framework



Source: own Figure, based on (Ostrom 2005, p. 829).

Any analysis starts with the identification of an action situation (Heikkila and Andersson 2018, p. 312). An action situation is defined as the social space in which different actors interact and produce an outcome, which is then evaluated by specific criteria (Ostrom 2011, p. 10). This situation is embedded in a certain socio-economic and ecological context. The individual elements are described in further detail in the next section. The basic assumption within this framework is that human actors can make individual or collective choices that have an influence on the potential outcome. However, these actors act within the context of a biophysical, social, and institutional setting that influences their behavior (McGinnis and Ostrom 2014, pp. 1–2). According to its name the IAD framework sets its focus on the study of institutions. In her definition of institutions, Elinor Ostrom follows Douglas North who stated that institutions are formal and informal rules that govern human behavior

(Ostrom 2005, p. 824). According to North (1991, p. 97) "*Institutions are the humanly devised constraints that structure political, economic and social interaction. They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights). Throughout history, institutions have been devised by human beings to create order and reduce uncertainty in exchange.*" Thus, institutions are the 'rules of the game' (North 1990, p. 3). This means that institutions provide an established frame for structured interaction and are thus important elements of SES. However, institutions do not always work in an efficient manner (Gagliardi 2008, p. 421). Whether these institutions are successful or unsuccessful in managing natural resources is also dependent on the complex interactions both among them as well as with other elements (Acheson 2006, p. 129). Following this definition of institutions, public policies concerning the nexus are nothing but legal rules managing the use of natural resources. In order to efficiently use these resources, those rules and processes need to be effective, enforceable, and adaptable to upcoming challenges (Acheson 2006, p. 118). These formal rules constitute the institutional setting of nexus governance and thus build the research focus of this study. Such an analysis, however, is challenging since the institutional setting is highly complex and interacts in a way that is not always predictable. Institutions, such as legal rules for example, influence each other and can therefore not be analyzed in isolation (Nilsson et al. 2012, p. 398). The IAD framework is a means to capture this complexity and to have a modus operandi for analysis (Heikkila and Andersson 2018, p. 309). The IAD framework presents a suitable framework for analyzing nexus governance since it especially focuses on the political and institutional dimension of resource management problems (Petty et al. 2015, p. 2).

Literature on the IAD framework mainly focuses on three different types of application: (1) as an approach for self-governance, (2) as an analytical lens, and (3) as a means to gain insights into institutional settings. Since the latter is not relevant to this analysis it will not be described in further detail. Generally, it helps anticipating how a certain policy intervention might influence the incentives of different actors and actor groups (Heikkila

and Andersson 2018, p. 319). The first type of application, however, is especially important to the original work done by Ostrom concerning problems with common-pool resources. Ostrom defines actors as fallible learners, and as such they are able to solve problems by themselves through learning and adaptation. These applications address so-called collective action problems in smaller communities (Heikkila and Andersson 2018, p. 311). In this regard, the IAD framework fosters bottom-up approaches. The insights that the IAD framework offers for self-governance also apply to many formal governance issues of public attention (Heikkila and Andersson 2018, p. 317). The second type of application is of special importance to this work and somewhat related to the first one. An efficient use of the natural resources that are related to the nexus concept and thus the guiding principle of sustainable development constitute public goods. These public goods are regulated by legal rules, such as laws. The provision of these goods creates central collective action problems (Pierson 2000, pp. 257–259). The aim of this study is not solving these problems by self-governance as mentioned above but to analyze them in a way that tackles their complexity. The framework offers a generic approach to analyze nexus-relevant policy processes in a structured way and helps understanding when and under which conditions important political decisions are made by whom. It facilitates reducing the complexity by identifying key components of the system. In doing so, the IAD framework helps raising relevant questions concerning important variables by asking what the important actors are, what rules enable or constrain these actors, and how the material and societal conditions affect them. In this regard, the purpose of the IAD framework is indeed not to provide solutions or answers to the respective problem. The great benefit of the IAD framework is to concentrate the researcher's main focus on certain variables and system elements (Heikkila and Andersson 2018, pp. 312–317). The framework is supposed to be neutral to any theory, so that it constitutes a common tool for analysis that allows comparing different theoretical backgrounds (McGinnis and Ostrom 2014). It works as a conceptual map pointing out important elements that need to be analyzed. It aims at developing a common vocabulary that allows scientists from different social sciences and humanities to unify their thinking

about collective choice processes (Cole 2017, p. 833). This general but structured character makes the IAD framework a valuable tool for analyzing the role of institutions and actors within their context conditions. Since it is not bound to any specific theory or application is can be easily adapted to the nexus and the analysis of relevant institutions and actors of nexus governance.

3.1.2. Elements of the framework

In the following paragraphs the elements included in the IAD framework are described in greater detail (cf. Figure 4). Firstly, the three exogenous variables are introduced (left part), followed by the elements included in the action arena (middle part), and the remaining elements of outcomes and evaluative criteria (right part).

Biophysical/material conditions

The biophysical and material conditions in the IAD framework refer to the physical environment of an action situation. This part includes the actual physical natural resources, infrastructures, industries, and technologies. Also, human resources, labor, and capital belong to this system element (McGinnis 2011a, pp. 174–175).

Attributes of community

The attributes of community describe the societal conditions that shape an action situation. These are not only about size and hetero- or homogeneity of the community, but also about what norms or values are held important. This is an important element in order to characterize the participants of an action situation (McGinnis 2011a, pp. 175–176).

Rules

The rules describe the institutional setting. Ostrom states that social interaction is determined by different types of rules, which she characterizes by their function (Cole 2017, p. 834). She defines rules as “shared understandings among those involved that refer to enforced prescriptions about what actions […] are required, prohibited, or permitted” (Ostrom 2011, p. 17). Generally, rules can be divided into formal and informal rules.

Whereas formal rules describe actual laws and regulations, informal rules refer to unwritten but universally agreed norms of human behavior (Cole 2017, p. 835). In order to understand interactions between actors and their behavioral choices formal legal rules are critical (Cole 2017, p. 836). Since Ostrom mostly applied the IAD framework to collective action problems on the local level that can often be solved through a stronger self-governance, the relation between formal legal rules and working informal rules has not been explained in further detail (Cole 2017, p. 844). Referring to Pahl-Wostl (2009, p. 356) the notions of formal and informal relate to the way institutions are developed, codified, and enforced. She states that there is a need for well working formal institutions whose objectives match with informal institutions in a balanced way in order to be effective (Pahl-Wostl 2009, p. 363). According to Cole (2017, p. 845) a focus on the role of formal legal rules has been a research gap in IAD scholarship so far. This study contributes to filling this gap by focusing on nexus-related formal rules thus providing an example of application.

Action situation

The action situation is the focal point of the IAD framework. It describes the social spaces in which participants interact with each other and produce an outcome (Ostrom 2011, p. 11). An action situation can be located at any political level. Hence, the framework enables analyzing decision-making processes at different governance levels and how these processes influence the actors' behavior. It is also possible to analyze action situations at any stage of policy-making (Heikkila and Andersson 2018, p. 312). The defined action situation can vary from one specific situation at one point of time to a whole process over a period of time. This highly depends on the specific research issue and the chosen level of aggregation. The decision on what is to be defined as an action situation is thus highly case specific (McGinnis and Ostrom 2014, p. 3). As it will be shown in the case study in section 6 the consultation process for the new edition of the German sustainable development strategy in 2015-2016 is defined as one action situation since the temporal analysis on the federal level necessitates a high degree of aggregation (cf. section 6.3.1). Many analyses thus include a number of sequencing action situations that are interdependent. The

outcome of one action situation usually influences another one. Also, participants of more than one action situation can be a form of interconnection between them. Accordingly, networks of action situations can emerge (Villamayor-Tomas et al. 2015, p. 738). These networks demonstrate the polycentricity of complex SES and its various interconnections among decisions and processes (McGinnis 2011b, p. 51).

Participants and interactions

The term 'participants' refers to individual actors and actor groups representing an entity that are involved in an action situation. Thus, also organizations can take part in an action situation and are thus denoted as actors rather than institutions (Pahl-Wostl 2009, p. 356). According to Ostrom (2011, p. 13) participants are fallible learners that can make mistakes and are able to learn from them. This is a broader conceptualization of an actor than the well-established homo oeconomicus, which assumes a fully informed and rational actor that has clear preferences. In contrast, actors as fallible learners vary in how they value the benefits and costs of other persons and how committed they are to promises or reciprocity. The institutional setting sets the framing conditions and thus determines if and how actors learn. Thus, the actors' behavior is influenced by the three context variables (Ostrom 2011, pp. 12–14) and is characterized as being boundedly rational (McGinnis and Ostrom 2014, p. 2). Additionally, the IAD framework captures how the participants interact with each other. By the element of interactions Ostrom opens up the action situation looking at patterns of interaction and the actual negotiation process between the participants. This allows a small-scale analysis of one particular action situation (Ostrom 2011, p. 10). Since this study conducts a rather large-scale institutional analysis focusing on nexus governance on the national level the outcomes of the action situations are of greater importance than the interactions within them.

Outcomes

Outcomes can be any output of an action situation. Ostrom does not further define them since she rather focuses on the processes within an action situation. Pahl-Wostl et al. (2010,

p. 576), in contrast, offer a more detailed definition of outcomes by dividing them into the three different categories of (1) institutions, (2) knowledge, and (3) operational outcomes. Analyzing the outcomes of an action situation, in fact, can be seen as an analysis of the performance of the political system (Polski and Ostrom 2017, p. 25). Regarding the analysis of nexus governance, the focus is rather set on institutional outcomes of the action situations.

Evaluative criteria

Evaluative criteria are not only used to assess outcomes but also to assess the process that resulted in this outcome. Ostrom names a number of criteria, such as economic efficiency or redistributional equity. A criterion of special importance for the nexus concept can be seen in ecological sustainability which necessitates flexible and adaptive institutions (Ostrom 2011, pp. 15–17).

These are the basic components that need to be considered when using the IAD framework for an analysis (Nigussie et al. 2018, p. 2). As already mentioned above depending on the case study several action situations need to be analyzed. Furthermore, as explained in section 2.3 the function and purpose of a system can only be captured by watching its behavior over time. Systems are dynamic entities that change over time through a complex interplay of their components (Dyball et al. 2005, pp. 43–44). For this reason, a temporal dimension is critical in analyzing complex SES, such as the nexus. The IAD framework incorporates this dimension in the form of feedback loops, illustrated as dashed arrows in Figure 4. These loops proceed from the outcome to the exogenous variables and thus add a dynamic perspective to the framework (McGinnis and Ostrom 2014, p. 6). In this regard, the notion of exogenous variables is rather misleading. Because of these feedback loops the exogenous variables are, in fact, connected to the rest of the system and are thus no external factors. Thus, these elements can be described as the physical, social and institutional context an action situation is embedded in rather than external conditions (Cole 2017, p. 831). Even if these feedback loops are integrated in the IAD framework they

are not described in further detail. These feedback processes, however, are of major importance since they reflect processes of institutional change. These change processes are critical for analyzing nexus governance. Only by understanding these processes barriers and drivers of integration among the nexus policy fields can be identified. Therefore, in the next section a more detailed understanding of these processes is provided by using the concepts of path dependence and social learning. Whereas the first concept elaborates the dynamics of why and when institutional change might happen (cf. section 3.2.1), the latter characterizes different levels of learning in order to characterize the nature of changes (cf. section 3.2.2).

3.2. Institutional change defined as social learning

In order to adequately respond to current and upcoming challenges institutions need to be flexible and adaptive and thus need to enhance social and ecological resilience (Petty et al. 2015, p. 2). Especially with regard to the nexus, many scholars argue that existing institutions are too sectoral. They foster isolated policies rather than integrated ones, which would be necessary for an efficient management of natural resources. Thus, institutional change towards a more interconnected institutional setting among the nexus policy fields is needed (Weitz et al. 2017, p. 165). However, institutional research shows that institutions, once they are established, barely change (Romero-Lankao et al. 2017, p. 235). However, this notion needs to be further specified since in reality, institutions are subject to constant change. The question rather is in what way and how deeply they are able to change (Andrews-Speed 2016, p. 220). In order to understand if, how, when and in what way institutions change the concepts of path dependence and social learning are used. Path dependence, firstly, describes why structural change within institutions is hard to reach and under what circumstances it might happen. Social learning, on the other hand, offers a suitable definition for different kinds of institutional change processes and enables a more detailed assessment of the development of nexus-related institutions. Combining the IAD framework with social learning makes it more dynamic and process-oriented (Pahl-Wostl et al. 2013, p. 3).

3.2.1. Path dependence

Research suggests that institutions, if at all, usually can only slowly be modified and tend to develop along the same track. This characteristic is captured by the well-established concept of path dependence. A lot of research on this matter has been done by Paul Pierson in the 1990ies and beginning of the 2000s (e.g. Pierson 1996, 2000, 2004). More recent literature still mostly refers to Pierson in terms of this concept (e.g. Hake et al. 2015; Andrews-Speed 2016; Villamayor-Tomas et al. 2015). Pierson (2000, p. 251) characterizes path dependence mainly as increasing return processes or positive feedback. The focus is thus set on questions of what and when something happens. Pierson argues that the longer a certain path is followed the more probable it is to stick to this path since the costs of exit increase over time. Therefore, increasing returns are self-reinforcing (Pierson 2000, p. 252). Those self-reinforcing dynamics are especially important in analyses of collective action and institutional development. In order to understand when and why institutional change occurs the concept of increasing returns is crucial (Pierson 2000, p. 260). Additionally, the impact of any specific variable, such as a certain event, can only be assessed with regard to the temporal conditions. Hence, the timing of key events and processes defines the path that is followed (Pierson 2004, pp. 66–67). Referring to Pierson, Andrews-Speed (2016, p. 220) names three main characteristics of path dependence: first, changes in the systems cannot simply be undone. Secondly, the options for change become more and more limited the farther a path has been followed. Therefore, it is easier to use earlier opportunities of change. Thirdly, institutional change often follows an incremental manner. Additionally, institutional change can come with high transition costs and rigid structures concerning the distribution of power (Pahl-Wostl 2009, p. 362; Lenschow 2002, p. 27). In other words, even in a changing environment, institutions often persist and are resistant to structural change. The reason for this is twofold: First, institutions are designed to be persistent and resistant. They were created with the purpose of ensuring a stable frame (Andrews-Speed 2016, p. 217). In combination with other system elements, such as e.g. technical infrastructure and societal conditions, the institutional setting as a whole creates an interconnected

network that ensures the functioning of the system (Pahl-Wostl et al. 2013; Pahl-Wostl 2009, p. 355). Nevertheless, in case of a problem or inefficiency this makes it hard to identify, which element needs to be modified to enhance the system's performance (Pierson 2000, p. 260). This can lead to a lock-in position in which institutions persist even if an alternative exists that promises to be more efficient (Pierson 2000, p. 253). Thus, institutions can be both a barrier to change and resistant to change (Andrews-Speed 2016, p. 219). Institutional change is thus impeded by inertia or the costs that can occur if reforms are undertaken. Those costs are very important especially because of the short time horizons of political mandates (Lenschow 2002, p. 27). As mentioned above, institutions are highly interconnected and influence each other, fostering a path-dependent development. Because of this interdependent nature, institutional change often requires changes in more than one institution. Only if adjacent and interrelated institutions change as well, a new or deeply modified institution can become effective without causing negative and unpredicted effects (Andrews-Speed 2016, p. 220).

However, under certain conditions institutions can change profoundly. Mostly, those changes become possible through unpredicted effects, external events or shifts of political power. If a path is altered it usually results from a changed polity. Those moments, in which the options towards an alternative path occur and are used, are called 'critical junctures'. Critical junctures are needed to distinguish exogenous factors from endogenous increasing returns (Gagliardi 2008, pp. 422–423). Critical junctures mainly occur in times of higher instability or crisis, which offer so-called windows of opportunity that can be used for change. They can be visible, for example, in the form of strong public debates or protests (Hake et al. 2015, p. 533). If a major crisis occurs even a full replacement of established institutions can be possible. These processes normally last several years before a new set of institutions is created. The critical junctures can trigger a switch from one established path to an alternative path (Andrews-Speed 2016, p. 220). In order to understand what creates increasing return processes and thus factors of stability and change such turning or

branching points need to be investigated. They are important to analyze the dynamics in political systems (Pierson 2000, p. 262).

The concept of path dependence demonstrates why history matters in institutional analysis. In order to capture system dynamics and to understand why problems or inefficiencies in the institutional setting occur, a temporal dimension is necessary. Thus, in order to understand the role institutions play for complex systems, their historical development needs to be investigated (Petty et al. 2015, p. 8). Often, institutions are determined by the past, *"institutions are historically specific"* (Gagliardi 2008, p. 420). They evolved, were influenced by, or created under specific context conditions in the past which is especially interesting when speaking of institutional change (Gagliardi 2008, p. 420). Therefore, the timing is of high relevance (Pierson 2000, p. 251). Path dependence also depends on the decisions that were made in the past. All social actors decide and make commitments within the context of existing institutions and policies what strongly increases their transaction costs (Pierson 2000, p. 259). In addition, historically, only a small set of important stakeholders were included in governance decisions and allowed to formulate their ideas and values (Romero-Lankao et al. 2017, p. 235). This is especially important for the management of natural resources. A historical institutional analysis can identify those elements that are determined by path dependence and thereby impede processes towards sustainable development (Malekpour et al. 2015, p. 68). Considering path dependence can therefore offer an explanation of why some countries perform better than others (Gagliardi 2008, p. 422).

3.2.2. Social learning

The notion of path dependence explains why the historical dimension is critical. Furthermore, it states that profound changes in the institutional setting only occur under certain conditions, such as so-called critical junctures. The whole process of institutional and system development is captured by the notion of institutional change. As mentioned in section 3.1.1, the IAD framework recognizes dynamic processes by including feedback loops. These feedback loops are, however, not further specified. The IAD framework thus

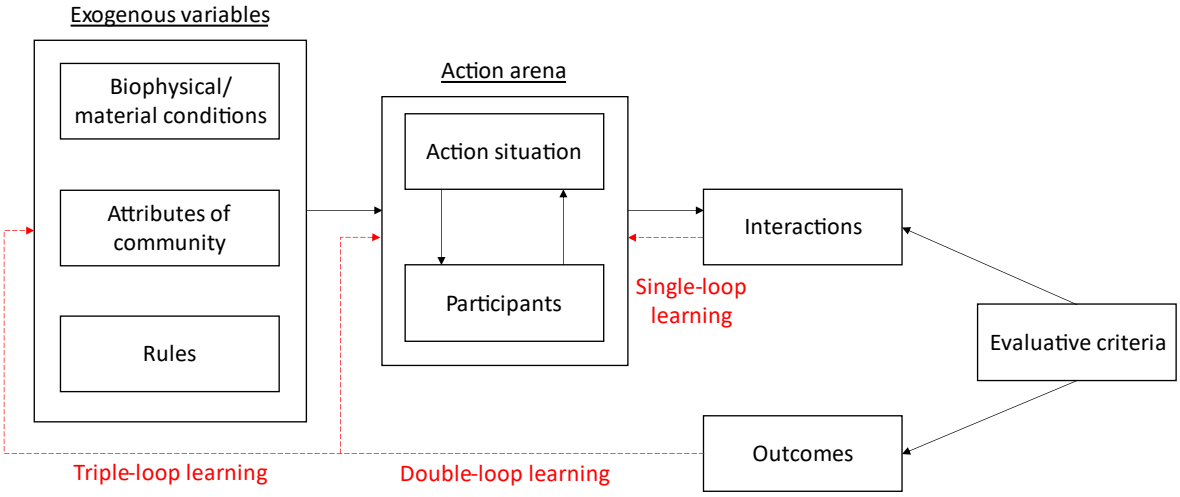
does not explain how institutions change. However, to assess the current state of nexus governance the temporal dimension is critical since existing institutions and processes are determined by their historical development (Gagliardi 2008, p. 420). An understanding of how, when and in what direction institutions in the nexus-related policy fields change offers important insights about chances and barriers of policy integration. It makes it possible to examine if and which policies developed towards more or less integration over time. To better understand institutional change the IAD framework needs to be expanded by a more detailed definition of these change processes. There is a broad range of literature dealing with institutional change suggesting a wide range of possible explanations. One promising way of describing the nature and characteristics of institutional change processes is the concept of social learning (Pahl-Wostl et al. 2010, p. 573). Pahl-Wostl (2008, p. 79) defines social learning as the "capacity of all stakeholders to deal with different interests and points of view and to collectively manage resources in a sustainable way." Therefore, social learning requires interactions among interdependent stakeholders that enable institutional change (Blackmore 2007, p. 519). Social learning emphasizes the involvement of stakeholders to gain knowledge or to reach adaptive solutions (Siebenhüner et al. 2016, p. 116). Social learning is necessary to improve a system's adaptive capacity towards changing environments (Baird et al. 2014, p. 61), especially in times of uncertainty and sudden events (Pahl-Wostl 2009, p. 355). Because of the complex nature of systems even small events or changes can have greater consequences also in other political areas. There is a non-linear relationship between causes and effects, which increases the possibilities of unexpected outcomes (Dyball et al. 2005, p. 45). As an answer to unpredicted consequences of complex system's interactions flexible management solutions are needed (Dyball et al. 2005, p. 44; Purkus et al. 2017, pp. 82–83). Traditionally, many policy decisions were made under the assumption of certain and constant conditions (Dyball et al. 2005, p. 48). Often, problems related to resources management are described as 'wicked problems', characterized by having neither a simple definition nor solution. Those problems require learning processes to capture the complexity of the problem, the unpredictability of events

and their consequences, and emerging conflicts in norms and values (Baird et al. 2014, p. 52). In order to reach higher adaptive capacity established values and beliefs need to be questioned and reconsidered, otherwise no structural changes will be possible and systems will not get more adapted (Pahl-Wostl 2009, p. 359).

In order to capture different kinds of learning Pahl-Wostl et al. (2009) developed the concept of triple-loop learning. The idea of different levels of learning originates from classical organizational theory (e.g. Argyris and Schön 1978) and management theory (Armitage et al. 2008, p. 87). Single-loop learning is characterized by an amendment of policies or actions without changing underlying principles or established processes. This type of learning adjusts policies that are already in place and maintains the main objectives (Pahl-Wostl 2009, p. 359). Adaptation to climate change, for example, is often a form of single-loop learning since it supports the normative value framework that is in place. According to Baird (2014, p. 53) this level of learning can be defined as cognitive learning whereas double- and triple-loop learning refer to normative learning (Baird et al. 2014, p. 53). Double-loop learning is characterized by questioning guiding assumptions behind policies and actions. It changes the frames of reference (Pahl-Wostl 2009, p. 359). In double-loop learning alternative solutions or instruments are taken into account instead of modifying existing approaches (Blackmore 2007, p. 517). In triple-loop learning underlying core values and objectives are questioned thus enabling structural change. Key elements of triple-loop learning include changing actor networks and institutions, interaction across different levels of administration, or policy integration (Pahl-Wostl et al. 2013, p. 2). Social learning is assumed to proceed in an iterative manner from single- up to triple-loop learning (Pahl-Wostl 2009, p. 359). For an effective governance of natural resources and thus stronger policy integration higher levels of learning are necessary (Adelle and Russel 2013, pp. 5–6). Only double-loop and triple-loop learning address transformative changes (Pahl-Wostl et al. 2013, pp. 2–3). As mentioned above the concept of social learning is used to further specify the feedback loops within the IAD framework. For this reason, Figure 5 shows how the different levels of learning can be included in the framework. Whereas

single-loop learning occurs within decision-making processes on existing policies and within a constant group of participants, double-loop learning alters the preconditions of an action situation, for example by changing participants or modified decision processes. Successful triple-loop learning results in profound changes of norms and underlying beliefs and thus impacts the societal context in which the action situation is embedded (Milchram et al. 2019, p. 4).

Figure 5: Dynamic IAD framework including social learning



Source: own Figure, based on (Milchram et al. 2019, p. 8).

Important for the analysis of social learning processes is a certain understanding of the respective system. This understanding strongly depends on the system's boundaries that have been set and the identified elements which interact and constrain each other (Dyball et al. 2005, pp. 43–45). Hence, the understanding of the nexus concept as a concept of systems thinking, developed in section 2.3, was critical. Additionally, social learning highly depends on the system's socio-economic conditions. For this reason, some political systems are more capable of reaching higher levels of learning than others. For example, it is assumed that in centralized political systems social learning is far more difficult to reach. Additional barriers of learning include privatization, inadequate access to information, and strict bureaucracies (Pahl-Wostl 2009, p. 358). Referring to section 3.2.1, also path

dependence is a factor impeding structural change (Pierson 2000, p. 260). It offers an explanation why most institutional change only happens in form of single-loop learning. However, social learning not always automatically leads to actual institutional changes. As Pesch et al. (2017, p. 2) state initiated learning processes can also end at the stage of discourse and dialogue. Many processes of higher social learning are induced at the stages of monitoring and evaluation of institutions or outcomes (Moser and Ekstrom 2010, p. 22027). In order to help translating these processes into practice suitable instrument are needed. Pahl-Wostl (2009, pp. 361–362) stresses the role of informal networks in this regard. Informal networks are essential in early stages of learning and they need to be linked to the formal policy processes. This link can happen by involving stakeholders in formal political processes or if these stakeholders carry a formal mandate. Both, formal and informal actor networks and institutions are essential for a functioning governance system. Ideally, they are strong and effective and do not only coexist but complement each other (Pahl-Wostl 2009, p. 356). Whereas informal institutions offer platforms for experiments that result in changing underlying principles, formal institutions and processes are needed to ensure that the outcomes of social learning are translated into new rules (Pahl-Wostl et al. 2013, p. 2). Thereby, any type of social learning usually follows the three phases of problem structuring and reframing (phase 1), developing an action plan and mobilizing additional support (phase 2), and implementation and evaluation of pilots/experiments (phase 3) (Pahl-Wostl et al. 2010, p. 577).

The combination of the IAD framework with social learning forms the basic analytical framework of this study. It offers a suitable approach to analyze institutional change with regard to nexus governance. By using this extended IAD framework not only relevant formal institutions and participants in the nexus policy fields can be identified but also institutional development processes. The concept of social learning allows to clearly characterize these change processes in aims and scope. In the next step, this basic analytical framework is extended by a value perspective. By considering the role of underlying values within the IAD framework three different objectives can be reached: (1) the underlying purpose of

institutions can be examined, (2) factors inducing social learning processes can better be understood, and (3) possible value conflicts can be identified that block policy integration.

3.3. Section summary

In this section a framework for institutional change was developed. The IAD framework, developed by Elinor Ostrom and colleagues, serves as its basis. It represents SES, its important elements and their interrelations. The framework helps understanding the complexity of complex adaptive systems and generates a structured way of policy analysis. The action situation can be seen as the most important element of the framework. It describes the arena in which actors interact. However, the decision on what can be classified as an action situation is highly case specific and should be well grounded. Furthermore, action situations do not stand for themselves. They are interconnected either by their outcomes or their participants. This way, networks of action situations emerge. One important notion about the IAD framework is the assumption that the actors' behavior is embedded in and constraint by the context factors of the biophysical conditions, the attributes of the community, and the institutional setting. One major critique regarding the IAD framework is the fact that these context factors are described as exogenous factors. Since the framework also accounts for feedback loops that proceed from the outcomes to these context factors, those factors are connected to the other parts of the system. They are thus no external factors per se. Institutions are defined as the rules of the game that interact in various ways resulting in a complex institutional setting. Classically, research using the IAD framework often focuses on small-scale or informal settings of social interactions. For this reason, Cole (2017, p. 845) calls for a stronger emphasis on formal rules in IAD research. The analysis presented in this study helps to fill this gap. In contrast to classical approaches this thesis also focuses more on the outcomes of action situations than on the processes happening within these situations.

In its basic form the IAD framework is a static framework describing one action situation. However, by means of the feedback loops it becomes dynamic. In order to assess the current state of the nexus a temporal dimension seems to be necessary: Institutions evolve

or are created in a certain historical context, which strongly impacts their design. Once established, they tend to develop path dependently what potentially impedes profound structural changes that often are necessary to face upcoming challenges. These dynamics are self-reinforcing and are mostly interrupted by critical junctures, such as external shocks. In times of crises opportunities emerge enabling a replacement of established institutions. The concept of path dependence can thus explain why structural change is often hard to achieve. Unfortunately, the IAD framework does not offer any further explanation for institutional change other than the existence of feedback loops. Therefore, an additional concept is needed that captures these processes well. In this regard, institutional change is characterized as social learning. The idea of triple-loop learning allows identifying different levels of learning that are necessary for structural change and it helps understanding how learning takes place in the nexus policy fields.

The combination of the IAD framework with social learning simultaneously presents a structured analytical approach and a profound understanding for change processes. This dynamic IAD framework serves as the basic analytical framework for this study (cf. Figure 5). However, in its current form it does not yet allow to adequately analyze nexus governance. In order to understand when and why institutional change is happening the role of values needs to be considered. IAD scholars regularly refer to the term ‘values’ they, however, do not structurally analyze their impact on institutional change. Hence, the dynamic IAD framework is complemented by a value perspective in section 4.

4. A value-based framework for institutional change

4.1. A value gap in scholarship on the IAD framework

The term value is frequently referred to in IAD scholarship. Elinor Ostrom stated that institutions need to be evaluated with regard to how they "fit the values of those involved" (Ostrom 2011, p. 16). According to McGinnis (2011a, p. 176) the question if the actors hold the same core values or goals important is a critical attribute of the community in which an action situation is embedded. Other scholars emphasized that values motivate human behavior and impact the development of institutions (Schlüter and Theesfeld 2010, p. 446; Ramaswami et al. 2012, p. 807). However, current IAD scholarship rarely takes a deeper look into the role of these values. Jason Prior (2016) was one of the first who undertook a profound analysis of values in research on environmental management for the case of soil pollution. Prior used a value survey developed by Schwartz (Schwartz 1992; Schwartz and Bilsky 1987). In his survey, Schwartz (Schwartz 1992, p. 6) distinguished between different categories or motivational types of values, such as self-direction, power, or universalism. Whereas wealth and authority can be seen as motivational values for power, unity with nature, social justice and protecting the environment are defined as universalistic values. Prior found out that the actors involved were driven by different values to conform to present institutions. His results showed that, for example, local governments were driven by universalist values (welfare and equity) whereas service providers responsible for removing the pollutants were mostly driven by values of power (power and success) (Prior 2016, pp. 833–835). In his research, Prior (2016) focused on individual values of the actors involved and how these comply with existing institutions. This refers to the value definition of social psychology, in which values are understood as characteristics of personality and principles that influence human behavior (Milchram et al. 2019, p. 7).

With regard to FEW nexus governance questions emerge about the role values play for institutional development. Do institutions incorporate values? And if so, what values are embedded? Are institutions in line with the values for which they were designed? How do

shared values influence institutions? IAD scholarship, so far, does not provide answers to these questions. In order to fill this gap a definition and conceptualization of values is necessary that leaves the level of individuals. In fact, values appear in various academic disciplines and conceptualizations. Applying different value understandings can offer valuable insights for varying research focuses within institutional analysis. In the following section (cf. section 4.2) the value definition of social psychology – as used by Prior (2016) and Schwartz (1992) – is complemented by the value definitions from institutional economics and moral philosophy. Adding a value perspective to the dynamic IAD framework can offer valuable insights into current problems and challenges regarding FEW nexus governance. For example, the framework can be used to assess if the values embedded in food, energy, and water policies are compatible or not. It is assumed that conflicting values could be one reason for nexus-related problems that may not be solved even in the case of an existing regulatory framework.

4.2. Adding a value perspective to the dynamic IAD framework

To understand better the role of values for institutions and institutional change, firstly, the value conceptualization of institutional economics is used. Institutional economics literature treats values as factors influencing – or guiding – actors' behavior and the design and development of formal institutions, e.g. laws and regulations (Correljé and Groenewegen 2009, p. 407). Usually, institutions are created to endorse certain goals or targets, such as, for example, emission reduction targets. These goals and targets are often based on underlying values. This means that formal institutions are laden with values they should support (Milchram et al. 2019, p. 7). For example, a formal law or regulation supporting the expansion of renewable energies would embed the values of climate or environment protection. Taebi and Kadak (2010, p. 1342) define resource durability and environmental friendliness as core values of sustainable development. These values, most probably, were embedded consciously by policy-makers. It is also possible that additional values are embedded unconsciously. Institutional changes and thus changes in rules and

regulations can be described as changing value judgements of those creating this rule, for example by prioritizing a new value over the existing ones (Milchram et al. 2019, p. 11).

To assess the performance and quality of institutions different evaluative criteria are used. According to Ostrom economic efficiency, accountability or sustainability are examples of such criteria (Ostrom 2011, p. 16). In this sense, evaluative criteria represent values as defined in moral philosophy. This conceptualization sees values as central normative guiding principles that are shared by a society or community (Pojman 1997, p. 12). Values are used to assess if institutions and institutional developments support the values for which they were designed and if they serve achieving their goals (Shrader-Frechette and Westra 1997, pp. 3–10). Members of the community in which the action situation takes place use these evaluative criteria. This means that the assessment of an institution as well as its potential impacts highly depend on the values the community shares and holds important (Taebi and Kadak 2010, p. 1343). These societal values can be used to assess the ethical goodness of actions or action options and to evaluate an ethically justifiable decision.

Ethics of technology as a specific stream of moral philosophy deals with the role of values for technologies. It states that technologies are not neutral or value-free; they incorporate values the same way that institutions do (e.g. Winner 1980; Flanagan et al. 2008). According to this stream of literature values describe the ethical and social impacts of different technologies. Energy systems, for example, often embed values, such as security of supply, affordability, or ecological sustainability (Milchram et al. 2018, p. 7). These values not only play an important role in the design of technologies; they eventually should also be supported by these technologies (van de Poel 2009, p. 973). However, values get not only embedded by the designers of technologies, but also by different usages or users of technologies (Shilton et al. 2013, p. 261). However, technologies do not automatically endorse the values for which they were designed. They can also have unintended negative side-effects that eventually support totally different values as intended (Barry 2001, p. 168). In this regard, the example of Winner (1980, pp. 123–124) is cited many times: Very low

overpasses that were built over the only highway connecting New York City with the Long Island Beach did not allow public busses to pass. Since mainly people with low income and racial minorities used these public busses these groups of the population were not able to access the beach. Even if the implications of this example have been critically debated, by Joerges (1999) for example, it shows how principles or values can be endorsed by technical artifacts, whether intended or not. In this sense, the value definition of ethics of technologies is especially suited when focusing on the biophysical and material conditions of a system.

The paragraphs above showed that different value conceptualizations are suitable for the elements of the IAD framework. A deeper value understanding can be helpful when focusing on one of the elements in particular. For this study, the value definition of institutional economics is most relevant. It describes how values are embedded in institutions and how they influence their development. The following table (Table 3) again summarizes which value conceptualization is most suitable for which element of the IAD framework.

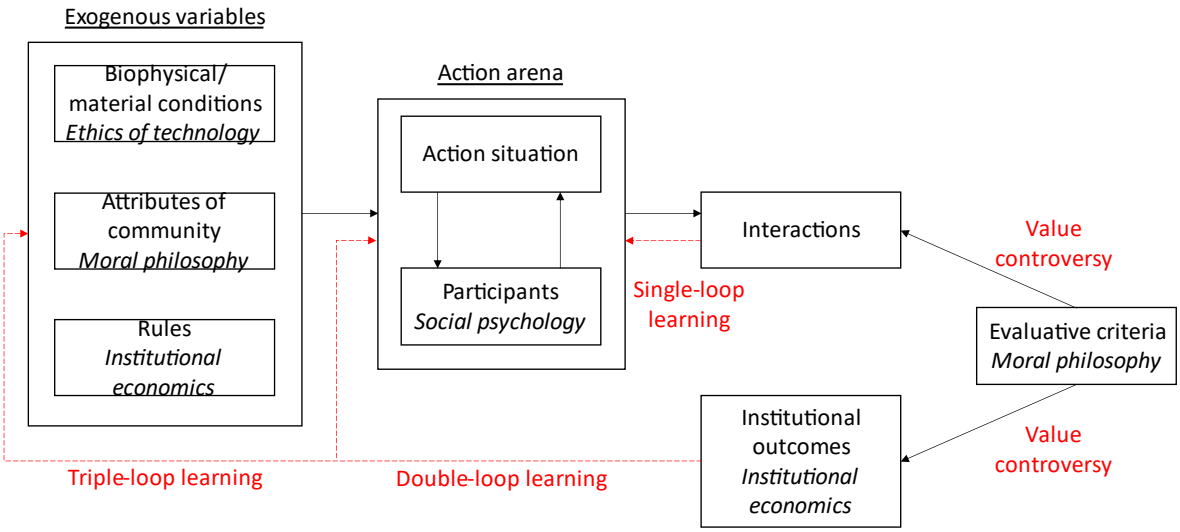
Table 3: Elements of the IAD framework and their value conceptualization

Element of the IAD framework	**Value conceptualization**	**Definition**
Biophysical/material conditions	Ethics of technology	Values embedded in technologies
Attributes of community	Moral philosophy	Values as shared normative principles
Rules	Institutional economics	Values embedded in rules
Participants	Social psychology	Values as personality characteristics
Evaluative criteria	Moral philosophy	Values as goal-oriented assessment criteria
Institutional outcomes	Institutional economics	Values as policy design goals

Source: own Table, based on (Milchram et al. 2019, p. 8).

The question remains if and how values influence institutional change processes. Or in other words, if values also play a role for the dynamic dimension added to the IAD framework in section 3.2. As described in section 3.2.2 social learning processes occur on different levels. These processes, firstly, require changes in understanding (Siebenhüner et al. 2016, p. 120), which can result from value changes. Changes in core values can thus directly and indirectly induce processes of social learning and policy changes (Shah and Niles 2016, p. 777; Iychettira et al. 2017, p. 178). Hence, a value perspective can also offer valuable insights into the understanding of institutional change. The values that are embedded in institutions, technologies or evaluative criteria are the invisible underlying principles behind visible design goals, policy objectives or societal norms. These invisible values, however, can become visible in times of crisis or emerging conflicts about formal policy processes, especially, when different actor groups perceive that their concerns are neglected by existing institutions. These concerns often relate to disregarded values and usually are discussed in public debates among state and – or – non-state actor networks (Pesch et al. 2017, p. 826). Such openly discussed value controversies can put existing institutions under stress and potentially initiate social learning processes. These controversies often emerge at the stage when institutions and outcomes are assessed using the evaluative criteria. Depending on the relevant actors, their preferences as well as the evaluative criteria used for the assessment, different processes of learning can be triggered, such as single-, double, or triple-loop learning (Milchram et al. 2019, p. 11). Figure 6 shows the dynamic IAD framework including the different conceptualizations of values as well as value controversies.

Figure 6: Dynamic IAD framework including a value perspective



Source: own Figure, based on (Milchram et al. 2019, p. 8).

4.3. Section summary

In this section the IAD framework was complemented by a value perspective. Values are often mentioned in scholarship on the IAD framework but they are rarely described in detail. Nevertheless, a deeper understanding of values for institutional analysis and its different elements can offer valuable information about how actors behave or how, why and when institutions change. To fill this research gap definitions and conceptualizations of values from three different academic disciplines were used: social psychology, moral philosophy, and institutional economics. When looking at the different elements of the IAD framework it becomes apparent that all of these different conceptualizations of values can offer valuable insights for understanding what role values play for institutional analysis. Which conceptualization applies most strongly depends on the respective research focus. If the actors' perspective (participants) is in focus – as in the analysis of Prior (2016) – the value definition of social psychology seems appropriate. It helps assessing and understanding human behavior since it assumes that individual behavior is determined by personal or professional objectives, which are based on and motivated by specific values. Values are thus particular personal characteristics (Schwartz 1992, p. 1). The definition from

institutional economics is appropriate when focusing on formal rules and institutions, as done in this study. Values represent the purpose of institutions and serve as the basis for their design. To understand the role of values for system assessment the definition of moral philosophy needs to be considered. Values serve as goal-oriented assessment criteria, or evaluative criteria (when using IAD terms). When analyzing technological design and impact more specifically literature on ethics of technologies should be used. This stream of literature explains how technologies and artifacts are value-laden.[4]

Values do not only play an important role for the analysis of the different elements of the IAD framework but also for the analysis of institutional change processes. Policy changes and processes of social learning can be induced by value controversies or changes in core values. Depending on the impact of the respective value controversy different levels of social learning can be triggered. In their strongest form they can result in changes within the exogenous variables. Thus, adding a value perspective to the dynamic IAD framework proved to be a very valuable task for analyzing nexus governance challenges.

So far, the basic IAD framework was extended by the concept of social learning in order to make it dynamic, and a value perspective that allows for an understanding of underlying principles. Even if this extended IAD framework already accounts for several very important aspects for analyzing institutional change, one central dimension is still missing. One of the most important notions about the nexus concept is its focus on interrelations between different sectors and policy fields. The extended IAD framework does not yet capture these interconnections. Therefore, a theory on policy integration is necessary that connects the different policy fields. The next section presents this last step of the method development towards an *integrated* value-based institutional framework for nexus governance.

[4] For detailed information on the value perspective in the IAD framework elements refer to Märker and Milchram (2018) or Milchram, Märker et al. (2019).

5. Developing two nexus policy integration frameworks

In this section the method development is completed by adding the dimension of policy integration to the value-based institutional framework developed in sections 3 and 4. The nexus concept aims at an integrated resources management that accounts for negative side-effects and supports holistic solutions. Therefore, an integrated governance among the nexus-related policy fields is necessary. This section, first, addresses critical aspects of policy integration. Policy integration is approached by a spatial dimension, a procedural dimension, and in terms of content. The first dimension is captured by polycentric and multi-level governance (section 5.1.1), the second by the policy cycle (section 5.1.2), and the third by EPI (section 5.1.3).

In the second part of this section (section 5.2) specific challenges regarding policy integration in terms of the nexus are described before two different frameworks are developed representing different types of policy integration.

5.1. Policy integration within the nexus

5.1.1. Polycentric and multi-level governance

As explained before, this study focuses on nexus-related challenges on the national level. (National) governments have a special role in providing effective regulation for the management of natural resources, as they are usually public goods. Thus, they also take an important part in the design and development of the nexus-related policy fields (Acheson 2006, p. 129). However, in many countries, not only governments, but also various other state actors as well as institutions play an important role within political processes and interact with each other in various ways (Pahl-Wostl 2009, p. 363). This complex interplay is captured by the notion of governance (Benz and Dose 2010a, p. 27). This represents a modified perspective on policy processes that has been broadened by actors, institutions, and different modes of governance. According to Pahl-Wostl (2009, p. 356): “Governance regimes are thus characterized by self-organization, emergence and diverse leadership.” This captures the fact that a broad variety of different actors is involved in governance

processes, such as public or private organizations from a smaller to a larger scale (Märker et al. 2018, p. 292). To specifically also include non-state actors the term polycentric governance is used. Polycentric governance systems are characterized by various interacting units that differ in size, purpose, and organization (McGinnis 2011b, p. 1; Ostrom 2010, p. 552). According to Berardo and Lubell (2016, p. 748) "the structure of polycentric governance systems seems to be at least partly a function of the strength of formal institutions, the organizational capacity of individual policy actors, the level of centralized authority vested in governmental actors, and the nature of the environmental collective action problems created by the ecological system." Pahl-Wostl (2009, p. 357) argues that governance systems that are highly polycentric are able to better adapt to changing environments and show a higher resilience. Thus, when analyzing nexus challenges on the national level, the role of non-state actors and organizations must not be neglected. In terms of the elements of the IAD framework (cf. section 3.1.2) the notion of polycentric governance describes the different actors and actor groups that can be involved in an action situation.

Governance is not only polycentric but also organized in a multi-leveled fashion across local, regional, and national scales. Reaching coordination across these different levels constitutes a major challenge in complex socio-economic systems that is often more difficult to solve than the development of technical solutions (Biesbroek et al. 2010, p. 448). Each of these levels includes a wide range of different actors and stakeholders who raise the complexity and make implementation more difficult (UNEP 2009, p. 8). Different governance levels perform different tasks in terms of resource governance that intertwine. For example, initiatives or small-scale projects can emerge bottom-up and instruments of resources management are implemented on the local level. Still, the national level is needed to develop overarching strategies and formulate binding goals or targets that need to be achieved. Furthermore, institutions on the national level provide the frame for action and take effect in times of crisis (Bleischwitz et al. 2014, p. 10). The regional level often works as a mediator. It converts national targets into regional development pathways that ensure

their achievement and their compatibility with local initiatives (Bhaduri et al. 2015, p. 727). These governance scales are especially important for the German case, due to its federal structure. Particularly, the role of the federal states needs to be taken into account (Monstadt and Scheiner 2014, p. 383). Additionally, in Europe, many laws and regulation are decided on the EU level. This is especially relevant for the nexus since responsibilities in the nexus-related policy fields are spread over different governance scales (Märker et al. 2018, p. 296). Agricultural policy serves as one example in which the regulative responsibility is mostly located on the European level. This policy field is strongly communitarized by the Common Agricultural Policy (CAP) (Venghaus et al. 2019, p. 10). Other EU regulations important for the German case study are analyzed in detail in section 6. In order to adequately address nexus-related problems coordination between these different levels is essential (Knieper et al. 2010, p. 592; Hoff 2011, p. 5). Armitage (2008, p. 8) argued that MLG can enable social learning and adaptation within socio-ecological systems. With regard to the IAD framework (cf. section 3.1) MLG captures the governance scale on which the action situation happens.

5.1.2. Policy cycle

In order to achieve integrated policies not only the actors and the governance level is relevant but also the procedural step in which policy integration is implemented. The procedural dimension of policy integration is captured by the policy cycle. Dividing policy processes into different stages has a long tradition in political science that aims at a more structured way of analysis (Gain et al. 2015, p. 902). The most common type of the policy cycle includes five stages: agenda setting, policy formulation, decision-making, implementation, and evaluation. Each of the stages can also be analyzed separately (UNEP 2009, p. 6). The policy cycle is a tool that is often particularly used for questions concerning policy integration within the field of environmental protection and sustainable development. In the following paragraphs the five stages are described in detail.

Agenda setting

The stage of agenda setting describes the process of recognizing that a certain public issue deserves the attention of policy-makers. It is put on the agenda and thus needs to be dealt with (UNEP 2009, p. 7).

