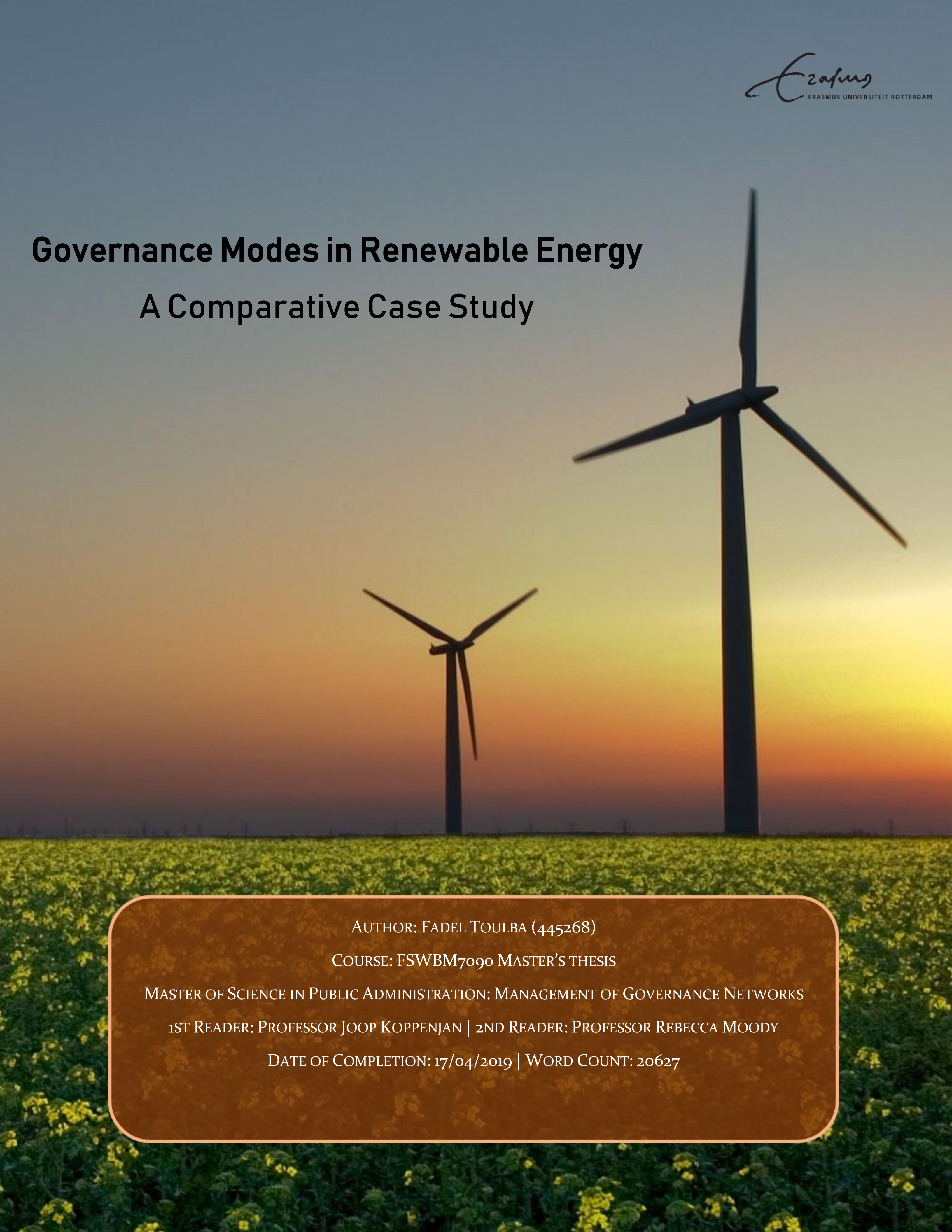

Governance Modes in Renewable Energy

A Comparative Case Study

Author: Fadel Toulba (445268)

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1st Reader: Professor Joop Koppenjan | 2nd Reader: Professor Rebecca Moody

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Summary

A transition towards sustainable energy is taking place across the world. The necessity of this shift is no longer an issue of serious debate, as evidenced by the commitments of virtually every national government to the precepts of the Paris Agreement which seeks to curb the environmental effect of human activity. There is however less uniformity in the ways in which individual governments seek to fulfill their international commitments in this regard. Electricity production is a notable example of this diversity as in their quest to fulfill an increasing portion of their electricity needs from renewable sources, governments have opted for a variety of instruments (or combinations thereof).

This research adopts a governance mode perspective on this diversity of approaches, categorizing them in terms of the extent to which they are of the regulatory command and control type, the market-oriented type, or based on communication, information and voluntary involvement. It analyzes the succession of instruments that have been adopted in the Netherlands, Germany and the UK against the observable performance in renewable capacity uptake over the period from 2000 to 2015 with the purpose of qualifying the pertinence and efficacy of each of the approaches.

Despite the complex and, at times, cumbersome choice of theoretical basis, valuable conclusions could be drawn about the characteristics of an effective mode of governance in the context of promoting renewables. These can be enumerated as consistency, comprehensiveness and a gradual shift towards market exposure.

Consistency refers to the necessity of maintaining a perceived stability of the principal support measures available to would-be investors; as opposed to the successive replacement of short-lived support schemes. My hypothesis for the underlying factor behind this observation is that as policies remain in force for an extended period they permit the formation of more tightly woven networks of actors and the factors of trust and branding play into increasing investor confidence, subsequently feeding into a virtuous cycle.

By comprehensiveness we refer to the perception that the adoption of instruments of all three main categories has been a more effective approach and produced more substantial results than cases where a singular support measure was available. This is an admittedly evident conclusion as it simply reflects a matter of coverage for different needs: The more varied support policies will allow for the fulfillment of more varied needs. A nascent field such as renewable technology presents many avenues of research and knowledge creation to increase efficiency, which are best supported with research and information-type instruments. The disruptive nature of the most important renewable energy technologies means that they clash with the pre-existent regimes and infrastructure of electricity production which rely heavily on consistent and controllable production from natural gas, coal etc. And may struggle with incorporating renewables. Therefore, regulatory support and the provision of guarantees by the government for the benefit of RE producers can be vital in securing investment.

The gradual shift towards market exposure is a trend that is inextricably linked to the above two conclusions. As the renewables sector benefits from a comprehensive support approach and viable ecosystem emerges, competition increasingly becomes a more efficient driver of growth than governmental support. Therefore, after a period of diversified policy instruments which support renewables in terms of initial investment, operational cost-effectiveness and profitability, research and development etc., comes a point in which the optimal next step is a shift towards market liberalization to allow the by-then established networks to operate more independently. This gradual approach however should not take place abruptly so as to not jeopardize the perception of consistency. To that end, I hypothesize that the substantive modification of support instruments to be more market-oriented should ideally be accompanied by a perceived stability in the branding of policy support measures.

ACKNOWLEDGMENTS

My most sincere thanks go to my supervisor Dr. Joop Koppenjan. Throughout the challenging process of writing this thesis, it would be an understatement to say that his complete support, patience and availability were instrumental. His advice and suggestions helped me not only with developing this research but also with overcoming successive mental barriers. Words cannot express how humbled and grateful I am to have benefitted from his assistance.

I would like to thank my dear mother, for being my anchor and a source of unconditional support and my brother, for standing by my side through thick and thin.

Finally, I would like to dedicate this thesis, insofar as it is the culmination of my academic education, to the memory of my late father Cheikh Sidi Ahmed Toulba. His life of hard work and entrepreneurship are the reason I am privileged enough to expand my horizons and attend such a prestigious institution in this great country.

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1 Introduction:

Climate change is increasingly viewed as the paramount issue of our time. It threatens to bring about major changes affecting weather patterns, food production and sea levels, and making large areas of the world uninhabitable. These changes can potentially exacerbate pre-existing global tensions and have even more fatal consequences. The overwhelming scientific consensus is that this phenomenon of climate change is to a large extent caused by human activity (NASA, 2016). This has led to increasing concern for the necessity of transitioning into more sustainable economic models. The increase in global temperatures is attributed to the emission of greenhouse gases, two thirds of which come from energy production and consumption (EPA, 2017). It is therefore no surprise that the transition towards a sustainable energy regime is one of the main fronts in the battle against climate change. For that purpose, renewable energy has emerged as a growing sector in many countries.

Renewable energy technologies are a sustainable alternative to the burning of fossil fuels, they do not rely on finite resources as the most prominent technologies make use of sunlight, wind, water power and organic waste. More importantly, their exploitation carries a low carbon footprint.

The pace at which uptake of such technologies is happening varies widely- even among developed economies, and experts are warning that the move towards sustainable energy is not happening quickly enough (Elliott, 2018). In addition to the urgent character of this transition, it is also seen as inherently disruptive with regards to the conventional modes of electricity production (Butler, 2017). Moreover, renewable energy requires significant initial investments and may not be consistently competitive in the energy market. With regards to that, many governments have taken on measures to promote it (Schaffer & Bernauer, 2014). These measures can vary in their number, substance, target and, most relevantly, effectiveness. Essentially this research aims to look at the effectiveness of such measures in spurring rapid uptake of renewables. To do so it looks at the progress of renewable energy governance in the Netherlands, Germany and the United Kingdom during the fifteen-year period extending from 2000 to 2015 both in terms of governmental approach as well as concrete performance as quantified by installed production capacity.

1.1 Research Aim and Problem Statement:

Constituencies across the world have taken a variety of approaches to supporting sustainable energy production, including renewables, with varying levels of success. This research project sets out to compare different such approaches with regards to their pertinence. For that purpose, this project will try to define a holistic understanding of the governance relating to renewable energy promotion and the concrete numbers in terms of performance in renewables adoption in three case study countries. These will then be compared to work towards a conclusion on which types of governance modes have produced optimal results.

The three countries looked at in this study are all bound by renewable energy targets set at the EU-level. However, there is no specified prescription on what approaches the respective governments are to take to achieve the targets. This research wants to investigate whether the different approaches are accountable for the disparities in renewable energy progress across the three States. The main research question is therefore:

How do governance modes affect the uptake of renewable energy?

To arrive at an answer to this question, it will first be necessary to answer several sub-questions. First, it's important to have a detailed idea of the various policies that the three case study countries have adopted during the research period, therefore the first sub-question is:

- *How have the UK, Netherlands and Germany tried to promote renewable energy from 2000-2015?*

The answer to this question will be shaped by our theoretical framework, with governance modes as a central concept. In pursuing it, the following elements must be addressed:

- How can governance modes be defined and differentiated?
- What makes a policy instrument, or combination thereof, indicative of a certain governance mode?
- What policy instruments have been deployed in support of RE in the UK, Netherlands and Germany over the period from 2000 to 2015?
- Which governance modes have characterized the approach of the case study countries to promoting renewable energy uptake from 2000 to 2015?

Next, a comprehensive account of the progress in renewable energy production must be established, making the second sub-questions:

- *How has renewable energy progressed in the UK, Netherlands and Germany during the 2000-2015 period?*

Moreover, because it's important to recognize that however significant governmental action is, the progress of renewable energy as any other field is at least dependent on a variety of other factors. Some of these factors may be described as internal (i.e. applicable solely within one country) or external. Therefore, I will also reflect on such factors in later chapters.

1.2 Societal Relevance:

Besides pushback and attempts at denial from conventional energy industry interests, there is virtually no serious debate about the necessity of moving towards a sustainable energy regime in modern societies, in response to both resource depletion and environmental concerns (Reynolds, 2014). However, as will become evident in the variety of approaches visited in this paper, there does not seem to be a consensus as to which methods are best to achieve such goals. By hopefully contributing to the available understanding of methods of RE promotion, this research can be construed as part of a learning process whereby other constituencies can learn from the cases studied. It is acknowledged that what works for one place may not necessarily succeed elsewhere. Nonetheless, the following work may help to identify patterns of weaknesses and strengths in different settings and for policy measures relating to renewable energy promotion. Therefore, the questions this research seeks to answer may be of concern not only to countries that have already embarked on a clear trajectory towards a fully renewable energy regime, but also to others which have yet to take large scale measures to that end. Aside from addressing environmental concerns, the advantages of the often localized and decentralized energy production from renewables also include a more secure and robust energy supply.

1.3 Scientific Relevance:

By characterizing the governmental approach towards supporting renewables in terms of governance modes, we hope that the ensuing findings from this research can contribute to a more *portable* understanding of how best to promote the growth of renewables: Ideally, the learnings from this research would be transferrable to other countries at a later time, and applicable not only to renewable energy but to other similarly urgent and disruptive transitions which require the mobilization of public resources.

Research assessing the effectiveness of various instruments in promoting renewable energy is not rare. Throughout the literature this topic has been approached from a variety of angles. However, less can be found in terms of works looking at the sum of policy instruments along with the power distribution among actors that they produce (i.e. governance modes) as an independent variable. This study aims to achieve that and hopefully result in meaningful recommendations.

1.4 Thesis Structure

This thesis begins with a theoretical section (chapter 2) which delineates the main concepts dealt with and the relationships among them. The third chapter presents a clarification of the methodological choices as well as the operationalization of the main concepts into workable variables. The fourth and fifth chapters provide context. The fourth part concerns statistics on renewable energy while the fifth looks at the sum of renewable energy policies and measures in the three case studies. The sixth section discusses the findings at length whereas the conclusion restates the main findings and introduces my recommendations based on this exercise.

