# Analysing the Climate-Energy Nexus

*Lisa Sanderink, Institute for Environmental Studies (IVM), VU University Amsterdam*
*Prof. dr. Philipp Pattberg, Institute for Environmental Studies (IVM), VU University Amsterdam*
*Oscar Widerberg, Institute for Environmental Studies (IVM), VU University Amsterdam*



*Abstract*

The Paris Agreement and the 2030 Agenda highlight the importance of an integrated approach to multiple problems to effectively pursue a sustainable future. Particularly climate mitigation and energy play a crucial role in reaching the sustainable development goals. Climate change forms a major threat to poverty alleviation and food security, and energy is key to the functioning of modern society. Consequently, there is much to gain from a closer study on the interactions between the climate and energy challenges. This research does so by structuring the so-called "nexus" between global climate and energy governance. Following the Online Oxford Dictionary, this paper defines the nexus, from the global governance perspective, as "a series of interactions linking two or more governance domains, and the governance institutions involved." The possible interactions are derived from a thorough literature review on interactions, also referred to as interconnections or interlinkages, and complemented by an extensive analysis of the institutional structure of the governance domains, and official documents of the governance institutions. The result is a detailed mapping of the climate-energy nexus and the multiple interactions occurring at different levels. Structuring the nexus in this manner enables the search for potential conflicts and seizing opportunities, which need to be resolved or optimised to ensure a transition to a sustainable future worldwide.

## 1 Introduction

Global environmental governance frameworks such as the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC) and the Sustainable Development Goals (SDGs), increasingly recognise the interconnectedness between different issue areas. For example, clean water is crucial for healthy lives and well-being, and high quality education plays an important role in ensuring productive employment and decent work for all. A particularly important interconnection for reaching the SDGs is the 'climate-energy nexus', comprising of institutions that address energy provision while also contributing to greenhouse gas reduction. It recognises that while energy access is key to lift people out of poverty, climate change is also exacerbating poverty-related problems such as food security in many vulnerable regions of the world. Consequently, an integrated approach to addressing these issues simultaneously is needed.

In this paper we discuss the emerging literature on interconnections between different issue areas, zooming in on the 'climate-energy nexus'. While the nexus concept is gaining increasing prominence in academic and policy circles, other concepts have also been created to promote integrated problem-solving and cross-sectoral approaches. For example, the idea of an "integrated earth system" (Griggs et al. 2013; Young et al. 2014) and the concept of "planetary boundaries" (Rockström et al. 2009; Steffen et al. 2015) have also supported this. In addition, policy and governance studies, for example on "environmental policy integration" (Lafferty and Hovden 2003; Jordan and Lenschow 2010), institutional interactions and regime interplay (Young 1996; Stokke 2001; Oberthür and Gehring 2006a), have stressed the urgency of integrated policy- and decision-making.

While the idea of a nexus has created new impetus for debates on integrated problem-solving and cross-sectoral approaches (Boas et al. 2016, 461), there is no commonly accepted definition, nor is it clear how the concept can be applied. Currently most efforts present a framework to systematise interconnections (Bizikova et al. 2013) and focus on a technical assessment of them to inform decision-makers on how to enhance synergies and prevent potential trade-offs (Biggs et al. 2015). However, strong institutions and institutional interactions also play a significant part in effectively addressing a nexus, and an approach to the nexus from the governance perspective is lacking.

This paper applies and tests a conceptualisation of the governance nexus between climate and energy, here referred to as the 'climate-energy nexus'. It starts from a definition provided by the Online Oxford Dictionary, which defines a nexus as *"a connection or series of connections linking two or more things"*.[1] From the global governance perspective this would imply that a governance nexus is a series of interactions linking two or more governance domains, and the governance institutions involved. This series of interactions is derived from a comprehensive literature review of nexus studies, comparable concepts, and case-studies and typologies of interactions, also often referred to as interconnections, interplay or interlinkages. Therewith, the proposed framework is a synthesis of existing approaches to the nexus and institutional interactions. Following the systematising approach that plays an important role in most assessments of a nexus, this paper also proposes systems analysis to structure and fully comprehend the climate-energy nexus. Structuring it this way facilitates the search for potential conflicts and seizing opportunities that need to be resolved or optimised, in order to promote policy interaction and governance integration in the climate-energy nexus, and to achieve a successful transition towards sustainable development.

# 2 Reviewing the 'nexus'

## 2.1 Introducing the 'nexus'

The word 'nexus' is increasingly used by scientists, policy-makers as well as by actors from civil society and the private sector to describe interconnected environmental problems (Cairns and Krzywoszynska 2016). With the introduction of the Sustainable Development Goals (SDGs) in 2015, the interlinkages between the world's challenges are increasingly being emphasised. The general idea is that issue areas

[1] https://en.oxforddictionaries.com/definition/nexus *(accessed: 08-11-2016)*

are often interrelated, so to effectively address them, they should be considered as such (Hoff 2011). A nexus-approach is necessary to reduce unintended trade-offs and optimise synergies, and promote policy coherence and decision-making.

The concept of the nexus started to gain prominence in 2008 at the World Economic Forum (WEF), which stressed the strong interlinkages between water, food, energy and climate. Thereafter, the word appeared at high-level workshops, seminars and conferences, such as the Bonn 2011 Conference, the Sixth World Water Forum in Marseilles in 2012 and the Rio+20 negotiations (Allouche et al. 2015). The term often appears in conjunction with water, energy and food, also referred to as the "resource nexus" (Biggs et al. 2015; Bazilian et al. 2011). However, it has rightfully been pointed out that the issue of climate change further aggravates these issues and amplifies their relations, so should also be linked (Allouche et al. 2015; Hoff 2011). In addition, even though to a lesser extent, the concept has been applied on other sustainable development topics, such as health, poverty, gender and education (Clancy et al. 2002; Iguchi et al. 2014; Kitamura et al. 2014).

