

# Functional Policy Recommendations for Stimulating, Facilitating and Supporting the Province of Gelderland's Regional Energy Strategies.

A Policy Assessment based on Technological  
Innovation Systems (TIS) Theory

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## Abstract

In response to national renewable energy (RE) targets, the Province of Gelderland must provide the Dutch federal government with a plan that increases the Province's renewable energy share while also continuing to accommodate the energy needs of its citizens. Gelderland is in the process of writing six regional energy strategies (RES) which it plans to use to achieve renewable energy generation target of 16% by 2023 (PRO, 2015, pg. 1). Gelderland's energy system is undergoing a fundamental transition; however, its success is being hindered by uncertainty over what strategies the Province should undertake to increase renewable energy production. To progress, possible bottlenecks must be identified in order to propose recommendations for how Gelderland's goals will be achieved using the RES. The purpose of this study is to provide the Province of Gelderland with a Technological Innovation System (TIS) theory-based policy assessment framework which contributes to the development of successful regional energy strategies. Under an interpretivist research philosophy, semi-structured expert interviews were conducted to better understand how the structural and functional elements of TIS theory are expressed in the Province of Gelderland's energy transition. The assessment resulted in the proposal of a policy mix that addresses the identified bottlenecks affecting Gelderland's energy transition.

Key Words: Energy Transition, Technological Innovation Systems, Regional Energy Strategy, Target Compliance Markets, Gelderland

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## Abbreviations:

CBA: Community benefit agreements

CCA: Community choice aggregators

GEA: Gelders Energy Accord

MAUT: Multi-Attribute Utility Theory

NGO: Non-Governmental Organization

RPS: Renewable portfolio standards

REC: Renewable energy credits

RES: Regional energy strategies

TIS: Technological Innovation Theory

## Chapter 1: Introduction

The research of this thesis is in response to the following problem statement:

*The Province of Gelderland does not yet have a set of regional energy strategies that can help it achieve the Province's 2020 and 2023 renewable energy generation targets of 14% and 16%.*

### 1.1 Context of the Research Problem Statement:

In accordance with commitments to the EU after the 2015 Paris Climate Agreement, the Netherlands must contribute to Europe's targets of "a reduction in greenhouse gas emissions of 40% in comparison with 1990 and a 27% share of renewable energy" by the year 2030 (Ministry of Economic Affairs, 2016, pg. 20). The Netherlands agreed to increase the share of its energy usage derived from renewable sources to 14% in 2020 and up to 16% by 2023 (Ministry of Economic Affairs and Climate Policy, 2019). These targets are preliminary and act as steps towards eventually achieving "almost 100% sustainable energy by 2050" (Ministry of Economic Affairs and Climate Policy, 2019). Yet as of 2017, the Netherlands energy transition had stagnated at only 6.6% (Centraal Bureau voor de Statistiek, 2019) and with just one year left, the Netherlands seems poised to fall short of the 2020 commitments it promised to the rest of Europe and the wider international community. The Netherlands' central government has subsequently tasked the provinces with coming up with independent strategies for achieving the national commitments. The Province of Gelderland convened with more than 200 partners from the civil, market and governmental spheres of society to create The Gelders Energy Accord which sets provincial renewable energy targets of 16% by 2023 and between 30% and 40% by 2030 (De la Court, 2018, pg. 9). The Agreement resulted in the decision to create six regional energy strategies (the regions being Achterhoek, Noord-Veluwe, FoodValley, Rivierenland, Cleantech and Arnhem-Nijmegen) within the Province which will collectively achieve the Province's renewable energy goals (GeldersEnergieakkoord, 2016, pg. 3). However, on its current trajectory the Province of Gelderland is unlikely to reach its 2030 goal of 27% renewable energy (55% CO<sub>2</sub> reduction from 1990 levels) let alone its much closer 2020 renewable energy generation target of 14% (PRO, 2015, pg. 1). While the Province of Gelderland is attempting to undergo a fundamental energy transition, its success is being hindered by continuing uncertainty over what governance approach the government should pursue. This difficult situation is compounded by not insignificant political and public opposition to the construction of additional wind turbines within the province. It is within this context that the Province of Gelderland finds itself tasked with delivering a set of regional energy strategies to the central government of the Netherlands before the end of 2019. Keeping with TIS theory, this thesis will work to identify the structures involved with the Province's RES. Once these structural elements have been identified and analyzed, they will be used to assess what the Province of Gelderland can do to stimulate and facilitate the development of innovative regional energy strategies that achieve its renewable energy goals.

## 1.2 Context of the Research Topic

The Gelders Energy Accord's (Gelders Energieakkoord) plan to form regional energy strategies officially began in 2017 when the North Veluwe and Rivierenland (Fruitedelta) regions of the Province of Gelderland took part in a national pilot program which established regional energy strategies. These strategies worked to “jointly arrive at choices for the generation of renewable electricity, the heat transition in the built environment and the necessary storage and energy infrastructure” (National Program RES, 2019) to achieve energy neutral regions and additional milestones until 2050. Under this program the regions took local approaches in order to consult with citizens to make sure the people were able to give feedback into the province's energy transition. Since implementation of this climate policy occurs at the local, regional and provincial level, Gelderland created the Gelderland Energy Agreement (GEA) to organize the goals of its regions and municipalities under a Gelders Energy Transition Model, which provides structural support for each region and municipality's energy strategy. Alongside the provincial level plans for an energy transition is the National RES program which “supports the regions in making the RES [by...] developing and sharing knowledge, data support (analyzes, calculation methods) or information about the Climate Agreement” to facilitate better communication between provinces (National Program RES, 2019). While the Province of Gelderland seeks to cut CO<sub>2</sub> emissions through measures to increase efficiency and cut energy waste, it also plans to achieve its goals through renewable energy adoption.

## 1.3 Research Questions and Aims

The following research question has been formulated to pursue this research topic:

*What can the Province of Gelderland do to stimulate, support and facilitate the development of innovative regional energy strategies that achieve its renewable energy goals?*

In order to sufficiently answer this foremost research question and provide organization for this research, three descriptive sub-questions are used. These questions seek to describe the state of existing renewable energy generation in the Province of Gelderland as well as identify the conditions needed to effectuate a TIS (Farthing, 2016, pg. 43). They will be used to assess the bottlenecks obstructing the Province's regional energy strategies so that a policy assessment framework can be developed.

1. What structural elements must be present for the Province of Gelderland to stimulate and facilitate the development of regional energy strategies?
2. What system functions most need improvement in order for the Province of Gelderland to stimulate and facilitate the development of regional energy strategies?
3. How can the necessary system functions be operationalized to recommend a mix of policy instruments that will address the identified systemic problems?

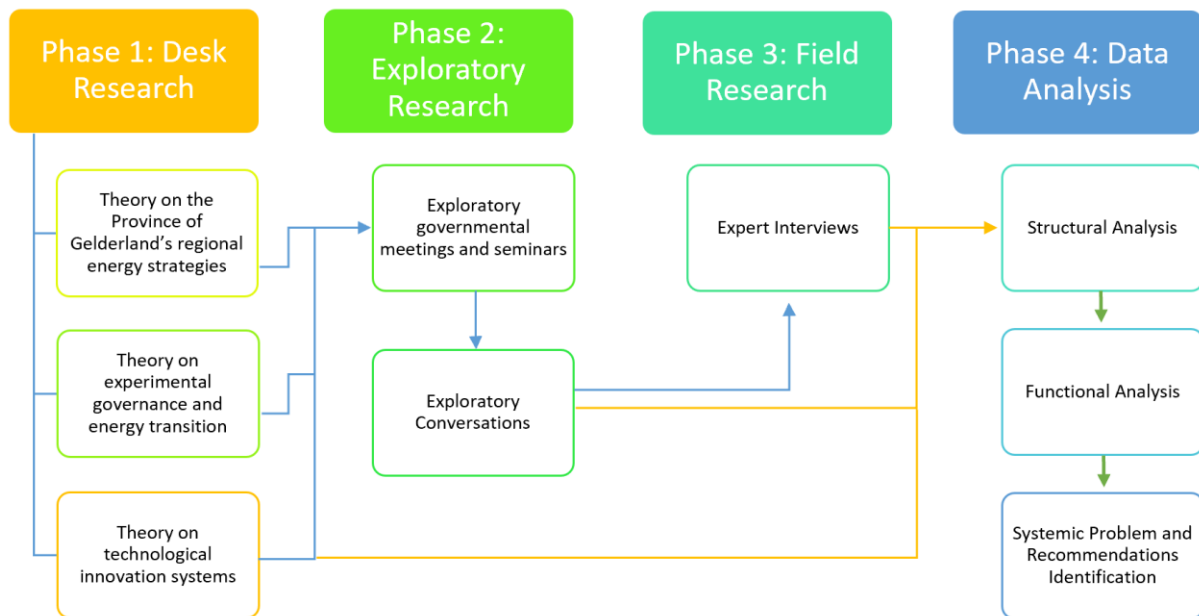
The aim of these questions is as follows:

*To aid the Provincial Council for Environmental Policy in its advise to the provincial government of Gelderland in achieving its RES's long-term renewable energy targets.*

### Research Framework:

The research framework depicts the process by which this study works to answer the research questions. This framework is split into four phases. Phase 1 involves desk research in the form of literature review for appropriate theory to tackle the identified problem facing the Province of Gelderland. Phase 2 involves attending governmental meetings/seminars, exploratory conversations and further reading of relevant literature to identify relevant actors, institutions, infrastructures and interactions present within the Province of Gelderland. Field research occurs in Phase 3 so that important actors may be interviewed. The movement from Phase 1 to Phase 3 can subsequently be observed by tracking the blue arrows in Figure 1 below. Phase 4 set about the analysis of the data to form a structural analysis. The structural analysis is made using data collected during desk and exploratory research in addition to field research. The structural analysis is used to interpret the health of the seven functions in functional analysis. The orange arrows in Figure 1 track the data forming the structural analysis. Together the structural and functional analyses from Phases 2 and 4 culminate in the identification of systemic problems and recommendations.

**Figure 1: Research Framework**



## 1.4 Societal Relevance of the Research

This research seeks to explore what the provincial government of Gelderland can do to help its energy regions achieve the provincial renewable energy goals. This research can help to identify the strengths and weaknesses of the RES by creating an assessment of the RES as a TIS. Having an analysis of the underlying structures and interactive processes involved in the Province of Gelderland's energy transition can help to determine where the systemic problems occur. In turn, having a clear understanding of where the systematic problems are, will allow for the selection and application of policies that specifically target the problems rather than provide support to areas that don't need strengthening. Having this research available is especially pertinent now since the Netherlands requires Gelderland to set up a regional energy strategy before 2019 (Gelders Energy Agreement, 2019). Europe has less than two years to meet its 2020 target of 20% share of renewable energy and while 12 member states have already met their commitments, many of Europe's largest economies including the Netherlands are still far from attaining their goals (Eurostat, 2019, pg. 2). If the Netherlands is serious about catching up with its own self-imposed deadlines, it must immediately move away from the status-quo. Such an about face turn will require innovative forms of policymaking that incorporate elements of experimental government.

Of importance will be the adoption of policies that can stimulate and facilitate the rapid and sustained growth of the renewable energy market in an efficient and cost-effective way. As a highly developed economy with a longstanding reliance on base-load dependent centralized-grids, the Netherlands' energy market continues to be dominated by three large energy "incumbents, Essent, Nuon, and Eneco with their affiliated brands, [which] serve about 80% of the market" (Mulder and Willem, 2019, pg. 233). However, the Province of Gelderland's energy transition has largely grown out of bottom-up initiatives that sprout out of the energy needs of individual communities in Gelderland (Assembly of European Regions, 2018). To be successful at achieving the RES goals by effectuating change on the municipality level, the Province of Gelderland must have a strong civil society that creates demand for renewable energy. However, recent polling to measure the awareness and opinions of Dutch citizen suggests that the civil society in the Netherlands is underdeveloped and uneducated on the realities of the Dutch energy situation. A public survey conducted by the Ministry of Economic Affairs of the Netherlands in 2016 revealed that most citizens believe they "have a limited responsibility for the energy transition" (Ministry of Economic Affairs of the Netherlands, 2016, pg. 137). Their study found that Dutch citizens "[over]estimate the current share of renewable energy to be much higher (33%) than it actually is (6.6%) and underestimate the share of gas in the energy mix" (Ministry of Economic Affairs of the Netherlands, 2016, pg. 137) suggests that the Dutch public is disconnected from the realities of the Netherlands' energy system. These findings conflict with the European Commission's 2017 Special Eurobarometer 459 Report on Climate Change, which found that "nearly eight in ten respondents in the Netherlands see climate change as a 'very serious' problem (78%, EU average 74%), a 20 percentage point increase since the previous survey in 2015" (EU Commission: The Netherlands, 2017, pg. 1). This same study found that 27% of Dutch respondents consider climate change to be the most serious global problem (EU Commission, 2017, pg. 5). With "59% of

citizens say[ing] they have personally taken action to fight climate change in the past six months” (EU Commission: The Netherlands, 2017 pg. 1) the Netherlands indeed boasts a citizenry that is largely committed to fighting climate change. What these statistics are meant to highlight is a dichotomy in which most Dutch citizens want something to be done about climate change, but because they haven’t been given the tools or resources to take action, they remain uninterested, uninformed and uninvolved in the Netherlands’ energy transition. If the Province of Gelderland wants to continue to pursue a bottom-up approach to its energy transition, then it is going to need to better stimulate and support the strengthening of its civil society. Overcoming this challenge will require the provincial government to implement rapid and significant changes including changing how renewable energy projects are financed, ensuring local citizens partially own local renewable energy projects, mandating that communities and developers complete legally-binding benefit agreements for all new projects, and increasing the transparency and ease of communication between citizens and the provincial government (GNMF, 2018).

## 1.5 Scientific Relevance of the Research

Energy cooperatives and other local renewable energy initiatives are increasingly being discussed as the solutions to the Netherlands’ energy transition problems. Previous research has highlighted the increasingly important role of citizens in the energy transition and the potential “shifts in the roles and responsibilities of all actors in the energy market” as a result (De Bakker, 2016). This shift in responsibility towards civil society to create new initiatives ignores the reality that most communities and municipalities do not have the skills or the financial, technical or legal resources to realize the energy transition in a timely manner. De Heer emphasized the need to reach out to “municipalities in the Netherlands struggling with their newfound responsibilities regarding the goals of the energy transition” in order to figure out what can be done to help them (De Heer, 2018, pg. 78). The problem is that previous studies have not truly considered what the structural and functional problems facing the Province of Gelderland are. For example, the Province has a highly developed and centralized one-way electricity grid which will require an immense amount of restructuring if it must connect to potentially hundreds of disparate distributed renewable energy projects (Docia, Vasileiadoua, Petersen, 2015). While energy cooperatives and communities offer many benefits, their growth in the marketplace makes it incredibly difficult for distribution system operators such as Alliander to add capacity to the electricity grid without significant development of micro-grids in the short term (Doyer, 2019). Indeed, energy cooperatives must be stimulated and supported and municipalities must be consulted to determine what is necessary for them to develop renewable energy locally, but there has been little research as to what other mechanisms and policies the provincial government can implement to increase the growth of renewable energy generally. The provincial government of Gelderland is in an identity crisis as to what its role should be in the RES, therefore this research seeks to close the knowledge gap by providing insight into where the provincial government’s finances, authority, expertise and connections are most needed. The policy assessment tool designed for this study will provide the province with information on which function elements are lacking or absent in the existing system and identify what is obstructing them from their full potential. In this way a policy instrument set will be proposed to close the knowledge gap by recommending solutions to the systemic problems facing the provincial government. Additional experiments could replicate the case study and subsequent decision-making using other provincial regions as case studies. This

research also serves as an opportunity for Dutch policy makers to be exposed to energy policies used in other countries which might offer new alternative pathways for the energy transition.

## Reading Guide

The structure and organization of the research contained within this study will be briefly discussed. The first chapter containing the introduction to the problem, questions, aim and relevance of the research has already been covered. The second chapter describes the relevant theories informing the body of research that this study belongs to and the reasons for why TIS theory was used over the other available relevant theories. It also describes the steps involved in the usage of TIS theory and detail the various aspects of the structural and functional analyses. Chapter 3 discusses the methods of data collection and analysis used as well as the reasons why this methodology was chosen over the other available options. Chapter 4, as the first of two results of the data analysis sections details the findings of the structural analysis of the RES. Chapter 5, as the second of the two results of the data analysis sections details the findings of the functional analysis of the RES using the structures identified in Chapter 4. Chapter 6 contains the conclusions and recommendations of the research. Chapter 7 closes out the study with a discussion that reflects on the shortcomings of the methods and results of the research. Chapter 7 also discusses the contributions made by this research to TIS theory and offers recommendations for opportunities of future research.

## Chapter 2: Critical Discussion and Theoretical Framework

### 2.1 Critical Discussion of Relevant Theories

Technological Innovations Systems research is based in a rich collection of literature discussing societal transition pathways towards environmental sustainability. Socio-technical transitions theory was initially considered for the theoretical framework, but it wasn't selected because it didn't support an exploratory/evaluative research framework. Socio-technical transition theory seeks to create "a framework for understanding transitions that provides an overall view of the multi-dimensional complexity of changes in socio-technical systems" (Geels, 2010, 495). In this way, it describes and typifies the transition pathways of technologies rather than evaluate the weaknesses of technology systems and explore potential strengthening solutions (Geels, 2010). MLP offers a useful typology for identifying transition pathways but applying the Province of Gelderland's energy transition to one of the four transition types: transformation, reconfiguration, technological substitution, and de-alignment and re-alignment (Geels and Schot, 2007, pg. 406) does not help answer the research question. While Socio-technical transitions theory was ultimately not selected for the assessment used in this study, it provided clarity for what a technology transition involves.

After socio-technical transition theory had been vetoed, the governance typology of Steurer (2013) was also seriously considered for the theoretical framework. Steurer's synoptic view of governance was appealing because it's domain-specific/spanning regulation types could be used to evaluate the RES (Steurer, 2013). Steurer discusses seven types of regulation types that fall under a definition of governance that is "synonymous with the broad notions of steering and regulation, [...] referring to formulating, promulgating, implementing and/or enforcing societally relevant rules (binding or voluntary ones) by government, business and/or societal actors" (Steurer, 2013, pg. 1). These actors form three distinct domains within society dictate and differentiate the seven regulation types: "three within a single domain and four between them" (Steurer, 2013, pg. 5). Since this research argues that "civil regulation, business self-regulation and private co-regulation are not simply alternatives or complements to but often-essential prerequisites for public policies" I thought that I could explain the strengths and weaknesses of the RES by measuring the level of "polycentric governance" occurring in the Province of Gelderland (Steurer, 2013, pg. 18). Steurer's governance typology, while more effective than socio-technical transition theory in identifying systematic problems associated with governance practices, is not helpful in explaining non-governance related structural weaknesses. TIS theory not only considers issues with the governance structure of an innovation system with the Guidance of the Search function, it makes the incorporation of geographical, cultural and social constraints into the analysis very easy. TIS theory is very practical in that it acts both as a mechanism for understanding the structural components of the innovation system, but also how those structural components influence the health of the system through specific functions (Wiezorek & Hekkert, 2012). Where the other major theories would be useful in analyzing what stage the Province of Gelderland's energy

transition is in or what effect the provincial government's regulatory system is having on the effectiveness of the RES, neither is as good at exploring what the individual effect of structures and processes are on the development of the RES (Hekkert et al., 2007).

## 2.2 Theoretical Framework

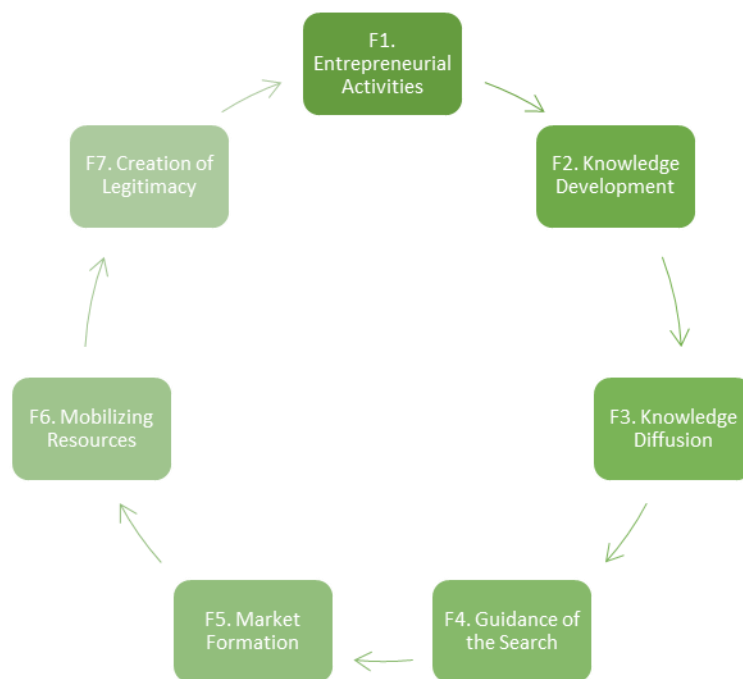
The purpose of this research is to design and provide the PRO with a policy assessment framework that sheds light on what the role of the province should be to stimulate and facilitate RES. In order to achieve this objective, an understanding of technological innovation systems theory (TIS) must be formed. This framework will therefore include theory based in innovation studies to help inform the context and usage of TIS.

TIS theory grew out of Carlsson & Stankiewicz's (1991) realization that while technological change is clearly a driver of economic growth, the "causal connections between technological change and economic growth [was] poorly understood" due to the continued usage of outdated neoclassical models for economic growth (Carlsson & Stankiewicz, 1991, pg. 93). They therefore called for a dynamic bottom-up approach to understanding economic growth at the macroeconomic level (Carlsson & Stankiewicz, 1991, pg. 93). They integrated the new technology as a micro level endogenous factor in the analysis in order to develop an understanding of the macro economy "as a complex network of micro relationships" (Carlsson & Stankiewicz, 1991, pg. 94). Carlsson and Stankiewicz define the *technological system* as "a network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure or set of infrastructures and involved in the generation, diffusion, and utilization of technology" (Carlsson & Stankiewicz, 1991, pg. 111), rejecting the notion that economic change can be explained by institutions, actors or innovations alone. They go on to say that technological systems are defined by the flow of knowledge rather than goods and services, meaning the five institutional and organizational factors discussed: "economic competence, "clustering" of resources, networks and development blocks and their constituent parts, and the institutional infrastructure" involve active knowledge and competency networks (Carlsson & Stankiewicz, 1991, pg. 94). Smits (2002) expanded the scope of innovation studies beyond the effect of technology on economic growth. Smits used the innovation processes developed by Carlsson & Stankiewicz to analyze the broader effects technology has on society. Smits was therefore interested in the macro and meso level effects new technology had on the structures, decision making processes, knowledge infrastructure and social networks of society (Smits, 2002, pg. 861).

Innovation studies' concept of technological change has expanded to include innovation processes which are "the development of technology in interaction with the system in which the technology is embedded" (Hekkert et al., 2007, 414). This broader definition of technological change employs a functional analysis tool that was first developed by Johnson in 2001 (Johnson, 2001). Functional analysis is a categorization of the innovation processes necessary for well-performing innovation systems, as functions of innovation systems (Wieczorek, 2014, pg. 25). After developing their broad definition of technological change, Hekkert et al. empirically tested

Johnson’s system functions and proposed a new set of seven functions to better map the important activities of innovation systems and to “describe and explain shifts in technology specific innovation systems” (Hekkert et al. 2007, pg. 421). The purpose of the functional analysis is to clarify the present status of a specific innovation (technology or policy) in order to identify the “inducement and blocking mechanisms” (Bergek, 2002, pg. 18). Functional analysis can subsequently “serve as a framework to identify emerging policy issues” because it gives the researcher answers to analytical questions (Wieczorek, 2014, pg. 25). The functional analysis used in this thesis will be based off the frameworks of Wieczorek and Hekkert (2012) developed specifically for policy makers and innovation researchers.

**Figure 2: The TIS Functions**



The crux of the functional analysis constructed and contributed to by Johnson, 2001; Bergek, 2002; Hekkert, 2007; Bergek et al, 2008; Wieczorek, 2014 are the functions themselves. The functions are processes integral for a well-operating innovation system and therefore act as indicators (symptoms) of the innovation systems underlying structural problems. Since functions correspond to the structural elements, proper TIS based assessment must first have a solid account of the actors, institutions, interactions and infrastructure of the innovation system (Wieczorek, 2014, pg. 25). In fact, structural elements can be thought of as the causes of the condition of the functional elements, with underperformance or absence of a function being a signal that there is a weakness in the structure of the innovation system (Wieczorek, 2014, pg. 26). To account for the

link between functions and structures, Wieczorek (2014) recommends examining each function using the four structural elements for either explanatory or policy reasons (Wieczorek, 2014, pg. 26). This means that a structural analysis identifying the actors, institutions, interactions, and infrastructure of the innovation system should always come before the functional analysis (De Heer, 2016, pg. 21). Therefore, issues associated with the actors, institutions, interactions and infrastructure of the RES will be considered the cause of why a function is underperforming or absent. The functional-structural analysis presents a clear impression of the innerworkings of the innovation system, what the existing problems are and why they are occurring. This research will seek out a policy mix that alters the structural elements of the RES to encourage the presence or strengthening of underperforming or absent functions (Wieczorek, 2014, pg. 26).