2 Theoretical Framework

2.1 Introduction:

At its core, this research intends to capture a descriptive profile of governments' approach to renewable energy and then investigate whether and to what extent the variation among approaches has been a significant factor in the diverse ways that RE developed in the Netherlands, Germany and the United Kingdom. In order to establish such a profile of a government's policy towards renewable energy, various classifications can be seen throughout the literature. In a study looking at the fifty United States policy instruments aimed at renewables, Park opts for a simpler classification based on whether governments adopted a command and control approach, relegated the issue to market forces, or employed information policy instruments (Park, 2013). But the author admits that in most cases governments employ a variety of instruments resulting in a "hybrid" approach. This multiplicity of instruments can also be seen in the case of the three countries looked at in this research. For this reason, it is important to adopt a theoretical instrument capable of capturing and operationalizing the sum of governmental handling of renewable energy development. For that purpose, this research relies on a certain conceptualization of governance modes.

2.2 Governance and Governance Modes

In the literature on policy science and public management the concept of governance is frequently discussed. The concept's definitions are as varied as the contexts to which they apply. Broadly speaking- and for the purpose of this research, governance is the way a policy process is set up. One of the more important distinctions that come with the concept of governance is an implicit acknowledgement that the activity of governing is often not exclusively conducted by government agents. The idea that policy processes and implementation can be and often are interactions between government and other forces is central to many conceptualizations of governance (Rhodes, 1997; Koster & Anderies, 2013; Koppenjan & Klijn, 2014). Another common feature of literature on governance is that it tends to conceive of governance within the realms of policy, polity or politics (Treib, Bähr , & Falkner, 2007). Within these three dimensions, literature on the topic has focused on various aspects of governance in order to classify it. To that end, it often proceeds by typifying governance modes into "ideal-typical" modes. These are not meant to be descriptive of any one case, they instead serve as archetypes to allow for an approximate classification of a governance mode along a continuity. The following three sections seek to explain and show the implications of each perspective on governance:

2.2.1 Governance in the Politics Dimension

The politics dimension implies defining governance based on participating actors and the way power is attributed and distributed among them. The variations in the degree to which the government, market forces and civil society actors exercise power over policy processes allow for a meaningful, albeit approximate, categorization of the nature of governance in the politics dimension. With regards to this, the term "governance modes" is used throughout the literature to refer to the distinct configurations that can take shape. Thus, it could be a network governance setting within which power is dispersed, a corporatist setting which implies some concentration of power in the form of interest groups vis-a-vis the State or a statism in which the State dominates.

An early classification of governance modes came with Kooiman's designation of self-governance, co-governance and hierarchical governance (Kooiman, 2003). This typology was further expanded on by Arnouts et al by nuancing co-governance into a closed and an open variant. In hierarchical governance, the actors are mainly governmental. State affiliated institutions hold a dominant portion of the power and they are positioned to set the rules and enforce them through governmental coercion. In closed co-governance, the government still retains much of the power, but other actors are still present in the decision-making process (Arnouts, Arts, & van der Zouwen, 2012). So, while the locus of power is within a pool of mixed actors, the cooperation dynamics are still restricted by the government which retains the ability to intervene in the process. An open co-governance situation would entail the participation of, along with the government, a large and heterogeneous group of actors, wherein power is diffused, and actors are persuaded to collaborate in a flexible manner. Finally, self-governance involves the quasi-total absence of government and non-governmental actors detain all the power. Kooiman defines self-governance as the "capacity of social entities to govern themselves autonomously" (2003).

2.2.2 Governance Modes in the Polity Dimension

Polity refers to institutions, in this case insofar as they dominate in shaping interactions within a certain domain. Despite differences in appellation, there is a general consensus that governance modes in the polity dimension feature the prevalence of either the State, the market or communities/networks/societies. Indeed, they are essentially a description of the "system of rules that shapes the actions of social actors" (Arnouts, Arts, & van der Zouwen, 2012; Treib, Bähr , & Falkner, 2007; Lange & Burger, 2013). All three "institutions" (market, State and community) have some amount of influence on any domain, the variations in influence are what constitutes governance modes in the polity dimension.

2.2.3 Modes of Governance in the Policy Dimension:

Policy as a governance dimension presents a broad range of practical criteria to qualify a governance domain. It is arguably the easier dimension to focus on because unlike politics and polity; it mainly necessitates the study of how one central actor (i.e. the State) sets the rules which then define power distribution among actors (to an extent) and defines the prevalent institutions. The spectrum of governance modes in the policy dimension is visible through the instruments that the State opts for. The substance of these policy instruments constitutes the main variable through which to conceptualize the mode of governance. Studying governance at the EU-level, Knill and Lenschow focus on the level of discretion and obligation granted to individual states through the policies deployed by the State.

	High level of obligation	*Low level of obligation*
High level of discretion	**New instruments** economic, communicative, framework regulation	**OMC** open method of co-ordination
Low level of discretion	**Regulatory standards** substantive, procedural	**Self-regulation** in the shadow of the state

Figure 1 Modes of Regulation according to (Knill & Lenschow, 2003

While not precisely equivalent, it's clear that instruments that are substantive and procedural, granting little discretion and placing rigid obligations are more reflective of a hierarchy. Whereas, at the other end of the spectrum, self-regulation often hints at a self-governance setting. To port these classifications to the national level (rather than the supranational EU which is the subject of Knill and Lenschow's research) and specifically to the energy sector, the subjects of regulation would be not the State but the non-State actors in renewable energy. Therefore, a possible approach is to classify policy instruments by the level of obligation and discretion that the State imposes on and grants renewable energy actors (which can be investors/RE producers, grid operators and final consumers). Generally, governments can provide subsidies to energy producers, impose obligations on distributors to ensure a share of the energy they procure is from renewables, and/or encourage engagement and investment with the renewable energy transition through discourse. These three, broad options fall within what Bemelmans-Videk et al refer to as the carrot, stick, and sermon, respectively (Bemelmans-Videc, Rist, & Vedung, 2003). These authors further specify that each of these three options can take either an affirmative or negative form.

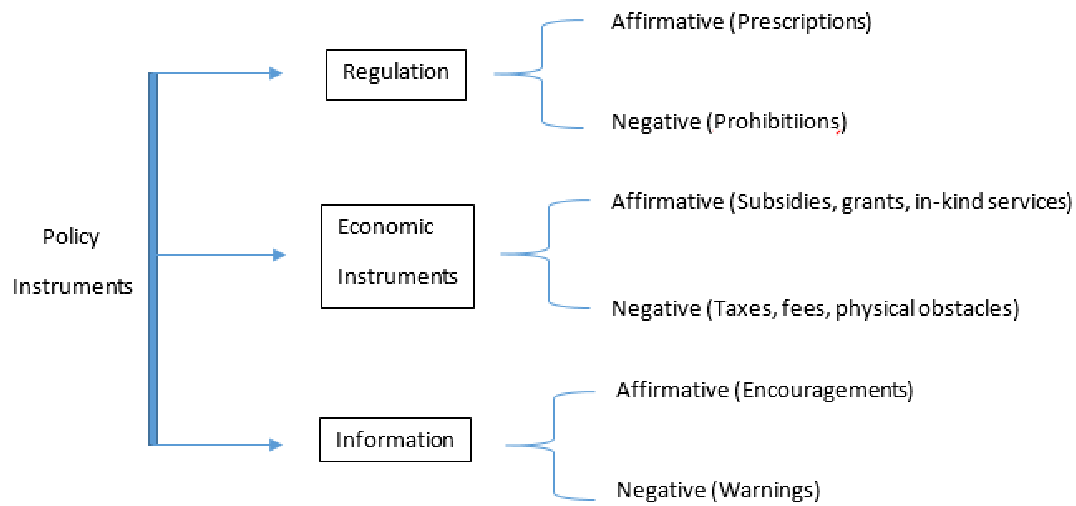

Figure 2 Types of Policy Instruments (Adapted from Bemelmans-Videk et al. ;p.249, 1998)

The above typology of policy instruments can comprehensively include the bulk of governmental action aimed at promoting renewable energy. However, the "information" category can also be amended to include negotiated and voluntary agreements for this purpose. This is because the latter also do not involve any regulatory coercion or economic incentives; they are mainly discursive in nature. More

2.2.4 Conclusion on dimensions of governance:

The above three perspectives on defining governance are not meant to be mutually exclusive. This is evident by the fact that each one of them is defined by the two others (e.g. power distribution is defined by rules and institutions, the choice of rules is a product of power exerted by various actors etc.). However, to embark on a descriptive analysis of governance modes in a specific case necessitates concentration on a single approach to form the theoretical backbone of said analysis. This is in line with the observation that in the literature on governance modes are often typified through one of the three dimensions (Lange & Burger, 2013). In this research the primary focus will be on the policy instruments employed by governments to promote the field of renewable energy. In doing so, however, a discussion of the resulting configuration of actors and the power distribution among institutions will also arise. Based on the classification of regulatory, economic and communicative instruments, the following section will provide more information on policy instruments for renewable energy.

2.3 Policy Instruments:

Policy instruments are defined as “a set of techniques by which governmental authorities—or proxies acting on behalf of governmental authorities— wield their power in attempting to ensure support and effect social change” (Bemelmans-Videc, Rist, & Vedung, 2003). In line with the idea that, in most cases, a governance domain features elements that are indicative of different modes, so too does the choice of policies for renewable energy promotion. Oftentimes, governments have a main “flagship” support measure for renewables which defines their general approach, along with other, relatively less impactful measures. These are sometimes grouped into one encompassing policy package, but it is important to identify the main mechanism of support from the additional measures. The table below lists several governmental measures classified according to the category of instruments they fall within.

Table 1 Policy Instruments categories and examples

Policy Instruments			
Command-and-Control Policy Instruments	Market-Based Instruments		Information/Voluntary Instruments
-Codes and Standards -Obligation Schemes -Auditing -Monitoring	-Direct Investments -Grants and Subsidies -Loans -Tax Relief -Feed-in tariffs/premiums	-Taxes -User Charges -Green Certificates	-Public-Private agreements (voluntary or negotiated) -Advice/aid in implementation -Professional Training -Awareness Campaigns

Below is a description of the most commonly found instruments within each of the three categories:

2.3.1 Command-and-Control Policy Instruments

Also referred to as regulatory instruments, command and control policy instruments seek to influence the behavior of actors through legal obligation (i.e. coercion). In terms of policies directly affecting uptake of renewable energy, obligation schemes (sometimes referred to as ‘renewable portfolio standards” are the most prominent. However, regulation can also aid the development of renewables within an economy through other indirect means, which can be widely referred to as codes and standards.

2.3.1.1 Codes and Standards:

This can refer to a wide variety of regulation aiming at facilitating the inclusion of renewable energy into the grid. Due to the cyclical nature of electricity produce through renewables and the reduced predictability of output (compared to e.g. coal generation), it’s important to ensure the grid is prepared for such fluctuation and that rules are in place regarding transmission costs, priority etc.

2.3.1.2 Obligation Schemes:

Sometimes referred to as Renewable Portfolio Standards, obligation schemes are one of the main support policies for sustainable energy production along with feed-in tariffs and premiums. Through an obligation scheme, a government imposes on electricity retailers a minimum percentage of their electricity coming from renewables. Obligation schemes are always accompanied by renewable energy certificates for RE producers (proving electricity was produced with RE). In order to comply with such an obligation, retailers usually have to do one of the following:

- Produce renewable energy by themselves.
- Acquire it from certified producers.
- Purchase renewable energy certificate from certified producers or on the market.

This policy may differ among countries mainly because in some jurisdictions retailers are not allowed to produce electricity at all, but generally the broad features are the same. A prominent feature of obligation schemes is that in principle they do not rely on State funding. The resulting additional cost of electricity is borne by the retailers who then pass it on to the consumers.

2.3.2 Market-based Instruments:

Based on the assumption that individuals (and most other entities) seek to maximize their own benefit, market-based instruments are designed to change market conditions to create settings in which the course of behavior desired by the State is more rewarding to pursue than others. This is admittedly a broad category of instruments, and the various types of market based instruments reflect different degrees of actor involvement.

2.3.2.1 Direct Investment, grants and loans:

Direct investment by governments in RE can take many shapes, from partial funding for private projects, to the full-on commissioning of State-owned production facilities. Within this category can also be included grants for RE investors and low-interest loan programs.

2.3.2.2 Feed-in Tariffs:

The purpose of Feed in Tariffs is to accelerate the adoption of renewable energy. They are essentially a form of subsidy that consists of long term contracts for renewable energy producers ensuring they are able to sell their production to the grid at profitable prices. Producers are paid a compensation based on the cost of production for their specific technology, essentially shielding them from market fluctuations and the risk of becoming unprofitable. Compensation in FiTs is usually set for each technology based on cost, and contracts often stipulate a ‘tariff degression’ whereby the compensation decreases gradually over time. The purpose of this is to encourage the development and adoption of more cost effective technology.

2.3.2.3 Feed-in Premiums:

Largely similar to FiT but they entail more market exposure because they consist of a (technology-specific) premium paid on top of the market price. In principle this means RE producers are more vulnerable to market forces because they premium might not cover the entire difference between market price and their cost of production.

2.3.2.4 Taxes and tax relief:

Taxes (and the absence thereof) can be used to stimulate production and consumption of renewable energy in different ways. One possible instance is governments giving tax exemption to companies on the income they chose to invest in renewable capacity. Also, the exemption of energy taxes on consumption of renewable energy may increase demand for it by improving its competitiveness vis-a-vis conventionally produced energy. Moreover, income from taxes on industries and activities with a high environmental impact may be earmarked for RE-related promotion schemes.

2.3.3 Informative, Communicative, Voluntary, or Research Instruments:

This category includes all instruments which feature neither governmental coercion nor funding. The State can function as an intermediary between various non-State actors to facilitate the realization of various RE-related project. Schemes such as Green Deals involve the State proposing arrangements between households, energy companies, construction companies etc.