Although the nexus is compelling and promising in terms of advancing current sector-focused governance of global challenges, the concept is not yet clearly understood, particularly not with regard to how it should be applied (Rasul and Sharma 2016). Currently, most efforts are developing frameworks to provide an informed and transparent approach to the nexus, building on a system perspective (Bizikova et al. 2013, 10). This implies that instead of analysing the smaller parts of a system separately, the interactions between these parts are studied as a larger system (Aronson 1996). Most studies do so by identifying, demonstrating and modelling crucial interactions, and thereafter applying systems thinking to inform decision-making (Bazilian et al. 2011). They have mostly been focussing on a technical assessment of the interactions (Biggs et al. 2015), such as the strong correlation between the price of crude oil and the Food Price Index of the UN Food and Agricultural Organisation (Allouche et al. 2015). However, to account for trade-offs and to optimise synergies, appropriate policy development and strong governance institutions are also of great importance. Therefore, there is much to gain from an exploration of the governance nexus. It is likely to provide insights into increasing effectiveness and enhancing interactions and cooperation in overlapping governance domains.

## 2.2 Physical and institutional interlinkages between global environmental issues

The natural sciences increasingly use new concepts to describe the functional interlinkages between different environmental problems. The concept of an "integrated earth system" (Griggs et al. 2013; Young et al. 2014), for example, suggests that current human development is affecting our planet and its natural capital in an unsustainable manner. To secure a stable functioning of large ecosystems such as oceans, forests and biodiversity, a "multi-layered approach" is necessary (Young et al. 2014). Similarly, the "planetary boundaries" concept has expressed critique on the effects of continued human development on the earth's systems (Rockström et al. 2009; Steffen et al. 2015). Planetary boundaries are *"scientifically based levels of human perturbation of the earth system beyond which the earth system's functioning may be substantially altered"* (Steffen et al. 2015, 736). These boundaries, or in other words, environmental processes interact, and should therefore be addressed simultaneously. The boundaries provide a safe operating space for humanity that informs decision-makers about the trade-offs that need to be dealt

with in order to guide sustainable human development. Among these boundaries, climate change is seen as a "core" planetary boundary recognising its fundamental importance for the earth's system (Steffen et al. 2015).

The discovery of physical interactions between ecosystems and environmental processes have prompted governance scholars to suggest integrated approaches to environmental policy-making. For instance, there are scholars who focus on "environmental policy integration" (Lafferty and Hovden 2003; Jordan and Lenschow 2010). The argument here is that environmental objectives should be integrated into all stages of policy-making in non-environmental policy-sectors, because of the interdependent relation between environmental protection and human development. Even though different interpretations exist on environmental policy integration, it is seen as an important principle to guide sustainability (Lenschow 2002). In addition, in international relations literature scholars have long been analysing interlinkages and interplay between different institutions or regimes addressing differing issue areas (Young 1996; Stokke 2001; Oberthür and Gehring 2006a). The main argument is that intricate connections between different issue areas exist, causing international institutions and/or regimes that address these to interact. Accordingly, as of the late 1990s scholars started studying these interactions through case-studies and categorisations of different types of institutional interactions and regime interplay. Extensive empirical work was carried out analysing the interactions between trade arrangements and environmental agreements (Brewer 2003; Charnovitz 2003; Zelli and Van Asselt 2010). Yet, few scholars have examined the institutional interactions between climate and energy institutions, despite the evident interconnection between energy consumption and production and the issue of climate change.

# 3 Conceptual framework

Approaching the nexus from the governance perspective involves a set of conceptual decisions. In this section, we outline the most important definitions and our understanding of key concepts including: global governance, domains and institutions; interactions; and systems thinking.

## 3.1 A Global Governance perspective

The nexus-concept has been introduced and has gained favour in the sustainable development debate. More specifically, the introduction of the SDGs in 2015 has further stimulated the nexus concept. The SDGs are part of a partnership that is globally oriented; the issues to be addressed are transboundary and need to be governed at an international and global level. Consequently, the conceptualisation provided in this paper is formulated from the global governance perspective. In line with Boas et al. (2016), this paper defines the nexus using the Online Oxford Dictionary as *"a connection or series of connections linking two or more things"*.[2] Putting this definition in a governance perspective, the nexus could be considered as "*a series of interactions linking two or more governance domains, and the governance institutions involved*".

Although in the late 1990s *global governance* became a key term in academic and policy debate, a clear definition of the term remains disputed (Biermann and Pattberg 2012). For this research the following conceptualisation by Sovacool and Florini (2012) will be followed. The term *governance* addresses *"the*

[2] [2] https://en.oxforddictionaries.com/definition/nexus *(accessed: 08-11-2016)*

*processes, systems and actors involved in addressing collective problems that individuals and markets cannot solve for themselves, as well as enforcing rules"* (Sovacool and Florini 2012, 237). Governance is seen as *global* when it deals with cross-border issues, causing multiple states and actors from different countries to be involved in problem-solving.

There are several transboundary issues that require collective action on a global scale, including climate change and energy. The global institutional structures addressing these issues are in this research referred to as *governance domains*. This terminology is preferred over issue areas or policy domains, where the emphasis lies with the issue or with the policy-making process respectively, whereas this research rather focuses on governance of these issues including all myriad activities and entities.

Within these governance domains the *governance institutions* are located, who aim to govern and address the issue at hand. The institutions that are included in this research can be defined as organisations that govern climate change and energy, which implies that they aim to globally steer behaviour of their members, that they mention a common governance goal and have identifiable governance functions (Widerberg et al. 2016, 9).

The governance goal in the climate-energy nexus can be divided into two elements: climate change and energy. The first element refers to the mitigation of climate change, and more precisely, stabilising greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system. In other words, the internationally accepted 1.5 degrees target, derived from the UNFCCC and the recently concluded Paris Agreement. The second element refers to the proposition that effective action in the energy sector is essential to tackling the climate change issue. Under effective action is included supporting the uptake of renewables, developing methods to put a price on and trade carbon, and supporting increased energy efficiency. In addition the development of clean technologies, improving energy access and security, increasing the use of low-carbon technologies and alternative fuels in the transport sector, and reforming harmful fossil fuel subsidies. In short, the governance in the climate-energy nexus entails the mitigation of climate change through a transformation of the conventional energy system. Finally, identifiable governance functions are setting up standards and commitments, exchanging information and networking, financing and operational functions.

## 3.2 Interactions

In the most basic sense, an interaction is *"reciprocal action or influence"*[3]. Interactions in the global governance domain are not a new avenue for research. Particularly interactions between institutions and regimes have been studied extensively, also referred to as institutional interlinkages and regime interplay respectively. Following a definition provided by Gehring and Oberthür (2006a), interactions refer to situations in which one governance institution ("source institution") affects the development or performance of another governance institutions ("target institution").

