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Organizing a Cross-Border Trade
of Regional and Civic Energy:
Prerequisites and Possibilities for the Dutch-German
Project Smart Energy Region Emmen – Haren

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Preface

This master thesis was written independently, but in cooperation with the project *Smart Energy Region Emmen – Haren* (SEREH). More specifically, the focus of the thesis was regularly discussed with the core of the SEREH project team, consisting of Siegbert van der Velde (project manager), Melinda Loonstra-Buzogány (city of Emmen) and Elke Einspanier and Jürgen Lenzing (city of Haren). Personal meetings took place with (various) members of this project team on the 24.11.2016, the 05.12.2016 and the 06.03.2017. Additionally, I participated in workshops in Emmen on the 20.01.2017 (on energy cooperation between Lower Saxony and the Northern Netherlands, at which the SEREH project was introduced) and in Verden on the 09.05.2017 (on civic energy and cooperatives in Lower Saxony).

The first contact between members from the SEREH project and myself was established in 2016, when I worked for the Heinrich-Böll-Stiftung European Union (HBS EU) in Brussels in the Climate and Energy Program. The focus in this program was on strengthening subnational regional cooperation in the 2030 energy framework by the European Commission. For a workshop in April 2016, the foundation invited SEREH project members to Brussels to introduce their project. Another get-together took place during a study tour in the North Sea region in the fall of 2016, that was organized by the HBS EU and the World Future Council (WFC) and that I helped to organize and implement. The tour started in Copenhagen and ended in Brussels. Along the way, several stakeholders from regions all over Europe looked at examples of the local and cross-border energy transition, including members of the SEREH team.

I hope that this thesis might contribute to implementing the SEREH project's vision of a cross-border trade of civic and regional energy. I would like to thank all the above mentioned people and institutions, the experts interviewed for this thesis, as well as my supervisors and fellow students, for their valuable input and fruitful discussions regarding the topic of this master thesis.

The CO₂-emissions occurring in the process of writing this master thesis – a total of 654 kg – were compensated. The emissions taken into account resulted from necessary travels with the car and the train, from the electricity used by the laptop and from printing the thesis and other materials.

Summary

This master thesis identifies obstacles and opportunities for the project *Smart Energy Region Emmen – Haren* (SEREH) in terms of trade models, actors and technological and regulatory conditions. The SEREH project aims to establish a physical exchange and local trade of renewable energy across the Dutch-German border, in which civic actors from the two cities can participate. With its local, civic and cross-border approach, the project is a pioneer in the European energy transition. As little research has been done on this specific topic, explorative and qualitative interviews are the main method used in this thesis. Seven interviews with nine experts on regional, civic or renewable energy from both countries are analyzed and complemented with desk research. Definitions for key ideas and background information on the electricity sector in Germany, the Netherlands and the EU is provided before the analytical part.

In the first part of the analysis, models for a *trade of regional and civic energy* (TRaCE) within a single country are identified. Regional energy is defined as a specific region (e.g. the cities of Emmen and Haren), producing, distributing and consuming its own energy as decentralized and autonomous as possible, engaging in an energy trade with other regions only as much as necessary. Civic energy means, that civic and locally rooted actors (such as private citizens, organized energy cooperatives, local companies or the municipal government) participate as owners or shareholders in the local energy production, procurement, conservation, distribution and consumption of renewable energy. TRaCE projects are analyzed in four analytical categories: The actors participating, the underlying technological and regulatory conditions and the applied economic TRaCE models. Eight TRaCE models are identified and discussed: Integration into overall markets; regional markets for generation or flexibility; a regional label or marketing; experimentation; local investments; tax exemptions; miscellaneous direct marketing and fixed-feed in tariffs. The thesis shows how these TRaCE models contribute differently to decentralization in three dimensions: The actual physical energy flows, the ownership and the markets.

In the second part of the analysis, obstacles and opportunities for a *cross-border TRaCE* are discussed along the four analytical categories. Regulatory aspects are especially challenging, although European regulation will likely dismantle some of the barriers for a cross-border TRaCE. Generally, the SEREH project is assessed beneficial from a technological standpoint, although the existing grid infrastructure and its management are a challenge. While some actors, such as the two cities, are strongly involved in the implementation of the SEREH project, other crucial actors lack involvement. As a result of the thesis, several elements can be recommended to ensure long-term success of the project: Committing more actors within the region to the SEREH project, learning from similar TRaCE and cross-border TRaCE projects in Europe and lobbying for such

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forms of cooperation on the national and EU-level. In the short term, concrete projects within Emmen and Haren respectively need to be started. The cross-border element is SEREH's last step, not the starting point. Decentralization in the ownership dimension and cross-border investments could yield the most immediate results.

Zusammenfassung

Diese Masterarbeit identifiziert Hindernisse und Chancen für das Projekt *Smart Energy Region Emmen – Haren* (SEREH) in Bezug auf Handelsmodelle, Akteure und die technologischen und regulatorischen Rahmenbedingungen. Das Projekt will einen lokalen Austausch und Handel von erneuerbarer Energie zwischen den beiden Städten an der deutsch-niederländischen Grenze etablieren. Daran sollen auch zivilgesellschaftliche Akteure teilhaben. Mit seinem lokalen, bürgerschaftlichen und grenzüberschreitenden Ansatz ist das SEREH Projekt ein Pionier in der europäischen Energiewende. Da zu diesem spezifischen Thema bislang wenig Forschung existiert, sind qualitative und explorative Interviews die Hauptmethode der Arbeit. Sieben Interviews mit neun Experten (zu den Themen regionale, bürgerschaftliche und erneuerbare Energie) aus beiden Ländern werden analysiert und die Ergebnisse mit zusätzlichen Schreibtischrecherchen ergänzt. Vor dem Analyseteil werden zentrale Konzepte der Arbeit definiert und ein Überblick über den Stromsektor in Deutschland, den Niederlanden und der EU gegeben.

Im ersten Analyseteil der Arbeit werden Modelle für einen *Handel mit regionaler und bürgerschaftlicher Energie* (TRaCE) innerhalb eines einzelnen Landes identifiziert. Bei der „regionalen Energie“ produziert, verteilt und konsumiert eine bestimmte Region (z.B. die Städte Emmen und Haren) ihre eigene Energie so dezentral und autonom wie möglich, tritt aber in einen Austausch mit anderen Regionen, wenn nötig. Bei „bürgerschaftliche Energie“ nehmen zivilgesellschaftliche und lokal verwurzelte Akteure (private Bürger, organisierte Energiegenossenschaften, lokale Firmen oder die Stadtverwaltung) als Besitzer oder Anteileigner an der lokalen Energieproduktion, -beschaffung, -speicherung, -Verteilung und dem Energieverbrauch teil. Die TRaCE-Projekte werden in vier Analysekategorien untersucht: Die teilnehmenden Akteure, die zugrundeliegenden technologischen und regulatorischen Rahmenbedingungen und die angewendeten wirtschaftlichen Modelle des TRaCE. Acht TRaCE-Modelle werden identifiziert und diskutiert: Integration in bestehende Märkte; regionale Märkte für Erzeugung und Flexibilität; ein regionales Label und Marketing; Experimente; Lokale Investitionen; Steuerbefreiung; sonstige Direktvermarktung und feste Einspeisevergütungen. Die Masterarbeit zeigt, wie diese TRaCE-Modelle auf unterschiedliche Art zu der Dezentralisierung in drei Dimensionen beitragen: Den tatsächlichen physikalischen Stromflüssen, den Besitzverhältnissen und den Märkten.

Zusammenfassung

Im zweiten Analyseteil der Arbeit werden die Hindernisse und Chancen für einen *grenzüberschreitenden TRaCE* anhand der vier Analysekategorien diskutiert. Regulatorische Aspekte sind eine besondere Herausforderung. Allerdings werden einige Barrieren für einen grenzüberschreitenden TRaCE wahrscheinlich in der Zukunft auf europäischer Ebene abgebaut. Generell wird das SEREH Projekt als technologisch sinnvoll erachtet, allerdings stellen die existierende Netzinfrastruktur und ihr Management eine Herausforderung dar. Während einige Akteure, wie die beiden Städte, stark in der Umsetzung des SEREH Projekts involviert sind, fehlt es von anderen wichtigen Akteuren an Engagement. Als Ergebnis der Arbeit können einige Elemente empfohlen werden, um den langfristigen Erfolg des Projekts sicherzustellen: Mehr Akteure in der Region sollten eingebunden werden, von ähnlichen nationalen und grenzüberschreitenden TRaCE Projekten sollte gelernt werden und auf nationaler und europäischer Ebene sollte weiterhin für das Projekt geworben werden. Kurzfristig müssen konkrete Projekte jeweils in Emmen und Haren gestartet werden. Der grenzüberschreitende Aspekt ist der letzte Schritt von SEREH, nicht der Startpunkt. Eine Dezentralisierung in der Dimension der Eigentumsverhältnisse und grenzüberschreitende Investitionen können in naher Zukunft Ergebnisse produzieren.

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Table of Abbreviations

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ACM	<i>Autoriteit Consument & Markt</i> (Netherlands Authority for Consumers and Markets)
APX	Amsterdam Power Exchange
BMWi	<i>Bundesministerium für Wirtschaft und Energie</i> (Federal Ministry for Economic Affairs and Energy)
BNetzA	<i>Bundesnetzagentur</i> (Federal Network Agency)
CHP	Combined Heat and Power
COBEN	Delivering Community Benefits of Civic Energy (INTERREG V B Project)
COP	Conferences of the Party (to the UNFCCC)
DSO	Distribution System Operator
EC	European Commission
ECBC	European Cross-Border Convention
EDSO	European Distribution System Operators' Association for Smart Grids
EEG	<i>Erneuerbare-Energien-Gesetz</i> (Renewable Energy Act)
EEX	European Energy Exchange
eG	<i>Eigentragene Genossenschaft</i> (organizational form for energy cooperatives in Germany)
EGTC	European Grouping of Territorial Cohesion
EPEX SPOT	European Power Exchange
ENTSO-E	European Network of Transmission System Operators for Electricity
GHG	Greenhouse Gas
GoOs	Guarantees of Origin
HBS EU	Heinrich-Böll-Stiftung European Union
IEA	International Energy Agency
LEC	Local Energy Communities [in the European Union Winter Package]
MS	Member States (of the European Union)
PPA	Power Purchasing Agreement
PRP	Program Responsible Party

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PV	Photovoltaic
RES	Renewable Energy Sources
SDE (+)	<i>Stimulering Duurzame Energieproductie</i> (Stimulation of Sustainable Energy Production)
SEREH	Smart Energy Region Emmen – Haren
TRaCE	Trade of Regional and Civic Energy
TSO	Transmission System Operator
UBA	<i>Umweltbundesamt</i> (Federal Environment Agency)
UNFCCC	United Nations Framework Convention on Climate Change
V	Volt (1.000 V = 1 kV); Unit for measuring voltage
WFC	World Future Council
W	Watt (1.000 W = 1 megawatt (MW), 1.000 MW = 1 gigawatt (GW)); Unit for measuring power
Wh	Watt-Hour (1.000 Wh = 1 megawatt-hour (MWh), 1.000 MWh = 1 gigawatt-hour (GWh)); Unit for measuring energy (the work performed over a period of time)

1 Introduction

The earth’s average global temperature has risen “approximately 1.2 ° Celsius above pre-industrial levels” by 2016 (cf. World Meteorological Organization 2016). Greenhouse gas (GHG) released by human activities is a major cause of this changing climate, especially the CO₂-emissions from burning of fossil fuels (cf. IPCC 2014). In order to keep global warming well below two degrees Celsius until the end of the century, almost all states have committed themselves in 2016 with the Paris Climate Accord to curb their GHG emissions. The European Union (EU) produces around ten percent of the global emissions. “Energy consumption is by far the largest emitter” of GHG in the world, especially in Europe (Eurostat 2015). Therefore, the EU needs to transition its energy sector away from the combustion of fossil fuels and towards overall less energy consumption that is increasingly based on renewable energy sources (RES).

This energy transition is underway in Europe: Between 2004 and 2015, the total share of RES on the gross final energy consumption rose from 8.5 to 16.7 % in the EU-28. In the electricity sector, the RES-share increased from 14.3 to 28.8 % in the same time (cf. Eurostat 2017a). Using RES has become technologically feasible, efficient and cost-effective. However, “policies and regulations for innovative renewable energy systems” do not yet reflect the “changing structure of energy generation” and the “roles and responsibilities of actors” as well as models to organize a renewable-based energy trade are still subject to experiments and remain uncertain (Lammers | Diestelmeier 2017: 1).

Therefore, the focus of the debate is shifting to questions with a qualitative dimension on how to best use RES and integrate them into the overall energy system, the markets and the grids (cf. Witte | Kaltschmitt 2016). The European Commission (EC) also recognizes that a new “governance [is needed] to provide the regulatory framework and accountability [...] to stimulate the transition” (Cañete 2016).

Among other aspects¹, the two concepts of *regional cooperation* and *regional energy* are discussed as possible answers on how to design the future energy system. In the European debate, regional cooperation encompasses the idea of regions – two or more EU member states (MS), as well as subnational entities – cooperating across borders to drive up their RES-share and to coordinate their energy systems in order to make them more efficient (cf. Ecofys | HBS EU 2015: 10). Regional energy² is based on the ideal of more self-sufficient regions, producing and consuming as much decentralized renewable energy within a territory

¹ These other aspects include larger trends like “electrification” (i.e. the substitution of fossil fuels in other sectors with electricity) or “digitalization” (cf. Haleakala-Stiftung 2017: 8-15), as well as direct alternatives to the key ideas in the center of this thesis, that are discussed in chapter 2.1.

² The term is not commonly used, but the idea standing behind it is popular and labelled in different ways for instance “low carbon regions”; 100 % renewable energy regions” or “smart cities” (cf. Mattes et al. 2015: 255).

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as possible, often incorporating ideas of civic energy and citizen's participation. Pioneering companies, regions and projects focusing on regional energy implement this idea in areas within one national state.

The project *Smart Energy Region Emmen Haren* (SEREH) is such a pioneer. By 2025, the project aims to have as much renewable energy as possible produced, marketed, distributed and consumed by – preferably local and civic – actors within the two cities Emmen (located in the Netherlands, with around 110,00 inhabitants and a share of RES of only seven percent) and Haren (located in Germany, with around 25,000 inhabitants and RES covering 110 % of their demand in 2015³). Ideally, this is to be achieved by a medium-voltage distribution power line connecting the region⁴. Additionally, new business models for production and marketing of regional energy shall be tested and implemented by the local and civic actors in a cross-border context. Overall, this project brings together the two above mentioned concepts of regional cooperation and regional energy. In their vision for 2025 Emmen and Haren aim to:

- Have regionally produced energy used more and more in the region, by using an intelligent infrastructure and investing in energy storage technologies
- Have local energy cooperatives promote the production of RES and the trade of RES between consumers within both cities. The companies in the region also increasingly use regional renewable energy
- Have the regional added value increased by the cross-border regional energy trade and profits from RES production staying in the region, while at the same time saving on energy imports
- Have their two energy systems directly connected by a grid (cf. Emmen | Haren 2016: 16 ff.)

While the vision is established, the concrete steps for reaching it are not clearly defined by the project. With its specific approach, the SEREH project is entering new territory and there are no best-practice examples or established projects from which direct leaning is possible. Therefore, this master thesis aims to identify prerequisites and possibilities for setting up a cross-border energy trade by civic actors on the local level. For this purpose, different regulatory conditions are analyzed and compared. To explore obstacles and opportunities for cross-border trade, already existing projects applying different models of a Trade of Regional and Civic Energy (TRaCE) within the territory of a single national state are examined. Experts from these projects are surveyed regarding their insights and assessments of SEREH's vision to implement a cross-border TRaCE.

³ On a 15-minute-scale, demand was covered in 45 % of the time between 2014 and 2015 (cf. Bleydorn et al. 2017: 28).

⁴ While the term region can be defined in a broad variety of ways, this thesis understands the region of the territory made up by the two cities of Emmen and Haren, if not specified otherwise.

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1.1 Research Question and Structure

The research question of this master thesis results from the direct needs of the ongoing SEREH project and the introductory description of the project’s background and the vision it wants to implement:

What obstacles and opportunities result out of external conditions for actors in the Emmen – Haren area if they design and implement their vision of a cross-border trade of regional and civic energy?

In order to answer the primary question, it is divided into a number of subordinate research questions:

- a) ... *actors in the Emmen – Haren area* ...: Who are the actors in Emmen and Haren, what are the features of the energy systems in the area and the overarching (national and European) energy sectors?
- b) ... *trade of regional and civic energy* ...: What concrete TRaCE models are applied by actors from TRaCE projects within a region in one national state?
- c) ... *external conditions* ...: What are the relevant external conditions (technological conditions and the respective national regulations in Germany and the Netherlands) affecting these TRaCE models?
- d) ... *obstacles and opportunities [...] if they design and implement their vision of a cross-border trade of regional and civic energy* ...: Which concrete obstacles and opportunities for the design and implementation of the vision of a cross-border TRaCE can be derived from the analysis in terms of external (regulatory and technological) conditions and in terms of concrete TRaCE models for actors within the two municipalities?

Chapter 1.2 defines which aspects of the topic will be included in the analysis and which will not. By *Introducing the General Background* (chapter 2), the overall research question is further contextualized by discussing key ideas and introducing the respective electricity sectors. The terms “regional energy” (chap. 2.1.1), “civic energy” (chap. 2.1.2), as well as “regional cooperation” (i.e. cross-border energy cooperation in Europe) (chap. 2.1.3) are explained by using current scientific literature. All of chapter 2.2 contributes to answering the subordinate question a), as it provides information on the overlaying energy system that actors in the Emmen – Haren area are connected to. Chapter 2.2 delivers background on the specifics of the commodity “electrical power”, before taking a closer look into the German (chap. 2.2.1) and Dutch (chap. 2.2.2) electricity sectors and the European context in which they are embedded in (chap. 2.2.3). Chapter 3, *Conceptualizing the Research*, describes the methods used to yield answers to the thesis’ questions (chap. 3.1) and introduces the interview partners (as qualitative interviews were the method mainly used) and their TRaCE projects (chap. 3.2). Chapter 4, *Analyzing the Trade of Regional and Civic Energy within a Region of one State*, starts with the analysis of the interviews and replies to sub-questions b) and c). It examines the interviews along the four analytical categories of TRaCE models, actors and technological

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and regulatory conditions (chap. 4.1 – 4.4). Chapter 4.4 goes into more detail with regards to regulatory conditions, by taking a look into these conditions in the respective countries (chap. 4.4.1 and 4.4.2). Chapter 4.5 summarizes the discussion on TRaCE projects within a single country by identifying central dimensions along which they can be clustered. Chapter 5, *Implementing a Cross-Border Trade of Regional and Civic Energy in Emmen and Haren*, brings together the previous results with the situation in the Emmen – Haren area. More background on the SEREH project is provided in chapter 5.1, therefore contributing further to answering subordinate question a). Some information on defining characteristics of the two cities are given in chapter 5.1.1. In chapter 5.1.2, the current energy system in the area is examined. Chapter 5.1.3 explains the state of the SEREH project, the actors involved in it and the project’s vision for a future cross-border TRaCE in the region. Chapter 5.2 begins with discussing results from the second parts of the interviews by providing a general assessment of possible uses and benefits of the SEREH project. In the following chapters 5.3 – 5.6, the identified obstacles and opportunities are discussed along the respective analytical categories regarding actors, technological and regulatory conditions and the cross-border TRaCE models itself, therefore answering subordinate research question d). In the last chapter 5, *Conclusion*, the results are summarized (chap. 6.1), the thesis is reflected on critically in terms of the applied methods (chap. 6.2) and further need for research (chap. 6.3) and a personal assessment is provided (6.4).

1.2 Narrowing Down the Research Field

This chapter provides definitions on some of the terms and aspects appearing in the research question. More specifically, the scope of the term “energy” is narrowed down, the most relevant actors are defined and the aspect of regional added value is discussed.

Energy is “the capacity to do work [...] [or generally] the potential ability of a system to influence changes in other systems by imparting either work (forced directional displacement) or heat (chaotic displacement)” (Cleveland | Morris 2015: 196). It appears in several forms, for instance as mechanical, thermal, electrical or chemical energy (cf. Quaschning 2015: 13). Discussions about energy policy and economics often distinguish between energy used in the electricity, the heating and cooling or the transport sector (cf. UBA 2016b; Quaschning 2016: 8-25) and the SEREH project includes all these three sectors into its vision as well (cf. Emmen | Haren 2016: 21). However, when the energy transition and the share of RES are discussed, the electricity sector is often in focus (cf. Agora Energiewende 2016b) and this sector already has the highest RES-share across Europe (cf. EC 2015b: 4). Because of sector coupling – the replacement of fossil fuels in the transport, heating and cooling sectors with electricity from RES by, for instance, power-to-x-technologies – electricity production will rise (cf. VDE 2015: 22). In Germany, it would have to double between 2015 and 2040 to keep in line with the 1.5 ° target (cf. Quaschning 2016: 29). However, taking all aspects of sector

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coupling into account would exceed the possible scope of this thesis. Therefore, when referring to the (cross-border) production, distribution, trade and consumption of energy in the SEREH context, electrical energy from RES, produced in onshore wind farms, by photovoltaic (PV) and biomass power plants, is meant. These RES are the most common RES in Emmen and Haren (chapter 5.1.2).

Accordingly, the main actors of a cross-border TRaCE are considered to be the local producers of the RES, as well as potential consumers of this (regional) energy and possibly third parties (acting for instance as aggregators or marketers). These actors are therefore central in the later analysis. As Bleydorn et al. (2017) have already examined the perspective of the grid operators and taken a look into European (and national) grid regulation, this topic is not focused on in this thesis. However, if a connecting power line would be needed for the RES generators to have a business case, this topic is included.

The increased deployment of RES for electricity production could increase regional added value. There is direct value creation along the process of energy production: land-use, electricity generation, distribution, retail and consumption. All these processes generate income and tax revenues (also for the municipal level, for instance through property and commercial taxes from wind farms). Additionally, there is indirect value creation along the life cycle of the installed plant: From the production of the plant, to the planning, the installation, the operation and its dismantling. These indirect effect could provide jobs and more tax revenues in the area (cf. Hoppenbrock | Albrecht 2010: 22 ff.). Increasing regional added value is also an important motive for citizens to be active in renewable energy cooperatives (cf. Holstenkamp | Kahla 2016: 117) and it is on the aim of the SEREH project. To limit the scope of the thesis, however, the concrete impact of different TRaCE models on regional added value is not discussed explicitly.

2 Introducing the General Background

After discussing research question of the thesis, it is necessary to take a closer look at underlying issues. This chapter does so by discussing key terms and ideas and the organization of the overall electricity sector. Laying out this general background provides the foundation for partly answering the first sub-question a): Who are the actors in Emmen and Haren, what are the features of the of the energy systems in the area and the overarching (national and European) energy sectors? Chapter 5.1 provides details on the specific situation in the region.

2.1 Introducing Key Ideas

In the introduction and the formulation of the research question of this thesis, the three terms “regional energy”, “civic energy” and “regional cooperation” have been used frequently. In the following chapters,

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these ideas are described in more detail by drawing on current discussions in the literature. The aim is to put these words in context and define their meaning more precisely for their use in the chapters to follow. In chapter 3.1, these ideas are used to develop the analytical categories onto which the interviews and analysis in chapters 4 and 5 are based.

2.1.1 Regional Energy

In nuclear and fossil-based energy systems, energy is produced centrally in large power plants close to urban centers and directly transported to industrial areas with a high consumption. With a high share of renewables, production is more decentralized and the installed RES capacity has to be higher because production is fluctuating. Productive areas for RES-based generation are often found in rural areas, that tend to have more solar radiation, wind, biomass or water energy (cf. VDE 2015: 26; Witte | Kaltschmitt 2016: 67). As the input and load within the circuit have to be balanced out at any time to prevent blackouts, this has implications for the grid infrastructure and other components of the energy system (cf. VDE 2015: 26 ff.).

One way to design and manage such a RES-based energy system is described by the notion of a “super-grid”. This system is managed from the top-down and renewable energy is produced in a large scale where it is most abundant – by PV and solar-thermal power plants in Southern Europe and Northern Africa, hydro power plants in Scandinavia and the Alps and (offshore) wind power plants in the North Sea and the Atlantic – and then transported via high voltage direct current grids to urban and industrial centers in Europe (cf. Fraunhofer 2016; Quaschning 2015: 175 ff.).

The opposite to this large scale approach is the full decentralization. Here, the smallest possible unit – for instance a city quarter or a town – strives to reach energy autarky, i.e. to become fully independent from electricity exchanges with the outside and operate their own island grid. This a promising approach for rural areas in developing countries, where a comprehensive grid infrastructure is not yet available. For an industrialized country, it is “no reasonable option economically” and from a supply-security perspective (Haleakala-Stiftung 2017: 17; cf. Quaschning 2015: 255; 323).

The “regional energy” approach is the middle course between the two previously introduced methods of organizing a RES-based energy system. It is especially interesting in rural areas with low consumption and high RES-production (cf. Schulz 2016: 27). In this thesis, the term is defined as a vision of a region that is producing, distributing and consuming its own energy as decentralized and autonomous as possible, engaging in an energy trade with other regions or a centralized grid only as much as necessary. The term is closely related to the concept of decentralized or distributed energy. Those concepts are often used but there is no definite and clear definition for them (cf. Woodman | Baker 2008: 4527; Haleakala-Stiftung 2017: 3).

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According to a study commissioned by the EC, distributed resources "consist of small- to medium- scale resources [...] connected mainly to the lower voltage levels (distribution grids) of the system or near the end users" and involve mainly three components: "Distributed generation [by] dispatchable resources like cogeneration units or biogas plants and variable renewable energy sources [...] energy storage [by] batteries, flywheels and other technologies that demand electricity and supply electricity at a later point in time [and] demand response [by] changes of electric usage by end-users from their normal consumption patterns in response to market signals" (Sweco et al. 2015: 18). A similar concept from recent discussions is the cellular approach (*Zellulärer Ansatz*) by the German Association for Electrical, Electronic and Information Technologies. It follows the idea to "balance production and consumption of [renewable] energy on the lowest possible level" (VDE 2015: 29). This is a bottom-up approach, where energy is balanced first in the lowest cell of an individual building – for instance a household or a single company – and only then in a higher unit: An urban quarter, *a city, a region, a distribution grid*, a transmission grid... (cf. VDE 2015: 30 ff.). The cellular units in italics are understood to be the relevant units for regional energy in this thesis. In the context of the SEREH project, the two cities Emmen and Haren are the relevant cellular unit.

Generally, the concept of regional energy follows the bottom-up thinking of the cellular approach. Regional energy does not only encompass generation assets but also optimizing electricity distribution in order to prevent shortages and congestions on higher grid levels (cf. Haleakala-Stiftung 2017: 15 f.). As the lower cellular units cannot realize a self-sufficient RES-based energy supply alone, especially in urban and industrial centers, exchanges of regional energy, for instance within a province or a federal state are regarded necessary and reasonable (cf. VDE 2015: 51 f.). Complete energy autonomy and the establishment of island grids is therefore not the approach of regional energy (cf. Haleakala-Stiftung 2017: 18).

Compared with the centralized super-grid approach, the regional approach offers a number of advantages: Integrating RES into the systems only by expanding transmission grids would require thrice the number of transmission grids alone in Germany by 2050. This would result in high costs, that can be lowered by balancing production and demand already at lower levels (cf. VDE 2015: 60). Grid expansions often provoke protest from citizens (cf. Lienert et al. 2015) and therefore a system less reliant on a big grid infrastructure can increase overall acceptance (cf. VDE 2015: 62 f.). Additionally, a regional energy system can provide companies and citizens with new business opportunities and increase the regional added value (cf. VDE 2015: 63; Göppel | Mindrup 2016).

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2.1.2 Civic Energy

The idea of civic energy is often discussed in the literature on energy systems and energy transitions, although it is often referred to under different titles that allude to main actors, such as “civic energy communities” (Vries et al. 2016: 51), “local energy schemes” (RTP Engine Room 2015: V), “local renewable energy organizations” (Boon | Dieperink 2014: 298), “renewable energy communities” (Dóci | Gotchev 2016: 26) or “community initiatives for renewable energy” (Oteman et al. 2014: 12). However, definitions for these terms share many similarities. Oteman et al. define community initiatives as “decentralized, non-governmental initiatives of local communities and citizens to promote the production and consumption of renewable energy” (2014: 12). Additionally, Vries et al. emphasize the grassroot-character of civic energy communities and the role of former mere consumers becoming something more with “bottom-up initiatives by end-users of energy, [...] where voluntary communities seek to collectively set up infrastructures in which decentralized, sustainable electricity can be produced and consumed” (2016: 51).

While these definitions focus on production and consumption of renewable energy, others also mention “collective procurement of renewable energy or technologies” (Boon | Dieperink 2014: 298), “conservation of energy” (Vries et al. 2016: 52) and the distribution of the produced energy (cf. Hall et al. 2014: 2). Hall et al. also focus on ownership and capital (cf. also RTP Engine Room 2015: V). Whereas in a “conservative” energy system, ownership of the energy infrastructure is concentrated in the hands of the state and / or large utilities, in a “civic energy sector [...] non-state and non-corporate [actors] at the local level” own relevant shares of the energy infrastructure (Hall et al. 2014: 2). Smaller utilities owned by municipalities (such as the German *Stadtwerke*) and municipal administrations are also regarded as civic actors by Hall et al. (cf. 2014: 4). Other authors also count public and corporate actors on the local level as components of a civic energy sector if they enter a partnership with other civil actors (cf. Boon | Dieperink 2014: 297; 302).

Collectively, all these actors are considered to be a “societal movement” and it is noted that their actions might bring about “social innovations, operating in a local niche from which ‘ideas’ and social practices might diffuse into society” (Vries et al. 2016: 51 f.). Finally, some authors include a value-based dimension into their description of civic energy actors, as they incorporate “values of decarbonization, economic development and stability, and self-determination/subsidiarity” (Hall et al. 2014: 18).

Byrne et al. connect the ideas of regional and civic energy. They claim that often only technically centralized scenarios are being discussed: Decarbonizing the energy system with a large new grid infrastructure, either powered by nuclear or RES. In these scenarios, “the leaders of the revolt are to be the same actors who built the modern (now disgraced) energy scheme. Huge electric utilities, megatechnical companies [...]

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(making nuclear plants and giant wind turbines), and finance mammoths [...] are to save the planet, maintain economic growth, and, of course, make money” (Byrne et al. 2009: 82). As an alternative, the authors argue for “sustainable energy utilities” that address not only the technological but also the societal site of an energy transition, by relying on institutions that own and govern small decentral renewable energy plants as a non-profit common (Byrne et al. 2009: 87 ff.).

The literature review shows that civic energy goes beyond the narrow definition of a single organizational form, such as an energy cooperative. Therefore, the thesis also includes other possible actors, constellations and forms of organizations for a (cross-border) TRACE. Civic energy is present, if local actors – private citizens, organized energy cooperatives and / or other collective organizations, such as local companies or the municipal government – participate financially (as owners or shareholders) in the local and decentral energy production, procurement, conservation, distribution and consumption of renewable energy in a voluntary, value-based and bottom-up manner.