Policy formulation

The stage of policy formulation is characterized by a process in which actors inside as well as outside the government discuss and formalize policy options which then work as the basis for decision-making (UNEP 2009, p. 7). This stage entails rules of policy-making, assessment processes, as well as the development of integrated policies (Gain et al. 2015, p. 903) and is thus critical for achieving policy integration.

Decision making

The stage of decision-making is one of the most influential steps since it determines the course of action. The decision might entail disadvantages for some actors or actor groups while benefitting others at the same time. Also, the case of no decision can be defined as a decision to maintain the current status which in turn has specific impacts (UNEP 2009, p. 8).

Implementation

The policies that have been decided, then, need to get implemented in order to fulfill the purpose for which they were designed.

Evaluation

Their effectiveness in achieving their purpose is assessed and evaluated by various stakeholders. Since the outcomes of the evaluation process will again influence following policy-making in this field a cyclic process is initiated (UNEP 2009, p. 8).

Figure 7: Policy cycle

Source: own Figure, based on (UNEP 2009, p. 6).

The policy cycle can be combined well with the IAD framework from section 3. With regard to its elements (cf. section 3.1.2) the first two phases of agenda setting and policy formulation happen within the action situation. The remaining three phases correspond to the outcome element and its feedback processes (policy outcome and implementation) and the element of evaluative criteria (evaluation). Even though nexus thinking should be incorporated at any stage, the stage of policy formulation is the most critical for policy integration. In this stage, the current state is assessed and integrated policies are developed (Gain et al. 2015, p. 902). Using the vocabulary of Ostrom, policy-making rules describe what way decisions are made within this process (Ostrom 2011, pp. 20–21). Within their nexus case study Gain et al. (2015, p. 904) split the first phase of agenda setting into the characteristics of the problem and conflicts, the political will, and the international policy context. The necessity for policy integration is inherent in the problem characteristics. Main drivers for policy-making are changing conditions, e.g., through climate change, their uncertain consequences and their potential for societal conflicts. Thus, policy integration is especially needed for problems that incorporate a high probability of societal conflicts. In

this situation, the success of policy integration is dependent on the political will which is assumed to be strong in cases of upcoming societal conflicts. Additionally, international policies set the context for action and impact national policy-making as well (Gain et al. 2015, p. 903). The paragraphs above described on which governance scales and at what procedural stage policy integration can happen. In the next section the possible design of policy integration is explained.

5.1.3. Environmental Policy Integration

Transferring nexus thinking into policy design necessitates integrated approaches that take interrelations into account and thus try to avoid negative side-effects and to create synergies. This means to develop policies that are integrated across nexus-related policy fields (Rasul 2016, p. 22). Questions about policy integration within the environmental field mainly appeared in the 1980s and 1990s in response to raising environmental concerns and the emergence of the guiding principle of sustainable development (Lafferty and Hovden 2003, p. 1). One of the most cited definitions of policy integration within the environmental field still used by scholars today stems from Arild Underdal. In 1980, he stated for the case of marine policy that an integrated policy is a policy in which the different relevant components together form a unified policy concept (Underdal 1980, p. 159). He defined a perfectly integrated policy "as one where all significant consequences of policy decisions are recognized as decision premises, where policy options are evaluated on the basis of their effects on some aggregate measure of utility, and where the different policy elements are consistent with each other" (Underdal 1980, p. 162). In his article, Underdal already pointed at the problem of sectoralization which is especially relevant for the nexus. In his regard, the increasing challenges governments are facing bear the risk of disintegration since governments tend to address new tasks by forming new departments or highly specialized agencies following a narrow focus. Underdal describes this process as centrifugal forces that lead to a higher degree of fragmentation (Underdal 1980, p. 161). Reaching policy integration, therefore, usually entails costs and thus needs to be evaluated by the results (Underdal 1980, p. 169).

Building on his work, the concept of EPI evolved in the 1990s. It aimed at balancing economic and social priorities by ensuring environmental boundaries through the integration of environmental goals into different public policies (Venghaus et al. 2019, p. 3). It is defined as "a process through which "non" environmental policy fields consider the overall environmental consequences of their policies, and take active and early steps to incorporate an understanding of them into policymaking at all relevant levels of governance" (Runhaar 2016, p. 2). Traditionally, environmental concerns were only addressed by policy-makers within the field of environmental policy and were not considered in other policies (Herodes et al. 2007, p. 6). However, especially against the background of the Brundtland-Report published in 1987 it became apparent that environmental policy alone would not be able to adequately address emerging problems. Hence, policymakers realized that environmental targets also needed to be integrated into 'non'-environmental policy fields (Lafferty and Hovden 2003, pp. 1–2). In recent years, EPI was further developed towards climate policy integration dealing with the implementation of climate mitigation and adaptation targets in various policy fields (e.g. Adelle and Russel 2013; Di Gregorio et al. 2017; Russel et al. 2018). According to Weitz et al. (2017, p. 168) EPI can also serve as a promising concept for closing research gaps regarding the governance of nexus related challenges. For this reason, and because it refers particularly to issues addressing natural resources, it is used in this thesis. With regard to the nexus, policy integration is less – or not only – about integrating general environmental or climate goals into other policies but more specifically about integrating or considering goals of other nexus-related policy fields.

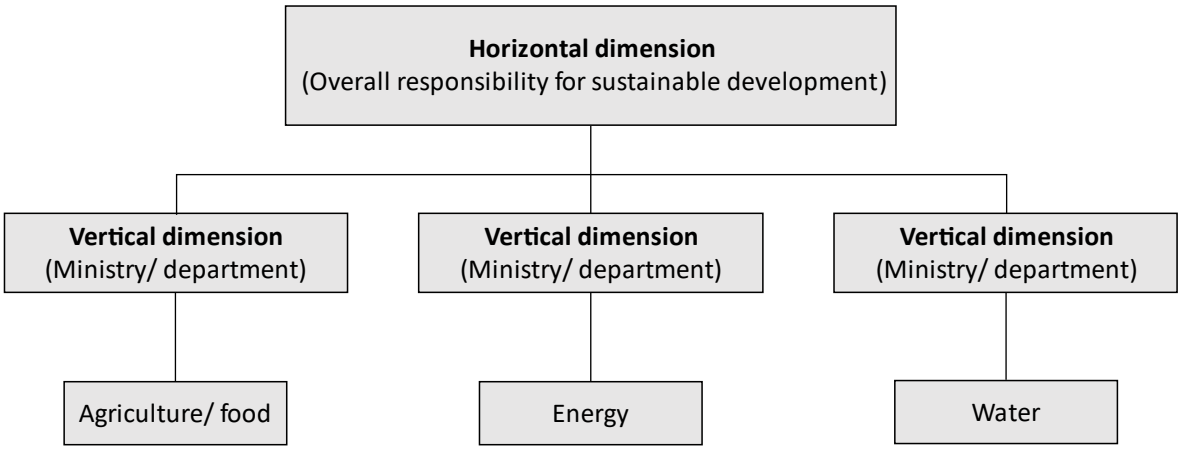
One of the most common definitions of EPI is the one developed by Lafferty and Hovden (2003). They differentiate between a vertical and horizontal dimension of EPI. Vertical policy integration describes the degree to which a policy field has been 'greened'. It refers to instruments and processes, or environmental objectives in general that have been adopted within the respective policy field (Lafferty and Hovden 2003, p. 13). Thus, in this sense, vertical integration does not refer – as widely used – to the division of power among

different levels of governance, e.g., the EU and national level. In this thesis, the latter is described as MLG (cf. section 5.1.1). Vertical integration, instead, assesses how many environmental objectives have been unified with the other objectives of one respective policy field. This is field-specific and can vary broadly depending on the commitment given to environmental concerns. Usually, vertical integration is assessable by quantitative or qualitative criteria. This kind of integration can become apparent in the form of specific policies including environmental goals, or impact assessment and monitoring (Lafferty and Hovden 2003, p. 13). Environmental Impact Assessment (EIA) is a commonly used regulatory tool in many countries around the world. However, usually these tools only have limited influence on actual decision-making. Furthermore, tools that are related to markets are of special importance for vertical integration. They include state subsidies or taxes, or cap and trade systems, such as the European emission trade system (Runhaar 2016, pp. 4–5). To implement environmental goals or such concerning sustainable development in sectoral policies a broad range of possible instruments and strategies have been adopted so far (Runhaar 2016, p. 1). However, in order to be effective they must be carefully considered and their enforcement needs to be ensured (Runhaar 2016, pp. 5–7).

Horizontal policy integration, on the other hand, describes if a central authority has adopted a comprehensive strategy that has a cross-sectoral character. This central authority can be represented by the government or a special committee that has been given the responsibility for related concerns (Lafferty and Hovden 2003, p. 14). Hence, the authority endowed with this responsibility is in charge of communication between the different policy fields. The main role horizontal policy integration has to play is to balance environmental objectives against other societal objectives. Consequently, this entails conflicts of interests which need to be addressed. Therefore, horizontal policy integration should provide a forum or platform in order to democratically discuss emerging conflicts. Usually, a sectoral environmental mandate does not receive enough attention. Therefore, an authority is needed that also possesses enforcement power (Lafferty and Hovden 2003, p. 16). Indicators to measure the level of horizontal policy integration include, for example, the

existence of an authority, a common national strategy, clearly designated goals, timetables and defined targets, progress reports, and an effective use of impact assessment tools as well as their monitoring (Lafferty and Hovden 2003, p. 15). Roadmaps or sustainable development strategies are common examples for horizontal integration. Ideally, the goals of sustainable development strategies should find their way into sectoral policies in order to get operationalized and to be reached. This, however, is not always ensured which is why their impact on sectoral policies remains limited. These strategies are often only supported by environmental ministries and agencies (Jordan and Lenschow 2010, p. 153). Figure 8 illustrates the definition of EPI developed by Lafferty and Hovden (2003) for the nexus policy fields.

Figure 8: Dimensions of EPI



Source: own Figure, based on (Lafferty and Hovden 2003, p. 14).

What is of special importance about their approach is the idea of ‘principled priority’. In their opinion, environmental objectives should be given a ‘principled priority’ over other objectives rather than balancing them (Lafferty and Hovden 2003, p. 9). They justify this idea for the reason of the irreversible damages actions could have on the ecological system and thus to ecosystem services essential for human life (Adelle and Russel 2013, p. 3). Against the background of the attention giving to sustainable development the principled

priority for environmental concerns was broadened towards balancing different social, economic, and ecological principled priorities (Jordan and Lenschow 2010, p. 149).

In its early years EPI was mainly analyzed with regard to European policies (Lenschow 1997, e.g., 2002; Nilsson and Persson 2003). In practical terms, EPI became relevant especially with the adoption of the first European environmental action program (EAP) in 1973. It included various related goals and stated that negative impacts on the environment need to be taken into account in any measure that could affect it. This represented a holistic perspective and formed the basis for the concept of EPI (Lafferty and Hovden 2003, p. 3). In the following EAPs EPI was strengthened and further developed. The first legal basis for EPI in the EU was provided by the Single European Act, which came into force in 1987. It included the objective of integrating environmental concerns into other policies (Lenschow 2002, pp. 21–22). The Maastricht Treaty, in 1992, clearly stated that sector policies need to integrate appropriate measures for environmental protection. The 1997 amendment of the European treaty gave EPI a higher importance and connected it directly to the idea of sustainable development (Herodes et al. 2007, pp. 6–7). Hence, EPI was supposed to carry out the objective of sustainable development which emerged as a central guiding principle in EU policy (Lenschow 2002, p. 21). However, these amendments did not clearly state that environmental concerns should be given a 'principled priority'. Thus, the treaty did, in fact, implement policy integration legally, however, it did not also automatically ensure its appropriate application (Herodes et al. 2007, p. 7). Hence, the attempt to formalize EPI in the EU treaties did not result in a clear framework as was hoped by its supporters (Adelle and Russel 2013, p. 4). Nevertheless, the EU is seen as the main driver in establishing EPI (Lafferty and Hovden 2003, p. 3). The first real attempt of implementing EPI in a way that went beyond the responsibility of the environmental department can be seen in the Cardiff process, which was inaugurated in 1998. Even if it eventually failed to produce significant outcomes (Adelle and Russel 2013, pp. 4–6) it counts as a milestone in formalizing EPI (Lenschow 2002, p. 26). The Cardiff process brought together the nine different departments of energy, transport, internal market, development, agriculture, industry,

fisheries, general affairs, and economy and finance. In varying council meetings, the respective ministers discussed possibilities to integrate goals for environmental protection and sustainable development into other policy fields. They were supposed to implement strategies and a regular monitoring process. In the end, the Cardiff process lost its drive and eventually phased out in the beginning of the 2000s (Herodes et al. 2007, pp. 12–13). EU policy shows that the possibilities to successfully implement EPI are strongly dependent on the respective policy field and the role environmental concerns play within it (Di Gregorio et al. 2017, p. 37). Up to 80 percent of the EU's budget is spent in policy fields highly relevant to environmental concerns, such as the CAP for example. In this area EPI is highly relevant (Herodes et al. 2007, p. 19). In the early years, starting with the EAPs EPI began by mere bottom-up incentives before a guiding approach including a legal basis came into force (Lenschow 2002, p. 26). These bottom-up approaches that often emerge from inside a policy field contrast to top-down approaches to which states commit themselves. The SGDs are a prominent example (Runhaar 2016, p. 2). Traditionally, on the EU level top-down approaches have been proved to be more successful than bottom-up initiatives. A missing clarity and enforcement in these approaches can explain why the implementation of a European sustainable development strategy and the Cardiff process had only limited impacts (Herodes et al. 2007, p. 17). However, EPI is of special relevance for the EU since it has a tradition of strong sectoral fragmentation (Adelle and Russel 2013, p. 5). In 2010, Jordan and Lenschow (2010, p. 147) stated that despite the increasing knowledge that emerged since the Brundtland report was published successful EPI in the EU is as far apart as it has ever been. Nevertheless, some instruments, such as environmental impact assessment, have been institutionalized on EU level (Nilsson et al. 2012, p. 396). Still, even today policy integration within the EU faces some significant barriers according to Russel et al. (2018, p. 48). Two basic assumptions that can be drawn from the EU case are, firstly, that EPI has to be implemented into daily policy-making in order to be effective (Herodes et al. 2007, p. 18). Secondly, the role that EPI plays within policy processes highly depends on the

attention that is given to it by the current leadership, such as the government (Jordan and Lenschow 2010, p. 152).

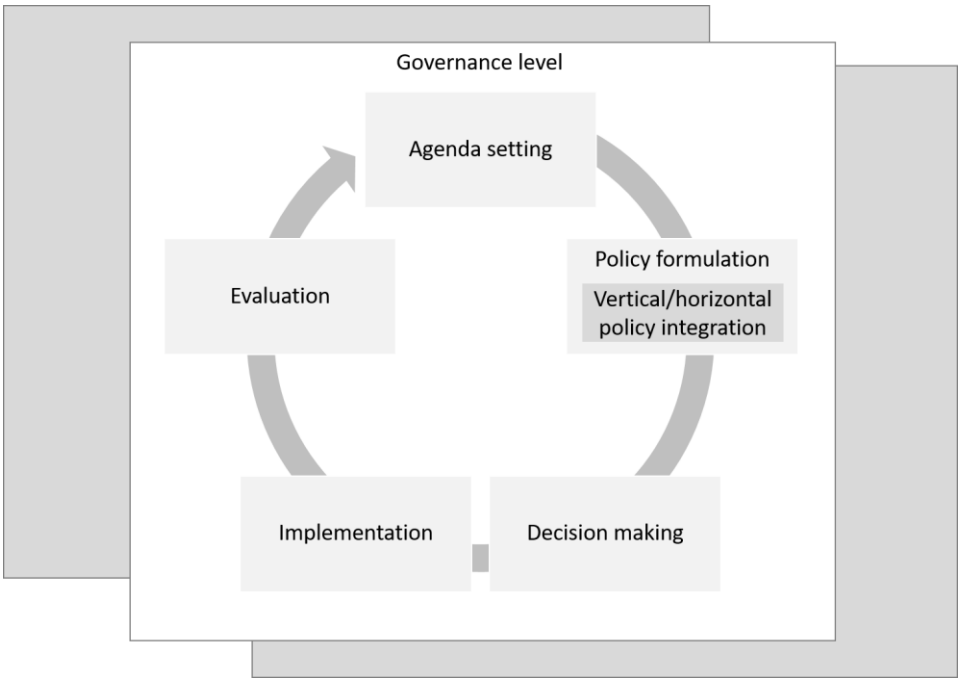
Using EPI in the context of the nexus helps to give a face to the frequently demanded call for more integration and a more holistic perspective. In this regard also the concept of systems thinking as included in section 2.3. is a valuable complement since it helps to adopt a wider and more comprehensive definition of problems (Nilsson and Persson 2017, p. 37). To successfully reach EPI and thus adequately address environmental and sustainable development targets both forms of policy integration are needed (Di Gregorio et al. 2017, p. 37). Whereas vertical policy integration takes care of the commitment of the different departments to include environmental targets, horizontal policy integration ensures the coordination on a higher policy. According to EPI literature, vertical integration is operationalized more often since it is associated with less conflict among different departments. It can be realized through changes within the policy fields. However, it is assumed that vertical integration alone will not suffice to achieve more sustainable development pathways since it does not ensure that overall goals are reached successfully. A national framework for EPI is needed to follow a comprehensive pathway that leads to a more sustainable system in the end (Lafferty and Hovden 2003, p. 17). Nevertheless, vertical integration is not only pursued more often, but has also greater impact on daily policy-making than the horizontal dimension (Lafferty and Hovden 2003, p. 20). Lafferty and Hovden (2003, pp. 17–18) use Germany as an example for strong vertical policy integration because sector-specific environmental targets and sustainable development strategies in relevant sectors exist, such as energy, transport, and agriculture. Also, a yearly conference of environmental ministers coordinating environmental targets within environmental policy across different levels of governance represents a form of vertical integration. Horizontal policy integration, however, has only weakly developed. Nevertheless, some important steps have been taken, such as the German sustainable development strategies. Thus, the authors at the time saw potential for a stronger focus on horizontal integration with the potential to turn Germany into a frontrunner in this area (Lafferty and Hovden 2003, p. 18).

It is interesting to analyze if these assumptions still hold true nowadays. This will be done in the case study part of this thesis (cf. section 6).

5.1.4. Section summary

Section 5.1 addressed the issue of policy integration. In order to include all relevant dimensions, policy integration was approached by a triangular approach covering a spatial (polycentric and MLG), procedural (policy cycle), and in terms of content (EPI) dimension. These three dimensions build an intertwined concept of policy integration that is illustrated by Figure 9. As described in section 5.1.1 various governance levels exist that need to be coordinated, such as the national, regional, or local level. These governance levels form the outer boxes. Within these governance levels policy processes proceed as explained in section 5.1.2 by means of the policy cycle (inner ring). The third dimension, namely the actual design and substance of a policy, is positioned within the stage of policy formulation since it is assumed to be most critical for policy integration. This dimension refers to the categorization of vertical and horizontal in the context of EPI as presented in section 5.1.3.

Figure 9: Different scales of governance



Source: own Figure, based on (UNEP 2009, p. 6).

5.2. Two nexus integration frameworks

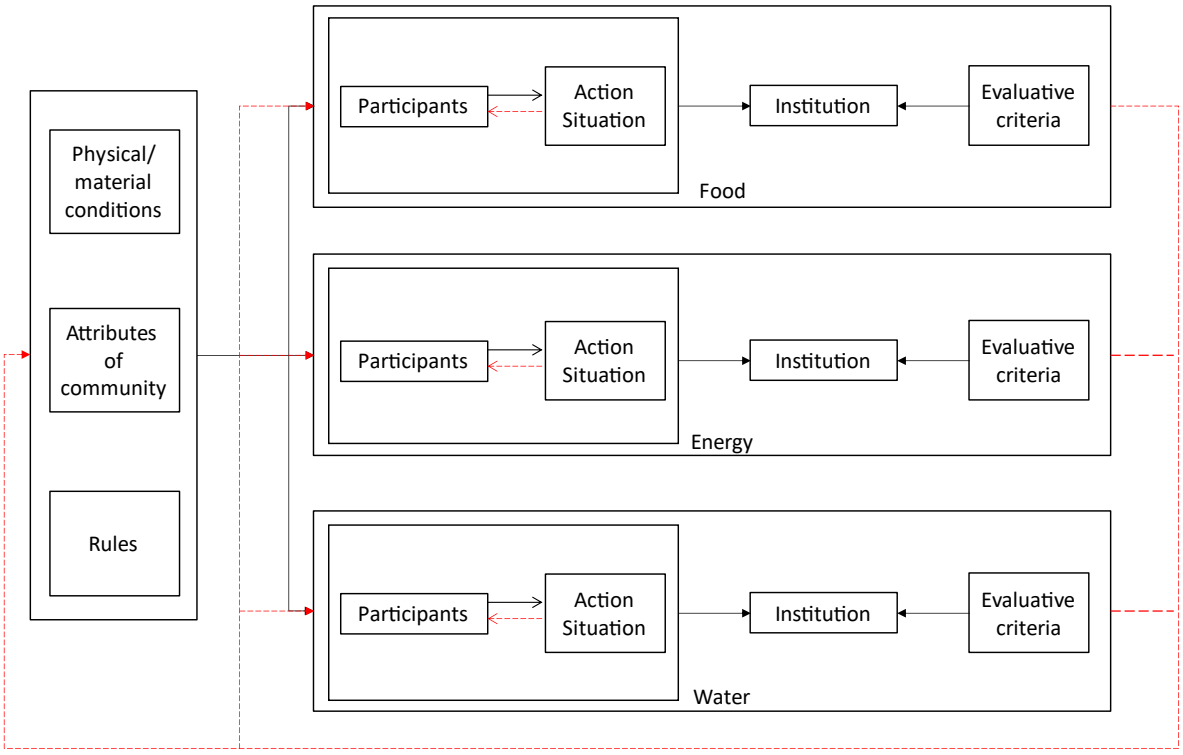
5.2.1. Specific challenges of policy integration for the nexus

Finding coherent policy and governance approaches supporting the goal of an effective resources management that prevents negative side-effects and ensures a secure and safe supply is one of the main challenges (Rodriguez et al. 2015, p. 68). From a political science perspective, the main issue in terms of the management of water, energy, and agriculture is that they are mostly organized separately in 'silos'. Even if various interlinkages have been known for a long time, these policy fields have historically been governed by isolated policies. Thus, a broad stream of research calls for an integrated approach (Al-Saidi and Elagib 2017, p. 1137). The problem of siloed approaches does not only occur on a specific level of governance. In contrast, it seems to be an issue across different scales of governance, from local to national or EU level as well as across them (Kaczorowska et al. 2016, p. 208). Separate policy approaches neglect resource interconnections and can

impede the overall goal of sustainable development (Bhaduri et al. 2015, p. 726). Furthermore, they can lead to accidental side-effects in other policy areas and might put other goals at risk (Howells et al. 2013, p. 622). Negative side-effects of an increasing food production on water and soil quality are common examples (Salomon et al. 2016, p. 158). Integrated nexus approaches, instead, are assumed to positively – or at least not negatively – influence other policy areas and eventually contribute to a higher resource productivity or efficiency (Hoff 2011, p. 14).

Traditionally, the political responsibilities mostly involve the ministries for energy, agriculture, and environment (European Environment Agency 2011, p. 10). However, those responsibilities often overlap or are not clearly defined what impedes an effective and coherent use of resources (European Environment Agency 2016, p. 14). Thus, currently, implementation of an integrated nexus policy design is far from being reached (Gain et al. 2015, p. 906). The need for more policy integration is a common denominator in nexus literature. However, due to the fact that several policy fields need to be integrated that include numerous actors and institutions, integration within the nexus comes with a number of difficulties. According to Stein et al. (2014) the question remains with regard to what should be integrated and how this is influenced by the socio-economic context? The latter can be adequately addressed by means of the framework for institutional change developed in section 3. The socio-economic context is represented by the exogenous factors of the IAD framework (cf. section 3.1.2). Against this background a framework is developed that illustrates current silo-thinking within the nexus policy fields (cf. Figure 10).

Figure 10: Framework representing silo thinking



Source: own Figure, based on (Ostrom 2005, p. 829).

Figure 10 represents the framework for institutional change for the three nexus-related policy fields. Under the premise of separate policies action situations take place within each specific policy field. No connections between the policy fields exist except that they are influenced by the same exogenous factors (physical/material conditions, attributes of community, and rules). This is because all three policy fields are part of the same SES. They, however, operate separately from each other. Participants develop and evaluate institutional outcomes (cf. Figure 10, box 'institutions') in action situations that are located within sectoral boundaries.[5]

This leaves the question of what should be integrated and "above all, how" (Stein et al. 2014, p. 4)? In this case, the 'how' is determined by the 'what' since only by means of a

[5] As explained in section 3.1.2 this thesis focuses on institutional outcomes of an action situation.

clearly defined objective a suitable design and an appropriate degree of integration can be elaborated (Weitz et al. 2017, p. 172). So far, there is no common idea on what integration actually means and what it could look like for the nexus concept (Al-Saidi and Elagib 2017, p. 1132; Benson et al. 2015, p. 760). Also, it is not clear what changes in the institutional setting and in actor constellations are required to achieve a higher level of policy integration (Al-Saidi and Elagib 2017, p. 1136). As already explained before, these changes should be incorporated in a holistic systems perspective including whole governance processes. Therefore, a broader nexus governance framework is necessary rather than single reforms (Al-Saidi and Elagib 2017, p. 1136). Naturally, nexus governance has to cope with trade-offs between the natural resources, currently existing policies, and their interrelations (Bhaduri et al. 2015, p. 726). Addressing these challenges necessitates institutional change. In this regard, reaching policy integration can be seen as a social learning process as explained in section 3.2.2. This assumption can add significant value to the current nexus debate in academia (Weitz et al. 2017, p. 170). Since the nexus concept represents a new impulse in resource management new policy designs will be introduced within this area of management (Al-Saidi and Elagib 2017, p. 1137). After a profound understanding of policy integration has been developed in section 5.1 the focus will now be set on the question of how an integrated nexus policy design could look like. Therefore, two new frameworks will be developed in the following sub-sections by taking the two dimensions of EPI. The first one represents vertical policy integration (section 5.2.2), the second one horizontal policy integration (section 5.2.3) among the nexus policy fields. Afterwards, both frameworks are compared and discussed in section 5.2.4.

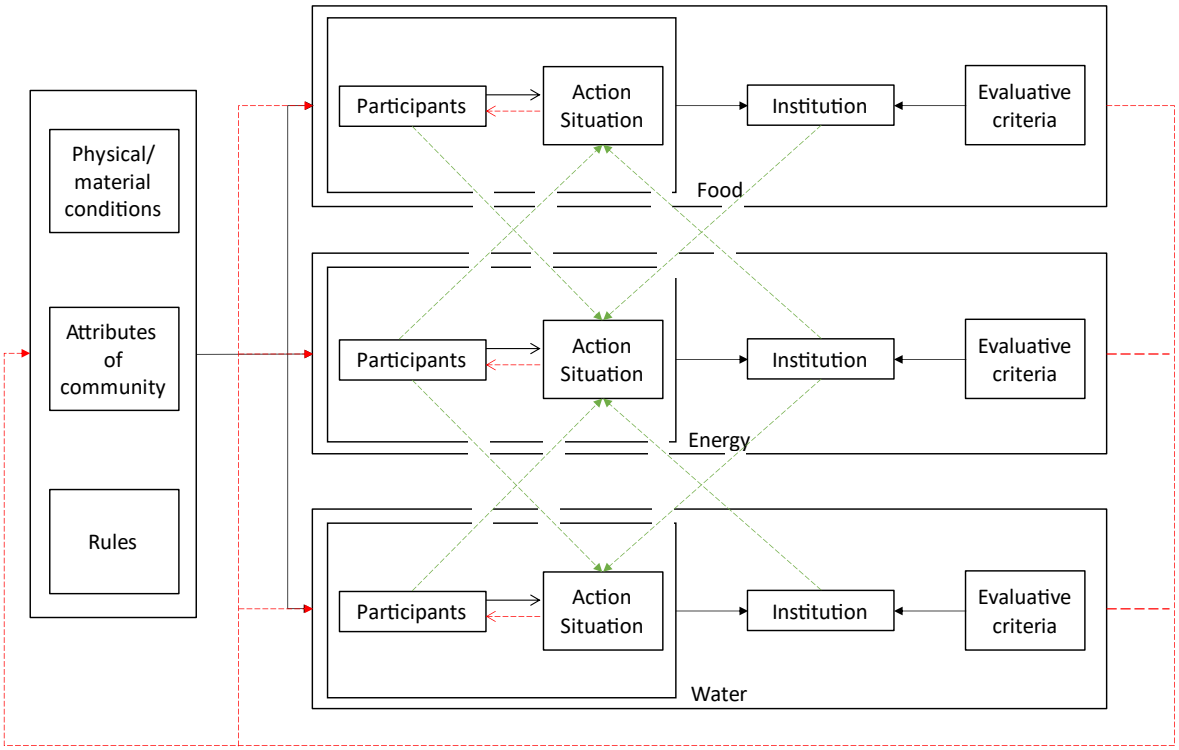
5.2.2. Nexus cooperation framework

As outlined in section 5.1.3 EPI distinguishes between a vertical and a horizontal dimension of policy integration. Both of them have different implications for an integrated nexus policy design and operate on different levels. Against this background, two different frameworks are developed that represent the case of vertical and horizontal policy integration within a stylized FEW nexus. In this sub-section, a closer look is spent on the vertical and thus

sectoral scale. In classical EPI literature vertical integration is understood as the roles, mandates and actual instruments that are implemented within the policy fields to reach environmental targets (Di Gregorio et al. 2017, p. 37). Each policy field is characterized by inherent political dynamics that strongly impact the processes of decision-making and how the system evolves. Therefore, it is necessary to know which elements are the most relevant ones and where the most critical difficulties lie in changing the system (Rodriguez et al. 2015, p. 70). Each policy field requires its own regulations and laws due to its specific context conditions, legal weight and organization that, on the one hand, complicates integration, but, on the other hand, makes it even more pressing since otherwise interlinkages would get neglected (Rodriguez et al. 2015, p. 87). Referring to Lafferty and Hovden (2003), in terms of the nexus, the goal is less about "greening" the respective policy fields in general, but to create policies that are "nexus-smart". This means that each policy field can develop its own concepts, measures, and sector-specific FEW nexus targets with which they contribute to overall climate change mitigation and adaptation goals (Al-Saidi and Elagib 2017, p. 1136).

Against this background, a nexus cooperation framework is designed (cf. Figure 11) that builds on Figure 10 in section 5.2.1. It shows that actors and institutions are still located within sectoral boundaries, but possibilities of exchange and cooperation exist (illustrated by dashed green arrows). The framework uses a 'prism-view' and looks through the lens of one policy field by simultaneously considering the links to the other two policy fields. According to Al-Saidi and Elagib (2017, p. 1135) this is defined as assimilation. Those action situations that are located at this sectoral scale are assumed to strongly influence daily policy-making and implementation (Lafferty and Hovden 2003, p. 17).

Figure 11: Nexus cooperation framework



Source: own Figure, based on (Ostrom 2005, p. 829).

Given the complexity of three different policy fields, each of them including a broad variety of interacting actors and institutions, many different opportunities of vertical integration seem possible (European Environment Agency 2016, p. 14). Strengthening existing institutions towards more cooperation and coordination (Bhaduri et al. 2015, p. 728) is one way that seems to be necessary for many nexus-related issues (Gain et al. 2015, p. 902). Through cross-cutting management on the sectoral level trade-offs can be reduced and synergies can be fostered (Hoff 2011, p. 36). In many cases increased coordination promises to be more effective than creating new institutions or policies, simply for practical reasons. Strengthening established structures can build on existing knowledge, capacities, and processes. Thus, institutional arrangements often need to get amended, refined, or redirected rather than being replaced (Stein et al. 2014, p. 18). Hence, if possible and appropriate successful institutions and structures should be preserved (Bhaduri et al. 2015,

p. 728; Stein et al. 2014, p. 18). Also, Hoff (2011, p. 39) stresses this way of achieving policy integration and states that “it is more important to strengthen existing institutions so they can build new links across sectors and deal with the additional uncertainty, complexity and inertia when integrating a range of sectors and stakeholders.” He adds that those institutions can also better manage the challenges that come with integrated policies (Hoff 2011, p. 39). Policy integration on a vertical scale aims at coherent outcomes across the nexus policy fields (Nilsson et al. 2012, p. 398).

In operational terms speaking, vertical integration can be reached through the actors included in an action situation; for example, when relevant actors from each of the three policy fields are included in the policy-making process initiated within the boundaries of one specific policy field. Like this, the actors can exchange their knowledge and identify possible trade-offs in an early stage of the process. In the optimal case, the result is a policy or an institution that accounts for interlinkages, benefits from synergies, and minimizes the risk of negative side-effects (Bhaduri et al. 2015, p. 730). Like this, action situations get linked what fosters vertical integration across sectoral scales (Knieper et al. 2010, p. 597).

Also, outcomes of other action situations as well as other institutions can influence each other. Currently, the goals of the EU WFD should getting integrated into the EU CAP what represents an example for such an institutional impact (Europäischer Rechnungshof 2014, p. 6). A directive developed for the protection of European water resources shall be integrated in an existing policy framework that represents one of the major polluters. This means, that interlinkages, that were former neglected, are now about to be considered. In order to develop concrete and effective measures it might be necessary to break down the nexus of three policy fields into a number of sub-nexuses, such as the water-food nexus as it is done in the WFD/CAP example. However, those approaches should still bear the full picture in mind (Al-Saidi and Elagib 2017, p. 1137). The example also shows that sectoral policy-making can work as a precursor for cross-sectoral approaches by means of integrating existing institutions, especially in water policy (Beck and Villarroel Walker 2013, p. 637). Thinking further, these integrated sectoral approaches can eventually be replaced

by cross-sectoral policies. Vertical integration can serve as a relatively fast and practical solution in times of rapid changes and increasing scarcities (Hoff 2011, p. 39). As explained in section 3.2 on institutional change necessary structural changes are difficult to achieve and can take a long time.

However, section 3.2 also explained why policy integration necessitates institutional change and thus learning processes. For the case of vertical integration mostly double-loop learning is needed. Even though the processes mentioned above usually happen within sectoral boundaries single-loop learning does not suffice to break-up siloed approaches. Sectoral policies need to be profoundly altered (Armitage et al. 2008, p. 88) and complemented by a nexus perspective. In those cases, in which cross-sectoral approaches are not possible a higher level of policy coherence and mutual understanding would already be a great improvement (Rodriguez et al. 2015, p. 85).

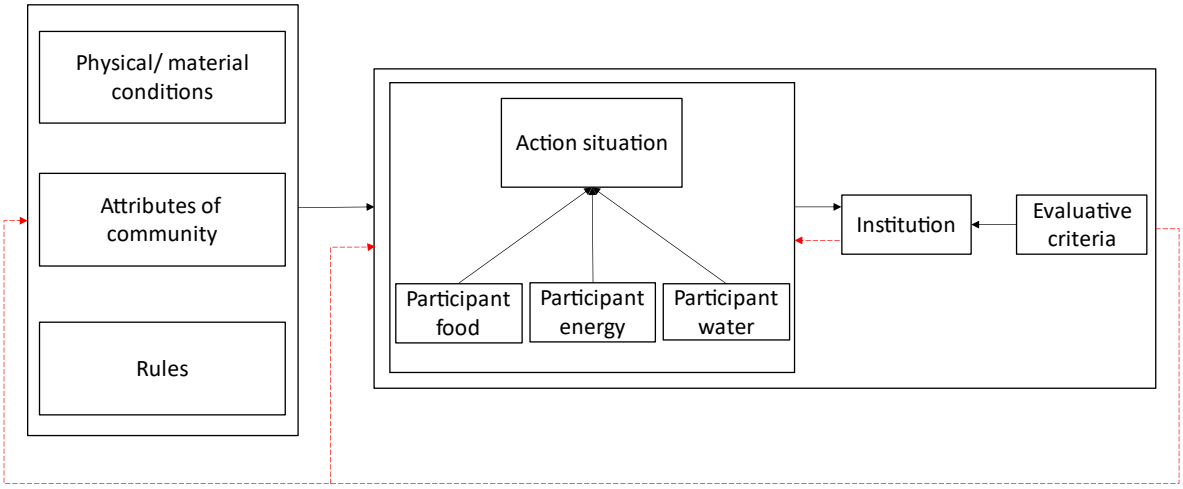
In terms of different governance modes, polycentric governance can be a driver for vertical integration. Instead of turning fragmented units of governance into one whole system, policy integration can be reached by an increased cooperation among these subunits and thus theoretically by preserving fragmented responsibilities (Candel and Pereira 2017, p. 91). Nevertheless, even if sector-related targets are an important step towards nexus governance, vertical integration also needs a central authority that monitors all activities and follows a comprehensive strategy (Di Gregorio et al. 2017, p. 37).

5.2.3. Holistic nexus framework

As mentioned above, vertical policy integration is an important component for successful nexus governance, but it needs to be complemented by the horizontal dimension. In classic EPI literature horizontal policy integration refers to an overarching strategy for EPI-related targets developed and monitored by a central authority (Lafferty and Hovden 2003, p. 14). For example, horizontal integration can occur in the form of strategies and plans, such as sustainable development strategies. For this kind of integration, a second framework is developed (cf. Figure 12) that leaves the sectoral level and instead is located on a supra-

sectoral level. It shows that actors from each of the policy fields are included in one action situation. The outcome would assume to be a comprehensive, fully integrated, nexus strategy that rules out potential conflicts by providing a predefined path and fixed priorities that work both as orientation and evaluative criteria for sectoral policies. This kind of integration can mostly be found on higher governance levels, such as the federal or even the EU level. This second framework represents a more holistic perspective on policy integration within the nexus and refers to what Al-Saidi and Elagib (2017, p. 1135) define as incorporation. It captures a stronger systems perspective addressing the whole SES on a higher level. This systems view has barely been used so far due to prevailing siloed management approaches (Al-Saidi and Elagib 2017, p. 1135). Nevertheless, this perspective is needed for nexus-related issues that tackle the biophysical as well as the technical, and social dimension (Madrid et al. 2013, p. 15).

Figure 12: Holistic nexus framework



Source: own Figure, based on (Ostrom 2005, p. 829).

For any nation-wide strategy to be successful, whether it is an adaptation, mitigation, or sustainable development strategy, the responsible authority needs a strong mandate in order to be able to further develop, push, and monitor the strategy (Biesbroek et al. 2010, p. 446). This authority could be the government itself or another kind of body or agency. A

ministry embracing the competencies for various nexus policy fields, for example, would probably make sense for countries in which some interlinkages are of higher importance than others, for example, if they depend on agriculture in water scarce regions (Al-Saidi and Elagib 2017, p. 1136). However, currently the responsibilities are divided among a broad variety of different actors which makes this kind of integration hard to reach (Howells et al. 2013, p. 621). The ministries that are involved most often in nexus issues are those of energy, economy, agriculture, and environment (European Environment Agency 2011, p. 10) whereas the latter classically embraces most of these responsibilities. However, in most cases, it does not suit as an authority. As explained above, the central authority should have a strong, legitimate mandate. This, however, is rarely the case for ministerial bodies since they are all located on the same level what impedes enforceability. Also, a cross-sectoral body, such as an inter-ministerial working group, is not assumed to be sufficiently strong. One exception can be made for departments or ministries that already possess established and recognized horizontal arrangements. In this case, horizontal integration is easier to achieve (Pardoe et al. 2017, p. 4).

Further tasks of the central authority include: putting important issues on the agenda, raising attention, and initiating action. Additionally, it is needed to provide information, support and generate necessary resources and capacities, and to take care of emerging conflicts through adequate regulation and instruments (Biesbroek et al. 2010, p. 446). The following implementation of these instruments and the strategy's goals again refer to the vertical dimension of policy integration. However, the initiative to integrate overarching goals into different policies in the first place, to mainstream policies by converting them into a coherent picture lies in the responsibility of the central authority. In most cases, this authority is incorporated by the government (Biesbroek et al. 2010, p. 446).

The development of an overarching strategy per se, already, constitutes a first challenge since it needs wide acceptance and active promotion (Candel and Pereira 2017, p. 90). A consensus on a comprehensive strategy including defined goals can have powerful radiance into sector-level policies (Candel and Pereira 2017, p. 91). Then, the question remains what

purpose these strategies are meant to fulfill. Are they about coordination and integration across various governance levels or should they set impulses for new activities on the local level? Are they supposed to keep up pushing a certain issue or should they rise awareness and recognition for the issue (Biesbroek et al. 2010, p. 448)? Even if a strategy is clear in what it pursues its actual impact also depends on the political will and competencies of the responsible authority.

Still, horizontal integration often faces the problem of resistance from sectoral departments since it usually involves a transfer of competencies. This can hinder the implementation process (Di Gregorio et al. 2017, p. 39). Also, these changes can come with high transaction costs due to strong path dependencies (cf. section 3.2.1). Yet, these structural changes are necessary in order to reach successful resource governance and a higher adaptive capacity. Therefore, higher levels of learning, such as double- and triple-loop learning, are required (Harwood 2018, p. 80). That is why initiatives for horizontal integration are assumed to be more probable within so-called windows of opportunity that are often caused by external events. In order to successfully use these windows the role of non-state actors and informal institutions, i.e. the role of polycentric governance, is emphasized (Pahl-Wostl et al. 2013, pp. 2–3). An additional issue is the time frame since policies often cannot be changed as fast as nexus-related issues occur (Howells et al. 2013, p. 625).

5.2.4. Discussion and section summary

The two frameworks described above show how policy integration within the nexus could look like. For successful management of the nexus both vertical and horizontal integration are necessary. Vertical integration takes place on a sectoral scale and can be achieved by lower levels of learning. In many cases, it builds on existing structures and institutions and results in increased cooperation and thus in nexus-smart sector policies. Still, by means of nexus-smart sector policies alone overarching goals, such as climate mitigation targets, most probably will not be achieved. Therefore, a central authority is necessary that enforces and monitors an overarching strategy which is defined as horizontal integration. The following table (Table 4) again summarizes main characteristics of both frameworks.

Table 4: Overview of the two integrated nexus frameworks

	Holistic nexus framework	**Nexus cooperation framework**
Aim	Nexus system perspective	Increased policy coherence and cross-sectoral cooperation
Benefits	Coordination, monitoring	High impact on everyday policy-making
Level of operation	Supra-sectoral level	Sectoral level
Outcome	Nexus strategies and plans, Nexus ministry or agency	Nexus-smart sector policy
Level of integration	Horizontal	Vertical
Level of learning	Double- and triple-loop learning	Double-loop learning
Perspective	Holistic nexus perspective	Single policy field perspective considering other policy fields

Source: own Table.

By emphasizing the need for policy integration, it, however, seems that current nexus literature neglects possible negative costs or unfavorable dynamics of a higher level of policy integration. Hence, the question arises if more integration automatically has to be advantageous. Areas might exist in which more integration is not needed or even disadvantageous (Weitz et al. 2017, p. 171). Also, it seems to be too narrow to only talk in categories of synergy or conflict since the interconnections between the policy fields are much more complex. However, occasionally, these are the only categories that nexus literature is dividing into yet (Weitz et al. 2017, p. 168). This hints to the fact that a suitable integrated nexus policy design highly depends on the specific case study. Thus, a need for more concrete case study analyses exists, especially on the national level since it takes an important role in dealing with increasing impacts of climate change and the supply of energy, water, and food resources (Al-Saidi and Elagib 2017, p. 1136). For these cases specific policy implications can be derived what would help to transform the nexus from a conceptual into a practical approach (Al-Saidi and Elagib 2017, p. 1137). Therefore, the

value-based integrated framework for institutional change that was structurally developed through sections 3 to 5 is applied to the case study of Germany in the second part of the thesis.

6. Case study Germany

6.1. Research question and background

In the first part of this thesis an integrated value-based framework for analyzing governance challenges related to the FEW nexus was developed. In this second part, this framework will be used for the case study of Germany, in particular for an analysis of nexus governance on the federal level. Three main reasons exist why Germany is well suited as a case study: firstly, its federal structure and EU membership, secondly relatively stable political conditions for many years, and thirdly, a high societal awareness for environmental and climate issues.

As explained in section 5.1.1 multiple governance levels are important scales for policy integration. In Germany, MLG is of special importance. As a founding country and important member of the EU, many developments in nexus-related policy fields are influenced or even determined on the European level. The importance of EU regulations and their processes of implementation highly differ among these policy fields and thus need to be considered for policy integration. Due to its size and economic power Germany, in turn, also significantly influences EU policies. This bilateral relation is an important factor for the development of nexus policies. MLG, however, is also of high importance within Germany. Because of its federal structure the role of the federal states must not be neglected. The responsibilities for many nexus-related issues are divided between the federal and the state level. Similar to EU regulations also the role of the federal states strongly differs between the different policy fields (Benz 2010, pp. 121–127). These MLG processes increase the complexity of nexus governance, nevertheless, they need to be understood. By using Germany as a case study, the importance of MLG is well represented.

The second reason making Germany very well suited for this analysis are its stable political conditions. Angela Merkel (Christian Democrats, CDU), currently chancellor in her fourth term, is governing since 2005. She replaced the red-green coalition of Social Democrats (SPD) and the green party (BÜNDNIS 90/DIE GRÜNEN) led by Gerhard Schröder. Since she

first took office Angela Merkel governed three times in a grand coalition of CDU/CSU and SPD (2005-2009, 2013-2017, and 2017-now), and once in a black-yellow coalition between the CDU/CSU and the Liberal Democrats (FDP) (2009-2013) (Hake et al. 2015, pp. 539–543). These relatively stable political conditions over a long period facilitate an assessment of underlying values, guiding principles and institutional developments. Furthermore, they allow for a better monitoring of objectives and goals since they are more likely to be maintained in times of similar political conditions. In addition, the role of external factors, such as extreme events or crises, can better be evaluated if political conditions do not regularly change profoundly.