First of all, there can be a *biophysical interaction*. This interaction is derived from the concepts of "integrated earth system" and "planetary boundaries", which stress the limits of the planet's natural

[3] https://en.oxforddictionaries.com/definition/interaction *(accessed: 12-04-2017)*

capital and the interactions between them (Griggs et al. 2013; Steffen et al. 2015). These are physical and biological interactions between the environmental issues or processes to be addressed. An example is the link between natural energy flows and oceans: the distribution of energy by latitude over land and sea surfaces has a big influence on the circulation of oceans (Steffen et al. 2015). Such a biophysical interaction often forms the foundation for interactions on a more detailed level, between institutions: institutional interactions.

A second type of interaction, which is also seen as a driving force for institutional interactions, is defined by Young (2002) as a functional interaction. This type occurs in situations where there is overlap or competition in terms of the purpose for which governance domains and institutions are designed. For example, when the issue of climate change influences our energy choices. Such an interaction is a fact of life and it occurs "whether we like it or not" (Young 2002, 23).

Thirdly and on the contrary, Young (2002) has defined *political interactions* as driving forces. In this case the interactions are politically induced and a result of human decision-making. For example, when domestic policies require a continuation of the extraction of natural gas, while the resulting earthquakes threaten human rights of the residents, living near to the gas drilling locations.

Scholar Young (1996: 2-6) was also among the first to study the interactions on a more detailed level, institutional interactions, and to provide a categorisation. It includes, first of all, institutions embedded in the principles and practices of the international society. For example, many international treaties are based on the international principle that all states own exclusive authority over domestic affairs and enjoy sovereign equality in their dealings with others (Young 1996: 3). The second category involves institutions nested in a broader institutional framework, such as substantive protocols to set forth framework conventions. An example is the integration of several protocols into the 1979 Convention on Long-Range Transboundary Air Pollution (Young 1996: 4). The third is referred to as clustered institutions, which are deliberately combined into one institutional package. A striking case in point here is the 1982 UN Convention of the Law of the Sea (UNCLOS), which combined a set of functionally differentiated arrangements for navigation, fishing, mining, research etcetera (Young 1996: 5). The fourth and last category includes overlapping institutions, which are institutions formed for different purposes, though intersecting each other on a de facto basis (Young 1996: 6). This interaction is often unforeseen and unintended, and therefore can be compared to the functional interaction described above.

Thereafter, a different typology was introduced by Stokke (2001: 10), who characterised interactions as utilitarian, normative and ideational. *Utilitarian interactions* refer to regimes or institutions affecting the costs and benefits of the behavioural options of another. Stokke (2001) provided the example of a Norwegian-Russian nuclear cooperation regime, which provided funds for the enhancement of a treatment facility for radioactive waste. These funds removed an obstacle in Russia's implementation of the ban on nuclear dumping in the London Convention 1996 (Stokke 2000). *Normative interactions* occur when institutions confirm or reject the norms of the other institution. For example, the potential incompatibility of trade restrictive measures under the Kyoto Protocol and the World Trade Organisation's (WTO) principles for free trade (Van Asselt 2014). Last but not least, *ideational interactions* refer to situations in which regimes or institutions influence each other through learning processes,

information and ideas. The diffusion of the precautionary principle exemplifies this interaction: it was introduced in the Vienna Convention for the Protection of the Ozone layer (1985) and then endorsed in the Rio Declaration (1992) (Stokke 2001).

Finally, Oberthür and Gehring (2006a) provided a framework to analyse the causal mechanisms of institutional interactions. The scholars distinguished among cognitive interactions, interactions through commitment, behavioural interactions and impact-level interactions. *Cognitive interactions* occur when institutions intentionally or unintentionally exchange knowledge and ideas. *Interactions through commitments* refer to overlapping or conflicting normative commitments. The third interaction, *behavioural interaction*, implies that the behavioural change triggered by one institution, affects the performance of another. For example, when the Kyoto Protocol created incentives to plant fast-growing trees, which has an adverse effect on biodiversity. The incentives and the change in behaviour in this case undermined the performance of the Convention on Biological Diversity (Jacquemont and Caparrós 2002). Finally, an *impact-level interaction* refers to the interdependence of the targets of different institutions. As an example, the World Trade Organisations is known for promoting economic growth, which as a side-effect resulted in the growth of international transport. This led to an increased level of greenhouse gas emissions, having a negative effect on the progress of the UNFCCC.

The interactions described above are derived from different studies and categorisations, having different focuses. Though based on the following conclusions and assumptions, it was possible to create a streamlined overview of different types of interactions (see table 1). First of all, reviewing the categorisations led to the conclusion that some types show similar characteristics. The normative interaction defined by Stokke (2001) is similar to the interaction through commitment, which has also been recognised by Oberthür & Gehring themselves (Oberthür and Gehring 2006b). Both refer to overlapping or competing norms and commitments. The same holds for the ideational interaction by Stokke (2001) and the cognitive interaction by Oberthür & Gehring (2006a), which are both related to learning processes and the diffusion of information and ideas. A third overlap was found comparing overlapping institutions (Young 1996) and utilitarian interactions (Stokke 2001), with impact-level interactions (Oberthür and Gehring 2006a). These three all focus on the unintentional intersection of the institutions' ultimate targets and impacts. The overlapping types are combined under the most recent heading: interaction through commitment, cognitive interaction and impact-level interaction.

Secondly, there can be made a distinction between the levels at which these interactions occur, based on the objects of interaction: the governance domains and institutions. The level at which the interactions between governance domains occur is referred to as macro-level, while those between the governance institutions are at the micro-level. In addition, the interactions differ in terms of intentionality. For example, whereas functional interactions are by nature unintentional, political interactions are forced and therefore intentional.

A third distinction can be made between the focuses of the interactions: they form a driving force for further interactions or focus on the causal mechanism. Interactions do not emerge out of thin air, therefore the assumption is that there is always a particular link between the governance domains that is at the root of institutional interactions. Biophysical, functional and political interactions form these

driving forces. Based on these, institutional interactions occur, which can affect institutions in different ways, or rather through different causal mechanisms. Stokke (2001) and Oberthür and Gehring (2006a) clearly emphasise these different causal mechanisms: learning processes, behavioural change and normative commitments.