This category also includes negotiated agreements between the State and RE investors to develop and operate capacity (so-called Public-Private Partnerships). Communicative instruments include measures to educate the public at large about the necessity of moving away from fossil fuels but also specialized operations to certify and standardize various professions within the industry (e.g solar panel installers or performance reviews). Also within this category is included RD&D (Research, Development and Deployment).

2.4 Policy Instruments from a Governance Mode Perspective

In order to establish the reliability of our broad classification of support policies (i.e. answering the question of whether a measure is regulatory, market-oriented or information-based), it is necessary to set the criteria for a proper classification of a policy in terms of governance modes.

Regulatory policies are most importantly characterized by a coercive nature. Their mode of operation consists of an obligation, imposed by the State on a non-State actor to behave in a certain way, failure to do so being illegal. If there are costs to behaving in such a way, they are generally not borne by the State budget. In renewable energy support measures, this most often refers to quota systems in which electricity suppliers are made to source electricity from renewables and the eventual additional cost is passed on to consumers. Market measures, on the other hand, create a financial incentive to behaving in a certain way. They do not rely on coercion but on the expectation that non-State actors seek to maximize profit. In RE, the cost associated with market measures can be either directly forwarded to consumers or drawn from the State budget. Finally, Information-based and voluntary instruments aimed at promoting renewables rely mainly on the government attempting to steer actors to behave in a certain way or provide information which can facilitate such behavior. Beyond the cost of outreach and communication there is no significant financial flow associated with such measures, especially not within the renewable energy market itself. Research programs, which also belong in this category, can be quite costly but those funds do not directly affect the market for electricity. This description is not meant to be exhaustive. Instead it specifically aims to isolate the defining differences which we illustrate in the table below.

However, as we attempt to categorize renewable energy policies based on how much regulatory coercion, market modification they entail and how they employ communication, information and research, it becomes clear that there can be significant variation along these axes within the same instrument type. Most relevantly, some support schemes that can be squarely described as “market-based” are deployed in different ways. There are instances of “open schemes” that are directly accessible to all renewable energy producers granting them subsidies that may or may not be indexed to the market price of electricity or to the estimated cost of production for their particular RE production technique. But most production subsidies (i.e. feed-in tariffs and feed-in premiums) are granted in the context of a contract between a government entity and renewable energy producers. These contracts are often limited in number, budget or total installed capacity to be supported. The State conducts a selection process to determine the selected applicants that will benefit from the subsidy. Theoretically, contracts may be distributed on a purely first-come, first serve basis. In most cases, however, selection is based on the projected cost of electricity production (with applicants promising cheaper renewable electricity being prioritized) and established quotas for specific techniques and installation sizes. The modality by which contracts for these subsidies are awarded are arguably expressions of a governance preference: Prioritizing projects with a cheaper cost of production encourages competition and can be seen as a partial deference to market forces. Establishing quotas for specific technology types reflects an imposition of the government's will on the composition of the RE sector, a feature that is evidently reminiscent of a command and control approach.

It is then clear that, at least within what we term "market-based instruments", there is significant variety in terms of governmental control and exposure to market forces. Specifically, this variety is manifest at the level of access to the support measure. It would be counterintuitive to ignore this variety for the purposes of this research as changes within are, by definition, developments in terms of the overall mode of governance. The illustration below aims to chart this variety of access conditions to support measures in a manner commensurate with the overall spectrum from "freedom to control" as expressed by Videc (2003,p. 23). The leftmost column corresponds to minimal government intervention. The center left column represents government intervention that empowers market forces and promotes competition. The center right column refers to government intervention that attempts to strike a balance between introducing competition *and* shaping the composition of the RE sector whereas the rightmost column shows market-based instruments whose access modalities mainly emphasize shaping the RE sector according to objectives set by the government.

Access Conditions for Market-based instruments

Technology—specific quotas (i.e. deployment corridors)	Priority for lowest-cost applicants along with technology-specific quotas	Priority for lowest-cost applicants	Open Scheme (All RE producers automatically qualify for subsidy)

Based on the above elucidation, we can produce the following sequence of criteria to visualize the spectrum of government intervention characterizing policy instruments, this is the deductive process through which policies are categorized in this research:

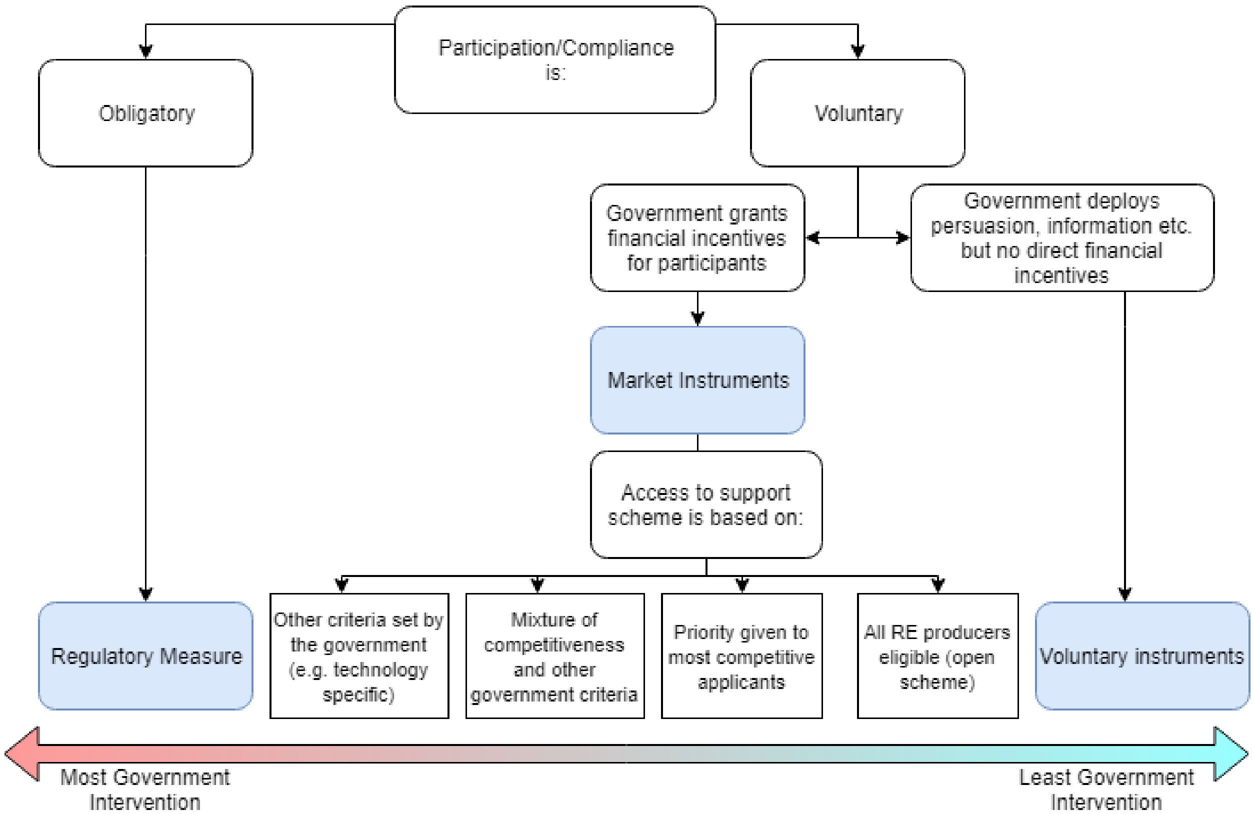

Figure 3 Criteria for classifying policies

Note: Participation/compliance in this case may refer to any of the non-governmental actors described below.

2.5 Actors in the Renewable Energy Sector:

The promotion, production, distribution and consumption of renewable energy are evidently activities which involve several actors. While it is unlikely that a completely equivalent set of actors would be found throughout all countries, this section will describe the main categories in this sector as a prelude to further explanation of how actors are impacted by various policy choices.

2.5.1 Consumers:

Final consumers can play a passive or proactive role in the renewable energy field through several arrangements. Whether they are households, businesses or government buildings, the end consumer is almost invariably affected by the introduction of renewable energy. Most of the time, feed-in tariffs or RE obligations are eventually financed via a surcharge on the final electricity bill that consumers pay. Moreover, businesses as well as households can sometimes benefit from tax breaks if they invest in renewable energy installations or opt to pay a premium in order to ensure their electricity consumption be sourced from renewables. Depending on the specific set of policy instruments in place, the involvement of consumers can range from voluntary to obligatory. There can also be variations in the substantial aspect of such involvement (i.e. whether consumers can either opt in or out of an arrangement or are allowed to participate in the formulation of such an arrangement).

2.5.2 Suppliers:

Suppliers are the companies which sell electricity. In most cases, consumers only interact with suppliers regardless of which policies are in place. Any additional costs linked to the promotion of renewables is reflected on the bills that consumers pay. This applies to voluntary agreements, taxes on energy consumption, as well as renewable obligations. In the latter, the onus falls on suppliers to ensure that a portion of the electricity they're supplying comes from renewables.

2.5.3 Transmission System Operators:

Grid operators are mainly tasked with ensuring a balance between electricity supply and demand at any moment. They are ordinarily not the target of support schemes but occasionally the government may step in to reinforce their ability to cope with the fluctuations in renewable energy production. All EU TSOs are members of the European Network of Transmission System Operators for Electricity which has the objective of increasing cooperation in the achievement of European collective energy targets, including those relating to renewables.

2.5.4 Producers:

Under the category of RE producers are a disparate group of entities. Producers may in fact be households and businesses who seek to reduce their electricity bill by installing RE capacity on their property (i.e. decentralized generation). Other than that, dedicated medium and large-scale investments may be brought forward by the government or private actors.

2.5.5 Government Agencies:

In various settings, governments may designate specialized agencies to administer a certain policy or support scheme. Such agencies are usually under the supervision of the ministry in charge of energy affairs. Depending on the policies in effect, government agencies may be tasked with assessing and granting bids, monitoring performance, providing counseling, issuing certificates etc. Government owned development banks, such as the German KfW, can also be included within this category.

2.6 Conceptual Model:

This research intends to investigate the pertinence of various governance modes in promoting a speedy uptake of renewable energy (particularly wind and solar). Drawing from the description of governance modes and policy instruments in the theoretical section, I can conclude that the choice of instruments (and combination thereof) defines the governance modes in terms of policy. And the causality we wish to investigate is that between the latter and the uptake of renewables. However, it must be recognized that other external factors (such environmental conditions or technological evolution) than policy also play a significant role in the spread of renewable energy. Therefore, the conceptual model may be charted as below:

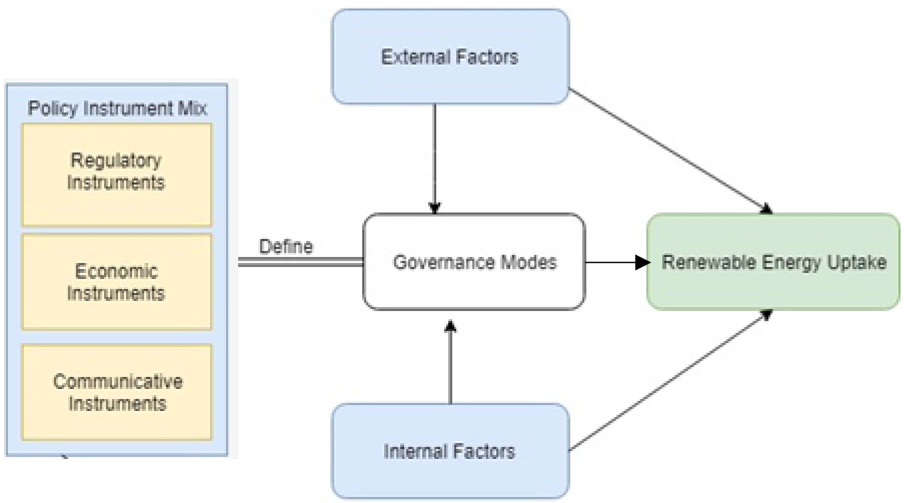

Figure 4 Conceptual Model

3 Methodology:

The essence of this research is to analyze whether and how changes in the relevant policy dimension, herein referred to as "governance shifts", relate to developments in the field of renewable energy within a given constituency. Because the key question here is one of causality (i.e. how policy affects uptake), the best approach is a comparative case study, with the main method being document analysis. It is then imperative to have comprehensive access to the sum of measures that have been directed towards renewables as well as reliable statistics on the evolution of renewable energy in the target countries.

3.1 Data Collection

3.1.1 Data on Policy:

The main two sources of information on policy in this research is the database compiled and maintained by the International Renewable Energy Agency (IRENA) and the RES-Legal resource. IRENA is a relatively new organization with the purpose of supporting and accelerating the worldwide transition towards sustainable energy practices. The database is maintained as a joint initiative with the International Energy Agency (IEA) and builds on data collected by this organization to provide "country-validated renewable energy policy data and country-specific policy profiles from 129 countries" (IRENA).

RES-Legal claims to be a "professionally edited and free of charge online database on support schemes, grid issues and policies regarding renewable energy sources in the EU 28 Member States, the EFTA Countries and some EU Accession Countries." It is an initiative of the European Council. Apart from these authoritative resources, more information about the policies was acquired through the respective governments' online documentation and other online publications.

3.1.2 Renewable Energy Statistics:

The figures for renewable energy production were extracted initially from the online resource provided by the IEA. To confirm the reliability of the figures, they were compared with those provided by the respective statistics offices of the three countries and they have been largely the same (with minor discrepancies likely due to rounding up decimals). Specifically, the data targeted was the annual output in electricity from solar photovoltaics and wind power from 2000 to 2015.