Thirdly, in Germany a high awareness for environmental and climate issues exists that dates back to the 1970s. Back then, the nuclear protests and the green movement became stronger and more influential (Andrews-Speed 2016, p. 222). The first German environmental action program was developed in 1971, the green party was founded in 1980 and the Federal Ministry for the Environment (BMU) was established in 1986. Already back then the idea of a profound transformation of the energy system towards more renewables was born. Since the Fukushima accident in 2011 German energy and climate policy has been internationally known as the German “Energiewende”, an energy transition that aims at a low-carbon energy system by 2050 and a nuclear phase-out until 2022 (Hake et al. 2015, pp. 542–544). In 2019, additionally the phase-out of lignite and hard coal until 2038 was agreed upon and resulted in the coal phase-out act (Kohleausstiegsgesetz 8/8/2020). The energy transition not only touches upon technical and environmental but also social aspects. It is characterized as a major societal transformation project (Heinrichs et al. 2017, p. 23). Besides its relevance for the energy sector, the energy transition is also connected to various other policy fields, such as transportation, land use or agriculture. These change processes gave rise to various nexus-related issues, such as land demand for renewables or the production of biofuels, and can provide valuable insights into the management of cross-sectoral challenges (Scheftelowitz et al. 2018, p. 8). Furthermore, the problem of sectoral fragmentation, which is often referred to in nexus research at least at a first glance, seems

also to apply for Germany. The responsibilities for the nexus policy fields are spread over three different federal ministries: the Federal Ministry of Food and Agriculture (BMEL), the Federal Ministry for Economic Affairs and Energy (BMWi), and the above-mentioned BMU. Whether these divided responsibilities also imply a lack of policy integration, amongst others, will be one aspect of the following analysis. These factors combined with a high level of data availability necessary for the analysis make Germany a good sample case for an analysis of nexus governance on the national level.

In order to answer the overarching research question discussed above and as a precondition for doing a comprehensive assessment on nexus governance – presented in section 6.5 – several other questions need to be analyzed first. These questions correspond to the methodological thoughts developed in sections 2 to 5 and will thus determine the structure of this part on the case study (cf. Table 5). On the way to the comprehensive assessment of nexus governance, first, the following questions need to be answered:

Table 5: Research questions of section 6.3

Research question	Main aspects	Related section
What are the most important institutions in the nexus and nexus-related policy fields and how did they develop?	Institutions, institutional change, actors	Section 3
What actors and instruments are important to reach these goals?		
What underlying values can be found in nexus-related policies and how do they affect institutional development?	Values, value conflicts, purpose of institutions, goals	Section 4
What are the main objectives and goals of nexus-related policy fields in Germany?		

Source: own Table.

In order to answer these questions, the value-based framework developed in sections 3 and 4 is used. By addressing these questions several important aspects can be revealed: amongst others, how institutional change processes work in the different policy fields, on what governance levels these changes occur, what actors or events are relevant for change, what institutions, goals or values are of importance for more than one policy field, or where potential value conflicts exist. After these questions have been analyzed, in section 6.4 the focus will shift towards aspects of policy integration by using the integration frameworks developed in section 5. Therefore, again several questions will guide the analysis (cf. Table 6).

Table 6: Research questions of section 6.4

Research question	**Main aspects**	**Related section**
Are there cases of established nexus thinking on the federal level in Germany?	Systems thinking	Section 2
What are the most important nexus issues in Germany?	Policy integration, nexus integration frameworks	Section 5
What kind of policy integration can be found regarding these nexus issues?		

Source: own Table.

Against this background the final assessment of nexus governance in Germany will be done. The aim, on the one hand, is to reveal where, why and what kind of integration works and, on the other, what the main barriers of integration are. Based on these insights policy recommendations for existing nexus issues will be developed. However, before the research questions are addressed, first, the methods will be described in the next section.

6.2. Methods

6.2.1. Qualitative Document Analysis

The state of nexus governance challenges on the federal level in Germany is mainly analyzed by means of a qualitative document analysis. Therefore, selected policy documents were investigated using the method of qualitative content analysis (QCA). The definition of QCA to which most researchers refer was developed in the 1980s by Philip Mayring (Kaefer et al. 2015, p. 4). Mayring defined QCA as "an approach of empirical, methodological controlled analysis of texts within their context of communication, following content analytical rules and step by step models, without rash quantification" (Mayring 2000, p. 2). This definition implies that QCA is a structured process of data interpretation. The basic idea of any data analysis is looking for patterns in the data material (Kohlbacher 2006, p. 9). Therefore, texts are thoroughly analyzed by assigning themes or categories to related text passages revealing certain patterns. The aim is to subjectively interpret the content of text material within its context by means of a structured approach (Hsieh and Shannon 2005, p. 1278). QCA emerged as a response to quantitative content analysis which was already used in the 1950s, mostly in form of frequency analyses. Many scholars criticized this quantitative approach of being a superficial method neglecting the context and not being able to adequately represent patterns. In his approach, Mayring suggested to develop a category, or code-system that can be used to highlight text passages (Kohlbacher 2006, p. 11). According to Kohlbacher (2006, p. 12), he, thereby, addressed the weaknesses of classical quantitative content analysis by a systematic and theory-guided process. Mayring (2000, p. 1) stated that the main idea of QCA is "to preserve the advantages of quantitative content analysis as developed within communication science and to transfer and further develop them to qualitative-interpretative steps of analysis." Thus, QCA aims at maintaining the transparency of quantitative content analysis while unifying two different methodological principles that usually contradict each other: openness and theory-guided investigation (Kaefer et al. 2015, p. 3). The advantages of QCA are twofold: on the one hand, it embraces the whole material and its complexity by taking a comprehensive perspective on the text.

On the other hand, a structured and rule-based category system is applied that breaks down the complexity (Kohlbacher 2006, p. 24). QCA is done in a stepwise fashion. Hsieh and Shannon (2005, p. 1285) suggest seven consecutive steps that are needed for any QCA:

1. Developing the main research question.
2. Choosing the data material.
3. Identifying main categories.
4. Drafting the process of coding and the necessary training for the coder.
5. Conducting the coding.
6. Ensuring the reliability.
7. Analyzing of the results.

These steps can be connected through feedback loops and in some cases, they need to be undertaken repeatedly to clarify the research questions or to refine the categories (Kohlbacher 2006). The final categories usually appear within a case-specific coding scheme. Thus, the development of a good, suitable, and valid coding scheme that allows answering the research question is the heart and soul of any QCA and usually necessitates many steps of pilot or double coding and refinement (Kaefer et al. 2015, p. 9). A good coding scheme is not only the tool to systematize the data but also to ensure the transparency and reliability of the coder. During the coding process text passages are tagged to different codes which break the passages down into a number of content categories (Hsieh and Shannon 2005, pp. 1285–1286).

There are two ways of developing a coding scheme: inductively and deductively. In deductive coding processes, the coder starts with a set of categories and themes that were defined prior to the analysis. This set is used as a frame and is applied to the text material (Kaefer et al. 2015, p. 10). The process of analysis, basically, is “controlled assignment of the category to a passage of text” (Kohlbacher 2006, p. 20). In deductive coding clear definitions, examples, and assignment rules are developed for every code in order to define in which cases a text fragment is tagged with a code (Mayring 2000, p. 5). This way of

developing a coding scheme is mostly used in cases where texts are supposed to be examined with regard to specific aspects that were defined beforehand. Thus, the categories included in the coding scheme are of main interest to the researcher rather than the text material. This process is rather used for confirmative research which tests hypotheses that have been formulated a priori (Nilsen et al. 2020, p. 843).

In inductive coding, on the other hand, the researcher starts with the text material. Inductive coding is characterized by an open procedure in which the categories are derived from the material itself rather than being defined prior to the analysis. This kind of coding scheme development is much closer to the actual material (Kohlbacher 2006, p. 19). Hence, the final coding scheme emerges while the texts are read. In this case, the research focus is set on the text material itself. Usually, this way of coding is suitable for grounded-theory analyses or strongly explorative analyses (Kaefer et al. 2015, p. 10). It is thus especially appropriate for studies that aim at uncovering new patterns and for research topics that just emerged, that have not been investigated much, or about which only little is known (Nilsen et al. 2020, p. 843).

Both ways of developing a coding scheme inhere advantages and weaknesses, which depend on the respective case study or research question. For some cases, like this study, a combination of both methods can be very useful. In these cases, some important categories can be derived from theory or literature, independently from the data material. In this study, for example, the three nexus policy fields of food, energy and water or vertical and horizontal policy integration form such categories. Other relevant categories, however, such as case study specific parameters, might be overlooked by this method. Therefore, in this study, first, an initial coding scheme was developed deductively prior to the analysis. It included main categories and schemes derived from theory and literature. It covered the most important aspects regarding the research questions. Afterwards, additional relevant categories were derived inductively from a document sample and used to complement or refine the coding scheme. In a final step, the whole data material was analyzed again using

the final coding scheme. The development of the coding scheme and the process of coding will be further described in the following sections (cf. sections 6.2.1.2 and 6.2.1.3.).

A QCA can either be done manually or computer-based. Since the 1990s, computer-assisted qualitative data analysis software (CAQDAS), such as MAXQDA or Atlas.ti, has been developed. Using software bears some key advantages over manual coding: Firstly, it allows a high flexibility during the analysis since codes can be created or deleted at any time, and text passages can be double or newly coded. Secondly, it facilitates the transparency of the analysis since every researcher can track the coding procedure (Kaefer et al. 2015, p. 16). Despite small modifications, the seven-step-approach, mentioned above, also applies for the use of CAQDAS. The steps of selecting and learning the software are added prior to step 1. Additionally, various tools for data visualization and presentation included in the software, complement the last step of analyzing the results (Kaefer et al. 2015, p. 6). In this thesis, the software MAXQDA was chosen due to its user-friendliness and its valuable tools, such as mixed methods features or visual tools. For the qualitative document analysis, the version MAXQDA 12 was used (VERBI GmbH 2015). The expert interviews, which will be described in section 6.2.2., were transcribed and analyzed with MAXQDA 2018 (VERBI GmbH 2017). This is because the 2018 version was launched after the document analysis was completed.

As mentioned above, QCA developed in response to criticism on classical quantitative content analysis. For a long time, both ways of data analyses were strictly divided and seen as opposing each other. In recent years, however, more and more researchers began to combine quantitative and qualitative approaches in so-called mixed-methods approaches. As Patricia Bazeley stated at the 2019 International MAXQDA Conference in Berlin: “The phenomena we study are not divided, even if our thinking about them often is” (Bazeley 2/28/2019, p. 4). She defined mixed-methods analyses as “the extent that different data elements and various strategies for analysis of those elements are combined throughout a study in such a way as to become interdependent in reaching a common theoretical or research goal, thereby producing findings that are greater than the sum of the parts”

(Bazeley 2010, p. 432). Nowadays, many scholars see clear advantages in such approaches since they can offer new valuable insights and a more holistic perspective on the research issue. It is also useful in analyzing specific case studies in order to cover additional aspects and different dimensions of the problem (Kohlbacher 2006, pp. 26–27). The advantages of both methods can be used to develop a combined approach. Quantitative and qualitative approaches can complement each other in various ways (Kohlbacher 2006, p. 23). For example, a preceding qualitative analysis can reveal critical themes that are to be investigated in large-scale quantitative analyses. Qualitative analysis can also provide in-depth knowledge about certain topics that were revealed in a quantitative analysis. Also, within the qualitative document analysis in this study quantitative features were used.

6.2.1.1. Selection of policy documents

As stated by Hsieh and Shannon (2005, p. 1285) choosing the data material constitutes the second step in a QCA after the definition of the research questions, which was done in section 6.1. The documents for the QCA were researched and selected between January and July 2018. The author followed a structured approach in searching for documents. The objective, thereby, was to find and analyze the most relevant policy documents rather than all nexus related ones. Qualitative analyses are characterized by a lower number of cases that allow an in-depth analysis considering the context (Venghaus and Hake 2018, p. 186). The objective of the document analysis in this study was to identify relevant nexus issues in Germany, barriers for policy integration or examples of successful management. The endeavor was not to conduct a large-scale study but rather a qualitative, in-depth assessment of nexus challenges on the federal level. For this reason, the selection of documents neither aimed to be complete nor representative. It aimed at representing critical policy documents revealing the most important nexus challenges.

In a first step, a suitable time period for the selection of documents was defined. Documents from different points in time were necessary to analyze possible value changes and institutional change processes. In this study, documents from the year 2000 onwards were considered. This decision can be seen against the background of the international context

at the time: the adoption of the Kyoto Protocol in 1997 and the MDGs in 2000. It marks a time in which climate protection and sustainable development became important political issues. As explained in section 2.1 international conferences on these two issues strongly impacted the emergence of integrated resources management approaches and, eventually, also the nexus concept. In Germany, this was reflected by the publication of the first climate protection program in 2000 (Bundesregierung 2000) and the first sustainable development strategy in 2002 (Bundesregierung 2002), which are both included in the document analysis. In a second step, relevant document categories for the analysis were defined against the background of the methodologic thoughts developed in sections 3 to 5. For an institutional analysis of nexus governance challenges on the federal level in Germany nexus-related formal federal rules were the main subject of investigation that is federal strategies and plans as well as laws and regulations related to the nexus. In a third step, policy fields relevant for the nexus were defined. With respect to section 2.1 the following policy fields were identified as important: energy, water, food/agriculture, climate, environment, and sustainable development.

Against the background of these preliminary considerations and EPI literature, German sustainable development strategies served as the starting point. Due to their overarching character, they address many nexus-related policy fields. To find the most relevant documents related to the sustainable development strategies the author searched for the term “Nachhaltigkeitsstrategie Deutschland” (German sustainable development strategy) on the official website of the German government. This search resulted in seven hits, which were all included in the document analysis (cf. Table 7, no. 1-7). Among them, both official German sustainable development strategies of 2002 (NHS 2002) and the new version of 2016 (NHS 2016). In between, the German government published three progress reports, in 2004 (FB 2004), 2008 (FB 2008), and 2012 (FB 2012). Additionally, two more documents exist from 2005 (WWN) and 2012 (10JN). In Germany, the Federal Statistical Office (Destatis) is responsible for the official monitoring of the strategy. Since 2006 Destatis published an indicator report every two years, in which the progress of the objectives

defined in the strategy is evaluated. At the time of the QCA seven of these reports existed. The indicator reports are openly available at the Destatis website (Statistisches Bundesamt 2020a). These indicator reports were also included in the document analysis (cf. Table 7, Ind06 – Ind16).

Table 7: Documents related to the German sustainable development strategy

No.	Original document name	English name	Year	Abbr.	Reference
	Sustainable development strategies and progress reports				
1	Perspektiven für Deutschland. Unsere Strategie für eine nachhaltige Entwicklung	Perspectives for Germany. Our strategy for sustainable development	2002	NHS 2002	(Bundesregierung 2002)
2	Perspektiven für Deutschland. Unsere Strategie für eine nachhaltige Entwicklung. Fortschrittsbericht 2004	Perspectives for Germany. Our strategy for sustainable development. Progress report 2004	2004	FB 2004	(Bundesregierung 2004)
3	Wegweiser Nachhaltigkeit 2005: Bilanz und Perspektiven	Guide on sustainable development 2005: Balance sheet and perspectives	2005	WWN	(Bundesregierung 2005)
4	Fortschrittsbericht 2008 zur nationalen Nachhaltigkeitsstrategie: Für ein nachhaltiges Deutschland	Progress report 2008 on the national strategy for sustainable development: For a sustainable Germany	2008	FB 2008	(Bundesregierung 2008)
5	Nationale Nachhaltigkeitsstrategie. Fortschrittsbericht 2012	National strategy for sustainable development. Progress report 2012	2012	FB 2012	(Bundesregierung 2012b)
6	10 Jahre Nachhaltigkeit "made in Germany". Die Nationale Strategie für eine nachhaltige Entwicklung	10 years sustainable development “made in Germany”. The national strategy for sustainable development	2012	10JN	(Bundesregierung 2012a)
7	Deutsche Nachhaltigkeitsstrategie. Neuauflage 2016	German sustainable development strategy. New edition 2016	2016	NHS 2016	(Bundesregierung 2017)
	Indicator reports				
8	Nachhaltige Entwicklung in Deutschland. Indikatorenbericht 2006	Sustainable development in Germany. Indicator report 2006	2006	Ind06	(Statistisches Bundesamt 2007)
9	Nachhaltige Entwicklung in Deutschland. Indikatorenbericht 2008	Sustainable development in Germany. Indicator report 2008	2008	Ind08	(Statistisches Bundesamt 2008)
10	Nachhaltige Entwicklung in Deutschland. Indikatorenbericht 2010	Sustainable development in Germany. Indicator report 2010	2010	Ind10	(Statistisches Bundesamt 2010)
11	Nachhaltige Entwicklung in Deutschland. Indikatorenbericht 2012	Sustainable development in Germany. Indicator report 2012	2012	Ind12	(Statistisches Bundesamt 2012)

12	Nachhaltige Entwicklung in Deutschland. Indikatorenbericht 2014	Sustainable development in Germany. Indicator report 2014	2014	Ind14	(Statistisches Bundesamt 2014)
13	Nachhaltige Entwicklung in Deutschland. Indikatorenbericht 2016	Sustainable development in Germany. Indicator report 2016	2016	Ind16	(Statistisches Bundesamt 2017)

Source: own Table.

Afterwards, the author searched for strategies and plans in the other nexus policy fields. First and foremost, climate action plans were considered in the field of climate policy. In total, four climate action plans were found from the years 2000 (KP 2000), 2007 (IntEKP), 2014 (APKlima), and 2016 (KSP 2050). They were downloaded from the website of the BMU and got included in the document analysis (cf. Table 8, no. 14-17). Besides climate action program also strategies and concepts from the other nexus related policy fields were included in order to represent them in a balanced way. For the field of energy, the energy concept of 2010 (EnKonz) and the federal action plan on energy efficiency (NAPE) were included because they were repeatedly referred to within the NHS 2016 (cf. Table 8, no. 18-19). For the field of food and agriculture the green book on nutrition, agriculture, and rural areas was included (GBEL) (cf. Table 8, no. 20). Since agricultural policy is completely communitized on the European level, only few national concepts were found. In Germany, water policy is traditionally treated as a part of environmental policy. Therefore, the current environmental protection program (IntUP) was included. Additionally, the latest monitoring report for water pollution through nitrate (NB 2016) was considered (cf. Table 8, no. 21-22).

Table 8: National strategies and plans from the other policy fields

No.	Original document name	English name	Year	Abbr.	Reference
	Climate action plans				
14	Nationales Klimaschutzprogramm	National climate action plan	2000	KP 2000	(Bundesregierung 2000)
15	Integriertes Energie- und Klimaprogramm	Integrated energy and climate program	2007	IntEKP	(Bundesregierung 2007)
16	Aktionsprogramm Klimaschutz 2020 der Bundesregierung	Climate action program 2020	2014	APKlima	(Bundesregierung 2014a)
17	Klimaschutzplan 2050 – Klimapolitische Grundsätze der Bundesregierung	Climate action plan 2050	2016	KSP 2050	(BMUB 2016b)
	Other policy fields				
18	Energiekonzept für eine umweltschonende, zuverlässige und bezahlbare Energieversorgung	Energy concept – for an environmentally friendly, secure, and affordable energy supply	2010	EnKonz	(BMWi and BMU 2010)
19	Nationaler Aktionsplan Energieeffizienz	National action plan on energy efficiency	2014	NAPE	(Bundesregierung 2014b)
20	Grünbuch Ernährung, Landwirtschaft, ländliche Räume	Green book on nutrition, agriculture, and rural areas	2016	GBEL	(BMEL 2016)
21	Den ökologischen Wandel gestalten – Integriertes Umweltprogramm 2030	Integrated environment protection program	2016	IntUP	(BMUB 2016a)
22	Nitratbericht 2016	Nitrate report 2016	2017	NB 2016	(BMUB and BMEL 2017)

Source: own Table.

Besides national strategies and plans, laws and regulations are important formal rules that need to be considered for an institutional analysis. For this reason, central laws from the nexus and nexus related policy fields were included as well (cf. Table 9). Due to the vast number of existing laws and regulations a selection was necessary. Selected were those formal rules of each policy field that gained the most attention in the NHS 2016 and NHS 2002. At the same time, choices were made so that a similar number of documents would represent the three nexus policy fields. In the end, five regulations from agricultural policy (DüV, AgrarZahlVerpflG, AgrarZahlVerflV, DirektZahlDurchfG, DirektZahlDurchfV) (cf. Table 9, no. 23-27) and four regulations each from energy (EEG 2017, EEV, EnWG, BiomasseV) (no. 28-31) and water policy (WHG, AbwV, OGewV, GrwV) (no. 32-35) were selected. Additionally, two environmental policy regulations were included (BNatSchG, BImSchG) (no. 36-37).

Table 9: Laws and regulations

No.	Original document name	English name	Year	Abbr. (= Reference)
	Agriculture			
23	Düngeverordnung	Fertilizer Ordinance	2007	(Düngeverordnung 3/5/2007)
24	Agrarzahlungen-Verpflichtungsgesetz	Agricultural Payments Commitments Act	2014	(Agrarzahlungen-Verpflichtungengesetz 12/2/2014)
25	Agrarzahlungen-Verpflichtungsverordnung	Agricultural Payments Commitments Ordinance	2014	(Agrarzahlungen-Verpflichtungenverordnung 12/17/2014)
26	Direktzahlungen-Durchführungsgesetz	Direct Payments Implementing Act	2014	(Direktzahlungen-Durchführungsgesetz 7/9/2014)
27	Direktzahlungen-Durchführungsverordnung	Direct Payments Implementing Ordinance	2014	(Direktzahlungen-Durchführungsverordnung 11/3/2014)
	Energy			
28	Erneuerbare Energien Gesetz 2017	Renewable Energy Act 2017	2017	(Erneuerbare-Energien-Gesetz 2017 7/17/2017)
29	Erneuerbare Energien Verordnung	Renewable Energy Ordinance	2015	(Erneuerbare-Energien-Verordnung 2/17/2015)
30	Energiewirtschaftsgesetz	Federal Energy Act	2005	(Energiewirtschaftsgesetz 7/7/2005)
31	Biomasseverordnung	Biomass Ordinance	2001	(Biomasseverordnung 6/21/2001)
	Water			
32	Wasserhaushaltsgesetz	Federal Water Act	2009	(Wasserhaushaltsgesetz 7/31/2009)

33	Abwasserverordnung	Waste Water Ordinance	2010	(Abwasserverordnung 3/21/1997)
34	Oberflächengewässerverordnung	Surface Water Ordinance	2016	(Oberflächengewässerverordnung 6/20/2016)
35	Grundwasserverordnung	Groundwater Ordinance	2010	(Bundesregierung 11/9/2010)
	Environment			
36	Bundesnaturschutzgesetz	Federal Nature Conservation Act	2009	(Bundesnaturschutzgesetz 7/29/2009)
37	Bundesimmissionsschutzgesetz	Federal Immission Control Act	1974	(Bundes-Immissionsschutzgesetz 3/15/1974)

Source: own Table.

Also, the website of the German Council for Sustainable Development (Rat für Nachhaltige Entwicklung, RNE) and the Parliamentary Council for Sustainable Development (Parlamentarischer Beirat für nachhaltige Entwicklung, PBnE) provided a large pool of interesting documents, mostly in the form of statements or policy recommendations. However, not all of the documents found on these websites, proved to be relevant for the nexus. Therefore, the following documents were chosen: all documents that were directly related to one of the documents included in the other groups, such as statements about the sustainable development strategy and documents that refer to one of the nexus policy fields. All RNE and PBnE documents included in the document analysis are displayed in Table 10. Because of the long document titles a shorter title was used in Table 10[6]. Documents no. 38-49 represent RNE statements to the NHS 2002 and NHS 2016, document no. 61-64 are statements of the PBnE. The other documents address the nexus policy fields (no. 50-60 (RNE) and no. 65-69 (PBnE)).

The final document sample consisted of $n_{documents} = 72$ from the four groups: (I) sustainable development strategies and related progress and monitoring reports, (II) concepts and plans, (III) laws and regulations, and (IV) RNE and PBnE documents.[7]

[6] For the full document name refer to Table 19 in Annex I.
[7] Annex I again shows a comprehensive list of all analyzed documents.

Table 10: Policy statements of the RNE and PBnE

No.	Document short name German	Document short name English	Year	Abbr.	Reference
	RNE				
38	Projektvorschläge des Rates für Nachhaltige Entwicklung	Project proposals of the Council for Sustainable Development	2001	RNE NHS02 Pro	(RNE 2001a)
39	Stellungnahme zu den Pilotprojekten	Statement on the pilot projects	2001	RNE Pilot	(RNE 2001b)
40	Stellungnahme zur Nationalen Nachhaltigkeitsstrategie der Bundesregierung	Statement on the federal strategy for sustainable development	2002	RNE NHS02	(RNE 2002)
41	Stellungnahme zum Regierungsentwurf des Fortschrittsberichts 2004	Statement on the government draft for the 2004 progress report	2004	RNE FB04 Ent	(RNE 2004a)
42	Beitrag zum Fortschrittsbericht 2004	Contribution to the 2004 progress report	2004	RNE FB04 GP	(RNE 2004b)
43	Stellungnahme zum Fortschrittsbericht 2004	Statement on the 2004 progress report	2005	RNE FB04	(RNE 2005)
44	Stellungnahme zum Indikatorenbericht 2006	Statement on the 2006 indicator report	2008	RNE Ind06	(RNE 2008c)
45	Stellungnahme zum Bericht des „Peer Review“	Statement on the peer review report	2013	RNE Peer 2013	(RNE 2013d)
46	Stellungnahme zum Indikatorenbericht 2014	Statement on the 2014 indicator report	2014	RNE Ind14	(RNE 2014c)
47	Für eine Richtungsentscheidung zur Nachhaltigkeitspolitik	For a directional decision on sustainability policy	2014	RNE NachP	(RNE 2014b)
48	Stellungnahme zur Nachhaltigkeits-Architektur und den SDGs	Statement on the sustainability design and the SDGs	2015	RNE SDGs	(RNE 2015a)
49	Stellungnahme zum Regierungsentwurf der Deutschen Nachhaltigkeitsstrategie	Statement on the government draft for the 2016 sustainable development strategy	2016	RNE 16 Ent	(RNE 2016b)

50	Erwartungen und Empfehlungen an die Bundesregierung	Expectations and recommendations to the Federal Government	2016	RNE 16 Emp	(RNE 2016a)
51	Anforderungen der Nachhaltigkeitspolitik an die Koalitionsverhandlungen	Requirements of the sustainability policy to the coalition negotiations	2013	RNE Koal 13	(RNE 2013e)
52	Der Strompreisdebatte fehlt die Nachhaltigkeit	The electricity price debate lacks sustainability	2013	RNE Strom	(RNE 2013a)
53	Die Energiewende braucht eine verbindliche und wirksame Energieeffizienzpolitik.	The energy transition needs a binding and effective energy efficiency policy	2012	RNE EnW	(RNE 2012)
54	Einen politischen Aktionsrahmen zum Ziel 30 Hektar schaffen	A political framework for action towards the 30-hectare target	2013	RNE Flä	(RNE 2013b)
55	Für ein politisches Signal zur Stärkung der Rolle des ökologischen Landbaus in Europa	For a political signal to strengthen the role of organic farming in Europe	2013	RNE Land	(RNE 2013c)
56	Bodenschutz	Soil protection	2014	RNE Boden	(RNE 2014a)
57	Position des Nachhaltigkeitsrates zur Revision der EU-Öko-Verordnung	Position of the Sustainability Council on the revision of the EU Eco-Regulation	2015	RNE Öko EU	(RNE 2015c)
58	Agrarpolitik der Europäischen Union	Agricultural policy of the European Union	2017	RNE GAP	(RNE 2017)
59	Schutz der Biodiversität heißt aktuell: Biomasse-Produktion nachhaltig machen	Conserving biodiversity now means: Making biomass production sustainable	2008	RNE Bio	(RNE 2008b)
60	Position des Nachhaltigkeitsrates zu aktuellen Fragen der Klima- und Energiepolitik	Position of the sustainability council on current issues of climate and energy policy	2008	RNE KliEn	(RNE 2008a)
61	Klimaschutz auf Deutschlands Agenda!	Climate protection on Germany's political agenda!	2015	RNE Klima	(RNE 2015b)
	PBnE				
62	Stellungnahme zum Bericht des Peer Review	Statement on the peer review	2014	PBnE Peer	(PBnE 2014)

63	Stellungnahme zum Indikatorenbericht 2014	Statement on the 2014 indicator report	2015	PBnE Ind14	(PBnE 2015e)
64	Impulspapier zum Entwurf der Deutschen Nachhaltigkeitsstrategie 2016	Impulse paper for the draft of the 2016 German Sustainability Strategy 2016	2016	PBnE IP NHS 16	(PBnE 2016b)
65	Stellungnahme zur Deutschen Nachhaltigkeitsstrategie 2016	Statement on the German strategy for sustainable development 2016	2017	PBnE NHS 16	(PBnE 2017b)
66	Ein langer Weg in eine nachhaltige Zukunft der Europäischen Union	A long road to a sustainable future for the European Union	2017	PBnE IP EU	(PBnE 2017a)
67	Impulspapier zur Tagung des “High Political Forum on Sustainable Development”	Impulse paper on the “High Political Forum on Sustainable Development” meeting	2016	PBnE IP VN	(PBnE 2016a)
68	Stellungnahme zu den SDGs	Statement on the SDGs	2015	PBnE SDGs	(PBnE 2015f)
69	Nachhaltige Stadtentwicklung	Sustainable urban development	2015	PBnE Stadt	(PBnE 2015d)
70	Nachhaltig Wirtschaften	Sustainable economic development	2015	PBnE Wi	(PBnE 2015c)
71	Mehr Transparenz für Verbraucher	Transparency for consumers	2015	PBnE Ver	(PBnE 2015b)
72	Bundestag-Fahrdienst	Parliamentary driving service	2015	PBnE Mob	(PBnE 2015a)

Source: own Table.

6.2.1.2. Development of the coding scheme

As mentioned above a well-developed coding scheme can be described as the heart and soul of any QCA. For this thesis, the coding scheme was developed in a process that combined the deductive and inductive approach. This method was chosen since it best served the purpose of analyzing the research question. In order to develop an initial coding scheme, the author started deductively by defining basic categories that were derived from the conceptual thoughts made in sections 3 to 5. Hence, the FEW nexus integration frameworks served as a basis for creating codes that represent their elements. The first code group, thus, referred to *I. Governance* and consisted of the governance level, actors, outcomes, and evaluation. In order to include the value perspective developed in section 4, a value category was added to this group. The sectoral level formed the second code group (*II. Sector*) and consisted of the three nexus policy fields food, energy, and water, as well as the important nexus-related policy fields of the ecosystem, and climate. One critical issue that became visible was caused by the fact that the nexus concept only emerged around the year 2011. As outlined in section 2, it can be seen as a relatively new concept even if its main idea of integrated thinking is not that new. Hence, a search for the term 'FEW nexus' was not expected to be very helpful. Consequently, the nexus needed to be understood as nexus thinking, which was included as a sub-code in this group. The code was intended to capture the interconnections between the three policy fields. The third code group represented the *III. Context factors*, namely infrastructures, and the societal conditions. These basic categories and codes served as a first frame and as the initial coding scheme (cf. Table 11) that, however, had no connection to the case study.

Table 11: Initial coding scheme

I. Governance	II. Sector	III. Context factors
Governance level	Food	Infrastructures
Actors	Energy	Societal conditions
Outcomes	Water	
Evaluation	Ecosystem	
	Climate	
	Nexus thinking	

Source: own Table.

Since “the nexus concept forms a superior analytical concept for the analysis of SES that needs to be defined context-specifically”, as stated in section 2.3, a more detailed coding scheme was necessary to be able to analyze the German case. In a first step, therefore, the NHS 2016 was used because of its universal character that touches upon many nexus-related issues. The strategy gave a broad overview on relevant aspects and thus served as a decent starting point. However, to come up with a valid coding scheme that captured the important aspects needed for adequately analyzing the nexus in Germany the scheme was developed further in an inductive process using a selected pre-sample of documents. Therefore, a certain number of documents from each of the four document groups presented in the previous section were chosen. The rule that applied for the selection of documents from group I, II and IV was to pick the newest and oldest documents each to capture the time horizon of the analysis. In the first group, this was the NHS 2002 and the NHS 2016. Additionally, the oldest and newest monitoring reports (SB Ind06 and SB Ind16) were included in order to ensure a more holistic picture. In the fourth group, important RNE and PBnE documents related to the NHS 2002 and NHS 2016 were included in the pre-sample. In the second group, the KP 2000 and the KSP 2050 were chosen. With regard to group III, one law from each of the policy fields food, energy, and water as well as environment was selected to cover the sectoral range. Table 12 shows the list of the documents included in the pre-sample.

Table 12: Documents included in the pre-sample

Doc. group	**I. NHS/ progress and monitoring reports**	**II. Concepts and plans**	**III. Legal rules**	**IV. RNE and PBnE documents[8]**
Doc. abbr.	NHS 2002 NHS 2016 Ind06 Ind16	KSP 2050 KP 2000	EEG 2017 WHG DüV BNatSchG	RNE NHS 02 RNE NHS 02 Pro PBnE NHS 16 PBnE IP NHS 16 RNE NHS 16 Ent RNE NHS 16 Emp

Source: own Table.

While these documents were thoroughly read, the coding scheme was modified several times. In the first code group (*I. Governance*) five main codes were defined: *1. Level (other than national)* covers the international and European level. *2. Actor* captures relevant state and non-state actors. *3. Policy integration* signifies the different forms of policy integration. *4. Evaluation* refers to management and monitoring, and code *5. Sustainable development* represents the overall goal of sustainability. Within the code group *II. Sector* a sub-code structure emerged containing rules, values, paradigm/conditions, and goals for every main code of *1. Agriculture/food, 2. Energy, 3. Water, 4. Climate,* and *5. Ecological system.* Since the nexus interconnections can appear in many different ways and are described very generally or in greater detail the main code of *6. Nexus thinking* was structured a little bit differently into values, general interconnections, paradigm/conditions, and goals. Whereas the general interconnections only represent aspects that refer to the general idea of nexus thinking, all possible combinations of the policy fields, i.e. food-water (FW), food-energy (FE), energy-water (EW), and food-energy-water (FEW), were included in the *Paradigm/conditions* code. A sub-code *FEW nexus* was added there as well to see when and if the term is used as defined at the Bonn2011 Conference. In every main code of group *I.*

[8] For the full name of the documents of group IV refer to Table 10.

Governance (except for *1. Level*) and *II. Sector* a code for *Recommendations* of the *RNE* and *PBnE* was included as well. The code group *III. Context factors* identified *1. Scandal/catastrophe, 2. Ecological system, 3. Infrastructure*, and *4. Societal conditions* as the most relevant codes. The final coding scheme is shown in Table 13. By use of this final coding scheme the document analysis was conducted that again also included the document of the pre-sample.

Table 13: Final coding scheme

I Governance	**II Sector**			**III Context factors**
1. Level (other than national)	**1. Agriculture/ food**	**2. Energy**	**3. Water**	**1. Scandal/ catastrophe**
	Rules	Rules	Rules	BSE scandal
International	CAP	EEG	WFD	Nuclear catastrophe
IEA	DüV	EU Reg	WHG	
G7/G8	Other	Other	Other	**2. Ecological system**
Paris Agreement				Environmental hazard
Kyoto Protocol	Values	Values	Values	Environmental service
Rio/ Rio+20	Consumer protection	Ecological sustainability	Security of water supply	
SDG process	Competitiveness	Competitiveness	Ecological sustainability	
	Food security/ nutrition	Energy security		**3. Infrastructure**
EU	Ecological sustainability			
Environment				**4. Societal conditions**
CAP				
Sustainable development	Paradigm/ conditions	Paradigm/ conditions	Paradigm/ conditions	
WFD	Organic farming	Fossil fuels	Energy	
Energy and climate targets	GHG emissions	> Coal reduction	Flooding	
> Kyoto targets	Nutrition	Nuclear energy	Climate change	
> 2050 targets	Land use	Import dependence	Agriculture	
> 2030 targets		Infrastructure	Quality/ protection	
> 2020 targets		Resource use	Water use	
		Renewables		
2. Actor		Efficiency		
		Mobility		
		Energy transition		
State				
Federal government	Goals	Goals	Goals	
> StsA	Land use	Mobility	WFD	
> BMU	Organic farming	Efficiency	Groundwater/ water bodies	
> UL-AG	Hunger/ nutrition	Renewables		
Parliament		Buildings	Flooding	
> PBnE				
Federal states	Recommendations	Recommendations	Recommendations	
City/ municipality	PBnE	PBnE	PBnE	
Destatis	RNE	RNE	RNE	
Other				
Non-state	**4. Climate**	**5. Ecological system**	**6. Nexus thinking**	
RNE				

NGO Private sector Trade union Science Church Other General <u>Recommendations</u> PBnE RNE **3. Policy integration** MLG Horizontal Vertical Recommendations >PBnE >RNE **4. Evaluation** Impact assessment Monitoring Management Indicators Destatis Recommendations >PBnE >RNE **5. Sustainable development** Values > Competitiveness > Transformation > Human rights > Guiding principle > Societal stability > Inter-/ intragenerational justice Recommendations >PBnE >RNE	<u>Rules</u> Climate action plan ÖkoStR Other <u>Values</u> Competitiveness Justice/ responsibility Planetary boundaries Combatting climate change <u>Paradigm/ conditions</u> Kyoto protocol Decarbonization > ETS Adaptation Circular economy <u>Goals</u> adaptation financing GHG emissions > Kyoto protocol <u>Recommendations</u> PBnE RNE	<u>Rules</u> BNG EU BImSchG <u>Values</u> Nature protection Protection of natural resources <u>Paradigm/ conditions</u> Ecological sustainability Biodiversity Resource use Water Agriculture <u>Goals</u> Ecosystem protection Resource use Biodiversity <u>Recommendations</u> PBnE RNE	<u>Values</u> Synergies Trade-offs <u>General interconnections</u> Ecological system Climate Agriculture/ food Water Energy <u>Paradigm/ conditions</u> EW FE FW FEW FEW-nexus <u>Goals</u> FW/ nitrate/nitrogen pollution <u>Recommendations</u> PBnE RNE	

Source: own Table.

6.2.1.3. Coding procedure

Even if a suitable coding scheme exists, the coding procedure is another very critical and challenging task. Since the researcher decides which and how text passages are coded this process might seem to be highly subjective, especially since most of the codes can be interpreted in different ways. Hence, in order to enable a structured, transparent, and reliable coding procedure several measures were undertaken. Firstly, to each code that represented a certain aspect, such as consumer protection for example, a code memo was added. These memos contain one or two coded segments that are seen as representative for this code and can thus serve as code definitions. A code book showing the final coding scheme including the code memos can be found as supplementary material I. Secondly, the following four rules for coding were applied in order to ensure a consistent coding procedure.

(1) Only running text was considered for coding, no head- and sublines or figures.
(2) No single words were coded, only sentences or paragraphs in order to capture the context.
(3) Text passages could be coded by more than one code.
(4) If the exact same sentence occurred more than once within one document it was only considered once.

These rules were intended to ensure that relevant aspects were adequately assessed with regard to their context. They, however, came with certain difficulties for the coding procedure. For example, due to rule one and two a lexical search for code terms did not prove to be very helpful. Furthermore, due to the nature of the FEW nexus and nexus thinking the author could not know beforehand in what way policy integration or nexus thinking might appear and be described in the documents. Therefore, every document had to be carefully read in order to capture the important information. To follow the author's coding procedure the analytical report containing all coded text segments is provided as supplementary material II.

6.2.2. Expert interviews

The document analysis was followed by complementing expert interviews. The method of expert interviews was chosen due to three important benefits: Firstly, they can generate knowledge in new and yet little explored research topics, such as the FEW nexus. Secondly, they can complement other methods in a qualitative method mix. Thirdly, they can offer a validation for theoretical analytical results in practical contexts (Kaiser 2014, p. 289). Against the background of the document analysis, these interviews were used to review and properly assess the results. Furthermore, additional aspects, future challenges, and policy recommendations could be revealed. The interviews conducted by the author were also part of the research project "ENERURB – Urbanisierung: Energiewende in NRW im Spannungsfeld von Stadt und Land" ("ENERURB – Urbanization: the energy transition in NRW between urban and rural areas" (own translation)).[9] The research project covered three main aspects: justice issues with regard to the energy transition, differences in perception and acceptance of the energy transition between urban and rural areas, and interconnections of the energy transition to other policy fields, such as agriculture or water (FEW nexus). The latter was of special interest for this work. Within the project ENERURB six semi-structured qualitative interviews were conducted that were intended to help achieve a more holistic perspective on the energy transition. The preparation and realization of the interviews followed the procedural steps according to (Kaiser 2014, pp. 298–300). The interview questions were carefully developed and pre-tested within the project consortium. The list of questions was structured in three parts according to the three main project's research interests mentioned above. The part on the FEW nexus and policy integration contained the following questions (own translation):

[9] The research project ENERURB was embedded in the project cluster "Governance und Partizipation" ("Governance and participation"), which belonged to the "Virtuelles Institut: Transformation Energiewende NRW" ("Virtual Institute: Transformation – Energy Transition NRW" (official translation)). For more information about the research project refer to the official project website: https://www.vi-transformation.de/enerurb/.

- Do you think that the interconnections between the three policy fields of food, water, and energy are adequately addressed in current policy making?
- How and on what political level (local, regional, federal, EU) could this be improved? What are the most suitable instruments to consider these interconnections?
- What are the main challenges regarding the integration of these policy fields?
- How important are these interconnections in your daily work? What experiences did you make when interacting with agencies, departments or ministries responsible for the other two policy fields?
- In your opinion, how would an integrated management of these three policy fields look like?[10]

In sum, five interviews with six people were conducted between May and December 2019. The interview partners were carefully chosen with regard to their expertise in the respective policy fields. The identification of them as experts was determined by their professional position. Five interview partners work in nexus-related policy fields at the ministerial level in North Rhine-Westphalia (NRW): two in water management, one in agricultural management, one in energy management and one in climate protection. The sixth interviewee works as a climate protection manager for a municipal administration in the district of Düren, NRW. The interviews were conducted in German and in person on site at the offices of all interview partners. One interview was conducted with two interview partners who answered the questions one by one. The evaluation of the interviews followed a structured scientific approach as well (Kaiser 2014, pp. 300–302). With the consent of the interviewees, the interviews were recorded and transcribed afterwards using MAXQDA 18. To ensure anonymity, which the interviewees asked for, the interviewees (itv) were labelled as follows:

- itv1: water management 1
- itv2: water management 2

[10] The complete list of questions can be found in Annex II.

- itv3: agricultural management
- itv4: energy management
- itv5: climate protection
- itv6: municipal administration, district Düren.

During the transcription process MAXQDA automatically sets timestamps every time the speaker changes, so that these marks can be used as references. The statements used in the results section will be referred to as follows: itv1-6, timestamp. The interview data was analyzed by means of a QCA as well using MAXQDA 18. Therefore, a specific coding scheme was developed with regard to the questions asked (cf. Table 14).

Table 14: Coding scheme for the QCA of the expert interviews

1. Energy transition	**2. Nexus thinking**	**3. Future challenges**
Perception of justice	Awareness of resource interconnections	Upcoming issues
…in urban areas	… in general public	…in water management
…in rural areas	… in politics	…in agricultural management
Expectations for practical implementation	Instruments for policy integration	…in energy management
... of the general public	…cross-sectoral	
… of NOGs	…MLG	
… of politics	…NHS	

Source: own Table.

6.3. Results I: A value-based institutional analysis of nexus-related policy fields

In a first step the $n_{documents}$ = 37 from document groups I (sustainable development strategies, related monitoring and progress reports), II (concepts and plans), and III (laws and regulations)[11] were analyzed with regard to the methodology developed in sections 3 and 4 in order to conduct a value based institutional analysis. In order to reveal and assess major nexus governance challenges on the national level in Germany it is essential to understand how policies in important nexus policy fields evolved and on what values they are based. For this purpose, it will be analyzed how and what values are embedded in important institutions and how they developed over time. Thereby, the section is structured with regard to relevant cross-cutting policy fields, such as the guiding principle of sustainable development, climate and environmental policy followed by the three nexus policy fields of agriculture, energy, and water. For this analytical step, the following code groups and main codes of the coding scheme described in section 6.2.1.2 (cf. Table 13) were important:

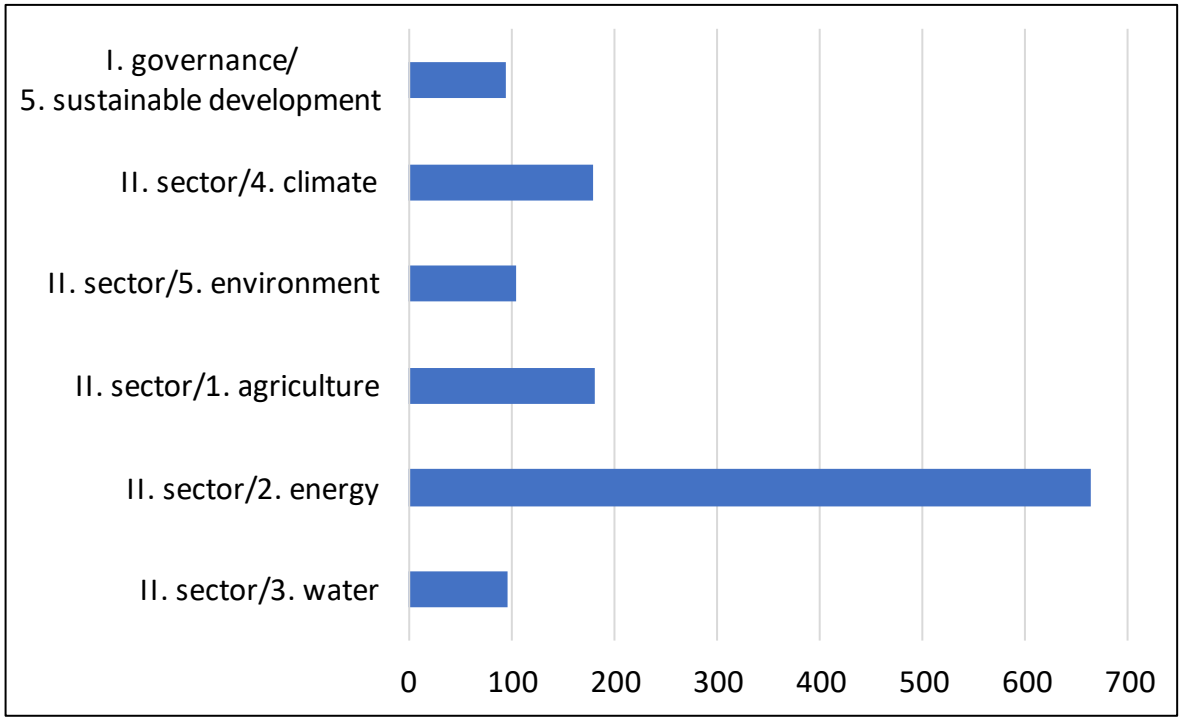
- *I. Governance: 1. Level; 2. Actor; 3. Policy integration/MLG; 5. Sustainable development*
- *II. Sector: 1. Food/agriculture; 2. Energy; 3. Water; 4. Climate; 5. Ecological system*
- *III. Context factors: 1. Scandal/catastrophe*

The main codes in code group (*1. Governance*) entail information about the different governance levels, policy integration across these levels as well as important actors. Furthermore, the overarching guiding principle of sustainable development is included. The code group *II. Sector* is important for the institutional development as well as the underlying values of the important policy fields. The code group *III. Context factors* includes information about critical junctures that might influence institutional processes. As explained in section 6.2.1 a qualitative document analysis is conducted. Therefore, all

[11] For the list of these documents refer to Table 7- Table 9.

important categories – represented by the respective codes (cf. Table 13) – were analyzed by structurally examining the assigned text segments. This methodological approach allowed an understanding of institutional processes as well as the identification of interconnections between different policy fields. Hence, the focus of this analysis clearly lies on the content of coded text segments, to which the descriptions in the following sections directly refer to. Nevertheless, the pure number of text segments coded with a specific code can already be an indicator for the importance of a certain category. For this reason, the total number of text segments assigned to one code is often used as a starting point for a more detailed qualitative analysis. Regarding the nexus-related policy fields Figure 13 shows the total number of coded text segments in the related code groups.