However, for the types described by Young (1996) it is more difficult to determine the focus. International regimes and more specifically treaties, were the object of Young's study, though it is commonly known that global governance is no longer dominated by state entities and hard law. Therefore, it is argued here that the types of interactions should be viewed more broadly and redefined. This implies that embedded institutions refer to institutions that are embedded in the principles and practices of an overarching institution. In addition, nested institution are restricted in terms of scope, domain and criteria of, though at the same time reinforce, a broader institutional framework. Finally, clustered institutions are, similar to the original definition, combined into institutional packages. Therewith, these types of interactions describe three ways of institutional clustering as a causal mechanism.

A final distinction can be made in terms of effect. The previously described interactions affect the development and performance of the governance domains and institutions, and hence the effectiveness of the nexus as a whole. This effect can be either conflictive, synergistic or neutral. Simply put a conflict arises when the interaction has a negative effect on the development and performance of the governance domain and the governance institutions involved. On the other end of the continuum are the synergies. These are often not a subject of extensive debates, as positive effects are often accepted without further action (Oberthür and Gehring 2011). A synergy involves a situation in which the policy direction of one institution is supported by the measures and rules of another (Oberthür and Gehring 2006a, 46). Last but not least, interactions do not necessarily disrupt or reinforce the development or performance of the other governance domain or institution. If that is the case the interactions can be characterised as indeterminate and have neutral effects (Gehring and Oberthür 2008).

Last but not least, it is important to note that these types of interactions are not exclusive and exhaustive. Additional interactions to consider are for example financial, discursive or geographical interactions. However, in terms of relevance these are probably case specific and can be only be found throughout the process of studying particular interacting governance domains and institutions.

| Level of Interaction: | Type of Interaction: | Source: | Intentionality: | Description: | Focus: | Potential effect: |
|---|---|---|---|---|---|---|
| Macro-level & | **Biophysical interaction** | Young et al. 2014; and Steffen 2015 | Unintentional | Physical and biological interaction between the issues at the centre of the governance domains. | Driving force | Conflict, Synergy, Neutral |
| Macro-level & Micro-level | **Functional interaction** | Young 2002 | Unintentional | Overlap or competition in terms of purpose for which governance domains evolve or institutions are designed. | Driving force | Conflict, Synergy, Neutral |
| Macro-level & Micro-level | **Political interaction** | Young 2002 | Intentional | Interaction as a result of political decisions. | Driving force | Conflict, Synergy, Neutral |
| Micro-level | **Embedded institutions** | Young 1996 | Intentional | Institutions embedded in the broader principles and practices of an overarching institution. | Causal mechanism: institutional arrangements | Synergy, Neutral |
| Micro-level | **Nested institutions** | Young 1996 | Intentional | Institutions restricted in terms of functional scope, geographical domain, or other criterion folded into a broader institutional framework. | Causal mechanism: institutional arrangements | Synergy, Neutral |
| Micro-level | **Clustered institutions** | Young 1996 | Intentional | Several institutional arrangements combined into institutional packages. | Causal mechanism: institutional arrangements | Synergy |
| Micro-level | **Cognitive interaction (or: ideational interaction)** | Oberthür & Gehring 2006; and Stokke 2001 | Unintentional/ Intentional | Interaction based on learning processes and diffusion of knowledge and ideas. | Causal mechanism: learning process | Synergy |
| Micro-level | **Interaction through commitment (or: normative interaction)** | Oberthür & Gehring 2006; and Stokke 2001 | Unintentional/ Intentional | Overlapping or competing rules, norms or principles. | Causal mechanism: rules, norms and principles | Conflict, Synergy |
| Micro-level | **Behavioural interaction** | Oberthür & Gehring 2006 | Unintentional/ Intentional | Interaction through behavioural change. | Causal mechanism: behavioural change | Conflict, Synergy |
| Micro-level | **Impact-level interaction (or: utilitarian interaction & overlapping institutions)** | Oberthür & Gehring 2006; and Stokke 2001; Young 1996 | Unintentional | Unintentional intersection of ultimate targets and impacts. | Causal mechanism: ultimate targets and impacts. | Conflict, Synergy |

Table 1 Overview of different types of interactions that constitute a nexus (own assessment: April 15, 2017)

### 3.3 System wise perspective

The governance nexus involves many interactions and different types of institutions and actors. According to Harrison (2006), these are the characteristics of a complex system. To comprehend the nexus as a complex system, this paper proposes systems thinking. While most analyses focus on separating and analysing the different parts that make up a system, this approach zooms in on the interactions between the constituents of the system (Aronson 1996). This implies that the systems approach to the nexus zooms in on the interactions between the governance domains and institutions, as part of the system. This helps to make sense and cope with the complex situations that evolve within the system (Cabrera et al. 2008).

Such an approach involves three important components: the elements, interactions and a function or purpose (Meadows 2008). Applied to the governance nexus, the elements are the governance domains and institutions, and the interactions can be distinguished among the different types described in the previous section (table 2). The function or purpose of the governance nexus is to address the issues at the centre of the governance domains that overlap.

The table below shows the three key components applied to the climate-energy nexus. The elements are, first, the climate change and energy governance domains. Second, the governance institutions that govern climate change and energy. A definition of such governance institution is provided in section 3.1. In addition, the interactions can be distinguished according to table 1 above. Last but not least, the common governance goal of the climate-energy nexus is seen as the function or purpose of the nexus as a system, also specified in section 3.1.

| The three key components of the climate-energy nexus as a system based on Meadows (2008): | |
|---|---|
| **Elements:** | • Governance domains: the institutional structures addressing and governing a particular issue.<br>  o Climate change domain<br>  o Energy domain<br>• Governance institutions: organisations that govern climate change and energy, which implies that they aim to globally steer behaviour of their members, that mention a common governance goal and have identifiable governance functions. |
| **Interactions:** | • Macro-level:<br>  o Biophysical interactions<br>  o Functional interactions<br>  o Political interactions<br>• Micro-level:<br>  o Functional interaction<br>  o Political interaction<br>  o Embedded institutions<br>  o Nested institutions<br>  o Clustered institutions<br>  o Cognitive interaction<br>  o Interaction through commitment<br>  o Behavioural interaction<br>  o Impact-level interaction |
| **Function or purpose:** | • Governance goal:<br>  o Address climate change through a transformation of conventional energy systems. |

Table 2 The three key components of a system according to Meadows (2008) applied to the climate-energy nexus (own assessment: April 15, 2017)

Applying the systems approach includes a set of steps (Arnold and Wade 2015). The first is to identify the elements. The second step is to identify the interactions and to understand the feedback loops, causes and effects, which impact the effectiveness of the system as a whole. Based on the previous steps, the

third and final step is to understand the structure of the system. These three steps support this first attempt to conceptualise a governance nexus and to test it on the climate-energy nexus. Further steps are possible, for example to identify non-linear interactions, dynamics within the systems and to study the system at different scales (Arnold and Wade 2015). However, considering the complexity of these steps and the first attempt to conceptualise and systematise a governance nexus, only these first three steps will be applied and described in the next section.