3.2 Data Analysis:

A qualitative analysis will constitute the central part of this research. Based on the data collected for both sets of variables I will compare the patterns and evolution of the renewable energy governance mode against the actual increase in capacity. However, the analytical section of this research will also feature an explorative perspective to account for the effect of non-policy factors on renewable energy growth.

3.3 Operationalization:

The table below illustrates the indicators based on which I will define the various variables. These variables in turn are the components of the main concepts dealt with in this paper (i.e. governance modes and renewable energy uptake). Additionally, it indicates the main sources from which I'll draw data for each of the respective indicators. The "policy" section delineates the criteria I will use to characterize governance modes and the "renewable energy growth" part states the specific figures I will be seeking to describe the progress made in terms of solar and wind power.

	Variable	Indicator	Source
Policy	Market Based Instruments Existence	Does the government deploy any market based instruments? What is their nature? Scope? Budget?	RES-E | Irena Policies and Measures Database
	Market Based Instrument Prevalence	Is the main instrument market based?	RES-E | Irena Policies and Measures Database
	Command and Control Instruments Existence	Does the government deploy any command and control instruments?	RES-E | Irena Policies and Measures Database
	Command and Control Instrument Prevalence	Is the main instrument command and control based?	RES-E |Irena Policies and Measures Database
	Communicative Instrument Existence	Does the government adopt any communicative instruments?	RES-E | Irena Policies and Measures Database
	Communicative Instrument Prevalence	Is the main instrument communicative?	RES-E | Irena Policies and Measures Database
Extraneous factors	Internal factors	Has there been an event or development, aside from support instruments, which arguably holds explanatory power regarding the growth of renewables? If so, how?	General document analysis IEA Energy Outlook
	External Factors		
Renewable Energy Growth	Wind Power from Overall Electricity Growth	(Percentage of electricity from wind power in year n+1) - (Percentage of electricity from wind power in year n)	IEA - Eurostat CBS – Destatis – ONS Own Calculation
	Solar Power from Overall Electricity Growth	(Percentage of electricity from solar power in year n+1) - (Percentage of electricity from solar power in year n)	IEA Eurostat CBS – Destatis – ONS Own Calculation
	Renewables from Overall Electricity Growth	(Percentage of electricity from renewables in year n+1) - (Percentage of electricity from renewables in year n)	IEA - Eurostat CBS – Destatis – ONS Own Calculation
	Wind Power Increase (absolute)	(Wind power production in year n+1) – (Wind power production year n)	IEA - Eurostat CBS – Destatis – ONS Own Calculation
	Solar Power Increase (absolute)	(Solar power production in year n+1) – (Solar power production year n)	IEA - Eurostat CBS – Destatis – ONS Own Calculation
	Renewables Increase (absolute)	(Renewable Electricity production in year n+1) – (Renewable Electricity production year n)	IEA - Eurostat CBS – Destatis – ONS Own Calculation

3.4 Considerations:

3.4.1 Case Selection

The choice of three EU countries for this comparative case study presents significant procedural advantages in terms of enhancing the reliability of the research. Thanks to the EU directives establishing a uniform methodology for reporting on renewable energy and the availability of unified, official databases listing European policies in this domain, it is possible to recognize patterns and divergences while minimizing the effect that different approaches to calculating energy capacity and output or reporting on policies may have otherwise had.

The choice of Germany, the United Kingdom and the Netherlands as cases for comparison is meant to enable reliable conclusions regarding policies by focusing on cases that are similar on many levels. The logic behind this being that the more similar a set of countries is, the more likely that variations in the development of renewable energy can be attributed to policy choices rather than other factors. There are of course limits to such similarities which I address later on, but aspects in which the three countries are similar include their supranational affiliations, development levels, geographic and climatic disposition and, to an extent, the broadly dominant societal norms and religious traditions which influences them.

3.4.1.1 Affiliations:

For the entirety of the period on which this research focuses, all three countries have been members of the European Union, the European Economic Area. The Organization for Economic Co-operation and Development (OECD), the North Atlantic Treaty Organization (NATO), the World Trade Organization (WTO) and the United Nations. Membership in such intergovernmental organizations usually implies a set of privileges and obligations that apply to all members. Especially in the case of the first four organizations, member countries are encouraged to achieve relative uniformity in terms of legislation and public spending.

3.4.1.2 Human Development:

All three countries are considered developed with an HDI surpassing 0.9, indicating high human development. The index is based on the quality of education, healthcare and the income per capita in a given country. According to the latest HDI report, Germany ranks fourth globally with a score of 0.926, the Netherlands scores 0.924 and the UK 0.909. All three countries are within the top 16. The human development index captures some of the variables that can be reflected in the availability of investment capital to create RE facilities as well as the human capital necessary to develop and maintain them.

3.4.1.3 Climate and Geography:

The energy matrix with a given country is bound to be affected by its physical setting. One of the ways in which geographic location affects the potential for renewables is the amount of sunlight that reaches the ground. Figures for average insolation per capita are relatively similar across all the countries, indicating similar prospects for the return on investment in terms of solar energy. The following map demonstrates photovoltaic output throughout the territory of the three countries. It is visible that in all three the expected return on solar investments is within a close range.

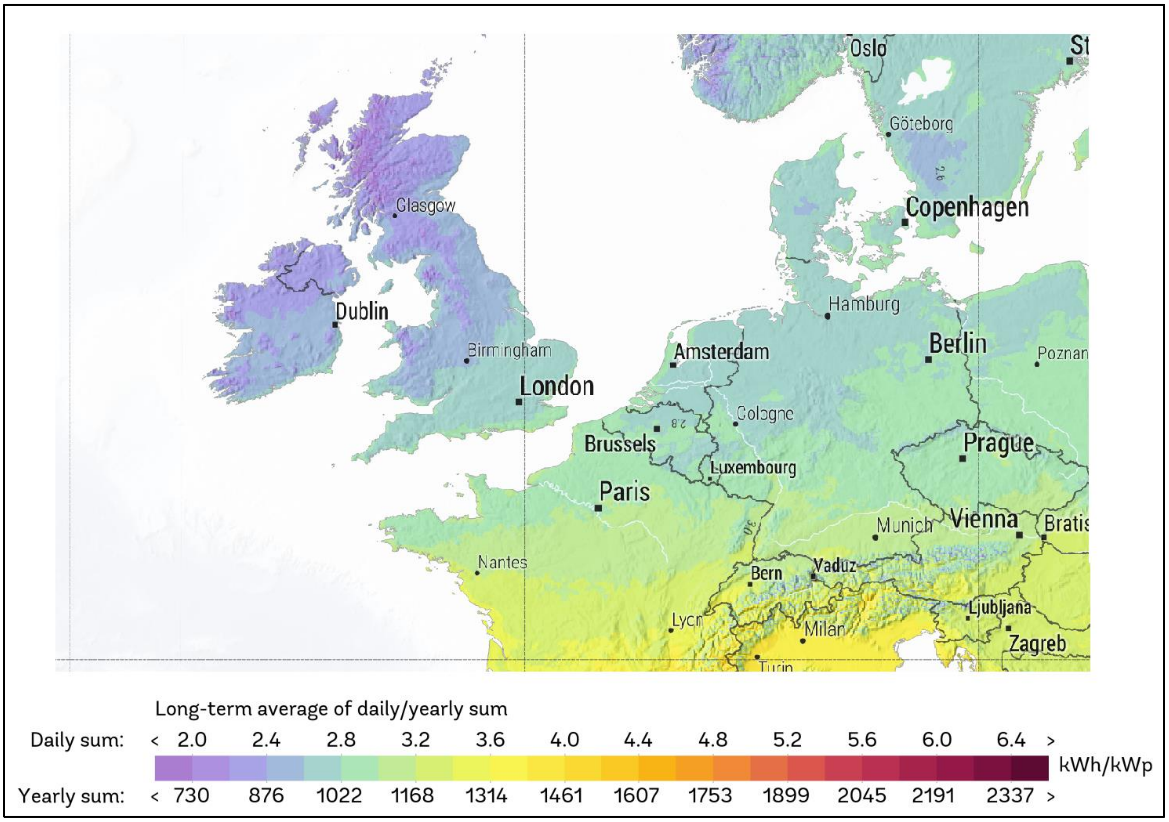

Figure 5 Solar Power potential in Germany, Netherlands and the UK Source: (Solargis, 2017)

3.4.1.4 Historic societal characteristics:
The three countries are traditionally majority-protestant and have often been cited as examples of societies embracing the protestant work ethic. Possibly relevant to the topic of this research is the idea that a protestant work ethic emphasizes frugality and hard work.

3.4.1.5 Aspects of Difference:
While the three countries this research focuses on are similar on a range of aspects, they also display some stark contrasts owing to their geographic, demographic and political disposition.

Geography and demographics:

This is the aspect in which the divergences are most apparent among the three countries, and many of these differences may have an impact on the feasibility, profitability and practicality of renewable energy investments. Population density is an important metric in this context because, all other things remaining the same, it provides good idea of the scarcity of space that could go towards renewable energy projects. With regards to that, the three countries in this study are quite dissimilar. The Netherlands is known to be one of the most densely populated countries in the world, with a density of 415 people/km^2, for the United Kingdom and Germany, that figure is 272 and 232 respectively. Coastline length can be a relevant indicator for the feasibility of offshore wind projects, as such projects are usually installed within the territorial waters of adjacent to the coast. In terms of this metric, the United Kingdom (Great Britain and Northern Ireland) being insular possesses a far larger coast than the continental countries with 12429 kilometers. The Netherlands is endowed with 451 kilometers of coastline whereas Germany has 2389. Topography is also an important geographical characteristic which strongly defines the accessibility of land and is closely linked to the feasibility of hydroelectric projects. This research does not address hydroelectricity as a renewable energy source directly, nevertheless it remains that in most cases hydroelectricity is include along with renewables and is often a beneficiary of the same support measures or at least is sold within the same market. That said, Germany is a significantly more mountainous country, especially in its southern portion. The Netherlands is famously flat and low whereas the United Kingdom is mostly flat with more hilly terrain in the north of Britain and Northern Ireland. Overall, the three countries constitute a viable set of cases for comparison in this context, the following section charts the performance of solar and wind power from 2000 to 2015.

4 Renewable Energy Progress

The account of renewable energy figures presented in this section includes both capacity and production. Renewable energy capacity is defined as the maximum net power generation that a country's RE facilities are capable of producing, therefore it is a predetermined figure for any such installation. Capacity is measured in watts (and Kilowatts, Gigawatts etc.). Renewable energy output, generation or production refers to the quantity produced and is therefore a more variable measure because it depends on various elements, most notably weather conditions in the case of solar and wind. Electricity production is measured in kilowatt and megawatt hours. While long-term patterns of growth or decline can be noticeable on both sets of data (capacity and output), there can be significant variation in the exact figures. Quite often, notable increases in capacity in one year tend to translate into notable output increases the year after. The simple explanation of this is that increases in capacity made later in the year can still count, despite only being active for a short period.

4.1 Germany:

In the following table the first two columns denote production of electricity from wind power and solar photovoltaics respectively with the third column being the sum of the two. The fourth column is the percentage of overall electricity production coming from wind and solar PV. The last two columns refer to the total installed capacity in both technologies.

Year	Wind (in GWh)	Solar (in GWh)	Total Wind and Solar (in GWh)	W+S out of Total Electricity (in %)	Wind Capacity in MW	Solar Capacity in MW
2000	9352	60	9412	1.6%	6097	114
2001	10456	116	10572	1.8%	8738	195
2002	15856	188	16044	2.7%	11976	260
2003	18713	313	19026	3.1%	14593	435
2004	25509	557	26066	4.2%	16612	1105
2005	27229	1282	28511	4.6%	18375	2056
2006	30710	2220	32930	5.1%	20568	2899
2007	39713	3075	42788	6.7%	22183	4170
2008	40574	4420	44994	7.0%	23815	6120
2009	38647	6583	45230	7.6%	25692	10564
2010	37793	11729	49522	7.8%	27180	17552
2011	48883	19599	68482	11.2%	29060	25037
2012	50670	26380	77050	12.2%	31304	32641
2013	51708	31010	82718	13.0%	34660	36335
2014	57357	36056	93413	14.9%	39193	38234
2015	79206	38726	117932	18.2%	44670	39786

Figure 6 Solar and wind power statistics in Germany Source: Primary data from IEA database

In 2000 Germany's total electricity production from wind and solar photovoltaics stood at 9412 GWh. This constituted 1.63% out of a total production of 576543 GWh comprised mainly of coal, nuclear energy and natural gas. This figure grew considerably over the following 15 years to eventually reach 117968 GWh in 2015 (with 79206 for wind and 38726 for solar PV). This translate to an average annual growth of 76.89 %. In 2015, Germany produced an estimated 18.23 % of its electricity from wind and solar. Therefore, the contribution of these two RE sources to the overall electricity production has increased eleven-fold from 2000 to 2015, averaging a 74.56 % increase per year. For perspective, it should be noted that overall electricity production from all sources increased annually by 0.81% on average. The highest additions to Germany's wind output occurred in the years 2015, 2011 and 2007 whereas the years 2009 and 2010 saw sharp decreases in production from this technology.

Solar, on the other hand, increased uninterruptedly during this 15 year period as the quantity of additional output grew from 56 GWh in 2000 to a peak of 7870 in 2011. It is notable however that 2010 saw the beginning of sharper rises with the 5000 GWh increase per year barrier was first broken.