Figure 13: Total number of coded text segments in different code groups



Source: own Figure.

It becomes apparent that, by far, the largest share of the coded text segments belongs to the code group energy ($n_{segments}$ = 664). Three times more text segments refer to this group

than to agriculture ($n_{segments}$ = 181) and almost seven times more than to water ($n_{segments}$ = 97). $N_{segments}$ = 179 were assigned to the code group *climate*, $n_{segments}$ = 105 to *environment*. $N_{segments}$ = 95 were coded with *sustainable development*. The different policy fields are in the focus of the following sub-sections. First of all, the overarching guiding principle of sustainable development is described. Afterwards, a closer look is taken into the cross-cutting policy fields of climate and the environment before the three nexus policy fields are described in detail.

6.3.1. Sustainable development policy

Sustainable development is defined as an overarching guiding principle that is supposed to be implemented in any policy field. In a broad sense, sustainable development touches upon ecological, economic, and social dimensions as shown by the UN SDGs. The text segments coded with *sustainable development* ($n_{segments}$ = 95) almost exclusively belong to the sustainable development strategies, its progress and monitoring reports ($n_{segments}$ = 85). Throughout the entire time horizon covered by this analysis sustainable development is described as the guiding principle for policy-making in the area of environmental and climate policy. The NHS 2002 was the first to define sustainable development and what it meant for German policy-making. The strategy referred to the definition of the Brundtland-Report of 1987 and emphasized the cross-cutting nature of the concept (Bundesregierung 2002, pp. 6–9). The very substance of sustainable development is the idea of inter- and intragenerational justice (Middleton et al. 2015, p. 637). It addresses the spatial, global, as well as the temporal dimension of the concept by considering the needs of the current as well as future generations (Petty et al. 2015, p. 7). Ecological sustainability, in particular, in this sense, means to respect planetary boundaries without transgressing ecological capacities (Bundesregierung 2004, p. 125, 2008, p. 19). By the definition of the federal government, therefore, renewable resources must only be used as far as they can regenerate, non-renewable resources must only be used as far as they can be replaced by other materials or energy carriers, and the level of polluting substances cannot exceed the adaptation capacity of ecosystems (Bundesregierung 2002, pp. 50–51). However, according

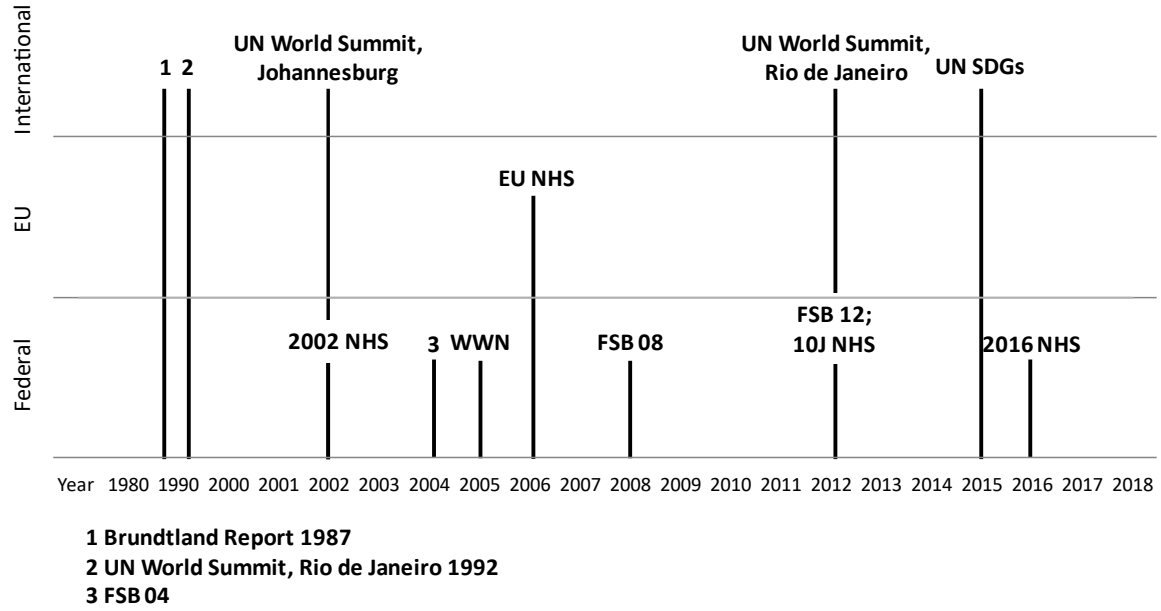
to the BMUB, this has not been achieved so far (BMUB 2016a, p. 25). Also with the change of government in 2005 and the beginning of Merkel's first term sustainable development was maintained as a guiding principle and described as a long-term approach that has to be respected independently from elections (Bundesregierung 2008, p. 22). The 2008 progress report (FB 2008) went two steps further and, firstly, stated that a sole strategy would be unable to cover all upcoming challenges. For this reason, the report called for an integration of this principle into other strategies and its acknowledgement by other actors as well (Bundesregierung 2008, p. 11). Secondly, sustainable development was given a principled priority for policy-making in each policy field (Bundesregierung 2008, p. 19). In the 2012 progress report (FB 2012) the principle was broadened to go beyond policy-making and to be considered by industry, society and any other aspect of life as well (Bundesregierung 2012b, pp. 24–29). The revised NHS 2016 confirmed this statement and adopted the structure of the UN SGDs. In general, calling sustainable development a, or later the, guiding principle was continuously strengthened and extended from 2000 to 2016. Due to its idea of inter- and intragenerational justice sustainable development has a strong international dimension and German sustainable development policy, from the beginning, was highly impacted by international negotiations, such as the *Rio/ Rio+20 process* ($n_{segments}$ = 23) and the *SDG process* ($n_{segments}$ = 22). The first NHS 2002 was the German contribution to the 2002 World Summit on Sustainable Development in Johannesburg, South Africa. The strategy not only emphasized the need for coordination with the international level (Bundesregierung 2002, p. 214) but also to use synergies and create links between the different governance levels (Bundesregierung 2008, p. 190). Besides the FB 2012, the federal government in 2012 also published the report "10 years sustainable development 'made in Germany'" (10JN) with regard to the Rio+20 Summit in Rio de Janeiro (Bundesregierung 2012a, p. 1). The majority of text passages coded with *SDG process* ($n_{segments}$ = 14) belongs to the NHS 2016. The federal government took the adoption of the UN SDGs in 2015 as an opportunity to profoundly revise its sustainable development strategy and defined SDG related targets for Germany. The NHS 2016, thus, served as a framework for implementing the UN Agenda

2030 (Bundesregierung 2017, p. 24).[12] The European level, in contrast, is of less importance in this matter. Even if $n_{segments}$ = 17 were coded with *EU/sustainable development* the European sustainable development strategy has not been updated since its adoption in 2006 (Bundesregierung 2017, p. 50). In 2016, the federal government and the European Parliament called upon the EU commission to update the European strategy (Bundesregierung 2017, p. 50). So far, the only present EU document is a "Communication on the next steps for a sustainable European future", published in 2017 (European Commission 2016). European treaties, however, e.g. the Amsterdam and Lisbon treaties, include sustainable development as a guiding principle (Bundesregierung 2017, p. 50). Within Germany the strategy is dealt with on the highest political level, the Chancellery, which underpins its overarching character. Furthermore, the federal states play an important role in the implementation of the NHS 2016 as well (Bundesregierung 2017, p. 46). So far, eleven federal states have own sustainable development strategies, other states developed indicator reports (Statistisches Bundesamt 2020b).

Until 2015 institutional change in the field of sustainable development went rather path dependently. Since the adoption of the NHS 2002, which was developed in preparation for the UN World Sustainability Summit in Johannesburg in 2002, the strategy has been steadily modified through several progress reports, which all kept its original structure and indicators. The adoption of the UN SDGs, however, can be seen as a critical juncture that initiated higher levels of learning, which eventually resulted in a profoundly revised NHS 2016. Figure 14 shows an overview of important action situations in the field of sustainable development.

[12] The development process of the NHS 2016 will be described in further detail in section 6.4.2 on general nexus thinking.

Figure 14: Important action situations in the field of sustainable development



Source: own Figure.

6.3.2. Climate policy

The underlying value of climate policy is the protection of the climate with regard to the impacts of anthropogenic climate change. Like sustainable development, also the value of climate protection includes the idea of inter- and intragenerational justice and has been a matter of priority for the federal government already in 2002 (Bundesregierung 2002, pp. 151–152). The value of climate protection has a strong connection to the global impacts of climate change (Bundesregierung 2000, pp. 5,8, 2017, p. 7). According to the federal government in 2005, industrialized countries have a special responsibility for combatting climate change since they have the highest per capita emissions and own modern technologies (Bundesregierung 2005, p. 74). Climate mitigation and adaptation are seen as two of the most important challenges in the 21st century (Bundesregierung 2008, p. 13, 2012b, p. 14) that necessitate international cooperation (Bundesregierung 2017, p. 181). Culminating in the adoption of the Paris Agreement in 2015, international climate negotiations have increasingly shaped European and German energy and climate policy

(Bundesregierung 2000, p. 69). The most important goals in climate policy are greenhouse gas (GHG) emission reduction goals (*goals/GHG emissions* $n_{segments}$ = 51). These goals have been adjusted many times throughout the years, mostly in relation to international negotiations. The Kyoto-Protocol, which was adopted in 1997, served as the first international agreement for binding emission reduction targets for industrialized countries (*Kyoto* $n_{segments}$ = 17). As stated in many documents, Germany has set itself the goal of reducing its CO_2 emissions by 25% by 2005 compared to 1990, and reducing its emissions of Kyoto GHG by 21% by 2012 (Bundesregierung 2000, p. 7, 2002, p. 147, 2004, p. 41). In 2007, during ongoing discussions on the Post-Kyoto-Process, the federal government decided to commit itself to a 40% reduction of GHG emissions by 2020 under the condition that the EU as a whole adopts a 30% reduction goal and that other industrialized countries will follow this path (Bundesregierung 2007, p. 2, 2008, p. 88). In 2010, this goal was complemented by a long-term goal for 2050 of reaching a 80% to 95% reduction (BMWi and BMU 2010, p. 4), which, in 2016, was still valid (BMUB 2016b, p. 28). Therefore, intermediate targets of 55% reduction until 2030 and 77% reduction until 2040 were defined (BMUB 2016a, p. 53). Furthermore, international climate funding was planned to be doubled until 2020 vis-à-vis 2014 (Bundesregierung 2017, p. 39). In contrast to the case of sustainable development, the EU plays an important role in the field of climate policy (*EU/energy and climate targets* $n_{segments}$ = 24). Since the EU often appears as one actor in international negotiations, European climate policy is also of direct impact for Germany. One important European instrument is the European Emission Trading Scheme (ETS) (*decarbonization/ETS* $n_{segments}$ = 23). The ETS was inaugurated in 2005 in order to reach the Kyoto targets (Bundesregierung 2004, p. 74) and is still expected to remain one of the most important instruments for reaching EU's 2030 climate and energy targets (BMUB 2016b, p. 37). The ETS created a carbon market and covers the allocation and trading of GHG emission allowances across the EU (European Commission 2020). Mainly due to the financial crisis in 2007/2008 a surplus of emission allowances has emerged. In order to maintain the functioning of the ETS it was reformed in 2015. As a short-term instrument, a

market stability reserve was adopted starting in 2019. Further adjustments for the trading period of 2021-2030 were adopted in 2018 (Europäische Union 3/14/2018). All remaining sectors, that are not part of the ETS, such as the transport and agricultural sector, are included in the Effort Sharing Decision (ESD) (406/2009/EC) (BMUB 2016b, p. 24).

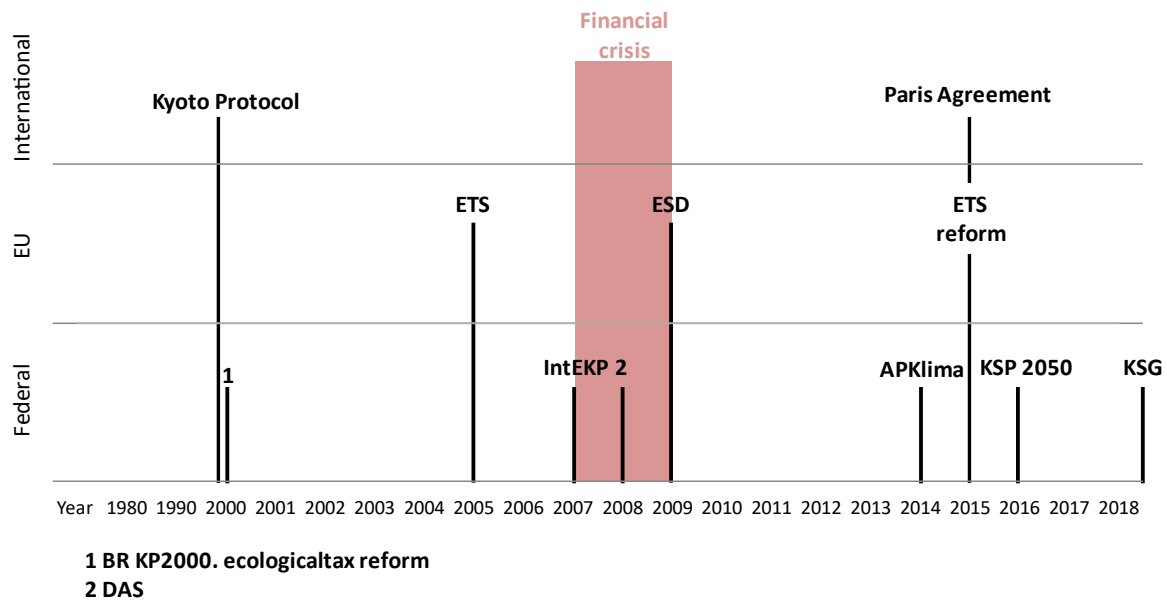
So far, the most important rules in the field of climate policy have been federal climate action plans ($n_{segments}$ = 17). The National climate action plan (KP 2000) was followed by the Integrated energy and climate program (IntEKP) (Bundesregierung 2007, p. 92), the Climate action program 2020 (APKlima) (Bundesregierung 2014a), and the Climate action plan 2050 (KSP 2050) in 2016 (BMUB 2016b, p. 10). Due to the federal structure of Germany, the federal states play a vital role in the implementation of these plans and programs. One important instrument for the communication between these two levels is the conference of environmental ministers (Bundesregierung 2008, p. 193), another relatively new instrument are the regional networks ("Regionale Neststellen Nachhaltigkeitsstrategien "RENN") (Bundesregierung 2017, pp. 47, 229). Besides the climate action program, other rules exist, such as the ecological tax ($n_{segments}$ = 5), for example. Introduced in 2000 the tax reform aimed at incentivizing the development of innovative technologies and a more efficient energy use through increasing energy prices (Bundesregierung 2000, p. 5). With regard to laws, the Renewable Energy Act (EEG) is of special relevance since it includes capacity expansion targets for renewable energies.[13] Additionally, seven federal states already adopted climate protection laws (Sina et al. 2019, p. 7). As mentioned in the introduction (section 1), since 2019 also a federal law exists: the Federal Climate Protection Law (Klimaschutzgesetz, KSG). It defines annual emission limits for different sectors, such as the energy industry, transport or agriculture (Klimaschutzgesetz 12/12/2019, p. 9). With regard to *adaptation* ($n_{segements}$ = 9), Germany adopted a federal adaptation strategy (DAS) in 2008 (Bundesregierung 2008, p. 101), which was monitored for the first time in 2015. The

[13] The EEG will be described in more detail in section 6.3.4. on Energy.

monitoring report entailed about 140 measures in various policy fields in order to adapt to climate change (Bundesregierung 2017, p. 183).

Even if the values of ecological sustainability and climate protection were seen as profound guiding principles of policy-making for many years, they should not undermine Germany's global competitiveness. Competitiveness was found as an important value underlying climate policy ($n_{segments}$ = 14), and it was also mentioned with regard to sustainable development ($n_{segments}$ = 2). The federal government promised to avoid competitive disadvantages for the German industry as far as possible (Bundesregierung 2000, 22, 77). Climate action should always stay affordable and be oriented towards economic development (Bundesregierung 2007, p. 2) in order to ensure investment security for companies and to reach a transformation of industry instead of deindustrialization. According to the BMU this was also necessary to serve as a good example for other countries in the world (BMUB 2016b, pp. 11–17). Climate action should be seen as an opportunity fostering more innovative and future-oriented technologies (BMUB 2016b, 11, 57). Until 2019, the development of German climate policy can be characterized as largely path dependent. Regularly published climate protection plans and action programs including adjusted climate targets show processes of single loop learning initiated mostly by international negotiations. The upcoming "Fridays for future" movement, however, characterized a critical juncture that initiated higher levels of learning resulting in the Federal Climate Protection Law (KSG). Figure 15 summarizes the important action situations in sustainable development and climate policy. The values of ecological sustainability and climate protection are guiding principles in many other policy fields as well, such as the ones related to the nexus. Hence, these values are also embedded in rules, regulations, and other policy instruments of these policy fields. This will be described in the following sub-sections.

Figure 15: Important action situations in climate policy



Source: own Figure.

6.3.3. Environmental policy

With regard to environmental policy the values of nature protection ($n_{segments}$ = 15) and the protection of natural resources ($n_{segments}$ = 3) were identified. In the NHS 2002, the value of an intact nature is emphasized for the quality of human life and for its own sake, as an intrinsic value (Bundesregierung 2002, pp. 14–15). These two dimensions are also referred to in later documents (Bundesregierung 2012b, p. 197, 2017, pp. 171–172). Environmental policy touches upon and is influenced by several other aspects, of which biodiversity seems to be the most important one ($n_{segments}$ = 18). Protecting biodiversity is seen as essential for many ecosystem services, such as air and water purification as well as preserving areas for recreation or quality of life (Bundesregierung 2008, p. 151). It touches upon many critical aspects of life like nutrition, energy, resource use, and livestock farming (Bundesregierung 2004, p. 115; BMEL 2016, p. 16) that are also relevant for future generations (Bundesregierung 2005, p. 114; Statistisches Bundesamt 2017, p. 98). Thus, ending biodiversity loss has been an important goal of German environmental policy for a long time (*goal/biodiversity* $n_{segments}$ = 13). The NHS 2002 demanded a stabilization of all species at a

high level without defining a time horizon (Bundesregierung 2002, p. 101, 2004, p. 45). The WWN specified that the goal of ending biodiversity loss was to be achieved until 2010 (Bundesregierung 2005, p. 114). The federal biodiversity strategy (BDS) adopted in 2007 confirmed this goal. The BDS was embedded in the sustainable development strategy (Bundesregierung 2012b, p. 197) and was based on the international biodiversity convention of 1992 and its strategic plan which aimed at ending biodiversity loss globally until 2020 (BMUB 2016a, p. 63).[14]

One factor strongly impacting biodiversity is current land use management (*paradigm/condition/land use* $n_{segments}$ = 17). Exceeding land use threatens habitats for animals and reduces areas for recreation (Bundesregierung 2002, p. 99). Hence, uncultivated land has become a scarce resource in Germany, mainly due to increasing and sometimes conflicting land demands for housing or infrastructure (Bundesregierung 2002, p. 207). Additionally, the increasing land demand for renewable energy sources in general, including bioenergy, wind, and solar, became a major issue. Sustainable land use, so far, is mainly integrated vertically in sectoral rules or regulations. One important legal rule is the Federal nature protection act (BNatSchG) which generally emphasizes the need to protect uncultivated land and to respect grasslands, flood plains or moors (Bundesnaturschutzgesetz 7/29/2009, p. 5). Furthermore, it includes several regulations for good agricultural practice in order to protect soil fertility and water, to preserve biotopes, and to improve animal welfare. It also refers to practices of fertilization according to the Fertilizer Ordinance (DüV) and the European directive on a sustainable use of pesticides (Pflanzenschutzrahmenrichtlinie) (Bundesnaturschutzgesetz 7/29/2009, pp. 5–8). With regard to the energy sector, the BNatSchG demands that infrastructure projects, such as roads and power lines are to be designed in a way that keeps impacts on the environment as little as possible (Bundesnaturschutzgesetz 7/29/2009, p. 5). The BNatSchG is complemented by the federal Immission Control Act (Bundesimmissionsschutzgesetz) of

[14] The issue of biodiversity loss will be described in section 6.4.3 in further detail.

1974 (Bundes-Immissionsschutzgesetz 3/15/1974, p. 1). In order to address this issue reducing daily land use has become an important goal (*goal/land use* $n_{segments}$ = 16) that was addressed in the sustainable development strategy. The NHS 2002 demanded the reduction average daily land use for housing and infrastructure to 30 hectare by 2020 (Bundesregierung 2002, p. 99). According to the federal government, in 2003, about 93 hectares per day were used (Bundesregierung 2005, p. 119), in 2016, still 69 hectares (BMUB 2016a, p. 78). Even if these numbers show that daily land use has, in fact, decreased, the 30-hectare goal was far from being reached. Therefore, the NHS 2016 extended the deadline for achieving this goal until 2030 (Bundesregierung 2017, p. 159). According to the BMEL the conflicting interests in land have been further aggravated by the fact that uncultivated land has also become an object for investment (BMEL 2016, p. 20). Thus, in the issue of land use no significant progress has been made. According to the federal government land use management necessitates strong sectoral cooperation due to its cross-cutting character (Bundesregierung 2004, p. 215).

Another issue closely related to the value of protecting natural resources is current resource use (*paradigm/conditions/resource use* $n_{segments}$ = 9). Germany has a high resource demand for its industry including a high water and land demand which leads to substantial interferences with nature and landscape, GHG and pollutant emissions not only in Germany but also in countries of supply (BMUB 2016a, p. 50). For this reason, reducing the use of natural resources is defined as an important goal (*goal/resource use* $n_{segments}$ = 12). Not only total resource use should be reduced (Bundesregierung 2012a, p. 7), it should also be decoupled from economic growth (Bundesnaturschutzgesetz 7/29/2009, p. 4) to support environmental protection. Since 2004 the federal government had aimed at doubling the productivity of raw materials until 2020 vis-à-vis 1994. This goal is mentioned in many documents from 2004 until 2016 (Bundesregierung 2004, p. 40; Statistisches Bundesamt 2007, p. 6, 2008, p. 6, 2010, p. 8; Bundesregierung 2012a, p. 8, 2012b, p. 29; Statistisches Bundesamt 2014, p. 8). In 2016, the goal slightly changed towards fostering general resource productivity until 2030 (Statistisches Bundesamt 2017, p. 53; BMUB 2016a, p. 56)

and decoupling resource use from industrial production (Bundesregierung 2017, p. 171). Furthermore, the federal government launched two programs aiming at more resource efficiency: the national program for sustainable consumption and the German resource efficiency program (ProgRess) (Bundesregierung 2017, p. 171).

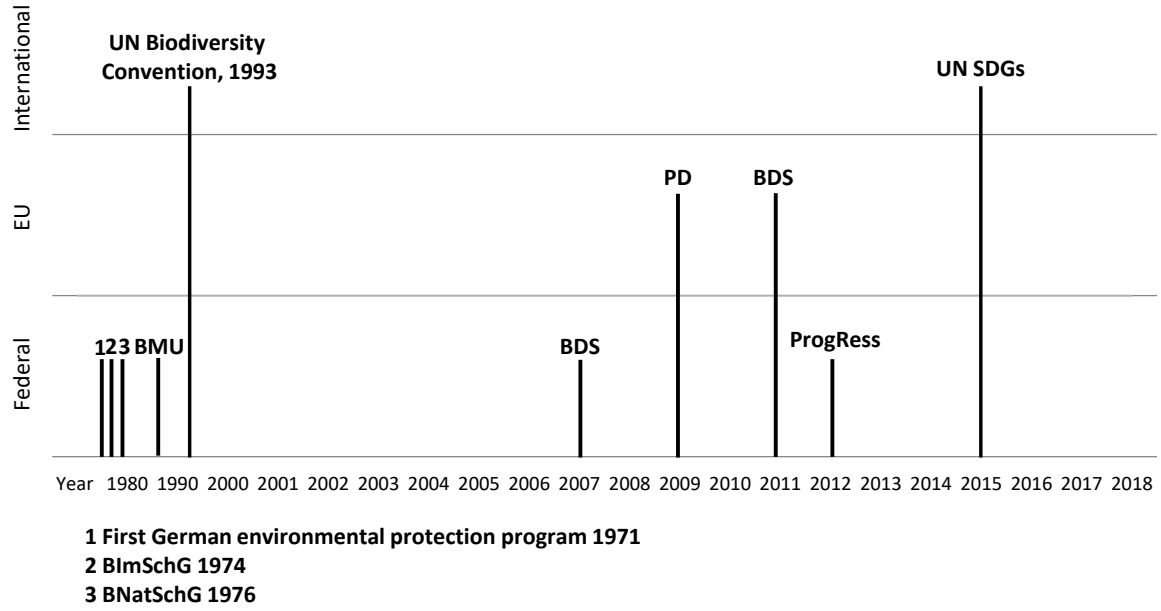
Important rules regarding environmental policy are environmental action programs, such as the Integrated environment protection program (IntUP) for example. The first German environmental action program was developed in 1971 as a response to the massive environmental impacts of the post-war period. The program can be seen as the starting point of German environmental policy. Since then, these programs have been regularly updated and further developed. Besides these programs, important legal rules on the federal level are the Bundesnaturschutzgesetz 7/29/2009, which – in its first version – was adopted in 1976, and the Federal Immission Protection Law (Bundes-Immissionsschutzgesetz 3/15/1974), adopted in its first version in 1974. Environmental policy is a policy field of shared responsibilities between the federal and the EU level. Therefore, several EU regulations are also of high relevance in this regard, the directive on the sustainable use of pesticides (2009/128/EC) is mentioned, for example (Bundesregierung 2012b, p. 169). Furthermore, in 2011 the EU also adopted a European biodiversity strategy to 2020 (Europäische Kommission 5/3/2011).

According to the BMU, which was founded in 1986, its task in its early years was merely repairing collateral damage of economic activities whereas nowadays planetary boundaries are promoted as the safe operating space (BMUB 2016a, p. 15). Since the protection of the environment and ecosystems is seen as a cross-cutting issue, its values and goals need to be integrated into other policy fields as well. The federal government referred to environmental policy integration in the WWN (Bundesregierung 2005, p. 117). It was seen as an instrument to reconcile economic interests and nature protection by creating a balance between the use and protection of natural resources. However, restructuring different policy fields towards this direction was emphasized as an important challenge

(Bundesregierung 2005, p. 117).[15] As the federal government stated, the value of ecosystem protection is also strongly prominent in the SDGs. It is embedded directly in SDG 15 'life on land' and indirectly in SDG 2, SDG 6, SDG 11, or SDG 12, for example (Bundesregierung 2017, p. 196).

Since the upcoming environmental concerns in the 1970s and 1980s in Germany, environmental policy mostly developed path dependently. However, its importance continuously grew and it has been increasingly integrated also into other policy fields. Nevertheless, so far, environmental policy has not been given a principled priority as demanded by Lafferty and Hovden (Lafferty and Hovden 2003, p. 10). In Germany, the most important state actor in the field of environmental policy is the BMU.

Figure 16: Important action situations in environmental policy



Source: own Figure.

[15] This aspect will be described in further detail in section 6.4.3.

6.3.4. Agricultural policy

In the field of agricultural policy, the values of food security, competitiveness, consumer protection as well as ecological sustainability were found, of which food security ($n_{segments}$ = 18) was the most basic value. Providing sufficient food at a reasonable price was a major challenge in Europe after the Second World War. Therefore, in 1962 the European Common Agricultural Policy (CAP) came into force, mainly aiming at an increasing food production through financial support for farmers. The CAP fully communitarized agricultural policy on the European level and became the most important institution for the agricultural sector in Germany. This is also reflected by the results of the QCA (*rules/CAP* $n_{segments}$ = 21). The CAP was created with a two-pillar structure. Whereas the first pillar referred to direct payments and market-price regulations, the second pillar addressed aspects of environmental protection and rural development (Zheng and Gohin 2020, p. 1). In the following years and decades, agricultural production strongly increased and in Europe food security has long been reached. In the context of globalization, international development policy, and the emergence of the principle of sustainable development, the issue of food security again occurred in a global perspective. In 2000, food security was included as goal one “eradicate extreme poverty and hunger” in the UN Millennium Development Goals (MDGs). The SDGs embedded food security in SDG 2 “zero hunger”. This global dimension was also embedded in various German policy documents (BMEL 2016, p. 48; BMUB 2016b, p. 63; Bundesregierung 2017, p. 35). Additionally, in Europe a discussion on food security again emerged in the context of the expansion of renewable energy sources, especially bioenergy. Due to the high land demand of energy crops, a conflict between land use for energetic or food purposes occurred. Even if the conflict barely directly affected the situation in Germany, it was highly debated in the public debate. Growing global bioenergy demands combined with the financial crisis, in fact, led to steeply increasing food prices on the global market in 2008 (cf. Figure 2). Therefore, following this year, also the federal government has repeatedly stated that food security always has to be prioritized over land use for energetic or material purposes (Bundesregierung 2008, p. 15, 2017, p. 61). Hence, since

then the support for biomass changed from energy crops towards biomass resulting from residual and waste materials (BMWi and BMU 2010, p. 11). According to Destatis, the land demand for biomass counts as one reason for the slow increase in organic farming (Statistisches Bundesamt 2014, p. 43).

After food security had been reached, in Germany, questions regarding consumer protection ($n_{segments}$ = 6), food quality and healthy diets became more and more important (Bundesregierung 2012b, p. 207; BMEL 2016, p. 20), especially in the beginning of the 2000s due to the BSE-crisis in Europe (Bundesregierung 2002, pp. 20, 205). Hence, human health issues were a top priority at that time (Bundesregierung 2002, p. 208). The so-called health-related consumer protection (gesundheitlicher Verbraucherschutz), which especially focused on safe, trustworthy products was consistently mentioned from 2002 to 2016 (Bundesregierung 2002, p. 51, 2012a, p. 7; BMEL 2016, p. 8). It was mainly supported through information campaigns about healthy diets (Bundesregierung 2017, p. 61) or food waste (BMUB 2016b, p. 66).

As mentioned above, the original purpose of the CAP was to achieve food security in Europe by supporting an increasing food production. However, even after extensive farming and food security had been reached, subsidies were maintained in order to stay competitive on growing global food markets. According to the federal government in 2002, consumers' decisions were mainly determined by prices which is why subsidies were granted further on to ensure global competitiveness (Bundesregierung 2002, pp. 205–206) and financial security for the agricultural industry and farmers (Bundesregierung 2002, p. 113). Thus, the value of competitiveness was also embedded in food and agricultural policies ($n_{segments}$ = 9). Several CAP reforms, such as the reform in 2003 which more strongly connected production and market trends, aimed at securing the EU's role on global markets (Bundesregierung 2004, p. 108). Even today, the agricultural sector is still highly supported by the CAP despite the existence of modern technologies, fertilizers, and pesticides that allow an intensive production. In 2016, the BMEL stated that the agricultural industry is further striving for an increase in productivity and competitiveness (BMEL 2016, p. 20). Technical progress and

structural change in the agricultural sector led to a development in which fewer companies produced the majority of agricultural goods. Due to the liberalization of agricultural markets and increasing competitive pressure, such agricultural companies took the lead that were characterized by intensification, specialization, and low production costs. This process, which can be compared to the industrialization process, additionally was supported by the former political funding practice and had immense impacts (Bundesregierung 2002, p. 24), especially on the environment.

Therefore, the most important value for the nexus analysis is ecological sustainability ($n_{segments}$ = 25), which can be divided into the three following more specific values: firstly, the protection of natural resources, such as water and soil; secondly, animal protection; and thirdly, combatting climate change. The high use of fertilizers and pesticides, and large amounts of manure caused by large-scale livestock farming negatively impact water and soil quality. As a result, Germany has been struggling with exceeding nitrate and nitrogen levels for a long time despite legal rules exist, such as the European Nitrates Directive (ND), for example, which was already adopted in 1991. It was implemented by the German Fertilizer Ordinance (Düngeverordnung, DüV), which was reformed in 2007. Complementary, the Federal Fertilizer Act *(Düngegesetz, DüG)* (Düngegesetz 1/9/2009) of 2009 also aimed at regulating and an improved monitoring of the use of fertilizers. Additionally, the CAP was reformed many times throughout the time period covered by this analysis and more sustainability criteria were included. In the 2003 reform, for example, subsidies were bound to a minimum of environmental standards instead of mere production quantities ("cross-compliance") (Bundesregierung 2004, p. 12). In 2013, the first pillar of the CAP was "greened" in order to strengthen ecological and climate aspects (BMUB 2016b, p. 64). However, the issues of nitrate and nitrogen pollution persisted. Since they are important nexus issues in Germany, they are further described in section 6.4.6. Additionally, animal welfare and livestock production became more and more important over the years. An appropriate animal husbandry evolved as one of the central pillars of a sustainable agricultural production (Bundesregierung 2002, p. 51, 2004, p. 107, 2012b,

p. 207). Whereas the BMEL generally emphasized the importance of animal welfare (BMEL 2016, p. 32), the BMU demanded to end factory farming (BMUB 2016a, p. 31).

In 2017 the agricultural sector accounted for 7.3% of total GHG emissions in Germany and was thus the second biggest emitter after energy-related emissions (Umweltbundesamt 2020b). The most important GHGs are nitrous oxide, which is caused by nitrogen containing fertilizers, and methane, which results from digestion processes of ruminants. Other emissions, such as ammonia or carbon dioxide are caused by manure, livestock farming and fuel consumption of machinery and vehicles (BMUB 2016b, p. 62). By supporting an intensive and profitable agricultural production especially the first pillar of the CAP contributed to increasing GHG emissions (Bundesregierung 2000, p. 126). Therefore, according to the BMU a CAP reform is of high relevance for emission reduction in the agricultural sector in Germany (BMUB 2016b, p. 64). In general, GHG emissions from agriculture remained relatively stable and only dropped by 16% compared to 1990 (Umweltbundesamt 2020b). According to the BMU, the agricultural sector, in contrast to other sectors, did not show the same level of innovation and technological development in order to limit its environmental impacts. For this reason, environmentally friendly technologies and structural changes are required that, at the same time, ensure global competitiveness (BMUB 2016a, p. 48).

Organic farming (*paradigm/conditions/organic farming* $n_{segments}$ = 15) is seen as one instrument to reduce GHG emissions in the agricultural sector that simultaneously can help improving animal welfare and protecting natural resources by using less and rather organic fertilizers (Bundesregierung 2000, p. 34). Therefore, increasing the share of organic farming has become an important policy goal (*goal/organic farming* $n_{segments}$ = 22). The NHS 2002 included the goal of 20% organic farming of total agricultural land by 2010 (Bundesregierung 2002, p. 113). Over time, the target year was adjusted several times. Whereas the NHS 2002 aimed at 20% by 2010 (Bundesregierung 2002, p. 227), the documents from 2008 onwards planned on reaching the goal within the next years (Bundesregierung 2008, p. 38, 2012a, p. 10, 2012b, p. 30). In several documents of 2016 no time horizon is mentioned at all

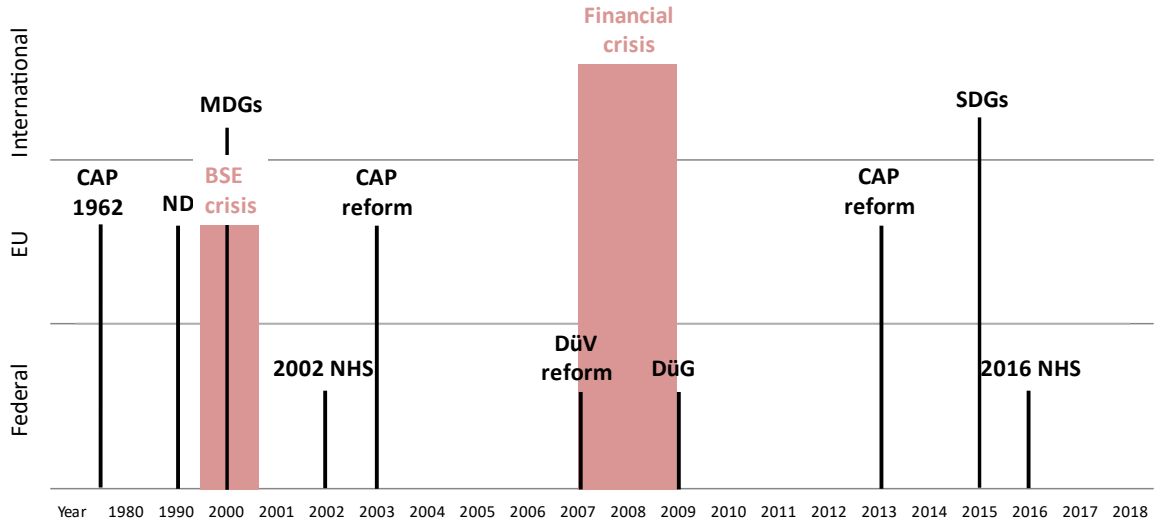
(BMUB 2016b, pp. 64–65, 2016a, p. 68; Bundesregierung 2017, p. 68). Although the share of products from organic farming has been strongly and continuously growing since the early 2000s (BMUB 2016a, p. 47), the actual share of organic farming has remained very small. In 2010 it only accounted for 5.9% (Bundesregierung 2012b, p. 207), in 2014 for 6.3% (BMUB 2016a, p. 31). Even when the federal government launched a new support program in 2015 (Bundesregierung 2017, p. 68), the share only reached 8.2% in 2017.

Food security, competitiveness, and ecological sustainability form the value triangle of German agricultural policy: "The guiding principle of the agricultural policy of the federal government entails the preservation and creation of livable and vital rural areas and a sustainable, environmentally friendly, economically efficient, and multifunctional agriculture […] in which food security always has to be prioritized over the production of raw materials used for material or energetic use (own translation)" (Bundesregierung 2017, p. 61). However, even if the federal government gave these values equal importance not all goals supporting these values have been reached. So far, especially the goals related to ecological sustainability, such as the share of organic farming, nitrate or nitrogen levels, have not been reached. In fact, the BMEL acknowledged that intensive agricultural production inevitably leads to side-effects on the environment. For this reason, the protection of natural resources, air, climate, ecosystems, and biodiversity has to be given special attention (BMEL 2016, p. 28). According to the BMU, in contrast, environmental protection can only be achieved by a profound restructuring of the existing agricultural sector (BMUB 2016a, p. 10).

Against the background of institutional development, it becomes apparent that the international level has only limited influence on German agricultural policy. International frameworks, such as the MDGs and SDGs, however, are important for the global dimension of food security. The CAP completely communitized agricultural policy on the EU level, which thus also determines German agricultural policy. On the federal level, the BMEL is the most important actor. The role of the federal states has to be emphasized in this policy field. They are not only responsible for the implementation of the CAP and the distribution

of payments but also for the management of EU's structural and investment funds (e.g. the European Regional Development Fund), which are instruments to achieve climate mitigation goals (Bundesregierung 2014a, p. 42). With regard to institutional change agricultural policy can be described as largely path dependent showing low levels of learning. Even though the CAP was reformed many times, it did not profoundly change. Throughout the analyzed time period, more and more sustainability criteria were added, such as the "greening" and "cross-compliance" requirements, in response to emerging negative side-effects caused by intensive agricultural production. Nonetheless, the two-pillar structure was maintained and existing regulations were repeatedly only adjusted.

Figure 17: Important action situations in agricultural policy



Source: own Figure.

6.3.5. Energy policy

Based on the total number of segments coded with the main code *energy* ($n_{segments}$ = 664) the energy sector seems to be of special importance in Germany, or at least in the analyzed documents. The qualitative document analysis shows that for a long time German energy policy has been based on a value triangle of energy security, affordability, and ecological sustainability, treated as being equally important (BMUB 2016b, p. 27). This is also

represented by the number of coded segments: *energy security* $n_{segments}$ = 77, *competitiveness* $n_{segments}$ = 72, *ecological sustainability* $n_{segments}$ = 65. This triangle was found throughout the entire time horizon of selected documents.

According to the federal government a safe energy supply is often considered the basis for a modern lifestyle, the functionality and quality of life (Bundesregierung 2002, p. 149). Security of energy supply is constantly reflected against the background of Germany's high import dependence (*paradigm/conditions/import depe*ndence $n_{segments}$ = 40). For example, Germany is highly dependent on oil and gas imports, which are especially needed for the transport, private, and industrial sector (Bundesregierung 2014a, p. 17). Thus, lowering the need for imports is an important goal (Bundesregierung 2004, p. 170) for improving energy security. In this regard, replacing conventional energy sources by renewables or reducing their demand through a higher energy efficiency are perceived as helpful instruments (Bundesregierung 2007, p. 3, 2008, p. 91, 2012b, p. 152). For example, in the early 2000s the federal government highly supported the production of biogas in order to face growing gas demands (Bundesregierung 2007, p. 32) that were expected to result from the intended nuclear phase-out (Bundesregierung 2002, p. 136).[16] Electric vehicles were seen as one instrument to reduce import dependence on oil (Bundesregierung 2007, p. 86). The value of energy security is embedded in many federal rules and regulations as, for example, stated many times in the Federal Energy Act (Energiewirtschaftsgesetz, EnWG) (e.g. Energiewirtschaftsgesetz 7/7/2005, pp. 10, 38).

The value of competitiveness mostly refers to affordability of energy for private households and industry (Bundesregierung 2012b, p. 147). Affordable energy prices are seen as an important factor to keep the industrial sector internationally competitive, especially with regard to the energy intensive industries, such as the chemical, metal, glass, paper, or steel industry, which are located in Germany. Furthermore, energy costs have a strong social

[16] The case of nuclear energy will be described further down in this section.

dimension and touch upon many critical areas of everyday life, such as heating, hot water, or transportation (Bundesregierung 2002, p. 150; BMUB 2016b, p. 15).

Ecological sustainability is the third core value of the energy policy triangle and of special interest in terms of the the nexus. It mainly addresses mitigating climate change. In total, energy-related emissions accounted for around 84.5% of total German GHG emissions in 2017. The highest shares of these emissions originated from the energy industry (around 40%) and the transport sector (20%). The rest resulted from other industries, the service and retail sector, or private households (Umweltbundesamt 2020b). Besides climate mitigation, also the issue of nuclear safety and its impacts on the environment plays an important role, as already mentioned in section 6.1. Ecological sustainability can thus be seen as one main driver of the German energy ($n_{segments}$ = 20), which insofar, is not only the German response to a transformation towards a low carbon energy system but, at the same time, also a response to the nuclear catastrophes of Chernobyl and Fukushima (Bundesregierung 2014a, p. 7). Due to its relevance and scope the energy transition has become a major societal challenge that touches upon many different sectors and areas of life, such as energy prices or job security in the energy industry. Therefore, the federal government emphasized the need for an economically and socially viable transition process (Bundesregierung 2014b, p. 5). Furthermore, the energy transition also has a European and an international dimension, firstly, because Germany is a member state of the EU and located in central Europe (Bundesregierung 2014a, p. 17), and secondly, because the energy transition serves as the implementation of SDG 7 “affordable and clean energy” and parts of SDG 13 “climate action” (Bundesregierung 2017, p. 113). A decarbonized energy system is thus also an important guiding principle – or value – in foreign energy policy as well as development policy (Bundesregierung 2017, p. 113). The energy transition is based on three pillars: (1) the expansion of renewables, (2) increasing energy efficiency, and (3) a nuclear phase-out. Since all of these three pillars have implications for possible nexus governance challenges in Germany, they are described in the following paragraphs.

Renewables have been an important aspect in German energy policy throughout the whole time period of analyzed documents ($n_{segments}$ = 56). However, their role has strongly increased over time. In 2000, German primary energy use and electricity production was mainly covered by fossil fuels, such as hard coal, lignite, oil, and gas. Even though the red-green government in 2002 already called for more environmentally friendly technologies (Bundesregierung 2002, p. 97), fossil fuels were repeatedly emphasized as being the central pillar of German energy supply (Bundesregierung 2000, p. 13, 2002, p. 132, 2004, p. 11, 2005, p. 84). Despite the fact that the federal government acknowledged that fossil fuels do not comply with the guiding principle of sustainable development and intergenerational justice due to their limited availability and high GHG emissions a major role was given to them both for the present energy system as well as for the near future (Bundesregierung 2002, p. 132). Especially with regard to the first planned nuclear phase-out, the use of fossil fuels was seen as inevitable, which is why the federal government called for new technologies, such as carbon capture and storage, and more efficient power plants including combined heat and power in order to reduce emissions (Bundesregierung 2007, p. 21, 2008, p. 91, 2012b, p. 153). In 2002, the law on combined heat and power (Kraft-Wärme-Kopplungsgesetz, KWKG) was adopted, which focused on the modernization and promotion of KWKG (Bundesregierung 2002, p. 153). Against the background of international climate negotiations and binding climate targets the federal government started to define clear capacity expansion goals for renewable energy sources. Those became one of the most important energy policy goals in Germany (*goals/renewables* $n_{segments}$ = 29). According to the EEG the following technologies are considered as renewable energy sources: hydropower, wind, solar, geothermal energy, and biomass (Erneuerbare-Energien-Gesetz 2017 7/17/2017, p. 9).