2.1.3 Regional Cooperation

All European institutions have called for an increased cooperation in the context of the Energy Union⁵ to reach the target of a RES-share of at least 27 % until 2030 on the gross final energy consumption, or even go beyond it (cf. Ecofys | HBS EU 2015: 6). The currently discussed Winter Package⁶ “will have a crucial impact on what regional cooperation will look like in the future” (HBS EU | WFC 2017c: 12).

Although an official and clear definition of what “regional cooperation” really means is lacking in the political debate (cf. HBS EU | WFC 2017a), regional cooperation has been mostly understood by the EC as the cooperation between MS, connecting their energy systems with extra-high voltage interconnectors run by large transmission system operators (TSOs) (cf. Cañete 2016). This type of cooperation, that is based on nation-state level and (inter)national ownership of assets, can be defined as *macro-level cooperation*. Other forms of this cooperation include the harmonization of rules and procedures, as it is happening in the North Sea’s offshore wind sector (cf. North Sea Countries 2016), the coupling of power wholesale markets (chapter 2.2.3) or the opening of RES support schemes to other MS, as it happened in the joint PV-tender between Denmark and Germany (cf. chap. 4.4.1; BNetzA 2016b; HBS EU | WFC 2017c: 7). Macro-level cooperation

⁵ The “Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy” (Energy Union) was adopted in 2015. Reaching an Energy Union is one of the top priorities of the EC. The five targets of the Energy Union are supply security, a fully integrated energy market, energy efficiency, emission reduction and research and innovation. A report on the State of the Energy Union is released annually and various policy measures are undertaken in order to reach the targets (cf. EC 2015a).

⁶ The “Winter Package” was released in November 2016 under the name “Clean Energy for All Europeans”. It contains legislative proposals on renewable energy, market design, energy efficiency and governance (cf. HBS EU | WFC 2017c: 12).

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can yield substantial savings and make the energy transition more cost-efficient as was shown in case studies on joint quota systems in Scandinavia, joint feed-in premium systems in central and eastern Europe or technology specific joint support schemes for offshore wind energy in the North Sea (cf. Ecofys | TU Wien et al. 2014). The energy transition in Germany also illustrates the need for more coordination on the European level, as the country's unilateral decision to shut down nuclear power plants and increase its RES-share "adds a new thread of conflict to [Germany's] European energy relations [...]", as the country's neighbors "have felt sidelined by the speed of the political decision" and experienced heavy impacts on their grids (Ćwiek-Karpowicz et al. 2013: 3; cf. Growitsch 2016: 90; Fischer 2017: 19).

On a smaller scale, there is micro-level cooperation, where subnational and / or civic actors (cf. chapter 2.1.2) such as regional and municipal authorities, as well as companies and the civil society, cooperate and learn from each other in terms of policy programs, planning, research and development. The actors could also undertake cross-border investments or physically link their electricity systems below the TSO-level and create a cross-border TRaCE as in the case of the SEREH project (cf. HBS EU | WFC 2017c: 7).

Most of the micro-level cooperation takes place in European border regions⁷. Around a third of the EU citizens (185 million) live in border regions. These areas are "often peripheral, underdeveloped or marginalised" (EC 2015c: 12). Their inhabitants regularly cross borders for work, shopping or leisure. Often, they share a job market or service infrastructure, like schools and hospitals. National policy often takes little account of the issues for border communities, and the "different political, legal, cultural and linguistic systems create obstacles to cooperation" (Transfrontier Operational Mission 2017).

By cooperating, border regions can create opportunities. Micro-level regional cooperation "relates to the principle of subsidiarity"⁸ (Ecofys | HBS EU 2015: 38). Small-scale cross-border projects "allow for participation [...] leading to a higher political legitimacy and fitted solutions for local conditions" (HBS EU | WFC 2017c: 3; cf. Ecofys | HBS EU 2015: 39). In the energy sector, micro-level cooperation can yield benefits that cooperation on the larger scale cannot. These projects can be understood as "laboratories" for testing solutions that might be scaled up later if they prove to be successful (Bulkeley | Castán Broto 2013: 364) and "there is no reason to presume that a monopoly government is more efficient than a system of governmental units at multiple scales" (Ostrom 2012: 355).

⁷ Micro-level cooperation does however, not necessarily have to happen exclusively within adjacent subnational border regions. There are other examples, for instance regions from all over Europe coming together in transnational projects on a specific topic or cities organizing themselves in networks or associations (cf. Ecofys | HBS EU 2015: 19).

⁸ Subsidiarity is a general principle of the EU law. It means that any political issue should be dealt with on the lowest possible level consistent with its resolution. The principle is laid out in the article 5(3) of Treaty of the European Union.

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2.2 Introducing the Electricity Sector

Several features distinguish electrical energy from other commodities. This mainly results from the physical properties of electrical power. Power is a homogenous good – every kilowatt hour (kWh) in the grid is of a normed quality in frequency (usually 50 hertz) and voltage (depending on the grid level, cf.). Whether current was generated using fossil fuels RES is not physically qualifiable once fed into the grids. Power is also almost not substitutable for many applications. Frequency and voltage in the grid have to be kept at a certain level at any time, which is ensured by a steady balance of load and supply. However, electricity is difficult to store and both generation (especially from RES) and consumption of electricity vary throughout the day and the year. If the balance is not kept, power shortages occur. This puts serious restraints onto the overall economy, as electrical energy is the base for most of their activities. Therefore, the short-term demand for power is inelastic (cf. Birnbaum et al. 2002: 66; Ströbele et al. 2012: 10-12; 227-229).

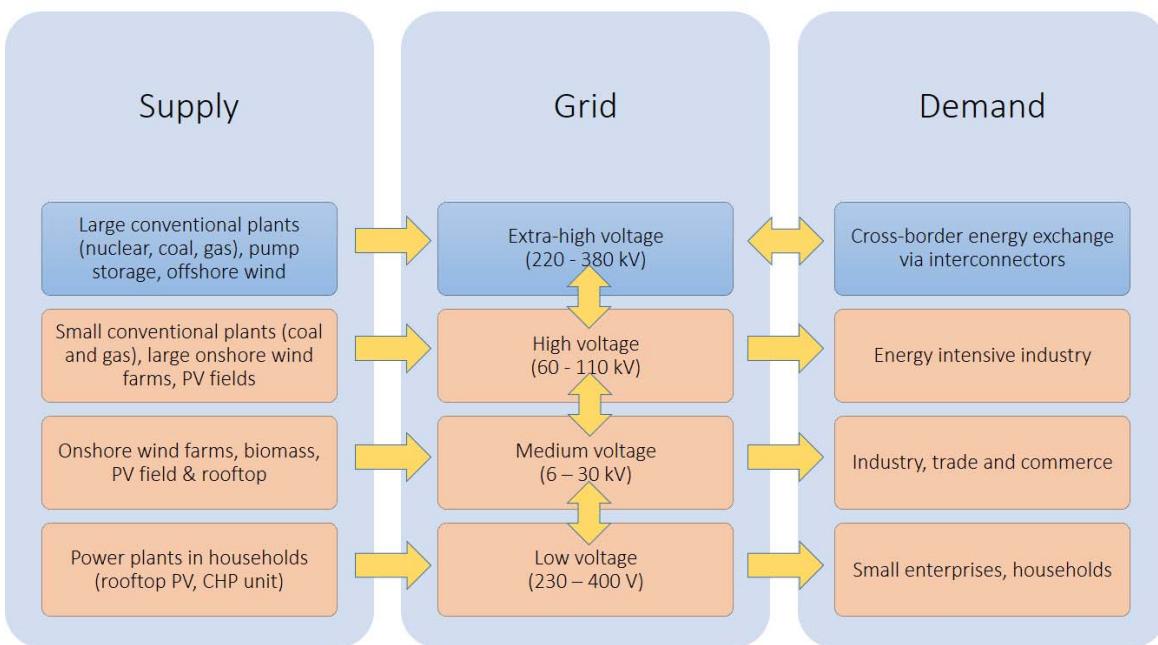


Figure 1: Structure of the Power Grid (Own Figure, Based on BMWi 2017b)

Because of the physical characteristics of electrical power and because it can only be transported through grids, they are a bottleneck in the electricity sector. Economically, it is more efficient to build and run a single integrated grid infrastructure instead of several competing ones. Therefore, grids constitute a natural monopoly (cf. Ströbele et al. 2012: 228 ff.; 291 ff.). shows the energy flows between supply and demand through the grids (the yellow arrows indicating the direction of the flow of the current). While TSOs are responsible for operating extra-high voltage transmission grids (with a voltage typically of 220 or 380 kV), distribution system operators (DSOs) operate distributions grids with a lower voltage.

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As mentioned in chapter 2.1.1, in nuclear and fossil-based energy systems the flow is typically top-down: Energy is produced in large conventional plants (on the top-left of the figure) and fed into the extra-high voltage grids. On this level, the electricity exchange between European countries is also conducted by TSOs via cross-border interconnectors. From the transmission grid, the electricity is then fed into the distribution grid via transformation substations. With an increasing share of decentralized renewable production (on the bottom-left of the figure), energy is directly fed into the distribution system and then flows upwards into transmission grids. Distribution power lines make up 97 % of the total power lines in Europe (cf. IEA ETSAP 2014: 1). Because of the shifting energy flows, the importance of distribution grids is likely to increase in the energy transition (cf. also Quaschning 2015: 325; Witte | Kaltschmitt 2016: 67).

Energy production and consumption in general is associated with the occurrence of external effects. In the electricity sector, these are mainly GHG emissions from fossil fuel power plants (cf. Quaschning 2015: 44). But also the use of RES imposes some external effects, for instance wind farms that potentially endanger certain animals and decrease the recreational value of a property (cf. Marg et al. 2013).

All these special characteristics – the physical properties of electrical power setting it apart from other commodities, the fundamental importance of electricity for the overall economy, the natural monopoly in the grid infrastructure and the external effects caused by the power sector – result in a profound regulation of the sector and make it strongly affected by political decisions. The energy and electricity sectors are thereby subject to a multi-level governance. Climate agreements are discussed internationally at the annual Conferences of the Parties (COP) of the United Nations Framework Convention of Climate Change (UNFCCC). The agreements – notably the latest Paris Climate Accord from the COP 21 – influence national climate targets and therefore also impact the energy and electricity sectors. In Europe, the EU is the sole contract party, negotiating in the name of its 28 MS. The EU is also responsible for setting broader frameworks, so far mostly on competition, in the electricity sector of its member states (chapter 2.2.3) and for developing policy instruments such as the European Emission Trading System. The influence of the national states and their sub-units on the electricity sectors is examined closer in the following sub-chapters for the cases of Germany (chap. 2.2.1) and the Netherlands (chap. 2.2.2).

2.2.1 The German Electricity Sector

The German energy policy is discussed under the term *Energiewende* which is the “substitution of the use of fossil and nuclear energy sources with an ecological and sustainable energy supply” (Duden 2016; own translation). Decades of debates and political struggles preceded the *Energiewende*, especially about nuclear energy. The country has been home to one of the strongest anti-nuclear movements in the world. In

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the 1970s, large demonstrations prevented the construction of a nuclear power plant in Wyhl. This sparked anti-nuclear protests across the country and the Green party evolved partly from this movement. The Chernobyl disaster of 1986 accelerated the shift in consciousness of the Germans and amplified the debate between advocates of the centralized fossil and nuclear based energy system and those in favor of a decentralized and RES-based energy supply on the other (cf. Morris 2014).

In 1990, the Electricity Feed-In Law (*Stromeinspeisungsgesetz*) was proposed in the Bundestag. It introduced the ideas of a feed-in tariff and priority grid dispatch for RES and tipped off the first wave of commercially successful RES in Germany. Ten years later, the government of Social Democrats and Greens accelerated the *Energiewende* with a plan to phase out nuclear energy and the Renewable Energy Act (*Erneuerbare-Energien-Gesetz*, EEG). The two central pillars of the EEG have been the priority for RES in the grid and fixed feed-in tariffs, based on technology-specific generation costs, guaranteed for 20 years and financed via a reallocation charge (*EEG-Umlage*) (cf. Quitzow et al. 2016: 164).

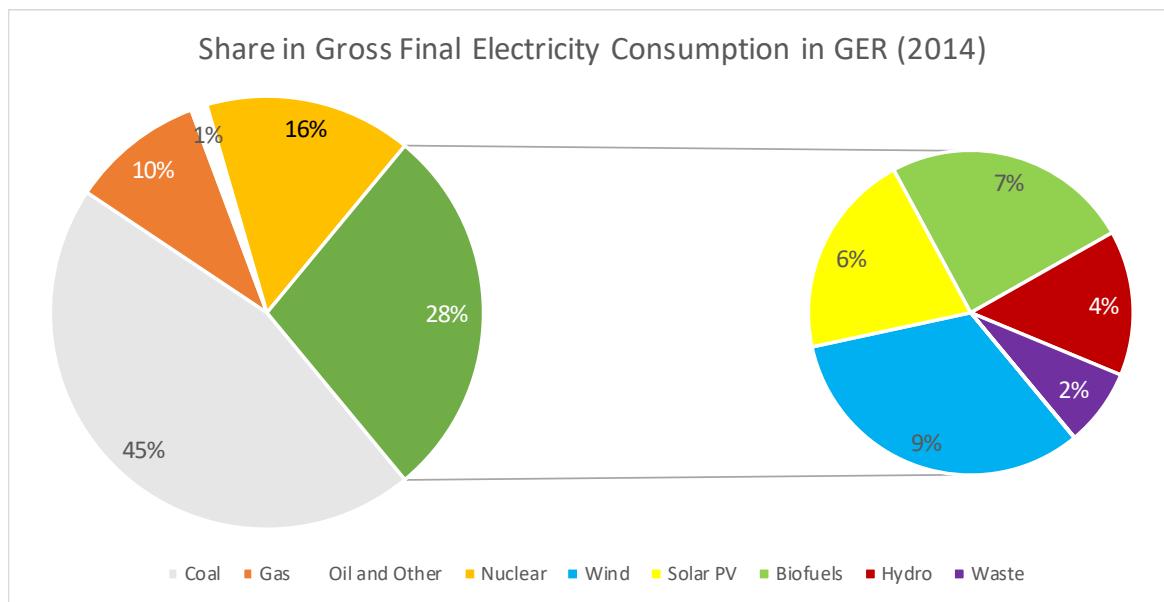


Figure 2: Share in Gross Final Electricity Consumption in GER (Own Figure, Based On IEA 2016)

After the nuclear disaster in Fukushima, the general idea of the *Energiewende* became broad party consensus. The conservative-liberal government took back their plans to withdraw from the nuclear phase out (Atomausstieg). As a result of this development, Germany had a relatively high RES-share in the electricity sector in 2014, as shown in Figure 2⁹. According to preliminary numbers, the RES-share in the electricity

⁹ As of July 2017, no more recent data on Germany was available. "Gross final consumption" in the electricity sector includes the consumption of the sector for electricity production, the transmission losses of electricity, as well as imports

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consumption was up to 32.3 % in 2016 (cf. Agora Energiewende 2017: 17). By 2025, the government wants to reach a share of 40 – 45 % and for 2035 a share of 55 – 60 % (EEG 2017 §1(2)). Shutting down a portion of nuclear power plants did not result in blackouts, as some had warned (cf. Buchan 2012), because of a strong growth in RES-capacity. Instead, Germany's electricity exports increased, yielding a surplus of two billion Euros in 2015 (chapter 2.2.3; cf. Fraunhofer ISE 2017).

With 1,712 energy civic energy corporations and 1,024 energy cooperatives¹⁰ active by the end of 2016 (cf. Kahla et al. 2017: 12; 26), the *Energiewende* has allowed citizens to profit from the roll-out of RES. However, changes in the regulation have slowed down the growth of these civic actors: In 2016, only 27 cooperatives were founded, while in 2011 it were 199 (cf. Kahla et al. 2017: 26). The “Big Four” utilities remain the main players in the German electricity sector: E.ON, RWE, EnBW and Vattenfall. Nevertheless, after the liberalization they have lost some of their market dominance and are lagging behind in terms of ownership in RES production assets (cf. Hall et al. 2014: 5). Around 850 communal-owned *Stadtwerke* also play an important role in the energy sector and their number and influence is increasing, due to the recent trend of re-communalization (cf. Hall et al. 2014: 3 f.).

The *Energiewende* has concluded its first phase: Technologies for producing RES have matured, allowing them to produce competitively in Germany and across the world. The country now enters another phase, in which specific characteristics of the technologies – in particular fluctuation, decentralization and vanishing marginal costs – have to be reflected in markets and the technical infrastructure (cf. Witte | Kaltschmitt 2016: 68-76; Luhmann et al. 2014). In this phase, the supply of cheap RES has led to decreasing electricity wholesale prices and higher electricity bills for consumers, who pay the EEG reallocation charge that around 2.000 companies are exempted from.

and exports (cf. EU 2009). “Oil” and “Other Sources” are listed separately in the International Energy Agency (IEA) publications; however, since they both contribute little to the gross final electricity consumption, they are combined into one category here. “Coal” includes both hard coal and lignite and “Wind” includes both on- and offshore wind. “Waste” is only partially renewable (only its biogenic content, such as food or paper) (cf. Brown 2014), but since the IEA does not differentiate between renewable and non-renewable waste, the whole category was counted to renewables. Electricity from the RES “Geothermal energy” only had a share of 0.02 % and is therefore not depicted. In electricity production, the RES-share in Germany is slightly higher, because the country exports to its European neighbors (chapter 2.2.3). The IEA data is provided in GWh, the percentage calculation carried out by me. Original data is available in annex II.

¹⁰ In this context, “energy cooperatives” are the German *eingetragene Genossenschaft*. This organizational form makes up 54.6 % of the civic energy corporations. The other relevant organizational form are companies with a limited liability (in German *GmbH & Co. KG*) with 36,6 % (cf. Kahla et al. 2017: 16). The majority of civic energy corporations is active in electricity production (1,516), a smaller share is active in distribution of energy (262) or running heat (206) or electricity grids (56) (cf. Kahla et al. 2017: 17). Over half of the civic energy corporations are based in Bavaria (21 %), Schleswig-Holstein (19 %) and Lower-Saxony (17 %) (cf. Kahla et al. 2017: 20). Most civic energy corporations exploit solar (646) or onshore wind energy (655) (cf. Kahla et al. 2017: 20). Chapter 4.2 provides more information on the organizational forms of civic energy corporations.

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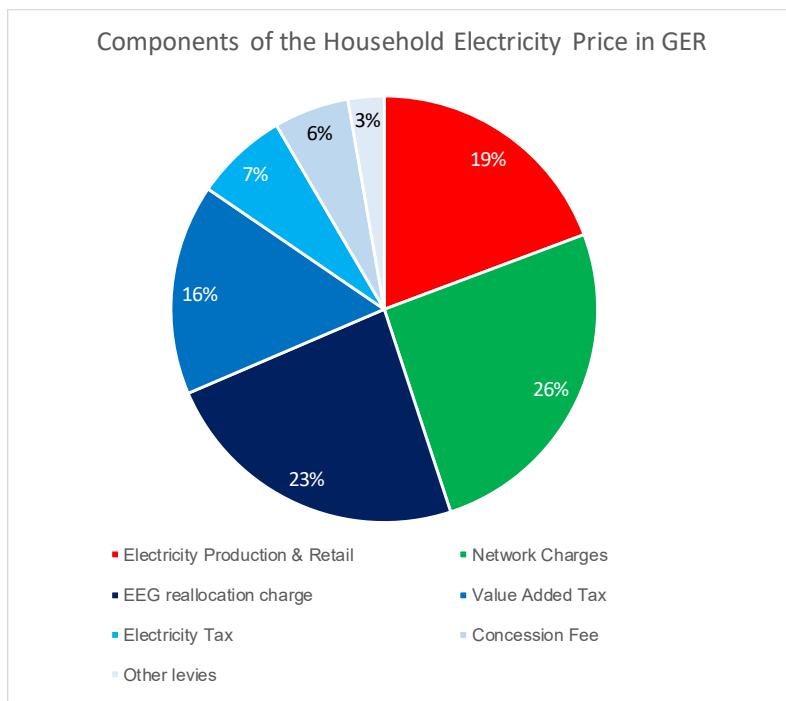


Figure 3: Components of the Household Electricity Price in GER (Own Figure, Based on BDEW 2017)

Rising consumer cost and distribution effects via the reallocation charge have been “the biggest questions” in the public debate on the *Energiewende* (Quitzow et al. 2016: 166; Gawel | Lehmann 2014: 651). Indeed, reallocation charges and taxes (that are all determined by the state and depicted in blue in Figure 3) make up 55 % of the average electricity price. However, the network charges for grid operation and expansion (depicted in green in Figure 3) are the largest single portion of the house-

hold electricity price¹¹. Energy utilities can only influence prices over “electricity production and retail” (depicted red in Figure 3). As this portion only makes up 19 % of the overall electricity price for households, decreasing wholesale prices had so far little effect on the overall electricity price. Both industry and household electricity prices have been higher in Germany than in the average EU-28 (cf. Figure 4)¹².

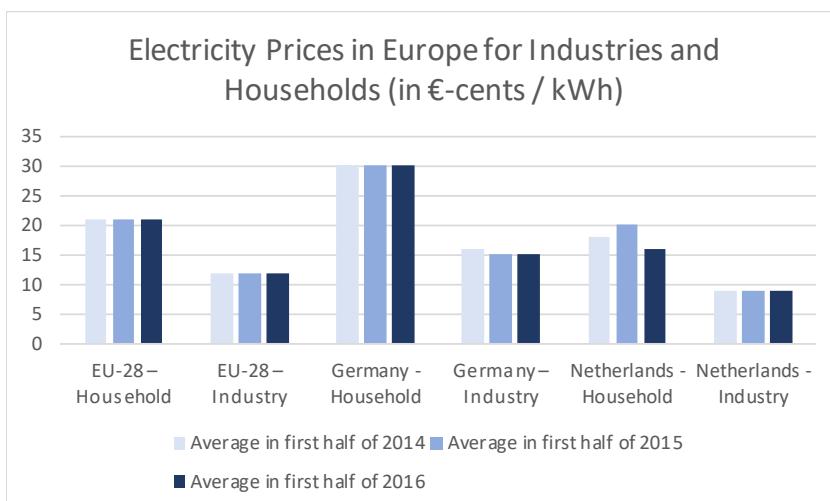


Figure 4: Electricity Prices in Europe for Consumers and Industry (Own Figure, Based on Eurostat 2016)

¹¹ The average consumer price for a household with an annual consumption of 3,500 kWh amounted to 29.16 cents per kWh in 2017.

¹² “Households” are those households with an annual electricity consumption between 2,500 kWh and 5,000 kWh. “Industry” are those companies with an annual electricity consumption between 500 and 2,000 MWh.

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Wholesale prices in Germany have decreased on both relevant spot markets: The short-term spot market at the European Power Exchange SE (EPEX SPOT) in Paris and on the long-term derivatives market at the European Energy Exchange (EEX) in Leipzig (cf. Figure 5)¹³. Renewable energy itself cannot be specifically labelled at the power exchange – as all other forms of electricity, it is traded as neutral “grey” electricity. However, the EEX offers a platform for the separated trade of Guarantees of Origin (GoOs). They guarantee that a MWh of renewable energy was produced and can be traded throughout Europe, without having to connect it to any actual physical energy flows (cf. EEX 2016)¹⁴. The derivatives market at the EEX is for long-term contracts up to six years in the future – for both financial forward contracts as well as actual physical options trading (cf. IWR 2017; Bleydorn et al. 2017: 10 f.).

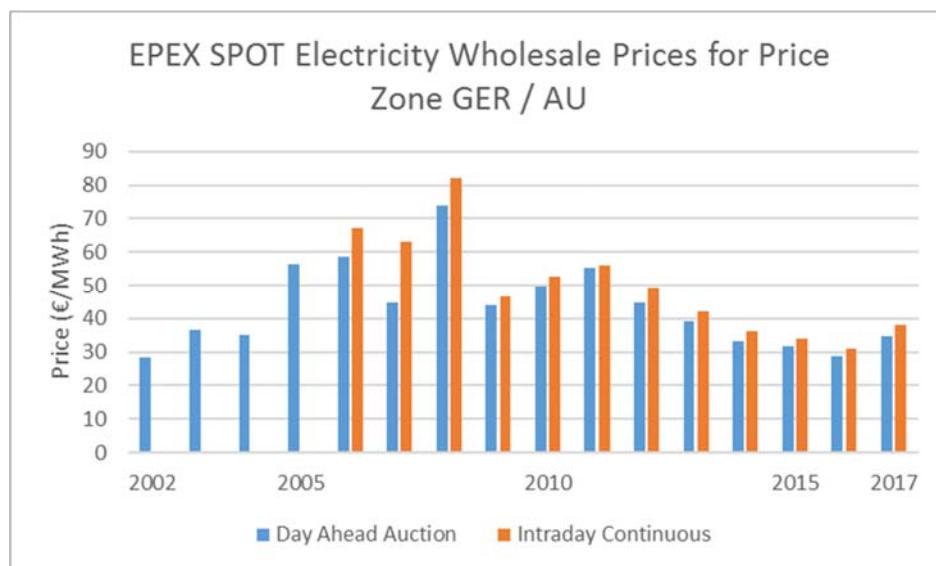


Figure 5: Electricity Wholesale Prices for GER / AU (Own Figure, Based On Fraunhofer ISE 2017b)¹⁵

The existing markets are so-called “energy only markets”, which means that only the actual production of electricity is remunerated, not the mere provision of capacity that might be needed at some time. In these energy only markets, the merit order system is the main mechanism for setting prices. Simply put, energy sources with the lowest marginal production costs are traded first to meet the demand. The plant with the

¹³ The EPEX SPOT is a market for power trading in Germany, Austria, France, Switzerland and Luxembourg; Germany and Austria form a joint price zone. As there are no congestions on the interconnectors between Luxembourg and Germany, and the small country relies heavily on energy imports, Luxembourg is de-facto also a member of the joint price zone (cf. EPEX SPOT SE 2016: 11). The EPEX SPOT is the place for day-ahead and intraday-trading, down to a 15-minute scale.

¹⁴ If the electricity produced in RES power plants already received EEG-funding, it is not allowed to also market this electricity volume with GoOs. Therefore, EEG-funded RES power loses its “green” characteristic at the spot markets and is traded indistinguishable together with electricity from fossil and nuclear power plants – therefore referring to it as “grey” electricity (cf. Paschotta 2017).

¹⁵ The data was contrived in mid-June 2017, therefore the data for the year 2017 is preliminary. Prices are adjusted for inflation and the yearly average is weighted according to the traded volumes.

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highest marginal costs, which production is still needed for covering the demand, sets the uniform market price for all other plants (cf. Hildmann et al. 2015). In energy only markets, electricity can also be traded over-the-counter, meaning two parties agree on a bilateral contract outside the exchange. There are additional markets for system services, for instance balancing energy (to uphold frequency) or reactive power (to uphold voltage). On these markets, TSOs directly tender for the capacity they need to stabilize the grids (cf. Next Kraftwerke 2017).

In Germany, gas has become economically inefficient under the merit order pricing, although its flexibility could be useful. On the other hand, many cheap old lignite power plants are still working to full capacity (cf. Quitzow et al. 2016: 165). As a result, RES-deployment has indirectly affected GHG emissions negatively: Between 1990 and 2016, they decreased around 28 % (cf. UBA 2017a) making the goal of a 40 % reduction by 2020 unlikely to be reached (cf. Deutsche Welle 2016). An oversupply of energy during peaks of RES-production paired with a steady and inflexible influx of coal energy is also a challenge to grid regulators in Germany and across Europe and further increases consumer costs. After the *Atomausstieg* is now almost completed, many economists, environmental groups and citizens call for the phasing out of coal (*Kohleausstieg*) as the next step of the *Energiewende* (cf. DIW 2014; Schubert et al. 2015).

Since 2005, a gradual shift of the EEG-system took place. Additional quantity controls ("expansion corridors") have been incorporated into the price-setting of the feed-in system and plant operators became obligated to commercialize power directly on the electricity market in order to stimulate a more demand-oriented approach (cf. Gawel | Lehmann 2014: 654). As small renewable plant operators are not able to market their generated electricity themselves on the energy exchange, service companies often take on that task, acting as aggregators or direct marketers. The operators receive a market premium as a compensation for the difference between the market price and the fixed remuneration (cf. Purkus et al. 2015). The system of politically fixed prices for RES is to be replaced by a tendering system, in which volume-based auctions take place for specific technologies. While proponents argue that these more market based approaches decrease prices, make the energy transition more plannable (cf. BMWi 2014: 6-7) and allow for better grid integration of RES (cf. BMWi 2016a), opponents doubt that (cf. Gawel | Lehmann 2014: 658) and point out that the increasing complexity of the new system favors the established large companies over small energy cooperatives (Deutschlandfunk 2016; EnergieAgentur NRW 2016b). The EEG 2017 will be discussed in more detail in chapter 4.4.1.

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2.2.2 The Dutch Electricity Sector

Although wind power was traditionally used to drain water and grind grain and natural conditions for this RES are optimal, the Netherlands lag behind most EU countries regarding energy production from RES. Of all 28 EU countries, the Netherlands have to make the most efforts to reach their targeted RES-share in gross final energy demand by 2020 of 14 % (cf. Ecofys | Fraunhofer et al. 2014 :52 ff.; cf. EC 2017c: 92).

On the one hand this laggard position in terms of RES-deployment is surprising, taking into account that the former grand coalition between the Liberals (*Volkspartij voor Vrijheid en Democratie*) and the social democratic *Partij van de Arbeid* made energy one of nine top-sectors in 2011 (cf. Deutsch-Niederländische Handelskammer 2016: 28) and in 2012 agreed on the ambitious goal to make energy “fully sustainable” (100 % Renewable - Renewables International 2013). On the other hand, the negligence of these ambitious RES-goals makes sense, considering that the energy system is and has always been built around the extraction and the export of fossil fuels, especially natural gas (cf. Oteman et al. 2014: 18). The Netherlands are the second largest gas exporter in Europe behind Norway and it is a priority for the government to keep this economic position by becoming an infrastructural gas roundabout for Western Europe. The share of gas revenues on the national budget amounted to about five percent in 2013 (cf. Triarii 2013: 19).

However, the Dutch gas deposits close to Groningen are getting exhausted within the next 30 years (cf. Energy Research Centre of the Netherlands: 12; Deutsch-Niederländische Handelskammer 2016: 15) and protesters from civil society oppose drilling for gas supply, which caused hundreds of earthquakes around the city (cf. The Guardian 2015). This development could result in further RES-deployment. Indeed, the RES-share in the electricity sector grew over the last years. Just between 2012 and 2013, solar electricity production doubled (cf. EurObserv'Er 2015: 5). Between 2014 and 2015 growth was still around 40 % (cf. En-Tran-Ce 2016: 3) and wind power increased 25 % (cf. En-Tran-Ce 2016: 5). Figure 6 shows the gross final electricity consumption in the Netherlands in 2014.