# 4 Analysing the Climate-Energy Nexus

## 4.1 Identifying the elements

The first step of applying the systems approach is to identify the elements. As stated in section 3.3 these are the climate and energy governance domains and the governance institutions involved. To identify the latter it is necessary to first map the institutional structure of the climate-energy nexus. For this purpose the CLIMENGO database and mapping is used.[4] This process included two steps. First, the compilation of the database, which includes all governance institutions active in the climate-energy nexus. Second, to visualise the institutions using the heuristic of the governance triangle, developed by Abbott and Snidal (Abbott and Snidal 2009a; 2009b; Abbott 2012).

The criteria for inclusion and exclusion are based on the CONNECT project, which includes institutions that are (i) international or transnational, which not only have (ii) the intentionality to steer policy and the behaviour of their members or a broader community, but also explicitly mention the (iii) common governance goal, accomplishable by (iv) significant governance functions (Widerberg, Pattberg, and Kristensen 2016, 9). The governance goal is described in section 3.1, which entails the mitigation of climate change through a transformation of the energy system.

Four sources were used to populate the CLIMENGO database on the climate-energy nexus. First, all the initiatives related to energy in the CONNECT project's database were assessed and integrated into the CLIMENGO database (Widerberg, Pattberg, and Kristensen 2016). Second, the CONNECT data was complemented with a list of institutions proposed by the Swedish Energy Agency. Third, three online databases were assessed including the Non-State Actor Zone for Climate Action (NAZCA, http://climateaction.unfccc.int/), the Climate Initiatives Platform (http://climateinitiativesplatform.org), and the Portal on Cooperative Initiatives (http://unfccc.int/focus/mitigation/items/7785.php) (Widerberg and Stripple 2016). Fourth, to validate and make sure no energy related initiatives were overlooked, especially since the foregoing sources departed from the climate governance silos, we reviewed literature on previous mappings of global energy governance (Suding and Lempp 2007; Kerebel and Keppler 2009; Van de Graaf et al. 2010; Sovacool and Florini 2012; Colgan et al. 2012; Leal-Arcas and Filis 2013; Wilson 2015; Escribano 2015).

[4] *The CLIMENGO project is project, funded by the Swedish Energy Agency, which aims to map the institutional complexity of global climate and energy governance, to evaluate its effectiveness and legitimacy, and to develop a knowledge base for decision-makers. For more information please visit www.climengo.eu*

The collection resulted in a global governance architecture of the climate-energy nexus, comprising 108 institutions (final cut: April 4, 2017). The institutions are visualised in the governance triangle in figure 1.

Within this triangle, the institutions are situated in the triangle according to the institutions' constituent actors, being public, firm and civil society organisations (CSOs). The public category includes individual states, groups of states, international organisations (IOs), cities or regions. The firm-category signifies businesses, groups of firms, industry associations and investors. Finally, CSOs include non-governmental organisations, other organisations that represent civil society and networks and coalitions of CSOs.

Based on these three actor categories the triangle is divided into seven zones. Governance initiatives in zones 1-3, the vertex zones, are led by a single type of actor. Those in zones 4-6, the quadrilateral zones, include two types of actors. Finally, the initiatives in the central zone 7 are the ones that involve all three types. On top of that, the greyscale defines the nature of government involvement - public (public institutions are dominant), private (firms and CSOs are dominant), and hybrid (governance is shared by governmental agencies and firms and CSOs).

The data demonstrates that public agencies are involved in 78 arrangements (72%) of which 48 are purely public. The private tier (zone 2, 3 and 6) includes a total of 30 governance arrangements (28%). Firms, businesses and investors are part of 51 initiatives (47%), of which 17 are purely firm-led. This leaves the majority of initiatives (34) to be collaborations between firms, public authorities or CSOs, or both. CSOs are involved in 35 governance arrangements (32%), of which 7 initiatives include CSOs exclusively.

Finally, the role of each initiative is highlighted by using colours. First of all, standards & commitments is colour coded in red and refers to rule-making and implementation schemes, involving mandatory compliance, standards for measurements and disclosure, and voluntary and private standards and commitments. The second role, operational activities, is coloured in yellow and comprises of, for example, technology research and development, pilot projects, demonstration and deployment activities, skills enhancement, and best practices. Thirdly, information & networking, which is coded green, encompasses information-sharing forums and networking, such as technical consulting, training and information services to build capacity, share knowledge and to support local governments. The fourth and final role of financing refers to a specific type of operational activity and is colour coded green.

'Information and networking' is by far the most common role with 39 occurrences. The second most common role is the combination of 'information and networking' and 'operational' activities, which occurs in 27 governance arrangements. 'Information and networking' is clearly the preferred way to govern climate and energy. Further research is necessary to answer questions related to why and to whether it is the way to go. Furthermore, 19 instances involve 'standards and commitments' and 8 are combining 'standards and commitments' with 'information and networking'. It is noteworthy that not one initiative is taking on the combined roles of 'standards and commitments' and 'financing' or 'operational' and 'financing'.