In 2000, the federal government set the goal of doubling the share of renewable energies in the electricity sector by 2010 compared to 2000, which corresponded to a share of 10% of electricity production by 2010. Also, the share of renewables in primary energy use was to be increased to 4% compared to 2000 (Bundesregierung 2000, p. 31). In the NHS 2002

this goal was slightly adjusted to 12.5% of electricity use and 4.2% of primary energy use until 2010. Furthermore, the NHS 2002 demanded a share of 50% of energy use by 2050 (Bundesregierung 2002, p. 156). Based on that, a 20% share of electricity use until 2020 for the electricity sector was derived (Bundesregierung 2004, p. 43). The energy concept (EnKonz) of 2010 stated that in the long run conventional energy sources would be continuously replaced by renewable energies (BMWi and BMU 2010, p. 3). It also stated that renewable energy sources were supposed to account for the major share in the future energy mix (BMWi and BMU 2010, p. 3). The whole energy policy triangle of affordability, energy security, and ecological sustainability also applied for the capacity expansion and system integration of renewable energy sources (Bundesregierung 2007, p. 10). However, capacity expansion of renewables came with certain challenges, such as natural fluctuations in the availability of wind and solar energy and far distances between the locations of electricity production and consumption. Whereas huge wind power potentials exist in northern Germany, the Baltic and North Sea, many energy intensive industries are located in the southern part of the country, thus necessitating adequate grid expansions (Bundesregierung 2004, p. 166). The most relevant law addressing these challenges as well as structurally organizing capacity expansion of renewables is the German EEG (*rules/EEG* $n_{segments}$ = 41). The EEG is based on the value of ecological sustainability and aims at an energy system development in the interests of climate and environmental protection (Erneuerbare-Energien-Gesetz 2017 7/17/2017, p. 7). It came into force in 1990 as the former Electricity Feed-in Law (*Stromeinspeisungsgesetz, StromEinspG*). In 2000, it was transformed into the first version of the EEG intending to ensure a profitable operation of renewables. Additionally, it promoted their further capacity expansion by regulating feed-in conditions of electricity produced from renewables (Bundesregierung 2002, p. 237) and introducing fixed feed-in tariffs for 20 years (Bundesregierung 2004, p. 75). Central technologies that were supported at this stage were wind and solar power (Bundesregierung 2002, p. 236), as well as biomass for electricity production (Bundesregierung 2002, p. 97). The EEG can thus be seen as an important instrument to

reach the Kyoto targets. Since then, the EEG has been reformed multiple times (in 2004, 2009, 2012, 2014, and 2017). The 2004 EEG reform further increased the support for biomass (Bundesregierung 2004, p. 114) and, for the first time, included capacity expansion targets for the electricity sector of at least 12.5% until 2010 and 20% until 2020. Furthermore, this reform also implemented EU Directive No. 2001/77/EG which promoted electricity production from renewables in the EU internal electricity market (Erneuerbare-Energien-Gesetz 2004 7/21/2004, p. 1).[17]

The 2009 EEG reform included the goal of at least 30% renewables in the electricity sector until 2020 as well as regulations regarding grid expansion (Bundesregierung 2007, p. 10). This version of the EEG also focused more strongly on wind power, especially offshore power plants in the North and Baltic Sea of which the first two were installed in 2010. By refusing feed-in tariffs for wind farms authorized in marine reserves higher environmental standards were included as well (Bundesregierung 2012b, p. 167). This reform also terminated subsidies for large scale open space PV systems due to their high land demands. Instead, solar PV on rooftops was promoted in order to reduce pressure on land demands and to increase the diversity of stakeholders (BMUB 2016a, p. 53). The 2012 EEG reform included adjusted climate and energy targets for 2020, 2030, 2040, and 2050 and focused on grid adaptation and market integration of renewables. It also amended the system of feed-in tariffs for bioenergy, solar PV, and offshore wind (Bundesregierung 2012b, pp. 151–152). The latest EEG reform in 2017 profoundly changed the nationally fixed feed-in tariff system into a market-based tender system (Bundesregierung 2017, p. 120). It also included the current climate goals for electricity production from renewables, which aim at a share of 40% to 45% until 2025, 55% to 60% until 2035, and at least 80% until 2050. Additionally, the share of renewables in final energy consumption was supposed to reach 18% by 2020 (Erneuerbare-Energien-Gesetz 2017 7/17/2017, p. 7). In fact, the share of renewables in Germany has steadily increased since the early 2000s, which, according to the federal

[17] The EU Directive 2001/77/EG was replaced by the EU Renewable Energy Directive (2009/28/EG) in 2009.

government, mostly directly resulted from the EEG (Bundesregierung 2005, p. 23; BMWi and BMU 2010, p. 7; Bundesregierung 2012a, p. 5).

Besides the EEG many other legal rules and regulations were adopted to integrate renewables into the energy system and to modify the existing power grid. Since 2009 the grid expansion is regulated by the Power Line Expansion Act (Energieleitungsausbaugesetz, EnLAG) (Bundesregierung 2008, p. 92). In order to further and faster promote grid expansion a law on a fastened grid expansion (Netzausbaubeschleunigunggesetz, NABEG) was adopted in 2011 (Bundesregierung 2012b, p. 152). Furthermore, the revision of the EnWG in 2011 included important regulations regarding infrastructure, grid expansion, and storage and initiated specific ten year grid expansion plans (Bundesregierung 2012b, p. 153; Energiewirtschaftsgesetz 7/7/2005, p. 9). The Electricity Market Act (Strommarktgesetz) of 2016 aimed at a more flexible electricity market and a better coordinated electricity production and consumption (BMUB 2016b, p. 35).

In order to not only address the integration of renewables in the electricity sector but also in the heating sector the Renewable Energy Heating Law (Erneuerbare-Energien-Wärmegesetz, EEWärmeG) came into force in 2009 (Bundesregierung 2008, p. 94). In 2012, the Destatis confirmed that the EEG, alongside with the EU Renewable Energy Directive and the EEWärmeG, contributed a great deal to the increasing share of renewables and the achievement of the 2010 expansion goals (Statistisches Bundesamt 2012, p. 13). For the transport sector the NHS 2016 included the goal of almost reaching carbon neutrality until 2050 (Bundesregierung 2017, p. 113). This goal is also found in the climate action plan 2050 (BMUB 2016b, p. 50). With regard to renewables this meant increasing the share of biofuels and promoting electric cars. The federal government aimed at one million electric passenger cars by 2020 and six million by 2030 (BMWi and BMU 2010, p. 30; Bundesregierung 2012b, p. 189). Instruments, that have been used so far, have been bonuses and tax exemptions (Bundesregierung 2014b, p. 13, 2017, p. 121). Since the transport sector is not part of the ETS, the ESD applies, which demands a 14% reduction compared to 2005 until 2020 (Europäische Union 6/5/2009, p. 147). Reaching this goal,

however, would necessitate much bigger efforts in the transport sector (Bundesregierung 2008, p. 94).

According to the BMU renewables, so far, have been integrated in the existing conventional energy markets. In the future, however, renewable energies and high energy efficiency should set the standard for any investment. Additionally, every energy consuming sector should exclusively use renewable energies and introduce sector coupling, if possible (BMUB 2016b, pp. 14–15). Like this, renewables would become the major pillar in all three key areas of the energy sector: electricity, heating, and transportation (BMUB 2016b, p. 34). In the Climate action plan 2050 (KSP 2050) the BMU clearly demanded a stepwise reduction of lignite in order to reach the climate targets. The plan suggested a broad stakeholder dialogue including industry, trade unions and affected regions (BMUB 2016b, pp. 35–37). The integrated environment protection program (IntUP) confirmed this statement and emphasized the need for a coal phase-out before 2050 for a successful energy transition (BMUB 2016a, p. 55). An agreement on a coal phase-out in 2038, eventually, was reached in 2019 by means of the so-called “coal-commission” (BMWi 2019, p. 64).

The second major pillar of the German energy transition is energy efficiency (Bundesregierung 2014b, p. 3) ($n_{segments}$ = 57). Its role for reducing carbon emissions as well as lowering both energy costs and import dependence was emphasized many times (e.g. Bundesregierung 2002, p. 10, 2004, p. 164, 2007, p. 2, 2012b, p. 148, 2014b, p. 13; BMUB 2016b, p. 29). The German government does not always distinguish precisely between energy efficiency and energy savings in the analyzed documents. Even if these aspects are closely interlinked, they need to be differentiated. Generally, the term efficiency is related to industry in the sense that productivity and competitiveness are maintained through reduced energy needs. Saving energy, however, more often relates to the building sector or private households. In the analyzed documents this differentiation, however, is not always maintained. One important rule for energy savings and efficiency is the Energy Saving Ordinance (Energieeinsparverordnung, EnEV), which is based on the Energy Savings Act (Energieeinspargesetz, EnEG) of 1976. At the time, this law was adopted as a response

to the oil crisis in order to reduce Germany's import dependence (Bundesregierung 2000, p. 113). The NHS 2002 demanded to decouple economic growth from resource and energy use (Bundesregierung 2002, p. 51). This was intended to be reached through a higher energy productivity (Bundesregierung 2008, p. 91). For this reason, the goal was to double energy productivity by 2020 compared to 1990 (e.g. Bundesregierung 2002, p. 93; Statistisches Bundesamt 2007, p. 5; Bundesregierung 2008, p. 88, 2012a, p. 8). The EnKonz of the federal government stated that primary energy use should be reduced by 20% by 2020 compared to 2008 and by 50% by 2050, which corresponds to an increase in energy productivity of 2.1% per year with regard to final energy consumption. Furthermore, electricity use was supposed to be reduced by 10% by 2020 and by 25% by 2050, compared to 2008 (BMWi and BMU 2010, p. 5). These goals were stated in many following documents (e.g. Bundesregierung 2012b, p. 147, 2014b, p. 7, 2017, p. 114). Additionally, in 2012, the EU Energy Efficiency Directive (2012/27/EU) was adopted, which aimed at reaching an efficiency increase of 20% until 2020. Amongst other things, it determined national efficiency energy saving targets (Bundesregierung 2014b, p. 12). The most important national strategy for reaching higher energy efficiency was the National Plan for Energy Efficiency (NAPE) presented in 2014 (Bundesregierung 2017, p. 117). According to the NHS 2016 a decoupling has already been reached to a certain degree since energy use increases more slowly than economic growth (Bundesregierung 2017, p. 17).

With regard to private households, since 1992, EU Directive 92/75/EWG has demanded efficiency labels for household appliances. In 2010, this was broadened by Directive 2010/30/EU to include further products, such as, e.g., TVs. In Germany, these directives were implemented through a law on energy efficiency labelling (Energieverbrauchskennzeichnungsgesetz, EnVKG) (Bundesregierung 2012b, p. 192). Besides private households the immense energy saving potential of the building sector by means of modernization and restoration is emphasized many times (e.g. Bundesregierung 2002, p. 2; BMWi and BMU 2010, p. 27; Bundesregierung 2012b, p. 153, 2017, p. 117). Already in 2000, a program was launched intending to foster emission reduction of buildings

(Bundesregierung 2000, p. 6). Currently, the German government aims at climate neutrality of existing buildings by 2050 (Bundesregierung 2014a, p. 24; BMUB 2016b, p. 42) and a reduced primary energy use by 80% compared to 2008 until 2050 (BMUB 2016b, p. 43).

Although passenger cars and trucks became less emission intensive over the years due to modern engines, exhaust systems and fuels, the overall emissions in the transport sector have remained on the same level as in 1990 (Umweltbundesamt 2020b). The NHS 2002 aimed at reducing transport intensity in passenger as well as freight transport by 20% and 5% respectively by 2020 compared to 1999 (Bundesregierung 2002, p. 111). These goals have not been adjusted in more recent documents (Statistisches Bundesamt 2014). In 2016 the sustainability indicator for freight and passenger transport changed. It was now measured by their final energy consumption which for both is supposed to be decreased by 15% to 20% by 2030 (Bundesregierung 2017, p. 38). Generally, more goods were intended to be transported by train which is why freight transport by rail and ship were supposed to reach a share of 24.3% and 14.1% by 2015 (Bundesregierung 2002, p. 112), respectively 25% and 14% (Statistisches Bundesamt 2008, p. 34).

The third pillar of the energy transition is the nuclear phase-out. Whereas a coal phase-out only recently has been addressed by means of the so-called “coal commission”, the decision to phase-out nuclear power was first made in 2000 (Bundesregierung 2000, p. 12). According to the NHS 2002 implemented by the former red-green government, the future energy supply was supposed to be based on the guiding principle of sustainable development. Even though nuclear energy has low GHG emissions, in their opinion, the technology does not comply with inter- and intragenerational justice due to the risks and the long lasting radioactive waste (Bundesregierung 2002, p. 144). The phase-out was planned to be realized within 20 years and was regulated by an amendment of the Federal Atomic Energy Act (Atomgesetz, AtG). The first nuclear power plant was shut down in 2003 in Stade, Lower Saxony (Bundesregierung 2004, pp. 80–81). After the change of government in 2005 the new black-red government, at first, upheld the envisaged phase-out. Against this background it emphasized the role of fossil fuels despite their high level of air pollution

and supported carbon capture and storage as an instrument to achieve climate targets (Bundesregierung 2007, p. 21). Nevertheless, as the FB 2008 showed the question of whether or not nuclear energy should further be used did concern the federal government at that time. Arguments in favor of this technology referred to energy security, affordable energy prices and low GHG emissions. In contrast, arguments against the technology were related to residual risks and the disposal of radioactive waste. Still, in this legislative term the regulations made in the Atomic Energy Act and the consensus on the nuclear phase-out were maintained (Bundesregierung 2008, p. 91). With the change of government in 2009 and the new black-yellow coalition the nuclear phase-out was questioned again and, this time, resulted in a lifetime extension of existing nuclear power plants for about twelve years. Nuclear energy was argued to be a bridging technology within the envisaged energy transition contributing to the energy policy triangle of climate mitigation, affordability, and energy security (BMWi and BMU 2010, pp. 16–18). The decision on lifetime extension, however, was immediately reversed after the nuclear catastrophe in Fukushima, Japan, in March 2011. In the aftermath of this event, an immediate inspection of all German reactors was directed and an ethics commission was instructed to assess the risks of nuclear energy with regard to the Fukushima accident. The parliament adopted an energy package containing of seven laws and one ordinance regarding a faster nuclear phase-out until 2022 as well as further capacity expansion and system integration of renewables (Bundesregierung 2012b, pp. 143–146, 152). However, the question remained of where to store heat developing radioactive waste. The process of finding a final repository was regulated in 2013 by a specific law (Standortauswahlgesetz, StandAG) (BMUB 2016b, p. 23) that assigned a commission ("Endlagerkommission") with this task. The commission held its first meeting in 2014 and presented its final report in July 2016 (BMUB 2016a, p. 55). Despite their work, so far, no final repository has been decided upon.

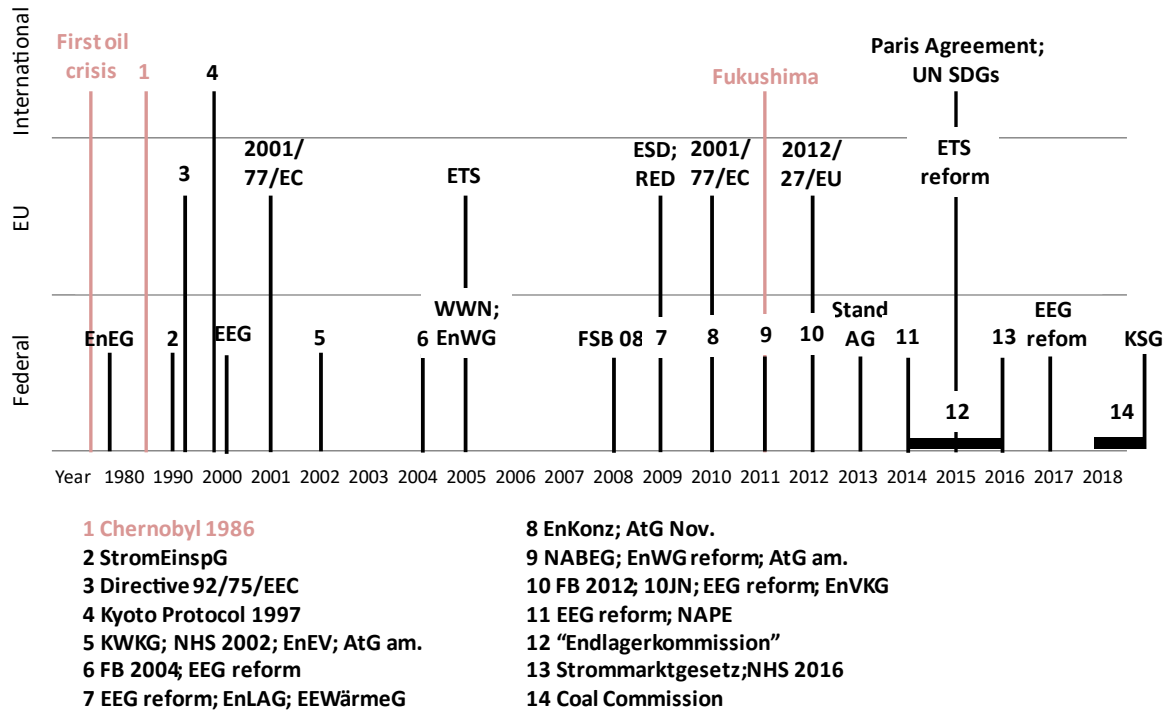
The case of nuclear power highlights two important aspects: Firstly, it shows how unforeseen external events can lead to a profound change of policy as in the case of the nuclear catastrophes in Chernobyl in 1986 and Fukushima in 2011. Both times the German

government responded with a nuclear phase-out. Secondly, the case of nuclear power shows a value conflict within the value of ecological sustainability. Whereas low carbon emissions serve the value of mitigating climate change, residual risks and radioactive waste contradict the values of nature protection and intergenerational justice. The catastrophes of Chernobyl and Fukushima eventually showed that, in this case, the values of intergenerational justice and safety were prioritized over climate mitigation and energy security.

Regarding the international level, German energy policy, so far, was mostly influenced by climate negotiations that translated into federal targets for the capacity expansion of renewables and a higher energy efficiency. The most important governance level in the field of energy remains the federal level. Even if European regulations exist, such as the Renewable Energy Directive for example, energy policy by European law mainly remains to be a field of national responsibility (Europäische Union 10/26/2012, § 194). Federal laws, however, most notably the EEG and the EnWG also incorporate the international and European perspective (Erneuerbare-Energien-Gesetz 2017 7/17/2017, pp. 11–12; Energiewirtschaftsgesetz 7/7/2005, p. 97). In Germany the federal ministry for economic affairs and energy (BMWi) is the main actor, although, e.g. with regard to the transport sector, also other federal ministries are touched. The policy field of energy generally is very divers and unifies many different aspects, what makes it rather difficult to treat it as one policy field in terms of the nexus. Regularly adjusted energy and climate targets that result in capacity expansion goals for renewables and increasing energy efficiency show a rather path dependent development. The federal government maintained an existing institution – the EEG – and aimed at achieving the climate goals by repeated modification. The EEG developed along a specific path and showed processes of single and double loop learning. So far, the share of renewables increased up to nearly 40% in the electricity sector in 2018. However, despite the existing goals, capacity expansion of renewables slowed down in the last few years, and Germany was long expected to miss its 2020 climate targets, which only changed due to the corona crisis (Tagesschau 2021; Bayerischer Rundfunk 2021). Especially

in the transport sector no significant improvements have been made so far. Since 2019, a new legal rules exists in the form of the Federal Climate Protection Law (KSG) setting clear annual emission limits until 2030, including the transport sector (Klimaschutzgesetz 12/12/2019, § 4). Besides international climate negotiations, energy policy in Germany has been strongly impacted by external events. The oil crisis in the 1970s resulted in measures for energy savings and energy efficiency aiming at lowering import dependence. The two nuclear catastrophes of Chernobyl in 1986 and Fukushima 2011 each led to a decision for a nuclear phase-out. Hence, in contrast to climate mitigation the German atomic policy has not been path dependent and was determined by critical junctures.

Figure 18: Important action situations in energy policy



Source: own Figure.

6.3.6. Water policy

Looking at administrative structures, water policy is usually treated as part of the environmental policy field. In general, water policy does not receive much attention

compared to the other policy fields as the number of coded segments shows. In total, $n_{segments}$ = 97 are included in the main code *water.* The two core values associated with water policy are: security of water supply ($n_{segments}$ = 12), and ecological sustainability ($n_{segments}$ = 10).

In Germany, safe water supply and functioning sewage systems have been established for a long time. Their maintenance is part of the municipal public services ("kommunale Daseinsvorsorge") (Bundesregierung 2012b, p. 162). Similar to food security, this value has developed a strong international dimension, which is also emphasized in German policy documents (Bundesregierung 2005, p. 74, 2012a, p. 6, 2017, p. 105). SDG 6 "clean water and sanitation" is represented by three indicators in the NHS 2016 of which one aims at increasing global access (Bundesregierung 2017, p. 111).

The second value of ecological sustainability mostly addresses the protection of water resources. According to the Federal Water Act (Wasserhaushaltsgesetz, WHG) water is part of the ecosystem, the basis for human and non-human life, habitat for many animals and a valuable and useful good (Wasserhaushaltsgesetz 7/31/2009, p. 2). Thus, water serves different ecological, economic, and social purposes, which is why the protection of water resources is connected to many other goals in other policy fields (Bundesregierung 2008, p. 156). This necessitates a harmonization of different users and uses of water resources in order to reduce negative impacts (Bundesregierung 2012b, p. 162). The value of water protection and water quality is also often connected to intergenerational justice, to the goal of providing clean water to following generations as well (Bundesregierung 2012a, p. 6, 2012b, p. 162). However, surface water bodies often suffer from structural modifications, such as straightening of rivers. Coastal and sea waters are negatively impacted by fishery, emissions, polluting substances, waste, and noise (BMUB 2016a, p. 65). A broad regulatory framework exists that addresses these issues. Between 1990 and 2000 and between 2006 and 2009 each several regulations were adopted and implemented. The first round started with the ND in 1991, which was implemented by the Fertilizer Ordinance (DüV) in 1996. The Waste Water Directive (AbwV) and the Ground Water Directive (GrwV) followed in 1997 on

the federal level. In 2000, one of the most important European legal rules for water management was adopted: the Water Framework Directive (WFD) (2000/60/EG) which aims at a good water status of all water bodies by 2027 at the latest. In Germany it is implemented by the WHG and the Surface Water Directive (OGewV). The WFD introduced a new system in managing water bodies by creating river basin areas that not only cross borders between several federal states but also between neighboring countries. New management plans and cross-border river basin management commissions for the Rhine and the Danube were established (Bundesregierung 2012b, p. 168). The main responsibility for the realization of the WFD and coordinated river basin management is in the hands of the German federal states (Bundesregierung 2012b, p. 168; Wasserhaushaltsgesetz 7/31/2009, p. 4). The federal government is responsible for federal water ways, especially with regard to biodiversity and the permeability for migrating fish (Bundesregierung 2012b, pp. 168–169).

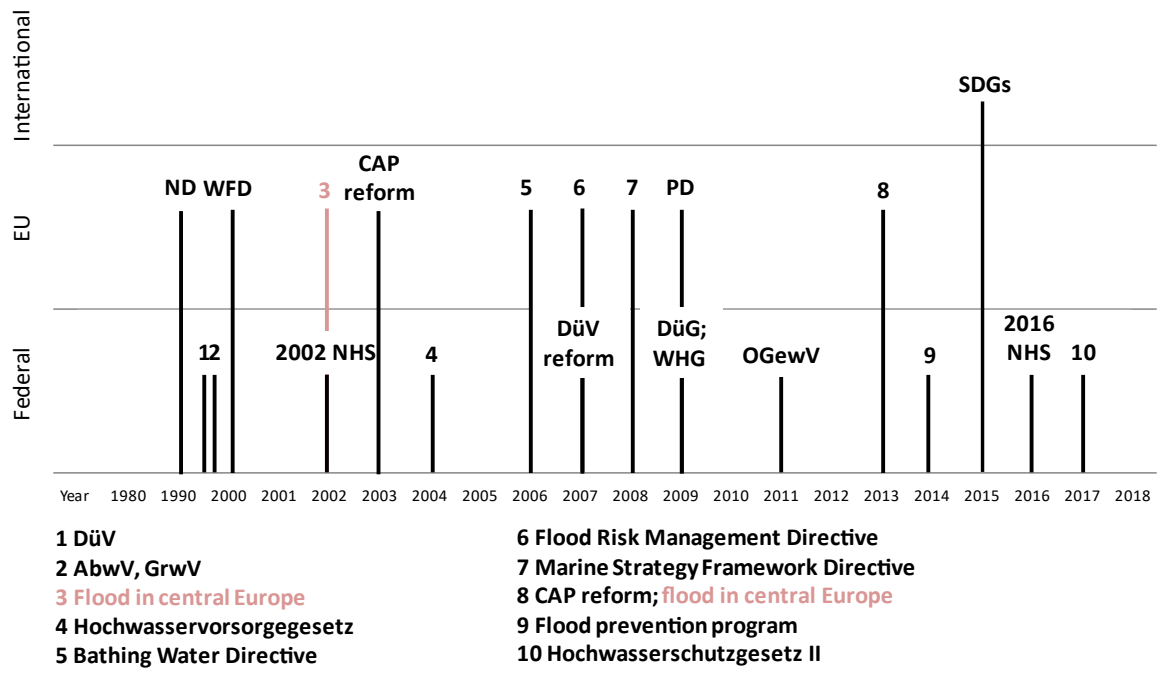
Between 2006 and 2009 various other more specific ordinances were adopted on the EU level, such as the Bathing Water Directive (2006/7/EG) or the Marine Strategy Framework Directive (2008/56/EG). Furthermore, agricultural fertilization practice was in focus as one main reason for water pollution and addressed by a DüV reform in 2007, the Federal Fertilizer Act (Düngegesetz, DüG) and the EU directive on sustainable use of pesticides (2009/128/EG) both in 2009. Since agriculture is a key water polluter (Bundesregierung 2012a, p. 6) , also the CAP and its reforms are important for water policy. Due to the strong interrelation between the agricultural and the water sectors, the case of water pollution is an important nexus issue in Germany and will thus be described in section 6.4.6 in further detail.

Not only the protection *of* water resources is an important aspect regarding ecological sustainability but also the protection *from* water. Especially against the background of the impacts of climate change the risk of flooding became more present. In response to the major flood disaster in central Europe in 2002, flood control was raised as an important issue. In 2004 Germany adopted a law (Hochwasservorsorgegesetz) aiming at better flood

prevention by introducing common binding requirements against flood damages, such as the creation of retention areas and special regulations for land use in flood plains (Bundesregierung 2004, pp. 199–200). In the aftermath of a second flood in 2013, a second version of the HWSG (HWSG II) was adopted in 2017. Additionally, the European Flood Risk Management Directive (Hochwasserrisikomanagement-Richtlinie) (2007/60/EG) demanded the development of flood risk maps until 2013 and management plans until 2015 (Bundesregierung 2012b, p. 170). These plans were about to be assessed with regard to how they account for increasing impacts of climate change. The directive was implemented by the German WHG (Wasserhaushaltsgesetz 7/31/2009, pp. 20–22). Also, in 2014 a national flood protection program was developed, which provided an overview on urgent, cross-regional actions for Germany (Bundesregierung 2017, p. 22).

With regard to MLG the international level has the least influence for German water policy. On the EU and the federal level water is usually treated as being part of environmental policy. Even if this policy field is only partly communitized several EU regulations exist that are of high importance for federal water policy, such as the ND and the WFD. The federal states take an important role for water policy, amongst other things they are responsible for the implementation of the WFD. The local level is in charge of a safe water supply and sanitation. With regard to institutional change the development depends on the specific issue. Water pollution has been a continuous challenge for decades. Laws and regulations that aim at improving the quality of water resources mostly developed path dependently and were adjusted over time. In the case of flood prevention, however, the role of external events, such as severe floods in central Europe in 2002 and 2013, initiated social learning that led to new institutions, such as the HWSG I or flood risk maps and management plans.

Figure 19: Important action situations in water policy



Source: own Figure.

6.3.7. Discussion and section summary

The value-based institutional analysis aimed at revealing the institutional developments in the nexus and nexus-related policy fields as well as their underlying values. This analytical step sets the basis for analyzing the specific nexus governance challenges in the next step. Only by understanding why and how policy fields develop and learn facilitators and barriers of policy integration and thus nexus governance can be understood. Therefore, related coded text segments from German policy documents included in document group I-III were structurally examined. This analysis showed that by far most of the coded text segments belong to the field of energy (cf. Figure 13). This hints to the fact that the energy field receives most of the attention or, at least, is of special relevance in the analyzed documents. However, by taking a deeper look into the coded segments, specific insights regarding the different policy fields can be revealed.

Sustainable development can be seen as an overarching guiding principle that dates back to the publication of the Brundtland report in 1987 and the first UN World Summit on Sustainable Development in Rio de Janeiro in 1992. Since then, in Germany the principle was strengthened continuously as a guiding principle for policy-making in any policy field. The most important rule in this area is the German sustainable development strategy. First published in 2002, in the context of the UN Summit on Sustainable Development in Johannesburg the strategy developed path dependently until 2015 through regularly published progress and monitoring reports. The adoption of the SDGs marked a critical juncture that led to a profound revision of the strategy according to the SDG structure. Thus, the international level is of high importance for the development of the strategy. The European level, however, is of less relevance in this policy field. In Germany, the issue of sustainable development is located at the highest political level, the German chancellery, which shows its overarching and central character.

Under the overarching principle of sustainable development, climate and environmental policy are two cross-sectoral policy fields that touch upon many other policy fields. Climate policy incorporates the value of combatting anthropogenic climate change. It has a strong inter- and intragenerational perspective, similar to sustainable development. Goals that support this value, first and foremost, are GHG emission reduction goals. German climate policy is strongly impacted by international climate negotiations and the European climate goals. Until 2019 institutional change in the field of climate policy mainly developed path dependently through regularly published climate action plans including adjusted GHG emission reduction targets and several EEG reforms specifying the capacity expansion of renewables. In 2019, a federal climate protection law was adopted which marks a process of higher learning mainly influenced and triggered by the Paris Agreement and the Fridays for Future movement. Besides the value of climate protection, climate policy, however, also is to further serve the value of competitiveness.

In environmental policy the protection of nature and natural resources are the main values. Ending biodiversity loss and reducing current resource use are the most important goals

related to these values. The beginning of German environmental policy can be located at the early 1970s. The first environmental protection program published in 1971 was followed by the BImSchG in 1974 and the BNatSchG in 1976. These still are important rules in this policy field. Furthermore, the BMU developed a German biodiversity strategy in 2007 that addressed various other sectors and policy fields as well what reflects the cross-cutting character of this policy field. Environmental policy is a field of shared responsibilities between the federal and the EU level. Therefore, various EU regulations exist that are important in this policy field. Since its early times, the objective of environmental policy changed from merely repairing negative impacts of economic activity towards saving natural resources and preserving an intact nature. The main actor on the federal level is the BMU. According to the federal government, the integration of environmental concerns into other policy fields can be seen as an important challenge since the environment can only be properly protected by environmentally friendly sector policies. Therefore, in the following nexus-related policy fields many values and regulations are found that touch upon this issue.

In the field of agricultural policy, the values of security of food supply, consumer protection, competitiveness, and ecological sustainability were found. While food security in Europe has been reach for a long time, it again emerged as an issue due to the global food price shock in 2008 (cf. Figure 2) and growing bioenergy demands. The values of food security and global competitiveness are strongly incorporated in the EU's CAP which provides financial support for farmers and agricultural businesses since 1962. Intensified agricultural production including large scale livestock farming, a high use of fertilizers and pesticides caused severe environmental impacts, such as water and soil pollution or increasing GHG emissions. Therefore, the CAP was repeatedly reformed towards including more environmental requirements. However, most of these environmental problems persisted in the form of exceeding nitrate and nitrogen levels in soil and water bodies or ongoing biodiversity loss. With regard to political responsibilities agricultural policy is completely

communitized on the European level and, so far, developed path dependently without higher levels of learning.

German energy policy throughout the entire analyzed time period incorporated a value triangle of security of energy supply, competitiveness and ecological sustainability. This triangle applies both for the former conventional energy system mostly based on fossil fuels as well as for the future low-carbon energy system based on renewable energies. Mainly since the Fukushima nuclear catastrophe in 2011 German energy policy is characterized by the aim of an energy transition towards a sustainable and almost carbon neutral energy system until 2050. This energy transition is based on the three pillars of capacity expansion of renewables, a higher energy efficiency, and a nuclear phase-out until 2022. German energy policy is, in fact, influenced by international climate negotiations, it is, however, mainly governed on the federal level. Even if relevant European directives exists, such as the renewable energy directive or the energy savings directive energy policy by European law remains an issue of national responsibility. The EEG is one of the most important legal rules in Germany. So far, it has been reformed many times. With regard to GHG emission reduction targets and capacity expansion of renewables institutional change developed mostly path dependently. Respecting the intended coal and nuclear phase-out the development is determined by critical junctures. The appointment of the so-called “coal commission” which negotiated a coal phase-out until 2038 was strongly influenced by the adoption of the Paris Agreement in 2015 and its development process happened within the context of the protests in the Hambach Forest and the upcoming Fridays for Future movement. Nuclear policy is mainly determined by external catastrophes, such as the Chernobyl and Fukushima accidents.

Water policy is usually treated as being part of environmental policy. Security of water supply and ecological sustainability can be seen as core values. Since security of water supply has been reached for a long time in Germany this value nowadays is characterized by a rather international perspective. Ecological sustainability mostly refers to the protection of water resources against pollution but also to the protection from water in the

case of flooding. With regard to pollution, the water sector is highly affected by industry and agricultural production. Many European regulations exist that address this issue. A first wave of regulations regarding water pollution was adopted between 1991 and 2000, starting with the ND and finished with the WFD. The latter represented a result of higher levels of learning since it introduced a new system of water management. Apart from that, institutional change regarding water pollution rather developed path dependently. Also, the second wave between 2006 and 2011 specified this issue for e.g. bathing or marine waters. For the case of protection from water, the development is different. It is mainly impacted by critical junctures in the form of two major floods in central Europe in 2002 and 2013. These events caused a number of flood prevention measures and thus triggered learning processes. Due to the different local conditions the regional and municipal level is of high importance for water policy. Table 15 again summarizes the results in the different policy fields.

Table 15: Overview of main factors in the institutional development of the policy fields

Policy field	Values	Institutional development	Critical junctures	Main level of governance
Sustainable development	Sustainable development as guiding principle	Path dependently until 2015	MDGs, SDGs	Federal
Climate	Combatting climate change	Path dependently until 2019	Kyoto Protocol, Paris Agreement	Federal
Environment	Protection of nature and natural resources	Path dependently	UN Convention on Biodiversity	Shared between federal and EU
Agriculture	Food security, Competitiveness, ecological sustainability	Path dependently		EU
Energy	Energy security, competitiveness, ecological sustainability	Partly path dependently, partly disrupted	Kyoto Protocol, Paris Agreement, Chernobyl, Fukushima	Federal
Water	Water security, protection from water, ecological sustainability	Partly path dependently, partly disrupted	Floods 2003, 2013	Shared between federal and EU

Source: own Table.

By comparing the institutional change processes in the different policy fields three very important aspects have been revealed. Firstly, the institutional development of the three nexus policy fields shows some important value changes over the analyzed time period. In agricultural policy the value of food security first changed towards food safety and quality in Europe before it later again emerged in a global perspective. The same applied for the value of safe water supply. The value of energy security, in contrast, remained of very high relevance for the federal level throughout the whole time period. The value of ecological sustainability, including its different sub-dimensions, was identified in all policy fields as an

important value that has become more and more important over time. In the field of agriculture, this was mainly caused by increasing negative side-effects of agricultural production through intensification and monocultures and a growing use of fertilizers and pesticides. Since these negative side-effects strongly affected the water sector, these developments also led to an increasing importance of protecting water resources. In the field of energy, ecological sustainability and climate protection emerged as a strong value due to international climate policy, starting with the adoption of the UNFCCC in 1994 and the Kyoto Protocol in 1997. Since that time, climate mitigation became more and relevant reaching a new peak in the adoption of the Paris Agreement in 2015. Besides security of supply and ecological sustainability, competitiveness was found as a core value both in agricultural and energy policy as well as in climate policy. Mainly for this reason, CAP payments were upheld despite the emergence of modern technologies, fertilizers and an intensification of agricultural production. Thus, the CAP directly financially supported and still supports an increase in competitiveness leading to the above-mentioned negative environmental impacts. Also, in the field of energy, competitiveness, mostly in the form of affordable energy prices, was always highlighted as a core value that should not be compromised by an increasing share of renewables.

Secondly, the different role of external events, such as natural disasters, nuclear accidents or international crises needs to be considered when looking at the nexus policy fields. In agricultural policy, external events have had only little impact on German policy-making. The strongest impact resulted from the BSE crisis at the beginning of the 2000s that made food quality and health issues a top priority. The financial crisis and resulting increasing global food prices brought the issue of food security back on the agenda, this time, however, in a global dimension. The ‘food vs. fuel’ debate, in fact, was highly debated in Germany but mainly addressed the situation in developing countries. In the context of water policy, the severe flooding of 2003 in central Europe led to a number of flood prevention measures in EU as well as German policies, such as the Federal Flood Prevention Act or the EU flooding directive. In the field of energy, the first oil crisis of 1973 led to some regulations regarding

energy efficiency and energy savings that were intended to lower the import dependence and are now used as instruments to combat climate change and to support the energy transition. The two major nuclear catastrophes of Chernobyl in 1986 and Fukushima in 2011 caused a political zigzag course in Germany with regard to the use of nuclear energy. Multiple shifts of positions eventually resulted in a nuclear phase-out decision until 2022, two years later than agreed upon in the atomic consensus of 2000. Also, the adoption of the Paris Agreement in 2015, the protests in the Hambach Forest in 2018 and the upcoming and strongly rising Fridays for Future movement impacted policy making and triggered the German government to actively think about a coal phase-out and to adopt the Federal Climate Protection Law (KSG). In the field of sustainable development and climate protection, the broad dialogue in the context of the UN SDGs also initiated higher levels of learning that resulted in a profoundly revised NHS 2016. These external events also play an important role in processes of learning and often triggered higher levels of learning. These issues were all heavily and openly debated in public and policy, which reflects the importance of societal and non-state actors for learning processes.

Thirdly, the significance of MLG highly differs between the nexus-related policy fields. The distribution of responsibilities highly varies between the different governance scales of European, national or federal state levels. The issues of sustainable development, especially ecological sustainability, and climate protection are highly influenced by the international level. Several UN conferences and international frameworks like the Kyoto protocol, the Paris Agreement or the SDGs strongly shaped German sustainability and climate policy. The EU's role, however, is more prominent in the field of climate mitigation by setting binding EU targets. On the federal level both issues of sustainable development and climate protection are priority fields of action of the chancellery. As shown by Figure 18, in the field of energy most action situations are located on the federal level. In the fields of agricultural and water policy more action situations occurred at the EU level (cf. Figure 17 and Figure 19). This mirrors the fact that energy policy is still mostly implemented nationally. Agricultural policy, in contrast, is completely communaritized through the EU's CAP.

Responsibility in water policy ranges in between. Many rules regarding the protection of water resources from pollution are adopted on the EU level like the WFD. Reaching the goals of the WFD, in contrast, is mainly the task of the federal states. Preserving a safe drinking water supply, in contrast, is the key task of so-called “kommunale Daseinsvorsorge” and thus managed on a local level. The federal level is responsible for federal water ways. With regard to the international level the UN Agenda 2030 and its 17 SDGs can be seen as an important framework relevant for all three nexus policy fields. This kind of divided and differentiated responsibilities comes with some important challenges regarding nexus governance.

All of these differences and similarities between the development processes of these policy fields are critical for an analysis of nexus governance challenges. Hence, the value-based institutional analysis of nexus policy fields serves as the basis for assessing the nexus on the federal level. Some important nexus related aspects already became visible since some rules are equally important for more than one policy field. For example, the ND plays an important role for both agricultural and water policy. Many following directives aiming at reducing water pollution caused by agricultural farming show that this still constitutes a major problem regarding the interrelations between these two policy fields. Also, the 2010 EEG reform, for example, is important for both agricultural and energy policy since it addresses the issue of bioenergy and the cultivation of biomass is a form of agricultural activity as well.

6.4. Results II: Nexus governance challenges in Germany

The value-based institutional analysis in the previous section was an important step to understand how the policy fields evolved over time. It analyzed important underlying values and institutions. Additionally, it revealed how social learning, i.e. institutional change, occurs in these policy fields. All of these factors are important when analyzing existing nexus governance challenges and the state of policy integration between these policy fields. Furthermore, the previous section already pointed to some relevant nexus-related issues in Germany, which will now be examined in detail by means of the methodological thoughts developed in section 5. The following code groups and main codes from the final coding scheme (cf. Table 13) are of special interest for this task since they refer to important aspects of policy integration, such as its different types (vertical and horizontal), the assessment of integration measures (management, monitoring) as well as actors involved. Furthermore, the main code "nexus thinking" addresses the specific nexus governance challenges revealed in the documents:

- *I governance: 2. actor; 3. policy integration/vertical and /horizontal; 4. management/monitoring*
- *II sector: 6. nexus thinking*

In this section, firstly, an overview of nexus governance challenges in Germany is provided, before these challenges are described in more detail with regard to horizontal and vertical policy integration.

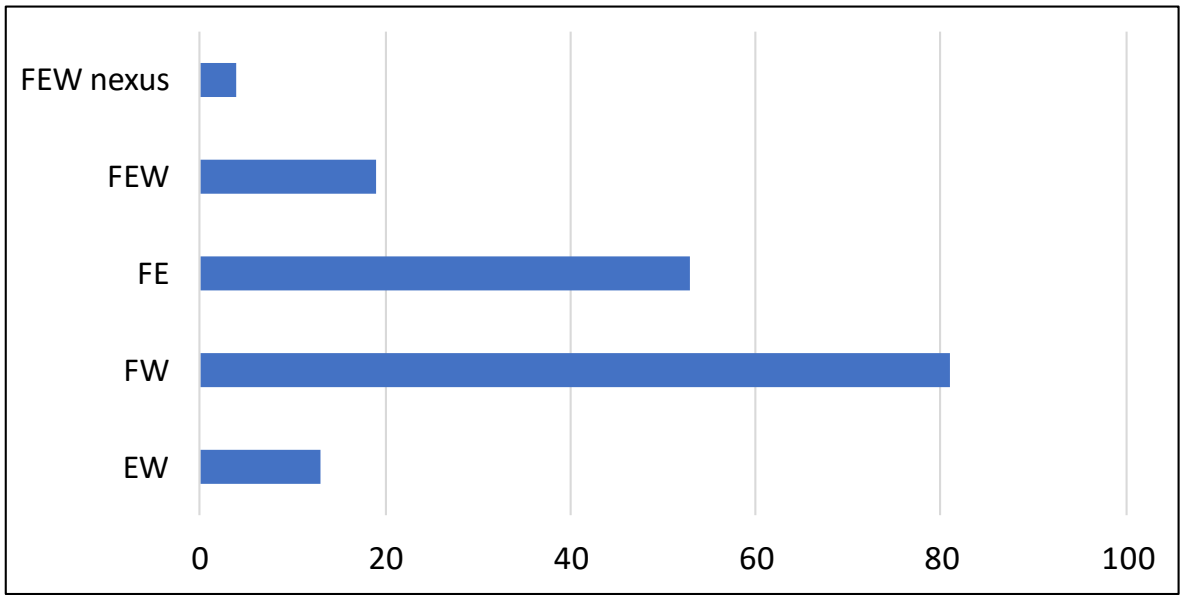
6.4.1. Overview of nexus governance challenges in Germany

At first, the documents from group I (sustainable development strategies, related monitoring and progress reports), II (concepts and plans), and III (laws and regulations) were analyzed with regard to general nexus thinking *(II sector/6. Nexus thinking/general interconnections*) ($n_{segments}$= 51). General remarks, for example, were found in all indicator reports (Ind06, Ind08, Ind10, Ind12, Ind14, Ind16) with regard to the indicators for energy use and mobility in the field of energy, organic farming and land use in the area of agriculture, emission reduction in climate policy, and biodiversity protection regarding the

ecological system. These reports all include the statement that the respective indicator has various interrelations to other indicators (e.g. Statistisches Bundesamt 2014, p. 11, 2010, p. 41, 2012, p. 17, 2017, p. 89). For the water sector no indicator was included. Hence, except for the water sector, these documents took potential trade-offs and interconnections between the different sectors into account. General interconnections regarding the water sector were found in progress reports of the sustainable development strategy. They referred to water as a cross-cutting issue (e.g. Bundesregierung 2008, p. 166, 2012a, p. 6, 2012b, p. 176). In the field of energy policy, additional general remarks on increasing efficiency (Bundesregierung 2014b, pp. 4, 16) and emission reduction (Bundesregierung 2014a, p. 9) have been found. These text segments show that nexus thinking, in principle, is included in documents related to the sustainable development strategy. It seems that nexus thinking has become increasingly important over the years – most of the segments are found in the more recent documents of 2016 (BMUB 2016b, p. 15, 2016a, p. 26; Bundesregierung 2017, p. 53).

A deeper look into nexus governance challenges in Germany was taken by referring to specific combinations of policy fields, which are covered by the code group *II sector/6. Nexus thinking/paradigm/conditions: FW, EW, FE, FEW, and FEW nexus*. Figure 20 shows the total number of coded text segments in the different sub-codes of the main code nexus thinking.

Figure 20: Total number of coded text segments in the different sub-codes of II. sector/6. nexus thinking



Source: own Figure.