This sharp rise in output from solar, as well as a relative deceleration in wind power output, correspond to figures for the installed capacity for each of the technologies in Germany. An interesting trend becomes apparent towards 2009. For the first time, the total net additions in solar photovoltaics capacity surpass wind power. The share of solar photovoltaic energy continues to rise and constitute a larger portion of overall capacity. The rate at which solar energy adoption increases is clearly different from the pattern exhibited by wind power. While wind capacity was multiplied by 6.5 times over the 16 year period, solar saw an impressive 358-fold increase. Much of these gains seem to have happened in the period between 2009 and 2013.

4.2 The Netherlands:

In the year 2000 the Netherlands' total electricity production from wind and solar photovoltaics stood at 837 GWh. This constituted barely 0.93% out of a total production of 89631 GWh dominated mainly by gas and coal (IEA). This figure continued to grow over the following 15 years to eventually reach 8672 GWh in 2015 (with 7550 for wind and 1122 for solar PV). This reflects an average annual growth of 62%. In 2015, The Netherlands produced an estimated 7.87 % of its electricity from wind and solar. Therefore, the contribution of these two RE sources to the overall electricity production has been multiplied by 8.46 from 2000 to 2015, averaging a 56% increase per year. To put that in perspective, overall electricity production from all sources increased annually by only 1.9% on average.

Year	Wind (in GWh)	Solar (in GWh)	Total Wind and Solar (in GWh)	Wind and Solar out of Total Electricity (in %)	Wind Cap. in MW	Solar Cap. in MW
2000	829	8	837	0.9%	447	13
2001	825	12	837	0.9%	485	21
2002	947	17	964	1.0%	672	26
2003	1320	26	1346	1.4%	905	46
2004	1871	34	1905	1.9%	1075	50
2005	2067	35	2102	2.1%	1224	51
2006	2735	36	2771	2.8%	1558	53
2007	3438	37	3475	3.3%	1748	54
2008	4260	39	4299	4.0%	2149	59
2009	4581	45	4626	4.1%	2222	69
2010	3994	56	4050	3.4%	2237	90
2011	5101	104	5205	4.6%	2316	149
2012	4981	226	5207	5.0%	2433	369
2013	5627	487	6114	6.0%	2713	746
2014	5797	785	6582	6.4%	2865	1048
2015	7550	1122	8672	6.2%	3391	1515

Figure 7 Solar and wind power statistics in Netherlands Source: data from IEA database

Annual additions to the output from wind energy kept rising gradually since 2001. The strongest years for wind energy in this 15 year period were 2015, 2011 and 2007. Interestingly, the year 2010 saw a sharp decrease of 587 GWh in output from wind energy compared to the previous year. 2012 also saw a 120 GWh fall in output from wind. Output from PV solar energy had remained insubstantial until larger additions began appearing by 2011. During the rather volatile period that wind was having from 2010 to 2015, solar energy gained considerable momentum.

The above numbers refer to actual output in terms of GWh, but renewable energy penetration can also be assessed based on installed capacity. In the Dutch case, figures pertaining to installed capacity in solar photovoltaics remain minimal up until 2010. Similar to data on actual output, annual increases in installed capacity for solar begin to increase significantly starting in 2011. Regarding wind energy, the initial trend of incremental growth is visible throughout both sets of data. It is, however, interesting to see that as output has in fact fallen in the years 2010 and 2012, installed capacity seems to have stagnated in the year 2010 and only increased marginally in 2012.

4.3 The United Kingdom:

The UK has had renewables contributing to electricity production since the mid-1990s. Yet in 2000 total electricity production from wind and solar photovoltaics in the United Kingdom stood at a mere 948 GWh with solar being almost absent. This made up 0.25% out of a total production of 377069 GWh comprised mainly of coal and gas with a significant nuclear capacity. This figure grew considerably over the following 15 years to eventually reach 47862 GWh in 2015 (with 40310 GWh for wind and 7561 GWh for solar PV). This translates to an average annual growth of 330 %.

Year	Wind (in GWh)	Solar (in GWh)	Total Wind and Solar (in GWh)	W+S out of Total Electricity (in %)	Wind Capacity In MW	Solar Capacity in MW
2000	947	1	948	0.3%	435	2
2001	965	2	967	0%	494	3
2002	1256	3	1259	0%	535	4
2003	1285	3	1288	0%	742	6
2004	1935	4	1939	0%	933	8
2005	2904	8	2912	1%	1565	11
2006	4225	11	4236	1%	1955	14
2007	5274	14	5288	1%	2477	18
2008	7122	17	7139	2%	3446	23
2009	9281	20	9301	2%	4419	27
2010	10255	41	10296	3%	5401	96
2011	15652	244	15896	4%	6467	995
2012	19835	1352	21187	6%	8899	1756
2013	28396	2008	30404	8%	11212	2873
2014	31966	4040	36006	11%	13037	5424
2015	40310	7561	47871	14%	14291	9187

Figure 8 Solar and wind power statistics in the UK Source: Primary data from IEA database;

In 2015, the United Kingdom produced an estimated 14.11 % of its electricity from wind and solar. Therefore, the contribution of these two RE sources to the overall electricity production has been multiplied by 56 from 2000 to 2015, averaging a 376 % increase per year. In comparison, it can be noted that overall electricity production from all sources has in fact decreased by an average of 0.1%.

From 2000-2015, annual increases in output from wind in the UK hit the highest point in 2013, however, a clear trend towards increasingly higher additions is seen starting from 2004, only slightly interrupted in 2010. Solar energy had been quasi-negligible in the UK until 2010, since then significant rises have been seen annually, with the highest occurring in the latest year (2015).

Installed capacity figures in the UK tell the same story as output levels. Generally, the highest yearly increases in capacity occurred in the period starting in 2010. For wind energy, yearly increases in capacity have grown steadily over the 15 year period but the most notable rises begin in 2008 with an almost 40% rise in capacity. Within this period the largest increase occurred in 2012 with 2432 MW more than 2011. Solar energy capacity multiplied tenfold from 2010 to 2011 to reach 995 MW. Over the following 4 years capacity was multiplied almost a further tenfold to each 9187 MW by 2015.

Summary:

Looking at the share of solar and wind energy in total electricity output across the three countries, it can be noted that at the beginning of the period the figures were relatively close to one another despite Germany displaying a slight early lead.

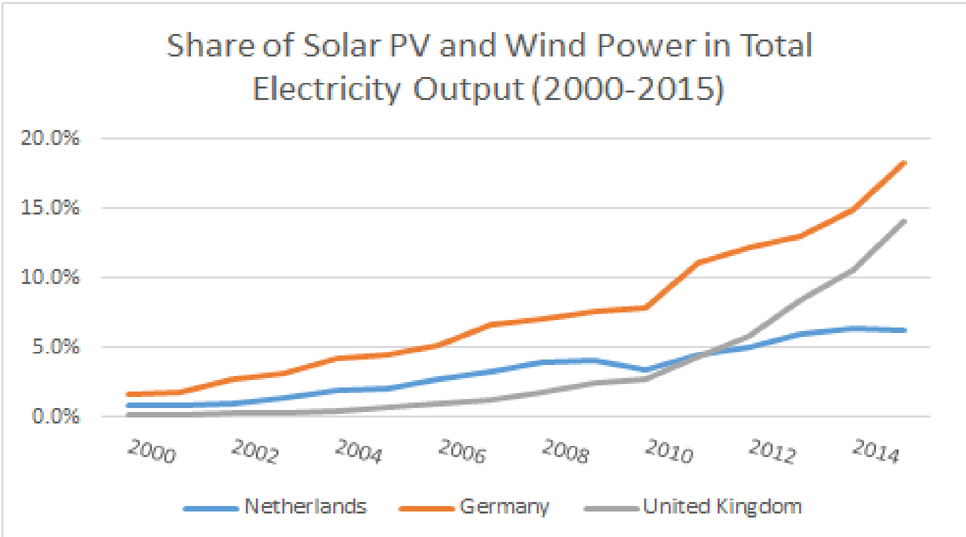

Figure 9 Solar and wind as % of overall electricity production

From then on, however, the pace at which German output grows as a proportion of total production significantly exceeds that of the Netherlands and the UK. Years in which Germany registers particularly strong growth are 2006, 2010 and 2014. Whereas Germany breaks through the 5% barrier in 2005, the UK and Netherlands only do so in 2011. The share of wind and solar in total production in the United Kingdom goes on to exceed the Netherlands' in 2010 and from then on registers significant growth in the following five years. By 2015, the United Kingdom looks poised to break through 15% whereas the Netherlands remains below 10%.

To sum up, the key developments over the 15-year period can be briefly described as such:

- In 2000 all three countries had less than 3% of their electricity needs supplied from wind and solar.
- Renewable energy in Germany grew at a higher pace over the entire period.
- The disparity among the three countries is largely in terms of solar energy adoption, with Germany being significantly ahead.
- UK: Sustained but moderate growth in both technologies, faster pace between 2010-2014.
- Germany: Sustained and significant growth in both technologies, fastest pace starting in 2010.
- Netherlands: Minimal growth in both technologies, faster pace starting in 2010.

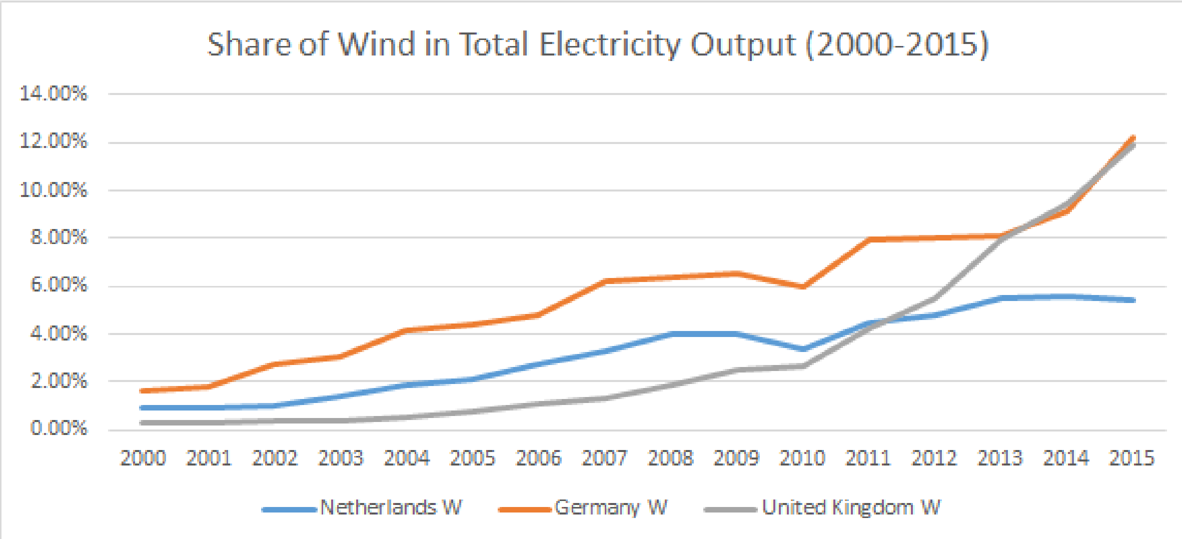

Figure 10 Share of wind in total electricity output 2000-2015

Considering technology-specific figures, the figures for wind alone are largely in accordance with the figures for the sum of wind and solar. One major conclusion that can be produced by looking at both above graphs is that the slowdown in total output growth from 2009 to 2010 in Germany and the Netherlands is at least predominantly caused by a decrease in production from wind. In the UK this effect does not seem to be equally visible although little growth is registered in this two-year period.

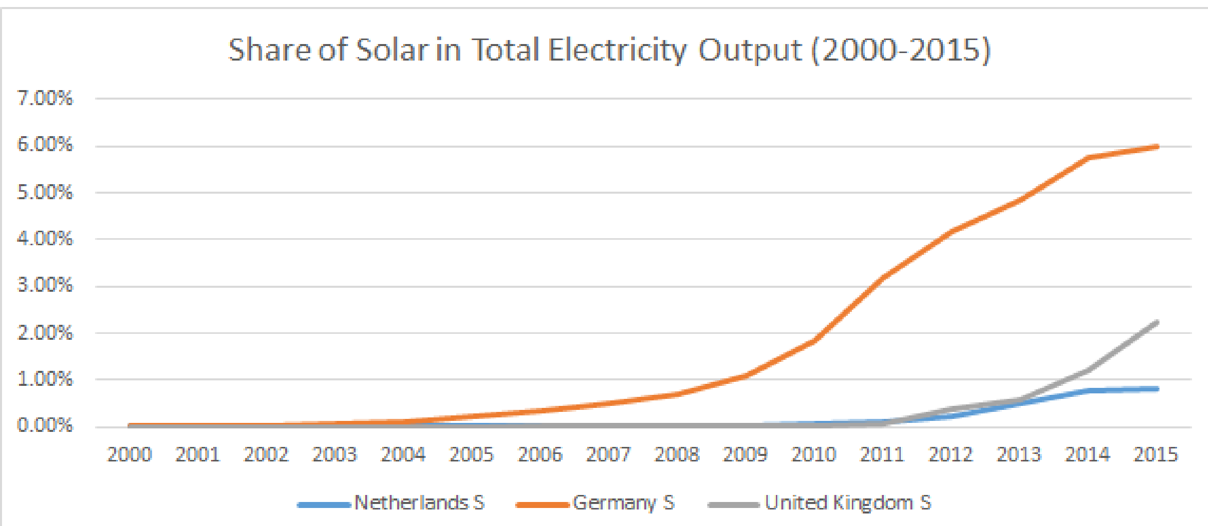

Figure 11 Share of solar in total electricity output (2000-2015)

Focusing on the figures for solar energy alone, it becomes apparent that for much of this 15 year period, solar energy was only a minor contributor to the electricity output in the three countries. Starting in 2005 in Germany, however, the growth of solar begins to gather pace. Higher growth can be seen happening starting in 2009 in Germany. As for the UK and the Netherlands, solar remains insignificant until the year 2011. From then on, the proportion of solar grows moderately with the UK outpacing the Netherlands in 2012-2013. At no point does output from solar seem to decrease for any of the three countries.