The Dutch government wants to have 4,450 MW of offshore and 6,000 MW of onshore wind capacities installed by 2020. In 2013, the national government and the twelve provinces agreed on a plan to construct eleven large onshore wind farms until 2020. While large farms of more than 100 MW are regulated on the national level, the provinces are responsible for the spatial planning of wind parks below this capacity (cf. Lexology | CMS 2014).

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Despite the recent growth of RES, gas remains the main electricity source as shown in Figure 6¹⁶. Notwithstanding the Dutch' lower coal and higher gas usage, the country produced slightly more GHG emissions per capita in 2015 than Germany (12.23 tons per capita in the Netherlands and 11.41 tons per capita in Germany) (cf. Eurostat 2017b)¹⁷.

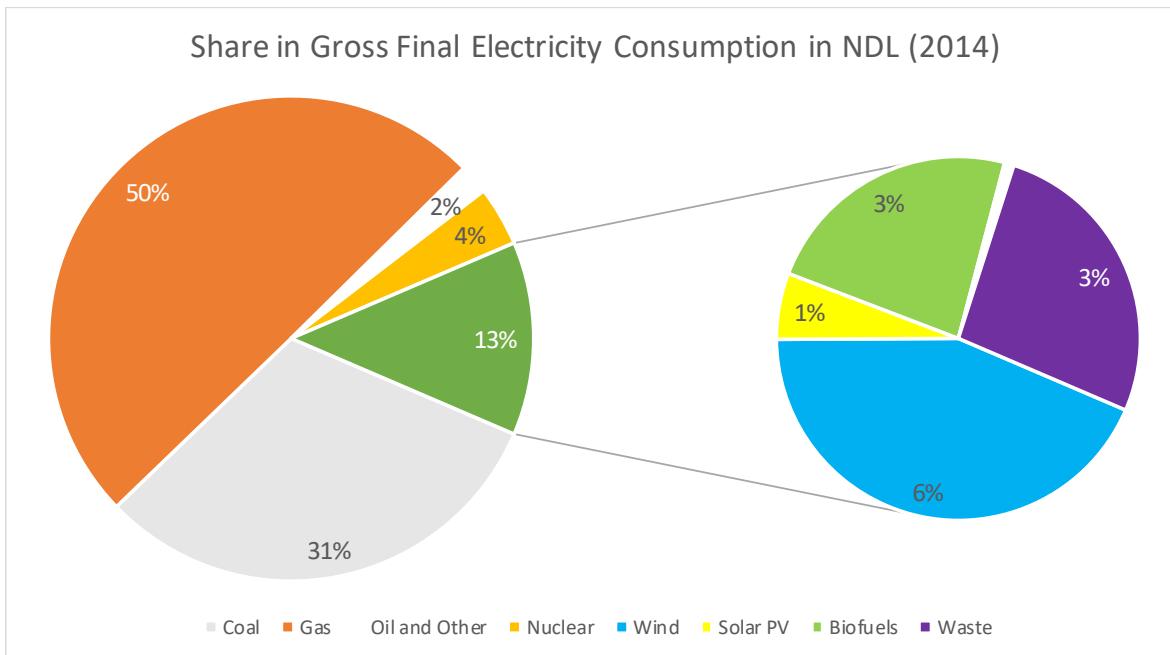


Figure 6: Share in Gross Final Electricity Consumption in NDL (Own Figure, Based on IEA 2016)

In the Netherlands, the first subsidy scheme for RES-production – the Environmental-Friendly Electricity Production (*Milieukwaliteit Elektriciteitsproductie*) – was introduced in 2003. This subsidy provided energy producers with a fixed compensation for sustainably generated electricity atop the market price. In 2006, subsidies for new plants were no longer granted, since the government expected to reach their 2010 RES-targets without any more funding. Two years later, the Stimulation of Sustainable Energy Production (*Stimulering Duurzame Energieproductie*, SDE) scheme followed, promoting renewable electricity and gas. The SDE-budget was fixed for over a year. After a few months, claims usually exceed the available budget. The

¹⁶ As this data is also contrived from the IEA, the same comments as in Figure 2 on Germany apply. Both RES "Hydro" and "Geothermal energy" are not depicted in the diagram, as they only had a share of 0.6 % and 0.0 %. In this figure, the RES-share of the Netherlands is about 3 % higher than in the Eurostat data from Figure 7. The difference can be explained by the "waste" category, that is not differentiated into renewable and non-renewable waste by the IEA and was counted as a whole to the RES category in this figure. If not electricity consumption, but production was considered, the RES-share in the Netherlands would be considerably lower, because the country imports heavily from Germany (chapter 2.2.3).

¹⁷ The GHG numbers are expressed in CO₂-equivalents, a unit including the major GHG carbon dioxide (CO₂), as well as other pollutants, such as "methane (CH₄), nitrous oxide (N₂O), and the so-called F-gases [...]. These gases are aggregated into a single unit using gas-specific global warming potential (GWP) factors. The aggregated greenhouse gas emissions are expressed in units of CO₂ equivalents." (Eurostat 2017b). The indicator includes emissions from international aviation, but not from international maritime transport or land use, land-use change and forestry.

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scheme consisted of several separated budget amounts available for different RES-technologies. The SDE+ scheme was introduced in 2011 as the SDE's successor and is now the major subvention scheme. There are some differences between SDE+ and SDE, notably the introduction of a joint budget from which all technologies are funded, leading RES-technologies to compete over subsidies. Another difference is the introduction of competitive bidding, where application for subsidies takes place in categories from low to high subsidy rates, in order to make the allocation of subsidies more cost-effective (cf. Spijker et al. 2015: 11). There are other subvention schemes mainly for small scale PV. They include net-metering for residential housing and a reduced tariff for collective generation (*verlaagd tarief voor collectieve opwek*, also called *Postcoder-oos*), where individuals can club together to generate solar energy and receive a tax deduction of nine cents per kWh over 15 years (cf. Government of the Netherlands 2017a; cf. LawyerIssue 2016). The subvention schemes will be discussed in more detail in chapter 4.4.2.

As illustrated in Figure 4 (cf. chapter 2.2.1), electricity prices for consumers and companies are generally lower in the Netherlands than in Germany. This is a result of lower fees and taxes. For example, while the German *EEG-Umlage* amounted to 6.88 cents per kWh for an average household in 2017, the Dutch counterpart *Opslag Duurzame Energie* was only 0.74 cents per kWh (cf. Energieleveranciers.nl 2017). The Netherlands have a degressive price system, under which consumers with a higher demand pay less energy taxes (cf. Triarii 2013: 12; Fraunhofer ISI | Ecofys 2015a: 9). On the energy wholesale markets, however, wholesale prices for electricity are higher by around a third in the Netherlands compared to Germany (cf. Taz 2014). The main trading place for electricity in the Netherlands is at the Amsterdam Power Exchange (APX). The APX also operates principal spot markets in Belgium and the United Kingdom and is completely integrated into the EPEX SPOT SE (cf. EPEX SPOT SE 2016: 12 f.). While only around 20 % of the electricity was traded at the APX in 2012, over-the-counter trading plays an important role in the Netherlands, as the remaining 80 % of the volume was traded bilaterally (cf. Fraunhofer ISI | Ecofys 2015a: 7).

In 2016, there were 237 local energy cooperatives (*Lokale Energie Coöperaties*) in the Netherlands, as well as 19 wind energy cooperatives and 57 independent project cooperatives (cf. HIER opgewekt 2016: 8 f.). The civic energy landscape in the Netherlands is "relatively new, except for the traditional wind cooperatives [...]. The recent large growth of initiatives has resulted in a heterogeneous group of early-phase projects [...] still exploring their options for local RE production and provision" (Oteman et al. 2014: 17). Chapters 4.1 and 4.2 provide more information on the respective trade models of these cooperations. Regardless of the growing cooperative movement, a few large energy companies dominate the Dutch electricity sector. Measured by the installed generation capacity, the largest four companies have a combined market share of 75 %. In retail, the largest three companies control 80 % of the market (cf. Agora Energiewende 2014: 9 f.).

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While the sole TSO TenneT (state-owned) and the eight DSOs (owned by provinces and municipalities) are in public hands, the major generation and retail companies Essent (owned by RWE, Germany), E.ON (Germany), Gdf Suez (Electrabel, France) and Nuon (Vattenfall, Sweden) are in foreign hands (cf. Agora Energiewende 2014: 11).

2.2.3 The German and Dutch Electricity Sector in the European Context

Figure 7 shows the development of the German and Dutch RES-shares in the gross final consumption in the energy sector¹⁸ and the electricity sector. The European targets for the RES-share in the respective country is provided in parenthesis¹⁹. The individual country's generation profiles are complementary: Germany already deploys a relatively high share of RES but is facing the challenges of integrating them into the grid and providing baseload electricity in times with little sunshine and wind. As of today, most of this baseload energy is generated by lignite and hard coal power plants. The Netherlands, on the other hand, have a high capacity of natural gas production in the electricity sector. This fossil fuel is the optimal backing technology for the roll-out of RES, as it has the lowest CO₂-intensity of all fossil fuels and production in gas power plants can be regulated quickly and flexibly (cf. Kästner | Kießling 2009: 44 ff.).

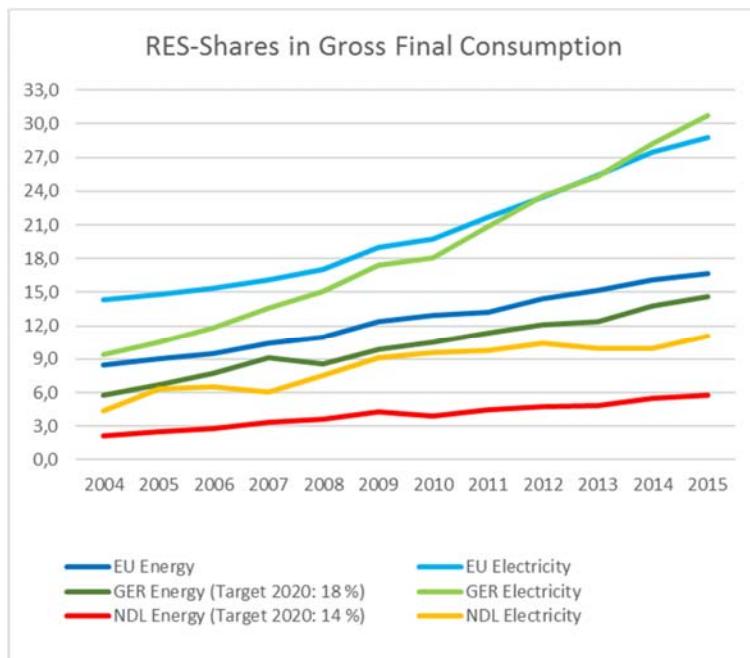


Figure 7: RES-Shares in Gross Final Consumption (Own Figure, Based on Eurostat 2017a)

¹⁸ In the sectors heating and cooling (RES-share has increased from 6.3 to 12.9 % between 2004 and 2015 in Germany and from 2.2 to 5.5 % in the Netherlands) and transport (from 1.9 to 6.8 % in the same time in Germany, from 0.2 to 5.3 % in the Netherlands) the RES-rollout is moderate (cf. Eurostat 2017a). In terms of efficiency, Germany is in the bottom third in terms of implementing the EU's energy efficiency directive, the Netherlands score higher (cf. The Coalition for Energy Savings 2015: 22-23). Between 2000 and 2013, efficiency improvements in Germany amounted to 1.25 % annually – looking only at the time between 2007 and 2013, this number drops to 0.7 % (cf. Odyssee-Mure | Fraunhofer 2015: 14). Because of that, environmental organizations filed an infringement proceeding at the EC (cf. DUH | BUND 2016). The Netherlands have a higher annual efficiency improvement rate (1.5 % between 2000 and 2012, although improvements also dropped after 2008 (cf. Odyssee-Mure | ECN 2015: 6).

¹⁹ Opposed to the 2020 targets, the 2030 RES-target is not broken down into national targets (cf. Ecofys | HBS EU 2015: 6)

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With the European Coal and Steel Community and the European Atomic Energy Community (Euratom) as predecessors of the EU, energy policy has been an important tool for driving European integration forward at the beginning of the Union. However, due to profound differences in the energy sectors and political systems of the MS, the implementation of an internal European energy market started late (cf. Fischer 2017: 23; Hey 2014: 00:10:42 – 00:32:34). Between 1996 and 2009, the EU adopted three legislative packages aiming to establish a “functioning [internal] market with fair market access and a high level of consumer protection, as well as adequate levels of interconnection and generation capacity” (European Parliament 2016). In 2009, the EU passed a directive specifically on renewable energy. In the directive, cooperation methods are laid out: Statistical transfers, in which “an amount of renewable energy is deducted [virtually] from one country's progress towards its [RES-share] target and added to another's” and joint projects, in which EU countries co-fund a project that involves RES-generation and the physical transfer of energy from one country to another, sharing the resulting energy for both of their national RES-targets (EC 2014b) .

With its proposed Winter Package, the EC is continuing the process of establishing an Energy Union (cf. Agora Energiewende 2016a). Unbundling was a core element of the liberalization: TSOs (and especially in the Netherlands also DSOs) are required to work independently of generation companies in the electricity and gas sector. As grids are a natural monopoly, this is a means to guarantee non-discriminatory grid access to third parties (cf. CEER 2016a, 2016b). To establish a liberalized EU-wide trade of energy, adequate grid infrastructure between the MS is needed to guarantee sufficient capacity for this trade. The EU is therefore promoting an increase of grid capacity, a common plan for investments into interconnectors and a greater cooperation between regulatory authorities, MS and TSOs (cf. European Parliament 2016). The European TSOs have set up an institutionalized cooperation in the form of the European Network of Transmission System Operators for Electricity (ENTSO-E).

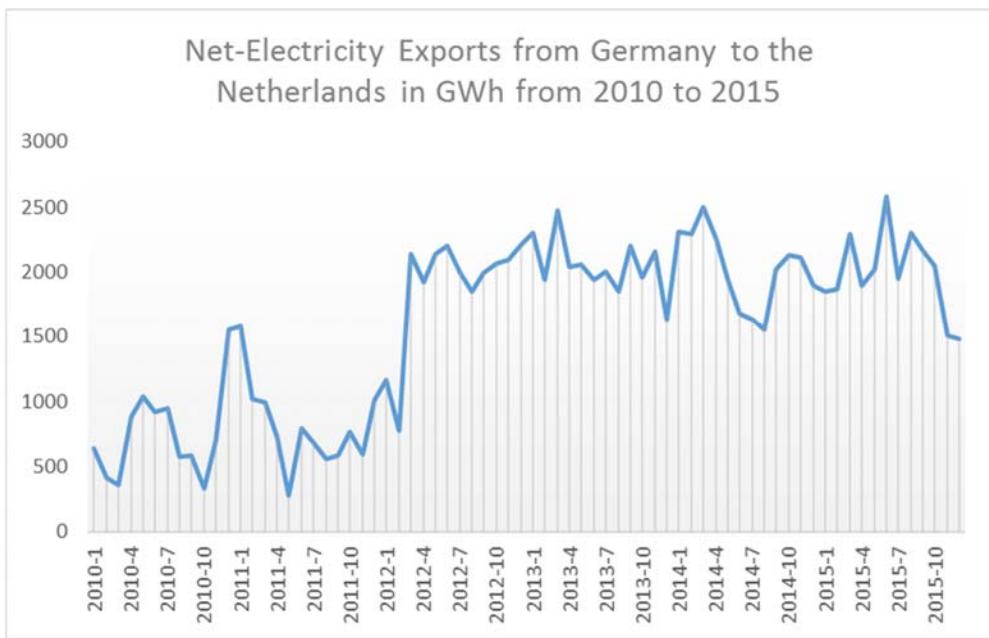


Figure 8: Net-Electricity Exports from GER to NDL (Own Figure, Based on ENTSO-E 2017)

As interconnection capacity between the Germany and the Netherlands increases, the general amount of the electricity trade has been rising over the last 15 years (cf. Agora Energiewende 2014: 19 f.) In net-values, Germany is exporting more electricity to the Netherlands than it is importing, as shown in Figure 8. The trade-imbalance has especially increased since late 2011, when Germany fast-forwarded its RES-rollout. The German RES have increased price convergences in the region, as the “Dutch gas-fired capacity was less competitive on the spot markets in 2012, as it was often cheaper to import electricity generated by coal, wind, and solar” from Germany (Agora Energiewende 2014: 19).

Prices are able to converge because of the coupling of wholesale power markets, that the EU has been working on in order to complete the internal energy market (cf. Ecologic Institute 2015: iii). The electricity day-ahead markets of Germany and the Netherlands are coupled via the flow-based market coupling in Central West Europe²⁰ in order to reduce price differences (cf. Ecologic Institute 2015: 12-14). In a first step, market participants trade within their market area and price-zone until an equilibrium price has been reached. It is therefore not possible for market participants to specifically buy electricity directly from another country. In a second step, the price differences between the market areas are settled, with the existing interconnector capacity as the limiting factor (cf. Bleydorn et al. 2017: 20 f.). This implicit capacity auction indirectly results in a “price building [that] is now transnational and continues until there is an equilibria

²⁰ France, Belgium and Luxembourg are also a part of this region. Because Austria shares a price-zone with Germany, it is de-facto also participating in the CWE market coupling.

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price in the whole region or until existing interconnector capacities are congested" (Fraunhofer ISI | Ecofys 2015b: 5, own translation).

Another reason for the increasing number of electricity exports from Germany are loop flows. Loop flows occur when excess renewable energy is produced in Northern Germany. Part of this energy needs to be transported to consumption centers in the South, but when there is congestion on the main transmission grids within Germany, the electricity takes a detour through the grids of neighboring countries (cf. Clean Energy Wire 2015). These loop flows are harmful as they might "reduce the interconnector capacity available for normal cross-border trade" (Agora Energiewende 2014: 20). They result from an imbalance of electricity supply and demand on the TSO-levels.

As of today, TSOs are responsible for guaranteeing system stability and preventing congestions in the grids, that result if the "physical or operational transmission limit of a line is reached or violated" (cf. van den Bergh et al. 2015: 65). For this purpose, they use markets for system services (cf. chapter 2.2.1) and apply top-down measures like European-wide and centrally controlled redispatch, i.e. "rearranging scheduled generation and consumption" (van den Bergh et al. 2015: 65 f.; TransnetBW 2015). Loop flows and grid congestions reinforce themselves (cf. van den Bergh et al. 2015: 71 f.). The centralized grid management measures are necessary, because the uniform electricity price does not reflect local shortages or congestions in the grid. Instead, under the current market design, Europe is assumed to be a "copper plate", with unrestricted electricity flows and no transmission bottlenecks (cf. Energy and Carbon 2016).

3 Conceptualizing the Research

The previous chapter 2 provided an overview on key ideas in this thesis and on the electricity sector in Germany, the Netherlands and Europe, by drawing on current scientific literature, statistical data, recent publications and newspaper articles reflecting on current public debates on the energy sector. Now that the general background has been illustrated, the methods and frameworks used for answering the research question(s) are introduced in chapter 3.1. The main tool for the analysis are expert interviews. Their selection is justified and the background and / or TRaCE model they represent is introduced in chapter 3.2.

3.1 Methods and Framework Used in the Analysis

It was shown previously, that the energy system is undergoing a transition towards deploying more fluctuating and decentral renewable energy power plants. These assets are increasingly owned by civic actors and new trade models with a more regional approach are emerging. The SEREH project follows this trend and is additionally adding a cross-border element to it. As these developments have only appeared recently, and

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the SEREH project’s vision to set up a cross-border TRaCE is unprecedented, there are no theories and studies on this specific topic yet. In order to draw to advance on these new developments and in order to be able to find answers on the research questions (cf. chapter 1.1), qualitative interviews with focusing questions are used as the main method. They are evaluated in the following chapters 4 and 5.

The interviews follow an exploratory approach that is fitted to examine new developments, where not much scientific research has been undertaken yet. Qualitative interviews offer a chance to focus on subjective perspectives in order to be able to describe empirical issues, set up classifications or typologies or extract hypotheses from the empirical material (cf. Diekmann 2011: 531 f.). At the same time, they are flexible regarding their order and potential further topics (cf. Diekmann 2011: 536 f.). A type of “focused interview” was used, in which all interviewees were subjected to a “stimulus” (in this case, a one-page summary of the SEREH vision) and afterwards questioned along guided questions containing thematic elements based on the analytical categories introduced further below.

Seven interviews were carried out with nine different experts from various fields and backgrounds (chapter 3.2) in order to examine existing TRaCE models from a single country (chap. 4) and to discuss obstacles and opportunities for a cross-border TRaCE from different perspectives (chap 5). Thematically, the interviews were divided into two segments, resonating with the content of the chapters 4 and 5²¹: The first segment focused mostly on the specific expertise of the interviewee and their concrete TRaCE project. The understandings were gathered for answering sub-questions b) and c) in chapter 4. The second segment of the interviews was used for answering sub-question d) in chapter 5. The segment focused on the cross-border element and the SEREH vision of a cross-border TRaCE (for more details on the vision cf. chap. 5.1.3 and annex I). The statements from this interview segment were used to assess merits and drawbacks of the vision and identify obstacles and opportunities in the implementation from the interviewees point of view.

²¹ The division is thematically, but was also aimed to be discussed chronologically. However, due to the open design of the focused interviews, sometimes cross-border aspects were discussed earlier on.

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The framework in Figure 9 served as a peg for the first segment of the focused interview. The purpose of this framework is to build a structure around which the different information on the analyzed TRaCE projects can be collected, sorted and interpreted. It is made up of four analytical categories: In the center is the concrete

TRaCE model(s) it uses (hence the eco-

nomic mechanisms used by the TRaCE project). Chapter 2.1.1 illustrated the regional energy approach and a TRaCE model needs to contribute to that approach in some way. It also needs to involve *(civic) actors* (cf. chapter 2.1.2) in the production, distribution, marketing and consumption of the regional energy. As shown in chapter 2.2, its physical properties distinguish electricity from other commodities and the electricity sector is subject to an ever-changing and profound multi-level regulation. Therefore, examining the *technological conditions* (concerning physical, technical and infrastructural prerequisites and possibilities) and *regulatory conditions* (regulating the application of the physical, technical and infrastructural prerequisites and possibilities, as well as the external market conditions in which a TRaCE is embedded) is crucial, as these conditions need to enable the TRaCE project to work. Other external conditions, such as geographical or environmental features (e.g. the size and climate of a region) are also relevant, but are not included as analytical categories to make the analysis manageable.

The framework in Figure 10 is used to organize and structure the discussion for the second segment of the interview. It reflects on a *cross-border* TRaCE in the sense of micro-level regional cooperation (cf. chapter 2.1.3). The framework differs from the one used in the first interview segment: While technological conditions for a trade of energy in a certain region are considered to be similar to a great extent, regardless of whether a national border runs through this region or not²², regulatory and market conditions on both sides differ from each other considerably (cf. chap. 2.2.1 and 2.2.2). Therefore, two separate analytical categories are applied, one for each of the respective national regulation. There are also different actors in both cities on the border (chap. 5.1.1). In order for the cross-border TRaCE to work, it has to operate in a way that is

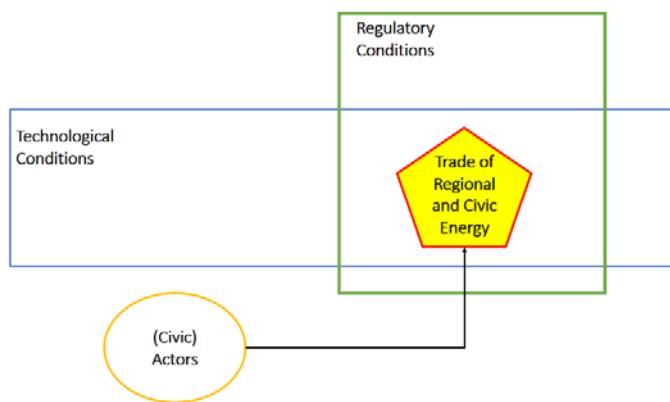


Figure 9: Trade of Regional and Civic Energy in One Country (Own Figure)

²² In terms of the technical infrastructure, there are some differences however. For instance, the smart meter roll out in the Netherlands for households is a lot more advanced than in Germany, which results in different technological preconditions (cf. chapters 4.3 and 5.4).

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legal under both the Dutch and the German law, feasible under conditions of both national energy markets (civic) and actors from both Emmen and Haren would have to be able to participate in this trade.

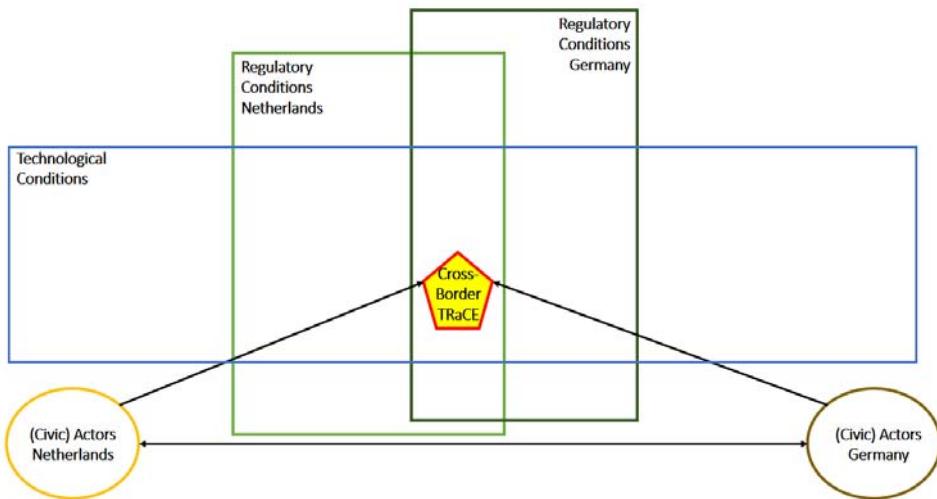


Figure 10: Cross-Border Trade of Regional and Civic Energy (Own Figure)

The interviews were transcribed and analyzed using the software MAXQDA. The content of the spoken interviews was smoothed in the process of the transcription, according to the rules for computer-based analysis from Kuckartz (cf. 2010: 44). With the help of the software, the answers were coded, using the analytical categories of the frameworks introduced above as the main categories. Additional subcategories were developed in the iterative process of analyzing the coded material, a common procedure for most qualitative content analysis (cf. Kuckartz 2010: 91 ff.; Kuckartz 2014: 109 ff.). For the purpose of this thesis, the method has some advantages, as it is less theory-bound, more descriptive, and "especially fitted to answer questions, on which there is little previously knowledge and exploration is standing in the foreground" (Kuckartz 2010: 96, own translation). The full list of all subcategories, including their definition and frequency, is presented in annex III. The subcategories are also discussed in the course of chapters 4 and 5, as well as the core results from the analysis of the interviews. Subcategories and their assignments to text passages were reviewed multiple times as a means of inter-personal verification. Each code is referring to an idea, which means that it can stretch out over multiple sentences (even over the statements of multiple speakers, if two persons were interviewed). Statements by the interviewing author were only coded, if they directly connect to the response of an interviewee. For the first part of the analysis in chapter 4, statements were only coded if they refer to an existing TRaCE (general project or concrete model) or national TRaCEs in general. If they refer to the SEREH project, or a cross-border TRaCE in general, they were coded with sub-categories evaluated in chapter 5.

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The statements from the interviews are referenced to by using ID numbers, composed of a Roman number assigned to each of the interviews and the paragraph number in the transcript. For instance, a quote referenced with the ID “V-52” originates from the interview the researchers from the University of Groningen from the 52th paragraph of the transcript. Most interviews were conducted in German, but all quotes used later in the thesis are in English and translated by myself.

Additional to the interviews, in chapter 4.4 relevant regulatory conditions for the actors in Emmen and Haren are selected, briefly analyzed and compared through desk research. Particularly for the German regulation analyzed in chapter 4.4.1, the desk research contributed more than the interviews. As the possibility to undertake interviews and the time available during the interviews, was limited, it was decided to focus not so much on (German) regulation in the interviews, as the necessary information could be contrived via desk research. The analysis in the regulatory chapter is based on the key points from the SEREH vision of the project. The chapter is designed to identify key pieces of legislation and explore their relevance for a (cross-border) TRaCE.

The energy transition is a multidisciplinary and comprehensive project. It brings along political, economic, regulatory, environmental, technical, ethical and other questions. Therefore, multiple scientific disciplines have identified this area as a field of research (cf. Joos 2016). Consequently, the discussion of the interview results is complemented with additional desk research where necessary, using literature from economics, political science, technology research and legal studies. Therefore, it aims to follow the interdisciplinary character of the energy transition.

3.2 Selection of Interview Partners and Introduction of TRaCE Projects

A total of seven qualitative interviews were carried out, with nine discussion partners. Interviews were either in German (five times) or English (two times). Where possible, they were face-to-face (four times); otherwise, interviews on the phone were the method of choice (three times). The interviews took between 55 and 80 minutes. They were not anonymized, as questions were not so much personal, but rather oriented on an external issue for the interviewees. Therefore, interviewees agreed to non-anonymization.

Table 1 provides an overview of all interviews carried out. Possible projects fitted for the interviews were identified in a process of desk research or discussion with the SEREH project team. The aim was to question a broad selection of interview partners, representing different ongoing TRaCE projects from Germany or

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the Netherlands with a focus on regional and or civic energy trade or having a profound expertise regarding regulatory or technological issues relevant to TRaCE models²³.

Position of the Interview Partner	Abbreviation	Institution	Topic of the Interview
Deputy Director	I	DLR Institute of Networked Energy Systems, Oldenburg	Technological Conditions of a TRaCE
Project Managers	II	Enera, Oldenburg	Establishing a Renewable Energy Region in Germany
Principal Consultant	III	Lumenaza GmbH, Berlin	A TRaCE Model from Germany in Practice
Founder	IV	Grunneger Power, Groningen	Local Energy Cooperatives in the Netherlands
Researchers	V	Center of Energy Law, University of Groningen	The Dutch Energy Regulation and Smart Grid Experimentation Projects
Project Staff	VI	Callia Project, Stuttgart	A European Research Project for Cross-Border DSO Cooperation and Business Models
Manager “Regulation”	VII	Netbeheer Nederland, The Hague	Power Grids and Grid Management in the Netherlands

Table 1: List of Interview Partners (Own Table)

In the following, the interview partners, their background and possibly the TRaCE project they represent, are introduced. The reason for selecting them for an interview is also illustrated.

The first interview with the deputy director of the DLR Institute of Networked Energy Systems²⁴ and head of the department for energy system analysis, did not specifically refer to a TRaCE project, but rather focused on technological conditions of a regional energy trade (chapter 4.3). The institute does research on technologies and system solutions for an energy system increasingly based on decentralized and fluctuating

²³ Three additional interviews were planned, but unfortunately, possible interviewees did not respond or it was not possible to schedule interviews on time: One interview with the company Agrowea, that plans and operates community wind farms around Haren and also develop a regional electricity product for consumers in that area; one interview with the German Federal Grid Agency in Bonn on the topic of regulatory conditions in Germany; and one interview with the German cooperative Energiegewinner that is investing not only in RES in Germany, but also carries out cross-border investments in projects in Luxembourg and France. In order to compensate for these three interviews, additional desk research was carried out and – where necessary – presented later in the analysis.