With regard to the code *FEW* (*II sector/6. Nexus thinking/FEW*) $n_{segments}$ = 17 of $n_{segments}$ = 19 segments belong to documents from group I and II (Ind06, FB 2004, WWN, FB 2008, FB 2012, NHS 2016, IntUP 2030, IntEKP) (cf. Table 7 and Table 8). This confirms their relevance for nexus thinking in Germany. The text segments, that mention all three policy fields at once, mostly address three aspects: firstly, conflicting interests regarding the use of resources ($n_{segments}$ = 5). Conflicting interests mainly concern the issue of land use for food or energy crop production and its impacts on water (Bundesregierung 2005, p. 93, 2008, p. 136, 2007, pp. 47–48). Secondly the aspect of water as a cross-cutting issue, that is needed by other sectors ($n_{segments}$ = 5). For example, the agricultural and energy industry demand high amounts of water and have negative impacts on the quantity and quality of water resources (Bundesregierung 2017, p. 105). Thus, especially in water policy cooperation between different stakeholders is needed for a successful management (Bundesregierung 2012b, p. 176). The third aspect addresses the global dimension ($n_{segments}$ = 4) and the need to globally achieve a safe and secure water, energy, and food supply,

especially in the light of a rapidly growing world population (Bundesregierung 2012b, pp. 11, 16, 116). Hence, this refers to the nexus as intended at the Bonn2011 Conference (cf. section 2.1). In fact, the actual combination of the terms 'water, energy, food, and nexus' (*II sector/ 6. nexus thinking/paradigm/conditions/FEW nexus*) only appears four times in the documents of group I to III (cf. Figure 20). All of these text passages directly refer to the nexus approach of the Bonn2011 Conference (Bundesregierung 2012a, p. 6, 2012b, pp. 15, 175, 2017, p. 106) and are thus not relevant for the situation in Germany. Generally, all segments that include all three nexus policy fields mostly remain on a relatively superficial level only stating that these policy fields are affected. It becomes apparent, that, taken as a whole, those text segments related to all three nexus policy fields (*II sector/6. Nexus thinking/FEW)* as well as those referring to general nexus thinking *(II sector/6. Nexus thinking/general interconnections*) touch upon aspects of the cross-cutting and overarching policy fields of sustainable development, climate policy, and environmental policy (especially biodiversity loss).

More specific nexus governance challenges are found when looking at the combination of two policy fields. It seems that the food-water (FW) nexus (*II sector/6. Nexus thinking/FW)* ($n_{segments}$ = 81) and the food-energy (FE) nexus (*II sector/6. Nexus thinking/FE)* ($n_{segments}$ = 53) are very important in the German case. Most segments of the FW nexus and the FE nexus deal with the problems of water pollution through agriculture and a sustainable production of bioenergy. Among the combinations of two policy fields, the energy-water (EW) nexus (*II sector/6. Nexus thinking/EW)* receives least of the attention ($n_{segments}$ = 13). These segments mostly address energy efficiency of wastewater systems. Table 16 provides an overview of important nexus governance challenges in Germany revealed by the document analysis. Except for climate protection, the challenges will be described in further detail in the next sub-sections. In particular, they will be analyzed with regard to their state of policy integration across vertical, horizontal and multi-level scales as developed in section 5.2. Climate protection, however, has already been dealt with in section 6.3.2. and by its nature, is a cross-cutting challenge. It is thus also incorporated within the other challenges.

Table 16: Overview of important nexus governance challenges in Germany

Sub-code	Nexus issue
FEW	Sustainable development as a guiding principle
	Climate protection
	Biodiversity loss
FW	Water pollution through agriculture
FE	Sustainable bioenergy production
	Energy use in agriculture
EW	Energy demand of waste water systems

Source: own Table.

6.4.2. Food- energy-water

Sustainable development as a guiding principle

As stated above, general nexus thinking in Germany is mostly captured by the guiding principle of sustainable development. It touches upon all nexus policy fields and emphasizes the need to take a holistic perspective. Therefore, the national sustainable development strategies are of special relevance since they offer a broad strategic framework that pinpoint the current most relevant topics. As this section will show, so far, nexus thinking is mostly integrated across horizontal scales, i.e., on a supra-sectoral level in form of national strategies (cf. section 5.2.3). This is also backed by the fact that the majority of text segments coded with *horizontal* ($n_{segments}$ = 20) can be found in the first document group (national sustainable development strategies, their progress and monitoring reports, cf. Table 7). Already the NHS 2002, for example, emphasized the existence of trade-offs between different goals and instruments when implementing an integrated sustainable development strategy (Bundesregierung 2002, pp. 59, 62, 90, 152). These general remarks on the existence of trade-offs have been repeated in various following documents (Statistisches Bundesamt 2010, p. 4; Bundesregierung 2012a, p. 2, 2017, p. 69; BMUB 2016b, p. 15). The WWN and the FB 2008 progress report more specifically demanded a

stronger integration of different policy fields, among them those related to the nexus (Bundesregierung 2005, p. 107, 2008, p. 129). Another aspect ($n_{segments}$ =12 in six documents) addressed the cross-sectoral purpose of the strategies and plans, as well as the need for projects that go beyond sectoral boundaries (Bundesregierung 2008, p. 33, 2017, pp. 53–54; BMUB 2016a, p. 15). With regard to section 5.1.3 the degree of horizontal policy integration according to Lafferty and Hovden (2003, pp. 14–15) depends on three conditions: if a central authority (first condition) has developed an overarching strategy (second condition) and is able to enforce and monitor its implementation (third condition). In order to assess the first condition, the important actors need to be identified. The matter of sustainable development is governed at the highest political level in Germany, the Germany chancellery, which, according to the 2008 progress report (FB 2008), represents its relevance as the guiding principle (Bundesregierung 2008, pp. 11–12). Locating sustainable development in the German chancellery instead of a federal ministry also mirrors the cross-cutting nature of this topic (Bundesregierung 2008, p. 29, 2012b, p. 12). The three main actors on the federal level are the federal government, more specifically the State's Secretary Committee for Sustainable Development (Staatssekretärsausschuss für Nachhaltige Entwicklung, StsA), the Parliamentary Council for Sustainable Development (Parlamentarischer Beirat für nachhaltige Entwicklung, PBnE), and the Advisory Council for Sustainable Development (Rat für Nachhaltige Entwicklung, RNE). The StsA is led by the head of the chancellery and – since 2005 – consists of state's secretaries from all ministries (Bundesregierung 2008, pp. 10, 29). Already in 2002, however, all nexus-related ministries were included (Bundesregierung 2002, p. 55). The StsA is mainly responsible for cross-sectoral cooperation within and regular reports for the government (Bundesregierung 2002, p. 55). It frames the general principles of sustainable development, oversees current developments, and intervenes if necessary. The StsA meetings are prepared by a subordinated working group of ministerial delegates responsible for sustainable development in their respective ministries, which is also headed by the chancellery (Bundesregierung 2008, p. 29). Additionally, in 2010 a special unit for sustainable

development was created within the chancellery. Furthermore, each ministry was requested to delegate a contact person to represent this issue inside and outside its department (Bundesregierung 2012b, p. 46). The federal government generally has the authority for decision-making regarding all changes and further developments of the strategy (Bundesregierung 2012a, pp. 2–3).

The PBnE was created in 2004 and brought the issue of sustainable development to the parliamentary level. It includes members from all parliamentary parties. The council supports the implementation of the sustainable development strategy, develops policy recommendations, prepares legislative initiatives, and fosters a broad political and societal dialogue on sustainable development (Bundesregierung 2004, p. 15) and its implementation as the guiding principle for policy-making (Bundesregierung 2008, p. 16). Due to the long-term perspective of sustainable development, the PBnE usually aims for unanimity in its decisions. This often causes difficult and long-lasting voting processes. In the end, these decisions, however, are outlasting and supported by the whole political spectrum of the parliament (Bundesregierung 2017, p. 229). So far, the PBnE is not included in the procedural rules of the German parliament. In contrast to other committees it needs to be reinstated in every legislative period (Bundesregierung 2012b, p. 34). A fact that it criticized within the NHS 2016 (Bundesregierung 2017, p. 229).

The RNE was appointed in 2001 for the first time as a consulting body for the federal government. It consists of 15 experts that are appointed by the government for a three-year period. The members represent relevant stakeholder groups from science, industry, and society like trade unions, churches and cities, as well as organizations of environmental protection or agriculture. This way, the RNE is supposed to function as a hinge between society and politics (Bundesregierung 2002, pp. 55–56). The mission of the RNE includes making suggestions for the further development of the sustainable development strategy, advising the government, and providing a forum for public activities and open discussions. The three most important policy fields by the time of its constitution were energy, mobility, and agriculture and thus highly nexus-related issues. Already in 2002, the RNE demanded

an emission reduction target of 40% until 2020, an increase in energy efficiency of 3% per year, and the termination of subsidies for lignite power plans until 2010 (Bundesregierung 2002, pp. 67–68). Some of the suggestions the RNE proposed over the years have been included in the sustainable development strategy. Others have not, like the termination of subsidies for fossil fuels. The three actors, StsA, PBnE, and RNE, regularly exchange through their common participation in StsA meetings (Bundesregierung 2017, p. 27). As this setup of main actors indicates, the first condition for horizontal policy integration is met.

The second and third conditions address the existence of an overall strategy including specific goals and targets that are regularly monitored. The NHS 2002 was developed in preparation for the World Summit on Sustainable Development in Johannesburg. It was preceded by a public dialogue process giving citizens the possibility to contribute and comment on the early strategy proposal (Bundesregierung 2002, p. 56). The federal states were included through a federal-state working group for sustainable development, created in 2001. Also, the strategy proposal was sent to all state governments which were requested to comment on the proposal (Bundesregierung 2002, p. 72). The final NHS 2002 included 21 key indicators intended to provide an overview of the most important topics. Additionally, the indicator set allowed for a regular monitoring (Bundesregierung 2002, p. 89), which since 2006 has been done every two years by the Federal Statistical Office (Destatis) (Statistisches Bundesamt 2017, p. 3). Regarding the FEW nexus, relevant indicators included in the strategy were the protection of natural resources, GHG emission reduction, the share of renewable energies, land use management, biodiversity protection, mobility, and nutrition. The federal government emphasized that the single indicators could provide insights in necessary fields of action but should not be considered in isolation (Bundesregierung 2002, pp. 325–326) thus referring to a holistic perspective. Regarding the further development of the strategy, an interministerial working group led by the BMU repeatedly discussed possible adjustments of the indicator set. Despite slight changes it, however, was maintained (Bundesregierung 2008, p. 36, 2012b, p. 33) until 2016. For example, no specific indicator for water was included over the years even though this was

discussed in 2012 (Bundesregierung 2012b, p. 63). Hence, the 2004, 2008, and 2012 progress reports (FB 2004, FB 2008, FB 2012) followed the structure of the NHS 2002 only making minor adjustments.

This changed with the adoption of the UN SDGs in 2015. This event can be seen as a critical juncture that strongly impacted the further development of the strategy since it offered a broad international framework for horizontal integration that emphasized cross-sectoral interconnections and the need for policy coherence (Bundesregierung 2017, p. 43). The development process of the NHS 2016 included an open consultation process starting in October 2015. The opening conference in Berlin was followed by four regional conferences in Dresden, Stuttgart, Bonn, and Hamburg, which were attended by regional ministers and delegates as well as federal state secretaries (Bundesregierung 2017, p. 26). Additionally, many stakeholder groups contributed through the submission of written statements. The result was a revised sustainable development strategy that transferred the structure of the SDGs into a federal strategy. Altogether, the NHS 2016 included 63 indicators, at least one for every SDG (Bundesregierung 2017, p. 34). For the first time, the strategy also contained indicators specific for the water sector. Related to SDG 6 “clean water and sanitation” for Germany the level of phosphor in running waters and nitrate levels of groundwater were included, besides an indicator for global access to water (Bundesregierung 2017, p. 37). The NHS 2016 also explicitly accounted for possible negative side-effects of renewables on other SDGs, such as biodiversity, organic farming or water protection (Bundesregierung 2017, p. 114). The development process of the NHS 2016 forms an action situation that resulted in the institutional outcome of a revised sustainable development strategy.

Looking at the question of implementation, according to the federal government the basic idea of a sustainable development strategy is to set political priorities and to define predominant action fields and goals that are to be implemented by the departments. The strategy is thus dependent on the commitment of the different ministries, the regional and the local level. This necessitates concrete measures to coherently achieve the targets (Bundesregierung 2017, pp. 44, 238). The NHS 2016 acknowledges the need for a balance

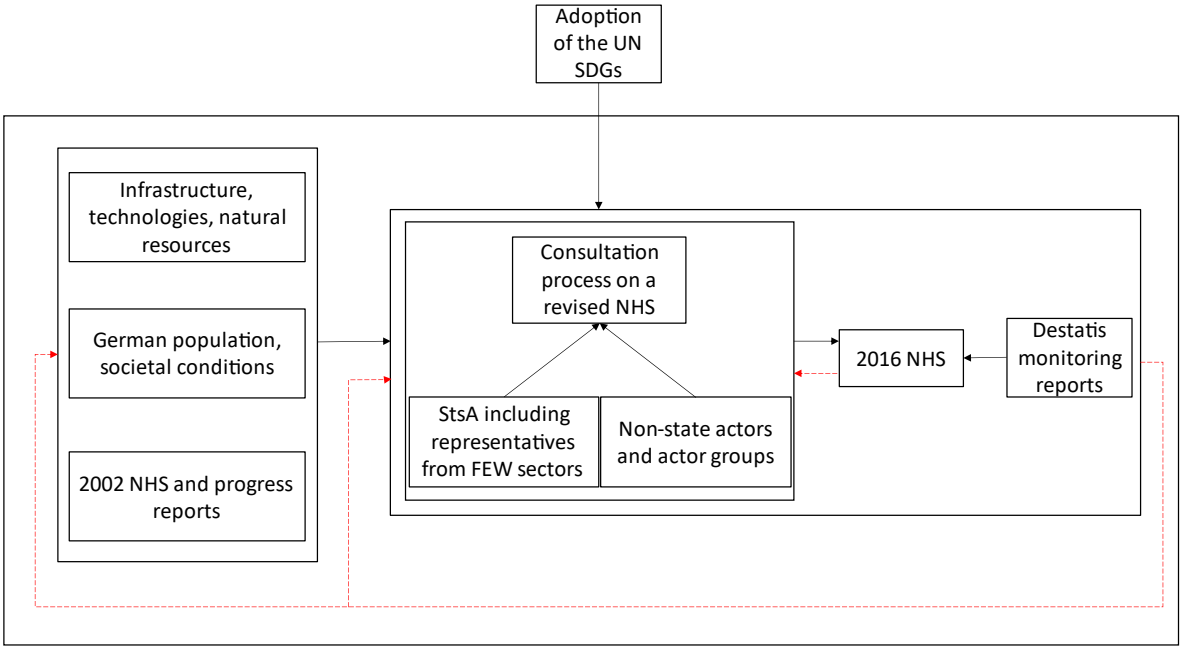
between central management on the level of the federal chancellery and the implementation of the goals on the level of the different departments within their policy fields. Redundant measures, thereby, should be avoided (Bundesregierung 2017, p. 44). The strategy stresses the responsibility of the different departments for their own policy fields (Bundesregierung 2017, p. 27). The role of non-state actors is also important for the successful implementation of FEW nexus governance (Bundesregierung 2002, p. 56, 2017, p. 23). Already within the NHS 2002 the role of NGOs, the church, trade unions (Bundesregierung 2002, pp. 75–82) as well as the private sector was emphasized. The latter were supposed to support more sustainable production patterns and provide transparent information for consumers (Bundesregierung 2002, p. 50). Furthermore, stronger environmental standards, more future oriented investments, and socially sustainable staff policies were to be supported (Bundesregierung 2002, p. 325). The federal government acknowledged that, to foster these, industrial actors would need clear and reliable political conditions that ensure security of investments and take global competitiveness unto account (Bundesregierung 2008, p. 100). Also, in the NHS 2016 the industry is seen as a key actor in the implementation of the SDGs (Bundesregierung 2017, p. 48). Moreover, the role of science is highlighted which has a special responsibility in uncovering upcoming challenges and discovering interconnections as well as possible negative side-effects (Bundesregierung 2002, p. 81), especially in the field of a future energy system (Bundesregierung 2008, p. 100) and the challenges that derive from the SDGs (Bundesregierung 2017, p. 49). Other actors are the consumers that can impact sustainable development through their consumption patterns (Bundesregierung 2008, p. 100). The emphasis put on the role of different ministries and various non-state actors shows that the possibilities of the chancellery to implement the goals of the strategy are rather limited. One way was by creating rules of management. In the first NHS 2002 the federal government developed ten rules of management that describe the requirements for a balanced ecological, economic, and social development. Together with the goals and indicators and their monitoring they form the management concept of the German

sustainable development strategy (Bundesregierung 2002, p. 53). The rules should serve as a means to put the principle of sustainable development from theory into practice (Bundesregierung 2008, p. 32). In the field of ecological sustainability, the rules include the principle of intergenerational justice, a rule on regeneration and substitution of natural resources, and the objective to avoid danger for people or the environment. Energy and agricultural policy are also included in the form of a rule on decoupling energy and resource use and economic growth, and a rule on an agricultural production that is profitable and environmentally friendly at the same time (Umweltbundesamt 2017b, p. 20). Since then, the rules have only slightly been changed. In the NHS 2016 twelve rules are included and structured in two parts: three ground rules and nine rules addressing specific fields of action (Bundesregierung 2017, pp. 33–34). Another instrument mentioned in the strategy and its progress reports is the process of environmental or sustainability assessment. Since 1990, in Germany the law on environmental impact assessment requires such an assessment for projects that might have relevant environmental side-effects due to their location or size. In the early 2000s, this instrument was complemented by the sustainability impact assessment. It also includes economic and social impact assessment, and addresses laws and policies (Bundesregierung 2008, p. 12). In 2009 sustainability was officially included as a criterion for any legislative proposal (Bundesregierung 2012a, p. 2). The PBnE takes a vital role in the evaluation of the sustainability assessment (Bundesregierung 2017, p. 30). Despite these rules and measures, sustainable development so far has not been attributed a principled priority in every policy field. Furthermore, throughout the whole development process of the German sustainable development strategy from 2002 until 2016, better coordination between the different governance levels of federal, state and local level as well as better coordination of their strategies has been demanded (Bundesregierung 2017, p. 46).

The development of the German sustainable development strategy, especially the decision to profoundly revise the strategy in 2016, serves as a good example for horizontal policy integration and high levels of learning. Since the strategy is governed by the chancellery on

a supra-sectoral level, a central authority exists that is responsible for a holistic strategy, which includes specific goals and targets and is regularly monitored. Thus, the basic conditions of horizontal policy integration as defined by Lafferty and Hovden (2003, p. 15) are met. Up to 2015 the strategy mostly developed path dependently. The adoption of the SDGs in 2015 opened up a window of opportunity to abandon its former structure. Additionally, the open consultation process included a broad variety of non-state actors. This enabled higher levels of social learning, such as double and triple loop learning leading to a profoundly revised strategy. These factors combined disrupted path dependence and allowed a profound restructuring of the strategy. Beginning with the first strategy in 2002 (NHS 2002) horizontal policy integration in the context of environmental protection, sustainable development and, hence, the FEW nexus became more and more important. The NHS 2016 is a good example for horizontal policy integration and how the holistic framework developed in section 5.2.3 (cf. Figure 12) can be used for analysis. Figure 21 shows the holistic nexus framework for the development process of the NHS 2016. The adoption of the UN SDGs acts as an external event strongly influencing the consultation process on a revised strategy (action situation). This process resulted in the NHS 2016 (outcome), which again is evaluated by the Destatis monitoring reports (evaluative criteria). Besides the StsA – the main state actor including representatives from the nexus policy fields – also a broad variety of non-state actors and actor groups was involved in this process. The action situation is embedded in the three context factors of biophysical conditions (infrastructure, technologies, natural resources), attributes of community (German population, societal conditions), and rules (NHS 2002 and progress reports). The different levels of learning are represented by red dashed arrows.

Figure 21: Development process of the NHS 2016



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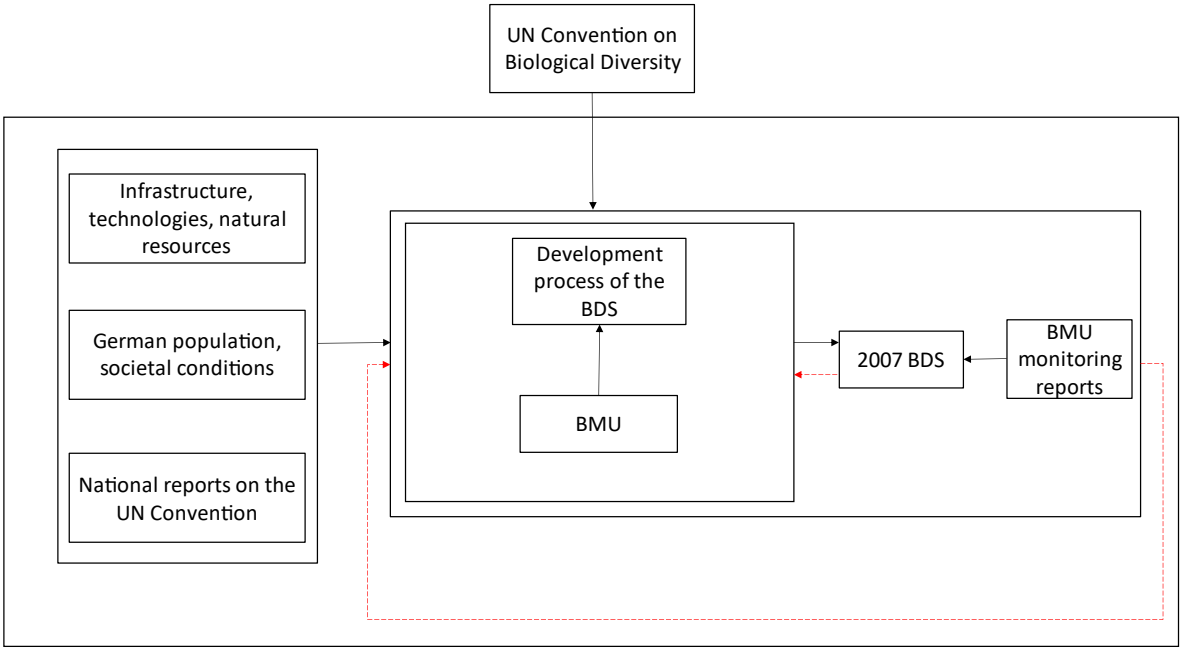
Biodiversity loss

As explained in section 6.3.3, Germany, for many years, has had the goal to end biodiversity loss. Despite various measures taken, so far, this has not been achieved. In the context of the 2002 World Conference on Sustainable Development, Germany set the goal of ending biodiversity loss until 2010 (Bundesregierung 2005, p. 114). An index was developed which was supposed to reach the target value of 100 – stabilization of the state of all species included in the indicator – by 2015. In 2016 the deadline was extended to 2030 (Statistisches Bundesamt 2017, p. 100). Biodiversity loss is impacted by developments in many other policy fields. As already mentioned in section 6.3.3, Germany adopted a national biodiversity strategy (BDS) in 2007. Similar to the sustainable development strategy, the BDS also has a strong multilevel character and was based on the UN Convention on Biological Diversity of 1992 (BMUB 2016a, p. 63). Since 1995, Germany published several national reports on the implementation of the UN convention which preceded the adoption

of the BDS in 2007 (BMUB 2007, p. 22). Regarding the implementation the role of the federal states is emphasized. They hold the responsibilities in the areas of environmental protection and landscape conservation, as well as land use management, which all have a strong impact on biodiversity. Some states also developed regional biodiversity strategies (Bundesregierung 2012b, p. 199). The European level is also relevant for this issue because not only natural landscapes cross borders but also because the EU holds responsibilities in the field of environmental policy. The European biodiversity strategy 2020 was adopted in 2010 and addressed the EU as whole as well as the member states (BMUB 2016a, p. 63). In Germany, an interministerial working group was built for the implementation of the strategy that included eleven different ministries coordinated by the BMU (Bundesregierung 2012b, p. 199). Furthermore, a dialogue process including state and non-state actors was initiated in order to implement the strategy (BMU 2020a). The strategy clearly called upon agriculture and energy as important policy fields in which action is needed. Agricultural production is an important factor impacting biodiversity due to the use of fertilizers and pesticides (BMEL 2016, p. 28), which is mirrored by the fact that agricultural areas show a lower level of biodiversity than non-agricultural areas (BMUB 2016a, p. 65). The BDS includes 19 indicators, nitrogen pollution, water quality, daily land use, and organic farming among them. The latter is supposed to help preserving diverse cultivated landscapes (Bundesregierung 2012b, p. 200). The BDS demands a monitoring in form of a progress report in every legislative period. Furthermore, several goals were also included in the sustainable development strategy (Bundesregierung 2012b, p. 200). In the 2014 indicator report, the BMU stated that most of the goals were clearly missed. 13 of the 19 indicators were quantitatively evaluated. Only two of these 13 indicators showed a positive trend, the rest of them showed a negative trend and were either far or very far away from the target value (BMU 2015, p. 97). In order to reach the goals of the strategy the BMU launched a nature protection program called “Naturschutz-Offensive 2020” in 2015 including ten priority areas of action and 40 urgent measures (BMUB 2016a, p. 23). The BMU emphasized the need to implement this initiative not only in close cooperation

with the federal state level but also with the different sector departments (BMUB 2016a, p. 70). However, according to the NHS 2016 progress report biodiversity continues to decrease. The current and target values of the general indicator measuring biodiversity and quality of landscape are further moving apart from each other (BMUB 2016a, p. 64). A second monitoring report published by the BMU in 2018 showed no changes in the overall assessment of the indicators compared to the report of 2014. The same eleven indicators were still far or very far away from the target value (BMU 2018, p. 94). Looking at the conditions defined by Lafferty and Hovden (2003, p. 15) it becomes apparent that the case of biodiversity also is an example for horizontal policy integration and its development process can be analyzed by means of the holistic nexus framework developed in section 5.2.3 (cf. Figure 22). The UN Convention on Biological Diversity constitutes an external event that required regular national reports. These reports formed the institutional setting in which the development process is embedded as an action situation. The BDS resulted as the institutional outcome of this process. The BDS is an overall strategy that touches upon many nexus-related issues and addresses all of the nexus policy fields and is governed by a central authority: the BMU. In contrast to the sustainable development strategy, however, which is governed by the German chancellery, the issue of biodiversity loss is located on a lower level, namely the ministerial level, even if it also is a cross-cutting issue. Like the sustainable development strategy, the BDS also includes a regular monitoring process that should enforce its implementation. Still, with regard to the indicator reports of 2014 and 2018 the strategy does not seem to be very successful.

Figure 22: Development process of the BDS



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6.4.3. Food-energy

Sustainable production of bioenergy

Generally, the importance of bioenergy for the German energy transition has declined over the years. In the early 2000s, the role of bioenergy was actively promoted due to its emission reduction potential for the energy sector (Bundesregierung 2000, pp. 121, 125, 129). According to the federal government in 2004, bioenergy potentials had not yet been exploited and land areas provided for the production of biomass were expected to grow (Bundesregierung 2004, p. 186). For economic reasons primary bio-based residual waste material was used to generate bioenergy. However, the profitability of energy crops steadily grew, also because of instruments, such as the ecological tax reform that led to an increase in the price of fossil fuels (Bundesregierung 2000, p. 119) and the EEG (Bundesregierung 2000, p. 125). By ensuring fixed feed-in tariffs, the EEG has continuously enabled farmers to have a second and safe source of income (Bundesregierung 2002, p. 212). Other

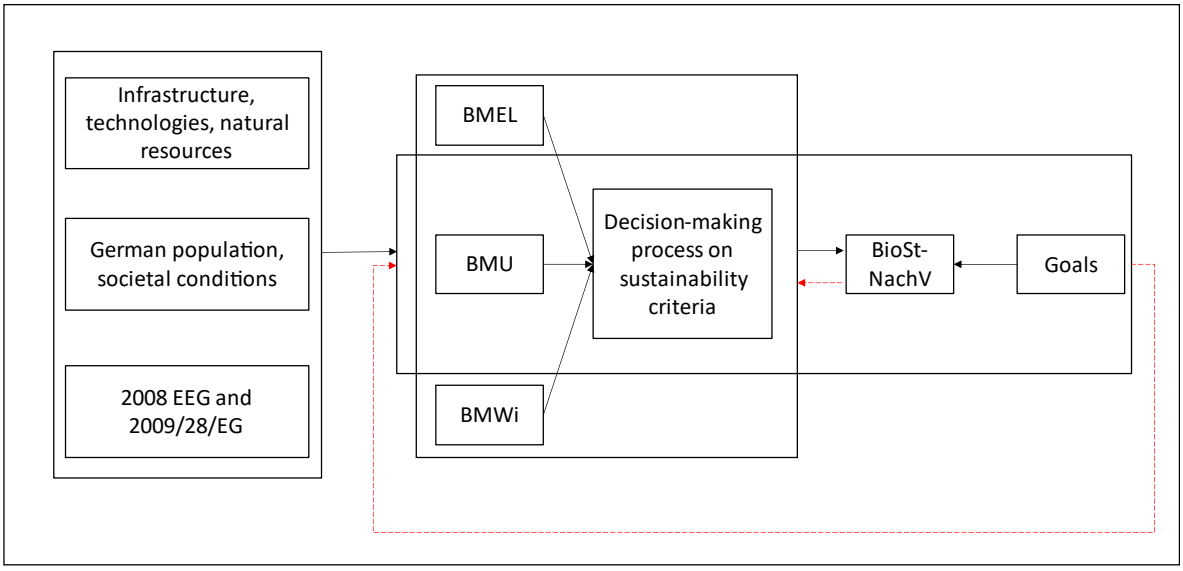
instruments, that were introduced in the following years, were the ordinance on electricity production from biomass (Biomasseverordnung, BiomasseV) of 2001 and a funding program for the expansion of renewable energies ("Marktanreizprogramm erneuerbare Energien") (Bundesregierung 2002, p. 236). The conditions for electricity produced from biomass again improved by the 2004 EEG reform that aimed at ensuring the profitability for farmers (Bundesregierung 2004, p. 111, 2005, p. 34). Not only was the electricity production from biomass promoted but also the production of biofuels through tax exemptions and special funding programs, such as, for example, a program supporting the change from fossil to biofuels in the agricultural industry (Bundesregierung 2004, p. 114, 2005, p. 28). Against this background, bioenergy was the most important renewable energy source at that time and was expected to also remain so in the near future. It accounted for two thirds of the overall share of renewables. However, even then the case of competing land use interests between energetic and material use of biomass arose, which is why the use of waste materials for energy supply instead of energy crops was further promoted (Bundesregierung 2008, pp. 91–92). The high land demand of renewable energies eventually led to the termination of subsidies for photovoltaic systems on agricultural areas by means of an EEG reform in 2010. Moreover, the system integration of renewable energies often necessitated new power and transportation lines because of the long distances between electricity producers and consumers (Bundesregierung 2012b, p. 197). It also became clear that bioenergy had a much higher land demand than, for example, wind and photovoltaic systems installed on rooftops (Bundesregierung 2012b, p. 197), which is why political support rather switched towards these technologies (Bundesregierung 2012b, p. 197). The increasing land demand turned out to be a negative side-effect of bioenergy promotion that hadn't been adequately addressed in the beginning. The cultivation of energy crops as well as the use of bioenergy have been identified to cause further side-effects on soil quality and water resources. In order to deal with these kinds of interconnections the EU Renewable Energy Directive (2009/28/EG) demanded sustainability criteria for the production and energetic use of biomass, for biofuels in the

first place (Bundesregierung 2008, p. 96). In Germany, the directive was implemented by the Biofuel Sustainability Ordinance for biofuels (Biokraftstoff-Nachhaltigkeitsverordnung, Biokraft-NachV) (Bundesregierung 2012b, p. 190), which was intended to ensure a sustainable cultivation according to the cross-compliance regulations included in the CAP. It also addressed issues of soil pollution, water quality, and biodiversity protection as well as emission reduction (Bundesregierung 2007, pp. 5, 47-48). Biofuels could only be categorized as sustainable if they, in general, saved at least 35% GHG emissions (50% GHG emissions from 2017 onwards) compared to fossil fuels and if no land areas worthy of protection were used or cleared (Bundesregierung 2012b, p. 190). These criteria were also included in the BImSchG (Bundes-Immissionsschutzgesetz 3/15/1974, p. 35). The Biomass Electricity Sustainability Ordinance (Biostrom-Nachhaltigkeitsverordnung, BioSt-NachV) then addressed the case of electricity production from biomass and demanded that subsidies need to be bound to certain criteria. This ordinance was integrated into the EEG (Erneuerbare-Energien-Gesetz 2017 7/17/2017, p. 97). Thus, the sustainability criteria were integrated vertically into sector policies. section 64 of the 2008 EEG – the current version at the time – called for specific criteria that producers of electricity from biomass needed to meet in order to receive financial support. The EEG itself, however, did not include these criteria but put the BMU in charge to decide upon them in accordance with the BMEL (Erneuerbare-Energien-Gesetz 2009 10/25/2008, § 64, p. 2089). Since the 2014 EEG reform, additionally the BMWi had to be included in this decision (Erneuerbare-Energien-Gesetz 2017 7/17/2017, § 90, p. 97). Eventually, these criteria were laid down in the BioSt-NachV (7/23/2009, p. 1). Even if the EEG is an energy policy rule, since its 2014 reform it involves all main nexus-related federal actors – BMU, BMEL, and BMWi. The BMU even became a leading role. This EEG development resulted in a policy integrating all three federal actors relevant for the nexus. This law is located on a sectoral level and thus closely related to daily policy-making since it directly impacted the payment of subsidies. Hence, this section of the EEG can be described as a ‘nexus-smart’ policy as defined in section 5.2.2. In 2010, bioenergy was still given an important role for the future energy system in all three areas

of electricity, heating, and transport (BMWi and BMU 2010, p. 11). The sales of biofuels were supposed to increase to 2% in 2005, to 5.75% in 2010 (Bundesregierung 2004, p. 176), and to 17% in 2020 (Bundesregierung 2007, p. 5). Because of the high land demands and the limited emission reduction potential the role of bioenergy produced from cultivated energy crops further declined. However, bioenergy produced from residual and waste material, was still seen as a viable contribution to a sustainable cross-sectoral energy supply (BMUB 2016b, p. 35). In 2019, electricity produced from biomass accounted for roughly 10% of total electricity production (Fraunhofer ISE 2020).

The development of sustainability criteria for the production of bioenergy can be defined as a process of vertical policy integration. This is also mirrored by the fact that $n_{segments} = 20$ out of a total of $n_{segments} = 23$ that were coded with both *vertical policy integration* and *FE* address the case of bioenergy. Thus, this process can adequately be analyzed by the nexus cooperation framework developed in section 5.2.2 (cf. Figure 23). The decision-making process of the sustainability criteria constituted an action situation in which all three nexus-related ministries – BMEL, BMU and BMWi – were involved. The BioSt-NachV resulted as the institutional outcome that is evaluated by the goals set in the EEG. However, two issues remained that were not covered by these sustainability criteria: Firstly, these criteria only applied for biomass cultivated in the EU, ignoring biomass imported from other non-European countries. Secondly, the criteria did not account for the effects of indirect land use changes that emerge when agricultural crops are turned into energy crops what causes agricultural crops to switch to former forest areas or areas with a high level of biodiversity (Bundesregierung 2012b, p. 190).

Figure 23: Development process of the BioSt-NachV



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Renewables in agriculture

The remaining $n_{segments}$ = 3 included in the sub-code *FE* that do not refer to bioenergy address the issue of energy use in the agricultural industry. As explained above the agricultural sector is an important GHG emitter in Germany (cf. section 6.3.4). These emissions partly result from the use of fossil fuels for vehicles and machinery and could be reduced through a switch to renewables. As one instrument, the federal government enabled an energy counselling program for agricultural and gardening businesses as stated in the integrated energy and climate program (IntEKP) (Bundesregierung 2007, p. 26). This program especially aimed at increasing energy efficiency and was organized by the BMU and the BMEL between 2009 and 2012. However, according to the federal government in 2014 not many farmers had made use of it (Bundesregierung 2014b, pp. 30–31).

6.4.4. Food-water

Water pollution through agriculture

With regard to the sub-code *FW* water pollution from agricultural activities, especially through nitrate, nitrogen, and phosphor, is the most important issue ($n_{segments}$ = 38). A critical legal rule regarding this issue is the European Nitrates Directive (ND) (91/676/EWG) adopted in 1991, which requested a limit of 50mg of nitrate per liter in groundwater and surface water bodies. As already mentioned in section 6.3.6, in Germany, the EU's ND was implemented by the Fertilizer Ordinance *(Düngeverordnung 3/5/2007)*. It set legal guidelines for the use of mineral fertilizers and manure (Bundesregierung 2000, p. 34, 2012b, p. 169). With regard to nitrogen pollution, the NHS 2002 included the goal of reaching an average nitrogen level in agricultural land of 80kg per hectare until 2010 (Bundesregierung 2002, p. 114) and 70kg between 2028 and 2032 (Bundesregierung 2017, p. 35). Nitrogen pollution does not only negatively impact soil and groundwater but also constitutes a strong GHG in form of nitrous oxide. Thus, reduced nitrogen levels are also important for climate mitigation (Bundesregierung 2014a, p. 35). In 2007, the DüV was reformed aiming at a further reduction of water and soil pollution (Bundesregierung 2012b, p. 165) by limiting the use of nitrogen (Statistisches Bundesamt 2010, p. 39). Another important regulation, closely connected to the ND, is the WFD (2000/60/EG) (*rules/WFD* $n_{segments}$ = 12). Adopted in 2000 the WFD aimed at achieving a good status of all water bodies until 2015 (Wasserhaushaltsgesetz 7/31/2009, pp. 10–14). In Germany, it was implemented in the WHG. According to the federal government the implementation of the WFD also touches upon various other related sectors, such as the chemical industry, fishery or the transport sector (Bundesregierung 2012b, p. 168). The WFD was complemented by other European directives addressing the protection of specific water bodies, such as the Bathing Water Directive (Badegewässerrichtlinie) (2006/7/EG), and the Marine Strategy Framework Directive (Meeresstrategie-Rahmenrichtlinie) (2008/56/EG). The latter, for example, aims at achieving or preserving a good status of the marine environment until 2020 (Bundesregierung 2012b, pp. 165–169).

Also, the CAP is of special importance for this issue since the agricultural sector is the main polluter of water bodies (Bundesregierung 2012b, p. 169). Because the CAP – as the most important agricultural institution – is determined by the EU, the German government sees itself only to a very limited extent in a position to make agricultural policy more ecologically sustainable (Bundesregierung 2000, p. 121, 2002, p. 214). For this reason the former government called upon the EU to strengthen the second pillar of the CAP (Bundesregierung 2002, p. 229), which specifically supports environmental-friendly and ecological sustainable land management. As already mentioned in section 6.3.4 the CAP was reformed several times, also towards including more environmental concerns. The 2003 reform, for example, introduced the "cross-compliance" regulation which bound subsidies to certain minimum environmental standards (Bundesregierung 2004, p. 12). This, however, did not lead to a significant improvement of water quality, and pollution levels continued to exceed the target value. Therefore, in the 2013 CAP reform stronger efforts regarding the protection of water resources were made. Not only was the first pillar "greened" towards ecological and climate aspects (BMUB 2016b, p. 64), the EU also tried to integrate the goals of the WFD into the CAP (Bundesregierung 2012b, p. 169), e. g. in form of specific permits to use water for agricultural areas as well as the prohibition of discharging substances into groundwater according to the WHG (Agrarzahlungen-Verpflichtungenverordnung 12/17/2014, p. 2). Furthermore, the restrictions of the DüV were also integrated into the CAP regulations (Agrarzahlungen-Verpflichtungenverordnung 12/17/2014, p. 2). The "greening" and "cross-compliance" reforms, however, did not achieve an environmentally friendly agricultural production. The European Court of Auditors also called these efforts only a partial success (Europäischer Rechnungshof 2014). Another instrument that was supposed to support water protection can be seen in the goal of reaching 20% organic farming as stated by the NHS 2016. However, as explained in section 6.3.4 this goal has also not been reached so far.

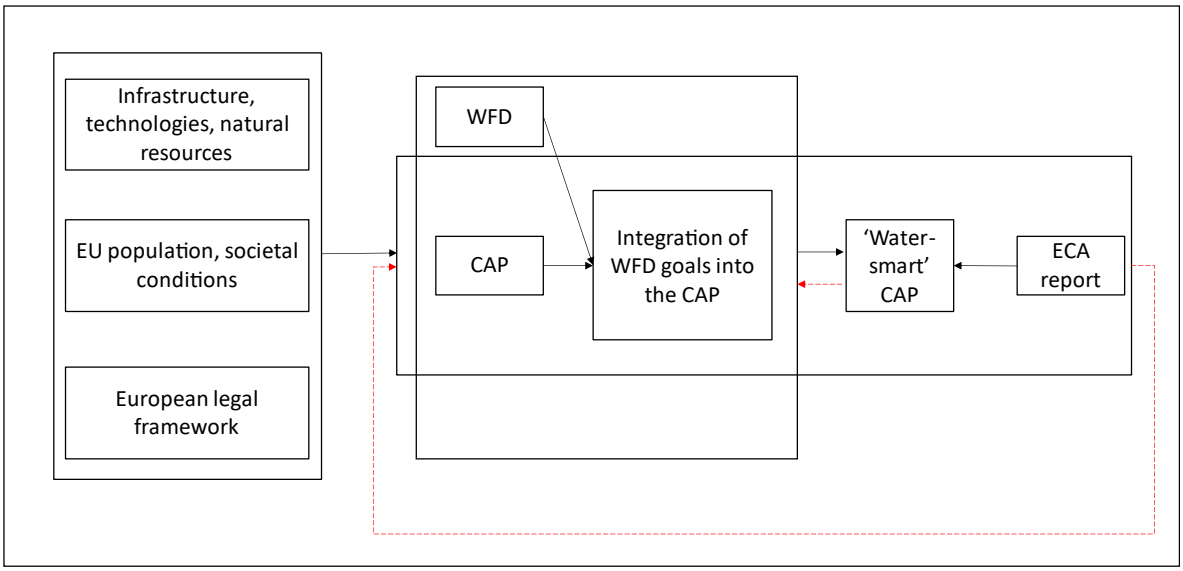
So, despite all these rules and measures neither the envisaged nitrate nor nitrogen level have been reached so far. Even if investments in new sewage systems and renaturation of

water bodies led to improvements in water quality, by 2015 still 90% of all surface waters and 36% of groundwater bodies failed to reach a good chemical status as required by the WFD (Bundesregierung 2017, p. 105). The worst situation was found for transitional and coastal waters of which none had reached a good status in 2015 (Umweltbundesamt 2017a, pp. 66–73). Hence, the original WFD target year of 2015 was moved to 2027 (Bundesregierung 2017, p. 105). In 2018 Germany was convicted by the European Court of Justice since still almost every fifth measuring point exceeded the target value for nitrate (Umweltbundesamt 2020a). According to a monitoring report on nitrate pollution in Germany (NitratB16) the goals probably will likely not be achieved by 2027 either (BMUB and BMEL 2017, p. 75). The same applies for nitrogen levels which were at around 94kg per hectare agricultural land between 2013 and 2017 (Umweltbundesamt 2019).

Thus, the protection of water resources and water bodies continued to be an important challenge (Bundesregierung 2012b, p. 15). With regard to the CAP, the BMU, therefore, demanded that payments originating from the first pillar, first and foremost, should be stronger tied to environmental aspects and eventually be eliminated gradually (BMUB 2016a, p. 10). For this reason, the BMU called for another reform in 2020 (BMUB 2016b, p. 64). The federal government demanded that the CAP needed to be more coherent to other policy fields as well as international frameworks, such as the MDGs, and it should more strongly support water protection (Bundesregierung 2012b, p. 207). Besides the CAP, also a planned reform of the DüV was proposed to deal with this issue (Bundesregierung 2014a, pp. 35–36, 2017, pp. 66, 110). Whereas the BMU suggested a comprehensive nitrogen strategy and a tax on pesticides (BMUB 2016a, p. 10) to tackle the issue of water pollution. the BMEL further promoted the proposed DüV reform instead (BMEL 2016, p. 29). Hence, in the case of water pollution, several attempts of vertical policy integration were made on the European level, for example, integrating the WFD goals into the CAP. This process is displayed by Figure 24, which uses the nexus cooperation framework developed in section 5.2.2 for the case of vertical integration. The integration of the WFD goals into the CAP constituted an action situation aiming at a ‘water-smart’ CAP. This process is a good

example of how not only actors but also institutions can influence each other in order to achieve policy integration. In contrast to the others (cf. Figure 21-Figure 23), this action situation is located on the EU level. This case of policy integration, however, so far has not been successful and did not result in a significant improvement of water quality in Germany.

Figure 24: Integration process of the WFD goals into the CAP on the EU level



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6.4.5. Energy-water

The EW nexus, in general, does not play an important role in the analyzed documents ($n_{segments}$ = 13). $N_{segments}$ = 4 address the energy demand of waste water systems. According to the federal government they are highly energy intensive and have huge saving potentials (Bundesregierung 2012b, p. 165). The National plan for energy efficiency (NAPE), for example, suggested energy efficiency checks for wastewater systems as one instrument (Bundesregierung 2014b, p. 30). In the progress report 2012 (FB 2012) and the AbwV this issue was found as well (Abwasserverordnung 3/21/1997, p. 12; Bundesregierung 2012b, p. 165). The remaining segments regarding the EW nexus focused, for example, on hydropower ($n_{segments}$ = 4). Water as a source of electricity only plays a rather small role in the German energy mix. Hydropower only accounted for 3.8% of electricity production in

2019 (Fraunhofer ISE 2020). The FB 2012 stated that nearly 82% of hydropower potentials are already used, based on conservative estimation, and that the disadvantages of hydropower, such as negative impacts on local ecosystems due to water impermeability, must not be neglected (Bundesregierung 2012b, p. 166). The remaining segments address the (negative) impacts of the energy sector on water resources, such as the water demand of power plants. Conventional nuclear and lignite power plants use massive amounts of surface water bodies, such as rivers or lakes. Increasing impacts of climate change also impact the temperature of these water bodies what might necessitate innovative cooling technologies (Bundesregierung 2012b, p. 166).