**Table 1. Structural Dimensions of TIS**

<b>Structural dimensions:</b>	<b>Subcategories:</b>
Actors:	<ul style="list-style-type: none"> <li>- Civil society</li> <li>- Companies: start-ups, SME's, large firms, MNC's</li> <li>- Knowledge institutes: universities, technology institutes, research centres, schools</li> <li>- Government</li> <li>- NGO's</li> <li>- Other parties: legal organisations, financial organisations/banks, intermediaries, knowledge brokers, consultants</li> </ul>
Institutions:	<ul style="list-style-type: none"> <li>- Hard: rules, laws, regulations, instructions</li> <li>- Soft: customs, common habits, routines, established practices, traditions, ways of conduct, norms, expectations</li> </ul>
Interactions:	<ul style="list-style-type: none"> <li>- At the level of networks</li> <li>- At the level of individual contacts</li> </ul>
Infrastructure:	<ul style="list-style-type: none"> <li>- Physical: artefacts, instruments, machines, roads, buildings, networks, bridges, harbours</li> <li>- Knowledge: knowledge, expertise, know-how, strategic information</li> <li>- Financial: subsidies, fin programs, grants etc.</li> </ul>

Table 1 summarizes all structural 'dimensions' of technological innovation. Source: Wiecezorek, (2014), pg. 25.

**The Structural Dimensions of Technological Innovation Theory:**

The actors, institutions, interactions and infrastructure of the Province's RES along with their abilities will first be mapped. The definitions of the structural elements are as follows.

**Actors:**

While there is unanimous agreement that actors are involved in innovation systems, there is disagreement about how actors should be grouped (Wieczorek, 2014, pg. 23). The difficulty of making the delineation of actors is that they oftentimes have multiple roles within and between one another. It is for that reason that this research will consider actors based off their activities within the economic system (Wieczorek, 2016, pg. 23). The actors involved in the RES innovation system are individuals, organizations and networks who are categorized as being part of

government (central, provincial, regional and municipal), business (energy suppliers, electricity system operators, contractors, other affiliated project development firms), civil society (universities, energy cooperatives, advocacy groups, citizen-collectives) or connector parties (individuals who have participated in the other three categories and possess a keen understanding of the system overall).

#### Institutions:

The institutional dimension is split between the body of controls that govern society such as “legal rules, norms” and strategies and the common/routine “public attitudes” behaviors, and beliefs people carry with them (Frishammar et al., 2018, pg. 14). The former set of institutions are known as hard institutions and the latter set are known as soft institutions (Crawford and Ostrom, 1995). As can be expected, both hard and soft institution dimensions are dependent on their geographic, sociocultural, political and historical specifics and should not be confused with the actors who work within their boundaries (Wieczorek, 2014, pg. 24).

#### Interactions:

Not to be confused with network actors, which are interconnected organizations, interactions describe the dynamic relationships between actors on network and individual levels (Wieczorek, 2014, pg. 24). They are therefore very difficult to nail down into constant positions as they involve evolving social/political/economic power dynamics.

#### Infrastructure:

The position of infrastructure as a structural element is not yet completely agreed upon because it is an element that incorporates both physical and metaphorical connotations for the innovation system in question. However, keeping with the definitions used by Wieczorek (2014) thus far, this research will implement her three categories of innovation system infrastructure: physical, financial and knowledge (Wieczorek, 2014, pg. 25). The physical infrastructure category includes “artefacts, instruments, machines, roads, buildings, telecom networks, bridges, harbours” while knowledge infrastructure constitutes “knowledge, expertise, know-how, strategic information” an Financial infrastructure can be considered as “subsidies, financial programs, grants” and other economic tools (Wieczorek, 2014, pg. 25).

**Table 2: Systematic Policy Framework**

System function	Structural element	Systemic problem	(Type of) systemic problem	Systemic instrument goals
F1 Entrepreneurial activities	Actors	Actors problems	Presence?	Stimulate and organise the participation of relevant actors (1)
			Capabilities?	Create space for actors capability development (2)
	Interactions	Interaction problems	Presence?	Stimulate occurrence of interactions (3)
			Capacity?	Prevent too strong and too weak ties (4)
	Institutions	Institutional problems	Presence?	Secure presence of hard and soft institutions (5)
			Intensity?	Prevent too weak and too stringent institutions (6)
	Infrastructure	Infrastructural problems	Presence?	Stimulate physical, financial and knowledge infrastructure (7)
			Quality?	Ensure adequate quality of the infrastructure (8)
F2 Knowledge development	Actors	Actors problems	Presence?	Stimulate and organise the participation of relevant actors (1)
			Capabilities?	Create space for actors capability development (2)
	Interactions	Interaction problems	Presence?	Stimulate occurrence of interactions (3)
			Intensity?	Prevent too strong and too weak ties (4)
	Institutions	Institutional problems	Presence?	Secure presence of hard and soft institutions (5)
			Capacity?	Prevent too weak and too stringent institutions (6)
	Infrastructure	Infrastructural problems	Presence?	Stimulate physical, financial and knowledge infrastructure (7)
			Quality?	Ensure adequate quality of the infrastructure (8)
etc				

Table 2 summarizes the pathway to determining systemic problems. Source: Wieczorek (2014), pg. 35)

The functional analysis will work with the following seven function definitions proposed by Hekkert et al. (2007).

**Function 1 (F1.): Entrepreneurial Activities**

Entrepreneurs are critical for the innovation system to operate properly. This is due to their role as changemaker, seizing new knowledge and opportunities to take tangible steps towards innovating the system. Entrepreneurs are typically either new entrants to the system whose outsider views see opportunity in a changing market/policy landscape, or they are incumbent actors who want to diversify their strategy for new developments (Hekkert et al., 2007, pg. 421). While entrepreneurs have traditionally been market actors, they aren't always and could be involved in government or civil society. Entrepreneurs are oftentimes important catalysts for the implementation of new strategies because they are willing to accept large amounts of uncertainty and risk (Hekkert et al., 2007, pg. 422).

**Function 2 (F2.): Knowledge Development**

Gaining knowledge to develop an understanding is one of the most important resources in the innovation process. Learning is fundamental to research and development of technologies and policies and is therefore a critical prerequisite to innovation systems. Hekkert et al. write that this function includes “‘learning by searching’ and ‘learning by doing’ and that the three indicators to

map this function over time are the number of R&D projects, patents and the amount of investment in research development (Hekkert et al., 2007, pg. 422).

#### Function 3 (F3): Knowledge Diffusion

Innovation is stymied by knowledge being limited to only a small subsystem; therefore, knowledge diffusion is an important function of TIS. The primary exchange of information takes place between and within networks (actors) in a heterogenous context where R&D occurs across, among and between researchers, markets, governments and competitors (Hekkert et al., 2007, pg. 423). Policy decisions (standards, long term targets) should be “consistent with the latest technological insights” and R&D plans should be “affected by changing norms and values” because network activity acts as a precondition to ‘learning by interacting’ (Hekkert et al., 2007, pg. 423).

#### Function 4 (F4): Guidance of the Search

This function is analyzed by mapping out the specific targets laid out by the government or industry behind the policy/technology for its use (Hekkert et al., 2007, pg. 424). Then professional journals, government reports and other legitimate documents should be assessed to discern what is expected from the policy/technology’s development (Hekkert et al., 2007, pg. 424). Understanding how the new technology is regarded (positively, negatively, etc.) allows for an assessment of whether particularly strong discussion either for or against will stimulate or hinder development (Hekkert et al., 2007, pg. 424).

#### Function 5 (F5): Market formation

New innovations inherently must overcome the incumbency advantages held by embedded policies/technologies, therefore new innovations oftentimes require a protective initial environment such as the establishment of niche markets, local adoption initiatives, favorable financial arrangements, or minimum quotas requirements (Hekkert et al., 2007, pg. 424). To analyze this function, the protective systems in place for the new innovation must be identified and mapped.

#### Function 6 (F6): Resources mobilization

Innovation systems, like any human system, require the investment of sufficient resources to function properly. Oftentimes financial capital and human labor are necessary for the system to operate effectively. Analysis therefore requires an understanding of “whether or not inner core actors perceive access to sufficient resources as problematic” (Hekkert et al., 2007, pg. 425) or feasible.

#### Function 7 (F7): Creation of legitimacy/counteract resistance to change

An innovation must “become part of an incumbent regime, or it even has to overthrow it” (Hekkert et al., 2007, pg. 425) if it is to become highly functional. Yet in order to become legitimate, new innovations oftentimes must also overcome actors with “vested interests opposed to this force of ‘creative destruction’ (Hekkert et al., 2007, pg. 425). Successful advocacy

organizations will grow in strength, membership and influence as the innovation they advocate for increasingly becomes part of the incumbent regime. It is for this reason that function 7 is most often analyzed by mapping the growth rate of affiliated interest groups and monitoring their lobbying efforts (Hekkert et al., 2007, pg. 425).

#### Coupled Structural-functional analysis:

The TIS theory has been chosen for this research because it has evolved into a useful tool for trying to alter the course of technological change through the implementation of innovative solution-oriented policies (Wieczorek, 2013, pg. 20). To do this, an effective policy instrument for stimulating the innovation system requires the functional elements to be analyzed using the structural elements in a structural-functional analysis. This analysis examines the functions through the perspective of the structural elements to identify the systems problems. The structural-functional analysis was designed by Hekkert and Wieczorek and then later converted into a framework to identify both systemic problems and instruments to solve those problems. TIS theory employs the use of systemic policy instruments as a means of encouraging technological innovations associated with renewable energy (Wieczorek, 2014, pg. 20). Systemic policy instruments are system level (as opposed to process level) tools that “aim to address the problems that arise at the innovation system level and which negatively influence the speed and direction of innovation processes” (Wieczorek, 2014. Pg. 20). Systemic policy instruments therefore identify the weaknesses of the system as a whole rather than identify the failures of single processes (Wieczorek, 2014, pg. 20). However, the framework recognizes that within the system there are many components (sub-systems), relationships (interactions between the components) and attributes (defining markers of the components and relationships). The components of the innovation system are the actors, institutions and infrastructure, while the interactions are the relationships between the components, each of these dimensions is described by their attributes. The performance or absence of a function acts as a determinant for the health of the innovation system as a whole and the structural-functional analysis seeks to identify the reasons for underperformance or absence of functions. This is done by determining the presence/absence of the structural elements and identifying the quality of the attributes of the present structural elements. Together, these analyses allow for the creation of a policy assessment framework depicting the systemic problems. This framework will be used to analyze the Province of Gelderland’s RES as innovation systems. If problems with the regional energy strategies are identified, a policy tool will be created to address the problems preventing the Province of Gelderland’s energy transition from being more successful.

## Chapter 3: Methodology

### 3.1 Research Strategy and Design

Since the Province of Gelderland's *Gelders Energy Agreement* was created using input from more than 200 partners, 24 consultation tables and 500 experts (De la Court, 2018, pg. 5) from all aspects of society, the agreement's RES were considered the invention of socially constructed processes, experiences and practices (Saunders et al., 2016, pg. 136). Evaluating the performance of these strategies required a focus on the perspectives of the people carrying out the Province's energy transition. As this research is concerned with "creating new, richer understandings and interpretations of social worlds and contexts" (these social worlds and contexts being the energy transition of the Province), it operates under an interpretivist research philosophy (Saunders et al. 2016, pg. 140). One critical-instance embedded exploratory case-study is conducted in order to explore how the Province of Gelderland is stimulating, facilitating and supporting its region's development of renewable energy. The case-study uses an embedded unit of analysis in order to account for actors from the Arnhem-Nijmegen, Rivierenland, Cleantech, North Veluwe and Foodvalley regions were interviewed in the Province of Gelderland (Yin, 2009, pg. 52). This research design was used in order to "generate insights from intensive and in-depth research" of how the Province of Gelderland currently contends with regional barriers to renewable energy development (Saunders et al., 2016, pg. 185). Additionally, this approach allowed for a greater breadth of meetings with actors from disparate parts of the province's energy transition and thus allowed for unique insights born out of regional experiences of the provincial government. Of the regions investigated, a particular focus was paid to the Rivierenland Region because it was the first region to adopt a RES, has the highest per-capita CO<sub>2</sub> emissions and is known for its intensive agriculture (Regio Rivierenland, 2019) as well as to the Arnhem-Nijmegen Region because it holds two of the largest population centers in the Province of Gelderland (Nijmegen and Arnhem) and its large urban area requires a different approach to implementing RES compared to Rivierenland. The Arnhem-Nijmegen Region is also unique in that it has the most detailed roadmap for how it plans to achieve its renewable energy targets (Pfeiffer, 2018). Interviews had been scheduled with actors in the Achterhoek region as well, however interviewee cancellations due to scheduling and unforeseen complications prevented any interviews with Achterhoek actors from taking place.

To pursue this course of research, TIS theory was used to construct the interview guides which corresponded to the structural and functional analysis. However, an inductive approach to developing the policy assessment framework was taken which allowed for the data collected from the region cases to be used to offer the Province of Gelderland with a set of context specific recommendations for successful RES. This abductive (deductive-inductive) approach allowed for the identification of the major trends, themes and patterns of the energy transition using data collected from semi-structured in-depth interviews and official document review based on existing TIS theory (Saunders et al., 2016, pg. 145). Once located, these elements were used to develop a context-specific policy assessment tool as the conceptual framework model (Saunders et al., 2016,

pg. 145). This conceptual framework incorporates existing TIS theory from the theoretical framework and made use of Wieczorek and Hekkert's (2012) methods. Collected data was analyzed using the *template analysis technique* and was facilitated by the Computer Assisted Qualitative Data Analysis Software (CAQDAS) ATLAS.ti. To help aid the data analysis procedure, self-memos as well as progress, transcript and document summaries were composed for self-reflection. The results of the data analysis were used to assess the Province of Gelderland's regional energy strategies and provide a set of recommendations for improving regional energy strategy performance (Saunders et al. 2016, pg. 176). This thesis is therefore an evaluative, single-embedded case-study that employs multiple qualitative methods.

## 3.2 Research Methods for Data Collection

### 3.2.1 Desk Research:

Data collection began with desk research of literature involving innovation and transition studies, RES reports and other renewable energy related literature (Bryman, 2016, pg. 552). Most of these documents were published by the provincial government of Gelderland, the region of Arnhem-Nijmegen and the municipalities in the region. This data was used to establish the interview guides and interactions with the interviewees. Desk research also served as the input for a structural analysis consistent with Wieczorek and Hekkert's (2012) structural and functional element based initial framework. Additionally, desk research helped triangulate the findings of the interviews in the functional analysis (Saunders et al., 2016, pg. 320).

### 3.2.2 Semi-Structured Interviews: Sample Selection Strategy

Once a preliminary set of important elements was identified during the desk research phase, data was collected through in-depth, semi-structured, one on one interviews with the governmental, market and civil society actors involved in the Province of Gelderland. To corroborate and supplement information gained from desk research on which actors to interview, a series of 15 nonrecorded exploratory conversations took place with civil servants as well as experts from within and outside of the provincial government. Of these 15 exploratory conversations, four were with actors who would later be interviewed: Carla Onderdelindon, Yvonne Tieleman, Arien Scholtens and Rudy Umland. It was only after these exploratory conversations that the interviewee list was composed. This list identified 23 potential interviewees of note and after checking the list with Prof. Dr. Pieter Leroy and Dr. Henk-Jan Kooij a condensed list of interviewees was composed. The resulting interviews drove the bulk of the functional analysis conceptualized during desk research.

### 3.2.3 Interview Design Strategy:

Of the 19 Interviews, 13 were conducted in person, while 6 were conducted over the phone. Interviews followed the structural-functional analysis layout as described in Wiecek (2014) and therefore interviews were semi-structured with interview guides depicting themes, leading

questions and potential follow-up questions. Questions and themes were organized according to the TIS function (theme) adapted from Wiezorek (2014) that they pertained to. Each function's questions were prefaced with a description of the function to clarify the context of the questions. Follow up questions, while available on the guides, acted more as reminders for what information was desired from the interviews. The semi-structured interview style allowed interviewees to respond as they wished and subsequently allowed for additional spontaneous questions to be asked when unique or thought-provoking interviewee responses warranted further investigation (Bryman, 2016, pg. 468). The interview guides were developed iteratively, meaning questions were refined and added to the guides based on evidence gathered from previous interviews. These interview guides were all written in English, but copies translated into Dutch were made for interviewees uncomfortable with reading or speaking English. Following the law of diminishing returns, after the initial 11 interviews, the original four interview guides were no longer useful as all questions had begun to show redundant answers. Therefore, for the final eight interviews, new short interviewee-specific interview guides were created with the purpose of closing the knowledge gaps that still hadn't been filled by the initial interviewing. These interview guides were again written in English except for three which were written in Dutch: for the omgevingsdienst, Eneco, and De Goede Woning. As I am not a native Dutch speaker, I had my interview guides double checked by Eric Derksen, the Provincial Accountholder for the Arnhem-Nijmegen Regional Energy Strategy. Additionally, interviewees were initially asked to make their responses in English unless they did not know how to answer the question without Dutch. If interviewees needed to answer in Dutch, they were encouraged to do so in lieu of not answering the question. Consequently, interviews were conducted in a mix of English and Dutch, with some interviews being almost entirely in English and some interviews being almost entirely in Dutch. To minimize the risk of interviewees being unprepared for questioning, all interviewees received their appropriate interview guide at least 48 hours in advance. However, a few interviewees admitted that they hadn't been able to review the questions prior to the interview.

All interviews were audio-recorded and later transcribed for data analysis; however, notes were also taken after the interview to reflect on how the interview went and to remark on how interviewee responses were given (Bryman, 2016, pg. 479). Interview notes were subsequently used to compose interview summaries to aid in data analysis and functional analysis formation. For ethical reasons, before all interviews, interviewees were always asked if it was ok to record their responses. All interviewees gave permission to be recorded and to be identified in this study. In this way, interviews gave flexibility with questions and response and helped to emphasize the patterns, events, processes and trends that the interviewees determine to be most important for the energy transition (Bryman, 2016, pg. 468). Additionally, using semi-structured interviews following TIS theory's seven functions allowed for comparison between interviewee responses as the interview structure remained roughly the same (Saunders et al., 2016, pg. 393). Comparisons were made to understand the the seven functions of the system from multiple perspectives in order to prepare a policy assessment that offers evaluations and recommendations constructed with multiple perspectives in mind (Saunders et al., 2016, pg. 393).

**Table 3. Interview List**

<b>Participant name</b>	<b>Affiliated organisation(s)</b>	<b>Position</b>	<b>Date of Interview</b>
Rudy Uwland	Provincial Government	Project Leader	4/6/2019
Auke Schipper	Gemeente Hattem	Alderman	6/6/2019
Edward Pfeiffer	HaskoningDHV, Regio Arnhem-Nijmegen	Senior consultant Energy and project manager Circular Economy	11/6/2019
Aart de Kruif	Gemeente Barneveld	Alderman	11/6/2019
Petra Souwerbren	Gelderland Milieu en Natuur Federatie	Director	12/6/2019
Thijs de la Court	Klimaatverbond, formally Gelders Energy Accord (GEA), formally Gemeente Lochem	Member of Klimaatverbond Secretary-General of GEA Alderman for Gemeente Hattem	13/6/2019
Arien Scholtens	Energie Samen Gelderland (Vereniging Energiecoöperaties Gelderland)	Director	13/6/2019
Sjoerd Sibbing	Provincial Government	Spatial Planning Strategy Team	14/6/2019
Carla Onderdelindon	Transitiereizen, formally the Provincial Government	Owner and Operator	20/6/2019
Yvonne Tieleman	Provincial Government	Program/project manager for the Energy Transition	21/6/2019
Ruben van de Belt	Omgevingsdienst Regio-Arnhem	Program Manager for Energy	24/6/2019
Machiel Bolhuis	Eneco	Adviseur Regulatory Affairs	24/6/2019
Jeffery Levine	Engie	Director of Government and Regulatory Affairs for North America	24/6/2019 and 25/6/2019
Marcel Doyer	Alliander	Strategic Environment Manager for the Province of Gelderland.	25/6/2019
Luuk van Wezel	ZLTO	Project Leader for Bio-Economy	25/6/2019
Krista Walters	De Goede Woning	Director	25/6/2019
Jared Braslawsky	RECS International	Secretary-General	26/6/2019
Freek Welling	OostNL	Team Manager for Energy	26/6/2019

Table 3. Depicts the interviewees that participated in this study along with their affiliated organization, position and the date of their interview.

### 3.3 Approach to Data Analysis

Like with this thesis's approach to data collection, data analysis was carried out using an iterative approach as much as possible. Data analysis began by preparing data collected through interviews and through official document review. Audio-recordings of interviews were transcribed

with assistance using the computer transcription tool *Transcribe*. This tool reduces the time needed to transcribe audio-recordings by letting the user dictate their audio-recordings to the computer using voice-recognition software. Data cleaning was simultaneously integrated into the transcription process (Saunders et al, 2016, pg. 572). Each interview transcription was saved in separate word-processed files using the: Interview number, (Initials of Interviewee) then date as file names (Saunders et al, 2016, pg. 573). As this study is also concerned with how information was delivered by interviewees, interview summaries were compiled after each interview to be used in the functional analysis. As mentioned previously, data collected from document reviews was condensed and sometimes translated before use in creating the structural analysis.

Data was analyzed in the CAQDAS, ATLAS.ti, using a hierarchical template analysis as this allowed for the linkage of data to the seven functions organized in the Technological Innovation Systems (TIS) theory functions for structure as well as the inductive identification of patterns through in-vivo coding in the dataset (Saunders et al., 2016, pg. 579). This approach was taken due to the flexible and systematic nature, providing different interpretations of Gelderland's energy transition through thematic descriptions of the data (Saunders et al., 2016, pg. 579). As research was approached abductively, a Priori, open-codes and in vivo codes were both used. Themes were organized according to TIS theory's seven functions which formed the top hierarchy of *a Priori* codes, (Saunders et al., 2016, pg. 588). A second tier of three codes was placed under the seven a Priori codes, these codes categorized data as being interpretive, evaluative or recommendary. The specifics of the data were captured inductively in a combination of *in vivo* and *open-codes*. This abductive path was selected as "using a purely inductive [...] approach may be problematic" due to the immense amount of time involved with coding all available data (Saunders et al., 2016, pg. 582). The purpose of this structure is to operationalize the TIS theory into a set of context specific discoveries. As the data was being coded, a process of constant comparison was undertaken in order to ensure consistency throughout the data set (Saunders et al., 2016, 583). Themes, and the relationships between them were defined.

### 3.4 Critical Discussion

As this research uses TIS theory to evaluate the performance of the RES in the Province of Gelderland and offer a policy mix to address the identified problem areas, it lends itself to many different research methodologies. The methods used to evaluate what the provincial government should do to improve the RES don't necessarily have to be qualitative methods. Quantitative methods like conducting simple-random purposive sampling of employees from each identified important actor could easily be used in lieu of interviews to gather a large dataset. While this method would lack the inductively generated details that grow out of semi-structured expert interviews, large surveys would have the advantage of increasing the likelihood that there is consensus surrounding a function's relative strength. Additionally, the use of surveys to collect data for the structural and functional analyses would allow for a potentially better policy recommendation fit because decision theory models like Multi Attribute Utility Theory (MAUT) decision analysis could be used. Such statistical models would be incredibly useful for the weighting of each function based on importance due to TIS theory's use of an ordinal scale for the function scores (Jansen, 2011, pg. 101). Using a MAUT would in turn be able to create a decision analysis that

recommends policies for the RES that best reflects the presence, quality, capability and intensity of structures in the innovation system. While MAUT is helpful in representing the preferences of actors under conditions of uncertainty, the use of such a deductive approach wouldn't allow for the discovery of unknown structure effects within the functions. The use of semi-structured expert interviews was taken, because it was assumed that most of the problems afflicting the RES are unknown or are causing damage indirect ways. The interviews did have some deductive structure as they followed an in-depth interview guide with a list of themes, leading questions and sub questions (follow-up questions), but their conversation manner also allowed for questions to be asked spontaneously. This means that interviews were really abductive in their approach and thus could be tailored to the individual interviewee, sometimes following the guide rigidly and other times stray far from the questions when it was appropriate. The natural/conversational pace of questioning also had the advantage of creating trust and cooperation which encouraged respondents to not only share information for sometimes over two hours, but also to provide the contact information of other potentially important sources of information. Such openness might not have been possible using quantitative methods like questionnaires and therefore could have hindered the discovery of new information.

Besides the pursuit of potentially different methods, this research could have employed alternative styles of case-studies. Rather than treat the whole Province of Gelderland as a single critical-instance case-study of the Netherland's RES approach, a more specific intra-provincial case study might have been discussed instead. For example, this research initially was going to pursue two critical-instance, single-embedded case-studies to compare the RES being used in two different regions in the Province of Gelderland. This research design would have focused on the Rivierenland and Arnhem Nijmegen Regions for the single-critical case-studies but ultimately became embedded when Gelderland itself was made a single-critical case-study. This choice to implement a case-study on the provincial level rather than the regional level was due to the desire to analyze all of the most critical actors present within the Province of Gelderland as a whole, who were not necessarily present within Arnhem-Nijmegen and Rivierenland regions.