²⁴ Until June 2016, the institute’s name was “NEXT ENERGY”. After that, it was officially integrated into the German Aerospace Center (DLR) and was given its new name DLR Institute of Networked Energy Systems. At the time of the interview, the institute was still called Next Energy, so this is the name appearing in the transcript.

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input from RES, especially focusing on “smart homes, smart cities and smart regions [and] their complex interconnections” (Next Energy 2017: 4)²⁵.

The next interviewees were two project managers from the Enera project. It is led by the EWE AG and over 30 other institutions are partners in the consortium (cf. enera 2016: 13-17). Enera is showcasing solutions for a “technical and digital interaction between the grid, the market, and data to produce an incubator for the Energiewende” (2016: 1) in the counties of Friesland, Wittmund, Aurich and the city of Emden. The project is organized in 14 working packages, started in 2017, has a running-time of four years and a budget of more than 200 million Euros. The project managers are involved in the working packages focusing on future energy markets and products (cf. II-4). The Enera project was selected as a case, because it is an example for a TRaCE project in a rural region, similar to the area of Emmen and Haren (chapter 5.1.1).

The interview with the principal consultant at Lumenaza, focused on regional energy products. The Berlin-based company Lumenaza was founded in 2013 and had nine of these products running by March 2017. They offer regional electricity products (e.g. for a county), as well as community electricity products (e.g. for a cooperative). Lumenaza is regarding itself mainly as an IT-company, developing the necessary software for these trades, but they also act as a registered energy supplier, a direct marketer of energy on wholesale markets and a manager of balancing groups. They also offer services and templates for webpages to other suppliers and customers (cf. III-3 f.). As they are active with different TRaCE projects in Germany, Lumenaza was identified as a fruitful case regarding national TRaCEs in Germany.

Another interview was conducted with a founding member of the cooperative Grunnegerpower in Groningen in 2012. Grunnegerpower is one of the largest cooperatives in the Netherlands (cf. Hufn | Koppenjan 2015: 30). It acts as a retailer for renewable energy to customers and invests its profits in PV projects in Groningen (cf. IV-25; IV-28; Hufn | Koppenjan 2015). As of spring 2017, the cooperative had around 1,000 customers (cf. IV-27). The interview was selected to provide insights on the situation of civic actors in the Netherlands and to discuss the TRaCE project of a Dutch cooperative.

A second Groningen-based interview took place with two researchers specialized in smart grids from the faculty of law at the university of Groningen (cf. V-4 f.). One focus of the interview was the regulatory background for the implementation of TRaCEs and the SEREH project from the Dutch regulatory perspective.

²⁵ As stated in chapter d)3.1, all participants were shown the summary of the SEREH vision in the beginning of the interviews, to provide a common basis for discussion and to reduce the broad variety of expertise represented in the interviews to a common denominator. Only in the first interview, the SEREH vision was not presented and discussed in detail, as the method was not yet fully developed and the main purpose of the interview was to get a first insight into general technological conditions.

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Additionally, regional energy projects under the Dutch experimentation decree were discussed, allowing “associations to engage in collective generation, peer-to-peer supply, and in ‘project grids’ for system operation” (Lammers | Diestelmeier 2017: 8)²⁶.

Another interview was conducted with a researcher at the University of Stuttgart at the Institute of Combustion and Power Plant Technology and involved in the Callia project. It focusses on (cross-border) inter-DSO-trading and -markets. Project partners from Austria, Belgium, Germany and Turkey are involved and concrete results from the demonstration phase are expected in 2019 (cf. VI-3 ff.). The project was not only chosen because of its technological approach (chapter 4.3) for regionalizing energy, but also because of its cross-border character, that is relevant for the analysis in chapter 5.

The last interview was conducted with a manager from Netbeheer Nederland, which is the association of the national and regional electricity and gas network operators in the Netherlands and is located in The Hague. The manager is responsible for regulation and market facilitation. Before that, he was working on the SEREH project. The interview was mainly used to gather further insides on Dutch regulatory topics and discuss some current TRaCE projects from the Netherlands (cf. VII-2 ff.).

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In the previous chapter, the methods for answering the research question(s) have been described and the interview partners and their TRaCE projects have been introduced. In this chapter, the analysis of the first segment of the interviews takes place. Each of the four analytical categories, which have been introduced in the chapter 3.1, are separately discussed (chapter 4.1 – 4.4). Each evaluation starts by presenting sub-categories developed for the four analytical categories along the interview transcripts. After introducing the relevant subcategories, central quotes and insights from the interviews are discussed and, if necessary, complemented with results from additional research. The last chapter 4.5 then suggests a clustering-approach for the identified TRaCE models and thereby draws an interim summary on national TRaCE models. This will help answering sub-questions b) and c): What concrete TRaCE models are applied by actors from

²⁶ The analysis of the projects from the Dutch experimentation decree are also based on an journal article by Lammers and Diestelmeier (2017) on that topic, as Mrs. Diestelmeier pointed out during the interviews that she could not add much more to the topic than what was discussed in the article (cf. LDDK-39).

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TRaCE projects within a region in one national state? And what are the relevant external conditions (technological conditions and the respective national regulations in Germany and the Netherlands) affecting these TRaCE models?

4.1 TRaCE Models

The subcategories defined during the analysis of the interview transcripts for the first analytical category *TRaCE model* are shown in Table 2. They provide more detail on the TRaCE models deployed by the analyzed projects (respectively general statements on national TRaCE models). A single project might use more than one TRaCE model in their overall business case. For instance, the cooperative Grunnegepower acts as a retailer for green energy to end-consumers (participating in regular existing *overall markets*; cf. IV-28 f.), taps *local investments* through crowdfunding (cf. IV-41) and takes advantage of *tax exemptions* (cf. IV-34 f.). According to the definition developed during the coding-process, a project with the TRaCE model *experimentation* is “designed to take place in a certain time period under certain experimental conditions, possibly with regulatory exemptions or state funding for the project”. All these own definitions from the coding-process for the other subcategories can be found in annex III.

1.1. TRaCE Model	Number of Statements (N=173)	Share (in %)
(Integration Into) Overall Markets	47	27
Regional Market for Generation & Flexibility	34	20
Regional Label / Marketing	28	16
General	18	10
Experimentation	14	8
Local Investments	11	6
Tax Exemption	8	5
Miscellaneous Direct Marketing	8	5
Fixed Feed-In Tariff	5	3

Table 2: Subcategories for the Analytical Category TRaCE Models (Own Table)

Figure 11 shows the frequency at which certain TRaCE models were discussed in the interviews. The bigger the square in the figure, the more frequent a statement on the respective subcategory appeared during the particular interview. It should be noted that the frequency is not necessarily correlating to the actual importance or involvement of the particular actors in the corresponding project, as both general statements on the role of actors in TRaCEs and the actual involvement (or non-involvement) of these actors in the individual projects were coded into these subcategories. However, the frequency that the TRaCE models were mentioned still gives a first idea of their relevance to the respective interviewee.

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Figure 11: Frequency of TRaCE Model Subcategories in the Interviews (Own Figure)

Generally, it was noted that trying and testing new TRaCE models is important, as they potentially increase social acceptance of the energy transition at the local level (cf. VII-24), could lower some of the need for transmission grid expansion and provide business opportunities for energy producers. New business opportunities are particularly needed in times of increasing RES deployment, that lead to falling wholesale prices, as marginal costs for production from RES are almost zero (cf. I-8 ff.).

The Callia and Enera projects have similar goals: Both want to overcome the flaw of the current market design that does not reflect on local shortages and congestions in the grid with its uniform electricity price and instead assumes a European copper plate (cf. chapter 2.2.3). However, the project's approaches for solving the issue differ: Enera has a more centralized approach and aims to integrate regionalized products and price signals for regional flexibility services into the existing overall energy markets (cf. II-4; II-26). Opposed to that, Callia aims to create additional *regional flexibility markets* for times with congestions, thereby supplementing existing markets (cf. VI-7). The regional markets would likely be platforms run by a neutral operator on which flexibility services – e.g. steerable renewable energy, batteries, load management – offer their services to DSOs. This would happen first on the level on an individual distribution system area as intra-DSO-trading and then between different distribution system areas as inter-DSO-trading – possibly across borders (cf. BM: 9). With these different TRaCE models, both projects could create new trading opportunities for (regional) providers of energy and flexibility and to decrease the need for grid expansion, as regional shortages and congestions would be reflected in the market design and thereby provide economic incentives for actors to respond to these issues in problematic grid areas (cf. VI-24; II-4). Furthermore, *regional markets for generation* could be envisioned, depicting a sort of regional merit order (cf. I-42 f.). This means, that in a defined region, those production assets with the lowest marginal costs of production generally feed in electricity into the grids first (cf. 100 Prozent Erneuerbar Stiftung 2013).

Both the Enera and the Callia projects strongly emphasize grid operators as actors and focus on the physical level of regional energy flows in grids. In contrast to that, Lumenaza focuses not on regional grids, but rather

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on a virtual regional trade between energy producers and consumers through *regional labels and marketing*. The company first defines a region, either based on administrative territorial units (for instance a county) or based on “any other social, economic or psychologic connection” (III-3). Then, they offer owners of RES assets in that region to act as direct marketers for them. Opposed to other direct marketers, Lumenaza is not directly selling the electricity on wholesale markets, but offers it under a regional label to consumers in that area. As balancing group managers, they balance out generation and supply within the region. Imbalances are first tried to be offset with production or demand from other regions in which Lumenaza operates a regional balancing group. Balancing group management refers to the virtual accounting of a balanced energy production and consumption within the portfolio of an energy trader (chapter 4.4.1). Only if all these options are exhausted, Lumenaza buys or sells the remaining volume on the energy exchange, thus participating in the overall markets (cf. III-6). The revenues plant operators can expect for choosing Lumenaza as a direct marketer are not higher than if they would choose a regular direct marketer trading directly on the energy exchange. The motivation to participate is rather emotional or psychological (cf. III-10). Much likely, the same applies to customers choosing to buy electricity with a regional label (cf. Herbes | Friege 2015: 10 f.). The regional marketing approach could result in increased local investments: If more customers in a region choose the regional electricity product, there is a higher incentive to invest in additional renewable capacity in that area (cf. II-40).

In a two-folded way, Grunnegerpower also resorts to local investments: On the one hand, they used crowd-funding to obtain additional financial resources from the local population (cf. IV-25; IV-43). On the other hand, they re-invest the revenue from their electricity retail in PV projects in the city of Groningen (cf. IV-25; Hufen | Koppenjan 2015: 31). The cooperative obtains most of its cash flow as an electricity retailer. Together with other smaller cooperatives in the region, they founded the cooperative retail company Noordelijk Lokaal Duurzam (cf. IV-45; IV-55). This retail cooperative buys green electricity that is certified with GoOs (cf. chapter 2.2.1), primarily from the Northern Netherlands, and delivers it to customers²⁷. Therefore, the TRaCE model is largely integrated into the already existing market mechanisms. Regulation requires the retailer Noordelijk Lokaal Duurzam to appear on the energy bill of the customer, instead of Grunnegerpower, which makes it more difficult for them to become more well-known (cf. IV-57). In order to make investments economical, Grunnegerpower also makes use of the *Postcoderoos* tax deduction scheme. People who do not have a roof fitted for PV production can collectively operate a PV plant on a roof of a

²⁷ In 2016, 71 % of the green electricity traded by Noordelijk Lokaal Duurzam came from wind energy, the rest from PV. The Landgoed Scholtenszathe, which is involved in the SEREH project, is also marketing the average solar production of 1,300 MWh / year with the cooperative retailer (cf. Noordelijk Lokaal Duurzaam (2017)

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house in their zip code area, or one of the adjacent zip code areas. They pay a share of a solar panel and collectively deliver the produced electricity to Grunnegerpower. For each kWh produced in that PV plant, the cooperative members receive a deduction of nine cents over 15 years on their energy bill (cf. IV-34 ff.; Grunnegerpower 2017)²⁸. This tax exemption is generally regarded as too low for cooperatives to really have a profitable business case on a larger scale (cf. IV-37; Dóci | Gotchev 2016: 30). It is also criticized because “rules like tax deductions [...] for cooperatives [...] are just trying to stimulate investments in renewables, but they do not enable any market integration” (V-53).

Older energy cooperatives from Germany rely mostly on RES power plants supported with a *fixed feed-in tariff* under the EEG. Like tax deductions, fixed-feed in tariffs do not contribute to market integration, but they offer purchase and price guarantees to the cooperatives (cf. IV-17) which makes this TRaCE model economically attractive to cooperatives (cf. IV-31). As the EEG has changed and now requires more integration on wholesale markets by the means of direct marketing (as in the regional label / marketing model), the relevance of a fixed feed-in tariff is decreasing. In the Netherlands, the SDE+ (cf. chapter 2.2.2) plays no role for civic actors and TRaCE models, as it is not effective in terms of eliminating risks for cooperatives (cf. Dóci | Gotchev 2016: 32 f.).

The experimentation TRaCE projects under the Dutch experimentation decree profit from “new temporary regulations [...] with a circumscribed scope [...] derogating from existing law or waiving the observance of a number of rules or standards. [They] are designed to try out novel legal approaches or to regulate new products or services so as to gather more information about them” (Lammers | Diestelmeier 2017: 4 f.). The projects aim to experiment with new modes for collective electricity generation, a peer-to-peer supply of the generated energy, and grids not run by traditional grid operators. All this is regularly not yet possible under the Dutch regulation (chapter 4.4.2). This means, that “associations” like energy cooperatives could apply to take over grid management and operation activities from the DSOs, if they provide the necessary expertise and resources. They can do so within a specified “project grid” consisting of a maximum of 500 connected users. Thereby, the “division of market and grid activities [that is especially strict in the Netherlands] vanishes” (Lammers | Diestelmeier 2017: 5). The peer-to-peer supply enables producers to supply electricity to other members of the project and thereby become more independent actors on energy markets. Under normal conditions, small producers would only be allowed to sell their surplus electricity to their contracted supplier (cf. Lammers | Diestelmeier 2017: 7). The applied TRaCE model in these experimentation projects is only possible so long as the exemptions are granted (which is a maximum of ten years)

²⁸ Even though prices for PV installations have decreased significantly over the last years, the amount of the tax reduction recently rose from 7.5 to nine cent per kWh.

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and the project design is too restricted to “experiment with other modes of governance”, preventing “the involvement of new actors and emerging activities” and limiting active consumer involvement (Lammers | Diestelmeier 2017: 11). As a résumé, it was stated in the interview that an experimentation project “is more [fitted to] accumulate knowledge, [...] but it doesn't really make a step further. Because all the rules are so specifically defined, it is already existing actors just shifting around a bit the responsibilities but not really making innovation possible in the electricity sector if you want to go for more efficiency” (V-39). These projects are also rather complex, making it difficult for local actors to truly participate (cf. VII-18).

Miscellaneous direct marketing is not directly applied by any TRaCE project, but this model was mentioned briefly. In this case, the operator of a RES power plant does not receive any additional support via a feed-in tariff or a tax deduction. In the case of the German *sonstige Direktvermarktung*²⁹, the plant operator usually sells the green electricity directly to an energy intensive company close by. The electricity could flow over a privately run grid from the generation site to the site of consumption. Theoretically, the non-subsidized electricity could also be transferred through a public grid, but in this case, (a share of) network charges and concession fees would have to be paid, which makes this model often uneconomical (cf. III-26). The model is only used by a few onshore wind or hydroelectric power plants in Germany – around 160 MW of RES were marketed this way in 2016 (cf. Next Kraftwerke 2017). For the Netherlands, RES financed by individual power purchasing agreements (PPAs) were coded in this category. They are common in the Netherlands (cf. chapter 2.2.2). In PPAs, two parties – for instance a wind farm operator and a nearby company – agree on an electricity price and the generated electricity is then supplied to the customer (cf. IV-11 ff.; VII-16 ff.).

²⁹ Note that the miscellaneous direct marketing / *sonstige Direktvermarktung* differs from the normal case of direct marketing, where the electricity is sold on the regular wholesale markets directly by the plant operator or a third party.

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4.2 Actors

Chapters 2.1.2 and 2.2 showed how the landscape of *actors* active in the energy sector diversified. Different models of a regional energy trade are implemented by different sorts of actors. The actors mentioned in the interviews are shown in Table 3. As civic energy is an important feature of TRaCE models, *cooperatives*, *small energy producers*, *households* and *cities* were discussed frequently. The actor-code *new energy companies* was defined in the coding-process as "companies active in new / emerging fields of the electricity market, acting for instance as renewable-portfolio-aggregators, managing virtual power plants, trading renewable energy on wholesale markets as direct marketer or developing new IT-solutions / apps for smart energy solutions". Both *small energy producers / prosumers* and *households* refer to individuals (and households), but the first subcategory emphasizes their role as generators, while the latter sees them as electricity consumers. *Prosumers* are

"active or passive actors in the value chain, not only consuming energy, but also producing it to a certain amount or participating with their assets in the energy supply system, with the help of services from third actors [e.g. new energy companies]" (cf. Huener | Bez 2015: 341). Similar to the previous discussion about *TRaCE Models*, Figure 12 shows the frequency of certain *Actors* discussed in the interviews.

1.2. Actors	Number of Statements (N=162)	Share (in %)
Cooperatives	24	15
DSOs	23	14
Small Energy Producers / Prosumers	19	12
TSOs	18	11
New Energy Companies	17	10
Households	14	9
General	12	7
Utilities	11	7
Cities	9	6
Energy Consuming Companies	8	5
Universities / Research	7	4

Table 3: Subcategories for the Analytical Category Actors (Own Table)

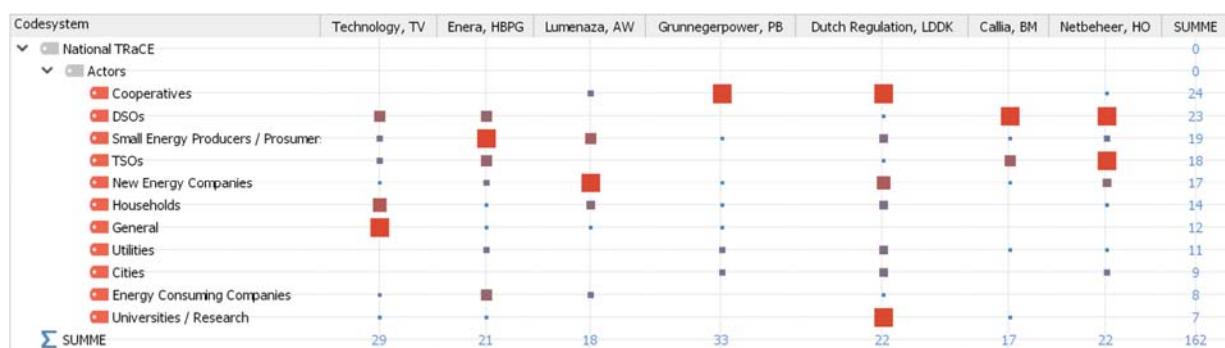


Figure 12: Frequency of Actors Subcategories in the Interviews (Own Figure)

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Generally, it was noted that all kinds of actors could possibly participate in future (regional) markets: Small and large actors who “as of today have no idea that they might participate” (I-5). Cooperation of actors was generally regarded beneficial, as it contributes to using infrastructure and technology more efficient and yields the best economic results (cf. I-9).

Many interviews showed that the power and responsibilities of different groups of actors are shifting in the current energy system, especially in innovative TRaCE projects. At the same time, the frequency at which specific actor groups were discussed in the interviews resonates with the thematic focus of the respective TRaCE projects. For instance, as Callia focusses mostly on inter- and intra-*DSO* trading, the perspective of the distribution system operators was most abundant. *TSOs* were also mentioned because in projects today “the question is always: How much responsibility are we transferring from the transmission grids to the distribution grids?” (VI-42); but grid operators could also loose competence to other actors. For instance, in the projects under the Dutch experimentation decree, new roles are assigned and “‘project grid’ associations, for instance energy cooperatives, have the option to take over responsibilities, and in consequence the powers, of current DSOs and energy supply companies” (Lammers | Diestelmeier 2017: 5 f.). In the interview with Lumenaza, as a prototype of a new energy company, *energy consuming companies*, households and small energy producers were also mentioned, as they aim to connect all these actors in a regional balancing group and often work on behalf or in cooperation with a local utility or cooperative (cf. III-4 ff.). New energy companies do not themselves own RES production assets, but they find new business opportunities in more decentralized and digitalized energy markets, as they are able to cluster capacities in a virtual power plant and trade these on wholesale markets (cf. I-23). They can therefore help to facilitate the exchange (physically and virtually) between the increasing number of market participants.

In the Netherlands, *cooperatives* are free to organize themselves in ways seeming most fitting for their purposes (cf. V-48). Because of that, there is a broad variety of types by which they are organized and how professionalized they have become. One type are wind cooperatives that are usually relatively old and well-organized. While in most cases they directly sell their generated electricity to large utilities, there are some examples for peer-to-peer supply. The other type of cooperatives came up more recent (called *Lokale Energie Coöperaties* – cf. chapter 2.2.2). Often, they are not registered as official (project) cooperatives and do not focus on RES generation itself, but rather on other issues like energy savings or education (cf. Oteman et al. 2014: 17; Hufn | Koppenjan 2015, 2015, 2015: 29 f.). There is a Green Funds Scheme (*Regeling groene projecten*) in the Netherlands to “offer cheap loans for environmental projects at an average interest rate 1 % lower than what is available on the market [...] specifically made for projects that would have difficulty

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getting financed otherwise” (Dóci | Gotchev 2016: 30 f.; cf. Government of the Netherlands 2017b). However, “it seems that the Green Funds Scheme is not available for all investors [and interested cooperatives]” (Dóci | Gotchev 2016: 33). The Dutch registered cooperative Grunnegerpower has chosen not to be “non-profit” but instead “profit for purpose”, meaning that instead of returning revenues to the cooperative members, they use them to “pay the staff, cover running costs and re-invest the rest in sustainable energy projects” (IV-25; cf. IV-60). The cooperative from Groningen sees cooperation with other actors (for instance the city and other cooperatives) as a crucial success factor for their business model (cf. IV-25; IV-45; Hufn | Koppenjan 2015: 32; 35).

In Germany, cooperatives are generally more institutionalized. Most of them are registered and organized as a *eingetragene Genossenschaft* (eG, especially for PV) and more focused on generating renewable energy (cf. chapter 2.2.1) and profits for their members, ensured by the relatively risk-free feed-in schemes of the EEG (cf. Dóci | Gotchev 2016: 33). Especially fitted for wind energy, there are other possible organizational forms or financing instruments ensuring civic participation (cf. ThEGA 2014: 57; Hoppe et al. 2015: 1910). Civic wind farms are often run by a company with a limited liability (*GmbH & Co. KG*). There are differences between the organizational forms in terms of, for instance, the corporate decision making processes or the capitalization. While the voting power of the members corresponds with the capital they brought in in a *GmbH & Co. KG*, in an eG, every member has one vote. *Gmbhs* have a higher share of outside capital (65 %) than a eGs (50 %) (cf. Kahla et al. 2017: 22; 24 f.).

Many interview partners frequently stated that there is not yet a real business case for consumers in households to participate in new energy markets via demand-side behavior: “On the end-consumer side, there are few approaches because it doesn’t pay off [...] we talk about savings of maybe 50 – 100 € that is no business case. However, everyone thinks it will become one in the future” (III-14); “No one really believes there is a motivation right now for households to participate in such a [demand-side] market [...] because the cost reduction would be 30 – 50 € a year. If you have an electricity bill of 800 – 900 € in a year, no one would say [...] ‘Yes, I do it’” (I-25). The two main barriers for small consumers to change their consumption behavior are high costs for the necessary smart meter unit (cf. II-31) and a static consumer electricity price (cf. I-26 f.). Some first movers and early adopters interested in the technology are however already pioneering with smart grid and demand-side management solutions in households (cf. I-27). As of today, most individuals or households participate rather on the production side: If they own a renewable power plant, they can increase self-consumption, especially by combining PV with storage technologies, and they can sell their excess electricity on markets, thereby becoming prosumers (cf. I-9).

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Cities are also civic actors (cf. chapter 2.1.2) and in a decentralizing and multi-level governed electricity system they have some opportunities for contributing to regional energy projects (cf. V-16; IV-23). For German municipalities, Philipp Schönberger identifies five means to promote RES (cf. 2013: 16 ff.):

- Overarching measures (such as local GHG reduction targets, climate actions plans or cooperations with other municipalities)
- Consumer behavior of the local administration (meeting municipal energy needs with RES or applying ecological criteria for procurement)
- Regulation and planning (building codes or the designation of areas for RES-plants)
- Provision of energy, public transport and housing (the municipality as a business actor, for instance via a municipal *Stadtwerk*)
- Support and information to local citizens and businesses

Especially the last two points are relevant in the context of supporting TRaCE projects. In the Netherlands, the general influence of the municipalities in the energy sector is smaller. This is mainly because provinces pass down targets for wind capacity installation requirements (cf. chapter 2.2.2) and municipal utilities were privatized in the process of the market liberalization in the 1990s (cf. IV-23). However, in the Netherlands provinces and municipalities own the DSOs (cf. VII-8).

4.3 Technological Conditions

Some technical features of the electricity system were already discussed in chapters 2.1.1 and 2.2. This chapter takes a closer look onto technological conditions for the different models of a regional and civic trade of energy, that were introduced previously. Table 4 provides an overview of the subcategories of technologic solutions discussed in the interviews.

Grid management was mentioned the most. It is defined as “all means taken by grid operators to stabilize voltage and frequency of a grid at any time”. Grid management becomes more important, as RES are

1.3. Technological Conditions	Number of Statements (N=152)	Share (in %)
Grid Management	52	34
<i>General</i>	23	15
<i>Distribution Grids</i>	19	13
<i>Transmission Grids</i>	9	6
IT and Data	22	14
System Services / Flexibility	19	13
Storage	17	11
Generation	14	9
Load	14	9
General	8	5
Sector Coupling	6	4

Table 4: Subcategories for the Analytical Category Technology
(Own Table)

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often installed in areas with a low population density “not necessarily close to the load center or to the existing high voltage grid” (cf. van den Bergh et al. 2015: 66). RES are not only decentralized, but their generation is also fluctuating, depending on the weather conditions, that can differ within different regions (cf. I-7). One grid management measure would be to expand the grids (especially transmission grids) to be able to react to the challenges of a decentralized and fluctuating RES generation by balancing out the lows and peaks over large areas (cf. chapter 2.1.1; I-9). An alternative measure of grid management resorts to using existing *generation* and *storage* capacities, grid infrastructure and *loads* more efficiently. As of today, this form of grid management is carried out mostly by TSOs: In times of shortages, they can resort to using balancing energy and in times of congestion they can redirect power flows around the congested grid area (also via loop-flows) or use redispatch measures (cf. chap. 2.2.3). If all these measures – which are called feed-in management or *Einspeisemanagement* (cf. Grimm et al. 2016: 469) – are not sufficient, the TSOs can force RES power plants to dim down generation. Especially in Germany, these measures are used increasingly, as the share of RES fed into the grid is rising: In 2015, 16,000 GWh were subject to redispatch. 4,722 GWh of renewable energy had to be shut down – this is called curtailment, i.e. the energy could have potentially been produced, but is effectively not used and thrown away, while the owners of the RES power plant receive a compensation. The year before, both numbers were only about one third as high. The total costs of these two measures alone amounted to around 900 million Euros in 2015 (cf. BNetzA | BKartA 2016: 7). All these forms of to-down grid management are centrally managed by TSOs.

Following a regional energy approach (cf. chapter 2.1.1), the grid management measures would need to be organized more decentral and bottom-up. Lower cellular units, like a neighboring municipalities or a whole DSO area, would have to be optimized before congestions in the transmission grids arise (cf. Haleakala-Stiftung 2017: 15 f.). Both the Enera and the Callia project are looking into these more decentral and bottom-up measures, increasingly involving DSOs and creating new markets or regionalized products on existing markets (cf. chap. 4.1). From a technological point of view, these new solutions have certain requirements: “Every street with a lot of PV has problems with the load in the grid. Today, the DSOs have to go there and manually solve the issue. Because the transformation substations are not digital. There are only very few transformation substations that are fit for remote control. EWE for instance has 16.000 substations in their area and only two are fit for remote control. Enera wants to change that” (I-9; cf. enera 2016: 25 ff.). The Callia project also focusses on “communication hardware” on the interface between grids, grid operators, markets and plants (VI-4) to “give DSOs a tool to better get to know their grids” (VI-7). Here, grid management is closely connected to the analytical subcategory *IT and data*, which was coded for statements referring to “issues connected to a more data-based, digitalized and automated energy system”. If

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the subcategories “grid management” and IT and data intersect, the term “smart grids” is often used. However, solutions involving IT and data do not only apply directly in the grid, but also on the generation side via steerable generation plants (cf. III-10) and on the load side via smart meters or apps for end-consumers and households (cf. II-31).

System services and flexibility are also closely connected to grid management measures. This subcategory encompasses “technical means to provide system services and ensure flexibility in the grid”. This includes balancing energy, which is used by TSOs to uphold frequency in the grids. Each of the four TSOs in Germany – TenneT, 50Hertz, Amprion and TransnetBW – as well as TenneT in the Netherlands, are responsible for upholding the frequency in their respective control area by tendering balancing energy, as primary reserve, secondary reserve or minute reserve. There is a distinction between positive balancing energy (increasing the frequency by adding generation capacity or taking load off the grid) and negative balancing energy (decreasing the frequency by shutting down generation capacity or adding load to the grid). All these sorts of balancing energy are being tendered on a joint platform of the TSOs in Germany (cf. 50Hertz et al. 2017). Flexibility is the capability of any technology connect to the grid to change its consumption or generation pattern quickly according to the grid’s needs. Therefore, not only RES that can be shut down provide flexibility, but also consumers adapting their demand and storage technologies (cf. VI-26). Projects like Enera or Callia try to establish new approaches that balance out grid imbalances, by utilizing providers of regional flexibilities and including DSOs in a bottom-up processes: “Our primary goal are system services. What the TSOs have today with their markets for balancing energy, we want to offer on a distribution grid level. While the TSOs have instruments like minute reserves, primary reserves and secondary reserves, [...] to keep the system in balance [...] so far the DSOs can only shut down power plants” (II-22; cf. VI-23). There are similar projects like these in the Netherlands (cf. VII-26). In order to be able to utilize an increasing amount of flexibilities, IT and data solutions are needed, for instance in the load segment, where households could offer flexibilities with the help of smart household appliances (cf. I-19). There is however, a general pitfall to these more regionalized approaches: In large and connected control areas, centrally managed by single TSOs, there is less need for providing balancing energy capacities, as power surpluses and demands partially compensate for one another (cf. BNetzA | BKartA 2016: 124). Even if regional flexibilities are utilized increasingly from a bottom-up level and DSOs receive more responsibilities, there will always be the need for some intra-regional energy exchanges and for overall wholesale markets to be able to minimize costs for balancing energy and the necessary backup capacities (cf. chapter 2.1.1; II-42; VII-22).