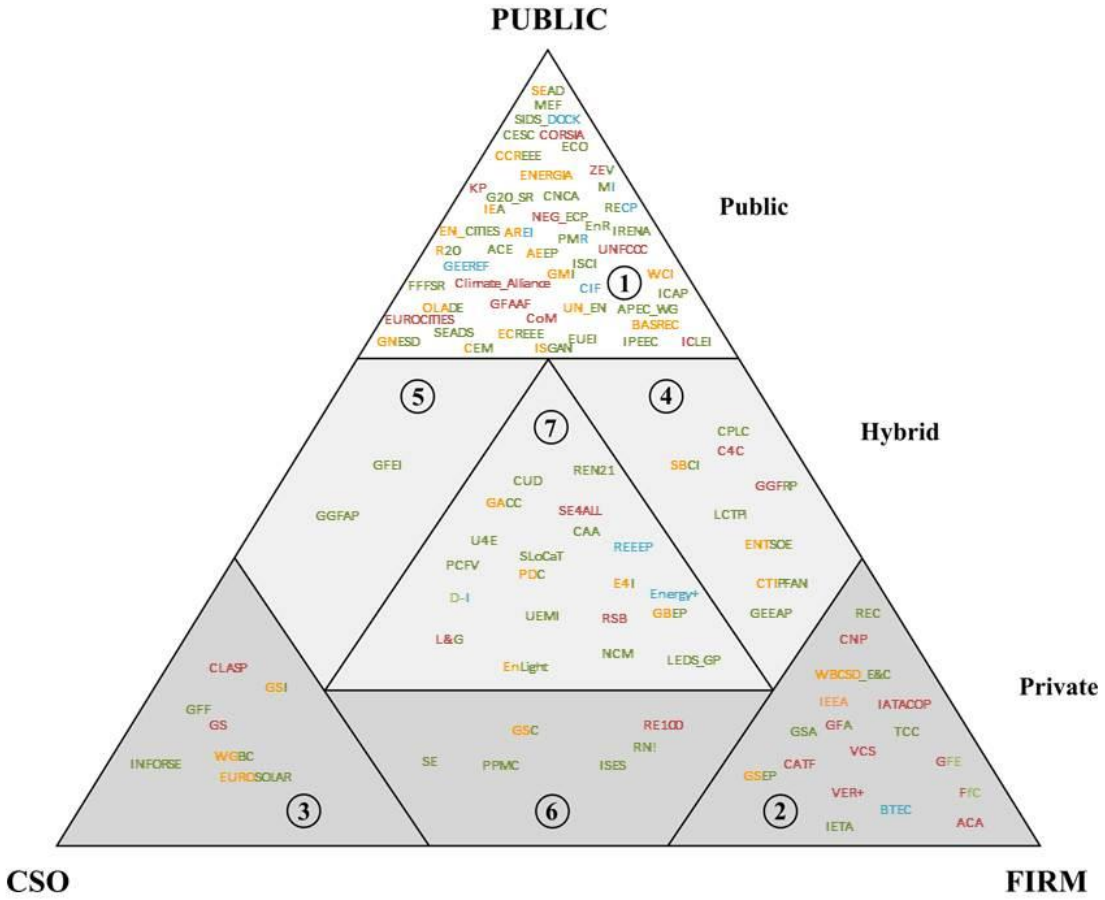


Figure 1 The CLIMENGO project climate-energy nexus governance triangle (based on Abbott & Snidal 2009a, 2009b, and Abbott 2012)(Sanderink et al. 2017)

## 4.2 Identifying the interactions

The second step is to identify the interactions and to understand the feedback loops, the causes and effects. The interactions can be identified according to the types described in section 3.2 and each type is tested in the climate-energy nexus. This implies that the next sections provide a first glance at the interactions in the climate-energy nexus.

### 4.2.1 Macro-level

As stated in section 3.2 interactions can occur on two levels. Starting with those on the macro-level, this section stresses the driving forces based on which institutional interactions evolve.

#### *4.2.1.1 Biophysical interaction*

Biophysical interactions include physical and biological interactions between the issues, or environmental processes, at the centre of the governance domains. For the climate-energy nexus these are climate change and energy. The International Energy Agency estimated that in 2015, two thirds of all anthropogenic greenhouse gas (GHG) emissions originated from fossil fuel use in the energy sector (IEA 2015, 20). This is a clear biophysical interaction: fossil fuel use in the energy sector results in an increased

level of GHG emissions, which causes climate change and the temperature to rise. The effect is a disruption, as it negatively influences the world's climate system.

#### *4.2.1.2 Functional interaction*

Functional interactions refer to situations in which there is overlap or competition in terms of the purpose or issue for which the governance domains are designed. Such interactions are unintentional and occur "whether we like it or not" (Young 1996, 23). The climate and energy governance domains functionally interact in the way that the issue of climate change influences the society's energy choices, which is an unintended effect. For example, in warmer climates more electricity will be used for air conditioning instead of gas, oil and wood for heating, and due to more precipitation and glacier melt, the use of hydropower could increase in Northern parts of Europe, while it could decrease in Southern regions due to droughts. This interaction can have positive and negative effects, and is therefore here categorised as having a neutral effect.

#### *4.2.1.3 Political interaction*

Political interactions refer to situations in which the interaction is the result of a political decision, which are of course intentional. As with the previous example, climate politics influence our energy choices as well. For example, international agreements such as the UNFCCC, unintentionally affect the way costumers use energy services and from which source the supplier takes the energy. The Paris Agreement was an important contributor to the unprecedented progress made in the renewable energy domain, in which renewable power capacity increased and significant cost reductions occurred (OECD/IEA 2016). This is a clear example of a political interactions having a synergistic effect, benefitting both governance domains.

### 4.2.2 Micro-level

The interactions described above are fundamental for the institutional interactions on more detailed level, the micro-level. This section provides examples of each type of institutional interaction in the climate-energy nexus.

#### *4.2.2.1 Embedded institutions: AREI and UNFCCC*

Embedded institutions refer to situations in which institutions are embedded in the broader principles and practices part of the international society (Young 1996). As stated in section 3.2 Young's definition mostly focuses on the interactions between international treaties. However, since this paper focuses on global governance including all myriad activities and entities, it applies on a more broader definition: institutions embedded in the broader principles and practices part of another overarching institution. An example of an overarching institution is the UNFCCC, which can be seen as the institutional core of global climate change governance, ratified by almost all nations (Biermann et al. 2009). This convention laid down fundamental principles and objectives for climate governance, for example, the objective "to prevent dangerous interference with the climate system" (article 2). Many governance institutions, including private arrangements, within the climate-energy nexus are embedded in this framework convention and base their practices on the UNFCCC's fundamental principles and objectives. For example the Africa Renewable Energy Initiative (AREI), which explicitly states that it acts according to the principles

of the UNFCCC.[5] The results delivered by AREI complement the effectiveness of the UNFCCC, especially since the AREI deliver additional means to reach the common objective. It is a clear example of an interaction resulting in a synergy.