## Chapter 4: Structural Analysis Results

### 4.1 Structural Analysis

In order to answer the sub question: "*What structural elements must be present for the Province of Gelderland to stimulate and facilitate the development of regional energy strategies?*" A structural analysis following Technological Innovation Systems theory was created. The structural elements involved in this analysis are the actors, institutions, interactions, and infrastructure. It should be noted that these structural elements should be present for the proper working of the innovation system's functions. These element groups have been adapted from those described in Wiezcorek and Hekkert 2012 to address this assessment's aim of creating a prescriptive instrument for supporting future policy designs and the selection of new practices by the Province of Gelderland.

The elements were identified as a result of a literature review of relevant research documents, monitors and government reports on the Province of Gelderland's regional energy strategies and energy transition. The information gathered during the literature review was later corroborated by the information collected from semi-structured interviews with government, market and civil society actors. After the preliminary analysis of the structural dimensions was completed, it was discussed with Henk-Jan Kooij the Deputy Secretary of the Provincial Environmental Policy Council of Gelderland in order to provide the completed version below.

## 4.2 The Actors

This analysis will begin with the identification of the actor structural dimension involved in the Province of Gelderland's energy transition. The categories of actor types will be described to provide context for the context-specific actors included in the assessment.

### 4.2.1 The Government:

The relevant governments involved in this assessment can be divided into the national, provincial and municipal levels. To make the policy assessment framework most applicable to the needs of the PRO, it is important to focus the discussion of government actors to those levels operating with direct authority within the Province of Gelderland. Consequentially, while the national government will be discussed to provide context for its structural role in shaping the energy transition in Gelderland, it will not be included in the policy assessment framework.

Table 4. The National, Provincial, Regional and Municipal Government Actors

<u>Government</u>	<u>Implementation</u>	<u>Capabilities</u>
National Level	Ministries of: Binnenlandse Zaken en Koninkrijksrelaties (BZK);  Economische Zaken en Klimaat (EZK) with the agency Rijksdienst voor Overnemend (RVO);  Infrastructuur en Waterstaat (IenW);  Landbouw, Natuur en Voedselkwaliteit (LNV)	The ministries outline national priorities and goals, measure and monitor create regulations and policies for the energy transition, enforce these policies, provide financial stimulation and support for renewable energy and energy savings, conduct environmental measurements and reports as well as balance the interests of constituent parties.
Provincial Level	1. The Provincial Government of Gelderland  2. Provinciale Raad voor Omgevingsbeleid (PRO)  3. The Interprovincial Overleg (IPO)  4. The Water boards	The Provincial Government of Gelderland: Voices ambitions by setting provincial targets; establishes energy regions; spatial planning; finances energy projects; stimulates, facilitates and supports renewable energy development in municipalities.  PRO: Provides solicited and unsolicited advice to the Province of Gelderland on energy and environmental practices.  IPO: Offers a the provinces a platform for stimulating innovation and exchanging their 'best practices' for the energy transition.  Water boards: Knowledge development and diffusion about structural monitoring of CO2 emissions control in CO2 performance ladders; development of biogas from wastewater treatment.
Regional Level:	1. Environment Agency NL (Omgevingsdienst)  2. The National Program Regional Energy Strategies (RES)  3. The Association of Dutch Municipalities (VNG)	Environment Agency NL: Facilitates and supports the system of environment services in their energy savings and other environmental regulation implementation activities.  The National Program RES: Support the development of regional energy strategies in the regions by diffusing knowledge between regions, conducting data analysis and providing a community of expertise.  VNG: Empowers municipal governments in the energy transition among other duties through exchange of experiences and mutual learning.
Municipal Level	Municipal Councils	Develop internal policy/regulation plans to achieve regional ambitions; engage with the public to measure and manage public support; implement the RES; provide financial support to local initiatives; customer activities.

Table 4. Discusses the governmental actors in depth as not all actors are discussed in the structural analysis.

#### National Level Government:

There are four ministries that oversee and implement operations either directly or indirectly associated with the energy transition within the Netherlands. These ministries are the Ministerie van Binnenlandse Zaken en Koninkrijksrelaties (Ministry of the Interior and Kingdom Relations abbreviated BZK), Ministerie van Economische Zaken en Klimaat (Ministry of Economic Affairs and Climate abbreviated EZK), Ministerie van Infrastructuur en Waterstaat (Ministry of Infrastructure and Water Management abbreviated IenW) and to a lesser extent Ministerie van Landbouw, Natuur en Voedselkwaliteit (Ministry of Land Use, Nature and Food Quality abbreviated LNV).

## Provincial Level Government:

### The Provincial Government of Gelderland:

The Provincial Government of Gelderland is one of the principal actors in the province's energy transition. As a mid-level government, it works closely with both its constituent municipalities as well as the national government to reduce CO<sub>2</sub> emissions and increase renewable energy development. While the provincial government was a signatory on the 2013 Gelderland Energy Accord (GEA) which began the Province of Gelderland's modern energy transition, it has largely taken a backseat in the formation of the regional energy strategies in order to foster a bottom-up governance approach. The Provincial Government has however been the key actor in the creation and organization of the Province's energy regions. In a similar manner, the provincial government manages and orchestrates the spatial planning of the Province of Gelderland's land. It therefore must oftentimes facilitate cross-stakeholder communication between actors with disparate objectives in the energy transition. Additionally, the provincial government has taken a significant role as a stimulator and investor in new small-scale renewable energy technologies and startups as well as in a more sustainable transportation system.

### The Interprovincial Consultation Association (IPO):

IPO represents the 12 provinces' shared interests in the national and European levels of government. IPO has played "an informative and guiding role" the preparation of policy significant to the provinces (IPO, 2019). It therefore acts as a platform for knowledge development, innovative decision making and communication between the provinces and their stakeholders to the national, European and other international governments. It subsequently uses this position to aid the provinces in establishing a set of best practices for provincial policy that can be shared by all provinces (IPO, 2019).

### The Water Boards:

The water boards are involved in the Province of Gelderland's energy transition to the extent that they are beginning to produce biogas from the organic waste removed during wastewater treatment (Waterschappen, 2019). The Water Boards must also be consulted in the spatial planning procedure for renewable energy developments adjacent to rivers, canals and other managed areas by the Waterboards. This is particularly relevant for wind development projects in Gelderland as many plans for increasing the amount of wind turbines see the borders of waterways as potential future development sites. The Waterboards will most likely continue to become more involved in the energy transition. Currently the Waterboard in Veluwe is investigating together with six other Waterboards, whether they would benefit from adopting a CO<sub>2</sub> Performance Ladder certificate (CO<sub>2</sub>-PerformanceLadder, 2019).

## Regional Level Government:

Omgevingsdienst Regions: The Omgevingsdienst or Environmental Service, is an implementation agency which licenses, oversees and enforces the province's environmental laws

during construction and renovation. On behalf of the municipalities the omgevingsdienst grants permits to buildings for energy efficiency renovations and for companies involved in industrial or manufacturing activities. The permits include references to expectations of what the process and building efficiency are supposed to be. These permitting conditions only apply to the larger companies of the regions and does not include small companies. In addition to issuing permits, the Omgevingsdienst inspects the large companies within its jurisdiction bigger companies to ensure that they are complying with the parameters of their permits. The Omgevingsdienst's role in Gelderland's energy transition is vital as under the Environmental Management Act, the Omgevingsdienst has the authority to control and require participation by businesses and building owners within its area of jurisdiction. The focus of this study is on ODRA, the Omgevingsdienst for Regio-Arnhem, which works on the behalf of 10 municipalities in the Arnhem region and the province of Gelderland (Omgevingsdienst Regio-Arnhem, Interview 11).

#### 4.2.2 Knowledge Institutions:

*Knowledge institutions and NGOS* are a group of actors defined by their shared role and capabilities rather than by their organizational similarities or position in society. These actors act first and foremost as centers of reliable and timely research and knowledge development. Through meetings, workshops, seminars, publications and expert consultations, these actors engage in knowledge dispersion. The knowledge produced and disseminated by *knowledge institutions and NGOS* helps support the growth of Gelderlands energy transition by providing other actors with data, advice and analysis. In this way, *knowledge institutions and NGOS* help monitor and measure progress on the development of the RES by keeping records of previous system developments. Actors from this sub-category may also provide solicited or unsolicited oversight of the RES by holding other actors accountable to their words and actions. With their roles as educators, record keepers, factcheckers and monitors, *knowledge institutions and NGOS* may use their deep understanding of Gelderland's energy transition to share recommendations and propose sets of best practices.

For this reason, knowledge institutions present in the Province of Gelderland have been divided into three groups: research universities; associations/coalitions; NGOs. Research universities include the most prominent centers of research and education such as Radboud University and Wageningen University. Associations/coalitions act as representatives, educators and databases for certain sectors, stakeholder groups or issues within Gelderland's energy transition. Some examples of associations/coalitions are Natuur & Milieu Federatie who represent the interests of nature and the environment, ZLTO who represent 13,000 farmers in Zeeland, North Brabant and South Gelderland, and the Gelders EnergieAkkord which organizes members to contribute to climate and renewable energy policy. Non-governmental organizations (NGOS) are independent organizations whose expertise and focus is bent towards addressing a specific aspect of the energy transition. Two NGOs who were interviewed in this study included Klimaatverbond Nederland which seeks to help the Netherlands become climate-neutral and climate proof, as well

as RECS International which advances the goal of implementing a guarantee of origin based target compliance market within Europe.

#### 4.2.3 The Civil Society:

What civil society is and which groups make up civil society is much debated among scholars and politicians alike. While it is widely recognized that individual citizens belong to civil society, it is more difficult to determine which organizations also can be considered civil society actors. Actors belonging to civil society have been categorized based on the capabilities and intensity of civil society. According to this framing, civil society is defined as including all citizens in their roles outside their work functions as well as citizen assemblies into community-led organization/coalitions engaging with local initiatives. This means aggregated non-governmental & non-profit organizations representing the will of citizens are not being included in civil society and will thus be placed in the knowledge institutions and NGOs actor category.

Civil society is divided into two constituencies: passive civil society and active civil society. Passive civil society is comprised of the general public of the Province of Gelderland, who while having opinions on the energy transition (sometimes strong opinions) are typified by little participation due to factors such as being uninformed, apathetic, having time constraints, being impoverished or not knowing how to get involved. Passive civil society does help shape the Province's energy transition because it votes for representation in the provincial and municipal governments. Additionally, passive civil society helps form a consensus on how much public support or resistance there is in the Province of Gelderland for action in the energy transition.

Active civil society on the other hand includes the engaged citizenry who participate in community led initiatives. Like passive civil society, they also shape the energy transition by voting for politicians. However, they generally vote for representatives who want to pursue action on increasing renewable energy development and decreasing CO<sub>2</sub> emissions. Along with voting, active civil society engaged in activities including but not limited to “the allinclusive neighborhood” , “De Nude” disconnection from the natural gas network initiative, membership in energy cooperatives, neighborhood energy savings partnerships, social associations, project initiatives or volunteerism for increased energy democracy and an accelerated energy transition (Transitiereizen, 2019). Active civil society can be noted for patterns of self-organization, personal investment in renewable energy and energy saving measures as well as more direct participation in the Province of Gelderland's energy transition. Additionally, it should be noted that active civil society is the smaller of the two civil society categories, as it typically is comprised of members who are wealthy, educated or are also involved in the energy transition In their professional lives.

Together these two civil society categories shape the general public opinion on how and to what extent the Province of Gelderland should pursue action in the energy transition. Therefore, the greater the influence of active civil society on passive civil society and on the government, the more action is taken by the government.

#### 4.2.4 Energy Companies:

The actors who belong to this sub-category vary widely in their functions, scope of business, scale of operations and organization/structure. For this reason, the actors who are considered to be part of the *energy companies* sub-category are those for-profit market actors who derive the majority of their revenue from energy related operations. This means that not only multinational, large firms, medium and small firms (SMEs) are included but also start-ups and energy cooperatives. The inclusion of energy cooperatives in this sub-category is to emphasize their capacity for professional business operations in the Province of Gelderland.

##### Network Administrators:

The network administrators in the Province of Gelderland are the transmission system operator (TSO) Tennet which oversees, installs, maintains, operates and manages the transmission lines throughout the whole of the Netherlands as well as parts of Germany as well as Alliander, the distribution system operator (DSO) which oversees, installs, maintains, operates and manages the distribution lines of the Province of Gelderland among other provinces. As the DSO, Alliander works to ensure that their distribution grid delivers electricity at as close to 100% reliability as possible while simultaneously remaining cost effective and secure. To contend with growing constraints and congestion of energy flows as a result of this two-way flow of electricity, Alliander is busy replacing, adding and widening electrical lines to add capacity to the electricity grid.

##### Energy Suppliers:

The retail energy suppliers, also known as load-serving entities (LSE) are those companies that purchase electricity on the electricity market and gas on the gas market in order to supply it to the end-user. The LSE could trade entirely in gray energy, or they can opt to sell a product that contains a percentage of renewable energy. The Netherlands has a liberalized energy market, meaning that instead of having a single utility generating, distributing and selling electricity or gas the government has allowed companies to step in as alternatives to supply energy. Of the 45 energy suppliers operating in the Netherlands, 24 conduct business in the Province of Gelderland (Energiewereld, 2019). These include large energy suppliers including Nuon (Vattenfall), Eneco, Essent (Innogy), Engie, and Greenchoice (Energie Concurrent B.V) as well as small independent suppliers like Huismerk Energie, Pure Energie and Energie van ons. Sometimes energy cooperatives like Cooperative ValleiEnergie in FoodValley are included in this sub-category because they inhabit the electricity supply role (ValleiEnergie, 2019).

##### Energy Cooperatives:

As citizen collectives organized around the needs of the local community, energy cooperatives take on many roles in the energy transition. In addition to sometimes banding together to take on the role of a local green energy supplier alternative, energy cooperatives exert control over energy savings and storage, renewable energy generation, district heating, and trade with the goal of returning revenues and investments to the local community. At 61 active community

initiatives in Gelderland, energy cooperatives have become increasingly important actors due to their intimate connection with their local municipalities (Scholtens, 2019). As citizen collectives, energy cooperatives have proven themselves particularly adept at securing community support for new renewable energy generation. Typically, spatial planning procedures and securing citizen ‘draagvlak’ (support) are tough hurdles for increased renewable energy permitting, however by involving the community throughout the entire development, cooperatives can bring their projects through the procedural pipeline faster. This is due to their ability to overcome resistance by maintaining trust with citizens commitment to ensuring project benefits remain local. This has resulted in about 50% of new solar and wind projects in the Netherlands involving energy cooperatives in some capacity (Scholtens, 2019).

Energy Project Developers, Engineering firms and Consultancies:

This group actors are important for their role in steering the development of renewable energy infrastructure. Energy project developers, engineering firms and consultancies seek entrepreneurial opportunities in Gelderland’s growing renewable energy market. Together, they bring a combination of technical innovations, expertise with advanced technological systems and project management consultancy to provide municipalities with the means to actualize their renewable energy targets. However, this group of actors must oftentimes navigate the difficult permitting landscape associated with developing projects in areas where space is scarce (HaskoningDHV, Interview 3). This has led permitting costs to expand to up to 30% of a projects total cost (RECs International, Interview 18). Additionally, projects built without local support can lead to the community adopting a ‘not in my backyard’(NIMBY) resistance mentality. To overcome such conflict, developers in consort with consultancies are increasingly engaging in community benefits or ownership agreements to promote mutual positive impacts from the renewable energy projects (RECs International, Interview 18).

#### 4.2.5 Other Parties:

This group of actors includes investment banks, venture capital firms, insurance agencies and legal services providers. While these organizations oftentimes do not just offer their services for energy sector purposes, they should be considered by the provincial government to be an integral piece of the RES.

Financial:

Financial institutions play a significant part in the financial infrastructure of the Province of Gelderland’s RES, and so for that reason they will only be mentioned briefly here. Once seen as very risky investments, renewable energy has become a more and more attractive investment opportunity in recent years. Banks such as Triodos and Rabobank have subsequently devoted a huge amount of their operations to creating energy funds, foundations and investment plans for renewable energy projects and innovation. However, in response to the banking crisis that occurred this past decade, they are legally constrained by a high-risk assessment structure which prevents

further investment. This high-risk assessment structure in combination with relatively high-interest rates has led to very long payback periods, discouraging a greater amount of private investment in sustainable housing and renewable energy (Klimaatverbond, Interview 6). These constraints emphasize the role for development agencies such as OostNL, which works with public venture capital to invest in clean energy and technology. These agencies operate like normal federal capital companies (FCC) in that they look at the same issues as private venture capital parties, except they are required to take on more risk than the market. Their purpose is therefore to close market failures and provide revolving funds with lower interest rates (OostNL, Interview 19).

#### Insurance agencies:

With the growing prominence of renewable energy in the Netherlands, comes the growing insurance business for both small and large-scale renewable energy projects. Green insurance agencies provide wind parks and solar fields with risk management assessments, due diligence studies, advisory and brokering services to ensure long term viability of the projects. These actors have a unique understanding of the risks associated with the construction and operation of renewable energy systems. While insurance agencies such as Profin Sustainable Energy Solutions limit their risk management activities mainly to wind power (especially offshore wind) they will increasingly become a part of the energy transition landscape (Profin, 2019).

#### Legal Services:

Legal services offered by groups like RenewabLAW have an important role in helping companies, organizations and governments navigate the sometimes-complicated legal framework underpinning the Province of Gelderland's energy transition. Increasingly, legal specialists in renewable energy are entering the field to help actualize renewable energy plans. They do this by assessing project feasibility, working through the contracting, permitting and regulation requirements, overseeing realization and maintaining the long-term viability of the project (RenewabLAW, 2019).

**Table 5. Structural Analysis of Actors**

Actors			
Subcategories	Local Examples	Capabilities	Local Capabilities Present: Yes/No + explanation of conditions
<u>Knowledge Institutions and NGOs</u>	<ol style="list-style-type: none"> <li>1. Research Universities such as Radboud University and Wageningen University</li> <li>2. Associations and Coalitions such as Natuur &amp; Milieu federatie, Gelders EnergieAkkord and ZLTO</li> <li>3. Non-governmental organizations such as Klimaatverbond and RECS International</li> </ol>	<ol style="list-style-type: none"> <li>1. Monitor and measure progress on development</li> <li>2. Knowledge dispersion</li> <li>3. Support innovation system growth through advice and progress reflection</li> <li>4. Provide oversight of other actor activities</li> <li>5. Share concrete best practices</li> </ol>	Knowledge Institutions: Existing as the change makers in the incumbent system, bridge the gap between government and market organizations and the civil society
<u>Government</u>	<ol style="list-style-type: none"> <li>1. Provinces</li> <li>2. Regios (dependent on agreements)</li> <li>3. Municipalities</li> <li>4. Water Boards</li> <li>5. Omgevingsdienst (Regional Environment Service)</li> </ol>	<ol style="list-style-type: none"> <li>1. Outlining visions and facilitating public support</li> <li>2. Developing official data</li> <li>3. Partnership creation (Regios)</li> <li>4. Crafting policy, standards and regulations</li> <li>5. Establishing the parameters of innovation system</li> <li>6. Framing implementation guidelines</li> <li>7. Providing and securing initial funding</li> <li>8. Reliable and realistic governance</li> </ol>	<p>Provincial Government: Currently takes the role of facilitator of municipal/regional communication and guidance</p> <p>Regios: Currently a platform for the exchange of ideas and best practices, effectively no regulatory power</p> <p>Municipalities: Effectuate renewable energy development, generally little resources or knowledge development though</p> <p>Omgevingsdienst: Implementation authority with enforcement powers, could have authority expanded</p> <p>Water Board: Important management and organizational skills when it comes to spatial planning</p>
<u>Civil Society</u>	<ol style="list-style-type: none"> <li>1. Community led initiatives</li> <li>2. Social housing associations</li> <li>3. Activists and engaged citizens</li> <li>4. Passive general public</li> </ol>	<ol style="list-style-type: none"> <li>1. Participation in voting (Provincial, Municipal and Water Boards)</li> <li>2. Voicing public support or resistance for projects</li> <li>3. Self-organization into groups, associations, cooperatives and project initiatives</li> <li>4. Volunteering and participation in community innovation initiatives</li> <li>5. Forming a consensus on the RES</li> </ol>	<p>Civil Society is very weak</p> <p>Citizens not engaged or educated on local energy issues</p> <p>Led by pioneers like activists and workers from the big energy companies</p> <p>New 50% ownership rule huge importance</p>
<u>Energy Companies: start-ups, small and medium-sized enterprises (SMEs), multinationals and large firms</u>	<ol style="list-style-type: none"> <li>1. Transmission system operator (TSO)</li> <li>2. Distribution system operator (DSO)</li> <li>3. Energy suppliers</li> <li>2. Energy cooperatives</li> <li>4. Project developers, engineering firms and Energy consultancies</li> </ol>	<ol style="list-style-type: none"> <li>1. Manage the electricity grid</li> <li>2. Negotiate new project development</li> <li>3. Invest in innovative practices (steer efficiency and experimentation)</li> <li>4. Administer implementation of best practices</li> <li>5. Commercially develop, supply, source and install renewable energy projects</li> <li>6. Stimulate economic activity in the renewable energy markets</li> <li>7. Facilitate growth of affiliated markets</li> </ol>	<p>TSO and DSO are very preoccupied with adding more capacity to handle distributed energy</p> <p>Energy cooperatives are rising starts, but most are still niche-level small scale.</p> <p>Energy suppliers are still learning how to change, but are enthusiastic to do so.</p> <p>Support market mechanisms for the RES</p>
<u>Other Parties</u>	<ol style="list-style-type: none"> <li>1. Investment banks such as Triodos or Rabobank</li> <li>2. Insurance Agencies such as Profin</li> <li>3. Legal services such as RenewabLAW</li> </ol>	<ol style="list-style-type: none"> <li>1. Procure capital for project financing, labor, and acquisition of large assets</li> <li>Provide stability in the marketplace</li> <li>2. Safeguard against risk in cases of uncertainty</li> <li>3. Maintain good legal standing of projects and satisfaction of all parties involved in project negotiations</li> </ol>	<p>Financial: Interested in green venture capital funds. Renewable energy not as risky as it was but still equally constrained by a high-risk assessment structure</p> <p>Green Insurance: Upcoming importance for assessing long-term project viability</p> <p>Many new environmental and renewable energy law firms developing</p>

## 4.3 Institutions:

The institutional structure of the Province of Gelderland's RES has been analyzed as belonging to either *Hard* or *Soft* institutional sub-categories (Wieczorek and Hekkert, 2012). The institutions discussed in the following sections will only be those that are directly involved in the Province of Gelderland. Therefore, while the Paris Agreement and the Netherland's Integrated National Energy and Climate Plan have influenced the energy transition in the Province of Gelderland, they will not be discussed as evaluating their role does not help answer the research questions of this paper.

### 4.3.1 Hard Institutions:

The hard institutions included in this structural analysis are the agreements, rules, plans and strategies that are integral to the formation of the RES in the Province of Gelderland. Hard institutions are important for establishing the legal and financial infrastructure supporting the RES. They do this by helping to define boundaries of what approaches or options are legally and lawfully available to the Province of Gelderland. By establishing what possible solutions exist in the realm of possibility, hard institutions help to provide certainty to the RES and additionally help lower risk for supporting and investing in technological innovation and experimental governance practices. Simultaneously, hard institutions might favor incumbent practices and therefore act as barriers to radical change to the energy system. In this way, hard institutions such as targets and documented ambitions have a role in stimulating the energy transition while also helping guide coordination between actors. Whereas laws and regulations may prevent certain experimental actions from taking place at all. Together, the capabilities of hard institutions should be understood as being highly influential on the RES, whether that be their power to offer new modes of opportunity for governance or to stop innovative practices in their tracks. It should be noted that the following hard institutions are not an exhaustive list and that the ones discussed are those which came up during the literature review and interviewing.

#### The Gelders Energy Accord (GEA):

Time and again the Gelders Energy Accord (GEA) was cited as being the most eminent institution guiding and defining the energy transition in the province of Gelderland. As an agreement between over 200 different actors from all corners of the province, GEA laid the groundwork for the Province of Gelderland's bottom up approach to the RES that it is constructing today. To prevent the decision making of the GEA from becoming dominated by the provincial government, they were excluded from the decision-making process. The provincial government only became involved at the end of the process as signatories (De la Court, 2019). In this way the

power and influence of the provincial government was not a shaping force on the GEA and instead has been used in organizing and implementing the visions outlined in the accord.