The Dutch experimentations projects try to use local grid infrastructure more efficiently by cutting down peak loads. This is also to be achieved by “remote-control of appliances in individual households”, but also

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by “peer-to-peer supply of electricity” and “energy management with batteries as storage units” (Lammers | Diestelmeier 2017: 9). An increased use of batteries could help overcome the central problem of the commodity power, which is fluctuating RES input into grids that have to be balanced at any time (cf. chapter 2.2). There is a trend that people add individual storage units – usually as lithium batteries – to their homes and connect them to a PV power plant on the roof – even though it might be uneconomical and technologically questionable to do so. Collectively using a larger storage unit within a “smart neighborhood” of a street or a city district would be more efficient in these regards (cf. I-9). Storage for wind power plants is technologically not yet so advanced; however, there are many research and development projects underway on that topic. Redox flow units, for instance, store energy in chemical components dissolved in liquids. They are a feasible technology for storing electrical energy produced in wind power plants (cf. I-31). Another alternative is electrolysis, where excess electricity is used to synthetically produce gas in the form of hydrogen or methane. This gas can be transported and fired up within the conventional gas grid and plant infrastructure, or it can be used as an alternative fuel for cars. As mentioned above, around five gigawatt hours of renewable electricity was not produced in 2015, because grids were congested. In these instances, it would be more reasonable to use the low electricity price and start filling up storage units or producing synthetic gas. When deployed on a larger scale, both the tanks containing liquid from redox flow batteries or the synthetic gas could be stored in caverns that are abundant in Northern Germany and the Benelux states. The Enera project is constructing several large storage unit for wind energy, that are to be a part of the regional flexibility portfolio³⁰. The batteries of electrical cars could also increasingly serve as energy storage units complementary to the grid (cf. I-25 ff.). All these are not only examples for storage, but also for *sector coupling*.

Projects like Grunneigerpower or Lumenaza are not explicitly about grid management, system services and flexibilities. However, Lumenaza believes grid management might become a business case in the future (cf. III-6). As of today and as explained above, Lumenaza builds a portfolio local generation capacities as a direct marketer and balancing group manager and markets this to consumers in a defined region. Their TRaCE model of regional labels and marketing could implicitly “align the physical flows of electrons and the balancing group based retail of electricity” (cf. Haleakala-Stiftung 2017: 16). However, if consumers choose to obtain a regional electricity product from the company, they do not receive that exact regional renewable

³⁰ One planned storage unit consists of lithium battery with a power of 7.5 MW and a capacity of 2.5 MWh and a sodium-sulphur battery with a power of 4 MW and a capacity of 20 MWh and is scheduled to be in operation as of 2018 (cf. EWE AG 2017). The EWE AG also announced their plans to build the largest battery in a world, based on the redox flow technology. This battery is supposed to have a power of 120 MW and a capacity of 700 MWh. The tanks needed for this battery, which is planned to become operational in 2023, are to be placed in caverns in Northern Germany. It is not clear, whether this will be in the Enera project region (cf. Klimaretter.info 2017; EWE Gasspeicher GmbH 2017).

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energy. To be able to really consume regional electricity, “you would have to cut the grid off [from the outside]. Because electricity is not a flowing product, but rather only the voltage in a system. There are no packages swimming through a grid. One does not get the electricity from the wind farm close by, even if one buys this electricity” (II-35). Therefore, only if there would be exclusively regional renewable energy fed into a disconnected regional the grid, actual regional electricity would be delivered. In their projects, however, Lumenaza aims to increase the congruence of regional renewable electricity production and electricity demand up to a 100 % – statistically over the year. The aim of increasing this congruence on a 15-minute scale is not yet on each project’s agenda, although some of Lumenaza’s regional projects (like Fichtelgebirgsstrom) want to achieve this (cf. III-6)³¹. Even though demand-side load management is not yet a business case (cf. chapter 4.1), Lumenaza believes it will become one in the future. As of today, they use standarized load profiles to calculate the consumption of households. This is standard procedure and necessary because most meters in households are not digitalized and therefore information about the real consumption patterns of individual households is not available. However, with an increasing number of smart meters in households and their background as an IT company, Lumenaza could increase demand-side management in order to better balance out local production and consumption on a shorter time scale. There are, however, still some technological challenges for smart demand-side management (possibly based on price signals), because “when I tell you ‘Energy is cheap now, just consume’, and I tell this to all the other consumers... everybody else will start to consume at the same time as well” – which could result in different types of problems for the grid operators (V-62).

On the generation side, the TRaCE model of Lumenaza increases incentives for local investments, but does not necessarily add to grid stability, as the representatives from the more grid-oriented Enera project pointed out: “Sarcastically speaking: You might as well put a savings box in front of a wind turbine and tell people to throw in five Euros if they like it. This regional approach has no relation to grid stability. The wind turbine operator will still connect to the grid, produce and forget [no matter the state of that grid] [...] These are good instruments to support the penetration with more renewables, but in terms of allocation, they are not always appropriate, as they might incentives to build new RES power plants in areas, that are already full in terms of grid capacity” (II-42). To this objection, Lumenaza replies that they work together with grid operators the same way all other energy retailers do, that their projects are not yet big enough to speak of

³¹ Fichtelgebirgsstrom is a joint project of the local utility, other cities and regional actors, as well as Lumenaza. Eight PV power plants, two wind power plants and two biomass CHP plants produced more than seven GWh in 2017 already (cf. Fichtelgebirgsstrom 2017). There are other regional electricity products like this in Germany, such as Bavariastrom, offered by regional cooperations from Bavaria (cf. Bavariastrom 2017). The company Vandebron from the Netherlands offers the possibility for customers to even buy electricity from a specific renewable energy plant (cf. AW-18; Vandebron 2017).

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overallocation and that with their software, they could increasingly contribute to grid stability in the future (cf. III-8).

Grunnegerpower almost completely disregards the technological side of regional energy and the topic was not subject to a closer discussion in the interview. Considering the actual physical energy flows is not part of their business model, as "we Europeans live on a copper plate anyways. [...] Ownership is more important. The people need to have the feeling, that the electricity produced here, is theirs. That is regional added value. It does not matter, whether this electricity is actually used by someone in Norway in the end" (IV-4).

4.4 Regulatory Conditions

The previous chapter showed that from a technological standpoint, many solutions needed for a more regionalized electricity system, for instance storage technologies or smart data-based managing of flexibilities, already exist and only need to be tested and implemented on a larger scale. But regulation is often lagging behind, hindering possible business models necessary for a larger roll-out of these technologies (cf. I-49). Regulators tend to favor central solutions and the expansion of transmission grids over more regionalized energy approaches – but a "paradigm shift is recognizable [...], driven by technological developments and entrepreneurial activities" (cf. Haleakala-Stiftung 2017: 40). The current development of these regulatory conditions are examined closer in this chapter.

In this chapter, the analysis of the interviews is complemented with a general overview of the regulatory conditions in the respective countries that are relevant for the different TRaCE models. Therefore, the structure of this chapter differs from the previous ones. The relevant regulatory authorities and key pieces of energy legislation are identified and analyzed in an additional process of desk research (cf. chapter 3.1); in chapter 4.1 for Germany and in chapter 4.2 for the Netherlands. This analysis focusses especially on aspects of importance to previously discussed TRaCE models and possibly to the SEREH project:

- State-funded and market-based revenue sources for producers of electricity from fluctuating RES
- (Special) regulations on civic actors such as energy producing and consuming local cooperatives, customers and companies in the region
- Special provisions for intelligent infrastructure and steering with smart meters, production and demand-side response options, as well as energy storage
- Special provisions for linking RES production and consumption in a spatial dimension

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4.4.1 Regulatory Conditions in Germany

In the interviews, the German *EEG* was mentioned most, as it is the central piece of legislation for increasing the deployment of RES (cf. Table 5). Details in the EEG not only determine how RES producers obtain their revenue, but are also important to the development of business models for civic energy cooperatives. Aspects of *network charges and balancing* are also important for some TRaCE models, as well as *regional certificates* providing provisions for linking RES production and consumption in a spatial dimension. As intelligent infrastructure is also central to many TRaCE models, regulation concerning the *digital energy transition* was also part of the interviews. Before examining these issues in more detail, an overview of central regulatory authorities is provided.

1.4. Regulatory Conditions in Germany	Number of Statements (N=32)	Share (in %)
EEG	14	44
Network Charges and Balancing	8	25
Digital Energy Transition	5	16
Regional Certificates	5	16

Table 5: Subcategories for the Analytical Category German Regulation (Own Table)

The German federal government is responsible for implementing EU legislation and for regulating the energy market in the country. Within the government, the Federal Ministry for Economic Affairs and Energy (*Bundesministerium für Energie und Wirtschaft*, BMWi) is mainly in charge. The portfolio of the BMWi also includes relevant regulatory agencies in the energy sector like the Federal Cartel Office (*Bundeskartellamt*) or the Federal Network Agency (*Bundesnetzagentur*, BNetzA). The Federal Ministry for Environment, Nature Conservation, Building and Nuclear Safety (*Bundesministerium für Umwelt und Bauern*) lost most of its competences in the field of legislation concerning RES to the BMWi in 2013, but it still has some relevant agencies in its portfolio, for instance the Federal Environmental Agency (*Umweltbundesamt*, UBA).

The “Energy Concept of the Federal Government” from 2010 contains central strategies for the national energy policy (cf. Becker 2010; cf. BMWi 2017b). The three equivalent targets in the center of the government’s strategy are to establish an energy system that is environmentally sound and provides a reliable and affordable energy supply (cf. CDU/CSU | SPD 2013; Bundesregierung 2010). In the energy concept, the government underlines the importance of an integrated European energy market and a connected European grid infrastructure (cf. Bundesregierung 2010: 17; 21; 36). However, in the 2010 strategy, regional cooperation is understood only as macro-level cooperation (cf. chapter 2.1.3) and neither cross-border distribution grids nor energy cooperatives or other civic actors are mentioned.

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The fundamental and general rules for the electricity and gas market are laid out in the Energy Industry Law (*Energiewirtschaftsgesetz*). It aims to establish a “safe, cost-effective, consumer-friendly and environmentally sound supply with electricity and gas”, regulate the grids and ensure “effective and unaltered competition” in the energy supply (BMWi 2017b, own translation). Section 20 (1) of the law states that grid operators have to allow a non-discriminatory access to the grids for every party fulfilling the requirements. These requirements are laid out in the Electricity Grid Access Provision (*Stromnetzzugangsverordnung*). This provision also regulates the management of the previously mentioned balancing groups. Balancing group management is a means to keep the grids in balance. For each of the four TSO-managed control areas in Germany, every energy producer or trader has to keep such a balancing group in order to be able to supply or obtain energy in the respective control area (cf. VII-10 ff.). The balancing group manager has to deliver schedules for the forecasted inputs into and withdrawals from the grids to the TSOs. If, for some reasons, the production and generation within a control area is not in balance, the TSOs have to counteract imbalances in the grid by retrieving balancing energy which they have secured in a tender. The responsible balancing group manager is charged with the costs for the actual provision of the balancing energy. If balancing energy was not needed, TSOs add costs for upholding it to the network charges on the electricity bill. The Electricity Network Charges Provision (*Stromnetzentgeldverordnung*) specifies the calculation of the network charges. Section 42 of the *Energiewirtschaftsgesetz* regulates how electricity providers have to provide information on the origin of the electricity and the RES-share in their electricity mix to the customers.

The fundamental rules for the utilization of RES are laid out in the EEG. It was first passed in 2000 (cf. chapter 2.2.1). So far, six amendments have been passed, the latest in 2016 (becoming effective at the beginning of 2017). Central fundamentals of the law are the priority access for RES to the grid and a fixed feed-in tariff with technology-specific rates, guaranteed for 20 years after the installation. In the beginning, the guaranteed feed-in remunerations were the results of political decisions and prices (in €/kWh) were the central variable for controlling the expansion of renewable energy production. This system began to shift towards a more capacity-based control in 2014, when a flexible cap (“*Atmender Deckel*”) was introduced to determine the exact remuneration rates for the individual technologies. For this, an expansion-target is politically defined (e.g. 2,400 – 2,600 MW onshore wind capacity added annually). If the actual added capacity is below this target in the previous year, the feed-in payments for newly installed assets are rising and vice versa (cf. Gawel | Lehmann 2014: 635). Another significant change in 2014 is the mandatory direct marketing for most of the new RES power plants, that has been introduced on a voluntary basis in 2012. Before that, all generated renewable electricity was passed on from the producers over the DSOs to the TSOs; the TSOs had to market the renewable electricity on the spot markets. The TSOs are remunerated for the difference

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between the spot market price and the fixed payments from the revenue of the reallocation charge on the electricity bill. This procedure is laid out in the Compensation Mechanism Provision (*Ausgleichsmechanismusverordnung*). Under the direct marketing, producers are now obligated to market the electricity themselves on the spot markets. This is complicated, particularly for small producers. Therefore, companies aggregating RES in a portfolio and marketing that portfolio on the spot markets, have emerged as service providers (cf. III-10). Producers receive a market premium on top of the spot market price. The market premium can be even higher than the EEG-payments if the power plant is generating electricity in times of high electricity spot prices. With these revenues, additional expenses for the direct marketing (and the mandatory remote-control technology that has to be installed in the power plants) are to be compensated and they provide an additional incentive for power plants to align their production schedule closer to the market (cf. Gawel | Lehmann 2014: 654).

With the EEG 2017, the shift from price-based control towards capacity-based control continues in order to make the energy transition in the electricity sector more market-oriented. New onshore (above 750 kW_{peak}) and offshore wind farms, as well as PV (about 750 kW_{peak} for tendering and above 100 kW_{peak} for direct marketing) and biomass (above 150 kW_{peak}) power plants now mandatorily need to participate in a tender and the direct marketing. The state issues several tenders over a year. For onshore wind, the capacity tendered annually is between 2,800 and 2,900 MW, for PV it is 2,500 MW. In the tenders, operators bid with the amount of money (in €/KWh) they need as a reference sum for calculating the market premium above spot market prices. Smaller power plants (especially PV power plants below 750 kW_{peak}, which are most rooftop PV installations) still receive the fixed EEG-payments. They can, however, voluntarily choose to participate in the direct marketing. The tenders are technology-specific. The EC favors technology-neutral tenders, in which technologies directly compete with each other on the lowest price. While proponents argue that this will drop prices, opponents stress that onshore wind would have an advantage over other technologies and this does not contribute to the technology-mix needed for more system stability (cf. Gawel | Purkus 2016: 911). The BMWi agreed with the EC to pilot technology-neutral tenders in 2018 (cf. BMWi 2016b). Under the EEG regulations, self-consumption and the consumption of electricity from energy storage units is economically thwarted as network charges and (a share of) the EEG reallocation charge have to be paid, even though electricity from the public grid is not used in these cases (cf. BNetzA 2016c)³².

³² Critics argue that more prosumers and self-consumption would threaten solidarity, as less people participate in financing important infrastructure developments (such as grid expansion and the roll-out of renewable power plants via the EEG reallocation charge). People who do not self-consume electricity therefore would have a higher financial burden to carry. Therefore, for some models of self-consumption, shares of the EEG reallocation and network charges have to be paid. Op-

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In the context of a (cross-border) TRaCE, the EEG contains three interesting provisions: For civic actors³³, for linking RES production and consumption in a spatial dimension and for cross-border subsidies for RES.

Civic actors and energy cooperatives profited greatly from the original EEG-provisions of guaranteed EEG-payments over 20 years, as these significantly decreased investment risks (cf. Dóci | Gotchev 2016: 31). The new tendering system increases these risks and poses an advantage for large utilities as they can participate with several projects in the tenders and therefore cope more easily with the risk of not winning in one of the bids. Originally, the EEG 2017 provided some exemptions in the tendering processes for cooperatives: In the onshore wind energy tenders, they did not have to undertake all the costly environmental impact assessment procedures beforehand and they received not the amount of subsidy they entered into the bid, but the amount of the highest bid that still won in the tender (cf. Hoppenbrock 2017). While in PV tenders, cooperatives have not proven to be very successful (cf. BNetzA 2016a), the majority of bids succeeding in the first PV tender were submitted by cooperatives – although it turned out that these cooperatives were mostly larger project development companies and utilities hiding behind this formal status (cf. Hoppenbrock 2017; BNetzA 2017; Welt 2017). Therefore, the privilege of not having to undertake an environmental impact assessment beforehand will not apply by 2018 (cf. BWE 2017).

In order to establish a certificate system for proving the spatial connection between produced and consumed electricity, the EEG 2017 contains a provision for the introduction of a regional certificate register (*Regionalnachweisregister*). The UBA is charged with building it up. The register is aimed to create a common system of certification until January 2018 for the rising number of TRaCE models using regional electricity labels and marketing. The idea is to issue these certificates if production and consumption of the directly marketed electricity takes place within a radius of 50 kilometers (cf. Haleakala-Stiftung 2017: 17), although it is still debated whether it would be possible to pass of certificates along the supply chain of a balancing group, which would make it possible to market regional energy for renewable energy produced in Northern Germany to a consumer in Bavaria (cf. III-12). Although details of the planned register are still developed (cf. UBA 2017b), the introduction of this register is generally appreciated, as it provides a secure regulatory basis for the marketing of regional electricity. This fundament was not given before, as it is generally prohibited to market electricity in a two-fold way. This is called *Doppelvermarktungsverbot*, meaning

ponents of this arrangement argue, that self-consumption of RES is in itself a solidary act in the society, as it spares resources and the climate. Additionally, they point out that – following the logic of opponents to self-consumption – planting vegetables in the garden would also not be solidary, as taxes are not paid (cf. Haleakala-Stiftung 2017: 28).

³³ Another provision is additionally interesting to civic actors: There is a new model aiming to roll out tenant electricity (*Mieterstrommodell*). This tenant electricity is trying to provide an economically attractive way for landlords to put PV power plants on the roof and deliver tenants with cheaper electricity. This models offers new business opportunities for civic actors and cooperatives (cf. Hoppenbrock 2017).

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that renewable energy marketed over the electricity exchange can generally not be marketed in an additional way (cf. chapter 2.2.1; III-12).

The new EEG also states that five percent “of the newly installed renewables capacity per year will be opened to installations from other EU Member States” (HBS EU | WFC 2017c: 18). For the first time in 2016, Germany opened a PV tender for bids from Denmark and vice versa (cf. HBS EU | WFC 2017c: 16 ff.).

The EU aims to have an 80 % rollout for smart meters in their member states by 2020. However, Germany opted for a selective roll-out based on a cost-benefit analysis and is expected to have a market share of smart meters around 23 % by that time (cf. EC | JRC 2017). While smart meters offer potential cost-savings in Germany by saving energy, shifting loads and avoiding distribution grid investments, they are connected to investment, communication and IT costs (cf. EC 2014a: 49). Provisions for smart meters and smart grids are laid out in the 2016 Law for Digitalizing the Energy Transition (*Gesetz zur Digitalisierung der Energiewende*). It regulates that only RES producers and energy consumers with a certain level of energy production respectively consumption are required to install and finance smart meters and only if the costs for the installation and operation is within a set price range (cf. BMWi 2017a). The DSOs are usually the operators of the smart meters and they receive more information about the energy flows in their area and the condition of their grids due to the new digitalization law (cf. VI-7; VI-46). There are still, however, regulatory uncertainties in terms of what actors are able to act in which ways on the information they are provided with (cf. I-14; I-23).

4.4.2 Regulatory Conditions in the Netherlands

In the interviews, aspects of *network charges and balancing* were discussed most for the regulatory case in the Netherlands, as shown in Table 6. *Laws for cooperatives* and the *digital energy transition* were also mentioned as provisions for civic actors and intelligent use of infrastructures. The *SDE+* and *tax deductions* are the two central state-support schemes for the production of RES in the Netherlands. Similar to the case for regulatory conditions in Germany, additional material is taken into account in the analysis, as specific regulatory topics were discussed the least in the interviews, and the discussion starts by providing an overview of central regulatory actors.

1.5. Regulatory Conditions in The Netherlands	Number of Statements (N=26)	Share (in %)
Network Charges and Balancing	10	38
Laws for Cooperatives	4	15
Regional Certificates	4	15
Digital Energy Transition	3	12
Tax Deductions	3	12
SDE+	2	8

Table 6: Subcategories for the Analytical Category Dutch Regulation (Own Table)

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The Netherlands Authority for Consumers and Markets (ACM) is the main authority for regulating the energy sector. It is responsible for enforcing European and national regulation, driving up RES supply and supervising “the exercise of dominance in the electricity sector, including regulation of third party access and tariffs related to the Dutch electricity transport networks” (Bouchez | Bos 2014: 316). Additionally, the Dutch Minister of Economic Affairs has some direct responsibilities and “plays an important role [...] as regards the cross-border transmission of electricity and gas” (Bouchez | Bos 2014: 317). The Social Economic Council (*Sociaal Economische Raad*) advises the government on regulatory and market issues in the energy sector. Overall, this sector is managed with a “strongly economical approach to renewable energy planning” (Oteman et al. 2014: 17). It is consensus-driven, as 47 organizations signed in 2013 the National Energy Agreement for Sustainable Growth, setting “energy and climate policy objectives and measures for the period until 2020 / 2023, aiming to put the Netherlands on its way achieve a sustainable energy system by 2050” (Agora Energiewende 2014). In order to reach the Agreement’s target for an RES-share on final energy demand in 2023 of 16 %, twelve pillars have been defined. They include “scaling-up renewable energy production” by (among other means) the expansion of onshore wind farms and “decentralized renewable energy generation”, aiming to have one million households or small and medium-sized enterprises using a substantial share of decentralized generated RES by 2020 (cf. Sociaal-Economische Raad 2015: 11).

Under the current legislative acts in the energy sector, electricity producers need to apply for a special license at the ACM in order to be able to supply electricity to domestic customers (cf. Bouchez | Bos 2014: 317; Lammers | Diestelmeier 2017: 7). The ACM also determines tariff conditions for using transmission grids and supervises TenneT, which is the national TSO for electricity and owned by the state. Similar to the system of balance responsibility in Germany, in the Netherlands TenneT is “supervising and recognizing each programme responsible party [PRP]” (Bouchez | Bos 2014: 321). A PRP can be compared to the balancing group manager in Germany (cf. VII-10 ff.). The PRPs have to be authorized by the TSO. On a daily basis, the PRPs have to inform TenneT about planned transactions and have to settle any remaining imbalances – the sum of all transactions is called the energy program. Actors having one or more connections to the electricity grid can choose to set up their own programs or assign this responsibility to a PRP (cf. TenneT 2017). Grunneigerpower chose to have a PRP as a service-company do the balancing for them (cf. IV-51 ff.). However, it is both relatively complicated and costly to become recognized as a PRP by a TSO; for households, the electricity retailer takes over balancing responsibilities automatically, and “small time grid connectors [for instance a rooftop PV power plant] [...] cannot have free choice in balancing responsible parties” and are also “obligated to hand over balancing responsibility to the retailer” (VII-14). State-issued regional

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certificates for regional electricity do not exist in the Netherlands (cf. VII-17 ff.) and there are also no regional balancing groups onto which they could be based, as the whole Netherlands is considered an integrated balancing and control area (cf. VII-18; 48 ff.). Therefore, companies offering a regionally labelled electricity product to customers, can only do so by accounting for the regional aspect within their own company system (cf. VII-20).

In terms of grid connection and dispatch, there are no “separate market conditions renewables and non-renewables” (VII-16). Compared to Germany, the situation is more difficult for RES producers in the Netherlands, as grid operators “can refuse the connection of electricity producers in the case of over-production. In every case, electricity producers have to bear the costs of establishing the grid connection and, above 10 MW production, they are even obliged to arrange the connection according to the grid administrator’s requirements. In that case, producers can be refused connecting to the closest point and be required to find another connection point further away [...] Moreover, there is an obligation for grid operators to buy the electricity only up to 10 MW” (Dóci | Gotchev 2016: 30; cf. RES Legal 2017).

All Dutch grid operators are fully unbundled in terms of ownership (cf. chapter 2.2.3) – in no other European country, the unbundling is as strict as in the Netherlands (cf. CEER 2016a: 5). As a result, “TSO and DSOs are all publicly owned, the TSO by the state and the DSOs by the provinces and municipalities; for instance, Emmen is a shareholder for Enexis. [Additionally], 95 % of the activities of DSOs and TSOs are within the regulated domain” (VII-8). So while in Germany, grid operators are more closely connected to their parent companies, in the Netherlands they are closer affiliated to their public owners.

As described in chapter 2.2.2, the SDE+ scheme is the primary subvention scheme for RES (except offshore wind energy). In two rounds per year, producers can apply for the tariff. The SDE+ operating grant “compensates [by paying a premium] for the difference between the cost price of renewable energy and the market-value of the energy supplied” over eight, 12 or 15 years (Netherlands Enterprise Agency 2017: 3). The premium is largely technology-specific, although there is no one budget for all categories taken together, which results in a certain competition between these technologies. Like in Germany, the premium is since 2013 financed by a reallocation charge on the electricity bill of individuals and business, but “unlike in Germany the SDE+ budget has still a finite amount of money. Each year, the projects are evaluated according to certain criteria and receive funding on a first come, first served basis until the budget is depleted” (cf. Dóci | Gotchev 2016: 30). The Dutch government has been increasing this budget: In 2015, the total subsidies granted in both annual rounds of the tender amounted to 3.5 billion Euros; in 2016 it was already nine billion Euros (cf. Deutsch-Niederländische Handelskammer 2016: 29; IEA 2017) and the 2017 spring

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round of the SDE+, it had a total budget of six billion Euros (cf. Netherlands Enterprise Agency 2017: 4). The largest portion of RES funded by SDE+ is traded on the APX in Amsterdam. Individual PPAs are also a common source of funding (cf. chapter 4.1; VII-16; IV-11 ff.)

Before being able to submit a tender for the SDE+ scheme, applicants have to meet certain criteria: They have to undertake a feasibility study, where applicable issue a wind report or geological survey and receive the necessary environmental permits. Different to Germany, there are no exemptions for cooperatives or other small civic actors in this application process (cf. Netherlands Enterprise Agency 2017: 28 ff.) which increases the risk for these actors, as meeting the requirements requires capital input before the participation in the support scheme is even ensured. Eligible technologies for SDE+ supports are solar, (onshore) wind, hydro, geothermal and biomass power plants. There are separate tenders for offshore wind. Solar PV power plants have to have a capacity of above 15 kW_{Peak} and a “large-scale energy connection to the grid” – which excludes most PV installations on household rooftops, that are typically operated by individuals or cooperatives, from this subvention scheme (cf. Netherlands Enterprise Agency 2017: 26). For these cases, other support programmes in the form of tax incentives and deductions exist in the Netherlands, for instance the balancing (*saldering*) law. If individuals and households produce renewable energy on their own property (behind their meter, without using the grid), tax exemptions on the energy bill for up to 5,000 kWh a year are possible (cf. Dóci | Gotchev 2016: 30). If the electricity is transported through a public grid, the tax exemptions do not apply, which makes collective energy production uneconomical. In order to change this situation, the *Postcoderoos* scheme was introduced in 2014 (cf. chapter 4.1).

In terms of digitalization, the Dutch roll-out of smart meters is more advanced than in Germany. The Netherlands chose a wide-scale roll-out and are expected to have a share of 100 % smart meters by 2020 (cf. EC | JRC 2017). Smart meters are installed and operated by DSOs, who cover also the costs for the installations in households and get compensated for these costs via network tariffs (cf. EC 2014a: 79). It is not obligatory to have the smart meter installed, but the refusal rate of the households is low (cf. Government of the Netherlands 2017c).

4.5 Interim Summary: Dimensions of Regional and Civic Energy

Based on the interviews and an additional research, different TRaCE models, their actors and technological and regulatory conditions, have now been identified and described. In order to better understand how exactly they reflect a *trade of regional and civic energy*, in this chapter a way to cluster these models along central dimensions is developed. In the literature, approaches to characterize and cluster regional trade models are rare. In a workshop report from the Leuphana University Lueneburg about “Green Electricity

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from the Region for the Region” (own translation), it is noted that “business models for regional marketing of renewable energy [...] differ in terms of how they are organized, in terms of which incentives in the regulatory framework they use and in terms of which customer expectations regarding a sustainable energy supply they attend to” (Holstenkamp | Bettinger 2015: 5, own translation). Holstenkamp and Bettinger further distinguish types of regional trade models based on actors governing them primarily – either a *Stadtwerk*, a private energy company cooperating with local actors or a regional cooperative (cf. 2015: 9). Following the analysis of the interviews conducted for this thesis, three dimensions fit for characterizing and clustering TRaCE models, partly following the categories of Holstenkamp and Bettinger, but also placing new emphases based on the previous analysis of national TRaCE projects. The dimensions are:

- Degree of decentralizing physical energy flows: This dimension addresses the analytical category technologic conditions and whether the TRaCE model is actually contributing to decentralizing physical flows of electrical energy in the grids, in accordance with the “regional energy” approach discussed in chapter 2.1.1. This technological level is largely disregarded by Holstenkamp | Bettinger 2015.
- Degree of decentralizing ownership: Similar to the distinction of which actors govern the regional trade, made by Holstenkamp and Bettinger (2015), this dimension addresses the analytical category of actors involved in a TRaCE model and whether it is actually providing opportunities for non-traditional, regional and civic actors to participate. This is following the “civic energy” approach discussed in chapter 2.1.2.
- Degree of decentralizing markets: This dimension addresses whether the TRaCE is fully embedded into the existing national and European platforms of power trade (as described in chapter 2.2), or whether the TRaCE is rather “outside” these markets – either by creating completely new regional markets or by not really participating in existing markets and instead mainly relying on state subsidies or experimental exemptions. This dimension reflects an aspect identified by Holstenkamp | Bettinger 2015, who distinguish regional trade models based on “which incentives in the regulatory framework they use” and therefore connects to the discussion on the analytical category *regulatory conditions*.

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Figure 13 illustrates the attempt to place TRaCE models in these categories. For each of the three categories, there are three manifestations of the degree of decentralization: A TRaCE model can either tend to be decentral, central or fall in the residual manifestation in between. In this case, the actual degree of decentralization was difficult to determine based on the interviews or the TRaCE model does not have any effect on the degree of decentralization. The TRaCE models were placed in the mani-

TRaCE Model	Dimension of (De)Centralization	Tends to be decentral	Difficult to determine / No effect	Tends to be central
(Integration Into) Overall Markets	<i>Energy Flows</i> <i>Ownership</i> <i>Markets</i>	x	x	x
Regional Market for Generation / Flexibility	<i>Energy Flows</i> <i>Ownership</i> <i>Markets</i>	x	x	
Regional Label / Marketing	<i>Energy Flows</i> <i>Ownership</i> <i>Markets</i>	x	x	
Experimentation	<i>Energy Flows</i> <i>Ownership</i> <i>Markets</i>	x	x	
Local Investments	<i>Energy Flows</i> <i>Ownership</i> <i>Markets</i>	x	x	
Tax Exemption	<i>Energy Flows</i> <i>Ownership</i> <i>Markets</i>	x		x
Miscellaneous Direct Marketing	<i>Energy Flows</i> <i>Ownership</i> <i>Markets</i>	x	x	
Fixed Feed-In Tariff	<i>Energy Flows</i> <i>Ownership</i> <i>Markets</i>	x	x	x

Figure 13: Central Dimensions for TRaCE Models (Own Figure)

festation-categories based on the analysis in the previous chapter, and their placement is elaborated further in the following paragraphs. The attempt of clustering TRaCE models is aimed to provide a basis for the following summarizing discussion on national TRaCE models.