6.4.6. Section summary

In this section important nexus governance challenges in Germany were analyzed. In total, seven important challenges were revealed: sustainable development as a guiding principle, climate protection, biodiversity loss, water pollution through agriculture, sustainable bioenergy, energy use in agriculture, and energy demand of waste water systems. It became apparent that the importance of nexus thinking has continuously increased. General nexus thinking was mostly found in the sustainable development strategy in the form of acknowledging interrelations between different sectors, resulting trade-offs or conflicting interests. The nexus approach as defined at the Bonn2011 Conference does not play any role for Germany and is exclusively referred to regarding the situation in developing countries. Nevertheless, also in Germany several nexus-related governance challenges exist. With regard to the threefold combination of food-energy-water (FEW) the issues of sustainable development, climate protection, and biodiversity loss were revealed to be important. All of these issues have a cross-cutting character but highly differ in their state of policy integration.

The development process of the German sustainable development strategy, especially its profound revision in 2016, serves as a valid example for horizontal policy integration since it fulfills all conditions set up by Lafferty and Hovden (2003, p. 14). The German chancellery, and hence, the highest political level in Germany is in charge of the strategy, which can be

described as an overall strategy for nexus governance since it accounts for interrelations between different resources. Furthermore, the NHS 2016 includes quantifiable goals that are regularly monitored. As described in section 5.2.3 horizontal policy integration often necessitates higher levels of social learning that can be triggered by external events and for which non-state actors play a vital role. In fact, the first NHS in 2002 as well as the revised NHS 2016 were impacted by international developments in the field of sustainable development: The World Sustainability Summit 2002 in Johannesburg and the adoption of the UN SDGs in 2015. Additionally, both development processes – although to different degrees – included an open consultation process involving a broad range of different stakeholder groups. This shows that general nexus thinking is of high importance for the German government. Especially the profound revision of the strategy against the background of the SDGs can be captured well by the holistic framework developed in section 5.2.3. However, despite these developments sustainable development has not been established as a guiding principle in all policy fields.

The challenge of climate protection has already been described in detail in section 6.3.2. Although, it forms a policy field for itself, it is completely dependent on GHG emission reduction targets within the other policy fields. Active climate policy means reducing emissions, first and foremost in the energy sector but also in the agricultural sector. To avoid repetition, climate protection is not additionally explained as a nexus challenge in this section. Furthermore, climate protection is directly and indirectly incorporated in more specific nexus challenges, such as energy use in agriculture (FE nexus), sustainable production of bioenergy (FE nexus), or energy efficiency of waste water systems (EW nexus). Climate policy, for a long time, has mainly, been integrated horizontally by national climate protection plans governed by the chancellery. Since 2019 a federal law exists, that gave climate protection a new legal character and defined sectoral climate goals.

Also, biodiversity loss is an important issue that touches upon all three nexus policy fields and that has been integrated horizontally. Since 2007 a strategy exists, which includes quantifiable goals that are regularly monitored and that is enforced by a central authority:

the BMU. In contrast to the sustainable development strategy which is governed by the chancellery biodiversity loss is thus located on a lower level, the ministerial level. According to the monitoring reports no significant progress in this issue has been made despite a new initiative in 2015. Many indicators measuring biodiversity address other important nexus issues in Germany, such as water pollution or land use management. The high land demand for housing, infrastructure, or renewable energies threatens habitats, biotopes and landscapes worth protecting. Thus, especially the agricultural and the energy sector have been found responsible for this problem whereas the water sector, in contrast, suffers from the consequences. The issue of biodiversity loss shows that strong interconnections between the different problems and goals exist and that successful policy integration highly depends on their interplay.

With regard to twofold combinations of policy fields, the FE nexus and the FW nexus turned out to be important in Germany. The EW nexus, however, received least of the attention. In the context of the FE nexus the case of a sustainable production of bioenergy is the most important issue. The second issue which is only of minor importance is energy use in agriculture. The promotion of bioenergy and biofuels in the early 2000s came with negative environmental impacts, such as high land demands and harmful side-effects on soil and water quality. In order to deal with these issues sustainability criteria and the CAP 'cross-compliance' regulations were integrated in energy policy rules, such as the EEG and specified by the BioSt-NachV and the Biokraft-NachV. In Germany, this process involved all nexus related ministries and led to policy integration on a sectoral level and eventually to a 'nexus-smart' policy for bioenergy that was more considerate for negative environmental impacts. Thus, it can be described as vertical policy integration and adequately analyzed by means of the cooperation framework developed in section 5.2.2. However, two important aspects not captured by these criteria are imported biomass from outside the EU and indirect land use changes that occur when areas that were formerly used for food production are now used for bioenergy causing food production to move to former non-agricultural land. The few remaining text segments regarding the FE nexus code address the

use of fossil fuels agriculture. So far, this issue has not been of great importance. The federal advisory program for energy use in the agricultural industry has not been used often.

With regard to the FW nexus the problem of water pollution, especially with nitrate and nitrogen from agricultural activity, is of high importance. This issue represents a case, in which vertical integration was tried on the EU level but failed. Neither existing legal frameworks, such as the ND and the WFD, nor repeated reforms of the CAP towards more environmental concerns proved to be successful in reducing nitrate and nitrogen levels. Therefore, attempts have been made to directly integrate the goals of the ND and WFD into the CAP during its 2013 reform in order to make agricultural policy 'nexus-smart'. This process of vertical policy integration can be captured well by the nexus cooperation framework. However, this has only been partially successful so far. In Germany, water pollution continues to be a major problem, which is why Germany was sued by the EU Commission for failing to reach the required nitrate levels in 2018. The BMEL supported vertical instruments to deal with this issue, such as reforming the CAP and the DüV. The BMU, on the contrary, suggested a horizontal instrument for dealing with nitrogen pollution by developing a comprehensive nitrogen strategy. Remaining text segments in the area of the EW nexus mostly address the energy demand of waste water systems. This issue, however, only play a minor role in the analyzed documents.

The analysis of nexus policy integration in this section shows that all issues addressing the combination of all three nexus policy fields are integrated horizontally. For all three issues of sustainable development, climate protection, and biodiversity loss a comprehensive national strategy or plan exists that is governed by a central authority: the German chancellery for sustainable development and climate protection and the BMU for biodiversity loss. These strategies and plans also include quantifiable targets that are regularly monitored. It also becomes apparent that the development of these strategies and plans is strongly impacted by events on the international level, such as the adoption of the UN biodiversity convention, international climate negotiations, or the adoption of the UN SDGs. What also becomes clear is that the implementation of the goals included in these

strategies and plans highly dependent on the sectoral level. For example, the goal of reducing water pollution which itself is a nexus issue serves the goals of sustainable development, climate protection, and biodiversity and is thus included in several strategies. The same applies for the goals regarding organic farming and daily land use. The latter is mainly caused by the agricultural and the energy sector. Land use is mostly integrated vertically into legal rules in the field of environmental policy, for example, the BNatSchG. Additionally, the federal states hold the responsibility for many questions regarding land use. Generally, exceeding daily land use has been a problem in Germany for many years now that haven't been successfully solved so far.

The issues regarding the combinations of two nexus policy fields (FW, FE, EW) are mostly integrated vertically on different governance levels. Despite the fact that it was demanded by the EU European renewable energy directive the process of integrating sustainability criteria for bioenergy happened on the federal level including federal actors, such as the related ministries. The attempt to integrating the goals of the WFD and the ND into the CAP took place on the EU level. This shows the relevance of MLG for these nexus issues. Generally, the importance of bioenergy and related questions declined over the years whereas the issue of water pollution continued and continues to be a critical issue. Hence, the success of policy integration among these German nexus governance challenges and the attention that is given to them highly differ. Table 17 again summarizes the key findings of this section by displaying the nexus governance challenges, their type of policy integration as well as the most important rules. Besides the analysis of policy integration this section already pointed to some remaining problems or weaknesses with regard to these challenges. The nexus assessment in the following section will take a deeper look into these aspects.

Table 17: Policy integration within the nexus governance challenges

Sub code	Nexus governance challenge	Type of integration	Main rules
	Sustainable development as a guiding principle	Horizontal	NHS 2016
FEW	Climate protection	Horizontal	KSP 2050, KSG
	Biodiversity loss	Horizontal	BDS
	Sustainable bioenergy	Vertical	BioSt-NachV, Biokraft-NachV
FE	Energy use in agriculture	Vertical	Information campaigns, consulting
FW	Water pollution through agriculture	Vertical	WFD, ND, CAP
EW	Energy demand of waste water systems	Vertical	AbwV

Source: own Table.

6.5. Results III: Assessment of nexus governance challenges

For the final assessment of FEW nexus governance in Germany the results from sections 6.3 and 6.4 are considered, the documents included in group IV (policy statements of the RNE and PBnE, cf. section 6.2.1.1, Table 10), and the interview data. The previous section showed that a certain degree of policy integration across horizontal, vertical, and multiple governance levels exists regarding the respective nexus governance challenges. However, critical issues remain with regard to these challenges, which is why several goals regarding every nexus governance challenge have been missed for a long time now. Nevertheless, for some challenges policy integration seems to be more successful than for others. This section takes a deeper look into these nexus issues and aims at a validation and assessment of the nexus governance challenges described above. Therefore, the main codes *"recommendations/RNE"* and *"recommendations/PBnE"* of each code group were used (cf. Table 13). All related text segments included in the documents from group IV were assigned to these codes. The expert interviews constituted the second data basis. As described in section 6.2.2 the transcripts were analyzed by means of a qualitative document analysis as well by using the coding scheme specifically designed for this purpose (cf. Table 14).

6.5.1. Sustainable development as a guiding principle

The current state of general nexus thinking in Germany can best be assessed by looking at overarching strategies, such as the sustainable development strategy, and their progress and monitoring reports. In these documents many nexus-related issues are addressed but, more importantly, the documents generally emphasize the need to integrate different goals and policies, to acknowledge possible trade-offs and conflicts of interests, and to achieve different goals not at the expense of each other. As mentioned above, these strategies, in general, fulfill all conditions of horizontal policy integration defined by Lafferty and Hovden (2003). Furthermore, the German sustainable development strategies incorporate a strong multi-level governance perspective since they are directly connected to international policies, partly EU policies, and the federal system in Germany. As described in section 6.4.2 the NHS 2016 is a good example for successful horizontal policy integration since firstly, it

is governed by the highest political level. Secondly, it includes quantifiable goals that are regularly monitored. Thirdly, its development process showed levels of triple-loop learning and included a broad variety of state and non-state actors. However, the question arises if the strategy is also able to effectively implement nexus thinking in actual policy-making. In order to assess this question, the results of the document analysis of the PBnE's and RNE's policy statements are used as well as the respective statements from the interviews. With regard to the development process of the revised NHS 2016, both consultation bodies, the RNE and the PBnE, regarded the SDGs as the most important impulse since the NHS 2002 and requested the federal government to use it as a momentum to profoundly reorient German sustainability policy (RNE 2015a, p. 5; PBnE 2015e, p. 4). They generally positively commented on the revised structure of the NHS 2016 and how it translates international goals into federal policy (RNE 2016b, p. 1; PBnE 2017b, p. 1). Nevertheless, the PBnE demanded a better cooperation between the different political levels and called for a deepened dialogue as well as new instruments and structures (PBnE 2015e, p. 3). Furthermore, the PBnE emphasized the need to more strongly include non-state actors, such as NGOs, civil society organizations or actors from industry at any governance level. Therefore, new forms of cooperation became necessary. Those were already tested by the open consultation process that preceded the revised NHS 2016 (PBnE 2017b, p. 1). The RNE requested an even stronger involvement of different stakeholders and non-state actors when developing the revised strategy by creating new platforms and dialogue processes. By openly discussing possible trade-offs and conflicts of interest constructive solutions can be fostered and interconnections be adequately considered. Only by interconnecting different actors, topics and governance levels to each other existing barriers can be removed (RNE 2015a, p. 9). Both the PBnE and the RNE, critized the small role the EU plays in the NHS 2016. The RNE, for example, suggested to stronger integrate sustainable development on the EU level, also, in order to face rising nationalistic tendencies in various member states and to strengthen the commonalities and advantages of the European Union (RNE 2016b, p. 6). The PBnE requested to revise the European sustainable

development strategy and to develop a common European vision for future developments. It also criticized that the strategy only included a few remarks on Europe (PBnE 2017b, p. 1).

The PBnE and the RNE did not only criticized the coordination between different governance levels but also the indicator set included in strategy, especially in terms of agricultural production and water quality. Indicators related to the latter, for example, have only been included in the revised NHS 2016 even though water pollution has been an important issue for decades. Furthermore, already in 2002, the RNE criticized the federal government for using the share of organic farming as a sustainability indicator for agriculture. Since most of the agricultural products were (and continued to be) produced conventionally it would be more appropriate to use such sustainability criteria that measure the impacts of this type of production (RNE 2002, pp. 10–11). The indicators regarding agricultural production, however, remained the same throughout the whole process: nitrogen pollution of agricultural land and the share of organic farming (Bundesregierung 2017, pp. 65–68). The PBnE called for a reevaluation of the existing indicators and their update towards 2030 (PBnE 2015e, p. 4). Moreover, according to the RNE, reporting on the indicators of the strategy needs to be better coordinated between the federal, state, and municipal level (RNE 2014c, pp. 7–8).

Concerning cross-sectoral integration, the PBnE and the RNE noted an existing lack of coordination between the departments. By addressing the Ind14 in 2015, the PBnE still criticized that there is a need for better coordination between different departments under the leadership of the chancellery. Many issues were still dealt with in a sectoral manner thus neglecting the common ground of the strategy. Also insights from sectoral initiatives should be spread and integrated into the overall strategy (PBnE 2015e, p. 3). Regarding the NHS 2016, the PBnE complained about the fact that cross-sectoral cooperation can only be found on the last page of the strategy, which what does not satisfy its relevance (PBnE 2017b, p. 2). The RNE acknowledged that assigning the different goals to specific departments, on the one hand, adequately divides responsibilities between the ministries. On the other hand, however, this approach impedes the identification of common cross-

sectoral challenges that need to be addressed in a unified manner. In the RNE's opinion the strategy lacked a common vision and a guiding principle. This could not be achieved by only summing up the indicators (RNE 2016b, p. 6). The PBnE, furthermore, requested a stronger involvement and discussion with all relevant actors in order to integrate sustainable development in all other policy fields. This, they claimed, cannot be the task of the ministry of environment alone (PBnE 2015f, p. 3). For this reason, the PBnE suggested that all ministries should regularly report their efforts and current state of sustainable development in their policy fields (PBnE 2017b, p. 2). Such reports exist for the nexus-related ministries BMU, BMEL, and BMWi (Bundesregierung 2020). The most recent reports were published by the BMU in 2020 (BMU 2020b), the BMEL in 2019 (BMEL 2019) and the BMWi in 2018 (BMWi 2018). Additionally, the RNE demanded to assess draft laws according to their coordination between different related departments (RNE 2016b, p. 3).

As mentioned above, the question of the effectiveness of instruments like sustainable development strategies were also asked in the expert interviews (cf. section 6.2). Generally, the interviewees mentioned similar points of criticism than the RNE and PBnE. Four interview partners evaluated sustainable development strategies generally as a good thing. Their main critique, however, was that such overarching strategies can only remain on a superficial level without having much impact on actual policy-making (itv1, 52; itv2, 60; itv3, 98; itv6, 54). The fact that they do not offer clear instruments for operationalization was stated as one reason (itv3, 98). According to the interviewee from the municipal level, the sustainable development strategy can offer guidelines to start with. It is, however, needed that mechanisms exist for transferring these guidelines into department policies, for example by departmental delegates for the case of climate protection (itv6, 54). Another way could be by developing specific sectoral strategies. The RNE, for example, requested to create such strategies for issues like resource productivity or circular economy (RNE 2015a, p. 14). So far, a number of these strategies exist, for example in the case of biodiversity or electro mobility. However, they do not exist for all relevant sectors (RNE 2014c, p. 8). This approach was also emphasized by the interviewee from energy policy, who stated that

either a sustainable development strategy can only be very broad and thus stay on the surface – this hints to the question as to how powerful the strategy can be if the actual impulses must still come from sectoral approaches – or the strategy digs deeper into the specific issues, but then it usually frays out the lower it goes and will not stay manageable (itv5, 45). Hence, the solution could be to develop a set of sectoral strategies that incorporate defined minimal requirements and are harmonized between each other. Having too many individual strategies like a separate energy efficiency strategy, a transport strategy, and an electricity production strategy in his opinion will not result in coherent policy-making. A holistic sustainable development strategy, as the other extreme, is not able to determine policy-making in every policy field. Therefore, the 'right' number of separate strategies is needed (itv4, 47).

Apart from the question of the strategy's design, barriers exist in day-to-day political business. The decisions on which policy-making is based often are hardly negotiated compromises that are not necessarily in line with the strategy. They rather depend on existing political conditions and majorities (itv2, 60). According to the second interviewee, coherent policy-making, therefore, currently suffers from inconsistency and incompetence fostering sectoral approaches. Silo-thinking is supported by short-term day-to-day business and personnel debates (itv2, 40).

6.5.2. Biodiversity loss

As mentioned above horizontal policy integration in form of an overall strategy exists for the case of biodiversity. Furthermore, the federal biodiversity strategy (BDS) has a strong MLG character since it is oriented towards the international biodiversity convention. Additionally, a number of federal states developed regional biodiversity strategies. The main exchange platform between these two governance levels is the conference of environmental ministers and a common working group (Bundesamt für Naturschutz 2020). Despite the existence of the strategy, which also includes relevant policy fields such as agriculture and energy (BMUB 2007, p. 5), the goal of ending biodiversity loss has been missed for many years and will not be reached in the near future either. The question is

why. First of all, the BDS is mainly governed by the BMU, which does not represent a strong authority comparable to the German chancellery that is able to enforce its implementation. Thus, the BDS is located on a lower political level than the NHS 2016. Therefore, the actual impact of the BDS is rather limited on policy-making. Furthermore, according to the PBnE, biodiversity is often still not considered as a cross-cutting issue and lacks vertical integration within policy fields like agricultural policy, fishery, transport, climate or energy policy (PBnE 2015e, p. 7). Two aspects that have a particularly strong negative impact on biodiversity are current land use management (itv3, 24) and intensive agricultural production. Thus, the cultivation of biomass is of special relevance for biodiversity loss (RNE 2008b, p. 4). Especially, the first pillar of the CAP challenges the protection of biodiversity and its related goals since it still supports production quantities and grants subsidies that depend on the size of the farms. This means that the underlying value of competitiveness of agriculture in many regards opposes the value of environmental protection and thus the goal of ending biodiversity loss. This underlying value conflict hinders the design of truly integrated policies that would support biodiversity protection. Therefore, for many years, the RNE demanded to pay more attention to a needed reform of the second pillar of the CAP (RNE 2008b, p. 11). Moreover, land use for housing threatens and destroys habitats (RNE 2008b, p. 3). Therefore, the goal of reducing daily land use for infrastructure and housing to 30 hectares was formulated many years ago. So far, it has not been reached. According to the RNE the goal is missed due to administrative competences and responsibilities spread over different political levels. Since the federal government can only impact the legislative level, all upcoming legislative changes, such as an intended revision of the construction law or the property tax, therefore, should carefully be reviewed in order to be able to use possible positive impacts on land use (RNE 2013b, p. 3). This shows that the case of biodiversity loss is not only strongly dependent on sectoral developments, especially in agricultural and energy policy but also on their common challenge: the food-energy nexus and especially the issue of bioenergy.

6.5.3. Sustainable production of bioenergy

In the document analysis bioenergy turned out be one of the most important nexus governance challenges. As stated by two interviewees from water and agricultural management, currently, the issue is not so prominent anymore since many aspects have already been dealt with (itv1, 28; itv3, 58). According to the interviewee from agricultural management a common unified European framework exists (itv3, 54) that everyone can relate to and that, for example, regulates all questions regarding the authorization and use of fertilizers and pesticides (itv3, 50). Additionally, a strong exchange between the federal states and the federal level exists, e.g., in form of a common working group. This exchange is highly institutionalized (itv3, 74). During the big hype on bioenergy in the 1990s bioenergy was too much considered as a pure agricultural issue without keeping the whole picture in mind. The agricultural sector kept strongly supporting bioenergy since it promised more income for farmers even if it always has been a very expensive technology in Germany (itv3, 60). Indeed, – as stated in the documents many times as well – biogas for many years has been an immense source of income for some farmers which, on the other hand, increased the prices in other areas of agricultural management, such as market prices for leases or for the usage of manure or digestates (itv3, 14). But also, other negative side-effects occurred. The two most prominent ones are conflicts over land use and a sustainable production which eventually led to a political turnaround in the support for bioenergy and biogas (itv3, 62, 64) as already described in section 6.3.5.

Many land areas were used for the production of biogas or energy crops in the context of the energy transformation. It is necessary to avoid that land areas are planned to be used multiple times and be over-used for the energy transformation. The possibilities of the agricultural sector to contribute to the energy transformation by the production of energy crops are strongly limited (itv3, 24). By planning more carefully with land resources many problems could be solved at once and less regulation would be needed (itv3, 40). According to the interviewee from agricultural management policy-makers need to be more sensible for the issue of current land use since it is seen as one of the most pressing problems in

energy and agricultural management (itv3, 40) and one of the main causes for biodiversity loss (itv3, 24) as already pointed out in section 6.4.2.

The most important issue that emerged around land use of bioenergy was the 'food vs. fuel-debate', which was mostly discussed during the global food crisis of 2008 (cf. Figure 2). The discussion on whether the land resources should be used for the cultivation of food or energy crops also concerned the RNE in 2008. In this regard, the RNE clearly stated that in case of conflicting interests, food security always receives highest priority, followed by an intact nature and the production of biofuels. Only in this order bioenergy could serve the purpose of energy security (RNE 2008a, p. 7). According to the interviewee from agricultural management the 'food vs. fuel' problem has been a global debate that was highly present in public and media mainly brought forward by NGOs (itv3, 34). They focused on the global side-effects of the bioenergy boom, not only with regard to global food production but also to global environmental impacts, such as palm oil production in Indonesia or deforestation in Brazil for soy production (itv3, 88). The discussion also led to international action, such as the creation of an international panel. The EU responded with the Renewable Energy Directive (2009/28/EG) that required sustainability criteria for bioenergy (itv3, 26). As explained in section 6.4.3, these criteria are implemented through the BioSt-NachV for the case of electricity production from biomass and the Biokraft-NachV for the case of biofuel production (itv3, 40). These sustainability criteria, however, only apply for the EU and not for the international market (itv3, 42) (RNE 2008b, pp. 3–5) resulting in an import of soy that produced under unknown conditions. Hence, as long as these criteria only apply for energy crops produced in the EU these regulations can only be considered a partial success (itv3, 42). Actually, sustainability criteria would be needed on a global level. This, however, does not seem to be reached in the near future (itv3, 46). The RNE additionally noted that the Biokraft-NachV does not include impacts of indirect land use changes that occur due to biofuel production (RNE 2008b, pp. 9–10). It also demanded that external costs such as fuels, fertilizers, and pesticides should be integrated to correctly estimate the impacts of an expansion of bioenergy. Biofuels should be evaluated with regard to their GHG reduction

potential (RNE 2008b, pp. 5–7). Hence, a regulatory framework would be needed including all of these missing aspects. In this case, it would not matter anymore if the land was used for food or fuel production (itv3, 44). According to the interview partner from agricultural management the 'food vs. fuel' debate has been one of the core problems in the last few years whose emergence needs to be avoided in any case for upcoming challenges within the energy transformation, such as fuel production or heating (itv3, 24). And bioenergy might be needed again for the mobility sector (itv3, 104).

6.5.4. Water pollution through agriculture

For many years now water pollution has been a major problem in Germany. One interviewee from water management emphasized the strong connection that exists between different uses for water, such as water supply and disposal, process water for industry, cooling water, water used as transportation routes, or ground water, and existing pollution from contamination or landfills (itv1, 8). The most important legal rule regarding the protection of water resources is the WFD, which was integrated into the WHG in Germany (cf. section 6.3.3.) and aims at achieving a good status of all water bodies until 2027. As stated by the second interviewee, the WFD, in fact, contributed a great deal to broaden the perspective of water management towards other environmental issues, mostly regarding ecosystem protection and renaturation (itv2, 8). The WFD brought forward the idea of thinking together water and nature. However, even if EU policy-makers currently argue about revising the WFD, according to the second interviewee it would not only still be too sectoral, but broadening the WFD would also result in an escalating monitoring process almost impossible to handle. The interviewee, therefore, suggested that non-state actors could be involved in the monitoring process. On the local level this could work by means of developing integrated city concepts which then could be used as evaluation criteria for different areas, water protection for example. On the EU level, however, this would not be possible (itv2, 44).

Looking more specifically at the case of nitrate pollution the agricultural sector can be seen as the biggest pollutant. With regard to policies the RNE already in 2013 demanded that the

agricultural sector as a whole and especially the CAP would need to get more sustainable (RNE 2013c, p. 1). In the opinion of its members, the CAP should be oriented towards the SGDs and their implementation on the EU level. A revised CAP would, thus, need to consider SDG 2 on food security, SDG 12 on sustainable production and consumption, SDG 15 on protecting biodiversity, SDG 13 on climate action, and of course SDG 6 on protection of water resources (RNE 2017, pp. 1–4). Additionally, the goal of a reduced level of nitrogen should be directly integrated into the CAP (RNE 2017, p. 6). The second interviewee, in fact, was convinced that policy-making would be more coherent if water and agricultural policies were organized and structured the same way on the EU level, i.e., have the same level of communitization. Nevertheless, even in the existing governmental structure a federal state like Germany should be able to adequately address this issue (itv2, 48). With regard to the question how political responsibilities are best distributed the interviewees from water management did not have a common standpoint. Whereas the first interviewee positively commented that water and agricultural issues are addressed within the same ministry in NRW (itv1, 50), for example, the second interviewee favored separate responsibilities (itv2, 54). According to the first interviewee many issues can be solved short distance by addressing them in the same department. Furthermore, in case of conflicts a clear hierarchy for decision-making exists. He acknowledged that, of course, not everything can be dealt within one department what, however, would not be problem per se since successful cooperation between different departments often depends on prevailing political conditions (itv1, 50). The second interviewee, in contrast, endorsed divided responsibilities for agricultural and water policy – as it is on the federal level – since like this, important upcoming conflicts need to be dealt with on a higher level of authority and cannot be eliminated by compromises on a lower administrative level (itv2, 54).

Contrastingly, according to the first interviewee a low level of harmonization between these two policy fields can be seen as the main reason for the problem of nitrate pollution. Currently, nitrate levels must not exceed 50mg per liter as demanded by the Nitrate Directive. The CAP, on the other hand, supports an intensive production aiming at high

production quantities. For this reason, it would be surprising that nitrate levels do not fall below the critical value of 50mg per liter (itv1, 26). This reveals a fundamental value conflict between water and agricultural policies, which is why related goals are opposed to each other. To really incorporate water and environmental protection into agriculture, another way and paradigm of economic production and management would be needed according to the first interviewee. By continuing with current production patterns, these problems will only be repaired on the surface, for example by spending a lot of energy to filter the nitrate out of the water, instead of fixing the actual causes (itv1, 32). According to him, this would also represent a societal challenge, not only a political one. As long as people are not willing to adequately pay for meat, for example, cheap prices will affect the way of livestock farming and result in high quantities of manure, which exceed adaptation capacities of ecosystems. Hence, current consumer and price policies in the agricultural and food sector need to be questioned and changing consumption patterns need to be supported (itv1, 38). He requested a mix of regulatory measures as well as more cooperation and dialogues with farmers so that they adapt their use of fertilizers in order to tackle the nitrate problem (itv1, 10). Looking at the role of the consumer also leads to question of the real culprit of the problem. Usually, in water policy the 'polluter-pays-principle' applies. For example, in the case of nitrate pollution, the classic polluter would be the farmers who use large amounts of fertilizers. However, according to both interviewees from the field of water, the role of the consumer of these agricultural products is not considered (itv1, 38; itv2, 72). This represents an incorrect line of argumentation, which, in this case, only holds the farmers responsible and not the consumer. The interconnections and the causes of these problems need to be made clearer to the general public through media (itv2, 72). The interviewee also stated that the polluter pays principle won't work for the case of climate change and adaptation either due to the broad range of affected and affecting actors. The same applies for the case of urbanization and its impacts on water infrastructure. All of these issues are of general interest. Hence, taxes should be used to pay for this and not the pollutant. If everybody has a CO2 footprint, he/she has to pay for, maybe everybody also has a water

footprint he/she has to pay for, for example for sediments of medication in surface waters (itv2, 76).

6.5.5. Remaining nexus governance challenges

Similar to the results of the document analysis the interview data confirmed the most important nexus governance challenges for Germany, which are the implementation of sustainable development as a guiding principle, biodiversity loss, a sustainable production of bioenergy, and water pollution through agriculture. Besides these four challenges also the other German nexus governance challenges revealed by the document analysis were mentioned in the interviews. The third interview partner, for example, mentioned the needed switch from conventional to renewable energy sources in the agricultural sector. So far, the agricultural industry produces large amounts of bioenergy and biofuel but does not use them itself. According to the interview partner, the agricultural industry should therefore urgently change to renewable electricity and biofuels (itv3, 56). The interview partner stated that the agricultural sector started to think more about the impacts of climate change and measures of mitigation a few years ago. This is mainly because many farmers are directly affected by changing weather conditions (itv3, 22). With regard to the water-energy nexus the second interviewee criticized that the interconnections between the energy and the water sector are not sufficiently considered even it both of them are critical infrastructures (itv2, 82). The high energy demand of waste water systems – an issue revealed in the document analysis – was also mentioned in the interviews as being critical on the local level. In this area, many saving potentials and innovations exist that aim at energy autarchy of these systems (itv1, 60; itv2, 86). Additionally, the second interviewee emphasized the challenges arising from changing future water demands of the energy sector. Currently, the quantities of water used for cooling purposes of power plants are much higher than those used for public water supply. Even if most of the water is fed back to the water bodies these usages are still big interferences in water systems. Hence, the envisaged coal phase-out and the shutdown of big power plants will also have huge impacts on water resources – an issue future water management has to deal with (itv2, 36). In

general, developments in water policy should more strongly consider possible impacts on energy use or energy reuse, impacts on the energy sector in general (itv1, 64).

6.5.6. Upcoming water challenges

Additionally, another important aspect was brought up by the interview partners that did not play an important role in the document analysis and added new information. With regard to water management the interviewees mentioned several upcoming challenges that are not adequately addressed or considered so far. Impacts of climate change, digitalization, and an upcoming lack of specialists, for example are some of these challenges (itv2, 2). For these issues no regulatory frameworks yet exist (itv2, 6). Regarding climate change droughts, frequent flooding, or new pathogens transmitted by water could be possible impacts (itv1, 12). Occurring droughts might necessitate reconsidering current behavioral patterns for the use of water and possible solutions for the future (itv1, 14, 18). In the water sector in Germany, the classical line of argumentation for many years has been to assume that no problem with water quantities exists. According to the first interviewee this, however, might change in the future (itv1, 18). According to the second interviewee water quantities will not be a problem in the future, but probably the water will not always be where it is needed. Therefore, new forms of water management, plans and solutions are needed that are flexible to upcoming changes (itv1, 18; itv2, 80). According to the second interviewee the water sector currently suffers from two basic problems that avoid water-friendly policies. Firstly, the water sector, so far, is seen as a service sector serving the water demands of other sectors by simply reacting to their requirements. This self-perception of the water sector is one reason why other available, more innovative and more sustainable solutions are often neglected. For example, in times of a drought the agricultural sector is usually just demanding more water by keeping on using classic irrigation systems that spread around large amounts of water, causing them to evaporate. Instead, the agricultural sector could adapt to irrigation systems as they are already used in arid countries like Israel (itv2, 36).

Secondly, water management highly depends on regional or local circumstances (itv1, 20), which is why many aspects need to be addressed by these political levels. This especially applies for the case of climate change adaptation. Water infrastructure planning is a classic task of the federal states since these projects, on the one hand, are region-specific but, on the other hand, too big for the local level (itv2, 20). For this reason, federal states need to come up with new solutions (itv2, 80). Despite climate change, water management also needs to adapt to ongoing global mega trends, such as urbanization (itv2, 12). The question arises if existing water and sewage systems will still be appropriate and usable if less people live in rural areas in the future. Water infrastructure will become more difficult to maintain and more expensive in the case of rural-urban migration since less people would have to bear its costs (itv1, 44; itv2, 16). Existing water infrastructure runs the risk of being over dimensioned in the future what could lead to times of standstill and thus to sediments. Besides these examples many other problems might occur with these ongoing trends (itv1, 44). In order to especially prepare rural areas for these challenges the second interviewee requested more cooperation between big water industries in urban areas and small water suppliers in rural landscapes towards creating more cooperatives (itv2, 34). Additionally, the trend of rural-urban migration should be counteracted by maintaining high standards of living in rural areas, using new digital tools, and keeping infrastructure affordable. Therefore, new, innovative solutions become necessary, such as more strategic infrastructure planning (itv2, 12, 18), and decisions made decades ago about how to provide a safe water supply might need to be reconsidered (itv2, 30). According to the first interviewee a central water infrastructure will also be the right solution for the future but maybe in another way than it is managed today (itv1, 46), for example regarding economic and technical aspects. The second interviewee dunned that preserving and maintaining water infrastructure would be a major issue that should not be ignored by policy-makers despite their current focus on climate action. Otherwise, this will lead to a crisis at some point in the future, which then will be handled by pure short-term action instead of creating new long-term solutions (itv2, 50). According to her water policy does not need everyone's

attention but it needs the attention of those who are in charge of it, which usually are specific policy-makers on state or local level (itv2, 52).

With regard to the role of non-state actors, NGOs and associations should play a more vital role in water management in the second interviewee's opinion. In her opinion, mere voluntarily organized associations currently have not enough power to take action, full-time NGOs and associations, on the other hand, should, therefore, more strongly address water and environment issues (itv2, 22). Non-state actors could be able to monitor developments in the long run and provide valuable knowledge to policy-makers (itv2, 26). In general, a broad public dialogue on future water management would be necessary, similar to the energy transition (itv2, 6).

6.5.7. Section summary

In this section the nexus governance challenges were assessed by means the results of the qualitative document analysis of the policy statements of the RNE and PBnE (document group IV, cf. Table 10). Additionally, the data from the expert interviews were used. This analytical step served as an assessment and validation of the nexus governance challenges that were revealed by the document analysis of German policy documents conducted in sections 6.3 and 6.4. Generally, all nexus governance challenges found in the document analysis of document groups I-III did also play an important role in the analysis of the RNE's and PBnE's policy statements (document group IV) and in the expert interviews. However, they received different attention. With regard to sustainable development as a guiding principle and thus general nexus thinking the question was raised of how effective sustainable development strategies are at the moment. Not only the RNE and the PBnE but also most of the interview partners generally positively evaluated the NHS 2016 for transferring the international agenda to the federal level and for offering an overview of important topics and aspects. Nevertheless, its implementation has been criticized. The RNE and PBnE demanded stronger involvement of non-state actors in order to address inconsistencies and barriers of successful implementation. Furthermore, they criticized the small role the EU plays in the current strategy as well as the existing indicator set which is

particularly unsuitable for the agricultural sector. Besides this, one main point of criticism concerns cross-sectoral cooperation. According to the RNE and PBnE too little attention has been paid to this issue within the strategy and so far, sustainable development has not yet been adopted as a guiding principle in all policy fields. A solution mentioned both by the interviewees and the consultation bodies was the development of a harmonized set of sectoral strategies for relevant nexus governance challenges that, on the one hand, incorporate required minimal standards ensuring that trade-offs are avoided and, on the other hand, are precise enough for successful implementation. An additional aspect mentioned in the interviews was that other barriers in daily policy-making exist that have nothing to do with the design of the strategy, such as, for example, prevailing political conditions, negotiation processes, or personnel debates.

For the case of biodiversity loss, a national strategy exists, which has not proved to be successful. According to the PBnE this issue has not been integrated as a cross-sectoral issue and is not properly addressed by relevant policy fields, especially agricultural and energy. Biodiversity loss is pushed by two factors in particular: land use for infrastructure and housing and intensive agricultural production. The former is mainly addressed by the goal to reduce daily land use to 30 hectares what has been missed for a long time. According to the RNE this is due to lacking administrative coordination. It thus suggested to assess all legislative proposals with special regard to land use issues. Concerning agriculture especially a high use of pesticides and fertilizers as well as the cultivation of monocultures negatively impact biodiversity. Therefore, the RNE calls for a reform and a stronger impact of the second pillar of the CAP which addresses environmental issues. In general, a value conflict can be revealed between the first pillar of the CAP that supports competitiveness and production quantities on the one side and the protection of biodiversity on the other. The case of biodiversity presents a cross-cutting issue that is highly dependent on sectoral goals, also because the BMU seems not to be strong enough to enforce the implementation of the strategy.

An issue strongly impacting biodiversity is land demand for bioenergy production. According to the interviewee from agricultural management many problems regarding bioenergy have already been regulated during its hype in the 1990s. Since then, a regulatory framework has existed to which everyone can refer. He also acknowledged that in the beginning bioenergy was too much defined as being a purely agricultural issue without consideration of its holistic perspective. Partly for this reason, several negative side-effects occurred, such as high land demands or environmental impacts. Regarding the former, the interviewee stated that bioenergy could only make a limited contribution to the energy transition. Both the interviewee and the RNE also referred to the 'food vs. fuel' debate, which emerged around 2008 and led to a global discussion about conflicting interests of land use. The RNE clearly demanded that food production and environmental protection always have to be prioritized over biomass production. According to the interviewee this discussion needs to be avoided at all costs in the case that bioenergy becomes relevant for other sectors in the future, such as the heating sector. The EU responded to these side-effects by a directive requiring sustainability criteria for bioenergy. In Germany those were included in the BioSt-NachV and the Biokraft-NachV. Both the RNE and the interviewee, however, criticized that those criteria only apply within the EU and thus not to imported biomass. Thus, global criteria would be needed. Furthermore, current criteria also do not account for indirect land use changes and do not properly internalize environmental costs of fertilizers and pesticides. Hence, through more careful land use management and a proper regulation that includes these missing aspects many problems could be addressed at once, biodiversity loss among them.

For the case of water pollution through agriculture different causes and suggestions were mentioned. In general, the WFD can be seen as the most important legal rule and an integrated instrument for the issue of water pollution. According to the second interviewee, however, it mostly deals with renaturation and ecosystem protection rather than water pollution through agriculture. More specifically, the CAP is mentioned as a possible reason for nitrate and nitrogen pollution of water bodies. According to the RNE, the CAP could be

made more sustainable by directly relating it to the SDGs and by integrating a nitrogen reduction goal. One interview partner suggested to align the way that water and agricultural policies are organized on the EU level in order to reach a more coherent management. With regard to the federal level, one interviewee supported the division of responsibilities across different ministries, like it is in the case of the BMU and the BMEL. Like this, possible conflicts are discussed on a higher level of authority. Another interviewee, on the other hand, highlighted the advantages of dealing with these two policy fields within one ministry, like it is in NRW for example. Besides these administrative structures, one interviewee saw the actual problem in a lacking harmonization between these two policy fields. An agricultural policy that aims at intensive production per se contradicts the goal of the Nitrate Directive. Thus, this hints at a possible existing value conflict between competitiveness of agriculture and water protection. According to the interview partner a paradigm shift is needed in agriculture which not only refers to current consumer and price policies but also to consumption patterns. It would thus be both a political and societal challenge. The consideration of the role of the consumer would also lead to a more accurate picture of the causes of the problem, since currently often only the farmers are made responsible for the problem.

The remaining German nexus issues were mentioned in the interviews as well. One interviewee, for example, emphasized the need for the agricultural sector to switch from conventional to renewable energy sources. The fact that the impacts of climate change become more visible, incentivized many farmers to think about climate mitigation. Furthermore, the high energy demand of waste water systems was pointed to as an important issue on the local level. In this regard, saving potentials and existing innovations should be implemented. Changing water demands of the energy sector were also addressed in light of the envisaged coal and nuclear phase-out. Table 18 summarizes these results by extending Table 17 by the effectiveness of and missing aspects within the current state of policy integration in the nexus governance challenges.

Table 18: Policy integration within nexus governance challenges and missing aspects

Sub code	Nexus governance challenge	Type of integration	Rule	Effectiveness/ missing aspects
FEW	Sustainable development as a guiding principle	Horizontal	NHS 2016	Not implemented as a guiding principle in all policy fields NHS 2016 too broad
	Climate protection	Horizontal	KSP 2050, KSG	No effective climate protection in each sector (e.g. transport)
	Biodiversity loss	Horizontal	BDS	Further decreasing biodiversity
FE	Sustainable bioenergy	Vertical	BioSt-NachV, Biokraft-NachV	Missing aspects: imported biomass, indirect land use changes
	Energy use in agriculture	Vertical	Information campaigns, consulting	No large-scale switch to renewables
FW	Water pollution through agriculture	Vertical	WFD, ND, CAP	No effective reduction of nitrate pollution
EW	Energy demand of waste water systems	Vertical	AbwV	Remaining energy efficiency potentials

Source: own Table.

Another aspect revealed in the interviews was that current ongoing global trends pose important challenges for the water sector, such as impacts of climate change or urbanization. With regard to these trends two main problems exist. Firstly, the water sector usually acts as a service sector only reacting to demands. In case of a drought, for example, the agricultural sector requests more amounts of water instead of rethinking existing irrigation patterns. This might become an important issue in the future when the consequences of climate change become more tangible. Secondly, water management

highly depends on regional and local conditions. Therefore, current urbanization trends challenge classic water infrastructure planning. This issue runs the risk of being overlooked due to current political priorities. With regard to these challenges, more non-state actors should be involved and a broad social discussion on water issues seems to be necessary.

This section on the assessment of nexus governance challenges served two purposes: firstly, to validate the results of the analysis of German policy documents, and secondly to reveal additional aspects important for nexus governance. Therefore, the policy statements made by the RNE and PBnE were analyzed as well as the interview data. Generally, the nexus assessment shows that the most important nexus governance challenges revealed in the document analysis in section 6.3 could be validated. For each of these challenges different causes and suggestions were mentioned. Furthermore, the central aspect of upcoming challenges in the water sector could be uncovered by the interviews. The comprehensive analysis conducted throughout sections 6.3 to 6.5 allowed firstly, to understand institutional processes within the nexus and nexus-related policy fields as well as their underlying values (section 6.3). These implications served as the basis for revealing important nexus governance challenges on the federal level in Germany as well as their state of policy integration (section 6.4). Eventually, these challenges were validated and assessed with regard to their weaknesses and missing aspects (section 6.5). These results will be used to derive specific policy implications in the following discussion.

7. Discussion and policy implications

The results sections 6.3 to 6.5 provide a comprehensive value-based institutional analysis of nexus governance challenges. In this section these results are discussed with the aim of deriving specific policy implications for German nexus governance. In the second part of this section, the research framework developed throughout sections 2 to 5 is evaluated with regard to its suitability and further research needs.

Yet, before evaluating the research method, the results of the case study analysis are discussed in terms of policy recommendations. In total, eight policy implications will be derived focusing on the following aspects:

1. Increasing the attention to water and environmental policy
2. Recognizing the different roles of the policy fields and give water and environmental policy a more active role
3. Defining a more sustainable agricultural policy as a priority field of action
4. Developing a German land use strategy
5. Increasing the attention to possible value conflicts
6. Increasing the coordination between different governance levels
7. Increasing stakeholder involvement by simultaneously respecting the constitutional and institutional processes
8. Giving sustainable development a principled priority in all policy fields.

The first policy implication is to increase the attention for the fields of water and environment in current policy-making. The analysis showed that different weight and attention is giving to the different nexus and nexus-related policy fields. Currently, the field of energy, by far, receives most of the attention. This circumstance is not a problem per se, as confirmed by the interviews. For example, the interview partner from agricultural management considered it appropriate that currently the social importance of the energy sector is significantly higher than that of the environmental or agricultural sector (itv3, 86). One of the interviewees from water management had a similar point of view. In her opinion

water management, for example, does not need general attention, but only needs to be addressed by those who need to take action, by decision-makers, local and regional politicians (itv2, 52). Hence, giving the policy fields different weight or attention per se is not seen as problematic. It, however, bears the risk that important challenges might not be identified and addressed in time, like in water management where upcoming challenges soon need to be brought to the political agenda (itv2, 50). Also, the field of environmental policy should be given greater prominence again according to one of the interviewees (itv1, 12). One suggestion of the BMU to address this issue was to give the ministry initiative power also in other policy fields in topics of environmental concern (BMUB 2016a, p. 8).

Not only the attention to the policy fields differs, but also the role that is giving to them. Nexus-related policy fields can generally be divided into affecting policy fields on the one hand and affected policy fields on the other. Energy and agriculture can be described as affecting fields since they have significant negative side-effects on the other three policy fields. The water, climate and environmental field can thus be defined as mainly being affected (Venghaus and Hake 2018, p. 6). The second policy implication is to pay more attention to the roles the policy fields currently play and more precisely to give the affected policy fields a more active role by allowing them to initiate change processes instead of only being able to react. Traditionally, the connection between these fields has been described as unidirectional: for example, the energy sector has negative impacts on the climate (e.g. Gölz and Wedderhoff 2018, p. 96; Mundaca et al. 2018, p. 292) or intensive agricultural production comes with negative environmental impacts (e.g. Salomon et al. 2016, p. 158; Kuhmonen 2018, p. 684). With increasing impacts of climate change, however, this connection has become mutual. The energy sector and more particular renewable energy generation is more and more influenced by changing weather patterns, for example with regard to wind (Wohland et al. 2018, p. 16). Also, the agricultural sector needs to adapt to more frequent and more severe droughts as a consequence of climate change (Drastig et al. 2016, p. 1300). By considering these relationships and causalities it becomes clear that, traditionally, the affected policy fields operated from a more passive position by reacting to

the impacts whereas the affecting policy fields actively contributed to these impacts. Increasing impacts of climate change as well as questions of sustainable development now challenge these roles and necessitate an adaptation to changing conditions. In general, this development is welcome as it encourages these fields to rethink their current patterns. However, in view of the threatening consequences of a global average temperature rise of more than two degrees by the end of the century urgent measures need to be taken that need to exceed current national climate contributions and thus necessitate stronger political action (Lenton et al. 2019, p. 592).