The Regional Energy Strategies (RES):

The RES being designed in the six regions of the Province of Gelderland are heavily impacted by the parameters placed on the national regional energy strategy program. The RES falls under the jurisdiction of the interprovincial organizations, VNG, IPO and the Unie van Waterschappen, which after consulting with the provinces, divided up the area of the Netherlands into 30 regions based off of the political unity of the regions. The RES therefore act as instruments for advancing the energy transitions of the provinces through a regional approach which focuses on renewable energy generation, transitioning buildings away from the use of natural gas to more sustainable sources like heat pumps and fuel cells and improving the energy infrastructure of the Netherlands to increase the infrastructures capacity and storage capabilities. The provinces then oversee the RES occurring within their borders and tailor them to meet the 49% CO<sub>2</sub> reduction from 1990 levels by 2030 set nationally. In Gelderland's case, they have opted to increase this target to a 55% reduction target by 2030 (National Programme RES, 2019).

Gelderland Spatial Planning Policy:

The small land area of the Netherlands was consistently mentioned by interviewees as being one of the biggest limiting factors for the energy transition. While the Province of Gelderland is the largest province in the Netherlands by land area, the space available for renewable energy is still limited. Therefore, the spatial planning policies of the Netherlands and more specifically in the Province of Gelderland are incredibly important for shaping the RES. Currently the Grondbeleid (Land Policy) is the main policy organizing the spatial objectives of “public housing, local economy, nature and greenery, infrastructure and social facilities” that must be adopted by the Province of Gelderland (VNG, 2019). This policy enables municipal councils to structure their own municipal spatial planning policies if they achieve the objectives of the program. However, this means that spatial planning for renewable energy has generally fallen into a dichotomy where municipalities are so internally focused that they don't consider the land outside their borders, while also not having plans that specifically name areas of land most suitable for renewable energy development.

#### 4.3.2 Soft Institutions:

Soft Institutions are the common habits, routines, shared concepts and other homogenous locked-in behaviors that are typical of actors who share a culture, language or other social commonalities. This analysis divides the culture of the Province of Gelderland into two sub-categories. The internal culture which organizes the interaction between people on the inside of the provincial house in Arnhem and the general external culture of the constituents of the Province of Gelderland.

Internal Culture:

The internal culture of the Province of Gelderland refers to the interactions between the different departments working on the Province's energy transition and the ways they organize their interactions. From my own observations, these interactions are typified by many conversations formal and informal, in private and at large meeting halls that seek to mitigate power dynamics or hierarchies by giving all participating parties the opportunity to speak. New ideas, practices and activities are oftentimes met with honest opinions and sincere questions both when solicited and unsolicited. Meeting attendees are expected to participate in activities or offer explanation for resistance. These observed dynamics point to a work culture that is open, contemplative and flexible to the possibility of new things. However, action or implementation of new things is typically only occurs after group agreement after much deliberation.

#### External Culture:

The external culture of the Province of Gelderland refers to the culture of the people in the Province of Gelderland outside of the provincial house and their effect on the internal culture of the provincial house. This can be understood as the general culture of the society outside the walls of the provincial house. External culture influences the attention and organization of actors within the province as they respond to external stimuli. These stimuli help determine the awareness of civil servants and policy makers to the operation of the energy system throughout Gelderland. Of significance, external culture can make the internal culture of the province more flexible and open to faster change. What should be noted on this last point, it that from the interviews, it became apparent that a duality exists where the provincial government is keenly aware, and receptive to hearing the needs and wants of its citizens, but it is dismissive of inviting the citizens into the decision-making process (Schipper, Onderdelinden, De la Court, 2019). The province seems to find a representative role for citizens to be more desirable than a participatory role. This runs contrary to the openness to participation and interaction that is commonplace internally between members of the provincial government. In many ways the dynamics of the internal culture are products of the external culture of the province. Where the external culture creates a framework for the province's organization, the external culture shapes the general behavior patterns of the people who enter the provincial house.

**Table 6. Structural Analysis of the Institutions**

<b>Infrastructure</b>			
<b>Subcategories</b>	<b>Local Examples</b>	<b>Capabilities</b>	<b>Local Capabilities Present: Yes/No + explanation of conditions</b>
<u>Natural-Geographical:</u>	Physical geography and geology like rivers, arable land, forest etc.	<ol style="list-style-type: none"> <li>1. Establishes physical limitations of the innovation system</li> <li>2. Contextualizes new policy developments</li> <li>3. Defines what is spatially possible</li> </ol>	<p>Very Limited Land, but land is technically available</p> <p>Veluwe is limiting factor</p> <p>Open areas for turbines along highways overlaps with migratory bird lanes</p>
Built environment: artefacts, instruments, built systems such as roads, buildings, zoning, machines, bridges, electricity grids, heat networks, technology	<ol style="list-style-type: none"> <li>1. The electricity grid (transmission and distribution) and heat networks</li> <li>2. Energy generation facilities</li> <li>3. Human matrix: patchwork of zoned areas</li> <li>4. The internet and associated digital environments</li> </ol>	<ol style="list-style-type: none"> <li>1. Establishes physical limitations of the innovation system</li> <li>2. Contextualizes new policy developments</li> <li>3. Defines what is spatially possible</li> <li>4. Defines what is digitally possible</li> </ol>	<p>Highly developed human matrix</p> <p>Grid is very reliable, but isn't built with 2-way cables- adding capacity difficult</p> <p>Communication and transportation very developed</p>
<u>Knowledge basis:</u> information baseline, expertise, practical skills, strategic decision making	Legal, technical, financial, organizational, administrative, scientific and social understanding of the innovation system.	Necessary for the successful construction and implementation of RES.	<p>Knowledge Base varies widely</p> <p>Aldermen prone to inaccurate information</p> <p>Need for knowledge workshops</p> <p>Public understanding of local situation low</p>
<u>Financial:</u> subsidies, grant systems, tax schemes, funds and other financial programs	<ol style="list-style-type: none"> <li>1. CO2 pricing</li> <li>2. Energy taxes 'Elektriciteitswet'</li> <li>3. Subsidy and incentives policies such as SDE+ and EIA</li> <li>4. Green funds</li> </ol>	<ol style="list-style-type: none"> <li>1. Facilitates market growth</li> <li>2. Arranges parameters of system scale</li> <li>3. Stimulates new startups and processes</li> <li>4. Sustains system</li> </ol>	<p>Very capable financial system</p> <p>Investment funds possible</p> <p>No effective market mechanisms in place</p>

## 4.4 Infrastructure:

The infrastructural dimensions associated with the RES can be divided into four sub-categories: physical-geographical, technological, knowledge and financial (Wieczorek and Hekkert, 2012). These dimensions are summarized to the extent that they are valuable for the RES.

### 4.4.1 Natural-geographical Infrastructure:

The matrix of all human structures is built upon the natural geography of the places we inhabit. The Province of Gelderland is no different. Many of the problems it faces, along with most of the solutions at its disposal are intimately tied to the geology, climate and environment within and without its borders. According to the province's website, Gelderland has an area of 5,137 km<sup>2</sup> making it the largest of the Netherland's provinces. Gelderland's regions are defined by divisions stemming from large rivers such as the Waal, Meuse, Nederrijn and Ijssel (Province of Gelderland, 2019). Additionally, the dominance of different natural features like fertile flood plains, heavily forested areas, wide meadows and heath lands has contributed to the distinctive culture, borders and subsequent built infrastructure. Whether it is the renewable energy development limitations facing North Veluwe due to forest conservation measures, opportunities for wind projects along the rivers and in the rural Achterhoek or the worry of replacing the productive farmlands of Riverienland with energy project developments, the regional energy strategies are being defined by Gelderland's natural-geographic infrastructure.

### 4.4.2 Built Environment:

The built environment associated with the RES in the Province of Gelderland is composed of all the technologies, instruments and built systems like roads, zoning, industry, machinery, electricity grids, heat networks, buildings made by humanity using the natural landscape. As a highly developed, urbanized and managed human ecosystem, the Province of Gelderland has a very robust and advanced built environment. Significantly, it has a reliable electricity grid, developed heating infrastructure, organized transportation system, spatial planning and has access to technology. The issues do not lie in whether the built infrastructure exists, but rather whether it is efficiently organized, sustainably powered and optimally operated.

### 4.4.3 Knowledge Infrastructure:

The knowledge infrastructure for the RES is the Province of Gelderland's baseline understanding and application of important information regarding topics like renewable energy, energy savings measures, energy governance and energy democracy. The presence or strength of knowledge infrastructure therefore informs the expertise, theoretical, practical and strategic decision-making capabilities of the province. The individual knowledge attributes of actors both

contributes to and is a product of the knowledge infrastructure. Additionally, the legal, technical, financial, organizational, administrative, scientific and social understanding of the energy transition by the Province of Gelderland composes an additionally important metric for the strength of the Functions Knowledge Development and Knowledge Diffusion.

#### 4.4.4 Financial Infrastructure:

Made up of the financial means of implementing the RES, the financial infrastructure involves both market mechanisms as well subsidies, grants, tax schemes, energy funds and voucher programs. The financial infrastructure typically deployed in the Province of Gelderland are national incentive programs such as the SDE+, BMKB and the EIA (RES Legal Europe, 2019). These types of policies funding guarantees for innovative entrepreneurs (BMKB), are premium feed-in tariff quotas (SDE+) or tax deductions for investments that result in substantial energy savings (EIA) (Rijksoverheid, 2019). Increasingly there is also the growth of energy and innovation funds, which act as sources of revolving capital to help startup projects (OostNL, 2019). CO<sub>2</sub> pricing is being discussed in the province in accordance with a general increasing EU interest in pursuing that market mechanism for lowering CO<sub>2</sub> emissions, however with some such as Klimaatverbond estimating the per ton price of CO<sub>2</sub> at between 600-700 euros while other place it at only 40 euros, there is still a wide variation on what price to set (Klimaatverbond, Interview 6). While the financial infrastructure takes many different forms, it typically embodies capabilities of facilitating renewable energy market growth, quality delivers either increased or decreased scale of operations, helps stimulate innovation by new entrants, and helps to sustain renewable energy projects and taking them to maturity.

**Table 7. Infrastructure involved in the structural analysis.**

<b>Infrastructure</b>			
<b>Subcategories</b>	<b>Local Examples</b>	<b>Capabilities</b>	<b>Local Capabilities Present: Yes/No + explanation of conditions</b>
<u>Natural-Geographical:</u>	Physical geography and geology like rivers, arable land, forest etc.	<ol style="list-style-type: none"> <li>1. Establishes physical limitations of the innovation system</li> <li>2. Contextualizes new policy developments</li> <li>3. Defines what is spatially possible</li> </ol>	<p>Very Limited Land, but land is technically available</p> <p>Veluwe is limiting factor</p> <p>Open areas for turbines along highways overlaps with migratory bird lanes</p>
Built environment: artefacts, instruments, built systems such as roads, buildings, zoning, machines, bridges, electricity grids, heat networks, technology	<ol style="list-style-type: none"> <li>1. The electricity grid (transmission and distribution) and heat networks</li> <li>2. Energy generation facilities</li> <li>3. Human matrix: patchwork of zoned areas</li> <li>4. The internet and associated digital environments</li> </ol>	<ol style="list-style-type: none"> <li>1. Establishes physical limitations of the innovation system</li> <li>2. Contextualizes new policy developments</li> <li>3. Defines what is spatially possible</li> <li>4. Defines what is digitally possible</li> </ol>	<p>Highly developed human matrix</p> <p>Grid is very reliable, but isn't built with 2-way cables- adding capacity difficult</p> <p>Communication and transportation very developed</p>
<u>Knowledge basis:</u> information baseline, expertise, practical skills, strategic decision making	Legal, technical, financial, organizational, administrative, scientific and social understanding of the innovation system.	Necessary for the successful construction and implementation of RES.	<p>Knowledge Base varies widely</p> <p>Aldermen prone to inaccurate information</p> <p>Need for knowledge workshops</p> <p>Public understanding of local situation low</p>
<u>Financial:</u> subsidies, grant systems, tax schemes, funds and other financial programs	<ol style="list-style-type: none"> <li>1. CO2 pricing</li> <li>2. Energy taxes 'Elektriciteitswet'</li> <li>3. Subsidy and incentives policies such as SDE+ and EIA</li> <li>4. Green funds</li> </ol>	<ol style="list-style-type: none"> <li>1. Facilitates market growth</li> <li>2. Arranges parameters of system scale</li> <li>3. Stimulates new startups and processes</li> <li>4. Sustains system allowing for maturity and continued investment in developed projects.</li> </ol>	<p>Very capable financial system</p> <p>Investment funds possible</p> <p>No effective market mechanisms in place</p>

## 4.5 Interactions:

The interactions structure is composed of the connections, networking and relationships that occur between the different actors in society and the organizational networks they form (Wieczorek and Hekkert, 2012). On an interpersonal level, boundary traversing change agents should be recognized as embodying the interactions structure in their own right. It should be recognized that oftentimes network organizations and boundary spanning change agents belong to more than one structure. Typically, they are valued more for the roles they fill as actors or institutions than they do as interconnectors.

### 4.5.1 Networks:

There are many different networks present in the Province of Gelderland. Some such as the IPO, is in fact a network that connects the province to the work and goals of the other provinces in the Netherlands. Since the Province of Gelderland is the largest shareholder of the liberalized DSO, Alliander, the company occupies a unique networking role as it intimately connects the province to energy suppliers and other market players. On the other hand, networks such as HIER Opgewekt and VECG are networks that work specifically to connect community led energy initiatives and energy cooperatives. The most prominent network that was discussed in the interviews was the Gelders Energy Agreement (GEA). While the GEA has already been listed twice as both an actor as well as an institution, GEAs role as a network underscores how integral it has been to the Province of Gelderland's energy transition and the RES. The interviews subsequently resulted in the understanding that the six regions set up under GEA, follow in its footsteps as a network. This is to say that the regions of Gelderland occupy an interaction and cooperation facilitating role for their member municipalities rather than a regulatory governing role. These networks while differing in which actors they connect and the scope of their connections, maintain similar capabilities in that they all help unite stakeholders, share experiences, influence the internal orientation of the organizations operating in the network, foster and grow the professionalism and knowledge development of relationships as well as facilitate in the exchange of knowledge, skills and best practices.

### 4.5.2 Interpersonal Level:

The interpersonal level interactions occur between individuals within and between organizations. Since these interactions are human driven connections, they technically encompass all actors when they engage in teamwork, workshops and negotiations among other interactions. However, while all individuals are ultimately involved in the interpersonal level of interaction, there are certain actors whose knowledge and experience of working in multiple spheres of society offer them a keen sense of how the RES system fits together as a whole. These individuals are considered boundary-spanning change agents in that they have crossed boundaries of society to form connections throughout the system and wield those connections to effectuate change. Change agents use their expertise to share information about aspects of the RES they think is being

overlooked. With this expertise, they can corroborate and support other knowledge institutions or researchers, disrupt entrenched positions or incumbent cultural practices of actors in each sphere of society because they hold both an internal and external view of the system. Therefore, they are uniquely poised to help overcome the dependence on the existing conceptions of the RES. Two such change agents were identified in Thijs de la Court and Carla Onderdelindon, due to their histories of working on Gelderland’s energy transition as part of the government, business and civil society at some point in their careers.

**Table 8: Structural Analysis of the Interactions**

<b>Interactions</b>			
<b>Subcategories</b>	<b>Local Examples</b>	<b>Capabilities</b>	<b>Local Capabilities Present: Yes/No + explanation of conditions</b>
Network Level	<ol style="list-style-type: none"> <li>1. Gelders Energy Agreement</li> <li>2. Regios</li> <li>3. IPO</li> <li>4. Public ownership of DSO (44.68%)</li> <li>5. HIER Opgewekt</li> </ol>	Connecting stakeholders: sharing experience, influence internal orientation of organizations, foster professionalism, information cocreation, exchanging skills and best practices.	Networks are present in all functions powerful at the provincial and inter-provincial level
Interpersonal Level	<ol style="list-style-type: none"> <li>1. Knowledgeable actors involved in each subcategory</li> <li>2. Connectors</li> <li>3. Change agents</li> </ol>	<ol style="list-style-type: none"> <li>1. Sharing Knowledge and information</li> <li>2. Corroborate and support</li> <li>3. Disruption of entrenched or incumbent patterns</li> <li>4. Overcome dependence on existing systems</li> </ol>	<p>The role of Connectors "boundary spanners" is of particular importance for Creation of Legitimacy</p> <p>Interpersonal Connectors act as backbone for Civil Society</p>

## Chapter 5: Functional Analysis Results

Now that the actors, institutions, infrastructure and interactions have been identified in the structural analysis, the functions (processes) associated with the RES will be analyzed through the perspective of the structures in the functional analysis to answer the sub-question: What system functions most need improvement in order for the Province of Gelderland to stimulate and facilitate the development of regional energy strategies? In concert with the methods described in Wiezorek (2014) this analysis will assess how well each function operates in the Province of Gelderland's energy transition by measuring the:

1. Presence and capabilities of the involved actors.
2. Presence and capacity/quality of the institutions.
3. Presence and capacity/quality of the infrastructure.
4. Presence and intensity/quality of the interactions.

Following these qualifications, the analysis of each function will result in a score of '0-absent' '1-very weak' '2-weak' '3-moderate' '4-strong' and '5-very strong' (Wiezorek, 2014). Recommendations (stimulating instruments) will be offered in the "Recommendations and Conclusions" section for functions that receive scores of 'moderate' or lower. Discovery of a lack of presence or weakness in the quality of any of the functions will denote a place where the PRO should advise the Province of Gelderland to take corrective action to improve the RES.

### 5.1 Entrepreneurial Activities:

#### 5.1.1 Context specific interpretation:

As the innovation system being analyzed in this study are the forthcoming regional energy strategies (RES) of the Province of Gelderland, the *entrepreneurial activities* constitute the experimental governance practices emerging to guide the province's energy transition. In this way the entrepreneurial activities of this innovation system differ from the traditional vision of emergent entrepreneurs being market actors taking advantage of new business opportunities or incumbent actors diversifying their business strategy (Wiezorek and Hekkert, 2012). Since the RES are being employed through new practices in governance, the entrants conducting the entrepreneurial activities are therefore mostly government actors, or actors involved in encouraging new governance practices. Subsequently, new methods of policymaking, hierarchy structures and renewable energy market stimulation are considered technological innovations, albeit political and social technologies. This section will analyze whether entrepreneurial activities are taking place by interpreting the actions and effects of the actors, institutions, infrastructures and interactions involved in the RES.

#### 5.1.2 Function requirements:

##### Actors

The Province of Gelderland's energy transition is typified by very high levels of entrepreneurial activities engaged in by actors from all sectors of society (Uwland, 2019). While

all actors are at least nominally present or open to being present in engaging in entrepreneurial activities like experimental governance, there is a high amount variation in the quality of entrepreneurialism practiced by the different actors. It became clear early on that the energy cooperatives are reshaping the civil society of Gelderland in that they encourage citizen participation in the energy transition (Scholtens, 2019). However, despite having a high quality of work and activism, energy cooperatives suffer from being new entrants to the energy market. For all their innovative ideas, they oftentimes lack the resources required to effectuate their innovative ideas (Scholtens, 2019). Energy companies like HaskoningDHV, are engaged in facilitating and stimulating innovation in the municipalities, but oftentimes must take on more of an educational role (Pfeiffer, 2019). The Provincial Government of Gelderland welcomes the input of many non-governmental actors, inviting them for meetings and engaging with them in GEA. Additionally, many actors noted that they felt the provincial government was interested in helping them (Schipper, Souwerbren, Walter, Scholtens, Doyer, 2019). It also became obvious that the provincial government was not the causal driver of entrepreneurial activity, and instead it has been the municipalities who enable new experimental practices and technologies to be deployed (Pfeiffer, 2019). Innovation is occurring locally, whether that takes form in small cities like Hattem, whose aldermen realized they needed to be creative with their energy zoning plans due to severe spatial constraints from conservation for the Veluwe (Schipper, 2019) and in Barneveld where the water boards are joining a CO<sub>2</sub> performance ladder, or in Lochem where the waste management service was socialized into a municipal company to strengthen the civil society (De la Court, 2019). On many occasions the city of Nijmegen was cited as being a leader in the Province of Gelderland's energy transition due to its initiatives developing a heat network and reputation as the Green Capital of Europe in 2018 (Souwerbren, 2019). In particular, the divide between rural and urban municipalities became apparent as rural communities feel overly responsible for shouldering the renewable energy demand of cities like Nijmegen and Arnhem (Sibbing, 2019). The municipalities that are taking action are being encouraged to take action due to citizen pioneers who work with the municipal government to implement change at the Neighborhood level (Onderdelinden, 2019).

## Institutions

### Hard Institutions:

The RES are not driving change in and of themselves, instead they act as a platform of information exchange that facilitates cooperation between parties who would not otherwise necessarily work together. Where GEA has been the main driver of idea generation such as mandating citizen ownership of new renewable energy projects, these hard institutions do not have a role in enforcing the adoption of new policies. This means agreements have largely been voluntary, which limits the extent to which their benefits are seen. For example, the Environmental Act (Wet Milieubeheer) was signed into law as early as 1991, but it didn't start becoming enforced until 2013 (Onderdelinden, 2019). In order to avoid long gaps between when the regional energy strategies are established and when they are enforced, the province must create hard penalties for municipalities not coming into compliance (Onderdelinden, 2019). In other cases, even when the province wants to encourage entrepreneurial activities engaged in by energy cooperatives, existing

municipal regulations are making it harder for them to fit in and compete with the large energy companies (Scholtens, 2019).

#### Soft Institutions:

The culture of the province has a large effect on how the provincial government interacts with the other actors in the innovation system. The civil servants of the provincial government are competent and professional in their positions and therefore respect similarly high skilled organizations. Companies reported great working relationships with the provincial government, with high amounts of mutual respect and professionalism (Pfeiffer, 2019). Energy cooperatives on the other hand reported feeling disrespected and dismissed by the provincial government (Scholtens, 2019). Cooperatives reported feeling patronized and condescended by the provincial government due to their being largely driven by volunteers (Scholtens, 2019). In short, the provincial government has adopted a paternalistic role in its approach to entrepreneurial activities, allowing energy companies and cooperatives to help the government carry out existing governance practices, but not giving them the freedom to innovate on the governance system.

#### Infrastructure

The Province's central location, wealth, strong communities, energy agreement and available land, relative to the western provinces, has made Gelderland an attractive area for investment (Pfeiffer, 2019). The province has a robust, reliable grid system, an advanced public transportation and communication system linking rural areas to urban areas and has a highly developed financial infrastructure that reduces risk and uncertainty for doing business in the Province (Doyer, 2019). Nevertheless, the energy regions do not have the regulatory power to sufficiently encourage or enforce municipalities to engage in entrepreneurial activities (Walter, 2019). So, while municipalities oftentimes have the capacity to adopt innovative practices, they haven't been taught the skills necessary to effectuate the desired changes (Souwerbren, 2019). In this way, the high performance of the function *entrepreneurial activities* is due to the independent municipalities' implementation of new experimental governance and renewable energy development projects despite very little assistance or structure set up by the regional or provincial government (De la Court, 2019).

#### Interactions

The network of interactions stimulating entrepreneurial activities is very high. This is largely due to the foundational presence of the GEA which has allowed for an exchange of best practices between actors (De la Court, 2019). Yet what has truly made the interactions strong is that since the GEA took form, other networks have emerged or stepped in to help the entrepreneurial activities. HIER Opgewekt has been a significant network encouraging and educating energy cooperatives on how they can navigate the province's complicated governance structures (Scholtens, 2019). IPO has likewise been helpful to the provinces as a representative and platform for trading the most effective governance practices (Tieleman, 2019). The regions themselves are communicating but their operations are not developed enough to be able to provide one another with concrete assessments of their plan's outcomes.

**Score: 3-Moderate**

## 5.2 Knowledge Development

### 5.2.1 Context-Specific Interpretation:

The interpretation of the *Knowledge Development* function was close to the definition given by Wiezorek and Hekkert (2012), meaning that it was interpreted as process of gathering, collecting and developing an understanding of the Provincial Government of Gelderland's RES. The knowledge being defined as valid information gathered by the provincial government directly or indirectly from the national government, municipalities, non-government organizations, companies and knowledge institutes regarding the RES.

### 5.2.2 Function Requirements:

#### Actors

There was initially very little consensus from the interviewees on how well developed the Province of Gelderland's understanding is of its own energy transition. A couple interviewees responded saying the province understood very little of the energy transition due to a locked-in view of the energy system (De la Court, Braslawsky, Onderdelinden 2019) while most others thought the province was doing very well in developing its understanding relative to the other provinces (Scholtens, Souwerbren, Walter, Doyer, 2019). There was a consensus among most of the respondents that the Province of Gelderland had a strong scientific based understanding of its goals and the path needed to get there (never mind the political hurdles). This the respondents said was a result of the amount of experts from universities and outside groups who work with the civil servants at the Province. The province's level of Knowledge Development is very wide ranging depending on what subject is being discussed.