The TRaCE model of integration into overall markets aims to establish and facilitate regional components in the regular electricity markets. This aims to decentralize energy flows if, for instance, a greater volume of regional flexibilities is used. At the same time, the trade would happen within a modified overall market system. Decentral actors could potentially increase their trade opportunities with these regional components, but the overall effect is difficult to determine.

The TRaCE model aiming to create regional markets for generation and flexibility is similar in terms of energy flows and ownership, but in this case additional decentral markets are created, instead of utilizing existing markets. Nevertheless, in some cases the decentral markets would still be coupled to existing markets, as in the case of the Callia project – the envisioned regional flexibility markets would only be used, if grid

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management issues occur on the regular markets. Regional markets for generation, that follow a regional merit order for feeding in electricity to the grids, would be even more decentralized.

A regional label for marketing regional electricity can (at least in Germany) result in a decentral ownership and a decentral market. Selling to or buying from this regional electricity product can create new opportunities for non-traditional and civic actors and it can additionally create a sense of ownership and identification within the region (cf. III-10; Haleakala-Stiftung 2017: 25 f.). In the case of Lumenaza, they try to market the electricity first within their balancing group portfolio and only participate in the overall electricity market as the last option, which creates a sort of regional market. So far, this regional balancing does not contribute to more decentral energy flows, but it might do so in the future (cf. chapters 4.1 and 4.3). In the Netherlands, energy flows and markets are more centralized in this TRaCE model, as there are no decentral balancing groups or regional certificates (cf. chap. 4.4.2).

Dutch Experimentation projects tend to be decentral in all three dimensions: One example is the Dutch wind energy cooperative De Windvogel, that uses their wind power plants for peer-to-peer supply to their cooperative members (cf. Hoppe et al. 2015: 1911) and experiments with flexible electricity tariffs that could help balancing out electricity supply and demand at a local level (cf. Lammers | Diestelmeier 2017: 8). Overall, the Experimentation projects try to optimize regional electricity flows with smart grid solutions, involve non-traditional actors (like cooperatives, owners' associations and research centers) and create decentral markets by enabling peer-to-peer supply. But it was also shown in the analysis, that these projects could be too complicated for the non-traditional actors having to take over many responsibilities and to create new organizational structures. At the same time, the projects are rather specific and have a limited time frame, which makes upscaling on a regional level difficult.

Local investments, for instance by a cooperative using their revenue to invest in further RES in their area or using income generated in a (local) crowd-funding platform, could result in a decentral ownership of assets. It is possible that these assets would then contribute to more decentral power flows or offer their services on decentral markets, but they might as well not (depending on the way the electricity is marketed and distributed), which makes the effect in these two dimensions difficult to determine.

TRaCE models based on tax deduction tend to be disconnected from central markets, because they do not require any sort of market integration. As these tax exemption models in the Netherlands are mainly de-

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signed for small actors like individuals, households and cooperatives, they tend to be decentral in the ownership dimension. As electricity produced with tax deductions is still fed into the regular grid, there is no incentive to decentralize energy flows.

Miscellaneous direct marketing tends to be decentral in all three dimensions, similar to the experimentation projects. If electricity flows through a private grid, the energy flows are decentral. In cases, where the electricity is fed into a public grid, however, this is different. In the market dimension, there is also a decentralization, because electricity is not marketed on overall energy wholesale markets, but rather directly traded between two parties (as with both PPAs and the *sonstige Direktvermarktung*). This arrangement offers the possibility for a range of regional actors to participate, which results in a decentralization in terms of ownership. The German *Mieterstrommodell* could also be added to this category (cf. chapter 4.4.1) but is was not discussed in the interviews. For a truly *regional* trade (cf. chap. 2.1.1), the miscellaneous direct marketing model might, however, be too narrow, as it relies on direct agreements between a small number of parties and does not create a truly connected regional platform.

A few years ago, a fixed feed-in tariff could have been considered to tend to decentralize ownership, as the great number of energy cooperatives in Germany shows (cf. chapter 2.2.1). For new RES projects today, the overall effect in terms of ownership is, however, difficult to determine, for two reasons: First, established large utilities can also use feed-in tariffs and, second, the EEG has increasingly becoming more complicated, thus reducing the opportunities for civic actors to participate (cf. chap 4.4.1). In terms of markets, there was not much market integration through this TRaCE model in Germany at the beginning and there are special exemptions for small RES producers (who did not have to market their electricity at the energy exchanges), which made the model tend towards the more decentral spectrum. Similar to the ownership dimension, the trend in the market dimension in Germany is moving towards more centralization, as EEG funded RES are increasingly integrated into markets (cf. chapter 4.4.1). In the Netherlands, the SDE+ has always been more market-oriented with its tendering approach (cf. chap. 4.4.2). Therefore, the overall decentralization of the market dimension is difficult to determine. In terms of physical energy flows, the generated electricity is sold and transported within the regular national market and grid systems, which lacks decentral elements.

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The previous chapter illustrated different TRaCE models, their actors and their technological and regulatory conditions. As a conclusion, the analysis identified three central dimensions along which TRaCE models can be decentralized: The actual physical energy flows, the ownership and the market platforms. In this chapter, the cross-border dimension is now added to the discussion and its implications in the specific SEREH case are analyzed. For this purpose, interviewees were asked to assess from their point of view the possible obstacles and opportunities for implementing different TRaCE models in this cross-border case. Before analyzing the results from the interviews, the Emmen – Haren region and the SEREH project are introduced in more detail (chapter 5.1). This also helps answering the sub-question a) on actors in the Emmen – Haren area. In the next sub-chapter, the first impression of the interviewees on the general meaningfulness of the SEREH project is illustrated. After that, the four analytical categories TRaCE model, actors, technological conditions and regulatory conditions are again used to structure the analysis in the subsequent sub-chapters – only this time, the analytical category TRaCE models is analyzed last in order to be able to take into account all the learnings from the previous discussion in this chapter. The interviews provided the main source of information and additional desk research was added if necessary³⁴. All the statements from the interviews referring specifically to the SEREH project or generally to a cross-border TRaCE were coded. The four code categories are similar to the four analytical categories. Each of the four main categories have the subcategories *obstacles* (if the statement describes a challenge in the respective category), *opportunities* (if the statement describes a possible solution or advantage of the project in the respective category) and *general* (if the statement is referring to a certain analytical category, but is neither positive nor negative). The analysis in this chapter is purely qualitative; an overview of the described subcategories and the quantification of the sorted statements can be found in annex III. Overall, this chapter aims to answer the sub-question d): Which concrete obstacles and opportunities for the design and implementation of the vision of a cross-border TRaCE can be derived from the analysis in terms of external (regulatory and technological) conditions and in terms of concrete TRaCE models for actors within the two municipalities?

³⁴ A discussion by the HBS EU and the WFC in June 2017 at the Committee of Regions in Brussels posed a fertile source for this additional research. The discussion focused on subnational cross-border cooperation in the energy sector in Europe. Panel speakers came from local cross-border projects (also including a representative of the SEREH project), TSO and DSO associations and European institutions (cf. HBS EU | WFC 2017a, 2017b).

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5.1 The Project “Smart Energy Region Emmen – Haren”

The SEREH project is carried by the two municipalities Emmen and Haren. Other project members include the DSOs Westnetz (Germany, subsidiary of innogy SE / RWE) and Enexis (Netherlands), the Universities from Twente and Osnabrück, the wind project development company Agrowea from the region, ENERCON, the *Wirtschaftsverband Emsland* and the *Landgoed Scholtenszathe*. Additionally, the city of Emmen is representing the SEREH project in the INTERREG V B North Sea Region program COBEN and funding via participation in additional programmes is a goal. The INTERREG program is a tool of the EU to guide the development and cooperation at regional level³⁵.

Because no direct grid exists between Emmen and Haren, the surplus energy from the German city is not directly transported to Emmen, even though the Dutch city could theoretically take it all up. Instead, the surplus renewable energy from in Haren is fed into the German national extra-high voltage grid, operated by TSOs. The electricity is then marketed and distributed within Germany or possibly across borders (Emmen | Haren 2016: 14 f.; Bleydorn et al. 2017). Two of the three interconnectors between Germany and the Netherlands are located close to the cities: Between Diele and Meeden and between Gronau and Hengelo (cf. Bleydorn et al. 2017: 34). One aim of SEREH is therefore to develop and implement a (smart) grid medium voltage interconnection between the two cities, hence avoiding curtailment and loop flows and creating a basis for a connected and more self-sufficient region. A cross-border wind farm is planned, with a capacity of around 20 MW on the Dutch side and 67 MW on the German side. The project in Germany is scheduled to start construction in 2018 (cf. NOZ 2017), in Emmen construction starts later. The wind parks are supposed to include research and development elements for storage and power-to-x technologies, where electricity is transformed into another form of energy in times of surplus electricity production (cf. Pieper 2017). The two wind farms could serve as the connection points for a medium voltage interconnector, thus reducing investments costs. In 2016, a group of master students from Osnabrück (Bleydorn et al. 2017) collected data on (renewable) energy supply and demand in Haren and identified European regulatory conditions on different grid connection possibilities. More specifically, they evaluated four possibilities: Integration into the established system of TSO connectors without a new power line³⁶; the construction

³⁵ There are different strands within this framework: INTERREG A is directly funding adjacent cross border regions in Europe, INTERREG B provides funding to transnational cooperation of different government-levels spreading across Europe and INTERREG C funds large interregional cooperation and exchange-networks (cf. Ecofys | HBS EU 2015: 19). The EU sets the overall budget and political guidelines and targets for a general funding period of seven years. The guidelines for the current INTERREG-period are based on eleven overall investment priorities, including “low carbon economy”, “combating climate change” and “environment and resource efficiency” (cf. EC 2017b).

³⁶ This option also assed the use of cooperation mechanism in the European Renewable Energy Directive, namely statistical transfers (cf. chapter 2.2.3; Bleydorn et al. 2017: 39 f.)

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of a direct line after directive 2009/72/EC Art. 2 (15)³⁷; a distribution line connected to the overall grid; or the construction of a new medium voltage line under the Merchant Transmission Investment (cf. Bleydorn et al. 2017: 38-47). If the two cities achieve their goal and deploy one of the latter three possibilities, they would have the first distribution-level interconnection between two countries in Europe (Bleydorn et al. 2017: 50 ff.). The cross-border medium voltage grid and the innovative wind farms could contribute to decentralizing energy flows in the region (cf. chapter 4.5).

Apart from the construction of a connecting grid, another aim of the project is to identify ways allowing individuals, cooperatives and local companies to participate in a local cross-border trade of energy. By experimenting with new roles and responsibilities for these local actors, new trade models are to be tested in a shifting regulatory landscape (cf. Emmen | Haren 2016: 36 f.). Within this strand, the goal is to show that there could possibly be incentives for actors to participate in a direct cross-border TRaCE. Or, put in other words: To show if and how actors on both sides of the border would have to gain by joining a sort of regional cross-border energy trade instead of just selling to or buying within the regular national energy system. This part of the project aims at decentralizing ownership and markets (cf. chapter 4.5).

5.1.1 The Emmen – Haren Area

Emmen is the largest city in the province Drenthe. About one fifth of the province's total population lives in that city, making it a regional center. The city has around 110,000 inhabitants and an area of 346 km² and is therefore less densely populated than the Dutch average (310 inhabitants/km² compared to 408 inhabitants/km²). Tourism is an important sector. The local zoo is one of the biggest of sights in the Northern Netherlands. An industrial park for the green chemical industry is another relevant economic factor in the city, as well as horticulture, greenhouse-farming (cf. Emmen 2017) and the largest oil field in the Netherlands (cf. VII-30). Wakker Emmen is the strongest party in the city council, holding 15 of the 39 seats. One of the main priorities of this local party is the opposition to wind power plants on Emmen's territory. However, the municipality is obliged by the provincial government to install 95.5 MW of wind energy capacity within the next years (cf. Wakker Emmen 2016; Gemeente Emmen 2017). Drenthe is supposed to install an overall capacity of 285.5 MW wind energy until 2020 – around five percent of the Federal Government's planned capacity (cf. chapter 2.2.2). In 2013, the province had installed ten megawatts (cf. Pondera Consult 2015). In the hope to avoid some of the wind farm constructions, Wakker Emmen supports the deployment of PV, a civic energy approach and efficiency increases as alternatives (cf. Dagblad van het Noorden 2016a). The party generally supports the SEREH project if it leads to a more efficient use of the already installed

³⁷ This directive is the latest of the three EU directives on the internal market for electricity (cf. chapter 2.2.3).

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renewable capacity and if the citizens profit (cf. Gemeenteraad Emmen 2016: 6). The other two bigger parties in Emmen’s city council, the Social Democrats (six seats) and the center-right Christian Democrats (five seats), also support the SEREH project (cf. Gemeenteraad Emmen 2016: 6).

The city of Haren is a small municipality in Lower Saxony (7.7 million inhabitants). With an area of 209 km², the city has a lower population density than the German average (113 inhabitants/km² compared to 230 inhabitants/km²). Haren is an important site for waterway transportation and the city’s ports and shipping companies are a relevant employer. Poultry slaughter and wind turbine construction are other important sectors (cf. Haren 2017). The party system in the municipal council is more consolidated than in Emmen: Only two parties hold seats, the Christian Democrats 25 and the Social Democrats nine. Both political groups and the Christian Democratic mayor support the SEREH project (cf. Meppener Tagespost 2016; NOZ 2016).

While Germany is a federation with a decentralization of power, the Netherlands are a unitary state with only some decentral elements (cf. Loughlin 2011: 204 f.). Accordingly, the federal states and their municipalities are more powerful in Germany than the provinces and municipalities in the Netherlands (cf. Loughlin 2011: 212 f.). This is shown in the division of tax revenues: Dutch provinces and municipalities receive 90 – 95 % of their revenues from the central government (cf. Lepszy | Wilp 2009: 440 ff.; WWU Münster 2012). In Germany, the 16 federal states receive about 40 % of the overall tax revenues (cf. Bundesministerium für Finanzen 2015) and the municipal budgets relies on a broad mix of shares from common taxes, municipal taxes and fees and horizontal financial allocations (cf. Scherf 2010: 372). However, also German cities are constrained because of debts and obligatory expenditures that higher policy levels require them to spend (cf. Holtkamp 2013). Cities in both countries have some responsibilities for spatial planning, local economic promotion, environment and infrastructure (cf. WWU Münster 2010), all of these policy areas being relevant in the context of the SEREH project. In the SEREH context, however, the city of Emmen generally has a relatively large leeway in terms of financial and personal capacity, since the city is about four times as big as Haren.

Despite the structural differences between the two cities, municipal officials started discussing a cooperation in the energy sector. The idea came up first after a meeting in Haren a few years ago, where plans for a new wind farm close to the border were introduced (cf. Leidreiter 2016). In 2013, an “Intelligent Kindergarten” in Haren was implemented by the city, the University of Twente and the RWE. Energy is produced in PV and geothermal power plants and stored in a storage unit. Production, storage and consumption within the building are steered intelligently with regards to the state of the overall grid (cf. RWE AG 2013). After these first talks, this demonstration project and a pilot phase that started in December 2014, the

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SEREH project officially entered its next stage in December 2016, when the two municipal councils agreed on the overall vision of the project. According to the members of the project team, this is the first cooperation project between the two cities on this level. However, both cities are members of the European cross-border administration unit Ems Dollart Region. This institution works on facilitating cooperation and supports European programs in the region, such as INTERREG projects (cf. Ems Dollart Region 2017).

In general, the Dutch-German border region has a high mobility, compared to other European border regions, as 74 % of the residents have travelled to the other side of the border (Eurobarometer 2015: 3). Trust between the people on both sides is high, as 83 % of the Germans trust their Dutch neighbors and 74 % of the people from border municipalities in the Netherlands trust their German neighbors (cf. Eurobarometer 2015: 4). The largest obstacles for cross-border cooperation between Germany and the Netherlands are considered to be the language (53 %), legal or administrative differences (42 %), social and economic differences (29 %) and cultural differences (28 %) by the interviewees in a 2015 Eurobarometer poll.

5.1.2 The Energy System in the Area

In 2015, the city of Haren had an installed capacity of 73.8 MW_{peak} wind, 27.5 MW_{peak} PV and 9.5 MW_{peak} biomass (cf. Bleydorn et al. 2017: 24). There is one wind park, on which citizens hold financial shares, and two privately owned single standing windmills. The biomass plants are owned by farmers and the PV power plants are installed on rooftops and decentrally owned. No energy cooperative exists in the city. Emmen did not have any wind or biomass plants or large PV ground-mounted systems in 2015. There is one active cooperative: Zonnige Toekomst, an initiative of a few citizens who set up the energy cooperative about four years ago. Their goal is to provide people with low income with solar energy in order to lower their energy bill. Some privately owned small rooftop PV installations produced around 92,000 MWh already in 2015. There is a relevant number of combined heat and power (CHP) plants in the Dutch city. They produced around 28,000,000 MWh of electricity, covering around seven percent of the city's high electricity demand.

Table 7 shows that overall electricity consumption is far higher in Emmen than in Haren³⁸. The analysis of Bleydorn et al. 2017 shows that Haren had excess production – 5.5 MWh on average and up to 15.2 MWh

³⁸ In the original source from Bleydorn et al. (2017), there is no information on the installed capacity of RES power plants in Emmen, and therefore this information is not included in Table 7. Since production of wind and biomass was 0 MWh in 2015, the installed capacity of these forms of RES is 0 MW.

It is not clear, whether the CHP power plants in Emmen are solely powered with RES, therefore they do not appear in Table 7. Haren did not have any production from CHP plants in 2015.

If the capacity factor for PV in Emmen and Haren is the same (which is reasonable to assume, as weather conditions and latitude are comparable in both cities), a PV production of 92,701 MWh would lead to the conclusion that the installed PV capacity in Emmen in 2015 was around 111 MW. This is around four times as much as in Haren. Given that Emmen is around four times larger, the penetration with PV power plants is comparable in both cities.

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in peaks – of electricity in 43.1 % of the 15-minutes between 2014 and 2015. Emmen was importing electricity in almost all the 15-minutes in 2014/2015 and the smallest shortage was 2,309.7 MWh. This demonstrates that the Dutch city could take up the excess production in Haren at all times. It also shows that even if more wind capacity is added, Haren’s excess electricity alone would not be able to satisfy all the demand in Emmen (cf. Bleydorn et al. 2017: 29-32). If the planned additional wind park in Haren would be connected to the grid, the city would be able to cover its electricity demand to 210 % and in 68 % of the 15-minutes over the year (cf. Pieper 2017).

	Haren (2015)			Emmen (2015)
	Installed Capacity in MW _{peak}	Total (Production) in MWh	Capacity Factor	Total (Production) in MWh
Biomass	9.48	54,410	0.66	0
Wind	73.98	127,923	0.20	0
PV	27.51	22,873	0.09	92,701
Total RES	110.97	205,206	0.21	92,701
Total Electricity Consumption		186,894		385,688,321

Table 7: RES-Electricity Generation in Emmen and Haren (Own Table, Based on Bleydorn et al. 2017: 28)

The capacity factor results from the full load hours generated by the installed capacity divided by 8,760 hours of the year. The numbers from Haren lie in the range of average capacity factors in Lower Saxony (BDEW 2013: 23 ff.). The low capacity factor of wind and PV power plants shows the need for technological solutions like storage, demand-side management and intelligent grids to make better use of the annual hours in which variable RES run to full capacity (cf. Quaschning 2015: 265 ff.). The newly planned and technologically advanced wind power plants in Haren can also increase the capacity factor, as they are expected to run with full power in 3,500 hours in the year, resulting in a capacity factor of 0.4 (cf. Pieper 2017: 6).

In Haren, the responsibility for basic electrical supply is divided between the utilities Innogy (RWE) and the EWE, which covers a smaller area in the east of the municipality. PV power plants in the city feed into low and medium voltage grids also run by Westnetz (RWE) and EWE Netz; wind power plants feed into medium- and high voltage grids run by Westnetz (RWE) and Avacon (E.ON) (cf. Bleydorn et al. 2017: 32; 40). In Emmen, Enexis is the sole DSO. TenneT is the responsible TSO in the cross-border region.

5.1.3 The SEREH Project's Vision for the Future

The SEREH project's vision for 2025 was introduced in chapter 1. In this chapter, the vision is depicted in Figure 14 and elaborated in more detail, as it served as a base for the discussion in the interviews (cf. annex I). Once this vision is established, obstacles and opportunities for the next steps of the project will be discussed in the subsequent chapters. The bullet points of the vision were also discussed with members of the SEREH core team to ensure that the vision of the project was captured correctly. So, according to the vision for 2025, the two cities want to:

- *Have regionally produced energy used more and more in the region, by using an intelligent infrastructure and investing in energy storage technologies:* This objective concerns technological conditions for a TRaCE (cf. chapter 4.3) and the physical dimension of decentralizing energy flows (cf. chap. 4.5): Intelligent infrastructure and energy storage technologies are needed to monitor and steer energy flows properly and to ensure an efficient use of the electricity and management of grids from the bottom-up. These technological solutions exist. The question is if and how they can be applied and managed by in a cross-border context. A cross-border trade of energy by the means of sector coupling and exchanges of heat or gas is also to be considered in the SEREH project (cf. Emmen | Haren 2016: 20 – 25).
- *Have local energy cooperatives promote the production of RES and the trade of RES between consumers within both cities across the border. The companies in the region also increasingly use regional renewable energy:* This objective shows that local energy cooperatives as well as local companies (civic actors) are supposed to be active in the regional energy trade and therefore relates to the ownership and market dimensions of decentralizing energy (cf. chap. 4.5). The following chapters discuss the obstacles and opportunities for these (civic) actors and their possible TRaCE models in a cross-border context.
- *Have the regional added value increased by the cross-border regional energy trade and profits from RES production staying in the region, while at the same time saving on energy imports:* An increased regional added value and more energy autonomy are stressed in this objective. This dimension is not in the focus of this thesis (cf. chap. 1.2), as it is assumed to be a side-effect of a regional trade with civic actors, especially if the ownership of the RES assets is decentralized.

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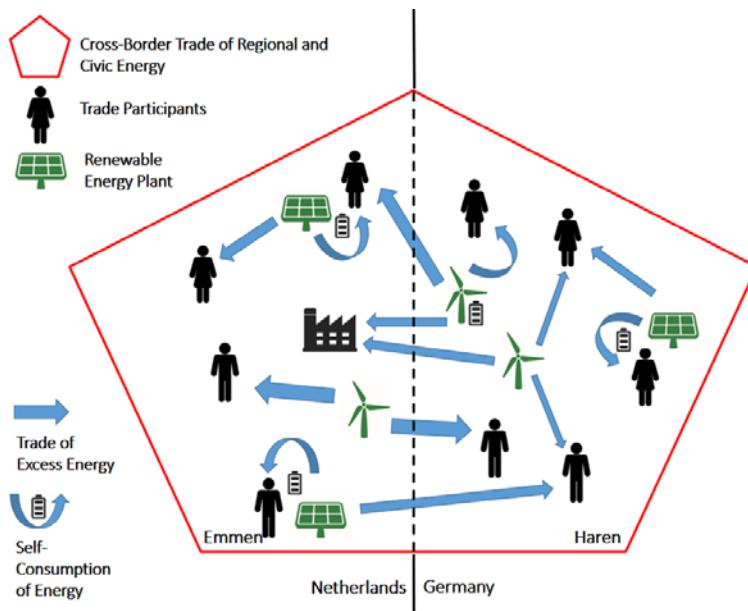


Figure 14: Vision for a Cross-Border-Trade in Emmen - Haren (Own Figure)

- *Have their two energy systems connected by a grid:* This objective also focusses on the decentralization of physical energy flows. Even though the perspective of energy producers and consumers was to be in the focus of the analysis (cf. chap. 1.2), the grid infrastructure and operation has been part of the analysis in chapter 4 and will remain to be one in this chapter, as a physical connection is the base for some TRaCE models and their technological condition.

5.2 Assessment of the SEREH Vision

The goals of the previously introduced SEREH vision were received positively in the interviews. They were regarded as "interesting" (V-2), "exciting" (VI-19), "evident, given the imbalance of too much and too little [renewable] electricity" (III-41) and "very good [...] and a worthwhile cause, from an economic point of view and abstracted from the existing system" (II-49). It was also stated that "if you want to integrate all those RES in an efficient way, use it close to the generation... Then it will make sense, most probably, in the future to take into account those [physical grid] connections across-borders. It is more efficient to use it in that way" (V-29). While this argument is more focused on the technological side and is in line with the regional energy approach (cf. chapter 2.1.1), there is also a positive argument for the SEREH project from the ownership side, following the civic energy approach (cf. chap. 2.1.2): "I am positive about it [...] because of the ownership of the system [and because] SEREH is an approach to bring something positive in this local energy transition instead of just seeing it as a burden" (VII-30).

This general assessment is, however, on a more abstract level and detached from the existing outside conditions. Even though the electricity sector is changing (cf. chapter 2), "energy systems are subject to strong and long-lived path dependence, due to technological, infrastructural, institutional and behavioural lock-ins" (cf. Fouquet 2016: 16098). Several interviewees pointed out the challenges resulting from these lock-ins of the external conditions in their first assessment: "While I think this approach is very exciting, I also see many problems arising. One has to weight these disadvantages against the advantages. I do not know

whether the result will be positive in the end, but I have strong doubts" (VI-19). The challenges for the project arise from the relatively small size of the market in the area (cf. VI-36), the historically-rooted and pre-existing grid infrastructure and management (cf. IV-4) and the restrictive, conflicting or non-existent national and European regulations (cf. VI-15; cf. V-2). In terms of the number of statements coded as obstacles, respectively opportunities, the results of the analysis with MAXQDA (cf. chap. 3.1) are rather balanced: Obstacles were mentioned 103 times and opportunities 86 times in all four analytical categories (an additional 100 statements in the residual category general). The following chapters weight these obstacles and opportunities regarding the identified TRaCE models and actors and the prevailing external regulatory and technological conditions.

5.3 Obstacles and Opportunities Regarding Actors

As shown in chapter 4.2, TRaCE models are usually implemented by a combination of different actors. By cooperating, they capitalize on their different and complementary competences. Cities (cf. VII-30) and municipal utilities (cf. IV-54 f.), individuals, private investors and cooperatives (cf. VII-43 f.; IV-7; HO 31 f.), TSOs (cf. VI-32) and DSOs (cf. V-68), local energy consuming companies (cf. III-35) and local producers of renewable energy (cf. II-48) were all identified to be important actors in the implementation of the SEREH vision.

The cities of Emmen and Haren are already "key stakeholders [with a] strong ambition [and] ownership of the project", which is regarded as an important asset (VII-30). But they cannot succeed alone in setting up a complex cross-border TRaCE, as the expertise on regulatory and technological conditions is usually limited within a small municipal government (cf. VII-32). The high motivation of the city's officials is thwarted by the relatively small staff, which also does not work exclusively for the SEREH project, as well as the lack of financial resources and legislative power on the municipal level (cf. chapters 4.2 and 5.1.1). The different forms of government in the two countries pose an additional obstacle: While German municipalities receive their own tax revenues, Dutch municipalities largely rely on payments from the federal government (cf. IV-65). Additionally, German cities often own the grid infrastructure and the municipal *Stadtwerke* which gives them more leverage to act in the energy sector (cf. IV-53). However, Haren owns no *Stadtwerk* and the grids are privatized. This further limits the municipal scope of action and results in the need for other actors to contribute to implementing a cross-border TRaCE.

The Dutch DSO Enexis, however, is owned by provinces and municipalities in its operating area of the Eastern Netherlands; Emmen is also a shareholder, though it sold a third of its share in 2016 (cf. VII-8; *Dagblad van het Noorden* 2016b). On the other hand, market competition regulation in the Netherlands prohibits cities to exert too much direct influence on the energy market (cf. IV-43; IV-57). Enexis, as well as its German

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DSO counterpart Westnetz, are involved with the SEREH project (cf. Emmen | Haren 2016: 12). This indicates their interest in the project’s vision (cf. V-68). The analysis of TRaCE models in chapter 4 showed that DSOs are important actors especially for decentralizing physical energy flows and markets; an increased involvement of the DSOs is therefore a vital prerequisite for these parts of the SEREH project.

The TenneT TSOs on both sides of the border are not a part of the project, though their involvement would be crucial, as the TSOs are the responsible party for cross-border energy transport (cf. V-6 f.). As they have undertaken this task for some time, “they think that they can do everything very good. And they do their task efficient and well. So, for them it is hard to image that there might be a better option or solution” (V-68). The tendency of some of these established actors to “have a hard time thinking about different models” (III-39) – reflecting the previously mentioned behavioral lock-in (cf. chapter 5.2) – can be an obstacle when it comes to involving TSOs more closely³⁹. Though it can be an opportunity that TenneT is the TSO on both sides of the border (cf. III-20; III-39; VI-32), the companies are unbundled and operate independently from each other (cf. VI-32; VII-8). A vertical cooperation between TSOs and DSOs, in the SEREH case possibly facilitated by the cities Emmen and Haren, is also regarded important for solving cross-border issues (cf. VI-7), but “DSOs and TSOs have no level of understanding with each other. There is no joint [institutionalized] platform [for discussing questions of future cooperation and system optimization]” (I-37). There is also no European DSO platform acting as an institutionalized counterpart to the TSO platform ENTSO-E (cf. chapter 2.2.3; I-39). The establishment of such a platform would be desirable, as it would strengthen the role of DSOs in the European Energy Union by giving the regional electricity distribution a louder and more comprehensive voice on the European level (cf. HBS EU | WFC 2017c: 14).

However, there are smaller associations like the European Distribution System Operators’ Association for Smart Grids (EDSO), that is comprised of 31 of the largest DSOs in Europe, which is only a small share of all the DSOs operating on the continent (cf. EDSO 2017). To connect with these associations and with other projects for cross-border DSO cooperation can pose an opportunity for the cities and DSOs in the region. A project especially interesting for SEREH to share experiences with could be the Smart Border Initiative between the DSOs Enedis (France) and Energis (Germany). The project aims to “design a replicable European project [...] for more cross-border cooperation in optimizing energy systems. This shall contribute to initiating a new stage in the EU electricity market integration by completing high voltage interconnections with

³⁹ This tendency, which poses as a barrier to innovation (cf. has been discussed under the term „knowledge filter”, i.e. a tendency in larger and established companies to face a “barrier limiting the efficient conversion of new knowledge into economic knowledge” (Acs | Plummer 2005: 442). New ventures can translate the knowledge on new solutions to (new) problems into cooperate knowledge. Thereby, they contribute to a regional spill-over of this knowledge into incumbent firms in the region (cf. Acs | Plummer 2005: 453).