#### *4.2.2.3 Nested institutions: GEEAP and SE4ALL*

Nested institutions are restricted in terms of functional scope, geographical domain and other criterion, which are folded into a broader institutional framework (Young 1996). Again, this interaction needs to be seen in a broader manner: institutions can be restricted in terms of functional scope, geographical domain and other criterion folded into a broader institutional framework. A well-known example is the Kyoto Protocol nested in the UNFCCC, which implies that the functional scope of the Kyoto Protocol is defined by the norms and principles of the UNFCCC. However, a different interesting case in point is the Global Energy Efficiency Accelerator Platform (GEEAP) embedded in the Sustainable Energy for All (SE4ALL) initiative. The GEEAP is an initiative hosted by SE4ALL, though can be considered as an institution on its own. It is established to help reach the objective of SE4ALL, to double the global rate of improvement in energy efficiency by 2030.[6] Therewith, the GEEAP's functional scope, the geographical domain and more specific criteria are determined by the SE4ALL. The GEEAP reinforces the function of the SE4ALL initiative, implying that the interaction results in a synergy.

#### *4.2.2.4 Clustered institutions: LCTPi*

If institutional arrangements are combined into one institutional package these institutions are referred to as clustered. For example, the Low Carbon Technology Partnerships initiative (LCTPi), an initiative for which the World Business Council for Sustainable Development (WBCSD), the International Energy Agency (IEA) and the Sustainable Development Solutions Network (SDSN) partnered up. The WBCSD and the IEA are included as institutions in the climate-energy nexus and are clustered together in the LCTP, which brings together companies and partners to "accelerate the development of low-carbon technology solutions to stay below the 2 degrees ceiling".[7] It is interesting to note that, therewith, the LCTPi is also embedded in the principles and practices of the overarching institution of the UNFCCC, which indicates it is an embedded institution. Assuming that a decision to combine institutions or to partner up is made for the purpose of increasing the effectiveness, this interaction can only result in synergies.

#### *4.2.2.5 Cognitive interaction: IEA, IRENA and UNFCCC*

In addition, there is a clear example of a cognitive interaction between the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA), which is based on learning processes and knowledge exchange (Oberthür and Gehring 2006a). The IEA voluntarily and unintentionally incorporated the information and ideas produced by IRENA, which influenced the development and performance of the IEA. The IEA, founded in 1974 to coordinate a collective response to the disruptions in oil supply, was mostly known for its focus on fossil fuels and for downplaying the role of renewables. However, the creation of IRENA, serving to promote a sustainable energy trajectory, has led to the IEA widening its portfolio and becoming more actively engaged in renewables (Van de Graaf 2012; Heubaum and Biermann 2015). Consequently, the creation of IRENA and the stream of information about renewables

[5] *More information: http://www.arei.org/ (accessed: 20-04-2017).*
[6] *More information: http://www.se4all.org/energyefficiencyplatform (accessed: 20-04-2017).*
[7] *More information: http://lctpi.wbcsd.org/the-solution/ (accessed: 20-04-2017).*

that came along, has been a great learning curve for the IEA and affected its development and preferences in a positive manner.

A cognitive interaction can, however, also be intentional based on a request by the affected institution. Such an interaction can be found between the IEA and the UNFCCC. In 2012 the IEA and the UNFCCC signed a Memorandum of Understanding, which committed both institutions to closer exchange of information (Heubaum and Biermann 2015). Upon request the IEA now provides its statistics and knowledge on energy systems to inform the UNFCCC secretariat and to support the country delegations part of the UNFCCC. It is a striking case in point with regards to a synergy resulting from an intentional cognitive interaction.

#### *4.2.2.6 Interaction through commitment: UNFCCC and Kyoto Protocol*

As stated, interactions can also occur through commitment, which implies that there are overlapping or competing rules, norms or principles (Oberthür and Gehring 2006a). Such an interaction can result in three situations. Firstly a synergy, if both institutions govern the same issue, with similar objectives and through similar governance instruments. A simple example is the interaction between the UNFCCC and Kyoto Protocol. Secondly a disruption, if both institutions govern the same issue, though pursue differing objectives. So far, no example of an conflictive interaction through commitment was found. Thirdly additional means, when both institutions address the same issue, with similar objectives, but through differing governance instruments. The latter creates the most benefits: it does not only increase the effectiveness of the source institution, it also results in additional means to reach the objectives.

#### *4.2.2.7 Behavioural interaction: FFFSR, IRENA and IPEEC*

Interactions can also be a result of behavioural change: behavioural interactions (Oberthür and Gehring 2006a). The interaction is in this case unintentional, as the behavioural change is a side-effect of the source institutions' practices. An interesting example in the climate-energy nexus is the synergistic interaction between Friends of Fossil Fuel Subsidy Reform (FFFSR), IRENA and the International Partnership for Energy Efficiency Cooperation (IPEEC). The FFFSR is an informal group of countries who partnered up in 2010. The group aims to build political consensus on the importance of phasing out harmful fossil fuel subsidies.[8] According to the FFFSR these subsidies do not only encourage wasteful consumption of energy, but on top of that disadvantage the use of renewable energy and the investments in energy efficiency technologies. The FFFSR phasing out these harmful subsidies triggers a behavioural change, for example an increased use of renewables and use of energy efficiency technologies. Therewith, the behavioural change triggered by FFFSR positively influences the effectiveness of IRENA, but also of the IPEEC, whose objectives are to support a transition towards more renewables and increased energy efficiency respectively.

#### *4.2.2.8 Impact-level interaction: Kyoto Protocol and GNESD*

Last but not least, impact-level interactions refer to situations in which the unintended side-effects of practices by the source institution affect the performance of the target institutions. An interesting example of this interaction lies with the Kyoto Protocol, more specifically the set-up of Clean Development Mechanism (CDM) projects, and the Global Network on Energy for Sustainable

[8] *More information: http://fffsr.org/ (accessed: 20-04-2017)*

Development (GNESD). For developed countries the CDM projects are a way to generate certified emission reduction units to achieve compliance to their emission limitation. The prerequisite was that the projects were to be set up in developing countries in order to support sustainable development. Therefore, the side effects of these CDM projects, for example improving energy access, positively influence the effectiveness of the GNESD, whose main objective is to support energy access and sustainable development in developing countries. A critical note to this example of an impact-level interaction is of course that for some CDM projects danger lurks in terms of human rights violations, resulting in a disruption instead.