#### Institutions

##### Hard Institutions:

Many respondents mentioned how the provincial government has worked to understand the energy challenges facing it for decades, being an early adopter of a provincial energy agreement: GEA (Souwerbren, 2019; Umland, 2019; Tieleman; Sibbing, 2019). However, De la Court and Braslawsky were both adamant that while the province understands its energy situation well from a technological and social standpoint, it is fundamentally misinformed on the institutional and market structures needed to realize its high renewable energy ambitions. This they said was due to an "identity crisis" that can be attributed to the provincial government being unsure of whether it should pursue a more regulatory or distributed approach to guiding the RES (Braslawsky, De la Court, 2019). They stressed that there were knowledge gaps for how to achieve a level playing field (De la Court, 2019). Braslawsky stressed that a huge issue was how the province is measuring its energy progress. Instead of focusing on local production of renewable energy, the government should measure the success of guarantee of origin purchasing to understand the amount of renewable energy consumption (Braslawsky, 2019). Currently the

Netherlands only considers renewable energy produced in the country as being renewable energy consumed, and this means the Netherlands is poised to fall short of meeting its RES 2020 goals (Sibbing (2019) additionally noted that from a spatial planning perspective, while the provincial government has a clear grasp of the planning challenges as well as the potential solutions, it has a less clear understanding of where there are available multi-use land areas available for renewable energy development (Sibbing, 2019).

#### Soft Institutions:

The Province of Gelderland benefits from having a strong external culture of awareness of renewable energy and climate change. Rural areas tend to have lower acceptance of renewable energy technologies because citizens are more likely to notice the changing effects of new developments in their communities. However, despite hearing from Sibbing and Tieleman that associations representing farmers like ZLTO would be anti-renewable energy, this did not end up being the case. In fact, ZLTO, described a high amount of support for renewable energy, especially wind power among its members (Van Wezel, 2019). ZLTO said that the Province has misinterpreted their reservations of renewable energy, and that they support new developments as long as farmers continue to be able to retain ownership of their land and that local communities see the benefits of new projects (Van Wezel, 2019). ZLTO saw itself as a liaison or meeting place for renewable energy development between interested farmers, municipalities and energy developers (Van Wezel, 2019).

#### Infrastructure

The Province of Gelderland boasts a highly skilled workforce with access to elite research institutions. These institutions have helped the government by offering their faculty as advisors to the province on energy issues (Uwland, 2019). Additionally, high-quality surveys like Vele-Tinten Groen and reports such as RES Foto have allowed for an easily understandable, visually appealing and communicable knowledge baseline (Uwland, 2019).

#### Interactions

While respondents said that citizens haven't been well informed, most generally agreed that the Gelders Energy Accord (GEA) has been an effective instrument in spreading knowledge and exposing organizations to new perspectives. In fact, GEA has caused many organizations who would not have otherwise interacted to cooperate and create solutions together (Souwerbren, 2019). Importantly GEA works as the platform for inter-region communication and communication with the provincial government (Sibbing, 2019). In fact, since the province has dedicated a civil servant to each of the regions, meetings between the provincial government and the regions occur every two to three weeks (Sibbing, 2019). This intercommunication allows for knowledge development and knowledge diffusion which helps planning coordination and realization (Sibbing, 2019). Sibbing described the main problem with the current meeting structure is that there is no decision making occurring and therefore all the meetings could just result in a lot of talk without noticeable progress (Sibbing, 2019).

**Score: 3-Moderate**

## 5.3 Knowledge Diffusion:

### 5.3.1 Context-Specific Interpretation

Knowledge Diffusion is being interpreted as the dissemination of information between the provincial government and municipalities, businesses, organizations and the general public. This interpretation narrows the definition of knowledge diffusion down from the broader definition of a process that “encompasses all activities that relate to the diffusion of knowledge among actors through learning by interacting. exchange of information” used by Wieszorek and Hekkert (2012). Notably this definition makes knowledge diffusion a process that only includes a flow of information to and from the provincial government. This choice was made because every function analysis already has a section commenting on the status of interaction presence and quality. The analysis of knowledge diffusion therefore becomes about how well the provincial government distributes information regarding the status of the RES, including the province’s specific regional objectives, expectations and role in their actualization as well as their ability to respond to new information.

### 5.3.2 Function Requirements

#### Actors

The quality of the provincial government of Gelderland’s messaging to the citizens of Gelderland on the regional energy strategies has been either absent or very weak. The interviewees were definitive that the average citizen of Gelderland is either not aware of the existence of the regional energy strategies or has heard of them but has no understanding of their content (Uwland, 2019). On the one hand there's a lot of information exchange occurring within regions as a result of the regional energy strategies, yet on the other hand, there's a lot of chances to actively disseminate information through the network of GEA that is currently just occurring passively (Tieleman, 2019). Herein lies the heart of the problem. While the active members of society can be reached through passive methods of information diffusion, passive members of society must be reached through active and structured methods of information diffusion.

#### Institutions

##### Hard Institutions:

The provincial government has had the view that it is better for the national government to manage knowledge diffusion through big generalized campaigns on television (Tieleman, 2019). The provincial government thought that if the BZK handled the awareness campaign then knowledge dissemination would be more efficient than having every province or municipality run their own local campaign. That way more direct information exchange and education could be conducted by municipalities because there's less distance between municipalities and the inhabitants (Tieleman, 2019). The GEA has worked as that more direct information exchange and has resulted in community collaborations like the energy-saving neighborhoods. Yet what many

interviewees complained of it that there continues to be no workshop that both explains the process of the regional energy strategies and allows the local people to get involved (Tieleman, 2019; Umland, 2019; De la Court, 2019). This call for a formal, provincial-government-run workshop is also present in the financial and business communities (Welling, 2019). In fact, OostNL brought up the issue that because not all companies will respond to invitations, the provincial government should get involved and enforce workshop participation or at least investigate whether a platform could be created to educate businesses about what they should be doing and then hold them accountable for their contributions (Welling, 2019).

#### Soft Institutions:

The study *Vele Tinten Groen* by Kieskompas BV (2019) found that there is a lot of variation on what being environmental means to people in Gelderland. Their study found that there is a nature versus agriculture dimension which pits the agricultural and fishing industries against the interests of land and animal preservationists as well as a conflict between energy-intensive economic activities against those in favor of rapidly switching to renewable energy (Kieskompas, 2019). These tensions were discussed in interviews with GNMF, ZLTO, and with the provincial government. Interviews resulted in a consensus that Gelderland is decidedly aligned on the fact that nature and the Earth needs to be protected, there are significant differences between people on how land should be used (Souwerbren, 2019; Sibbing, 2019; Van Wezel, 2019). If the province is to be able to provide directionality to the RES, then it is going to need to align the interests of the four factions by finding spaces of common ground and by being flexible to compromises (Van Wezel, 2019; Levine, 2019).

#### Infrastructure

The Province of Gelderland has a well-developed communication infrastructure that is based on an electrical grid with 99.9% reliability (Doyer, 2019). The province benefits from having an electricity grid that is increasingly having its distribution and transmission cables added underground which prevents power outages and the loss of communication abilities (Tennet, 2011). The province's relatively dense population and high amounts of urban areas supports widespread internet access and mobile phone signals. Besides its developed physical infrastructure, the province also has a well-developed financial infrastructure that would be able to finance the creation of government sponsor workshops. Currently however, knowledge diffusion to civil society is not being funded by the provincial government (Schipper, 2019).

#### Interactions

The RES are predominantly considered to be "official jargon" that only the experts within the process truly understand (Umland, 2019). Likewise, while municipalities understand that they are responsible for effectuating the RES, they largely do not intimately know what the energy transition will mean for them (Pfeiffer, 2019). The experts themselves, while happy to educate the municipalities via workshops and seminars, they do not see these measures as being the most effective teaching tool (Pfeiffer, 2019; Doyer, 2019). The issue cited by Pfeiffer is that it is there is a lot of variability on who comes to the meetings (Pfeiffer, 2019). For example, HaskoningDHV

invited all the city councilors from West Brabant (about 400 councilors) for an educational workshop on the RES, and of those invited, only 70 people from 18 cities showed up (Pfeiffer, 2019). This instance displays the reality that only those councilors who are interested in taking the time to learn about the RES are being educated, while the majority of councilors are not receiving the education they need to make informed decisions on the municipal councils. The variance in understanding among councilors is a result of the unstructured information exchange (Pfeiffer, 2019). Since there is no structured official platform for knowledge diffusion, councilors oftentimes are influenced by inaccurate sources and then use the RES as a vehicle to spread that false information (Pfeiffer, 2019). The larger power structures such as IPO, which has a lot of inter-provincial information exchange also often acts like a black box to the general public (De la Court, 2019). These large organizations have information on their sites that transparent on a shallow level, but while the details are technically available to the public, accessing that information requires a complicated multi-step process that dissuades practical access (De la Court, 2019). A more structured and transparent system is needed to provide accurate, easy to access information to decision makers and citizens. These changes would also have the indirect effect of protecting the integrity of IPO, RES and GEA as trustworthy information marketplaces.

**Score: 2-Weak**

## 5.4 Guidance of the Search:

### 5.4.1 Context-Specific Interpretation

Guidance of the Search is interpreted as being the provincial government of Gelderland's organization and direction of the development of the RES. This function therefore evaluates both how the provincial government decided to carry out the national government's plan to form the RES as well as its role supporting the regions and municipalities. The interpretation of Guidance of the Search subsequently follows Wiezorek's (2014) definition because it "refers to those processes that lead to a clear goal for the development of new technology" (Wiezorek, 2014, pg. 45) and is the "process [that] enables selection (use), which guides the distribution of resources" (Wiezorek, 2014, pg. 45). Questions for interviewees subsequently asked about the provincial government's current role in planning and implementing the regional energy strategies as well as what their ideal role would be.

### 5.4.2 Function Requirements

#### Actors

The provincial government is the primary actor involve in this function since this study interprets the Guidance of the Search as pertaining only to the performance of the provincial government. plan we can combine parties, actors and institutions together. Currently the role of the provincial government is much debated. While officially the province is the regional authority and has the power to draft original agreements and provincial rules, in practicality it rarely takes a

regulatory approach to governance (Uwland, 2019). In fact, the provincial government's approach to is very bottom-up and generally takes on a conciliatory tone (Tieleman, 2019). Rather than dictate what the Province of Gelderland expects municipalities to do and then keeping a close eye on municipality cooperation, Uwland said "municipalities asked to Province take this or do that or that's your role" (Uwland, 2019). Tieleman when asked how she would characterize the province's approach to the energy transition, responded by saying "as bottom-up yes" (Tieleman, 2019). This practice "comes really more or less by nature or by history or by agreements [...] we have to take steps together with institutions and companies and inhabitants" in order to govern (Uwland, 2019). The bottom-up approach taken by the provincial government is being heavily emphasized because it sets the stage for why the Guidance of the Search functions so poorly.

### Institutions

#### Soft Institutions:

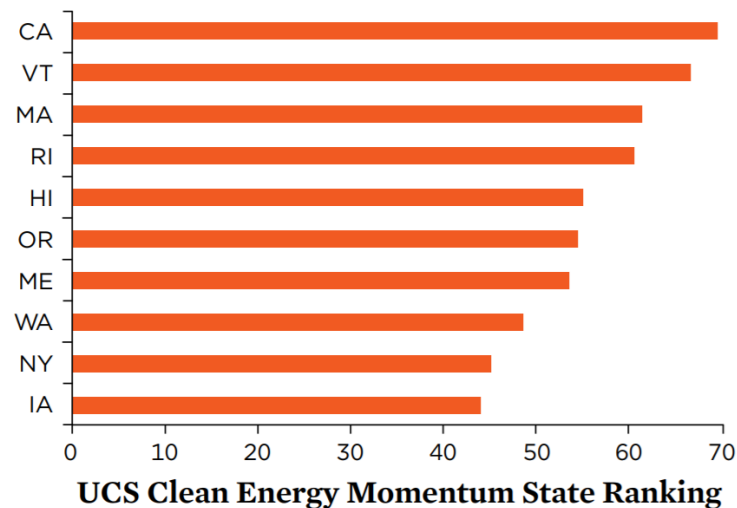
A strength supporting the Guidance of the Search is the internal culture of non-partisanship that characterizes the work of the provincial and municipal governments. Interviewees belonged to multiple parties including ChristenUnie (CU), GroenLinks (GL), Christen-Democratisch Appèl (CDA), Volkspartij voor Vrijheid en Democratie (VVD), Staatkundig Gereformeerde Partij (SGP) and Democraten 66 (D66) and all interviewees stressed the importance of cooperation and conversation. Interviewees attributed cooperation and non-partisanship to Dutch culture which is by principal prone to conversation and compromise. Pfeiffer remarked, that someone responding to another person's request with a flat no is a rarity, "at the end it's always flexible" (Pfeiffer, 2019). However, Pfeiffer also cautioned that the Dutch "stay for a very long term in the startup phase" and don't move to the policy enforcement phase (Pfeiffer, 2019). To put it another way, there is no culture of experimental governance.

#### Hard Institutions:

There is a considerable lack of rules, laws and "the government has been pretty easy going on not punishing municipalities that don't take action and also hasn't done enough to reward the cities that are doing a good job" (Pfeiffer, 2019). This is due to the provincial government's aversion to angering or fraying bonds with the municipalities (De la Court, 2019). While the provincial government welcomes the analysis of what municipalities can do to improve their renewable energy performance, they abhor the idea of ranking municipalities or regions based that performance in the RES (De la Court, 2019). Klimaatverbond made a report that compared and ranked Gelderland's municipalities based on their monetary policy efforts to support renewable energy in order to reward the municipalities had the best results and call attention to the municipalities not pulling their weight (De la Court, 2019). However, the provincial government tried to stop them because they rejected the competitive nature of municipality ranking (De la Court, 2019). Klimaatverbond argued that a competitive environment is needed for municipalities to advance their climate policies because a voluntary system doesn't create a sense of urgency or pressure to change the incumbent system (De la Court, 2019). Rankings of state, municipality and city performance are used extensively in the United States alongside company rankings to drive policy competition towards renewable energy production (Union of Concerned Scientists, 2019).

**Figure 3. UCS Clean Energy Momentum State Rankings**

FIGURE ES-1. States Leading the Way in Clean Energy



To determine the clean energy momentum state ranking, UCS analyzed the 50 states on 12 metrics, such as job creation, pollution reduction, renewable energy in the electricity generation mix, and policies to advance clean energy. California leads the way, with strong showings on eight metrics and the number one position in electric vehicle adoption.

Note: For each metric, top-performing states receive a 10, bottom ones receive a zero, and other states are rated according to their position relative to those two benchmarks. A state's overall score is the total of their metric scores. The highest possible score is 120.

*Figure 3. Source: the executive summary of the Clean Energy Momentum: Ranking State Progress by the Union of Concerned Scientists (2017).*

When asked how the Guidance of the Search has been handled, the majority of interviewees responded along the lines of “we are performing very bad[ly]” (Pfeiffer, 2019) or “I’m disappointed in the province, in the provincial governments” (Souwerbren, 2019). Most respondents said that the provincial government needs to take a larger role in the energy transition. Respondents gave many different answers as to what taking action meant, but it generally involved the provincial government taking a more top-down approach like create mechanisms to facilitate community participation (Souwerbren, 2019), stimulate and strengthen civil society (De la Court, 2019) engage in standard-setting (Pfeiffer, 2019), implement enforcement measures (Onderdelinden, 2019) and create regulations to provide structure for municipalities (Schipper, 2019). Pfeiffer, Onderdelinden and Van de Belt each said the provincial government has a history of passing laws and then not enforcing them. Most importantly, the “government needs to enforce regulations, it took forever to enforce the Wet Milieubeheer” (Pfeiffer, 2019), which wasn’t enforced from 1993 when it was established until 2013 after the Omgevingsdienst started to enforce it (Van de Belt, 2019). This was a major issue because the Wet Milieubeheer is integral to allowing the Omgevingsdienst to enforce energy savings measures on businesses and building owners (Van de Belt, 2019). For the longest time, the Omgevingsdienst only had a legal obligation to take

measurements and it wasn't until three years ago that Appendix 19 was formed in the law that created a list of specific sectors and well-established measurements to enforce compliance (Van de Belt, 2019). Currently, the provincial government has treated the RES as a vision for what the province wants and this has led to targets that are largely arbitrary and born out of ambition (De la Court, 2019; Pfeiffer, 2019). Instead the provincial government needs to take on more of an implementation role where they ensure municipalities and regions are complying with the RES.

### Infrastructure

The underlying issue of the RES for the Guidance of the Search is that the energy regions were divided up with no regard for the physical, economic or natural geography of the Province of Gelderland. Instead the regions were divided according to the political network they belonged to (Sibbing, 2019). This has the effect of making renewable energy production seriously complicated for some regions, while making an energy transition very easy for other energy regions. For example, most of the land belonging to the energy region of North Veluwe is protected forest and cannot be developed, whereas the region of Achterhoek has a lot of land and is relatively sparsely populated. The division of regions based on existing political divisions paired municipalities with no existing working relationship together, while dividing municipalities that have a history of working together. This was an issue highlighted by Schipper; the municipality of Hattem must work with Harderwijk, which it has nothing in common with, while it cannot have the same energy strategy as its next-door neighbor Zwolle. The provincial government's planning team did not consider this to be a major concern as "there are pros and cons for everything" and because the "strategies are a political instrument [...] it's a good choice for that goal" (Sibbing, 2019). Sibbing made the point that this structure of the RES is good because it creates understanding for political boundaries which aren't as immediately apparent as the natural boundaries (Sibbing, 2019). This contrasts with many interviewees who thought the natural geographical and economic divisions should be considered.

### Interactions

The current system has been organized to be a bottom-up approach and this means that the provincial government relies on individual pioneers among the civil servants to interact with municipalities and businesses (Uwland, 2019). However, this places a large amount of responsibility on the shoulders of a few number of people to effectuate change. There is currently a low level of support by programs and policies to empower the civil society of the province (Onderdelinden, 2019) and the most active individuals cannot unilaterally induce government activity (De la Court, 2019). On a network level, while GEA has the power to link up with all the organizations and structures and has the transparency where members can check on one another to see if everyone is doing their part, it is not enough because they do not have the regulatory authority to enforce action (De la Court, 2019).

**Score: 1-Very Weak**

## 5.5 Market Formation

### 5.5.1 Context-Specific Interpretation

This analysis interprets the Market Formation function as being the policies and actions taken by the provincial government to stimulate and support the production of renewable energy within the context of the RES. It is a function that deals mainly with how the provincial government is creating demand for renewable energy or is enabling municipalities to create demand for renewable energy. This interpretation aligns closely with Wiezorek (2014) and Wiezorek and Hekkert (2012). The analysis of the strength of this function is subsequently tied to the presence and quality of financial incentives/disincentives, market mechanisms and other regulations deployed by the provincial government and municipal governments present in the Province of Gelderland.

### 5.5.2 Function Requirements:

#### Actors

The provincial government does not have a central role in the creation of demand for renewable energy in the Province of Gelderland, because the province is not making new laws but is rather enforcing national laws (Tieleman, 2019). What this means however, it that currently the energy market undergoes a kind of business to business approach (B2B) because there is no provincial policy structuring the energy transition (Pfeiffer, 2019). The business actors cannot expect consistent treatment from the provincial government and therefore the issuance of licensures, grants and permits feels like the picking of winners and losers (Pfeiffer, 2019). The consequence of giving the municipalities the responsibility to craft their own policies for meeting the RES is that companies must also tweak their policies to comply with every municipality they operate in (Pfeiffer, 2019). That being said, the Province of Gelderland does have an agenda for climate and energy that says as part of its annual expenditure, the Province will spend for the next 10 years, 30 million a year towards innovation to find new ways to become more sustainable (Uwland, 2019). Yet it would cost between €30 and €40 billion to transition the Province of Gelderland's roughly 950.000 households to the energy saving and efficiency standards required to meet the 55% CO<sub>2</sub> reduction target (Walter, 2019; Souwerbren, 2019; Schipper, 2019).

Currently only the pilot cities or front-runner municipalities are really making changes, the province needs the front runner green cities to encourage the other cities to scale up production (Pfeiffer, 2019). The prohibitive issue is that it has been difficult to create a market that both punishes the heavy industries for polluting while also ensuring that they remain viable. The first step would be for the province to begin creating tools and a program office to create standardized recommendations, outlines, schedules and working procedures (Pfeiffer, 2019). By exerting more control over the stimulation of the marketplace, the provincial government would be creating more certainty, security, transparency and trust between project developers and communities (Pfeiffer, 2019). Since the system is unstructured, only a few municipalities are preparing themselves by creating tender procedures to challenge entrepreneurs to come with the best benefit programs for the municipality (Pfeiffer, 2019).

## Institutions

### Hard Institutions:

The Province of Gelderland uses the national government's tools for increasing renewable energy production. The SDE+ is feed-in-tariff designed subsidy which pays renewable energy producers for the energy they generate in order to cover the higher production costs associated with renewables as compared to fossil fuel production (RVO b, 2019, pg. 3). The SDE+ national budget stands at €5 billion for the Spring 2019 season (RVO b, 2019, pg. 3). While this is a national budget, it must be mentioned as the Province of Gelderland derives a significant amount of its local renewable energy production as a result of the SDE+ (Welling, 2019). This national commitment, while significant, must be compared against the high level of financial support the Netherlands continues to devote to fossil fuels, about €4.4 billion annually (most over €3.5 billion to the transportation sector) (Van der Burg and Runkel, 2017, pg. 1). About €513 million per year goes to subsidize fossil-fuel based electricity production; an additional €1.8 billion was provided annually in the form of guarantees and insurances by Atradius DSB, the Dutch government's export credit agency (Van der Burg and Runkel, 2017, pg. 3). Like the tax incentive EIA for renewable energy production, the Netherlands "reintroduced a tax exemption for the use of coal in electricity production, after it was abolished in 2012 for environmental reasons" (Van der Burg and Runkel, 2017, pg. 1). Besides helping support the fossil fuel industries, these pro-fossil fuel subsidies make it harder for feed-in tariffs, tax incentives and voucher programs from making renewable energy become financially competitive with fossil fuels by ensuring that fossil fuels remain cheap.

Despite the effectiveness of feed-in tariffs in issuing grants to new renewable energy production, many of the business actors and municipalities interviewed considered feed-in tariffs to be incredibly inefficient (Braslawsky, 2019). De Kruif discussed the usage of municipal level sustainability loans to incentivize citizens and small companies to build renewable energy projects (De Kruif, 2019). He stressed that because it is a loan, people would still have to pay it, but it would make it easier for smaller actors to make investments where they want to (De Kruif, 2019). Souwerbren argued that the provincial government should take on a role as an investor, because as an investor the province can better monitor whether funds are being used efficiently (Souwerbren, 2019). De la Court, on the other hand viewed the province's biggest issue with Market Formation was that it is dominated by large multi-national energy investors like Vattenval, RWE and Engie which are highly structured and powerful compared to local community initiatives which are underdeveloped (De la Court, 2019). He argued that there needs to be more public money generated from local community ownership to counterbalance the predominantly privately funded renewable energy market (De la Court, 2019). While De la Court said that ideally, the implementation of a €600 to €700 CO<sub>2</sub> price would be the best, most efficient mechanism for scaling up renewable energy production in the province, it would be exceedingly difficult to actually get a price that high implemented (De la Court, 2019). Both Sibbing and De la Court said the next best thing to CO<sub>2</sub> pricing would be to create a formal spatial plan in every municipality specifically for renewable energy development (De la Court, 2019; Sibbing, 2019). To direct

renewable energy production to the identified sites, many interviewees agreed that the province could have an unofficial target compliance market organized at the regional level by requiring that regions accept targets jointly and organize a governance system that forces regions into compliance using the Omgevingsdienst (De la Court, 2019; Van de Belt, 2019; Braslawsky, 2019; Levine, 2019).

#### Soft Institutions:

Dutch culture poses some challenges for the Market Formation function because the conversational and drawn-out nature of Dutch negotiations on projects ignores some of the financial realities associated with renewable energy projects (Pfeiffer, 2019). Since the average time it takes to process and license a wind park is seven years (Sibbing, 2019), companies must be very resilient to get their projects through the permitting process (Pfeiffer, 2019). Only the most financially stable and responsible companies can go years without having a project provide a profit, so companies must ensure that they stagger their renewable energy developments to avoid multi-year losses. Oftentimes the long permitting and preparation process means that the company in question is going out of business by the time the project finally breaks ground (Pfeiffer, 2019).

#### Infrastructure

There are serious concerns with the financial, physical and the knowledge infrastructure associated with Market Formation. The RES does make clear in the energy markets to which extent a region requires large scale power production and clarifies where new capacity needs to be added on the grid (Pfeiffer, 2019). So, it makes the direction of the market transparent and allows for focus on where capital should be spent (Pfeiffer, 2019). Yet in order to achieve the Province of Gelderland's 2030 and 2050 goals, the whole grid infrastructure which took 80 years to build, has to be reorganized very quickly to allow for added supply of renewable electricity and that is going to take a lot of money (Doyer, 2019). Additionally, Doyer stressed that the knowledge infrastructure is lacking because not enough people are being trained as technicians due to a labor market shortage (Doyer, 2019). Combine these problems with knowledge gaps about where new renewable energy production will occur and whether it will be distributed or centralized has a huge effect on how much of the cables get replaced (Doyer, 2019). For Alliander, the most important issue is knowing where new production locations will take place and Doyer reported that in the bi-monthly meetings Alliander has with the provincial government, they rarely can predict where new projects will be placed in the near future (Doyer, 2019).