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local, medium- voltage integration at DSO level” (Deutsch-Französische Energieplattform 2017). It wants to establish joint planning procedures, compatible smart grid standards, adjust infrastructure operation and data management and enable cross-border e-Mobility (cf. HBS EU | WFC 2017b: 01:07:30).

Regarding additional civic actors, there is an active cooperative in Emmen, Zonnige Toekomst (cf. chapter 5.1.2), planning to install PV panels. This group had difficulties with receiving a loan from the bank, so Emmen subsidized their start and now 300,000 Euros are up for financial participation of citizens (cf. Emmen Nu 2016). 1,200 solar panels are planned and their electricity is supposed to be marketed with the help of the cooperative energy retailer Noordelijk Lokaal Duurzam (cf. chap. 4.1). The cooperative is not yet officially involved in the SEREH project, but it already takes part in the COBEN project in which Emmen is looking into civic energy innovations (cf. chap. 5.1). This existing cooperation could be capitalized in the future development of cross-border TRaCE models. In Haren, there is no active energy cooperative, but citizens are financially involved in the existing wind park. Therefore, there are first approaches of decentralizing the ownership of the local RES assets, which has been identified as an important starting point (cf. VII-44).

Financial involvement and cooperative membership are not the only means to ensure civic participation. Individuals and households are also to be involved as actors in the SEREH project: “100-150 households from both cities shall be invited to analyze their energy consumption in a simple manner” (Emmen | Haren 2016: 35). This could potentially, but not necessarily, involve the installation of smart meters in the respective households. Besides the technological approach, this project is supposed to strengthen the “social infrastructure” and involve possibilities for personal exchange and joint events. With regards to improving the image and the acceptance of the SEREH project, smart meters could however also be an obstacle, as some “privacy minded people” might bring forward issues regarding the usage of their data, especially in Germany (V-62 ff.) and the business case of smart meters for household-customers is not a strong one yet (cf. chapter 4.2). These obstacles could be overcome by adding service values to the installation of a smart meter. There could be, for instance, a connected app providing information on the conditions of household appliances or enabling owners of PV power plants to virtually sell their electricity to their neighbors. Gamification can also increase the attractiveness of smart meters (cf. II-50). In the case of the SEREH project, a competition between households in Emmen and Haren on who saves more electricity could be a potential frame for the smart meter project.

However, at this point in time, concrete projects for making SEREH more well-known in the community are not scheduled, as “there are too many question to answer on this topic. If we start with a publicity campaign, we need at least to have the answers on the most important questions” (as a city official from Emmen put

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it in an e-mail). A clearly laid-out plan containing the next steps and a more concrete vision of the project is therefore a prerequisite for any concrete involvements of the citizens into the project on a larger scale.

If this plan exists, it could be an asset to start involving innovative new energy companies and their services as aggregators, IT-experts or direct marketers as well. Whether and how they would really need to be involved also depends on the concrete TRaCE models that are going to be applied (chapter 5.6). Nevertheless, external competences, especially in the area of intelligent and data-based energy use and in electricity markets, would likely be needed for implementing a complex cross-border project.

5.4 Obstacles and Opportunities Regarding Technological Conditions

One aim of the SEREH project is to establish a physical energy exchange across the border between the two cities and therefore decentralize physical energy flows within the region (cf. chapters 1 and 5.1). The idea is driven by the complementary electricity mix in the two cities: Haren, on the one hand, with its surplus production of fluctuating RES and Emmen, on the other hand, with a small share of RES and high share of natural gas, that is relatively low on CO₂ and is able to provide constant base load production (cf. chap. 2.2.3 and 5.1.2). A main focus regarding the cross-border electricity exchange lies on the efforts to build a cross-border medium voltage connection grid (cf. chap. 5.1; Bleydorn et al. 2017). It was controversial in the interviews whether such a grid would be reasonable from a technological standpoint. One interviewee pointed out that there are already two high voltage grid interconnectors close by and therefore an additional medium voltage connection would “not really make sense” (cf. VII-33 f.). Grid infrastructure would only have to be built if it was “physically necessary to release a congested area” (cf. IV-4). If an additional grid between Emmen and Haren existed, it would create a mere feeling that electrons flow from one city to another, but this would not be physically guaranteed (cf. IV-4).

From a grid management perspective, there would be additional technical difficulties like the frequency monitoring within the two adjacent TSO control areas or loop flows within the connecting power line. Network codes containing all the technological requirements for the operation of grids have been drawn up nationally, but are becoming increasingly harmonized in the EU which could contribute to solving these technical difficulties (cf. V-46; EC 2017a). However, a power line with a relatively small capacity could potentially become a congestion itself, instead of solving larger congestion issues (cf. VI-19; VI-30).

The system for balancing by balancing group managers (respectively PRPs in the Netherlands) and the TSOs in their respective control areas is organized nationally and energy exchange is “benchmarked on [the ex-

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isting] transmission interconnectors” – an additional medium voltage connection could disturb the accounting in the existing system (V-26; cf. V-30; VI-30)⁴⁰. EDSO also underlines technological difficulties for a cross-border distribution grid with regards to technical standards, but at the same time believes that physical losses in the transport of electrical power could be decreased by not having to transform voltage up and down in the process of transmitting electricity in extra-high voltage interconnectors (cf. HBS EU | WFC 2017b: 01:54:00). The harmonization of technical standards for DSO operation on both sides of the border therefore is a prerequisite for the construction of a cross-border medium voltage interconnector.

It was also noted in the interviews how the grid infrastructure has grown historically (cf. IV-4): In the past, cross-border distribution grids were not necessary for two reasons: First, the market was not liberalized and the utilities owned both production and grid assets in a defined area. There was no incentive to expand the grid to a region where it was not possible to obtain new customers (cf. II-12). Second, electricity flows were centralized, one-directional and top-down (cf. chapter 2.2; II-13). Regardless of the previously illustrated obstacles for a cross-border medium voltage grid, the interviewees also identify opportunities for implementing this target. As this situation in the energy sector is changing towards more production from RES and an increasing importance of distribution grids, it is technologically reasonable to use RES electricity close to generation sites – regardless if there is a border or not (cf. V-29; III-41) – and it could be interesting to complement the different production and load profiles in the respective cities with a smart grid approach (cf. III-43). An experiment with a cross-border distribution line could reveal “hidden benefits” (cf. VII-34), and bring about further technological advantages if connected to local flexibility or congestion markets (chap. 5.6; VII-37 f.).

The SEREH project also hopes to decrease the need for overall grid expansions and therefore lower electricity costs for consumers. This is to be achieved by storage and demand-side solutions and the optimization through a cross-border energy exchange (cf. Emmen | Haren 2016: 9; 31 f.). In terms of the bare costs for grid infrastructure, there was no consensus by the interviewees whether it would be cheaper to build a new distribution grid instead of increasing the capacity on the existing TSO interconnectors (cf. II-14; II-49) or whether it is more expensive to build this additional power line, which would also be associated with

⁴⁰ In Germany, there are four control and balancing areas; balancing group managers account for each of these four areas separately, and the TSOs tender for the necessary physical balancing energy for their respective control areas individually (but in a joint tender). Therefore “balancing groups should not overlap across control areas” (BM-30). It is unknown to me, how this is practically applied in Germany, as some control areas are enclaved within others. For example, the city of Hamburg lies within the control area of Amprion and is surrounded at all sides by the control area of TenneT. The question is, how it is accounted for when electricity from the TenneT control area in Lower-Saxony and Schleswig-Holstein is consumed in the Amprion control area of Hamburg. The proceeding in this case could pose an opportunity for the SEREH project to solve the obstacle of accounting for electricity flows between two control areas.

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costs for acquiring the land and potential resistance from land owners and citizens (cf. III-35; III-47). Storage and demand-side solutions in themselves pose no technological obstacle, if they are implemented within the territory of a single city, and would contribute to more decentralized energy flows within the respective municipality.

Possible future projects could aim at installing smart meters in households of the two cities, which could create a base for demand-side management. However, as mentioned in the previous chapter, there are yet several obstacles for a smart meter roll-out on the household-level. From a cost-benefit point of view, “in the case of final users with low levels of annual consumption, the costs of a smart metering system would far outweigh the average potential annual energy savings [...]. [While] a roll-out to high-consumption end-users [...] makes sense” (EC 2014a: 50). Instead of targeting private households for demand-side projects in Emmen and Haren, corporate actors with a high energy demand should be the targeted group. In Germany, companies with more than 100 MWh of annual demand already have to monitor their demand closely (cf. III-14; StromNZV §12) and in the Netherlands, the roll-out of smart meters is far advanced, including in companies (cf. EC 2014a: 79 ff.). As there are many energy intensive firms in the SEREH region, especially in Emmen, they should be the first actors to be addressed for demand-side projects. Aligning storage and demand-side solutions across borders would be a later step, as the necessary transport capacity, accounting or balancing procedures and market solutions would be needed first (chapter 5.6; VI-13 ff.).

Creating a (partial) island grid for the Emmen – Haren area was speculated to be a possible solution to some of the technological challenges arising from a cross-border distribution grid: “The cross-border trade works within [the region of the two municipalities]. If nothing [no electricity flows] get out or come in [...] it would be easy operationally. Emmen and Haren would be regarded as a country – an island grid” (II-17). But then the grid connection to the outside would need to be cut – at least to one side (cf. II-21; II-51). However, if the cities would really establish a disconnected island grid, problems would arise in terms of the supply of security. As of today, backup base load capacity is needed in times of little RES production and physical connections between and across smaller regions can provide this capacity more cost-efficiently (cf. chapter 4.3; cf. IV-7). A truly disconnected island grid would also no longer be considered “regional energy”, as the definition for this approach includes energy exchanges between regions (cf. chap. 2.1.1). There are additional challenges arising with the island-grid solution from a market perspective (cf. chap. 5.6).

Sector coupling was mentioned a few times as a possible opportunity for decentralizing the energy flows across borders: “You could use large batteries and drive them across the border all day [...]. Or you can install electric charging stations directly on the border and the Dutch people can drive across the border to

charge their electric cars” (III-55). The planned wind farm in Haren is supposed to incorporate innovative solutions not only for storage, but also for power-to-x technologies⁴¹.

5.5 Obstacles and Opportunities Regarding Regulatory Conditions

The cross-border medium voltage connection is aimed to be established by the SEREH project in order to decentralize regional energy flows and comes along with several regulatory challenges. Many of them have been discussed in detail by Bleydorn et al. (2017). In addition to that, the assessment of this issue by the interviewees is summarized here. At first, there is the question who would operate this interconnecting medium voltage line “because all medium voltage connections would fall under DSO control and interconnection is specifically something that falls under TSO... But this is what makes this project very interesting, because there is nothing regulated. But it also offers opportunities” (V-7).

The reason for this non-regulation is rooted in history: “Cross-border electricity flows were just interesting on transmission levels because you had those huge generators and you go by long-distance transmission... So that's why there was no regulation. But [...] if there is no regulation, there is no competence. And if there are no electricity flows there is also no competence for [...] the EU to establish regulation, because there is no cross-border element in low-voltage distribution” (V-8). Therefore, an increase in TSO cooperation and a strengthening of the existing TSO interconnection infrastructure has been the priority of the EU (cf. VI-40). However, the energy system is changing and it is likely that “there is in the future the need to regulate cross-border on lower levels” (V-10). Under current regulation, a public cross-border distribution grid would have to be operated by a TSO (cf. Bleydorn et al. 2017: 42 ff.). Such a public interconnector would likely have to make its full capacity available to the regular cross-border energy trade via market coupling (cf. chapter 2.2.3). Because of European rules for non-discriminatory grid-access to third parties, it would not be allowed for actors in Emmen and Haren to exclusively trade electricity on this line or reserve a share of the capacities for regional trade (cf. II-16). Third-party market participants would also be able to make use

⁴¹ As described in chapter 1.2, sector coupling is not the focus of this thesis. In the following, some ideas and opportunities are therefore only briefly described: One option would be to establish a system for charging electric cars on both sides of the border (cf. AW-29). A similar project is conducted in the border region between Germany and Luxembourg (cf. SWT 2013). Excess heat from industrial areas in Emmen could possibly also be transported over the border to Haren by a cross-border long-distance heating system. There are some pioneering projects for cross-border distance heating, for instance at the German-Austrian border (cf. Simbach am Inn 2005) or at the French-German border (cf. Baden Online 2014). The hydrogen produced in a power-to-x wind farm could be used to power hydrogen buses going from Haren to Emmen and synthetic methane (or natural gas from the Netherlands) could also be transported across the border. Interestingly, for gas there are “single gas storage facilities connected to different virtual trading points. They are located at the border, between Germany and the Netherlands, for instance in Epe [Gronau, Germany]. As a fact, these storage facilities can store gas from Germany and then flexibly pour the gas in either the German or Dutch market” (HBP-15). In terms of the regulatory conditions, “cross-border gas fields [with] connection points on both sides of the border” might provide a model “to see how Germany and the Netherlands deal with that on a bilateral perspective” (LDDK-46).

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of the line, thereby causing “unwanted effects” (II-21). If third-parties should be kept out, a private power line would be necessary – directly going from the wind park in Haren to an energy intensive company in Emmen (cf. Bleydorn et al. 2017: 41 f.)⁴². Nevertheless, receiving a permit from regulatory authorities in this case would be a challenge (cf. Bleydorn et al. 2017: 42), so it is important for the SEREH project to closely work together with the BNetzA and the ACM as regulatory authorities (cf. IV-3; III-37). It is possible, that hurdles for the permission of a cross-border medium voltage line are lower, if its construction is directly connected to the construction of the two planned wind farms in both cities (cf. III-52).

The support schemes for the production of electricity from RES differ between the Netherlands and Germany, but both systems are organized nationally (cf. chapters 4.4.1 and 4.4.2). There is no possibility for RES plants outside the Netherlands to participate in the SDE+ tenders (cf. Netherlands Enterprise Agency 2017). *Postcoderoos* could very likely not be extended across the border, as “the postal range in Germany [...], would not be valid in the Netherlands” (V-50). Renewable energy produced in the Netherlands and consumed in Germany is also not eligible to EEG funding (cf. III-51). However, the EEG 2017 contains a cross-border element, aiming to open five percent of the annually tendered capacity for bids from other MS (cf. chap. 4.4.1). The Danish PV systems that won the German tender will receive 5.38 cents per kWh as a feed-in tariff, financed by German consumers via the EEG reallocation charge (cf. BNetzA 2016b). Germany is open for new joint tenders, but has not reached additional mutual agreements with adjacent countries yet (cf. HBS EU | WFC 2017c: 18; Hoppenbrock 2017). If the Netherlands were to open a joint tender with Germany, RES power plants from Haren or Emmen could place bids. However, a further regional component is not included in this, which makes a specific joint tender for the Emmen – Haren region very unlikely.

For a regional electricity label, state-commissioned regional certificates are an important element. While these do not exist in the Netherlands, Germany is currently implementing such a system. It is debated to also issue regional certificates for RES power plants abroad, delivering electricity physically to Germany (cf. UBA 2016a: 16 f.). This could pose an opportunity for such a business model, although it remains to be seen if and how this option will be included in the final design of the register.

⁴² In 2014, there was a discussion about whether it would be possible to have a direct (public or private) transmission line from a Dutch gas-fired power plant to the Belgian transmission system (cf. LDDK-30). Two Dutch gas power plants were competing in a tender by the Belgian TSO Elia for subsidies over six years. Delta, the utility owning one of the Dutch gas power plants, said that “If we win the tender, we will either contact the Dutch transmission system operator [TSO] TenneT to help build the grid – or we will do it ourselves” (ICIS 2014). This scenario was highly debated and could have served as a reference scenario to the SEREH project (cf. LDDK-30). Unfortunately, the tender was stopped by the Belgian government, due to unrelated reasons (cf. Enerdata 2015).

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The TRaCE model regional label / marketing uses balancing. Therefore, the system in the Netherlands is an obstacle, as “balance is something you have to maintain within a regionally defined system. And the Netherlands is one regionally defined system. So, you can't really balance the Netherlands with Germany” (V-26). In addition, new energy companies acting as direct marketers (or the DSOs, for EEG power plants not participating in direct marketing) have to account their own EEG balancing group which is the basis for the later settlement of the EEG subsidies (cf. III-20 f.). If renewable energy was produced in Germany but marketed and consumed in the Netherlands, it is questionable how to account for the produced volume in the EEG balancing group and whether the produced electricity would still be eligible to EEG funding (cf. III-51; II-51). If it was possible to create a sort of regional, cross-border balancing group for the cities of Emmen and Haren, from which “electricity suppliers are able to supply to Dutch end-consumers [...] [the TRaCE model regional label / marketing] would be uncomplicated” (III-31). The TSO TenneT on both sides of the border would have to agree to such an experiment. Some “issues of balancing and balancing responsibilities” could also be solved with the help of a new energy company, serving as a “sort of intermediate service provider” (V-12).

From a regulatory point of view, there is very likely not a “limitation for [...] Dutch cooperative to trade in Germany, if you have all the necessary licenses [and vice versa]” (V-18). Examples like the German cooperative Energiegewinner (chapter 5.6) show, that it is possible for a German cooperative to regularly engage in the electricity market of another European company and install and operate RES power plants⁴³. The foreign cooperative would, however, have to regard all regulations in the country it becomes active in. Apart from the issues discussed in this thesis, these also include models for electricity supplier contracts (with retail companies or end-consumers) and rules for consumer protection (cf. V-18).

As the previous examples illustrated, rules for trading electricity between two countries on TSO interconnectors are clearly laid out, while there is uncertainty and non-regulation concerning a regional cross-border trade (cf. VI-15; VI-22). Bilateral agreements between the national governments would be limited in terms of solving those issues (cf. VII-42). One obstacle, however, would need to be removed bilaterally: A contract between the states on the exact course of their border from 1824 prohibits construction around 376 meters on both sides of the border (cf. NOZ 2014). This would effectively prevent the construction of a cross-border

⁴³ As mentioned in chapter d)3.2, an interview with a representative from Energiegewinner was requested, but did unfortunately not take place. I assume that it would be possible for people not living in Germany, to also become regular members of a German cooperative, but it was not confirmed by an Energiegewinner representative. The same should apply to Dutch cooperatives. However, if the Dutch cooperative bases their TRaCE model on tax deductions, a direct participation of German cities would not be reasonable, as they do not pay Dutch taxes and have nothing to be exempted from (chapter 5.6). It could be assessed, whether a sort of indirect participation via a cooperate construct set up in the Netherlands, would make participation possible for people living in Germany.

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medium voltage grid. The two countries could also set up an agreement to enable a cross-border experimentation project – similar to the Dutch experimentation projects (cf. V-42) – or enable a cross-border tender for EEG subsidies (as discussed above). But overall, with regards to concrete energy regulation issues, “legal frameworks from both countries are not well suited to make a cross-border market possible [and] national governments are struggling with this regional cooperation”. Therefore, “European directives or regulation [is needed] to make such a thing work” (VII-42).

One such European instrument already exists, specifically designed for the purpose of facilitating micro-level cross-border cooperation in Europe (cf. chapter 2.1.3), going a step beyond common INTERREG projects (cf. chap. 5.1): The European Grouping of Territorial Cohesion (EGTC) which needs to serve a public interest and “allows public entities [for instance cities] of different Member States to come together under a new entity with full legal personality” (European Committee of the Regions 2017). Ten EGTCs exist in Germany and three in the Netherlands. The tool was originally created to make EU funds more accessible in border regions and jointly manage infrastructure, though the actual use has developed a much wider scope (cf. HBS EU | WFC 2017b: 00:28:00). The EGTCs have their own budget, staff and long-term strategies. Administrative burdens are decreased for this entity and, very importantly, only the legislation of the MS at which the office of the EGTC is registered applies to the whole entity – although some legal issues resulting from this provision are not yet solved (cf. HBS EU | WFC 2017b: 00:29:30 – 00:31:30).

A new tool, which was proposed under the name European Cross-Border Convention (ECBC) by the Luxembourg government in their last presidency of the European Council, aims to dissolve restraints from the current INTERREG and EGTC instruments – mainly their lack of cross-border policy making opportunities (cf. HBS EU | WFC 2017b 02:28:00 – 02:31:30). The ECBC would enable local authorities to define new legal rules and provisions on their territory. These rules would be “subject to approval of the national authorities” (HBS EU | WFC 2017b: 02:31:45). An example is a wind farm at the border, where the tool could be used to implement common spatial planning standards, so that the minimum distance between a wind power plant and a house would be the same on both sides of the border (cf. HBS EU | WFC 2017b: 02:33:15). This would be an opportunity for border-cities to become living laboratories for new regulatory conditions. However, it is unclear whether national subsidy schemes for RES like the EEG or the SDE+ (cf. chapter 4.4) could also fall under this regulation. Also, the tool has not yet entered into European law, as a working group is scheduled to present detailed proposals in a report in the end of July 2017 and afterwards the EC would have to set the regular legislative process in motion.

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The EC has already started this process with the Winter Package in 2016 (cf. chapter 2.1.3). This fourth legislative bundle on common rules for the internal electricity market (cf. chap. 2.2.3) is currently discussed among MS and in the European Parliament. Unlike the EGTC and ECBC, it is not providing special provisions for cross-border regions, but rather redefining the overall market rules and regulations for the European electricity sector. Still, it is regarded “remarkable” (VI-34) and a “game changer” (VII-36) for regional cross-border cooperation on RES (cf. also Haleakala-Stiftung 2017: 36 f.). The reason for this is found in article 2 (7I, in which local energy communities (LECs) are introduced and defined as “an association, a cooperative, a partnership, a non-profit organisation or other legal entity which is effectively controlled by local shareholders or members, generally value rather than profit-driven, involved in distributed generation and in performing activities of a distribution system operator, supplier or aggregator at local level, including across borders” (EC 2016: 52). Further provisions for the LECs are laid out in articles 8 (MS “shall ensure that specific authorisation procedures exist for small decentralised and/or distributed generation, which take into account their limited size”) and 16 (stressing the ability of LECs to own and manage their own distribution networks, participating freely and not discriminated as “final customers, generators, distribution system operators or aggregators”) (EC 2016: 60; 68).

These provisions would enable a cooperative in Emmen or Haren to own and operate a cross-border medium voltage grid. They resemble the approach of the Dutch experimentation projects (cf. chapter 4.1), though, if entering into law, they would enable permanent solutions. It was stated on record by an official from the directorate general for Energy of the EC, that “the experience of Emmen and Haren was central to the definition of the policy in local energy communities (HBS EU | WFC 2017b: 03:02:00). The interviewees assessed the proposals as a “balloon [...] and they [the EC] want to see how people react to it” – the DSOs would be “puzzled in how to deal with this” (V-36). While the proposals are large opportunity for the SEREH project, the legislative process is not yet over and up to now, there was a different direction for the European regulation, towards more TSO-cooperation (cf. VI-40; V-5). Additionally, in the current Winter Package the sort of regional cooperation mentioned in context of the proposal is understood as macro-cooperation (cf. chapter 2.1.3; EC 2016: 7) and the exact rules for LECs and their integration into existing energy markets remain vague (cf. Haleakala-Stiftung 2017: 17). The legislative process will take more time and the final outcomes are unclear. Generally, it is likely that some of the regulatory hurdles for cross-border civic RES projects will be gone by 2020 (cf. VI-11).

5.6 Obstacles and Opportunities Regarding Cross-Border TRaCE Models

The actor constellations in the Emmen and Haren (cf. chapter 5.3) and the specific technological (cf. chap. 5.4) and regulatory (cf. chap. 5.5) conditions in this border region influence the possibilities for implementing TRaCE models identified in chapter 4.1. The resulting obstacles and opportunities are discussed in this chapter, serving also as an interim conclusion to the overall chapter 5.

The TRaCE models most discussed by the interviewees (cf. chapter 4.1) concern the degree of decentralization of the market dimension (cf. chap. 4.5): While the *integration into overall markets* aims to establish and make use of regional and bottom-up incentives into those overall markets, the *regional markets for generation and flexibility* approach tries to establish additional and complementary markets. However, the regionalized products and price signals for regional flexibility services, that projects like Enera want to establish on energy exchanges (cf. chap. 4.1), do not yet exist and they are designed to be elements of national markets (cf. II-4). Therefore, at the moment there is no possibility for owners of RES power plants in Emmen or Haren to receive additional benefits by utilizing any local or even cross-border element in existing spot markets, as they do not exist. There are also no regional trade platforms for exchanging and trading electricity, only the existing mechanism of coupling national spot markets (chap. 2.2.3; V-60).

For the TRaCE model of regional markets for flexibility, there are at least some first attempts to implement those in a cross-border context, as is the case with the Callia project. This goal, however, is connected to "so many details, that we do not yet have any answers on, or have even recognized at this early stage of the [Callia] project" (VI-11). Some of the greatest obstacles for cross-border flexibility markets seem to be the lack of and market access to physical cross-border transport capacity, the cross-border balancing and the distribution of network charges (cf. chap. 5.4 and 5.5; VI-10). Therefore, the recommended approach from the point of view of the Callia project is to "leave out these technical issues first and start the [virtual] exchange over markets" (VI-20). Cross-border regional balancing could be reasonable, even without a direct interconnection between Emmen and Haren, to make use of the complementary energy mix in both countries more efficiently – thereby preventing congestions and loop flows in the existing interconnectors (cf. chap. 2.2.3; II-7). However, for completely decentralizing markets, the Emmen – Haren region might be too small, as other examples have shown: "We had an approach that was similar to SEREH, 'Intelligence Cuxhaven' [in which] the refrigerated warehouse traded with the wind power plant. The result: Technologically easy, but a catastrophe regarding the market. The market was too small, the market entry costs too high [...] and there was no active trading" (II-4). Small markets have the additional problem of providing too little financial liquidity (cf. VI-9). This is one reason for the increased market coupling of European power markets (cf. chap. 2.2.3).

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The Callia project also believes that a single DSO area with an additional market for flexibilities would be too small, and therefore they hope to couple a greater number of these decentral markets (cf. VI-26). Equal to possible unwanted effects caused by third-party actors using a possible cross-border medium voltage power line (cf. chap. 5.4), there might also be disturbances if actors trade simultaneously on a regional and the overall market (cf. II-24). If a regional cross-border flexibility market is to be implemented, the first steps would have to be a close cooperation with the DSOs (cf. chap. 5.3) and the development and installation of the necessary technical soft- and hardware tools (cf. chap. 5.4; VI-13).

The TRaCE model based on *regional labels and marketing* is an alternative (and likely more practical) approach for implementing a TRaCE in the Emmen-Haren region. Instead of waiting for the creation of new decentral markets, or the reform of existing ones, this model can be applied immediately by using virtual markets and balancing group management (cf. chapter 4.1 and 4.3). Actors like Noordelijk Lokaal Duurzam, Agrowea (cf. chap. 3.2 and 5.1) or new energy companies like Lumenaza or Vandebron (cf. chap. 4.3) could develop such a TRaCE model for the region, possibly together with cooperatives or a local utility from the wider area. If cross-border regional certificates are going to be introduced this year by the UBA (cf. chap. 5.5), they could be used. Otherwise, an internal and virtual cooperative accounting system could serve at the beginning, as is the case with such TRaCE models in the Netherlands (cf. VII-20). These systems do not regard balancing, which could solve the issues of cross-border balancing (cf. chap. 5.4). If balancing was to be taken into account as well, a sort of experimental, cross-border balancing group would need to be set up in cooperation with TenneT and the national regulatory authorities (chap. 5.5; III-32 f.).

The electricity price for households and local companies obtaining an electricity product based on regional and cross-border RES would likely not be lower than the average electricity price. Even though Dutch consumers could profit from lower electricity wholesale prices in Germany (cf. chapter 2.2.2), the additional national network charges, taxes and other levies such as the EEG reallocation charge would likely still have to be paid (cf. III-49) and they make up the greatest share of the costs. If electricity was produced in one country and then traded to and consumed in another – via a regional trade platform or under a regional electricity label – it becomes necessary to find ways for distributing these costs (cf. VI-11; HBS EU | WFC 2017b: 01:53:00). In the case of a regional electricity product, it could be an option to try to offer two electricity products to the same balancing group – one for German customers paying German charges, taxes and levies, and one for the Dutch customers accordingly (cf. III-49). However, in the case of regional RES, the price is not the sole reason for customers to choose a product, but also the customers' preference to support "real change" and obtain "psychological benefits" (Herbes | Friege 2015: 10 f.). If the TRaCE model regional label / marketing would, however, only be based on internal cooperative accounting or buy regional

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certificates, that are not specifically from Emmen and Haren, on overall markets, this solution could be regarded a “crook” (III-25). Therefore, real benefits in terms of regionalizing ownership or physical energy flows would have to be guaranteed, in order for the regional electricity product to appeal to customers.

In the sense of the Dutch experimentation decree (cf. chapter 3.2), the TRaCE model *experimentation* does not fit in a cross-border context. First, it is a model for accumulating knowledge instead of evoking real change, as investments are high and connected to uncertainties about the time after the legal exemptions (cf. chap. 4.1) and second, a bilateral agreement between the two national governments would be needed to establish such a project in Emmen and Haren, which seems unlikely and impractical (cf. chap. 5.5). Other legal tools, like the EGTC and the ECBC, are more suited to attract funding and enable a joint administration under more harmonized standards (cf. chap. 5.5).

Local cross-border *investments* are likely the quickest and easiest TRaCE model to be implemented. Citizens from Emmen could, for instance, possibly obtain financial shares in the planned wind farm in Haren, if the operators choose to give out shares to citizens from across the border. This could be a way to both enhance acceptance of the wind power plants (cf. Marg et al. 2013) and raise awareness of the cross-border energy project. A new SEREH cooperative could also be set up, after evaluating which side of the border is more favorable regarding taxes and organizational requirements, investing in RES or energy efficiency projects in both cities (cf. V-18). Cross-border investments could also help solving the “biggest problem for civic actors in the Netherlands”, which is a lack of funding (IV-57). There are examples in Europe for civic cross-border investments. For instance, in the French city Colmar, a French and a German cooperative jointly invested and installed 400 kW_{peak} of PV power plants on factory roofs (cf. Énergie Partagée 2015; fesa Energiegenossenschaft 2015). The German cooperative Energiegewinner implemented PV projects in Luxembourg and plans another in France (cf. Energiegewinner 2017). In order to unlock capital, Energiegewinner uses a crowd-investing platform for some projects (cf. GLS Crowd 2016). While crowdfunding utilizes donations, crowd-investing aims to collect capital from a large number of people, who get their capital returned with a certain interest rate (cf. EnergieAgentur NRW 2016a). Regardless of the market and physical dimension, the cross-border investments would decentralize the ownership dimension in the SEREH region.

A direct participation of foreign citizens in *tax exemption* schemes or *feed-in tariffs* for the operation of RES power plants in the other respective country is, however, not possible and the *Postcoderoos* scheme does not apply for citizens from the German side of the border (cf. chapter 5.5; V-49 ff.). From a market perspective, these support schemes are “not too interesting [...] to look into in the future because those kinds of

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rules [...] are just trying to stimulate investments in renewables, but they do not enable any market integration, because of course they do not participate in the market as they are not selling electricity right on the spot for real value [in the case of tax deductions], and they are only getting a reduction for an amount [of electricity they produce]" (V-53). The ownership dimension of decentralization is therefore more relevant than the market dimension. Even though RES power plants or consumers are not directly eligible for support schemes from the other side of the border, they can indirectly profit by investing directly in the assets on the other side or in the cooperative operating the assets.