Having presented a detailed account of RE statistics in the three case studies, the following step is to chart the progress of policy measures aimed at supporting renewables over the same time period.

5 Analysis of RE Policy Instruments

5.1 Evolution of Policy Instruments in Germany

There have been various measures taken by the German government with regards to renewable energy, concrete steps towards the promotion of renewable energy had been taken by the (then West-) German government since 1989 with a grant program that eventually produced 250 MW in wind capacity. The support scheme was accompanied by a "Scientific Measurement and Evaluation Programme" which monitored the turbines for a period of 10 years. More importantly; the 1990 Electricity Supply Law obliged suppliers to grant grid access to electricity produced from renewables and remunerate it accordingly. Throughout the following decade other economic instruments have been deployed targeting renewables in general and solar and wind in particular. A notable measure introduced in 1999, and remaining in force throughout the whole period, is the Market Incentive Programme. This program offered grants for smaller installations of renewable energy and reduced rates for loans directed towards larger projects. The project was administered by Federal Office for Economic Affairs and Export Control and the loans for large installation were provided by KfW, a German government-controlled bank. This leads to the conclusion that prior to the year 2000, political will to support renewables was present and resulted in the deployment of several measures. Namely, regulation granting grid access, economic measures such as subsidies and loans as well as communicative, information-based measures such as the research programs. The developments during this period laid the ground for what was to happen in the following years. The following is a description of the relevant policies and measures undertaken by the German government over the period from 2000 to 2015, focusing on support schemes that target solar photovoltaics and wind power.

The first iteration of Germany's *Renewable Energy Sources Act* set the standard for the following updates. On April 1st, 2000 the principal German feed-in-tariff scheme was first introduced. The Renewable Energy Sources Act (henceforth referred to as EEG) had three main characteristics. First, it sought to protect investments in renewable energy by guaranteeing producers a certain feed-in tariff and that their output will be admitted into the grid for a period of 20 years. Second, the payments disbursed to RE producers were not originating from public funds. Rather, they were financed through a public surcharge on electricity consumers. Finally, the legislation takes into account that nascent and new energies tend to become increasingly efficient with time. Therefore, the feed-in-tariffs were scheduled to decrease gradually so as to exert pressure on producers to accelerate optimization and encourage the adoption of more efficient innovations. It essentially obliged electricity distributors to give preferential access to electricity from renewables ensuring all electricity from renewables receives is remunerated at a fixed price for each technology (BMU, 2000). Despite the feed-in tariffs being a central mechanism of the policy, the EEG 2000 (and indeed, its future iterations up to the 2014 version) is classified primarily as a command and control instrument due to it having the following characteristics:

- The extra cost of the Feed-in tariff was borne by suppliers and ultimately the customers.
- Suppliers were under an obligation by the State to give preferential access to renewable electricity.

The differential tariffs among the various RE technologies reflect an interventionist attitude from the government, as opposed to a more market-inspired approach based on competitiveness.

The 2000 EEG ran in tandem with the 100.000 Solar Roofs Program, a low-interest loans scheme financing solar power installations. This program was quite significant in terms of scale as it was backed by EUR 562.4 million in funding before ending in 2003. After the expiry of this program, a successor initiative was taken by KfW in the same format, with a larger budget of 783 million. This one ran until 2008. The KfW “Renewable Energies – Standard” Programme was introduced in January 2009 as a consolidation of all the programs aimed at supporting small scale renewable energy. Its goal was the financing the construction, expansion or acquisition of renewable energy installations through low-interest loans (KfW, 2019). Since KfW is a government-owned bank this scheme is classified as an economic instrument in the form of preferential loans with low interest rates. Beneficiaries could voluntarily apply for loans, but acceptance was contingent upon specified conditions. Therefore, it can be noted that throughout much of the period we focus on, there were sizeable low-interest loan programs available to prospective investors in solar photovoltaics in Germany- especially for smaller installations. Afterwards, KfW shifted its focus towards offshore wind energy with a subsequent loans program in 2011 (KfW, 2019).

The 2004 version of the EEG came with more differentiated tariff structures and instituted some environmental protection measures, but the core of the policy remained the same and therefore this version did not constitute a shift in terms of policy measure. Similarly, the 2009 and 2012 version maintained the feed-in tariff structure while adopting measures to alleviate grid problems and other minor modifications (Gründiger, 2016).

Starting in 2006, the government sought to further stimulate investment in renewables by financing the creation of the Solar Power Development Center, a facility within the Fraunhofer Institute for Solar Energy Systems which is a public-private institution. This facility would be made available for solar cell and systems manufacturers to test out their products and simulate mass production (Fraunhofer ISE). While this measure is not directly geared towards deployment of renewable energy capacity, it supports research efforts that may potentially result in increased efficiency and cost-effectiveness for solar modules, therefore encouraging uptake. The non-binding nature of this arrangement and its focus on improving expertise justify it counting as an “information instrument”.

In 2014, however, a significant shift happened in the EEG. While existing installations were able to continue benefiting from their support arrangements, new RE plants under the Renewable Energy Sources Act of 2014 are no longer guaranteed preferential dispatch, instead they are to market their electricity production directly. They are then compensated by the grid operators, through a market premium, for the difference between the average market price (which is set on a monthly basis) and the remuneration set by the law for each RE technology. Moreover, the 2014 EEG stipulates that starting in 2017, the selection process for beneficiary producers will be based on tendering. Producers which can offer renewable electricity at lower prices are given priority in receiving financial support (BMWi, 2016). These crucial changes that came in 2014 have led to this law being called EEG 2.0 since it departs significantly from its predecessors (Dinkloh, 2014). In terms of policy instrument classification, this updated version of the EEG reflects a transition towards more of a market-oriented approach as indicated by the loosening of State guarantees (and obligations), and the scheduled implementation of a tendering procedure for new beneficiaries.

Summary:

Since the early 1990s the German approach to stimulating renewable energy can be described as a multi-pronged one since it includes both regulatory elements, significant financial schemes from KfW as well as a robust succession of research and knowledge-related initiatives. The EEG in 2000 was accompanied by the solar panel loan program, financed by the government. The simultaneous existence of dispatch guarantees, loan programs and research funding has characterized German renewables up to 2014. Perhaps it can be argued that the governmental approach relied more heavily on regulatory measures because while the loans programs had a definite budget, the obligations that come with the EEG (for operators to prioritize the dispatch of electricity from renewables) was universal. In terms of communicative approaches, there were a variety of programs aiming at supporting research, feasibility studies and encouraging investments since the 1990s. The only observable shift happened in 2014 with the newer version of EEG. This law signaled a shift towards a more market-centered approach as it increased the exposure of RE producers to market risks. To sum up, German support for renewable energy in the period between 2000 and 2015 can be described as such:

- A predominantly regulatory approach along with significant economic support and a variety of informational measures was adopted up until 2014, signaling a hybrid form of governance.
- A shift towards a more market-dominant mode of governance occurred in 2014.
- Diversified instruments targeting different technologies, installation sizes and issues arising in RE development.

5.2 Evolution of Policy Instruments in the Netherlands

Prior to the year 1999, little can be seen in terms of policy measures aiming at the promotion of renewable energy in the Netherlands, especially with regards to solar and wind energy. One notable measure was an all-encompassing Green Fund scheme started in 1995 and aimed at providing funding for environment-friendly projects, some of which were focused on improving energy efficiency. That same year also saw the issuing of energy performance standards for buildings which, among other stipulations, factor in the presence of connected renewable energy installations in determining the energy efficiency of a building. These performance standards would be further increased over the following years requiring buildings to be designed so as to consume less gas for their heating needs.

The following is a brief description of the main measures the Dutch government has taken in a bid to increase the uptake of renewables in the period 2000-2015:

In 1999 electricity from renewables was relieved of the REB (Regulerende Energie Belasting) energy consumption tax. Further in 2001 the Dutch government made commitments to ensure a growing share of the energy consumption of its buildings and general operations is of renewable provenance. The 1999 tax exemptions for renewable energy were phased out between 2004 and 2005 (Laanstra, 2016). This phase-out happened proportionally with the introduction of the first outright subsidy for local renewable energy producers in the Netherlands: the “Milieukwaliteit van de Elektriciteitsproductie” (MEP) measure. This consisted of a premium added on to the market price of electricity paid to the domestic producers of renewable energy. The premium differed among technologies with offshore wind, photovoltaics and hydroelectricity receiving the largest amounts while landfill gas received the smallest subsidies. However, all of these RE production techniques were automatically eligible for the subsidy. The government suspended this premium for new projects in 18 August 2007 when it became evident that the previously set target of 9% electricity from renewables for 2010 would be met. This subsidy was financed from the national budget, it is therefore an economic instrument which qualifies as an open scheme.

In 2006, an Energy Transition Taskforce was commissioned by the cabinet to publish a Transition Action Plan. This was a strategic plan during the formulation of which the government established consultation platforms including private actors. The goal was to outline the next steps to improve sustainability in the Netherlands on multiple fronts (including RE). Further in 2008 an innovation agenda was established to supplement this transition plan with a budget of 438€ million (EnergieTransitie, 2006). This was the lead-up to the establishment of the Stimulering Duurzame Energie feed-in tariff in that same year.

The SDE was essentially a feed-in-tariff whereby a fixed subsidy is guaranteed to RE producers over the period of a contract. When the market price for electricity is lower than the renewable electricity cost of production, SDE grants a premium to RE producers. When the market price rises so that RE producers can generate a profit, they receive no premium or subsidy for their input. Moreover, the amount of subsidy was variable depending on the price of fossil fuel energy. The “cost of production” of renewable energy, which is used in calculating the amount of subsidy, is determined as an average for each RE technology and applies for the entirety of the subsidy period (RES - Legal, 2012). Up to and including 2009, the SDE was financed from the revenues of natural gas extraction and energy tax. After 2009, the financing was drawn from a supplement on the energy bill of citizens and businesses. In terms of access to the subsidy, SDE contracts were allocated through tendering rounds held multiple times each year, with a maximum budget set for each category. It is therefore an economic instrument, but access to it is subject to government-criteria as well as competitiveness.

To further promote the achievement of its 2020 sustainability goals, the Dutch government initiated in 2011 the Green Deals programme. This project enlisted various actors by allowing citizens, businesses and local governments to propose projects aimed at sustainability improvements. Subject to negotiations, the government may in some cases eliminate legislative and regulatory hurdles. The government also may act as a mediator to facilitate multilateral negotiations (Rijksoverheid, 2019). From 2000 to 2015, the Green Deals programme is the most prominent example of voluntary instruments in support of renewables. In 2011, and as part of the Green Deals, the Dutch Government and the Dutch Wind Energy Association reached an agreement to facilitate investments in offshore wind energy and set a concrete target of reducing the cost of wind energy by 40% before 2020. This agreement came to fruition in July 2015 with the adoption of the Netherland’s Offshore Wind Energy Act. With the aim of streamlining the decision-making process and actual implementation of offshore wind energy projects, this regulation entrusts the government (rather than private investors) with the tasks of spatial planning arrangements, assessing environmental impacts and ensuring connection to the main grid. This act was applicable to the tendering process for the Borssele Lot I and Lot II projects, which are also scheduled to be beneficiaries of the SDE+ subsidy for the first 15 years of operation. This is a noteworthy project because of its size and the fact that both its creation as well as its operation would benefit from government support policies, making it a product of two different instrument choices.

The updated version of the SDE policy introduced some instrumental changes. Unlike its predecessor, the 2011 SDE+ does not take into account the RE technology when granting contracts. Instead beneficiaries of subsidies, which aim to cover the gap between market price and RE electricity prices for the duration of 15 years for each contract, are selected on an expected production cost basis. Additionally, the selection process happens four times per year, with the lowest subsidy amounts granted first. This is meant to ensure that the most efficient producers are granted priority access to the allocated budget of the measure. With the budget for each quarter set beforehand, this segmentation encourages efficiency and ensures subsidies go to projects with the lowest cost of production first. The yearly budget for this subsidy has been quite significant - EUR 1.5 billion in 2011; EUR 1.7 billion in 2012; EUR 2.2 billion in 2013; and EUR 3.5 billion in 2014 (Agentschap NL, 2012). The most relevant element of the SDE+ compared to SDE in this discussion is the change in the tendering criteria and procedure. The lack of distinction among technologies reflects a more market-oriented approach allowing the most efficient proposals to benefit from support. Similarly, the 4-times a year, cost-based queue for receiving contracts has the same effect in granting priority to the more competitive contenders.

Summary:

Looking at the progress of RE policies in the Netherlands, an interesting succession of shifts happens in the main support measure. Starting with the somewhat unconditional MEP which, despite being a form of subsidy, still left RE producers exposed to the market to an extent (because its payments were not a function of market prices but rather predetermined, technology specific premiums), in 2007 the introduction of SDE removed this exposure by calculating the compensation based on market price rather than a set premium and instituting budget maximums for each technology. The updated SDE+ sought to increase competitiveness and lower costs by prioritizing the applicants with the lowest production costs as beneficiaries of the feed-in tariff.