Since it is challenging to find sufficient space for wind turbines or solar panels in Gelderland, the permitting costs have become a significant portion of costs for any type of new project (Braslawsky, 2019). It is getting increasingly difficult to get permitting done affordably because people don't want new infrastructure near their properties (Braslawsky, 2019). This compounds the issue that the Netherlands is building renewable electricity in locations where it is costly and inefficient (Braslawsky, 2019). Braslawsky argues that the Netherlands should not view the provinces as islands, instead the Netherlands should import and export renewable electricity

from neighboring countries, where it's easier and cheaper to produce renewable electricity (Braslawsky, 2019).<sup>1</sup>

### Interactions

The interactions occurring in the Market Formation function deal mostly with whether the provincial government works as a network facilitating partnership creation (Pfeiffer, 2019). The provincial government is presently not operating a platform that facilitates partnership interaction and subsequently relies on other networks like the GEA and RES to drive cooperation in the marketplace (Pfeiffer, 2019). As was previously discussed, the new requirement that all new projects are 50% owned by citizens goes a long way to creating a new energy marketplace where personal interactions will gain in importance (BZK, 2019, pg. 9). Having local ownership in the process will shift more of the power balance away from the large companies towards the civil society and this will in turn have the effect of opening up the network to normal citizens who want to participate (Souwerbren, 2019).

**Score: 1-Very Weak**

## 5.6 Mobilization of Resources

### 5.6.1 Context-Specific Interpretation

This analysis interprets the Mobilization of Resources function as being the availability and allocation of resources such as human capital, financial capital, land (zoning), public support, political capital and natural resources to the RES. This function also considers the accessibility of resources available and allocated to the involved actors by the provincial government. This interpretation aligns closely with Wiezorek (2014) and Wiezorek and Hekkert (2012)'s definition of the Mobilization of Resources function. Unlike the other six functions which were analyzed based on the actors, institutions, infrastructure and interactions, the analysis of the strength of this function will be divided into two sections: the presence and quality of resources as well as the capacity of actors to access those resources to advance the aims of the RES.

### 5.6.2 Function Requirements

#### Presence and Quality of Resources:

Due to the sale of the public electricity utility that became Alliander, the Province of Gelderland is the wealthiest province in the Netherlands (Schipper, 2019). The Province of Gelderland holds a €4 billion surplus which is used to allocate funds and invest in projects as it sees fit (Souwerbren, 2019). While this is a vast amount of money, it will not cover the entirety of the costs for the province to complete its energy transition (Souwerbren, 2019). Therefore, the

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<sup>1</sup> See Appendix E for a complete reasoning for international electricity importation and exportation.

province is currently in the process of deciding how it will best invest and loan out the money in the fund (Tieleman, 2019). Most of the money driving the Province of Gelderland's energy transition is private money coming from very large international companies like Engie, Vattenfall and Inology (De la Court, 2019). The huge influx of private money into Gelderland has combined with the climbing demand for renewable energy through the purchasing of Guarantees of Origin (BRaslowsky, 2019). The renewable energy market is subsequently a growing market, with a growing number of energy companies, energy cooperatives and other citizen initiatives working to meet a still climbing energy demand (Souwerbren, 2019).

Spatial planning conducted by the provincial government revealed that there is technically/geographically enough land in Gelderland to power the province locally (Sibbing, 2019). However, 94% of the available land has already been zoned for agriculture (Sibbing, 2019) which comes into conflict with the production of food (Van Wezel, 2019). After all possible energy saving measures have been included and the other 6% of available lands (mostly marginal lands) are used for energy production, 4% extra land would have to be taken away for agriculture (Sibbing, 2019). Farmers are open to the production of renewable energy on their land, if they can retain ownership of the land. As was mentioned earlier in the Market Formation function, there is a labor shortage for skilled electricity technicians as well as for lower skilled laborers (Doyer, 2019). Public support for renewable energy tends to be high, while local support for renewable energy development is dependent on the quality of the benefits being received from the project's development.

**Figure 4: Map of Gelderland**

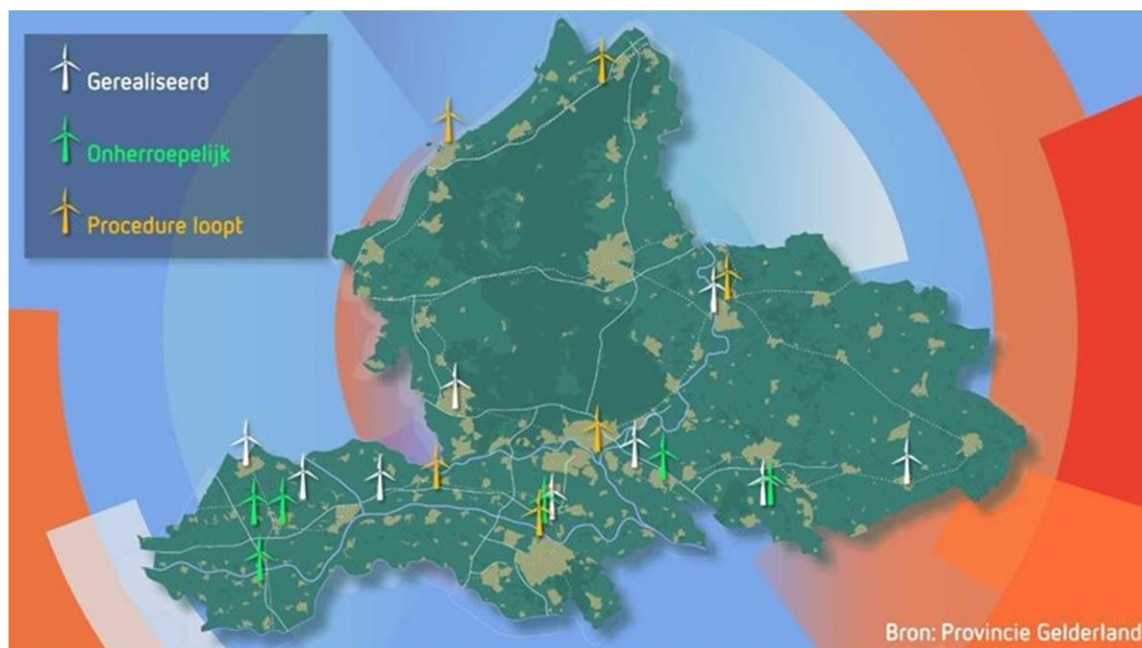


Figure 4. Map depicting existing wind turbine sites in the Province of Gelderland as of 2018. Source: Omroep Gelderland. (2018).

### Capacity of Actors to Access Resources:

While there is a lot of money available, accessing it is difficult for municipalities who need to implement the RES (De la Court, 2019). The Province of Gelderland has been very frugal with its money because it doesn't want to waste it on one sector of the economy (Souwerbren, 2019). While there is a lot of black tape preventing the easy access of provincial money, there are small amounts of seed money readily available to new energy communities if they join the RES structure (De la Court, 2019). Land can also be quite difficult for large companies to develop due to local resistance to a large investor disrupting their community (De Kruif, 2019). However, land for renewable energy development is much easier to access for energy cooperatives because the cooperatives are made up of members from the community hosting the development (Scholtens, 2019). Trust between the community and the energy cooperatives is therefore an intrinsic advantage enjoyed by community initiatives because people do not feel taken advantage of during negotiations (Onderdelinden, 2019).

**Score: 4-Strong**

## 5.7 Creation of Legitimacy

### 5.7.1 Context-Specific Interpretation

This analysis interprets the Creation of Legitimacy function as being the ways in which the RES are perceived by the actors in the system and how the RES overcome resistance to the energy transition. The function refers to the 'legitimacy' of the RES not through the word's legal definition, but rather through the subjective perspectives of actors involved in the RES. This interpretation does not align closely with Wiezorek (2014) and Wiezorek and Hekkert (2012)'s definition because it is not concerned about whether the RES are considered legitimate or valid approaches to the energy transition. Instead the analysis of the strength of the function Creation of Legitimacy is tied to the level of doubt or hostility different actors have towards the province's actions towards producing renewable energy through the RES as well as the measures of counteracting resistance taken.

### 5.7.2 Function Requirements

**Figure 5. Heat Map of Gelderland Citizen Environmental Positions**

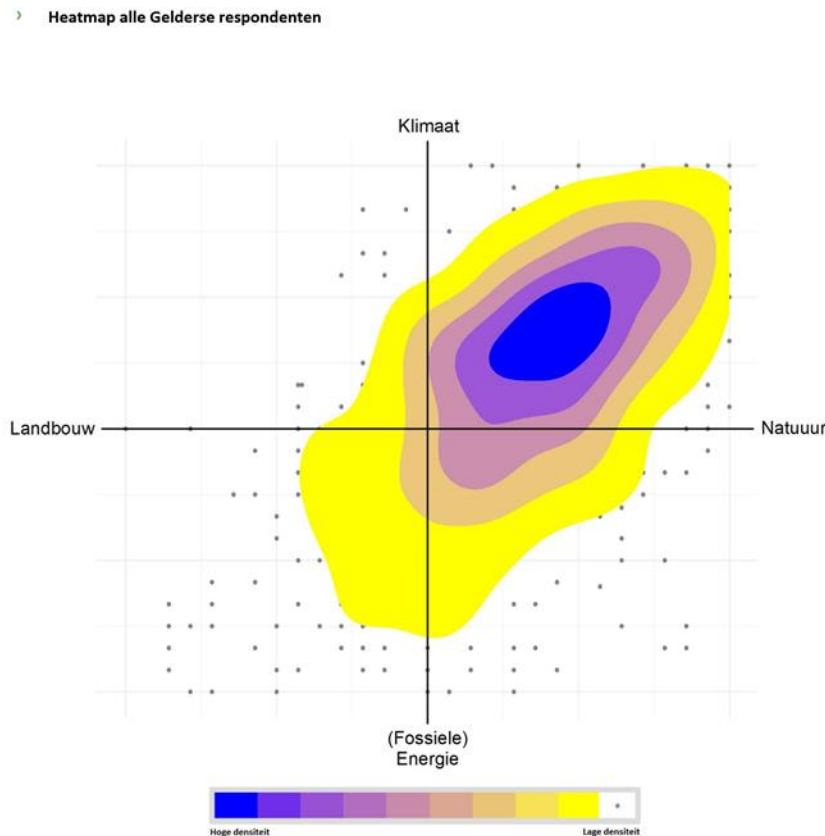


Figure 5. Depicts the First Findings: Vele Tinten Groen (Many shades of Green) display of citizens from Gelderland’s opinions on renewable energy, (2019), Source: Kieskompas

### Actors

The legitimacy of the Province of Gelderland’s energy transition is intimately tied to the public’s perception of how the provincial government’s performance. The government is aware of this connection, and therefore is intensely focused on the public support (draagvlak) for renewable energy. However, for all their focus, the province has been slow in adopting practices that mandate benefit agreements between renewable energy developers and citizens (Onderdelinden, 2019). Simultaneously, citizens seem sincerely divided on whether renewable energy developments bring positive economic benefits to their communities, or if they devalue their properties. Most of the Province’s population believes the province should take action on climate change, (See figure below). Yet there is great resistance towards wind power by urban citizens due to fears that properties close to windmills will be devalued (Schipper, 2019). While most individual farmers look forward to renewable energy projects being built on their land as new sources of stable income, there is some resistance towards renewable power (Van Wezel, 2019). Some farmers are skeptical of the effects of climate change and therefore view developments as a degradation to the farming community (Van Wezel, 2019). Additionally, while ZLTO is generally in favor of renewable energy developments, they stressed that farmers need to retain ownership of the projects because they are worried that otherwise future generations of farmers won’t be able to farm their

family farmlands again (Van Wezel, 2019). Most of the resistance to renewable energy development was reported as being a result of fears that citizens and farmers will incur financial or property ownership losses due to renewable energy development.

## Institutions

### Hard Institutions:

The Province of Gelderland is aware of this cause and so just recently agreed that the RES 1.0 will ensure that 50% of all new renewable energy projects are owned by citizens (Schwencke, 2019). This is a powerful first step by the Province of Gelderland. Now it must provide its citizens with the knowledge and marketplace that allows them to be successful owners of the new energy projects (De Kruif, 2019). In addition to the state of citizen participation in the RES, the legitimacy of the system is connected to the influence of businesses and organizations on the region's decision-making bodies. All the regions' strategies are currently in the pipeline, and while their general structures look quite similar, the compositions of the decision-making bodies can vary significantly depending on the influence of regional actors (Foto-RES, 2019). What this means is that there are a huge number of different stakeholders who are represented on the steering committees (Foto-RES, 2019). The influence of these companies, organizations and other stakeholders relates to the fact that the regions are not recognized as existing on a democratic level (See figure below). The RES are really modes of facilitating debate and maintaining coordination, but without clear governance (De la Court, 2019) generally this mix of positive and negative capabilities regarding the RESs' legitimacy has left citizens happy with the Province of Gelderland's ambition while leaving them doubtful of their methodology.

**Figure 6. The involvement of non-governmental organizations**

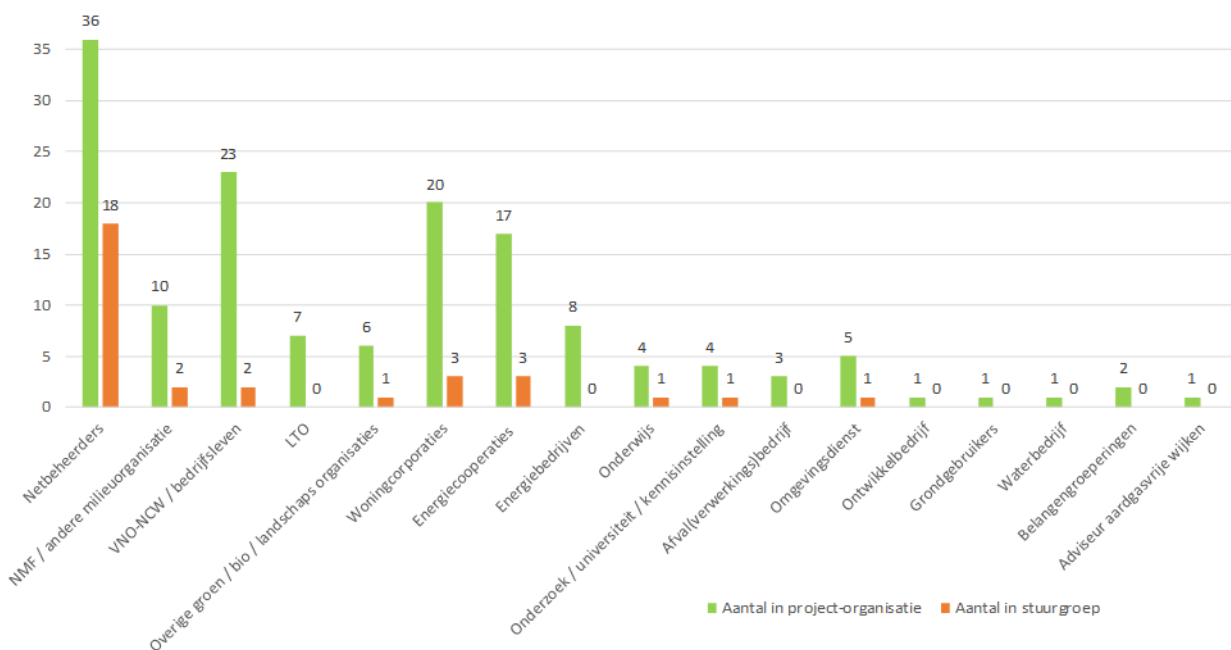


Figure 6. The influence of different stakeholders in the Province of Gelderland, Source: Foto-RES, (2019).

#### Soft Institutions:

The sustainability of the Netherlands' social structures is interwoven with its environmental practices, so much so that it will be difficult to reorganize energy systems, build new infrastructure and encourage average citizens to invest in renewable energy without also increasing the rates of participation and ownership of local energy projects by citizens (Onderdelinden, 2019). Consequently, citizen participation in renewable energy adoption remains concentrated among people with higher incomes. In order to contend with the large numbers of people left incapable of financially participating in the energy transition, the Province of Gelderland must embark on a path which encourages new mechanisms of citizen participation and embraces environmental, social and economic sustainability as parts of the same path towards strengthening communities.

#### Infrastructure

The Creation of Legitimacy is based on a strong cultural infrastructure based on high levels of social cohesion. The Netherlands is a country where citizens have faith in their governments to do their duty and carry out the will of the people (Schipper, 2019). Citizens do not doubt that the Province of Gelderland is sincere in its ambition to reach a 55% CO<sub>2</sub> reduction target by 2030 because they trust that the official statements of the provincial government are based in facts (Souwerbren, 2019). This does not mean that they have doubts about whether the goals are achievable. Citizens' high level of trust in the security of elections, the low amount of money in politics and politician integrity is a product of a legal structure firmly based in the rule of law. The stability of the Netherlands' political and social infrastructure has subsequently led to high amounts of coalition forming between civil society, businesses and municipalities despite the power imbalances between the societal spheres.

#### Interactions

The interactions occurring in the Creation of Legitimacy are those community initiatives that increase citizen participation in the RES while simultaneously lowering resistance to renewable energy production. The Province considers pursuing renewable energy policy that is accepted by the public to be incredibly important. Consequently, increasing citizen participation in renewable energy adoption, especially installation of residential PV solar remains a high priority of the provincial government. Already, energy consumers are transitioning into active participants on the energy market, with some even forming energy cooperatives to aggregate ratepayer interests and buying power (De Bakker, 2016, pg. 10). Increasingly, the Dutch energy market is undergoing a trend towards decentralization; causing new energy cooperatives to emerge as energy generators

and suppliers while shifting traditional energy companies towards more advisory and support roles in addition to large-scale generation projects (De Bakker, 2016, pg. 10 & 20).

**Score: 5-Very Strong**

## 5.8 Structural-Functional Analysis:

*Table 9: Structural Functional Analysis*

<b>Function</b>	<b>Function Evaluation</b>	<b>Causal Inducement Mechanisms</b>	<b>Causal Blocking Mechanisms</b>
<b>F1. Entrepreneurial Activities</b>	3- Moderate	High-rates of private investment Many new entrants Municipality policy innovation Citizen pioneer initiatives Many energy technologies available: solar, on-shore wind, fuel cells, heat networks, district heating, biomass	Lack of effective market mechanisms for renewable energy stimulation
<b>F2. Knowledge Development</b>	3- Moderate	Strong and developed scientific knowledge Clear articulation of research objectives Numerous research institutions available High quality surveys, reports and assessments funded by the province Skilled Workforce	Identity Crisis Lack of institutional understanding Insufficient understanding of civil society
<b>F3. Knowledge Diffusion</b>	2- Weak	Well developed communication networks GEA created powerful foundation Strong partnerships between government and business Present news-media	Lack of Knowledge Application Poor communication of ideas to citizens Weak partnerships between civil society and government Knowledge does not correspond to needs of system

<b>F4. Guidance of the Search</b>	1- Very Weak	Clearly articulated and shared goal of the system System led by front runners Technology present	Goal is generic and has no implementation plan Low level of support by programs, policies Objective is not inducing government activities Expectations for accomplishing goals are low Articulated vision doesn't fit existing policy No culture of experimental governance Under-developed Civil Society
<b>F5. Market Formation</b>	1- Very Weak	Existing market is developed and privatized Incentives such as EIA and SDE+	RE mostly small community or pilot projects Incumbents slow down transition High permitting costs Voluntary electricity market Low CO2 price Feed-in tariffs insufficient New market must be created
<b>F6. Resource Mobilization</b>	4- Strong	Very wealthy province due to selling public energy companies Spatial Planning reveals sufficient land to meet needs Actors willing to negotiate on land development Sufficient risk capital Energiefonds High public funding	Municipalities have difficulty accessing funds Funds are mostly used for research not large-scale production

<b>F7. Creation of Legitimacy</b>	5- Very Strong	Investment in renewable energy is seen as a legitimate decision High levels of coalition forming between civil society, businesses and municipalities Low level of corruption High level of faith in Government Institutions Most political parties aligned on taking action	High levels of citizen resistance to wind power
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Table 5. The combined Structural-Functional Analysis allowed for an evaluation of the seven system functions through the perspectives of the structural elements. It provided a functional score as well as the reasons for function strengths (the causal inducement mechanisms) and weaknesses (the blocking mechanisms). The functional analysis attributed the blocking mechanisms to problems occurring in the structural elements: actors, institutions, infrastructure and interactions. In this way, the weakness of a function can be traced to problems associated with the structural elements. Therefore, instead of offering recommendations to the functions, recommendations will be made to negate the problems causing weak performance in the functions of the RES. These recommendations thus seek to address the major problem themes identified in the functional analysis in order to generate the presence or added capacity, intensity and capability of the functions (Wiezorek, 2014).

## Chapter 6: Conclusions and Recommendations

### 6.1 Conclusions:

Following the proposal of the research question:

*“What can the Province of Gelderland do to stimulate and facilitate the development of innovative regional energy strategies that achieve its renewable energy goals?”*

This research sought to identify and develop an analysis of the health of the functions (processes) occurring in the Province of Gelderland’s regional energy strategies (RES) by reviewing the presence and quality of the structural elements (actors, institutions, infrastructure and interactions) underpinning each process. In this way the study asked three descriptive sub-questions to try to evaluate the state of existing renewable energy generation in the Province of Gelderland and to discover which necessary conditions for a successful energy transition are obstructed by bottlenecks.

To answer the first sub-question:

*“What structural elements must be present for the Province of Gelderland to stimulate and facilitate the development of regional energy strategies?”*

The structural analysis attempted to determine which structural elements are present in the Province of Gelderland and describe what they do to stimulate and facilitate the development of renewable energy in the RES.

To answer the second sub-question:

*“What system functions most need improvement in order for the Province of Gelderland to stimulate and facilitate the development of regional energy strategies?”*

The functional analysis sought to determine the relative health of the system functions present in the RES. This analysis concluded with a functionality score that allows the reader to understand which functions need the most improvement to ensure that the Province of Gelderland’s RES successfully achieve their renewable energy goals.

To answer the third and final sub-question:

*“How can the necessary system functions be operationalized to recommend a mix of policy instruments that will address the identified systemic problems?”*

The conclusions of this research will be divided into two parts: problems and recommendations. It should be noted that no structural elements were completely absent from the innovation system. Instead, the Province of Gelderland needs to improve the quality of the existing structural elements. While many problems have already been identified in the structural and functional analysis, many of these problems belong to four different problem areas: the provincial government has failed to effectively communicate the status, goals, pathway and expectations of the RES to the general public; there are structural-foundational insecurities that exist in the

Province of Gelderland's RES due to a weak civil-society; there is a lack of enforceable renewable energy standards being implemented at the provincial level; there is high levels of citizen resistance to local renewable energy development (especially wind) which is preventing development and driving up permitting costs.

## 6.2 Problems Identified

### 6.2.1 Problem Identified: Failure to effectively communicate RES to the public

One of the most significant problems identified in the functional analysis is that the provincial government of Gelderland has failed to effectively communicate what the citizens of the Province of Gelderland to inform them about what it is doing in its regional energy strategies. The province has mostly relied on national renewable energy and climate change awareness campaigns; however, it has done very little to promote discussion of what the province's energy transition means on a community and neighborhood level (Tieleman, 2019). This has created a dichotomy where, Gelderland has a population that is overwhelmingly supportive of renewable energy development, purchasing renewable energy and combating climate change (Vele Tinten Groen, 2019), but is resistant to local deployment of renewable energy projects and is severely unaware of the effort required to achieve the emissions reduction target of 55% from 1990 levels by 2030 (Uwland, 2019)

### 6.2.2 Problem Identified: Weak Civil Society

There is no strong institutional framework for having a civil-society capable of negotiating on a level playing field with the provincial government and the large energy companies. This is reflected in the structure of the energy cooperatives, which remain very small and cannot grow past just a few thousand members, in total there are just fifty thousand citizens participating in energy cooperatives in Gelderland (De la Court, 2019). It is subsequently difficult for civil society to enter the energy market as an equal player. The government will have to make real change to create a playing field that recognizes civil society as an entity that has its own legitimate economic power (De la Court, 2019).

### 6.2.3 Problem Identified: Lack of enforceable standards

The Province of Gelderland currently has not implemented policies that act as the regulatory 'stick' to force companies and municipalities to develop renewable energy quickly. The mechanisms employed by the province to stimulate renewable energy is limited to voluntary market mechanism, tax incentives, grants and quotas (Braslawsky, 2019). This is additionally hampered by the situation where renewable electricity is the only commodity in Europe that you're allowed to subsidize the production of within your own member state (Braslawsky, 2019). This

means that there is currently a low impetus to create regulatory systems using market mechanisms to produce more renewable energy quickly (Levine, 2019).

#### 6.2.4 Problem Identified: Citizen resistance to renewable energy development

There remains significant resistance among citizens to build onshore wind energy near their communities due to public rejection of the look of windmills and the sounds generated by them. Renewable energy developments continue to be seen as a burden to communities that allow them to be developed (De Kruif, 2019). Additionally, since the benefits of most renewable energy projects typically are only felt by a few people, (such as the farmer allowing his land to be developed and the energy developers) most people see new projects as threats to their home's property value rather than a source of income for the community (Schipper, 2019).