The TRaCE model *miscellaneous direct marketing* could be implemented by constructing a private grid connection between a wind farm and an energy intensive company. Apart from the inherent technological and regulatory challenges (cf. chapters 5.4 and 5.5), the business case for this is also uncertain. While up to now, wholesale prices for electricity are lower in Germany than in the Netherlands (cf. chap. 2.2.2), they will tend to converge as the capacity of the existing TSO interconnectors, as well as the coupling of markets, will increase (cf. chap. 2.2.3; II-7; II-44). An increased interconnection capacity (either by TSO interconnectors or by the planned public or private medium voltage power line) would also mitigate the problem of curtailment, i.e. the forced shut down of wind power plants. If the threat of curtailment no longer exists for the wind farm operator, there is no economic need to leave the EEG system of fixed feed-in tariffs and market the electricity over a yet-to-be-build private line to an industry customer across the border (cf. III-22), because "business people constructing an additional line, would never do it, just because the electricity is green" (II-42).

The creation of a (partial) island grid was proposed as an additional solution for the SEREH project (cf. chapter 5.4). But the backup capacity needed to ensure system stability would be very expensive, as it would have to be provided by additional (fossil) power plants or bought somehow on retail markets in a short-term (cf. II-56 ff.). Determining final electricity prices – a task normally fulfilled by wholesale markets – would be very difficult within an island grid area. Generally, island grids are regarded uneconomical for regions in industrialized countries (cf. chap. 2.1.1). However, there might be possible price savings when the island grid leads to exemptions in network charges or other levies (cf. II-59).

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In the previous analysis, the overall national and European energy systems and its actors, the actors in Emmen and Haren, possible models for a trade of regional and civic energy and their external technological

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and regulatory conditions have been examined, as well as the resulting obstacles and opportunities for implementing a cross-border TRaCE (according to the research question(s) from chapter 1.1). The results of this analysis are summarized and discussed in the last chapter of the thesis.

Chapter 6.1 starts with a summary of the results, especially focusing on the cross-border dimension of a TRaCE (as a general conclusion on national TRaCE models was already drawn in chapter 4.5). The approach and methods for obtaining these results (cf. chap. 3) are critically evaluated in chapter 6.2. The next chapter 6.3 identifies further needs for research on TRaCE models in general and on the special cross-border SEREH project. The last chapter 6.4 concludes with a personal assessment on what the next steps for the SEREH project should be and on the role that it and comparable cross-border energy projects can play in the future of the European Energy Union.

6.1 Summary of the Results

The climate crisis caused by human activities and the political commitments on tackling this issue make the transition from the old, centralized and fossil-based European energy sector towards a system based on renewable energies inevitable (cf. chapter 1). RES already play a central role and consequently their contribution to the electricity sector will further increase. The electricity sector, its regulation, management and markets, that were previously organized nationally and centrally (cf. chap. 2.2), is shifting in order to reflect the special characteristics of RES – mainly their fluctuating generation, their decentralized distribution and their close-to-zero marginal production costs (cf. chap. 2.2.1). Even though path dependencies prevail in the energy sector (cf. chap. 5.2) and regulation has yet to fully catch up to the emerging technological requirements and possibilities (cf. chap. 4.3 and 4.4), new solutions in terms of governance emerge: Electricity generation and consumption is increasingly optimized on a regional level and managed in a bottom-up process (cf. chap. 2.1.1); civic actors increasingly become active in the energy sector and take over new responsibilities (cf. chap. 2.1.2); and national states, grid operators, subnational and municipal entities, as well as local citizens and companies increasingly cooperate across European borders, bridging national borders to learn from each other and optimize the system (cf. chap. 2.1.3).

In both Germany and the Netherlands, different projects are implementing innovative versions of trades for regional and civic energy (cf. chapter 3.2), that reflect on these developments in the energy sector. Depending on the concrete TRaCE model (cf. chap. 4.1), different actors are involved and a variety of technological (cf. chap. 4.3) or regulatory (cf. chap. 4.4) conditions are either facilitating or hindering the implementation. The TRaCE projects are either focusing on decentralizing the actual physical energy flows, the ownership of the assets, the market platforms for trading or a combination of these dimensions (cf. chap. 4.5).

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The SEREH project wants to respond to the energy transition by the means of strengthening regional energy, civic energy, and cross-border regional micro-level cooperation (cf. chapter 5.1). The project's vision for 2025 contains elements of decentralizing all the three dimensions – energy flows, ownership and markets (cf. chap. 5.1.3). However, with regards to concrete steps that are to be taken and concrete TRaCE models that could be implemented in this cross-border context, the vision remains unclear. By using the method of exploratory expert interviews (cf. chap. 3.1), possible TRaCE models were identified (cf. chap. 4) and the obstacles and opportunities of their implementation were discussed in order to answer the main research question of the thesis (cf. chap. 1.1).

Obstacles for the implementation of the SEREH project arise from the lack of involvement from actors that would be crucial for the implementation of certain TRaCE projects, especially the TSO TenneT, local energy cooperatives, and possibly new energy companies. A lack of a clear plan on the next steps to be taken makes the communication to and the involvement of the general public difficult (cf. chapter 5.3). From a technological standpoint, the usefulness of constructing a medium voltage cross-border power line remains uncertain. It would likely only contribute to an increase of technical efficiency, if it was connected to specific market and management instruments (cf. chap. 5.4). The differing national regulations also pose a barrier for the cooperation: Especially the system of balancing based on TSO control areas, the support schemes of feed-in tariffs and tax exemptions, that are bound to national borders, and the network charges, taxes and levies that are allocated nationally (cf. chap. 5.5). Market incentives abandoning the idea of a copper plate and instead incorporating regional elements, are not yet established. The use of (cross-border) direct marketing or the establishment of a (partial) island grid seems unfeasible from both a regulatory and an economic perspective (cf. chap 5.6).

The SEREH project can, however, also build on opportunities for its cross-border approach. The strong involvement of the two cities and other actors (especially the DSOs) is an asset which it can capitalize on (cf. chapter 5.3). Generally, the border poses no technological restraint to efficiency and the complementary characteristics of the generation and consumption portfolio in the two cities supplement each other (cf. chap. 5.1.2 and 5.2). Aligning supply and demand within each municipality is already possible and can be a first step towards a more efficient energy use. The DSOs can also start working towards harmonizing technological and grid management standards (cf. chap. 5.4). Support from national governments could help to overcome some concrete challenges or set up experimentation projects, that would be limited, however, in their time-frame and impact. EU regulation is more crucial for enabling a full cross-border TRaCE. The establishment of an EGTC could be a first step to attract more funding, enable a joint administration and planning and reduce some regulatory hurdles. Additionally, the possible future regulation on ECBSs and the

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internal energy market of the EU (Winter Package) promises large opportunities for the implementation of the SEREH project. As the introduction of LECs by the EC was the result of SEREH’s lobbying effort, the presence of the project in Brussels should be continued in order to ensure that the voice of micro-level cooperation projects is heard (cf. chap. 5.5). As the current plans for LECs resemble some approaches from the Dutch experimentation projects (cf. chap. 4.1), SEREH officials should connect with them to learn from their experiences.

As a result, several elements can ensure the long-term success of the project: Committing actors within the Emmen – Haren region to the SEREH project, learning from similar TRaCE and cross-border TRaCE projects in Europe and lobbying for micro-level cooperation on the national and EU-level. In the short term, however, it is important to start with concrete projects in both Emmen and Haren (cf. IV-65). The cross-border element is the “end game of the project, not the starting requirement” that is to be scaled up “once the European legislation is ready”. Before that, it is “important to create local commitments to the project [...] [and] start with projects they can do within their own municipality and thereby committing the local community to these projects – also financially [...]. If you have truly evolved and financially committed local communities, then it is much easier to add the complex cross-border layer to it” (VII-44). Therefore, decentralizing the ownership dimension, for instance by local (cross-border) investments, should be the first step in implementing a cross-border TRaCE in the Emmen – Haren region.

6.2 Critical Reflection on the Thesis

Qualitative and exploratory interviews were the main method used for answering the research question(s) of this thesis (cf. chapter 3.1). As regional and / or civic energy are relatively new developments and concepts (cf. chap. 2.1.1 and 2.1.2) and the SEREH project is pioneering with its comprehensive approach on micro-level cross-border cooperation in the energy sector (cf. chap. 2.1.3 and 5.1), the open and exploratory interviews generally proved to be well-suited for making these topics more accessible scientifically.

The selection of the interview partners was challenging. As a broad topic had to be covered from different angles and, simultaneously, the time and capacity for undertaking interviews was limited, the smallest number of interviews had to cover as many topics and provide as many insights as possible. Generally, this worked well, as all interview partners were able to contribute significant insights and thoughts from their area of expertise. There was, however, a lack of exploitable interview materials on the topics of regulatory conditions in Germany (though it was planned to use more results from desk research on this topic beforehand, cf. chapter 3.1), cooperatives in Germany and direct insights from the Emmen – Haren region. Three planned interviews – with the BNetzA, Agrowea and the cooperative Energiegewinner – unfortunately did

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not take place (because actors did not reply to interview request or it was not possible to schedule a meeting) and could therefore not contribute to solving the lack of interview material on these topics.

Even though Dutch and German are closely related languages, the language is still a practical barrier. This is often an obstacle to cross-border projects. As I do not speak Dutch, original documents in the language had to be translated with the help of translation programs. This bares the danger of not completely understanding the content. Nevertheless, using secondary sources in English or German or asking Dutch interviewees for clarification and verification proved to be suitable methods for compensating this lack of language skills.

As some of the interviews rather focused on general technological or regulatory conditions, the number of actually examined TRaCE projects was limited. Therefore, the selection of cases for developing the three dimensions of decentralization in chapter 4.5 was restricted. A broader selection of more representatives from TRaCE models as interview partners (for instance with VandeBron, De Windvogel or the green and regional electricity company Grünstromwerke) could have helped to broaden the base for the analysis and develop more quantitative, specific and precise categories and coding in this framework. With regards to the limited time, this would have made it necessary to cut interviews on underlying conditions. As a general first overview and base for the qualitative and summarizing discussion on the end of chapter 4, the number of TRaCE projects examined was therefore regarded as sufficient by me.

Originally, it was planned to disregard the aspect of the planned medium voltage interconnecting grid (and its operators) and instead focus rather on the perspective of the RES power plant operators and their customers (cf. chapters 1.2 and 5.1.3). Nevertheless, in the final evaluation in chapters 4 and 5, the grid, as well as its operators and management, played an important role. This was the result of the topic being frequently brought up in the answers to the guided but open questions of the interviews. Since the research was designed to be explorative to find possible solutions to a rather unprecedented issue, the stronger focus on the grid is justifiable and reasonable.

6.3 Further Need for Research

As the thesis has shown, the energy sector is currently undergoing considerable changes in terms of its structure, its actors and their roles and responsibilities (cf. chapter 2). Consequently, regulatory conditions are also quickly changing, although they often lag behind the technologically feasible and sometimes already existing business models (cf. chap. 4.3 and 4.4). Research will constantly be needed for the monitoring of these developments and for contributing relevant insights to practical projects and policy making. In the SEREH context, this especially applies to the European regulation, as major legislative changes (the Winter Package with its LECs and the possible introduction of the ECBC, cf. chap. 5.5) relevant to such a cross-

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border TRaCE are expected. The new national governments in the Netherlands (where at the finishing of this thesis in July 2017, coalition negotiations are still ongoing, after the election in March 2017) and Germany (where a new government will possibly be formed after the parliamentary election in September 2017) are likely to also introduce new regulation on the energy and electricity sector, that might affect TRaCE models (cf. Haleakala-Stiftung 2017: 38).

This thesis followed a qualitative approach, analyzing a small number of TRaCE projects. It would be insightful to evaluate and compare a greater number of TRaCE projects from Germany and the Netherlands. This would make a more systematic and quantitative analysis possible. It would offer a more comprehensive base, from which the identified analytical (sub)categories or dimensions of decentralization (cf. chapter 4.5), that were used in this thesis, could be checked and – if needed – revised or refined. In the evaluation of the interview material in this thesis, general statements about TRaCEs, specific statements on specific TRaCE projects and TRaCE projects from either country were coded into the same subcategories (cf. chapters 3.1 and 4.1). While this is justifiable regarding the qualitative character of the research, a more precise coding could possibly be developed from a qualitative analysis of TRaCE projects. Identifying TRaCE projects from other European countries could also provide relevant results. Some regulatory challenges could be solved differently in different countries, thus providing possibilities to learn from best-practice solutions and disseminate innovative concepts into national or European regulation. A greater and more systematic understanding of national TRaCE projects could also contribute to solve cross-border issues as they appear for instance in the SEREH context.

Other projects operating in micro-level regional cooperation (cf. chapter 2.1.3) could offer learnings as well. Unfortunately, there is no systematic database and evaluation of all the cross-border INTERREG and EGTC projects in the energy sector in Europe (cf. HBS EU | WFC 2017c: 8). A research focusing on establishing comprehensive and accessible databases could facilitate peer-to-peer learning by providing future projects with best- and worst-examples. This could contribute to highlighting cross-border issues to policy makers in the multi-level energy governance system (cf. chap. 2.2).

Not only a more extensive and qualitative research approach could offer relevant results, but also research focused internally on specific projects like SEREH. While this thesis mainly analyzed external (regulatory and technological) conditions and TRaCE projects from Germany and the Netherlands, further investigations could place emphasis directly on the actors and their ideas in Emmen and Haren. For this thesis, the connection to the SEREH project was mainly established through regular contact with officials from the administration of both cities (cf. Preface). Another study could focus on more regional actors: Companies, citizens

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or cooperatives from Emmen and Haren. These actors could be asked to provide their assessment or vision of a regional cross-border trade, their attitude towards the SEREH project or their thoughts on possible TRaCE models. By systematically evaluating these local voices, a more profound assessment on obstacles and opportunities of the SEREH project could be provided.

As the grid (and management of it) turned out to be an important aspect of a cross-border TRaCE, an investigation focusing specifically on the perspective of TSOs and DSOs regarding (cross-border) TRaCEs would be especially insightful. This was also stressed by the interview partners in this thesis (cf. III-20; VI-32). The perspective of the regulatory authorities for the grids – in this case the BNetzA and the ACM – could complement the analysis of the grid perspective.

Sector coupling was largely disregarded in this thesis (cf. chapter 1.2). However, involving the heating, cooling and transport sector via the use of power-to-x technologies was frequently mentioned as a possible solution to many obstacles in the regional cross-border electricity trade (cf. chap. 5.4). The SEREH project itself wants to take sector coupling into account (cf. chap. 5.1.3) and the planned cross-border wind park with research and development elements on power-to-x technologies poses a starting point for more sector coupling (cf. chap. 5.4). Therefore, there is more need for research specifically evaluating the opportunities for sector coupling in a cross-border context, from a technological, but especially from an economical and a regulatory point of view.

6.4 Personal Assessment

With its comprehensive and ambitious vision for implementing a cross-border regional and civic trade of renewable energy, the SEREH project is a pioneer in micro-level cooperation in Europe. Although the technical characteristics of RES downright require new forms of governance and the involvement of more actors, regulation on all levels is lagging behind these developments. A lack of comparable and (successfully) completed projects prevents SEREH from simply copying best-practice solutions and requires it to test new solutions. Because the project operates in largely uncharted territory “all these questions cannot be answered finally up to now, but it is necessary to work on concepts and have to implement and evaluate them. In this process, arguments can be found in favor or against certain approaches. In the end, we will have to see what politics and the local administration make out of this” (VI-46).

These local politicians and administrators are strongly committed to achieving the SEREH project’s vision. But its implementation can only succeed, if more actors from the electricity sector and the civil society in the region add their expertise, resources and efforts to the project. Even though directly comparable cross-border projects do not exist, many projects have (partly) similar goals and approaches. The SEREH project

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team therefore needs to continue to identify these projects and discuss issues with them, in order to find possible solutions to their difficulties, find allies and raise awareness for the potentials and challenges of a cross-border TRaCE project.

The aim to implement and operate a cross-border medium voltage grid between the two cities makes the SEREH project unique in Europe. However, the project’s other targets of involving local citizens, cooperatives and companies and of testing new business models for RES production are equally important. The thesis showed that decentralization in these areas – especially the ownership dimension – offers the most potential for immediate results. Therefore, the financial involvement of citizens and companies into renewable energy should be strengthened in the two cities, while more complex cross-border issues are resolved.

Generally, it is important to continue supporting regional energy, civic energy and regional cooperation – both micro-level and macro-level – in the future, as the energy transition is not only a technical issue, but also a social one. Fortunately, the regional energy approach of optimizing energy flows first on the lower levels matches perfectly with the EU principle of subsidiarity, that aims to solve political problems as far as possible on the lower policy levels first. The regional and civic energy approaches can additionally help to increase the social acceptance and citizens’ participation in the energy transition and unlock efficiency potentials that cannot be accessed solely by higher policy levels. Overall, the speed of this transition could be increased by strengthening these approaches. If the EU enables micro-level cooperation, it can contribute to reinforcing a positive assessment of the European integration, as it becomes possible for citizens to participate in the energy transition and to connect with neighbors from the other side of the border.

“Renewable resources are not national, they are natural” (HBS EU | WFC 2017b: 03:37:00). To harvest the RES efficiently and allowing them to serve as public goods, more macro- and micro-level cooperation is therefore needed in the energy sector’s multi-level governance. This requires national governments to hand over some of their competences to both the European and the subnational levels: The EU would need more competences in setting a broad policy frame and for coordinating the overall energy transition and the different policy levels. At the same time, it would have to enable local cooperation through fitted policy frameworks and through revenue and subsidy streams not only going to national governments, but increasingly and directly to local and civic actors. The regional and local policy level would need more competences in planning and implementing energy projects and the ground and have more space for experimentation. If more cross-border experimentation is possible, there is a greater chance of finding innovative solutions that can be scaled up. Overall, a mixture of top-down and bottom-up, of macro-level and micro-level cooperation, offers the best governance mode for managing the complex transition towards renewable energy.

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Annex

I. The SEREH Vision for 2025

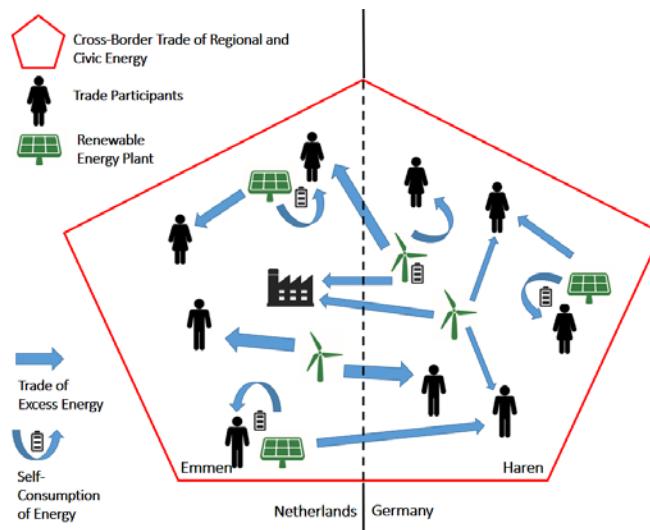
This handout with the SEREH project description and vision was given to each interviewee. Along this vision, obstacles and opportunities for the project (regarding trade models, actors, technological and regulatory conditions) were discussed. The expertise of the participants shaped the focus of the discussion. The handout with the SEREH vision served as the base for the second part of the interviews.

The cities Emmen (Netherlands) and Haren (Germany) work together in the Project “Smart Energy Region Emmen – Haren”. Situated next to each other on both sides of the Dutch-German border, they want to pioneer in subnational cross-border cooperation, aim to connect their very different energy systems and hope to provide local businesses and civic actors with new business models in a regional energy trade.

	Emmen (Netherlands)	Haren (Germany)
Population	110.000	24.000
Energy Consumption 2015 in MWh	385.688.321	186.894
RES Production 2015 in MWh (7 % of Demand)	27.904.316	205.205 (110 % of Demand)
Variable RES Production 2015 in MWh (Wind and Solar) (0,02 % of Demand)	92.701	150.796 (81 % of Demand)

By 2025, the two cities want to:

- Have regionally produced energy used more and more in the region, by using an intelligent infrastructure and investing in energy storage technologies
- Have local energy cooperatives promote the production of RES and the trade of RES between consumers within both cities. Companies in the region also increasingly use regional renewable energy
- Have the regional added value increased by the cross-border regional energy trade and profits from RES production staying in the region, while at the same time saving on energy imports
- Have their two energy systems connected by a grid [possibly on the DSO level]



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II. Original Data Used in Own Figures

Figure 2: Share in Gross Final Electricity Consumption in GER (Own Figure, Based On IEA 2016)

Source	Production in GWh	Share
Nuclear	97,129	15.47
Gas	62,270	9.92
Coal	284,911	45.38
Oil and Other	7,682	1.22
Wind	57,357	9.14
Solar PV	36,056	5.74
Biofuels	43,345	6.90
Hydro	25,444	4.05
Geothermal	98	0.02
Waste	13,503	2.15
Total	627,795	100.00

Figure 3: Components of the Household Electricity Price in GER (Own Figure, Based on BDEW 2017)

Part of Household Electricity Price	Costs in € ct	Share on Total Costs
Electricity Production & Retail	5.63	0.19
Network Charges	7.48	0.26
EEG reallocation charge	6.88	0.24
Value Added Tax	4.66	0.16
Electricity Tax	2.05	0.07
Concession Fee	1.66	0.06
Other levies	0.80	0.03
Total	29.16	1.00

Figure 4: Electricity Prices in Europe for Consumers and Industry (Own Figure, Based on Eurostat 2016)

Customer Segment	Price in € per kWh (average in first half of 2014)	Price in € per kWh (average in first half of 2015)	Price in € per kWh (average in first half of 2016)
EU-28 – Household	0.204	0.209	0.206
EU-28 – Industry	0.123	0.121	0.117
Germany - Household	0.298	0.295	0.297
Germany – Industry	0.159	0.151	0.151
Netherlands - Household	0.184	0.199	0.162
Netherlands - Industry	0.093	0.090	0.086

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Figure 5: Electricity Wholesale Prices for GER / AU (Own Figure, Based On Fraunhofer ISE 2017b)

Year	Day Ahead Auction (in € / MWh, adjusted for inflation)	Intraday Continuous (in € / MWh, adjusted for inflation)
2002	28.27	Not available
2003	36.53	n.a.
2004	35.05	n.a.
2005	56.52	n.a.
2006	58.64	67.16
2007	44.87	63.21
2008	73.81	82.25
2009	43.96	46.63
2010	49.65	52.52
2011	55.07	55.93
2012	44.64	49.35
2013	39.03	42.30
2014	33.31	36.28
2015	31.81	33.96
2016	28.62	30.98
2017	34.66 (preliminary, mid-June)	37.9 (preliminary, mid-June)

Figure 6: Share in Gross Final Electricity Consumption in NDL (Own Figure, Based on IEA 2016)

Source	Production in GWh	Share
Nuclear	4091	4.0
Gas	51,522	49.8
Coal	32,420	31.3
Oil and Other	2,051	2.0
Wind	5,797	5.6
Solar PV	785	0.8
Biofuels	3,105	3.0
Hydro	112	0.1
Geothermal	0	0.0
Waste	3,535	3.4
Total	103,418	100.0

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Figure 7: RES-Shares in Gross Final Consumption (Own Figure, Based on Eurostat 2017a)

Year	EU Energy	EU Electricity	GER Energy (Target 2020: 18 %)	GER Electricity	NDL Energy (Target 2020: 14 %)	NDL Electricity
2004	8.5	14.3	5.8	9.4	2.1	4.4
2005	9.0	14.8	6.7	10.5	2.5	6.3
2006	9.5	15.4	7.7	11.8	2.8	6.5
2007	10.4	16.1	9.1	13.6	3.3	6.0
2008	11.0	17.0	8.6	15.1	3.6	7.5
2009	12.4	19.0	9.9	17.4	4.3	9.1
2010	12.9	19.7	10.5	18.1	3.9	9.6
2011	13.2	21.7	11.4	20.9	4.5	9.8
2012	14.4	23.5	12.1	23.6	4.7	10.4
2013	15.2	25.4	12.4	25.3	4.8	10.0
2014	16.1	27.5	13.8	28.2	5.5	10.0
2015	16.7	28.8	14.6	30.7	5.8	11.1

Figure 8: Net-Electricity Exports from GER to NDL (Own Figure, Based on ENTSO-E 2017)

Year - Month	Electricity Net-Exports from GER to NL in GWh
2010-1	643
2010-2	410
2010-3	362
2010-4	881
2010-5	1,036
2010-6	920
2010-7	943
2010-8	576
2010-9	584
2010-10	330
2010-11	707
2010-12	1,550
2011-1	1,578
2011-2	1,022
2011-3	989
2011-4	730
2011-5	279
2011-6	795
2011-7	688
2011-8	555
2011-9	588
2011-10	764

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2011-11	594
2011-12	1,007
2012-1	1,162
2012-2	778
2012-3	2,139
2012-4	1,921
2012-5	2,140
2012-6	2,199
2012-7	1,999
2012-8	1,852
2012-9	1,995
2012-10	2,069
2012-11	2,093
2012-12	2,214
2013-1	2,302
2013-2	1,944
2013-3	2,471
2013-4	2,036
2013-5	2,062
2013-6	1,937
2013-7	2,000
2013-8	1,849
2013-9	2,203
2013-10	1,962
2013-11	2,156
2013-12	1,637
2014-1	2,308
2014-2	2,289
2014-3	2,497
2014-4	2,260
2014-5	1,945
2014-6	1,682
2014-7	1,636
2014-8	1,556
2014-9	2,018
2014-10	2,135
2014-11	2,117
2014-12	1,897
2015-1	1,853
2015-2	1,867
2015-3	2,293
2015-4	1,893

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2015-5	2,026
2015-6	2,584
2015-7	1,949
2015-8	2,298
2015-9	2,166
2015-10	2,052
2015-11	1,504
2015-12	1,476

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III. List of All (Sub)Categories

Interview Part (1 st Part national TRaCE 2 nd Part SEREH Vision)	Analytical Category	Subcategory I	Subcategory II	Memo / Definition	Number of Statements (N=846)
National TRaCE					0
	Actors				0
		Cities		A city itself or a utility owned by the city ("Stadtwerk")	9
		Cooperatives		A cooperative - owned by citizens, that are not (only) profit- but also value-driven - that is active in the electricity sector	24
		DSOs		Distribution System Operators	23
		Energy Consuming Companies		(Larger) companies with a high demand for energy/electricity	8
		Households		Regular households as consumers of energy	14
		New Energy Companies		Companies that are active in new / emerging fields of the electricity market, acting as renewable-portfolio-aggregators, managing virtual power plants, trading renewable energy on wholesale markets as direct marketer, developing new IT-solutions / apps for smart energy solutions...	17
		Small Energy Producers / Prossumers		Individuals / Households owning and operating their own renewable energy plants - maybe even acting as "Prossumers", meaning they produce and self-consume their own electricity, possibly even selling excess electricity but also buying	19

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		electricity from the grid if needed.	
TSOs	A transmission system operator	18	
Universities / Research	Universities / Research Facilities involved in a project	7	
Utilities	A (larger) privately-owned electricity company, active in "classic" sectors of the electricity market (generation, retail...)	11	
General		12	
TRaCE Model		0	
Experimentation	A project designed to take place in a certain time period under certain experimental conditions, possibly with regulatory exemptions or state funding for the project.	14	
Fixed Feed-In Tariff	A model that is based on the guaranteed feed-in-tariff for RES generation, or other forms of subsidies	5	
(Integration Into) Overall Markets	Regional electricity trade in the context of external market conditions (in the state and/or Europe) and attempts to integrate more decentral, regional elements into the market design.	47	
Local Investments	A model that involves facilitating local investments into local RES projects	11	
Miscellaneous Direct Marketing	A direct physical marketing (e.g. from a windfarm supplying exclusively electricity to a nearby company), potentially via	8	

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	privately owned and run (grid) assets.	
Regional Label / Marketing	A (virtual) regional electricity label, mainly used as a marketing-tool. The "regional" trait is proven by (private or state-sponsored) labels and/or IT-based systems.	28
Reg. Market for Generation & Flexibility	A regional market platform for regional renewable generation, the provision of flexibility and / or capacity.	34
Tax Exemption	A model that is based on exemptions from taxes and fees	8
General		18
Regulatory Conditions		0
General		1
Germany	Relevant rules, and regulations regarding the electricity sector and electricity markets in Germany.	0
Digital Energy Transition		5
EEG		14
Network Charges and Balancing		8
Regional Certificates		5
The Netherlands	Relevant rules, and regulations regarding the electricity sector and electricity markets in the Netherlands.	0
Regional Certificates		4
SDE+		2
Network Charges and Balancing		10
Tax Deductions		3
Laws for Cooperatives		4
Digital Energy Transition		3

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European Union	Relevant rules, and regulations from the European Union regarding the electricity sector and electricity markets.	1
Winter Package		2
Unbundling / Liberalization		2
Technological Conditions		0
Generation	Technological conditions concerning the production side of RES electricity generation (e.g. steering of plants)	14
Grid Management	All means taken by grid operators to stabilize voltage and frequency of a grid at any time. This can be done by using existing grid infrastructure better (for instance via redispatch, better prediction tools, better grid communication...) or by increasing the grid infrastructure.	1
Distribution Grids	Means to manage especially distribution grids	19
Transmission Grids	Means to manage especially transmission grids	9
General	General means to manage the grids and / or to connect transmission and distribution grids	23
IT and Data	Issues connected to a more data-based, digitalized and automated energy system (for instance smart-meters, digital / automatic means to steer electricity demand, new software / apps...)	22
Load	Means to steer demand side behavior	14

Organizing a Cross-Border Trade of Regional and Civic Energy:
Prerequisites and Possibilities for the Dutch-German Project 'Smart Energy Region Emmen – Haren'

	of electricity consumers	
Sector Coupling	Means of sector coupling, e.g. power-to-X	6
Storage	Storage options for decentral and fluctuating renewable energy, including solutions for self-consumption	17
System Services / Flexibility	Technical means to provide system services and ensure flexibility in the grid	19
General		8
General		6
SEREH Vision		0
General		19
Actors	Statements regarding actors involved in a possible cross border TRaCE	0
General		9
Obstacles		16
Opportunities		16
Regulatory Conditions	Statemets regarding (market) regulation in a possible cross-border TRaCE	2
General		24
Opportunities		23
Obstacles		35
Technological Conditions	Statements regarding technological conditions of a possible cross-border TRaCE	0
General		15
Opportunities		15
Obstacles		20
Cross-Border TRaCE Models	Statements regarding the set-up of a possible cross-border TRaCE	0
General		31
Opportunities		32
Obstacles		32

Declaration of Independent Work

Declaration of Independent Work

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Oldenburg, den 26.07.2017

Sebastian Rohe