Thirdly, the analysis made apparent that the majority of nexus governance challenges, such as biodiversity loss, climate mitigation, water pollution, and bioenergy strongly involve agricultural policy. Therefore, the third policy implication is to tackle the question of a more sustainable agriculture first. Like this many different nexus governance challenges could be addressed at once. Making the agricultural sector more environmentally friendly by keeping its competitiveness at the same time is a difficult task. In this regard, a broad public dialogue including various stakeholders and non-state actors becomes necessary. As explained in section 4.2 such a dialogue could induce higher levels of social learning and thus enable structural change processes. The analysis revealed that the type of learning and institutional development to some extent differs between the different policy fields (cf. section 6.3.). It also became apparent that profound structural changes are often induced by external events, such as crises, catastrophes or international events. When looking at agricultural policy the development regarding ecological sustainability mostly developed path dependently what, so far, prevented profound structural changes (Kuhmonen 2018, p. 684). Against the background of a series of arid years the agricultural sector becomes more and more considerate for the issue of climate change. This accumulation of droughts could serve as a momentum and open up a window of opportunity. However, unilateral attempts to reduce negative environmental side-effects would have a major impact on productivity and market mechanisms which is why regulations and solutions need to adopt a holistic perspective (Kuhmonen 2018, pp. 684, 693-694). Future food policy should therefore clearly

formulate political priorities and directly address potential conflicts (Candel and Pereira 2017, p. 90).

An important issue that is closely related to the agricultural sector is current land use management. In order to reduce pressure on land resources a more careful planning with those resources is needed that weights land demands against nature conservation. This automatically would account for land use changes caused by renewable energies and would support biodiversity protection (Kati et al. 2021, p. 2). Hence, a fourth policy implication is to develop a German land use strategy which should be enforced by a strong authority, such as the German chancellery. This would follow the suggestion made by the RNE and in the interviews of developing more specific strategies that are easier to manage than those overarching ones. In theory, this has already been tried by the biodiversity strategy (BDS), for example, which, however, is not successful also due to the reasons mentioned in the paragraphs above. Thus, the challenge of biodiversity loss and land use management in particular seems to necessitate stronger horizontal policy integration. However, whereas in the other governance challenges that cross all sectoral boundaries – sustainable development as a guiding principle and climate protection – some important progress has been made through a revised NHS 2016 and the adoption of the Federal Climate Protection Law (KSG) biodiversity continues to decrease in particular because of current land use and despite the existence of a federal strategy. This shows that every nexus governance challenge needs a specific type of integration. A specific land use strategy could complement the BDS and might be able to address this issue more successfully.

Besides these four policy implications related to the specific policy fields or nexus governance challenges also four more general implications can be derived. The analysis revealed how interdependent the different nexus issues are. If the prominent example of nitrate pollution of groundwater is taken, it became apparent during the analysis that this is mainly caused by intensive agricultural production, which in turn is one of the main factors of land use which in the case of bioenergy in turn also includes the energy sector (cf. sections 6.4 and 6.5). Similar chains of interdependencies can be made for the other nexus

issues as well. For example, GHG emissions from the agricultural industry contribute to climate change, the impacts of which in turn negatively affect crop yields and, in the case of drought, put additional stress on the water sector (Drastig et al. 2016, p. 1300). Therefore, integrated management is of such importance (Albrecht et al. 2018, p. 2). In trying to get to the root of the problem, a value perspective can provide valuable insights since conflicts in basic underlying guiding principles prevent successfully integrated rules and regulations. Hence, the fifth policy implication is to uncover existing value conflicts and to question the compatibility of underlying values between the different policies. As described in section 6.5.4 it seems that for the case of water pollution through agriculture the value of competitiveness in agricultural policy contradicts the value of ecological sustainability and thus the protection of water resources. The same applies for the protection of biodiversity. By looking at the connection between energy and agricultural policy the relationship between the values is different. Since renewable energies, including bioenergy, simultaneously serve the purpose of ecological sustainability and competitiveness, bioenergy is compatible with both policy fields. Renewable energies are a strong economic factor, an object of investment and a source of income for the agricultural industry (Purkus et al. 2017, p. 83). They serve the value of climate protection and energy security by simultaneously becoming more competitive and affordable (International Renewable Energy Agency 2020, p. 12). Problems arise in the moment when the environmental or water sector is touched by their side-effects, mainly in the form of land use or water and soil pollution (Volk et al. 2009, p. 586). Then again, the same value conflict emerges as the one mentioned above.

The analysis also revealed that multi-level governance (MLG) is an important factor for successful nexus governance. MLG plays different roles within the nexus policy fields what complicates an integrated management. Since agriculture is completely communitized on the EU level, MLG is of special relevance for this policy field (Kuhmonen 2018, p. 684). The interviewee from agricultural management supported the development of a common regulatory framework for this policy field in order to create unified competitive conditions

(itv3, 46). In the field of energy, most of the responsibilities remain on the level of the member states. According to one of the interview partners, a more unified European framework could lead to more goal-oriented solutions. But, for this, the EU would need more power and responsibility in this policy field (itv3, 50). Still, important energy policy guidelines, such as, for example, the EU Renewable Energy Directive come from the EU level and must be implemented in national policies. It was criticized that these existing EU energy guidelines sometimes still contain certain inconsistencies that are difficult to address at a lower governance level (itv4, 41). In these cases, a stronger dialogue and exchange would be necessary on the EU level prior to the adoption of the regulation. In particular, the opportunities for exchange between the federal states and the EU are very limited. These aspects show clear disadvantages of MLG. On the other hand, MLG, in his opinion, sometimes also positively increases the pressure to deal with certain issues that otherwise would be neglected (itv4, 43). Generally, each of these governance levels takes over important functions with regard to risk or natural resource management (Bleischwitz et al. 2014, p. 11). According to the fourth interviewee the most important challenge of MLG is to divide responsibilities without losing the whole picture (itv4, 29). In order to tackle this challenge exchange mechanisms between the different governance levels exist. Within Germany, the most important institutionalized exchange platform between the federal and the state level for all policy fields remains the federal council (itv2, 68). In general, MLG is mostly discussed regarding the connection between the EU, federal and state level. However, the final step to the local level is often neglected. For example, climate and energy targets exist on the European, the federal and maybe also on a state level. On the local level such targets are missing. The BMU, for example, criticized that climate policy is not part of municipal public services. Even if many cities already take measures in climate action, climate friendly policy making is not a given. The municipal level, however, has high importance for successful implementation (BMUB 2016b, p. 77). Also, the interviewee from the municipal level criticized that cities having a high CO_2 footprint currently are not sanctioned while others causing less emissions are not rewarded. In his opinion, it would,

therefore, be necessary for the federal level to translate its goals into municipal goals (itv6, 18) and to develop a stronger regulatory framework that forces cities to choose environmentally friendly alternatives (itv6, 22). Hence, the sixth policy implication concerns MLG and suggests to strengthen exchange channels between the EU and the federal state level and to translate climate, energy, and environmental goals to any governance level, including the local one.

Besides formal governance and administrative structures, the role of non-state actors, such as non-governmental organizations (NGOs), was emphasized by the documents and all interview partners. On the local level, for example, NGOs play an important role since they are very close to the general public (itv6, 24). As stated by one interviewee policy-makers usually act according to their political opinions, but they also act according to public pressure. Insofar, the general public and non-state actors, in fact, can use their influence and could, for example, demand more climate-friendly options (itv6, 48). The fourth interviewee emphasized the need that every stakeholder or stakeholder group should have a lobby, no matter if it represents the interests of nature or climate protection, the steel industry, or students' interests. In a democratic system, each of these groups should have the opportunity to declare its standpoint (itv4, 49). Eventually, the elected policy-maker has the responsibility to make a decision by weighting these different interests against each other and balance them in a way that supports the future development of the country (itv4, 49). However, to initiate a goal-oriented dialogue policy-makers need to openly discuss upcoming trade-offs and conflicts of interests (RNE 2014c, p. 4). Taking the example of the ongoing discussion about the necessary distance between wind power plants and housing one interviewee demanded that politicians must have the courage to clearly state possible consequences – that in the case of larger distances not as much renewable electricity can be produced as is needed to reach the climate targets (itv6, 48). The question remains what the best way is to involve these actors in order to create feasible strategies and solutions that can be implemented (Bhaduri et al. 2015, p. 730). It is not only the type of participation that is important, but also how much influence the outcome has on policy-making (Reed et

al. 2009, p. 1933). The interview partner from the field of energy, for example, was not convinced by recent developments in which more and more tasks that typically belong to the political level are delegated to non-state actors. In his opinion, this does not comply with the idea of a representative democracy. He cited the coal commission as one example. In this process a broad variety of different stakeholders came up with a compromise that policy-makers then took as a decision. According to him such an important decision process would clearly have been the task of elected representatives (itv4, 55). This remark shows that stakeholder participation and the involvement of non-state actors is generally desired and evaluated as a positive development. The type of participation, however, does play an important role not only for the outcome but also for the legitimacy and acceptance of the outcome (Gupta et al. 2013, p. 577). Hence, the seventh policy implication would be to organize stakeholder participation more often in form of open dialogues but to make sure that important decisions are made by democratically legitimized decision-makers, such as elected policy-makers.

Lastly, another important aspect in actual policy-making is that in the end political decisions are often laden with a certain symbolic power. This holds true especially for the field of energy. According to the fifth interviewee, energy policy often follows specific normative concepts of how something needs to be due to its massive societal and economic role. Energy policy-making, therefore, does not need to and also cannot consider all possible consequences. Occurring negative side-effects are usually repaired afterwards. The case of bioenergy can serve as a valid example in this regard. He stated that the ‘food vs. fuel’ debate was only discussed when it was already too late, only after the decision has been made to strongly support bioenergy. The same also applied for the case of electric mobility, which was seen as the panacea for the transport sector before a discussion about the extraction of rare earths emerged that are needed for battery production (itv5, 30). For this reason, new types of batteries are now developed that do not need as much rare earths as the former ones. The interviewee stated that, of course, interconnections and interdependencies exist, which are however, at first, overlooked or ignored by policy-

making before they are repaired in the aftermath by administrative processes (itv5, 30). This standpoint was also supported by the fourth interviewee who mainly saw experts and the administration responsible for considering interconnections (itv4, 29). This statement generally questions the effectiveness of developing integrated policies and it shows that political decisions can be subject to external events, societal pressures or intragovernmental discussions. Furthermore, political decisions with regard to the nexus face a high degree of uncertainty and complexity (Pahl-Wostl et al. 2020, p. 9). To be able to deal with these practical challenges the eighth policy implication would be to give the guiding principle of sustainable development a principled priority in all policy fields according to the idea of Lafferty and Hovden (2003). In this case all political decisions would at least comply with the planetary boundaries. Other side-effects could then be dealt with in the aftermath.

The results from the case study analysis show that the integrated value-based framework for analyzing nexus governance challenges proved to be very suitable for analyzing the state of nexus governance on the federal level in Germany. The methodological development of a novel analytical framework (sections 2-5) is the main contribution this work adds to current research on the nexus concept. This analytical approach offers the great advantage of enabling an overview on important nexus-related challenges that exist on the political level. This provides a significant added value compared to those approaches often found in literature that look at one nexus issue at the time. The holistic perspective, the new framework offers, makes it possible to oversee and understand the complex interrelations that exist between the different sectors and policy fields. This expands the scope of possible solutions. An analysis with the framework developed in this study uncovers problems and barriers as well as chances for successful nexus governance on a superior level, which facilitates finding bigger solutions that can lead to a more effective management of natural resources in general. In line with the idea of respecting planetary boundaries as well as the SDGs the framework can help addressing the root of current problems with natural resource management instead of treating symptoms in a fragmented way.

The methodological development of this novel framework followed a structured and consecutive way, with each section building on the previous one, further completing the framework. Regarding current global challenges integrative approaches such as the nexus are critical (Al-Saidi and Elagib 2017, p. 1137). The nexus concept can help to specify the object of investigation and the related research questions, however, many possibilities exist to operationalize it for the analysis (Albrecht et al. 2018, p. 2). Therefore, in a first step, the conceptualization of the nexus as an analytical concept for socio-ecological systems focusing on resource interrelations has defined a clear operating space for the analysis (cf. section 2). It became apparent that the focus in nexus research should not be set on the selection of the respective policy fields but instead on the basic idea of this concept.

Against the background of these preparatory considerations, a framework for institutional analysis was chosen to start with (cf. section 3.1). Institutions are the core of public policies, the formal and informal rules that determine policy development and are thus central for governance and policy analyses. In this thesis, the IAD framework was used since it allows a structured analysis of important system elements by specifically focusing on the role of legal rules and regulations as well as involved actors (Heikkila and Andersson 2018, p. 320). Thus, it proved to be suitable for analyzing nexus governance on a national level. However, in its classical form the IAD framework does not offer insights into the nature and characteristics of institutional change processes. These processes, however, are critical to understand for analyzing nexus governance. In order to capture institutional change in the nexus and nexus-related policy fields the basic framework was combined with social learning (cf. section 3.2). Social learning and its concept of triple-loop learning enabled a differentiated understanding of how the different policies change (Pahl-Wostl 2009, p. 359). In the case study it could be revealed that some processes have developed path dependently for many years whereas others were characterized by critical junctures. These insights are important to comprehend how and where integration might work.

In addition to the extension with social learning the IAD framework was also complemented by a value perspective, which enabled to uncover on which values current policies are based

and where potential value conflicts lie (cf. section 4). Values often represent the purpose for which institutions are created. They mirror the underlying guiding principles that policy-makers and the society hold important (Milchram et al. 2019, p. 5). This perspective offered two very important insights into the nexus and nexus-related policies: Firstly, it could be revealed that value changes can induce institutional change in various ways. For example, the increasing awareness of climate issues and the resulting emerging value of climate protection led to a series of political reforms including GHG emission reduction targets or capacity expansion targets for renewables as laid down in the EEG (Erneuerbare-Energien-Gesetz 2017 7/17/2017, § 1). Secondly, the value perspective made it possible to discover existing underlying value conflicts (Milchram et al. 2019, p. 10). This helps to understand why integration in one case works and not in another even if regulations exist for both cases. In case of a profound value conflict, like the conflict between competitiveness and ecological sustainability of agriculture, political reforms often only scratch the surface attenuating the symptoms instead of fixing the actual cause of the problem. Hence, these values need to be reconciled in order to solve this problem. This value conflict can also help to explain why policy integration between the fields of agriculture and water only had limited success.

Eventually, the last step of the framework development added the actual nexus perspective. The core idea of the nexus concept is to focus on the interrelations between different resources, sectors or policy fields instead of treating them separately. Hence, in terms of policy and governance the nexus concept refers to interconnections between the different policy fields and their state of integration. Therefore, a suitable definition of policy integration was needed. In this thesis, EPI was chosen for the following reasons: Firstly, it especially addresses environmental concerns, and secondly, it provides different dimensions of cross-sectoral integration, which are of special interest for nexus research (Nilsson and Persson 2017, p. 36). By means of EPI, first of all, relevant nexus governance challenges could be revealed and secondly, it could be shown how policy integration could look like in terms of the nexus. The two dimensions of vertical and horizontal integration

enabled a differentiated analysis of the different nexus issues. These two dimensions were represented by two nexus integration frameworks that were specifically designed for this purpose: the nexus cooperation framework and the holistic nexus framework (cf. sections 5.2.2 and 5.2.3). It became clear that cross-cutting nexus governance challenges that touch upon all policy fields are usually integrated horizontally whereas those challenges that touch dual combinations of policy fields are integrated vertically. It, however, highly differs how successful this kind of integration is. The two nexus integration frameworks developed in section 5.2 proved to be very helpful in understanding policy integration among the nexus challenges. Furthermore, the consideration of MLG turned out to be a critical aspect as well, which not only strongly influences how sectoral policies develop but also determines on what governance level and in what process policy integration can be reached. The notion of polycentric governance, additionally, acknowledged the role that non-state actors play in these processes (Pahl-Wostl 2009, p. 356).

The end result was an integrated value-based institutional framework for the analysis of nexus governance challenges. This framework offers a broad range of possible analyses. First of all, it allows a value-based institutional analysis of the nexus and nexus-related policy fields – as conducted in section 6.3. This analytical step does not yet focus on nexus challenges but is critical to gain a deeper understanding of the causes and characteristics of nexus challenges as well as for the development of effective solutions. This analysis reveals the most important institutions and actors in the policy fields, which is important to know in order to understand what and who needs to be addressed for a better management. Additionally, the analysis allows an understanding of how these policy fields change. Every policy field shows different dynamics of change that need to be taken into account for possible solutions. Lastly, the analysis uncovers the values underlying the different sectoral policies, which, on the one hand, allows to understand what purpose or goal institutions should serve and on the other hand, to compare whether the values are compatible, both within a policy field and between multiple policy fields.

Secondly, the integrated value-based framework can be used to analyze nexus-related governance challenges – as conducted in section 6.4. This analysis also offers numerous insights: To begin with, it reveals all central nexus challenges within the different combinations of policy fields. It shows nexus challenges that touch upon all nexus and nexus-related policy fields at once as well as challenges that exist between specific policy fields. The analysis thus provides an overview on all relevant nexus challenges that exist at the policy level under review. Furthermore, the analysis examines the state and character of policy integration of these challenges. It shows if these challenges are currently integrated vertically or horizontally and allows conclusions about current barriers of integration. Finally, the analysis also reveals how the different nexus challenges are interconnected. This provides an essential added value for the design of holistic and integrated solutions.

A further great benefit of this novel framework that goes beyond this work is its transferability to other case studies. The framework is applicable to a broad variety of different case studies on different policy levels and is thus especially interesting for comparative studies of different countries, for example. In regard to the research gaps described in the introduction the integrated value-based framework developed in this study contributes to existing socio-economic approaches in nexus research by strongly emphasizing the role of institutions as well as offering a clear definition of how policy integration can be analyzed and defined in terms of the nexus concept.

For the case study, the framework was operationalized through a qualitative document analysis of German policy documents. The advantage of this approach was that all of these official documents and policy statements can be openly accessed, what provided an immense data pool. In order to filter these documents properly and to represent the nexus and nexus-related policy fields well a structured, stepwise approach was taken, which is defined in detail in section 6.2.1.1. The development of the coding scheme, the coding procedure, as well as the analysis of the results followed the structure of the novel research framework. The computer-assisted qualitative content analysis with the software MAXQDA

enabled an open and comparable coding process that ensured a high level of transparency. As explained above, the complete analytical report containing all coded text segments is provided as supplementary material.

As explained above the main features of the framework developed in this thesis are the analysis of institutional change processes as well as the state of policy integration within the nexus and nexus-related policy fields. The analysis thus mainly focused on the institutional outcomes of governance processes, such as laws, strategies and plans. Depending on the case study, additional aspects might become interesting, such as for example how institutional outcomes are negotiated, which important aspects or processes run alongside the official administrative structures or what the practical impacts of strategies and policies are. In order to address these three aspects, the following analytical steps were taken in this case study: Firstly, policy statements of the two most important advisory boards of the federal government – the RNE and PBnE – were used in order to put the official governmental documents into context and to take a look at the ongoing debates at the time. Secondly, several complementary expert interviews were conducted, which have fulfilled the functions of verifying the results gained in the document analysis on the one hand and uncovering important aspects that were not revealed by the document analysis on the other. Thirdly, documents were chosen from a broad time horizon of approximately 20 years, which made the consequences and impacts resulting from different institutional change processes visible since they were referred to in later documents. Those information were used for the final assessment in section 6.5. All in all, the well-developed framework, the profound document analysis, and the additional expert interviews allowed a comprehensive and detailed analysis of German nexus governance challenges. The methodological and empirical approach chosen in this thesis was thus very well suited to answer the research questions.

8. Conclusion

This thesis provided a novel framework for analyzing nexus governance challenges and showed that the nexus concept is of high relevance for successful natural resource governance in Germany even if the concept, first and foremost, was developed to be applied to developing countries. By structurally designing a well-grounded conceptual and methodological framework that accounts for institutional development as well as for underlying values and policy integration a new method was developed that contributes to filling an important gap in existing research on nexus governance. The framework allows a comprehensive analysis and assessment of nexus governance by providing insights into the institutional development of the nexus and nexus-related policy fields, the values on which these policies are based as well as how these policy fields are integrated. The framework has a high transferability and can be used for numerous comparative case studies in the future, such as national or regional comparisons. Also, the framework provides some interesting starting points for future research, for example regarding the role of state- and non-state actors. In order to focus on their individual preferences and behavior the framework could be complemented by a more actor-centered methodological design, which could be operationalized through stakeholder participation in workshops or interviews.

For Germany the analysis revealed seven important nexus governance challenges that need to be dealt with. Regarding the cross-cutting issues touching all three nexus policy fields it became apparent that sustainable development has already been promoted as a guiding principle for a long time. In fact, its prominence has been strengthened continuously. Nevertheless, it still has not received the principled priority that would ensure staying within the planetary boundaries. Concerning climate protection, it can be stated that the adoption of the Federal Climate Protection Law (KSG) in 2019 disrupted the former path dependence of regularly adjusted climate goals defined in climate action plans or sectoral policies. It remains to be seen if the KSG is strong enough to put politics on a climate-friendly

course. According to various experts and NGOs the efforts made in the law are too weak to reach the goals of the Paris Agreement (Zeit Online 2019). Also, the Federal Constitutional Court ruled in a landmark decision "that the provisions of the KSG […] are incompatible with fundamental rights insofar as they lack sufficient specifications for further emission reductions from 2031 onwards" (Bundesverfassungsgericht 2021). In its current form, the KSG only defines emission reduction targets until 2030. With regard to the Paris Agreement this shifts the main burden of emissions reductions to the period after 2030. The federal government now needs to adjust the KSG in order to take the rights of the younger generations more into account. The ruling is seen as groundbreaking for German climate policy (Süddeutsche Zeitung 2021; Tagesschau 4/29/2021).

In the case of biodiversity loss, the situation could not be improved and is getting worse instead despite the existence of a comprehensive strategy. It remains to be seen whether significant progress can be made in the near future. The current BDS was adopted in 2007. With regard to a new edition, the BMU mainly refers to international processes and states that the Corona-related postponement of the adoption of a new framework for the UN biodiversity convention makes a new edition of the BDS possible in the fall of 2021 at the earliest, and thus not during the current legislative term. Furthermore, the new BDS should take into account the European biodiversity strategy for 2030, which was adopted in 2020. Currently, a stakeholder process is organized by the BMU in preparation for the new edition (BMU 2021b). Besides, biodiversity loss is mainly due to the fact that sectoral goals that are closely related to biodiversity, such as reducing water pollution and daily land use as well as increasing organic farming, are not reached. Hence, current agricultural and land use management turned out to be the focal points to which all of these aspects are connected. For this reason, these two points should become the top priorities on the German and European political agenda. So far, the 30-hectare goal for daily land use in Germany seems a long way off. Currently, approximately 52 hectares are designated daily. Still, the federal government is holding on to the goal and specified that zero net-land use should be achieved by 2050 (BMU 2021a). Because of the high level of communitization agricultural

policy needs to be tackled on the EU level. The basic two-pillar structure on which the CAP is based seems to be outdated and urgently needs to be revised. Otherwise, the basic value conflict between competitiveness and ecological sustainability will not be solved in the future either. So far, this step has not been made. Also, the most recent reform of the CAP, which was negotiated under German presidency, did not initiated a transformation of agricultural policy but kept its former structure by adjusting its funding regulations for the time period after 2020. More financial resources were assigned to the second pillar, which specifically supports rural development and measures of climate and environmental protection. Furthermore, direct payments from the first pillar will be more strongly linked to climate and environmental conditions (Rat der Europäischen Union 10/21/2021; BMEL 10/29/2021). Environmental organizations, such as Greenpeace or the BUND e.V., highly criticized the facts that the reform continues to support mainly large farms and that its requirements for environmental and climate protection are still far too weak (Zeit Online 2020; Kafsack 2020; Süddeutsche Zeitung 2020). The reform was also criticized by the opposition in the German parliament. The green party missed the required structural change in agricultural policy and called it “a deliberate misleading of the public” and a “pure label fraud” (Bundestag 2020b, p. 23272). The coalition partner (SPD) could not see any significant progress either and called for further improvements (Bundestag 2020a). Additionally, the recent reform of the DüV followed the same path as former reforms by further limiting the use of fertilizers and pesticides (Bauchmüller 2020). It maintained the classic ‘polluter-pays-principle’ by only addressing the farmers instead of questioning underlying production patterns.

The developments in agricultural and biodiversity policy show two things very clearly: Firstly, they show how important the consideration of underlying values is and how strong the barriers for structural institutional change can be. Secondly, they show what role real and unforeseen factors, external events, personnel debates or negotiation processes can play. In the end, these factors may cause that those political decisions are not automatically in line with the intention and goals that were defined in plans or strategies. In addition,

some political decisions are laden with a strong symbolic power due to their socio-economic importance, like in energy policy for example. Therefore, perfectly integrated policies may exist on paper but this does not mean that their implementation also works as intended. Policy-making will always be influenced by these factors and remain unpredictable to a certain extent which is why also problems with natural resources will probably always exist. Against this background and with regard to the pace at which the impacts of climate change become apparent, the most important policy implication is to finally enforce sustainable development as the guiding principle for all decisions in all policy fields and to respect planetary boundaries. Therefore, it might be worthwhile to think about integrating sustainable development as a basic principle in the German constitution as repeatedly suggested by the RNE and PBnE (RNE 2016a, p. 2, 2016b, p. 2; PBnE 2016b, p. 3). It is equally important to initiate a broad debate in politics, economy, and society about the way we currently act economically. The Corona crisis should be used as a momentum and a window of opportunity to profoundly rethink and change prevailing paradigms. The Corona virus was transmitted from animals to humans. According to the minister for the environment this was also made possible because of our way of interacting with nature. Humans and animals are moving ever closer together and ecosystems are thrown out of balance. In this context, she explicitly emphasized the need for a sustainable agricultural policy as well as sustainable global supply chains (Tagesschau 2020). Several (inter)national organizations request that short- and medium-term financial support in the Corona crisis must be designed in such a way that it simultaneously promotes the necessary long-term transformation towards a sustainable and low carbon society (EEA 2020; UNEP 2020; Gibis et al. 2020). Only by respecting the planetary boundaries as the safe and only available operating space a minimum standard for a future-oriented development can be defined.

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Annex I

Table 19: Documents included in the document analysis

No.	Abbr.	Title	Type	Year	Search for	Found
	Group I					
1	NHS 2002	Perspektiven für Deutschland. Unsere Strategie für eine nachhaltige Entwicklung	Policy Paper	2002	Nachhaltigkeitsstrategie Deutschland	Jan 18
2	FB 2004	Perspektiven für Deutschland. Unsere Strategie für eine nachhaltige Entwicklung. Fortschrittsbericht 2004	Policy Paper	2004	Nachhaltigkeitsstrategie Deutschland	Jan 18
3	WWN	Wegweiser Nachhaltigkeit 2005: Bilanz und Perspektiven	Policy Paper	2005	Nachhaltigkeitsstrategie Deutschland	Jan 18
4	FB 2008	Fortschrittsbericht 2008 zur nationalen Nachhaltigkeitsstrategie: Für ein nachhaltiges Deutschland	Policy Paper	2008	Nachhaltigkeitsstrategie Deutschland	Jan 18
5	FB 2012	Nationale Nachhaltigkeitsstrategie. Fortschrittsbericht 2012	Policy Paper	2012	Nachhaltigkeitsstrategie Deutschland	Jan 18
6	10JN	10 Jahre Nachhaltigkeit "made in Germany". Die Nationale Strategie für eine nachhaltige Entwicklung	Policy Paper	2012	Nachhaltigkeitsstrategie Deutschland	Jan 18
7	NHS 2016	Deutsche Nachhaltigkeitsstrategie. Neuauflage 2016	Policy Paper	2016	Nachhaltigkeitsstrategie Deutschland	Jan 18
8	Ind06	Nachhaltige Entwicklung in Deutschland. Indikatorenbericht 2006	Report	2007	direct search	Mar 18
9	Ind08	Nachhaltige Entwicklung in Deutschland. Indikatorenbericht 2008	Report	2008	direct search	Mar 18
10	Ind10	Nachhaltige Entwicklung in Deutschland. Indikatorenbericht 2010	Report	2010	direct search	Mar 18

11	Ind12	Nachhaltige Entwicklung in Deutschland. Indikatorenbericht 2012	Report	2012	direct search	Mar 18
12	Ind14	Nachhaltige Entwicklung in Deutschland. Indikatorenbericht 2014	Report	2014	direct search	Mar 18
13	Ind16	Nachhaltige Entwicklung in Deutschland. Indikatorenbericht 2016	Report	2017	direct search	Mar 18
	Group II					
14	KP 2000	Nationales Klimaschutzprogramm. Fünfter Bericht der Interministeriellen Arbeitsgruppe „CO2-Reduktion“	Policy Paper	2000	NHS 2002	Mar 18
15	IntEKP	Integriertes Energie- und Klimaprogramm	Policy Paper	2007	direct search	Jan 18
16	APKlima	Aktionsprogramm Klimaschutz 2020 der Bundesregierung	Policy Paper	2014	direct search	Jan 18
17	KSP 2050	Klimaschutzplan 2050 – Klimaschutzpolitische Grundsätze und Ziele der Bundesregierung	Policy Paper	2016	direct search	Jan 18
18	EnKonz	Energiekonzept für eine umweltschonende, zuverlässige und bezahlbare Energieversorgung	Policy Paper	2010	direct search	
19	NAPE	Nationaler Aktionsplan Energieeffizienz	Policy Paper	2014	direct search	Jan 18
20	GBEL	Grünbuch Ernährung, Landwirtschaft, Ländliche Räume. Gute Ernährung, starke Landwirtschaft, lebendige Regionen	Green Paper BMEL	2016		Jan 18
21	IntUP	Den ökologischen Wandel gestalten - Integriertes Umweltprogramm 2030	Policy Paper	2016	BMUB Umweltprogramm	Jun 18
22	NB 2016	Nitratbericht 2016. Gemeinsamer Bericht der Bundesministerien für Umwelt, Naturschutzk, Bau und Reaktorsicherheit sowie für Ernährung und Landwirtschaft	Report	2017	BMUB Water	Jun 18
	Group III					
23	DüV	Düngeverordnung	Regulation	2006		Jan 18
24	AgrarZahlVerpflG	Gesetz zur Regelung der Einhaltung von Anforderungen und Standards im Rahmen	Regulation	2014	direct search	Jul 18

		unionsrechtlicher Vorschriften über Agrarzahlungen (Agrarzahlungen-Verpflichtungengesetz - AgrarZahlVerpflG)				
25	AgrarZahlVerpflV	Verordnung über die Einhaltung von Grundanforderungen und Standards im Rahmen unionsrechtlicher Vorschriften über Agrarzahlungen (Agrarzahlungen-Verpflichtungenverordnung - AgrarZahlVerpflV)	Regulation	2014	direct search	Jul 18
26	DirektZahlDurchfG	Gesetz zur Durchführung der Direktzahlungen an Inhaber landwirtschaftlicher Betriebe im Rahmen von Stützungsregelungen der Gemeinsamen Agrarpolitik (Direktzahlungen-Durchführungsgesetz - DirektZahlDurchfG)	Regulation	2014	direct search	Jul 18
27	DirektZahlDurchfV	Verordnung zur Durchführung der Direktzahlungen an Inhaber landwirtschaftlicher Betriebe im Rahmen von Stützungsregelungen der Gemeinsamen Agrarpolitik (Direktzahlungen-Durchführungsverordnung - DirektZahlDurchfV)	Regulation	2014	direct search	Jul 18
28	EEG 2017	Gesetz für den Ausbau erneuerbarer Energie (Erneuerbare-Energien-Gesetz - EEG 2017)	Regulation	2017	direct search	Jan 18
29	EEV	Verordnung zur Durchführung des Erneuerbare-Energien-Gesetzes und des Windenergie-auf-See-Gesetzes (Erneuerbare-Energien-Verordnung EEV)	Regulation	2015		Mar 18
30	EnWG	Gesetz über die Elektrizitäts- und Gasversorgung (Energiewirtschaftsgesetz - EnWG)	Regulation	2005	direct search	Jul 18
31	BiomV	Verordnung über die Erzeugung von Strom aus Biomasse (Biomasseverordnung - BiomasseV)	Regulation	2001	direct search	Jun 18
32	WHG	Gesetz zur Neuregelung des Wasserrechts. Wasserhaushaltsgesetz	Regulation	2009	direct search	Jan 18

33	AbwV	Verordnung über Anforderungen an das Einleiten von Abwasser in Gewässer (Abwasserverordnung - AbwV)	Regulation	1997	Deutsche Wasserpolitik	Jan 18
34	OGewV	Verordnung zum Schutz der Oberflächengewässer (Oberflächengewässerverordnung - OGewV)	Regulation	2016	Deutsche Wasserpolitik	Jan 18
35	GrwV	Verordnung zum Schutz des Grundwassers (Grundwasserverordnung - GrwV)	Regulation	2010	direct search	Jan 18
36	BNatSchG	Gesetz über Naturschutz und Landschaftspflege (Bundesnaturschutzgesetz - BNatSchG)	Regulation	2009		Jan 18
37	BImSchG	Gesetz zum Schutz vor schädlichen Umwelteinwirkungen durch Luftverunreinigungen, Geräusche, Erschütterungen und ähnliche Vorgänge (Bundes-Immissionsschutzgesetz - BImSchG)	Regulation	1974		Mar 18
	Group IV					
38	RNE NHS02 Pro	Projektvorschläge des Rates für Nachhaltige Entwicklung	Statement	2001	Rat für nachhaltige Entwicklung	Mar 18
39	RNE Pilot	Stellungnahme zu den Pilotprojekten zur nachhaltigen Entwicklung der Bundesregierung	Statement	2001	Rat für nachhaltige Entwicklung	Mar 18
40	RNE NHS02	Stellungnahme zur Nationalen Nachhaltigkeitsstrategie der Bundesregierung	Statement	2002	Rat für nachhaltige Entwicklung	Mar 18
41	RNE FB04 Ent	Am Roten Faden arbeiten. Stellungnahme zum Regierungsentwurf des Fortschrittsbericht 2004 „Perspektiven für Deutschland. Unsere Strategie für eine nachhaltige Entwicklung“	Statement	2004	Rat für nachhaltige Entwicklung	Mar 18
42	RNE FB04 GP	Nachhaltigkeit im Visier. Gesellschaft fordert Politik – Unsere Schlussfolgerungen	Statement	2004	Rat für nachhaltige Entwicklung	Mar 18
43	RNE FB04	Dem roten Faden konsequent folgen. Stellungnahme zum Fortschrittsbericht 2004 der Nachhaltigkeitsstrategie der Bundesregierung	Statement	2005	Rat für nachhaltige Entwicklung	Mar 18

44	RNE Ind06	Welche Ampeln stehen auf Rot? Stand der 21 Indikatoren der nationalen Nachhaltigkeitsstrategie – auf der Grundlage des Indikatorenberichts 2006 des Statistischen Bundesamtes	Statement	2008	Rat für nachhaltige Entwicklung	Mar 18
45	RNE Peer13	Für einen neuen Aufbruch in der Nachhaltigkeitspolitik. Stellungnahme des Rates für Nachhaltige Entwicklung zum Bericht des Peer Review 2013 “Sustainability – Made in Germany”	Statement	2013	Rat für nachhaltige Entwicklung	Mar 18
46	RNE Ind14	Mehr Nachhaltigkeitspolitik! Stellungnahme des Nachhaltigkeitsrates zum Bericht über Nachhaltigkeitsindikatoren 2014	Statement	2014	Rat für nachhaltige Entwicklung	Mar 18
47	RNE NachP	In den ersten 100 Tagen: Für eine Richtungsentscheidung zur Nachhaltigkeitspolitik. Empfehlung an die Bundesregierung	Statement	2014	Rat für nachhaltige Entwicklung	Mar 18
48	RNE NHS16 SDGs	Deutsche Nachhaltigkeits-Architektur und SDGs. Stellungnahme des Rates für Nachhaltige Entwicklung an Herrn BM Peter Altmaier nach § 1 (2)b RNE-Geschäftsordnung	Statement	2015	Rat für nachhaltige Entwicklung	Mar 18
49	RNE NHS16 Ent	Mutiger und nicht nur moderat verändern! Der Regierungsentwurf zur Nachhaltigkeit bleibt hinter den Erfordernissen zurück. Stellungnahme zum Regierungsentwurf der Deutschen Nachhaltigkeitsstrategie vom 31. Mai 2016	Statement	2016	Rat für nachhaltige Entwicklung	Mar 18
50	RNE NHS16 Emp	Mehr Mut! Nachhaltigkeit muss politische Relevanz beweisen. Erwartungen und Empfehlungen an die Bundesregierung	Statement	2016	Rat für nachhaltige Entwicklung	Mar 18
51	RNE Koal13	Nachholen und voranstellen. Anforderungen der Nachhaltigkeitspolitik an die	Statement	2013	Rat für nachhaltige Entwicklung	Mar 18

		Koalitionsverhandlungen. Herbst - Statement 2013				
52	RNE Strom	Der Strompreisdebatte fehlt die Nachhaltigkeit	Statement	2013	Rat für nachhaltige Entwicklung	Mar 18
53	RNE EnW	Die Energiewende braucht eine verbindliche und wirksame Energieeffizienzpolitik. Empfehlung des Nachhaltigkeitsrates an die Politik	Statement	2012	Rat für nachhaltige Entwicklung	Mar 18
54	RNE Flä	Einen politischen Aktionsrahmen zum Ziel 30 Hektar schaffen Stellungnahme zur Flächeninanspruchnahme an den Staatssekretärsausschuss für nachhaltige Entwicklung auf der Basis der bisherigen Arbeiten des Rates für Nachhaltige Entwicklung	Statement	2013	Rat für nachhaltige Entwicklung	Mar 18
55	RNE Land	Für ein politisches Signal zur Stärkung der Rolle des ökologischen Landbaus in Europa	Statement	2013	Rat für nachhaltige Entwicklung	Mar 18
56	RNE Boden	Bodenschutz: Für einen neuen politischen Anlauf zum Nachhaltigkeitsgebot für die Bodennutzung in Europa	Statement	2014	Rat für nachhaltige Entwicklung	Mar 18
57	RNE ÖkoEU	Position des Nachhaltigkeitsrates zur Revision der EU-Öko-Verordnung	Statement	2015	Rat für nachhaltige Entwicklung	Mar 18
58	RNE GAP	Agrarpolitik der Europäischen Union. Stellungnahme zur gemeinsamen Agrarpolitik (GAP)	Statement	2017	Rat für nachhaltige Entwicklung	Mar 18
59	RNE Bio	Schutz der Biodiversität heißt aktuell: Biomasse-Produktion nachhaltig machen	Statement	2008	Rat für nachhaltige Entwicklung	Mar 18
60	RNE KliEn	Position des Nachhaltigkeitsrates zu aktuellen Fragen der Klima- und Energiepolitik	Statement	2008	Rat für nachhaltige Entwicklung	Mar 18
61	RNE Klima	Klimaschutz auf Deutschlands Agenda! Stellungnahme des Rates für Nachhaltige Entwicklung	Statement	2015	Rat für nachhaltige Entwicklung	Mar 18
62	PBnE Peer	Stellungnahme des Parlamentarischen Beirates für nachhaltige Entwicklung zum Bericht des	Statement	2014	PBnE	Mar 18

		Peer Review 2013 zur Nationalen Nachhaltigkeitsstrategie „Sustainability – Made in Germany				
63	PBnE Ind14	Stellungnahme des Parlamentarischen Beirates für nachhaltige Entwicklung zum Indikatorenbericht 2014 „Nachhaltige Entwicklung in Deutschland“ des Statistischen Bundesamtes und Erwartungen an den Fortschrittsbericht 2016 der nationalen Nachhaltigkeitsstrategie	Statement	2015	PBnE	Mar 18
64	PBnE IP NHS 16	Impulspapier des Parlamentarischen Beirates für nachhaltige Entwicklung zum Entwurf der Deutschen Nachhaltigkeitsstrategie - Neuauflage 2016	Statement	2016	PBnE	Mar 18
65	PBnE NHS 16	Stellungnahme des Parlamentarischen Beirates für nachhaltige Entwicklung zur Deutschen Nachhaltigkeitsstrategie 2016	Statement	2016	PBnE	Mar 18
66	PBnE IP EU	„Ein langer Weg in eine nachhaltige Zukunft der Europäischen Union“ Impulspapier	Statement	2017	PBnE	Mar 18
67	PBnE IP VN	Entschieden voranschreiten, niemanden zurücklassen. Impulspapier des Parlamentarischen Beirates für nachhaltige Entwicklung anlässlich der Tagung des „High-level Political Forum on Sustainable Development“ der Vereinten Nationen	Statement	2016	PBnE	Mar 18
68	PBnE SDGs	Stellungnahme zu den globalen Zielen für eine nachhaltige Entwicklung (SDGs)	Statement	2015	PBnE	Mar 18
69	PBnE Stadt	Nachhaltige Stadtentwicklung. Positionspapier	Statement	2015	PBnE	Mar 18
70	PBnE IP Wi	Nachhaltig Wirtschaften: Lebenschancen sichern! Impulspapier	Statement	2015	PBnE	Mar 18
71	PBnE Ver	Mehr Transparenz für Verbraucherinnen und Verbraucher Impulspapier	Statement	2015	PBnE	Mar 18

72	PBnE Mob	Bundestags-Fahrdienst: Vorreiter für nachhaltige Mobilität. Beschluss	Statement	2015	PBnE	Mar 18

Source: own Table.

Annex II

Interviewleitfaden Experteninterviews

1. Personenbezogene Angaben

- Name
- Position (seit wann) + Kurzbeschreibung der Tätigkeit
- Können Sie mir kurz skizzieren, warum Sie sich beruflich für diesen Schwerpunkt entschieden haben?

2. Gerechtigkeit der Energiewende

Im Rahmen des VI-Projekts „Mentalitäten und Verhaltensmuster im Kontext der Energiewende NRW“ wurde im Zuge einer qualitativen Erhebung deutlich, dass die Energiewende von mehreren Befragten aus unterschiedlichen Regionen und sozialen Milieus als ungerechtes Projekt wahrgenommen wird. In einer repräsentativen Studie bestätigte sich dieser Befund.

- Worin liegen Ihrer Meinung nach die Hauptgründe dafür, dass ein Teil der Bürgerinnen und Bürger die Energiewende als ungerecht empfindet?
- Glauben Sie, dass sich diese Gründe zwischen der Bevölkerung in der Stadt und auf dem Land unterscheiden? Wenn ja, warum und inwiefern?

3. Spannungsfeld Stadt-Land

In NRW ist das Phänomen der Schrumpfung bestimmter Städte zu beobachten (z.B. Ruhrgebiet) wie auch das Phänomen eines (moderaten) Bevölkerungswachstums bzw. -zuzugs in bestimmten Regionen (z.B. Köln). Dies hat auch Auswirkungen auf Lebens- und Verhaltensweisen der Bürger.

- Inwieweit stellen diese Urbanisierungstrends Herausforderungen an die Umsetzung der Energiewende?
- (Erläuterung bei Nachfrage: z.B. demografischer Wandel, Digitalisierung, veränderte Mobilitätspraxis)
- Sehen Sie Wechselwirkungen zwischen diesen Trends? Wenn ja, welche? Und wie könnte man diesen begegnen?
- Welche grundlegenden Unterschiede in Bezug auf die Akzeptanz/Wahrnehmung der Energiewende ergeben sich, wenn man entweder in einer Stadt wie Bochum oder Köln oder in einem Dorf wie Bad Berleburg wohnt?
- Was erwarten Sie von den Bürgerinnen und Bürgern Bochums/ Bad Berleburgs, um die Umsetzung der Energiewende zu befördern?
- Was erwarten Sie von Organisationen der Zivilgesellschaft, um die Umsetzung der Energiewende zu befördern?
- Wie kann die Politik (welche Ebene? Lokal, regional, BRD/EU) Sie dabei unterstützen?
- Was müssen Politiker Ihrer Ansicht nach tun, um den Herausforderungen an die Umsetzung der Energiewende gerecht zu werden?
- Welche Wünsche haben Sie an die Zusammenarbeit mit
    - Der Politik auf den unterschiedlichen Ebenen?
    - Den Bürgerinnen und Bürgern?
    - Zivilgesellschaftlichen Organisationen?

4. Vernetzung und Food-Energy-Water Nexus

Die Energiewende ist kein reines Energieprojekt, sondern hat ebenfalls Auswirkungen auf andere Politikfelder, wie die Landwirtschaft oder die Umwelt. Sie steht damit in einem größeren Zusammenhang mit Fragen zur Nutzung und zum Management unterschiedlicher natürlicher Ressourcen. Dies betrifft Aspekte, wie die Landnutzung für Energiepflanzen und damit einhergehende Flächenkonkurrenzen oder den Wasserverbrauch zur Kühlung von Kraftwerken.

- Sind Sie der Ansicht, dass die Wechselwirkungen zwischen diesen natürlichen Ressourcen in der Bevölkerung bekannt sind und wieso sind Sie dieser Ansicht?
- Was können Politik und Verwaltung hier unterstützend tun?
- Welche Effekte hätte es Ihrer Meinung nach, wenn die Energiewende von der Bevölkerung insgesamt in einem größeren Zusammenhang mit der Nutzung natürlicher Ressourcen gesehen würde?

Der Food-Energy-Water Nexus ist ein Konzept, das Zusammenhänge zwischen unterschiedlichen natürlichen Ressourcen in den Vordergrund rückt. Es ist damit ein Konzept, das auf eine stärkere Politikintegration der oben genannten Politikfelder abzielt, um Synergien besser zu nutzen und Zielkonflikte zu vermeiden.

- Glauben Sie, dass Wechselwirkungen zwischen den drei Bereichen in der aktuellen Politikgestaltung ausreichend berücksichtigt werden?
- Wie und auf welcher Ebene (lokal, regional, BRD/EU) könnte dies verbessert werden? Welche Instrumente sind Ihrer Meinung nach geeignet, diese Wechselwirkungen zu berücksichtigen?
- Worin liegen Ihrer Meinung nach die größten Herausforderungen bei der Integration dieser Bereiche?
- Spielen die Wechselwirkungen eine Rolle bei Ihrer täglichen Arbeit? Welche Erfahrungen haben Sie im Austausch mit Behörden, Ämtern und Ministerien der jeweiligen Politikfelder?
- Was stellen Sie sich unter einem integrierten Management dieser drei Politikbereiche vor