In terms of purely regulatory instruments (so called command and control), solar and wind energy have not been the target of any obligations aimed at increasing uptake. With regards to communicative and voluntary approaches, a few initiatives have been taken place, aimed at helping households and businesses to increase energy efficiency of their locals or invest in renewable capacity. These measures remain modest especially insofar as the portion concerned with actual installed capacity. Only with the advent of the Green Deals program in 2011 was there a large scale effort at encouraging investment.

To sum up the shifts in Dutch support for domestic renewable energy:

The main instruments have been market-based, but the following characteristics of each of the three are notable:

- MEP: This production subsidy reflected a relatively market-oriented approach with little interference from the government, being an open scheme accessible to virtually all RE installations, granting a specified premium per technology regardless of market prices.
- SDE and SDE+: Both economic instruments in the form of feed-in tariffs supporting the generation of RE. The second version is mainly meant to increase the efficiency of the policy by prioritizing more competitive techniques and applications.
- Minor communicative and voluntary measures have been a feature of the government's approach. The most impactful one being the Green Deals starting in 2011.
- No obligatory measures can be identified with regards to solar and wind power from 2000 to 2015.

5.3 Evolution of Policy Instruments in The United Kingdom

The policies focused on in this research are those which have been in force during the period from 2000 to 2015. Nevertheless, limited consideration will also be directed towards measures taken in the preceding decade in order to provide some perspective.

The development of wind energy in the UK during the 2000-2015 period is strongly contingent on the historical background in terms of policy. Specifically, the preceding decade had seen the government enact policies with the purpose of reducing reliance on fossil fuels in the production of electricity. The non-fossil fuel obligation (NFFO) was the main government measure at the time. Established as part of the 1989 Electricity Act, the NFFO required electricity supplying companies in England and Wales to ensure a portion of new generating capacity from non-fossil fuel sources such as nuclear and renewables. The coordination between electricity suppliers and renewable energy generators was the task of the Non-Fossil Purchasing Agency. In England and Wales, the NFFO put out five regulatory orders, the first of which was issued in 1994, compelling energy distributors to acquire a certain amount of their input from a renewable or nuclear power facility. Subsequent legislation ordering more bids for contracts under the NFFO frame was issued in 1997, 1998, 2000. The contractors under NFFO were further granted the ability to relocate (geographically) while still maintaining their eligibility status in 2001. In Scotland, the Scottish Renewable Obligation was the equivalent of NFFO. Like the latter, orders were issued at intervals and were subsequently amended with legislation making it possible for projects to relocate and retain eligibility. The Scottish government issued three orders in 1994, 1997 and 1999 (Pearson, 2010).

The Climate Change Levy was introduced in 2001, taxing energy consumers on their energy usage. It included partial exemptions among which are businesses sourcing their electricity from renewable sources (Pearson, 2010). According to Park (2013), tax breaks and exemptions are a form of market-instruments, in this case one for which all renewable electricity is eligible.

A significant stimulus for photovoltaics came in 2002 when a Demonstration Programme received a £20 million budget for the creation of a platform to promote PV growth. The allocated budget was gradually increased to eventually reach 31.75 million£ by 2006. The grants within this program were divided between two types of projects. The first stream concerned smaller projects such as single household installations of solar energy systems. The second stream of funds was geared towards larger actors such as housing corporations, large companies and local authorities. Depending on installation type, nature of the grant applicant and size (in the case of private companies), grant coverage would cover from 40% to 50% of total costs. Allocation of funds happened on a first-come first-served and all projects meeting basic criteria were automatically admitted. This program ran from 2002 to 2007 when the last applications were submitted and selected (IEA, 2014). This program qualifies both as a voluntary/research-based instrument in the sense that its true purpose is to stimulate growth and increase awareness of renewables, while also providing significant financial support to investment in renewables- which is more characteristic of economic instruments.

Renewables Obligation:

While consultations pertaining to a successor policy for NFFO began as early as 2000, a concrete policy was only introduced in 2002 in the form of the Renewable Obligation (RO), which remains to this day the chief mechanism of support for large scale renewable energy projects in the UK. Classifying the

Renewables obligation proves challenging because, being the government's main RE support policy, it combines elements of many policy instruments. Below are the defining elements of the policy:

1. Obliges energy suppliers to ensure a certain amount of their electricity comes from renewable sources.
2. Renewable energy producers are awarded Renewable Obligation Certificates (ROCs) in proportion to their production.
3. ROCs can be traded at market prices; producers sell them to suppliers who must present them as proof of having fulfilled their obligation to source part of their electricity from RE.
4. Suppliers who haven't been able to acquire sufficient ROCs must pay into a buy-out fund, the proceeds from which are redistributed to RE suppliers in proportion to the ROCs they've presented. (Ofgem, 2017)

It can therefore be seen that the primary governmental action through the RO is obliging suppliers to conduct their activity in a certain way (1). The ROCs granted to producers (2) are a form of green certificate, an economic, market based instrument. The trade in such ROCs (3) and the proceeds from the buy-out fund (4) ultimately act as a sort of feed-in premium or tariff. This means that the RO functions as a financial subsidy to producers. However, it is classified as a regulatory measure because the government itself does not provide subsidies to RE producers, it merely compels suppliers to do so. Suppliers then pass on the costs to consumers.

As the Renewable Obligation was being phased out, Contracts for Difference were introduced in 2014 as its replacement. It is a relatively simple Feed-in tariff scheme whereby each RE technology is assigned a "strike price", if the market price is lower than the strike price the government agency compensates the producers which secure such a contract for the difference. If it is higher the producers must pay the difference to said agency. Potential beneficiaries of CfDs had to compete in tendering rounds, technologies are grouped into "established" and "less established" categories. The less established ones being allocated significantly more funds (Gov.uk, 2015). CfDs are thus a market instrument with access conditions that involve competition as well as government-set criteria; this marks a significant shift from the obligation-based instrument that was central to UK policy.

Before the introduction of CfDs as the flagship instrument to replace the Renewable Obligation, in 2009 the government introduced a program of feed-in tariffs for small producers. This targeted small-scale installations in homes and businesses. It does not require beneficiaries to repay the government for the compensation on the electricity which they have produced and consumed locally. It was initiated in 2010 and is still ongoing with applications being admitted on a yearly basis. Once admitted into the scheme, solar PV and wind electricity generators can receive these payments for the following 20 to 25 years with the amounts adjusted for inflation (Ofgem, 2018). Other than the limit on the maximum size of installations, this market instrument is open to all eligible applicants with no tendering process.

The UK government also instituted a measure to provide a framework for homeowners who wish to decrease their houses' energy consumption (including by installing RE production). As part of the Green Deal which began in 2013, the government arranged free energy efficiency assessments and matched potential RE investors with lending companies that were government certified (Pearson, 2010, p. 30). The procedures were clearly outlined. It was however completely voluntary and did not involve government funds. It is therefore classified as voluntary instrument providing information and administrative help.

Observable Trends:

Based on the account above and the fact that the British government adopted the Non-Fossil Fuels Obligation policy (a similar policy to the RO) throughout the 1990s, a preference for regulatory obligation characterized the early approach to promoting renewables and low-carbon energy sources. Up until 2005, the government did not provide direct subsidies to renewable energy producers, instead opting to mandate suppliers to source a percentage of electricity from renewables or by taxing non-renewable energy sources. This predominantly regulatory policy mix continued until 2009. Although a subsidies program started in 2006, this was relatively small in scale (GBP 131 million over four years) and focused more on energy efficiency rather than RE production. In 2010 the first outright government funded subsidy for renewable energy production started, focusing on small-scale producers. It was during this period that the Renewable Obligation became the target of increasing criticism and calls for an alternative approach started being considered. In 2013 with the Electricity Market Reform it was decided that the RO is to be phased out, with the successor Contracts for Difference policy introduced the following year. Along with the 2013 Green Deals voluntary program, this signaled a shift from the regulation-focused approach towards more market- and citizen-focused methods of RE promotion.

To sum up, the notable shifts in UK renewable energy policy can be broadly described as follows:

- 1990s-2001: the approach was largely regulatory and did not specifically target renewables. In 2001, a first, but minor, RE-only policy came about with the Climate Change Levy exemption, a market-based instrument.
- 2002-09: The preference for a command and control approach continues with the RO.
- 2010-11: First market-based subsidy aimed at smaller producers and calls for a replacement of the RO. Shift towards economic market instruments and introduction of voluntary schemes.
- 2014: Contracts for Difference: Economic instrument set to replace the main RO policy.

6 Findings

The following section utilizes data gathered from the previous chapters on renewable energy and policies and measures to spot the visible effects, if any, of policies on RE uptake. By extension, we hope to derive useful insights regarding the relationship tying the choice and succession of governance modes, as well as the shifts within, to the concrete results in terms of RE capacity. For that purpose and for each of the three case studies, we will first assess the annual additions in RE that have accompanied supports instruments (or groups thereof), then inquire as to which governance preferences we can identify as prevalent. Beyond that, this section aims to identify any noticeable patterns, or known internal and external factors that may hold explanatory power regarding the subject matter.

Regarding statistical data on the growth of renewables, I opted to simply display the absolute yearly additions in terms of both renewable technologies. The numbers graphed below are the differences in total installed capacity from one year to another, based on the data previously presented. The use of absolute numbers, rather than a figure which factors in the size differences across the three countries, does not facilitate a side by side comparison at this point, but it remains helpful at tracking the growth of renewables against the backdrop of evolving support policies, which is the focus of this section. As a result of this choice, the illustrations topping the three following sections are on wildly different scales in terms of megawatts, with Germany's having an upper value of around 10000 and The Netherlands' a tenth of that. The illustrations below are stacked bar charts, only the area with a blue gradient filling represents additions in wind energy, and the orange-gradient area represents solar.

6.1 Germany:

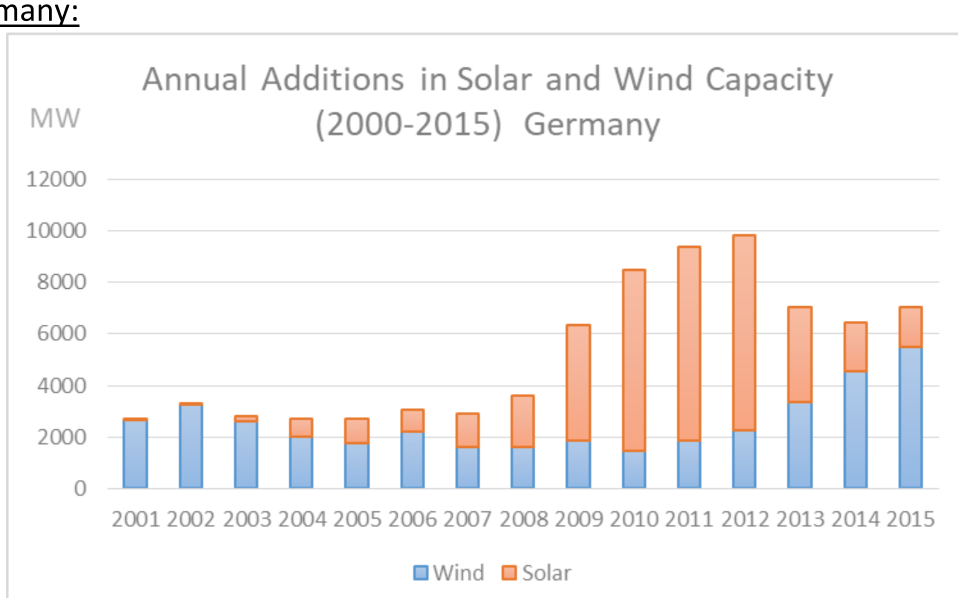

Figure 12 Charting RE capacity in Germany (2000-2015)

An initial glance at the annual additions in German renewables reveals gradual growth for much of the 2000-2015 period, with solar photovoltaics beginning to form an increasingly larger portion from 2004 onwards. This continuous trend of accelerating growth remains largely uninterrupted until 2013 when the annual figures drop back to 2009 levels. In terms of support measures, Germany has adopted a diversified approach since the beginning of its commitment towards renewables.

<table>
<tr><th></th><th></th><th colspan="4">Market Measures</th><th></th><th></th></tr>
<tr><th></th><th>Regulatory Measures</th><th>Government Criteria</th><th>Govt Criteria & Competitiveness</th><th>Competi-tiveness</th><th>Open Scheme</th><th>Voluntary Measures</th><th>Notes</th></tr>
<tr><td>2000</td><td rowspan="5">EEG 2000</td><td rowspan="4">100,000 Roofs Program</td><td rowspan="14"></td><td rowspan="16"></td><td rowspan="5">EEG 2000</td><td rowspan="5">4th Energy Research Program</td><td rowspan="14">Up to 2014, the EEG consisted of both regulatory and economic elements, providing subsidies to producers and compelling power grid operators to purchase all electricity from renewable sources.</td></tr>
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<tr><td>2005</td><td rowspan="4">EEG 2004</td><td rowspan="4">KfW Producing Solar Power</td><td rowspan="4">EEG 2004</td><td rowspan="6">5th Energy Research Program</td></tr>
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<tr><td>2009</td><td rowspan="3">EEG 2009</td><td rowspan="7">KfW Renewable Energies Programme</td><td rowspan="3">EEG 2009</td></tr>
<tr><td>2010</td></tr>
<tr><td>2011</td><td rowspan="5">6th Energy Research Program</td></tr>
<tr><td>2012</td><td rowspan="2">EEG 2012</td><td rowspan="2">EEG 2012</td></tr>
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<tr><td>2014</td><td rowspan="2"></td><td rowspan="2">EEG 2014</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>2015</td></tr>
</table>

Figure 13 Policy support for German renewables (2000-2015)

When the flagship EEG was introduced in 2000 it came along with a loans program targeted at decentralized solar (The 1000 Solar Roofs Program). The same period saw the deployment of successive communicative and voluntary initiatives aimed at research, development and assistance. While the government and State-owned bank KfW undertook many State-funded programs, the German EEG itself is best described as a mixture of market-based subsidy and command-and-control purchasing obligation. It is also noteworthy that the compensation granted by EEG is scheduled to gradually decrease over time. This so-called "degression" is meant to account for improvements in efficiency and encourage innovation. Thus, it is clear that the early availability of cheap financing through the 1000 Solar Roof KfW loans as well as the prospects of a stable and predictable return on investment offered by the FiT can be credited with catapulting German renewable energy, and particularly solar photovoltaics ahead of the Netherlands and the United Kingdom at a time when the technology was prohibitively expensive. As we continue to chart the development of renewables in Germany, it will become increasingly clear that this comprehensive approach of providing financial support at both the investment and operation level, deploying regulatory guarantees for the commercialization of renewable electricity, and supporting research and expertise-creation, that has benefited Germany the most.