## 4.3 Understanding the structure of the system

The third and final step is to understand the structure of the system, for which it is best to map and visualise the elements, the interactions and the effects. The table below provides an overview of the interactions described in the previous sections, which causal mechanisms are involved and which consequences are related.

| Level of interaction: | Objects of interaction: | Type of interaction: | Intentionality: | Effect: |
|---|---|---|---|---|
| Macro | Energy domain → Climate domain | Biophysical | Unintentional | Disruption |
| Macro | Climate domain → Energy domain | Functional | Unintentional | Neutral |
| Macro | Climate domain → Energy domain | Political | Intentional | Synergy |
| Micro | AREI → UNFCCC | Embedded institution | Intentional | Synergy |
| Micro | GEEAP → SE4ALL | Nested institution | Intentional | Synergy |
| Micro | WBCSD & IEA → LCTPi | Clustered institution | Intentional | Synergy |
| Micro | LCTPi → UNFCCC | Embedded institution | Intentional | Synergy |
| Micro | UNFCCC & IRENA → IEA | Cognitive interaction | Unintentional/ Intentional | Synergy |
| Micro | UNFCCC → Kyoto Protocol | Interaction through commitment | Intentional | Synergy |
| Micro | FFFSR → IRENA & IPEEC | Behavioural interaction | Unintentional | Synergy |
| Micro | Kyoto Protocol → GNESD | Impact-level interaction | Unintentional | Synergy/ Conflict |

Table 3 Overview of interactions in the climate-energy nexus (April 23, 2017)

More importantly, to help understanding the climate-energy nexus the interactions are mapped and visualised in the figure below. The figure includes the governance domains that form the nexus, the different types of interactions and more specifics on the interactions' effect and causal mechanisms. The figure supports the search for conflicts and synergies, and appropriate measures to resolve or optimise these.

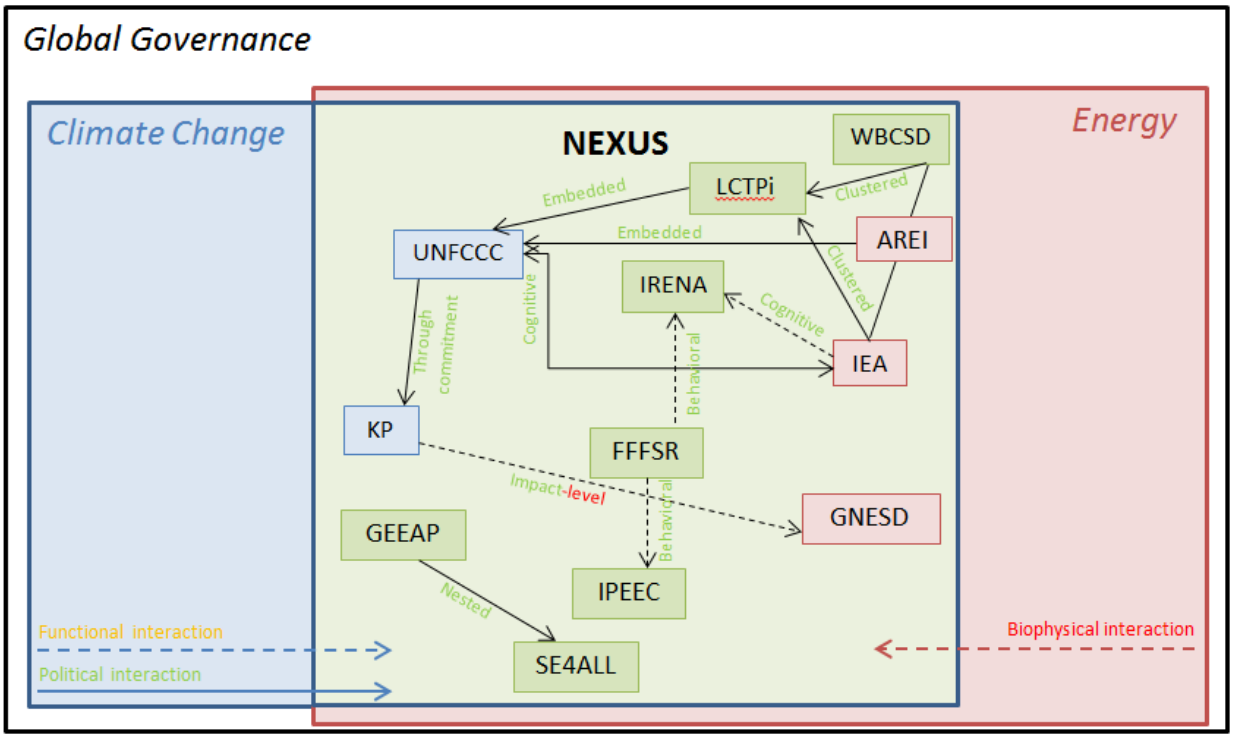


**Figure 2 A visualisation of the climate-energy nexus as a system (April 23, 2017)**

## 5 Final thoughts

The application to the climate and energy domains demonstrates the usefulness of the conceptualisation of the governance nexus as a system. However, it is yet too early to draw conclusions for this particular nexus, since there are many more interactions to be studied in more detail. Still, it demonstrates that structuring and visualising the governance nexus as a system supports the search for conflicts and synergies, as well as for appropriate responses to these. Eventually, this will support the institutionalisation of an integrated approach to multiple problems, and improve the effectiveness of a nexus as a whole. It forces practitioners as well as researchers to approach the problems from an interdisciplinary point of view.

The systems perspective allows for a flexible range of types of interactions and to create an overview of a system characterised by complexity. However, throughout this research also a set of challenges appeared. First of all, it can be challenging to systematise and visualise all interactions. Many global governance domains are characterised by highly populated institutional structures, and therefore, it could become a challenge to not let complexity prevail. In addition, it could be a challenge to objectively study all interactions. Empirical evaluation of the interactions relies on the review of grey literature and, if necessary, interviews. It might be challenging to find out whether an interaction resulting in a disruption, was truly unintentional.

Despite of these challenges approaching the nexus in this manner is promising and there are many opportunities left to explore. For example, assigning weights to particular interactions and understanding the effect of particular interaction managements options, and incorporating those in the system. Furthermore, it is of great value since it can be applied to any interacting governance domains and environmental issues. Consequently, it is of great importance to keep exploring the governance nexus in order to eventually support a successful sustainable development trajectory.

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