### 6.3 Recommendations:

#### 6.3.1 Recommendation for Failure to Effectively Communicate with the Public: Create Games and Facilitate Trust

The provincial government can help municipalities to more effectively educate citizens about the RES by creating platforms for discussion like spatial planning mapping games. These games allow citizens to look at their own neighborhood relative to the other land features within their municipality and become engaged in spatial planning. The point of this exercise is to not only try to include the citizens of municipalities in the spatial planning conversation, but also to demonstrate greater transparency in the decision making process so that citizens do not feel taken advantage of or feel like they are being cut out and have no say in the province's energy transition. Almost every single interviewee mentioned NIMBY as the biggest hurdle the province needs to overcome. This activity is part of a larger recommendation for the province to begin building trust with citizens by treating civil-society as equal partners. If the province can capture some of the initiative power of people in local neighborhoods and small businesses, then they won't have to work through years of negotiations and deal with the hassle of high permitting costs. Instead the province should support local initiatives by asking neighborhood committees and municipalities what they specifically need and connect them together to the communities that have the resources required. Essentially, if the provincial government wants to pursue a bottom-up approach to the energy transition, then it should create outreach networks that facilitate communication, trust and cooperation within municipalities and between municipalities in the regions.

#### 6.3.2 Recommendation for Lack of Enforceable Standards: Target Compliance Markets

In contrast to the Dutch energy policies SDE+ feed-in tariffs and the EIA tax benefit, target compliance markets make use of market mechanisms expand upon the Netherlands' existing voluntary market for green certificates. The Netherlands currently uses green certificates called Guarantees of Origin (GoOs) to provide proof of renewable energy generation for energy

purchasers on a voluntary green certificate market (CertiQ, 2019). This existing system could be changed to additionally require energy suppliers to purchase a certain amount of electricity from renewable sources by adding a target compliance market which would require electricity suppliers to supply a minimum percentage or amount of their total retail load with renewable energy by a specific date (National Conference of State Legislators, 2019). For every unit of renewable energy generated, the producer earns a Renewable Energy Credit, which they can sell along with their electricity to a supply company (National Conference of State Legislators, 2019). In turn, the supply companies send the certificates they buy to a regulatory body to demonstrate their own compliance (NCSL, 2019). Target compliance markets are usually enforced using various types of penalties for non-compliance such as having to pay the government twice the current market value of the green certificate (Barbose, 2017, pg. 37). The revenue acquired by the government through penalties is then used to either purchase additional green certificates, invest in more expensive renewable energy technology or is passed along to help the ratepayers carry the costs (Barbose, 2017, pg. 37).

Target compliance markets have the benefit of providing a floor for renewable energy adoption in down years for renewable energy investment (Barbose, 2017, pg. 14). Despite these advantages, target compliance markets must overcome several obstacles to become successful. Most obviously, there are costs associated with suppliers being forced to come into compliance, which means that when the certificate scheme isn't properly managed the overall costs can be initially higher using target compliance markets than when using feed-in tariffs (Barbose, 2017, pg. 39). There are also risks associated with the electricity price and certificate price just as there are in voluntary certificate markets. However, one of the biggest benefits is that a target compliance market could be implemented without national approval. Instead it could be organized at the regional level by having regions accept targets jointly and organize a governance system that empowers the Omgevingsdiensten to enforce the renewable energy compliance targets the way they do with energy savings measures under the Wet Milieubeheer currently (Van de Belt, De la Court, Braslawsky, 2019).

### 6.3.3 Recommendation for Addressing Weak Civil Society: Consumer Choice Aggregators

Community Choice Aggregation (CCA) programs provide consumers with an alternative to the traditional utility supply system. Instead of having an investor owned utility supplying electricity, CCAs allow the community itself to form a local not-for-profit public agency as an aggregator that “aggregates the buying power (energy demand) of individual customers within a defined jurisdiction in order to secure alternative energy supply contracts” that best reflect the needs of the community (Burke and Stephens, 2017, pg. 39). CCA gives local governments the flexibility to procure electricity from an alternative supplier based on the needs of their residents, businesses, and the municipality itself (Mow, 2017) while still receiving transmission and distribution services from the existing utility provider (Environmental Protection Agency, 2019). This means the incumbent utility doesn't disappear, its business focuses on “providing reliable transmission, energy efficiency and billing services” which come with the responsibility of owning and maintaining the transmission and distribution infrastructure (CleanPowerSF, 2019). A CCA

would be helpful in getting the government to recognize that civil society can have legitimate economic power in its own right and would help strengthen the civil society of the regions by helping to increase the number of energy cooperatives and increase citizen oversight of the municipalities energy purchasing and investment decisions.

These types of effects make CCAs an attractive “option for communities that want more local control over their electricity sources, more green power than is offered by the default utility, and/or lower electricity prices” but that don’t necessarily want to form an energy cooperative (EPA, 2019). The CAA offers a hybrid type of “approach that exists between the investor-owned (often monopoly) utility and a municipal (or member coop) utility” and therefore benefits from controlling its own power generation and supply without the financial risk and drain of purchasing new or maintaining old infrastructure (LEAN, 2019). In the United States, the CCA is now considered to be the natural progression of energy systems after deregulation. The separation between generation, supply, transmission and distribution that comes with deregulation allows citizens to choose their electricity generator, additionally deregulation provides the CCA with the opportunity to choose the electricity generation mix on behalf of consumers without having to establish the infrastructure to move electricity. In the eight U.S states where CCAs are legal, they work in conjunction with the state target compliance market to increase renewable adoption through a simultaneous top-down and bottom-up approach (LEAN, 2019).

#### 6.3.4 Recommendation for Overcoming Citizen Resistance: Community Benefit Agreements

Community Benefit Agreements (CBA) act as a “formal, clear and transparent framework within which project applicants, Local Planning Authorities (LPAs) and communities can openly discuss” financial payment arrangements (RenewableUK, 2019). A CBA is a legal measure intended to “distribute the benefits of projects or programs among a community” (Burke and Stephens, 2017, pg. 39) rather than concentrate benefits to a small group of stakeholders. CBAs are generally used to ensure that the communities hosting renewable energy projects receive tangible, long-term benefits (Burke and Stephens, 2017, pg. 39). In this way, compensation to communities by developers does not always take the form of a direct payment to the local community, it can also be “standards for wages or union jobs, local hiring, shared community and minority ownership, rights of participation and public engagement, environmental restoration, greenhouse gas emissions reduction strategies” (Burke and Stephens, 2017, pg. 39).

The Province of Gelderland’s recent move to require that 50% of renewable energy projects are owned by citizens will have a significant positive impact on increasing communities bargaining power in CBAs. In places where “not in my back yard” (NIMBY) mentalities dominate local opinions of renewable energy developments like onshore wind or solar fields in farming communities, CBAs can be useful tools for convincing communities to adopt renewable energy developments (Kerr, Johnson and Weir, 2017 pg. 203). This could be especially significant to the Netherlands considering the nation’s spatial constraints. CBAs are also useful for increasing the agency and economic advancement of rural communities because “renewables infrastructure is routinely sited adjacent to smaller rural communities” (Kerr, Johnson and Weir, 2017, pg. 204). Additionally, CBAs can be set up to provide citizens with an annual dividend that goes directly into the pockets of the citizens living in that community which hosts the new development. CBAs

thus offers a flexible policy alternative that helps certify that communities receive benefits from renewable energy projects developed within their borders while also potentially opening up NIMBY areas to renewable energy development.

## Chapter 7: Discussion

### 7.1 Contribution to Further Development of TIS Theory

While this research is meant to provide the Provincial Environmental Policy Council with practical information to help advise the provincial government of Gelderland, it also contributes to the existing Technological Innovation Systems (TIS) theory. This research entailed 19 interviews, 17 of which were with actors active within the Province of Gelderland to provide a case-study for the use of TIS theory in a renewable energy policymaking setting. TIS theory developed as a response “to influence both speed and direction of innovation and technological change” (Hekkert et al, 2007, pg. 413) and therefore the majority of the research conducted using TIS theory has revolved around technology development and innovation. However, because TIS theory broadly defines the concept of technology development as “the development of technology in interaction with the system in which the technology is embedded [and] call[s] this joined and interactive process the innovation process” (Hekkert et al., 2007, pg. 414) it has always allowed for multiple interpretations of what a technological innovation system is (Hekkert et al., 2007). This research defines the Netherland’s RES-based approach to the energy transition as a technology innovation system. It therefore adapts on the predominant technical definition of what a TIS is by applying the relevant aspects of the theory to a socio-political system. In this way, the policy assessment of the RES helps expand on the existing conception of what a TIS is and creates new opportunities for the use of TIS theory. Furthermore, as TIS theory-based studies generally assess the embeddedness of specific technology innovations, they tend to view innovation systems through national or even international perspectives (Wiezorek, 2014). As this high-level perspective tends to overlook some of the more specific qualities of local actors, institutions, infrastructures and interactions, there has been a need for research that “look at how the actors in the TIS define the system themselves” to construct the system assessment in a bottom-up way (Wiezorek, 2014, pg. 176). By creating a structural analysis to identify the most important groups of actors institutions, infrastructures and interactions involved in Gelderland’s energy transition and then analyzing how those structural elements effect and form the functions (processes) in the innovation system, this study helps give future researchers the ability to see which structures matter most to the health of the system.

### 7.2 Limitations of the Research, Results and Recommendations

It should be noted that there are many limitations that accompany the research contained within this study. To begin, almost the entire research process involved in this thesis took place between March and July, an extremely limited amount of time considering the scope of information that needed to be collected, transcribed, translated and analyzed before the write up could be completed. Of the 19 interviews that took place between June 4<sup>th</sup> and June 26<sup>th</sup>, nine interviews took place within a three-day span. This high concentration of interviews meant that transcription and data analysis took place in marathon sessions, rather than iteratively which would have allowed for the gradual gathering of ideas and development of recommendations. Where for the first half of interviews, in-vivo and open-coding helped inform the scope and extent of the a

Priori coding, the short amount of time to complete these interviews meant that the coding of the data became increasingly reliant on a Priori codes in order to manage the volume of data.

A major constraint on the data collection process was the language divide that exists between me and all but two of the interviewees. Since I am an American and Dutch is not my native language, my ability to ask questions was severely limited in Dutch and thus most of the interviews took place in English albeit with some questions in Dutch. However, since only two of the interviewees were also Americans (Levine, Braslawsky), interviewing in English placed a burden on the interviewee's ability to answer my questions. A few interviewees felt very uncomfortable speaking in English and so I had to conduct those interviews in Dutch. While I always mentioned that it was better for interviewees to respond in Dutch than to not respond at all, there were still plenty of opportunities when there were communication issues or misunderstandings between myself and the Dutch interviewees. Following this issue down to the transcriptions and data analysis, there are most likely many pieces of transcribed Dutch data from the interviews that I did not completely understand. Obviously, these miscommunications and the potential lack of understanding could have cascading effects, potentially jeopardizing some of the results and subsequently the conclusions I reached.

As mentioned, the structure of this thesis is based on TIS theory and therefore the structural and functional analyses are supposed to include an assessment of all of the actors, institutions, infrastructure and interactions over a certain period of time. The design of this research has several shortcomings in the way it follows a TIS theory. Chiefly among its problems is that this research does not ask interviewed actors from the innovation system to rate the relative strength of each function. Instead interviewees were asked various questions regarding whether actors, institutions, infrastructure and interactions were present within the system and if they were, were asked how these structures performed. The choice to interview this way neglects to include direct interviewee opinions on the function scores to the functional analysis. The function scores are therefore products of interviewee responses and not direct assessments. Additionally, since I the researcher am the one who is scoring interviewee responses, there is a certain level of subjective opinion on how functions should be scored due to TIS theory's use of an ordinal scale: absent-0; {...} Very-Strong-5. Other research employing TIS theory has typically constructed a context-specific policy assessment framework that they submit to a government or organization to begin to understand what is happening in the local innovation system (De Heer, 2018). However, this study sought to provide a policy assessment itself, rather than just a framework.

The problems and recommendations discussed in Chapter 6 represent only a small number of the total problems and recommendations discussed in the interviews. This is because the sheer number of relevant systemic problems and associated recommendations went way beyond the scope of this research paper which is limited to 26,000 words maximum. Therefore, the most common problems that were cited as occurring within the system were condensed into four categories contained within Chapter 6. These four problem categories mask the true number of problems identified in the structural and functional analyses. While these categories do indeed typify the four largest systemic problems facing the Province of Gelderland's energy transition, they are not tied directly to the functions in the functional analysis. This means that the problems

discussed in the analyses do not all receive recommendations. Furthermore, the number of recommendations discussed represent only a fraction of the total number of recommendations that were discussed in the interviews. In order to partially compensate for this shortcoming, I have attached important excerpts from three interviews with experts on the renewable energy market.

### 7.3 Future Implications of the Research

The practical implication for this research is that it could be used to help construct an advisory report for the provincial government of Gelderland. Since it is the aim of this research to help the Provincial Council for Environmental Policy (PRO) to advise the provincial government of Gelderland in the RES, the results of the structural and functional analyses could be immediately applicable to finding new pathways for the governance of renewable energy. Since the results chapters' layout which actors, institutions, infrastructures and interactions are present within each function, the PRO will be able to see which parts of the RES need the most government support versus the areas that do not need further assistance. In this way the provincial government could reorganize the way it finances, supports and participates in the energy transition and could potentially even help the provincial government to settle into their ideal role.

From a theoretical standpoint, there is a need for additional research on what level of authority the regions the RES are being developed for will have. This research treated the Province of Gelderland as a single-critical embedded case-study and therefore examined the different constraints facing the RES throughout the Province of Gelderland rather than focus on just one or two specific RES regions. Since the RES continue to be in development, it would be beneficial if someone researched what the optimal role of the regions would be and whether they should have the authority to enforce the compliance of the municipalities within their borders. This research also took a lot of interest in potentially expanding the authority of the Omgevingsdienst to enforce renewable energy compliance under a target compliance market. Having increased insight into how the provincial government might go about deploying a target compliance market without needing to change national law would be very beneficial to helping the Province of Gelderland achieve its future renewable energy goals.

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## Appendices:

### Interview Guides:

#### Interview Guide A:

Matthew Mininberg

Questions are organized along Wieczorek and Hekkert's (2012) Functional-Structural Analysis outline. Descriptions of the functions precede each set of questions.

### Themes (The Seven Functions):

1. Entrepreneurial activities
2. Knowledge Development
3. Knowledge Diffusion
4. Guidance of the Search
5. Market Formation
6. Mobilization of Resources
7. Creation of Legitimacy

### Research Question:

*What can the Province of Gelderland do to stimulate and facilitate the development of innovative regional energy strategies that achieve its renewable energy goals?*

**F1 Description: Entrepreneurial activities**- Entrepreneurs are critical for the innovation system to operate properly. This is due to their role as changemaker, seizing new knowledge and opportunities to take tangible steps towards innovating the system. Entrepreneurs are typically either new entrants to the system whose outsider views see opportunity in a changing market/policy landscape, or they are incumbent actors who want to diversify their strategy for new developments (Hekkert et al., 2007, pg. 421). While entrepreneurs have traditionally been market actors, they aren't always and could be involved in government or civil society.

F1 Questions:

Leading Question: Have the regional energy strategies (RES) inspired innovation in renewable energy development?

Sub-questions:

1. Where does change happen? In the regions or the municipalities?
2. What opportunities are there for renewable energy growth?
3. Will RES encourage experimentation with renewable energy governance, technology or organizational methods?

4. Does the current system allow for the easy implementation of new policies, practices and actors?

**F2 Description: Knowledge Development-** Gaining knowledge to develop an understanding is one of the most important resources in the innovation process. Learning is fundamental to research and development of technologies and policies and is therefore a critical prerequisite to innovation systems. Hekkert et al. write that this function includes “learning by searching’ and ‘learning by doing’ (Hekkert et al., 2007, pg. 421).

F2 Questions:

Leading Question: Does the province and its regions have a clear understanding of their local energy situation (how much is consumed, produced and where it comes from)?

Sub Questions:

1. Has the RES encouraged new research and development of projects?
2. What are the knowledge gaps?

**F3 Description: Knowledge Diffusion:** Innovation is stymied by knowledge being limited to only a small subsystem; therefore, knowledge diffusion is an important function of TIS. The primary exchange of information takes place between and within networks (actors) in a heterogenous context where R&D occurs across, among and between researchers, markets, governments and competitors (Hekkert et al., 2007, pg. 423). Policy decisions (standards, long term targets) should be “consistent with the latest technological insights” and R&D plans should be “affected by changing norms and values” because network activity acts as a precondition to ‘learning by interacting’ (Hekkert et al., 2007, pg. 423).

F3 Questions:

Leading Question: In what ways do you see knowledge being shared and adopted?

Sub-Questions:

1. Are there strong partnerships between Gelderland’s regio’s facilitating the development of the RES?
2. Are provinces discussing their strategies with one another?
3. What is the method of interaction?
4. How is this information being communicated to the public?
5. Are policy decisions corresponding to the knowledge being collected about Gelderland’s energy situation?

**F4 Description: Guidance of the Search-** This function deals with the reality that not all technological/policy options can be chosen for research, investment and implementation. The guidance of the search is therefore concerned with how government and businesses select a

policy/technology from a pool of available options. The guidance part of this function refers to the steering actions (these pertaining to the direction of technological change) of actors (mostly governments and businesses, but also can be a product of idea exchange between producers and users of the policy/technology) that “positively affect the visibility and clarity of specific wants among technology users” (Hekkert et al., 2007, pg. 424).

F4 Questions:

Leading Question: What policies, programs, tactics are currently being used to support and stimulate local renewable energy and are they enough to achieve the goals?

1. Why did the national government choose the RES approach to the Netherland’s energy transition?
2. Is it realistic to expect municipalities to lead the energy transition?
3. What are the common solutions being considered by municipalities?
4. In what ways can the provincial government facilitate those solutions?
5. What could the province do to better organize and structure the energy transition?
1. What has been the role of non-government actors in the decision-making process (Do citizens have a role in steering the RES discussion)?
2. What obstacles face the implementation of community choice aggregators?
6. Does the articulated vision of the RES fit in the existing policy mix utilized by the province?
7. What are your expectations of the RES achieving their goals?
8. What is the next step after creating the RES?

**F5 Description: Market Formation-** New innovations inherently must overcome the incumbency advantages held by embedded policies/technologies, therefore new innovations oftentimes require a protective initial environment such as the establishment of niche markets, local adoption initiatives, favorable financial arrangements, or minimum quotas requirements (Hekkert et al., 2007, pg. 424).

F5 Questions:

Leading Question: What does the energy market in Gelderland look like?

Sub-questions:

3. How developed are the renewable energy players?
4. Who is driving the renewable energy market: private or public?
5. Who is purchasing renewable energy?
6. Are there institutional incentives/barriers to market growth?
7. What could the province be doing to overcome those barriers that it is currently not doing?
8. Once the renewable energy market has matured, could a target compliance market be implemented?

**F6 Description: Mobilization of Resources-** Innovation systems, like any human system, require the investment of resources (oftentimes financial capital and human labor) for the system to operate effectively. New innovations typically require high levels of special skills, knowledge and experience for them to be successful. Analysis therefore requires an understanding of “whether or not inner core actors perceive access to sufficient resources as problematic” (Hekkert et al., 2007, pg. 425) or feasible.

F6 Questions:

Leading Question: Are there sufficient resources (money, land, public support etc.) available for developing the amount of renewable energy called for in the RES within the Province?

Sub-questions:

1. Can renewable energy developers (municipalities, civil society or market actors) easily access the resources?
2. Are new companies, advocacy groups etc. starting or expanding operations in the province as a result of the RES?

**F7 Description: Creation of Legitimacy-** An innovation must “become part of an incumbent regime, or it even has to overthrow it” (Hekkert et al., 2007, pg. 425) if it is to become highly functional. Yet in order to become legitimate, new innovations oftentimes must also overcome actors with “vested interests opposed to this force of ‘creative destruction’ (Hekkert et al., 2007, pg. 425). In the case of RES for developing RE, they must overcome the parties with a vested interest in fossil fuels and the slow development of RE. In these situations, civil society actors can act as change agents by exposing policymakers, the media and the public to the innovation. They might also help set the agenda of the government, lobby for resources and support as well as advocate for a competitive edge to gain legitimacy for the innovation (Hekkert et al., 2007, pg. 425). Successful advocacy organizations will grow in strength, membership and influence as the innovation they advocate for increasingly becomes part of the incumbent regime.

Leading Question: Where are the points of resistance to the RES in the Province of Gelderland?

F7 Questions:

1. How does this resistance manifest itself?
2. How does the province overcome these points of resistance?
3. How much investment is taking place to support the RES?
4. What is the lobbying power of the actors in the system?
5. Is the provincial government taken seriously when it proposes plans for reaching its renewable energy targets?
6. What do you see as the best way forward for Gelderland’s energy transition?

## **Interview Guide B:**

Matthew Mininberg

Questions have been organized along the Wieczorek and Hekkert's (2012) Functional-Structural Analysis questioning outline. Be aware that descriptions of the functions precede each set of questions.

### **Themes (The Seven Functions):**

8. Entrepreneurial activities
9. Knowledge Development
10. Knowledge Diffusion
11. Guidance of the Search
12. Market Formation
13. Mobilization of Resources
14. Creation of Legitimacy

### **Research Question:**

*What can the Province of Gelderland do to stimulate and facilitate the development of innovative regional energy strategies that achieve its renewable energy goals?*

**F1 Description: Entrepreneurial activities-** Entrepreneurs are critical for the innovation system to operate properly. This is due to their role as changemaker, seizing new knowledge and opportunities to take tangible steps towards innovating the system. Entrepreneurs are typically either new entrants to the system whose outsider views see opportunity in a changing market/policy landscape, or they are incumbent actors who want to diversify their strategy for new developments (Hekkert et al., 2007, pg. 421). While entrepreneurs have traditionally been market actors, they aren't always and could be involved in government or civil society.

F1 Leading Question: *Have the regional energy strategies (RES) inspired innovation in renewable energy development?*

#### **Sub-Questions:**

5. *What types of changes to the system have you seen occur, if any as a result of the Province deciding to use a RES approach to the energy transition?*
6. *Do you think RES encourage experimentation with renewable energy governance, technology or organizational methods?*
7. *Do the regions have the capacity to adopt innovative/experimental approaches to renewable energy development?*

**F2 Description: Knowledge Development-** Gaining knowledge to develop an understanding is one of the most important resources in the innovation process. Learning is fundamental to research and development of technologies and policies and is therefore a critical prerequisite to innovation systems. Hekkert et al. write that this function includes “‘learning by searching’ and ‘learning by doing’ (Hekkert et al., 2007, pg. 421).

F2 Leading Question: *Do the regions have a clear understanding of their local energy situation (how much is consumed, produced and where it comes from)?*

Sub-Questions:

1. *What are the knowledge gaps?*
2. *What is being done to close the knowledge gap?*

**F3 Description: Knowledge Diffusion:** Innovation is stymied by knowledge being limited to only a small subsystem; therefore, knowledge diffusion is an important function of TIS. The primary exchange of information takes place between and within networks (actors) in a heterogenous context where R&D occurs across, among and between researchers, markets, governments and competitors (Hekkert et al., 2007, pg. 423). Policy decisions (standards, long term targets) should be “consistent with the latest technological insights” and R&D plans should be “affected by changing norms and values” because network activity acts as a precondition to ‘learning by interacting’ (Hekkert et al., 2007, pg. 423).

F3 Leading Question: *In what ways do you see knowledge being shared and adopted?*

Sub-Questions:

6. *Are citizens aware of the RES?*
7. *Are there strong partnerships between municipalities in the regio's facilitating the development of the RES?*
8. *Are policy decisions corresponding to the knowledge being collected about Gelderland's energy situation?*

**F4 Description: Guidance of the Search-** This function deals with the reality that not all technological/policy options can be chosen for research, investment and implementation. The guidance of the search is therefore concerned with how government and businesses select a policy/technology from a pool of available options. The guidance part of this function refers to the steering actions (these pertaining to the direction of technological change) of actors (mostly governments and businesses, but also can be a product of idea exchange between producers and users of the policy/technology) that “positively affect the visibility and clarity of specific wants among technology users” (Hekkert et al., 2007, pg. 424).

F4 Leading Question: *Why did the Province of Gelderland choose to implement a RES approach in its energy transition?*

Sub-Questions:

9. *What policies, programs, tactics are most likely to be implemented by the Regios in response to the Gelders Energy Accord?*
10. *How do the policies, programs, tactics of the Regio's differ from one another?*
11. *What are the expectations of the RES?*
12. *Do the existing energy policies of the province fit their articulated vision?*

**F5 Description: Market Formation-** New innovations inherently must overcome the incumbency advantages held by embedded policies/technologies, therefore new innovations oftentimes require a protective initial environment such as the establishment of niche markets, local adoption initiatives, favorable financial arrangements, or minimum quotas requirements (Hekkert et al., 2007, pg. 424).

F5 Lead Question: *What steps has the provincial government taken to support the regios and stimulate local renewable energy growth and do you consider these steps to be sufficient for meeting the targets?*

Sub-Questions:

1. *What could the province be doing to stimulate renewable energy growth that it is currently not doing?*
2. *Have the province's renewable energy targets encouraged new companies, advocacy groups etc. to start or expand operations in the province?*
3. *Is it reasonable to expect the regios to be able to produce all their renewable energy locally?*
4. *Are there institutional incentives/barriers to market growth?*

**F6 Description: Mobilization of Resources-** Innovation systems, like any human system, require the investment of resources (oftentimes financial capital and human labor) for the system to operate effectively. New innovations typically require high levels of special skills, knowledge and experience for them to be successful. Analysis therefore requires an understanding of “whether or not inner core actors perceive access to sufficient resources as problematic” (Hekkert et al., 2007, pg. 425) or feasible.

F6 Lead Question: *Are there sufficient resources (money, land, public support etc.) available for developing the amount of renewable energy called for in the RES within the Province?*

Sub-Questions:

1. *Where do renewable energy projects typically receive their funding from?*

2. *Can renewable energy developers (civil society or market actors) easily access the resources?*

**F7 Description: Creation of Legitimacy-** An innovation must “become part of an incumbent regime, or it even has to overthrow it” (Hekkert et al., 2007, pg. 425) if it is to become highly functional. Yet in order to become legitimate, new innovations oftentimes must also overcome actors with “vested interests opposed to this force of ‘creative destruction’ (Hekkert et al., 2007, pg. 425). In the case of RES for developing RE, they must overcome the parties with a vested interest in fossil fuels and the slow development of RE. In these situations, civil society and market actors can act as change agents by exposing policymakers, the media and the public to the innovation. They might also help set the agenda of the government, lobby for resources and support as well as advocate for a competitive edge to gain legitimacy for the innovation (Hekkert et al., 2007, pg. 425). Successful advocacy organizations will grow in strength, membership and influence as the innovation they advocate for increasingly becomes part of the incumbent regime.

F7 Lead Question: *Do most actors approve of the RES or is there resistance?*

Sub-Questions:

7. *What is the lobbying power of the actors in the system?*
8. *Do you approve of how the province has handled its energy transition thus far?*
9. *What do you see as the best way forward for Gelderland’s energy transition?*

Interview Guide C:

Matthew Mininberg

Questions are organized along Wieczorek and Hekkert’s (2012) Functional-Structural Analysis outline. Descriptions of the functions precede each set of questions.

**Themes (The Seven Functions):**

15. Entrepreneurial activities
16. Knowledge Development
17. Knowledge Diffusion
18. Guidance of the Search
19. Market Formation
20. Mobilization of Resources
21. Creation of Legitimacy

**Research Question:**

*What can the Province of Gelderland do to stimulate and facilitate the development of innovative regional energy strategies that achieve its renewable energy goals?*

**F1 Description: Entrepreneurial activities-** Entrepreneurs are critical for the innovation system to operate properly. This is due to their role as changemaker, seizing new knowledge and opportunities to take tangible steps towards innovating the system. Entrepreneurs are typically either new entrants to the system whose outsider views see opportunity in a changing market/policy landscape, or they are incumbent actors who want to diversify their strategy for new developments (Hekkert et al., 2007, pg. 421). While entrepreneurs have traditionally been market actors, they aren't always and could be involved in government or civil society.

F1 Leading Question: *Do you think the Province of Gelderland's regional energy strategies (RES) encourage innovation?*

Sub-Question:

8. *Do the RES encourage citizen participation in the province's energy transition (in energy cooperatives or in some other way)?*
9. *Does your organization see the Province of Gelderland as a favorable environment for innovation?*
10. *Do you think RES encourage experimentation with RE governance, technology or organizational methods?*

**F2 Description: Knowledge Development-** Gaining knowledge to develop an understanding is one of the most important resources in the innovation process. Learning is fundamental to research and development of technologies and policies and is therefore a critical prerequisite to innovation systems. Hekkert et al. write that this function includes "learning by searching" and "learning by doing" (Hekkert et al., 2007, pg. 421).

F2 Leading Question: *Do civil society organizations (including yours) have a clear understanding of the Province's local energy situation (how much is consumed, produced and where it comes from)?*

Sub-Question:

3. *Have the RES encouraged new research and development projects?*

**F3 Description: Knowledge Diffusion:** Innovation is stymied by knowledge being limited to only a small subsystem; therefore, knowledge diffusion is an important function of TIS. The primary exchange of information takes place between and within networks (actors) in a heterogenous context where R&D occurs across, among and between researchers, markets, governments and competitors (Hekkert et al., 2007, pg. 423). Policy decisions (standards, long term targets) should be "consistent with the latest technological insights" and R&D plans should be "affected by

changing norms and values” because network activity acts as a precondition to ‘learning by interacting’ (Hekkert et al., 2007, pg. 423).

F3 Leading Question: In what ways do you see information being shared and adopted between civil society, energy companies and the government?

Sub-Questions:

9. *Are citizens aware of their region’s RES or the RES in general?*
10. *Is the provincial government responding sufficiently to the needs of your clients?*

**F4 Description: Guidance of the Search-** This function deals with the reality that not all technological/policy options can be chosen for research, investment and implementation. The guidance of the search is therefore concerned with how government and businesses select a policy/technology from a pool of available options. The guidance part of this function refers to the steering actions (these pertaining to the direction of technological change) of actors (mostly governments and businesses, but also can be a product of idea exchange between producers and users of the policy/technology) that “positively affect the visibility and clarity of specific wants among technology users” (Hekkert et al., 2007, pg. 424).

F4 Leading Question: *What level of involvement have non-governmental organizations had in the formation of the RES?*

Sub-Questions:

13. *Have the views, opinions and needs of the citizens of Gelderland been sufficiently considered in the province’s RES?*
14. *Has your organization been positively affected by the province’s existing renewable energy policies?*

**F5 Description: Market Formation-** New innovations inherently must overcome the incumbency advantages held by embedded policies/technologies, therefore new innovations oftentimes require a protective initial environment such as the establishment of niche markets, local adoption initiatives, favorable financial arrangements, or minimum quotas requirements (Hekkert et al., 2007, pg. 424).

F5 Leading Question: *Do you see any institutional incentives/barriers to renewable energy growth in the Province of Gelderland?*

Sub-Questions:

1. *What could the province do to better support the energy needs of your organization?*
2. *What could the province be doing to stimulate renewable energy growth that it is currently not doing?*

3. *Have the province's renewable energy targets encouraged new companies, advocacy groups etc. to start or expand operations in the province?*

**F6 Description: Mobilization of Resources-** Innovation systems, like any human system, require the investment of resources (oftentimes financial capital and human labor) for the system to operate effectively. New innovations typically require high levels of special skills, knowledge and experience for them to be successful. Analysis therefore requires an understanding of “whether or not inner core actors perceive access to sufficient resources as problematic” (Hekkert et al., 2007, pg. 425) or feasible.

F6 Leading Question: *Are there sufficient resources (money, land, public support etc.) available for developing the amount of renewable energy called for in the RES within the Province?*

Sub-Questions:

3. *Where do your renewable energy projects typically receive their funding from?*
4. *Can your organization easily access the resources needed to adopt renewable energy?*
5. *What do you perceive to be the optimal role of the province in mobilizing resources?*

**F7 Description: Creation of Legitimacy-** An innovation must “become part of an incumbent regime, or it even has to overthrow it” (Hekkert et al., 2007, pg. 425) if it is to become highly functional. Yet in order to become legitimate, new innovations oftentimes must also overcome actors with “vested interests opposed to this force of ‘creative destruction’ (Hekkert et al., 2007, pg. 425). In the case of RES for developing RE, they must overcome the parties with a vested interest in fossil fuels and the slow development of RE. In these situations, civil society actors can act as change agents by exposing policymakers, the media and the public to the innovation. They might also help set the agenda of the government, lobby for resources and support as well as advocate for a competitive edge to gain legitimacy for the innovation (Hekkert et al., 2007, pg. 425). Successful advocacy organizations will grow in strength, membership and influence as the innovation they advocate for increasingly becomes part of the incumbent regime.

F7 Leading Question: *What role do you see for citizens in the energy transition: should they be active participants, or should they be represented?*

Sub-Questions:

1. *Do energy companies help or hinder citizen participation in the energy market and in energy governance?*
2. *What is the lobbying power of the actors in the system?*
3. *Is the provincial government taken seriously when it proposes plans for reaching its RE targets?*
4. *Do you approve of the province's creation of RES to achieve its energy transition?*

Interview Guide D:  
Matthew Mininberg

Questions are organized along Wieczorek and Hekkert's (2012) Functional-Structural Analysis outline. Descriptions of the functions precede each set of questions.

**Themes (The Seven Functions):**

22. Entrepreneurial activities
23. Knowledge Development
24. Knowledge Diffusion
25. Guidance of the Search
26. Market Formation
27. Mobilization of Resources
28. Creation of Legitimacy

**Research Question:**

*What can the Province of Gelderland do to stimulate and facilitate the development of innovative regional energy strategies that achieve its renewable energy goals?*

**Introduction to the Research:**

The purpose of this study is to provide the Province of Gelderland with a Technological Innovation System (TIS) theory-based policy assessment framework that sheds light on what the role of the Province should be to stimulate and facilitate its regional energy strategies. To do this, the actors, institutions, interactions and infrastructure of the Province's RES along with their abilities will first be mapped. Then the processes of the innovation systems: F1 – entrepreneurial activities, F2 – knowledge development, F3 – knowledge diffusion, F4 – guidance of the search, F5 – market formation, F6 – resources mobilization, F7 – creation of legitimacy will be examined *through the perspective of the structural elements to identify the systems problems*. The data collected from interviews will be used to better understand how the structural and functional elements of TIS theory are expressed in the Province of Gelderland's energy transition. A data analysis of the TIS structures and functions will be conducted using the software ATLAS.ti to construct a policy assessment framework. This framework will propose a policy mix to address the identified bottlenecks affecting Gelderland's energy transition.

**Questions are organized along Wieczorek and Hekkert's (2012) Functional-Structural Analysis outline. Descriptions of the functions precede each set of questions.**

**F1 Description: Entrepreneurial activities-** Entrepreneurs are critical for the innovation system to operate properly. This is due to their role as changemaker, seizing new knowledge and

opportunities to take tangible steps towards innovating the system. Entrepreneurs are typically either new entrants to the system whose outsider views see opportunity in a changing market/policy landscape, or they are incumbent actors who want to diversify their strategy for new developments (Hekkert et al., 2007, pg. 421). While entrepreneurs have traditionally been market actors, they aren't always and could be involved in government or civil society.

F1 Leading Question: *Do you think the Province of Gelderland's regional energy strategies (RES) encourage innovation?*

Sub-Questions:

11. *Do you see the Province of Gelderland as a favorable environment for renewable energy production?*
12. *Do you think RES encourage experimentation with renewable energy governance, technology or business methods?*
13. *What effect, if any has the Province of Gelderland's RES had on your business?*

**F2 Description: Knowledge Development-** Gaining knowledge to develop an understanding is one of the most important resources in the innovation process. Learning is fundamental to research and development of technologies and policies and is therefore a critical prerequisite to innovation systems. Hekkert et al. write that this function includes “learning by searching’ and ‘learning by doing’ (Hekkert et al., 2007, pg. 421).

F2 Leading Question: *Do energy companies have a clear understanding of what the Province wants from the RES?*

Sub-Questions:

4. *Is this knowledge theoretical or applicable?*
5. *Have the RES encouraged new research and development projects?*
6. *Who finances the research and development?*

**F3 Description: Knowledge Diffusion:** Innovation is stymied by knowledge being limited to only a small subsystem; therefore, knowledge diffusion is an important function of TIS. The primary exchange of information takes place between and within networks (actors) in a heterogenous context where R&D occurs across, among and between researchers, markets, governments and competitors (Hekkert et al., 2007, pg. 423). Policy decisions (standards, long term targets) should be “consistent with the latest technological insights” and R&D plans should be “affected by changing norms and values” because network activity acts as a precondition to ‘learning by interacting’ (Hekkert et al., 2007, pg. 423).

F3 Lead Question: *In what ways do you see information being shared and adopted between energy cooperatives, energy companies and the government?*

Sub-Questions:

11. *What methods are employed for sharing knowledge (networks, workshops, conferences etc.)?*
12. *Is the exchange of knowledge driven by consumer demand?*
13. *Is there strong competition for information on the RES?*
14. *Does your organization feel listened to by the provincial government?*

**F4 Description: Guidance of the Search-** This function deals with the reality that not all technological/policy options can be chosen for research, investment and implementation. The guidance of the search is therefore concerned with how government and businesses select a policy/technology from a pool of available options. The guidance part of this function refers to the steering actions (these pertaining to the direction of technological change) of actors (mostly governments and businesses, but also can be a product of idea exchange between producers and users of the policy/technology) that “positively affect the visibility and clarity of specific wants among technology users” (Hekkert et al., 2007, pg. 424).

F4 Lead Question: *Have the goals of the province’s RES been clearly indicated to market actors?*

Sub-Questions:

15. *What level of involvement have energy companies had in the formation of the RES?*
16. *Which policies and tools available have positively contributed to the production of renewable energy?*
17. *Are there policies and tools preventing greater production of renewable energy?*
18. *Has the government’s plan for increasing renewable energy development been sufficient and if not, what could the province do to stimulate renewable energy growth that it is not already doing?*

**F5 Description: Market Formation-** New innovations inherently must overcome the incumbency advantages held by embedded policies/technologies, therefore new innovations oftentimes require a protective initial environment such as the establishment of niche markets, local adoption initiatives, favorable financial arrangements, or minimum quotas requirements (Hekkert et al., 2007, pg. 424).

F5 Leading Question: *Are there institutional incentives/barriers to renewable energy growth in the Province of Gelderland?*

Sub-Questions:

5. *What could the province do to better support companies wanting to generate or sell electricity?*
6. *Have the province’s renewable energy targets encouraged new companies to start or expand operations in the province?*
7. *Are there external pressures (political, social, environmental, organizational, scientific) influencing the province’s decisions regarding RE?*

**F6 Description: Mobilization of Resources-** Innovation systems, like any human system, require the investment of resources (oftentimes financial capital and human labor) for the system to operate effectively. New innovations typically require high levels of special skills, knowledge and experience for them to be successful. Analysis therefore requires an understanding of “whether or not inner core actors perceive access to sufficient resources as problematic” (Hekkert et al., 2007, pg. 425) or feasible.

F6 Leading Question: *Are there sufficient resources (money, land, public support, grid constraints etc.) available for developing the amount of renewable energy called for in the RES within the Province?*

Sub-Questions:

6. *Where do renewable energy projects typically receive their funding from?*
7. *Can renewable energy developers easily access the resources?*
8. *Is it difficult to access the resources necessary to develop renewable energy?*
9. *What is the optimal role of the province in mobilizing resources?*

**F7 Description: Creation of Legitimacy-** An innovation must “become part of an incumbent regime, or it even has to overthrow it” (Hekkert et al., 2007, pg. 425) if it is to become highly functional. Yet in order to become legitimate, new innovations oftentimes must also overcome actors with “vested interests opposed to this force of ‘creative destruction’ (Hekkert et al., 2007, pg. 425). In the case of RES for developing RE, they must overcome the parties with a vested interest in fossil fuels and the slow development of RE. In these situations, civil society actors can act as change agents by exposing policymakers, the media and the public to the innovation. They might also help set the agenda of the government, lobby for resources and support as well as advocate for a competitive edge to gain legitimacy for the innovation (Hekkert et al., 2007, pg. 425). Successful advocacy organizations will grow in strength, membership and influence as the innovation they advocate for increasingly becomes part of the incumbent regime.

F7 Leading Question: *Is there resistance to the RES or the energy transition in general?*

Sub-Questions:

1. *What role do you see for citizens: should they be active participants, or should they be represented in the province’s energy transition?*
2. *What is the lobbying power of the actors in the system?*
3. *Is the provincial government taken seriously when it proposes plans for reaching its RE targets?*
4. *Do you approve of the province’s creation of RES to achieve its energy transition?*
5. *What do you see as the best way forward for Gelderland’s energy transition?*

Summarizing Question for each Function:

1. *What is the quality of entrepreneurship and new innovation in the Gelderland energy market?*
2. *What is the knowledge base of the effects of the regional energy strategies in terms of quality and quantity?*
3. *In what ways is information being shared and are strategies being adopted in response to the new information gained?*
4. *Does the articulated vision and values of the Gelders Energy Accord fit in the regional energy strategies?*
5. *What are the constraints on Gelderland's electricity system and what is the plan to remove them?*
6. *How efficiently are the Province of Gelderland's resources being used to make the energy transition and what can the province do to make access to these resources easier?*
7. *How well are governments (national, provincial and municipal) working with companies and civil society organizations to achieve the targets of the energy transition? What are the points of resistance?*

#### Interview Guide for De Goede Woning

1. What is the role of housing cooperatives in the energy transition?
2. How can the province best support the participation of people on a low income in the energy transition?
3. What is being done to bring old houses into line with energy saving standards and how can these costs be covered?
4. What are the biggest knowledge gaps?
5. How do you communicate with and teach your members?
6. How can municipalities and province better support you?
7. Which resources (money, space, support, work, etc.) are scarce or difficult to access?
8. Do you resist or do your members welcome the energy transition?
9. What can the province do to ensure that people on a low income do not bear the burden of the energy transition?

#### Questions for OostNL:

1. Can you describe the role of OostNL in the energy transition so far?
2. What is being done to reduce investment risk and stimulate innovation?
3. What effect are the energiefonds having?

4. A huge part of the expense of renewable energy are the permitting costs. What can be done to reduce those costs?
5. What do you recommend the province do to better stimulate renewable energy?
6. What else should I know that I haven't asked about?

#### Alliander Questions:

1. How would you characterize the quality of entrepreneurship and innovation in the Gelderland energy market?
2. To what extent is action subject to limitations in the network infrastructure;
3. In addition to the electricity market, does the Netherlands have a Capacity Market (capaciteitsmarkt)?
4. What does Alliander see as the greatest challenge for the energy transition within the province?
5. Does the provincial government adequately respond to these challenges?
6. How does your organization view the implementation of a "target compliance market" for guarantees of origin?

#### Important Recommendary Interview Excerpts:

##### Interview 18:

This section contains important information for understanding the scope of the Market Formation function's problems from excerpts from the 26/06/19 interview with Jared Braslawsky, the Secretary-General of RECs International. Be aware that the following section is a direct transcription of the conversation and does not include grammar edits.

“Jared: Produce solar where the sun shines and wind where the wind blows and where the permitting costs essentially are low to get that done. It's going to be a lot better and a lot more cost efficient. Right now what you would look at different types of national support schemes around Europe and a lot of people talk about the feed-in tariff system of course, Now a feed-in tariff was extremely effective. It was extremely effective it put a lot of new Renewables on the grid. It was great for the development of Renewables in Europe, but it was not that all efficient. Yeah cost efficiency was not at all considered when it came to the development of the feed-in tariff system. So if we're going to be developing an entire Revolution within the electricity sector, we need to be efficient and effective. We can't just be one or the other and we're seeing that now in Germany as well where there's a bit of a backlash against the costs of the feed-in Tariff system because it's just so damn expensive if you tell someone hey, this is the fixed cost for what you're going to be

producing and it doesn't matter if you produce it where it's sunny or you produce it where it's cloudy. This is what you're going to be getting. Well, there's going to be per definition windfall profits. Windfall profits are the definition of feed-in tariffs and by allowing a more market-based mechanism. You're still going to have windfall profits, by the way. There's nothing wrong with windfall profits. It means that someone that's producing something like renewable electricity is making money for that. Now that's great. That's what we all want of course, but excessive windfall profits are maybe something that should be discouraged. Yeah, if those windfall profits are coming in the form of a market versus in the form of taxpayer dollars. That's my preference because then people still have the option to go to another provider that potentially can offer that product for less if it's being offered through taxpayer dollars as with feed-in tariffs or other types of subsidies than yeah, that's not necessarily the case just the taxpayers paying way too much for a given product, which is probably not very beneficial. So the entire concept of Renewables Targets in Europe is wrong because you look at renewable targets. You say Europe has a certain amount of renewable electricity and what they say, now this is in the Renewables directive written this way that every country is responsible for a certain amount of consumption of renewable electricity within their borders. Okay, so, okay. So you say no this is a great target you're responsible for consumption. That means I can consume renewable electricity that was produced in Spain or in France or in Belgium and I can count that towards my target. No, no. No, it doesn't work that way because the definition of consumption in the Renewables directive is how much renewable electricity is produced within your National boundaries. So they defined a consumption target saying hey, you have to consume a certain percentage of renewable electricity within your country, they define that as a production target actually it has to be produced within your borders. And the reason for this, there's one reason for this: protectionism. That's it. Because the German government didn't want that German taxpayer dollars were going to build renewable Technologies in Spain. The Dutch government didn't want the renewable technologies that their money, their taxpayer dollars were going to pay for renewable electricity in another country or another region. This is the reason why RPS standards are impossible in Europe impossible. Just not going to happen.

It's not going to happen at an international level between different countries. It can happen in a governmental, within a single member states so between different regions that is possible. But an RPS standard within Europe is impossible. I say it's just not going to happen. It's politically impossible. It's not legally impossible. Actually, we believe that legally it's the only way that it should take place. We've conducted two lawsuits against the European Commission, in went all the way to the European Court of Justice. I can provide the information to you as well. Great and one of the lawsuits was about a wind turbine in Sweden that was connected physically to Finland. It was on Swedish ground, but the electrical connection was to Finland. Now they requested the subsidy from Finland because they're on Swedish ground, but they're electrically connected to Finland. Yeah per definition all the electricity is going to Finland. Now Finland rejected them, of course because Finland is saying essentially we're not going to pay for the subsidy that is now being counted towards the targets of Sweden and Sweden essentially said, yeah, you can get subsidy from us and that's no problem. You're on our land and we took that all the way to the European Court of Justice to essentially more or less explode the electricity subsidy system in Europe. Now, we lost twice but that's a big bullshit that we lost because it was essentially political

influence. That was the reason that we lost. But that was our whole intention to try and take away this conception that Renewables targets are National targets and it, that's not the way it should be. It should be that you should be able to trade and compare and contrast and that's why in the U.S. There are National targets like RPS standards. Now in RPS standards in the states, you have the Commerce Clause, which is the same thing as *State Aid rules* in Europe *State aid rules* say that you are only allowed to have, you're not allowed to essentially produce a product and say it's not allowed to put restrictions on where that product can be purchased in Europe. Europe is a single Market. Yeah. So if I produce a guarantee of origin, I cannot restrict that guarantee of origin to any other market player and any other country in the whole EU system because it's a single Market. Yeah and a guarantee of origin was a product just like a bicycle. I can't produce a bicycle and say this bicycle is allowed to be sold everywhere in the Netherlands but nowhere in France or Germany. You're not allowed to do that in Europe. It's a single market. It's protectionism. Just like you can't say in Europe, I'm the German government and I'm going to subsidize the production of electric vehicles. You're not allowed to do that. It's against state aid rules. It goes down to that single market aspect because if you do that, if the German government were to do that Renault, Peugeot BMW even Ford, every car manufacturer would go to Germany and produce electric vehicles there because they make money for the production of electric vehicles. Yeah, there's one product that you are allowed to do that. There's one product that is exempted from all state aid rules in Europe. What is that one product? It's renewable electricity.

So renewable electricity is the only product in all of Europe the only commodity of any commodity anywhere in Europe of anything that you're allowed to subsidize the production of within your own member state within your own borders and say we're not going to subsidize the production of that in other member states. It's the only product and the reason is protectionism. So when you produce a guarantee of origin and a guarantee of origin is the proof of electricity production, you sell that to the individual consumers this guarantee of origin is the same as a REC in the US and the foundation of RPS systems in the U.S are RECs. So essentially they produce a REC and then the RPS in Kentucky says hey you're allowed to use Kentucky RECs to meet the standard from wind, from solar and from chickenshit. That's a real example, in Kentucky, chicken shit is one of the renewable sources like for the RPS.

Matt: It is probably a class 2.

Jared: Probably but Yeah. Yeah. Yeah. I have no idea what it is, but it's chicken shit. So I don't know if it's necessarily renewable, but in Kentucky probably is because it got so much of it. So like Pennsylvania with burning tires. Yeah. Yeah. Okay. So so essentially you produce that but in Europe you have that guarantee of origin and it's a product you're not allowed to restrict its sale to any other member state. So essentially that was the reason that the guarantee of origin is not used for target counting because if you can't restrict its sale in another member state, yeah, so that means if Germany is using that as its target counting mechanism then per definition they would have to allow for the sale of RECs to meet that RPS from other member states. Yeah, so they change the rules and said we're not going to use RECs for Target counting. We're going to do it based upon National borders where something is produced and that's how that consumption target became an essentially a production target more or less within these different member states. And that's why RECs in the US are compliance mechanisms for RPS has but also voluntary mechanisms and then

in Europe it's only a voluntary mechanism and the compliance mechanism is essentially National borders.” (Braslawsky, 2019)