We have established that the mix of support measures employed by Germany over the period from 2001 to 2008 can be characterized as a hybrid of command and control policies and market-oriented ones as well as communicative approaches. These policy choices starting in 2000 have been unequivocally successful, resulting in a more than 9-fold multiplication of solar capacity from 2000 to 2004 as well as a steady, albeit comparatively less remarkable, growth in wind power. The accessibility of government support measures, both within the EEG framework and the availability of funding from KfW seems to have favored solar energy over the following eight years up to 2013 as well. In fact, the largest increases in PV took place in the 2009-2013 period. This was despite no significant change in terms of policy support.

The EEG was adjusted several times over the period of its existence, mostly to account for increased capacity, take maintenance costs into account and mitigate its cost on consumers. The policy's success, however, also meant it became increasingly costly and as early as 2009 calls were made for action to be taken as a response to a very high amount of solar photovoltaic additions over the previous few years. This was causing heavy strain on consumer electricity prices and an initial response was the degression of the tariff for solar being increased. Yet another, even more important change to the EEG saw light in 2014. Before EEG 2014 the feed-in tariff scheme was open to all producers, this was no longer to be the case as a tendering procedure was introduced forcing applicants to compete for a contract. Moreover, the government has set "growth corridors" for each technology, specifying the amount of newly installed capacity that is to be supported for wind and solar each year. The yearly amounts were equal for *onshore* wind energy and solar photovoltaics at around 2.5 GW, but the government also provided for 6.5 GW of offshore wind energy to be supported by the year 2020. The effect of these developments already becomes visible in the deceleration of annual additional capacity starting in 2010 and an outright decrease of additions in solar in favor of wind beginning in 2013.

From a policy branding perspective, it's interesting to note the perception of stability generated by the EEG's gradual evolution. For almost 18 years the main German support scheme for renewables has been referred to by this name, despite it having transformed into a significantly different law by the 2014 revision- one that offers fewer guarantees to producers, seeks to bring back under control the growth of solar photovoltaics, and promote more large-scale wind energy. The simple fact that the policy name was retained throughout these modifications may have played a significant part in boosting, or at least preserving, investor confidence in German renewable energy; according to Klijn and Eshuis, branding can play a crucial role in encouraging involvement of potential stakeholders in a policy process (p.67).

Conclusion:

In looking at the development of renewable energy in Germany with regards to the governmental approach, the impression is that towards the end of this period the government is purposely attempting to rein in the growth of renewables until other components of the energy ecosystem adapt to such growth. Additionally, with constant research and innovation the technology incrementally reaches the level of maturity allowing it to be viable without any form of subsidy. The initial hybrid approach had been very successful, aided by the flexibility demonstrated through frequent adjustments to the stipulations of the law in terms of compensation, infrastructure and technological focus while maintaining the core identity of the support scheme largely intact.

In the literature on governance modes, there is strong emphasis that rarely does a policy domain display a single ideal-typical governance mode as described by specific characteristics. This is especially the case in German renewable energy as elements of command and control, market approach and communicative/voluntary measures can be identified. This remains true over time as well and has been especially true in those formative years in which renewable energy needed external support to materialize. This holistic approach may be credited with the German success in this regard. Nevertheless, it remains that the policies in place were continuously tuned to the present conditions as evidenced by the successive updates.

6.2 The Netherlands:

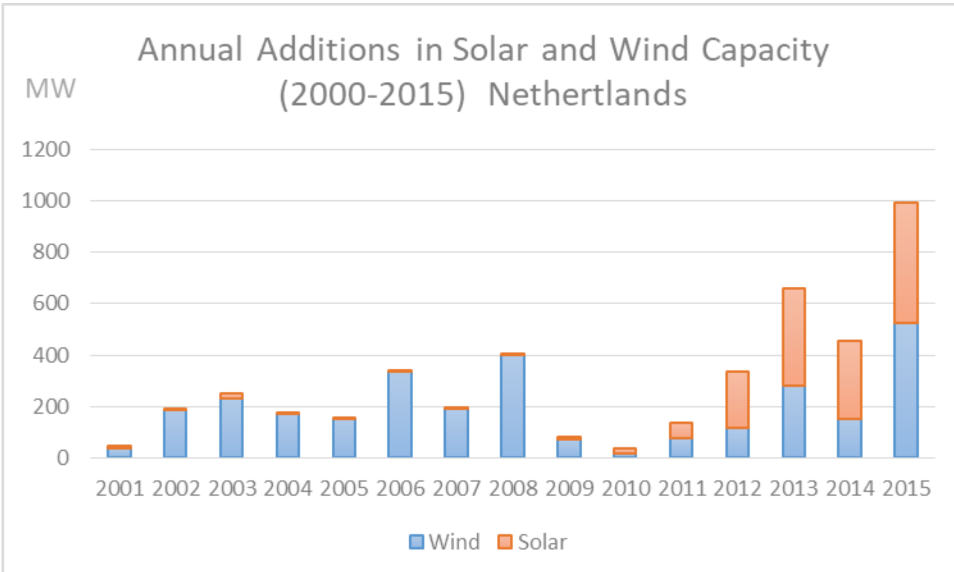

Figure 14 Charting RE capacity in the Netherlands (2000-2015)

With an initial look at the graph above, once can immediately note a lack of regularity. From one year to another, the uptake of solar and wind energy over the years seems rather erratic. It's also worth reminding that this graph is on a much smaller scale than the one preceding it. As this section will begin to elucidate, this pattern is directly correlated to the policy choices that the country has taken during this period. Below is an account of the Dutch policy measures that have accompanied this performance.

At the start of the decade, little growth is visible during 2000-2001. Throughout this period, the main policy support for renewables was a tax exemption on the consumption of RE. The small additions that took place during this period were predominantly in wind energy. There was a modest increase in the pace of additions for the following three years. In 2003, the tax exemption was removed to pave the way for a successor policy. This was the first "affirmative" policy instrument for renewables in the Netherlands (being a feed-in premium as well as a partial tax exemption), known as the MEP (Environmental Quality of Electricity Production). As the table below demonstrates, this was a rather short-lived measure.

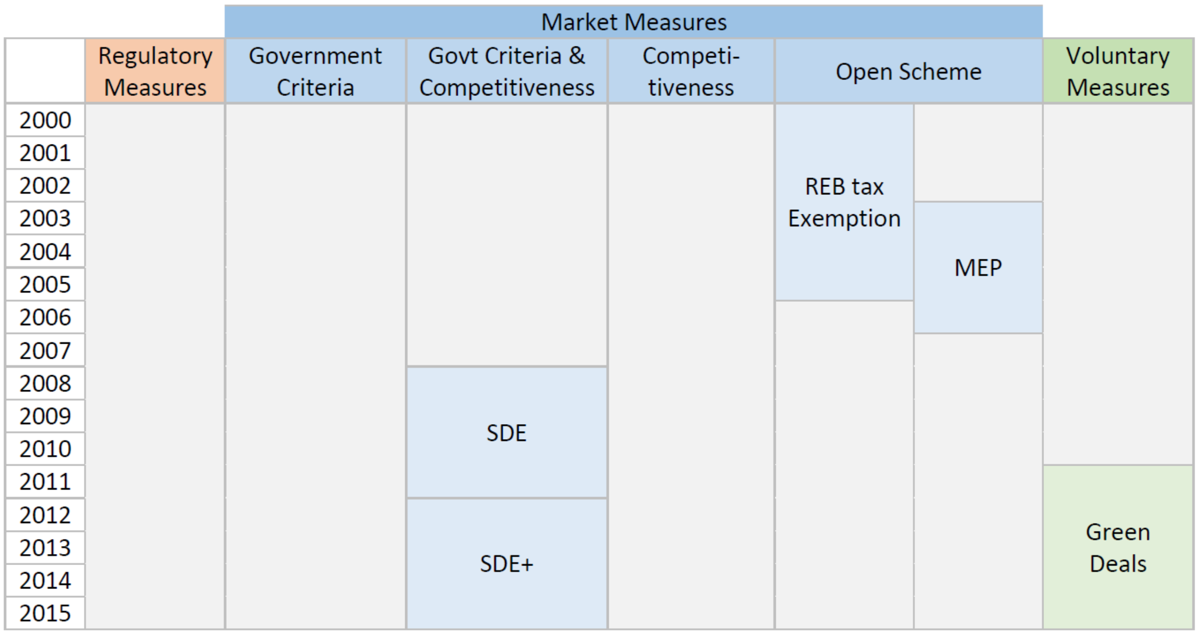

Figure 15 Policy measures in support of Dutch Renewables (2000-2015).

Interestingly, the first two full years of MEP being in force saw a decrease in solar and wind additional capacity compared to 2003. This was despite the absence of any tendering processes and the accessibility of MEP to most Dutch renewable energy producers. Only in 2006 is there a significant uptick in additions. By then the MEP was phased out due to its rising costs. The following year, 2007, annual additions returned to 2004 levels as no major support policy was in place during this interim period.

In 2008, the Stimulering Duurzame Energie (SDE) policy was introduced. It was a feed-in tariff for which the financing was drawn entirely out of the national budget. This instrument was designed to remedy to the shortcomings of the MEP and it seems to have encouraged high investment in wind power during the first year. Up to this point, an overwhelming portion of renewable energy investment in the Netherlands was in wind energy. In 2009, and over the next three years, yearly additions were relatively low in solar power and wind. This may be partially attributed to the financial crises that characterized this period. However, the fact that the other two case studies do not display such a slump (despite the UK and Germany suffering from a recession of comparable gravity) calls for a deeper look into the effectiveness of the SDE policy at the time. SDE in its first iteration was market-oriented type of policy. Specific technologies were assigned a set budget and did not have to compete with other more cost-efficient ones for the State funds. This segmentation has in fact resulted in years in which the funds allocated to ground-based wind power went unused due to lack of demand, whereas solar PV funds were largely insufficient given the number of applicants (BeterDuurzaam, 2018). This inefficient allocation of resources, informed by government-set criteria more than competitiveness, was among the main shortcomings that led to the SDE being updated.

Significant developments seem to happen starting in 2011. The updating of SDE into SDE+ brought with it a shift towards more exposure to market forces. All technologies competed for the same pool of subsidies. Additionally, the tendering of contracts was done four times each year, with projects requiring less maximum subsidy amounts being considered first and the ones needing higher subsidies allowed to bid in the later tender rounds. These changes coincide with a notable acceleration of uptake in the Netherlands over the following few years. Most importantly, starting in 2012 more than half of newly installed capacity is solar photovoltaics. This sudden prevalence of solar photovoltaics can be explained by the shift towards a more market-centered support scheme and the fact that (according to some estimates) the levelized cost of electricity from photovoltaics dropped 60% in the three years leading up to 2012 (Wells, 2012) and began to approach the cost of wind for the first time. This drop in costs, coupled with photovoltaic installations necessitating a smaller minimum amount of investment than wind power, are most likely why the tendering process has benefitted solar.

Renewable energy in the Netherlands seems to be on the path to catching up with the EU average. However, even during the years with the highest new additions the country continues to trail the UK and Germany. One possible explanation for this deficit is, as stated in the beginning of this section, the irregular policy trajectory that the country has taken. It is safe to assume that investments are attracted to jurisdictions with a high degree of stability. The abrupt ending of MEP after three years, and the significant modification that SDE has undergone may have played a part in discouraging investment. This could be through a simple increased perception of risk, through a decreased likelihood of the formation of relationships among actors that would otherwise be conducive to further investments, or simply by not running the program long enough for it to attract mainstream interest. The idea that policy stability over time is crucial to cumulative growth warrants us to look beyond our designated study period, at the three full years since 2015. It just so happens that SDE+ remains the flagship policy in the Netherlands running for its seventh year with virtually no changes other than allocated budget. Indeed, from 2015 to 2016 wind power registered its largest year-on-year increase so far with 26% growth and so did photovoltaics with 36% (CBS Statline, 2019). The following years continue to build on this growth. So perhaps SDE+ has begun to elicit a similar level of trust and perception of state to the German policy experience.

To sum up, in terms of instrument typology, support measures for renewables in the Netherlands have been predominantly market-based. But up until 2012 these mechanisms had limited impact. The early open scheme mechanisms were either not sufficiently attractive or too expensive to be sustainable. In 2008 the government opted for a market instrument with a limited budget and technology-specific access conditions, this policy registered moderate progress until it was updated into a competitive tender. Since that point the highest results in Dutch RE came about and continue to do so. Aside from the substance of policies, the manner in which they were rolled out early on, characterized by interruptions and change of course, may have played a part in a less than satisfactory performance. This later seems to have been gradually reversed with a stable and ambitious policy.

6.3 United Kingdom:

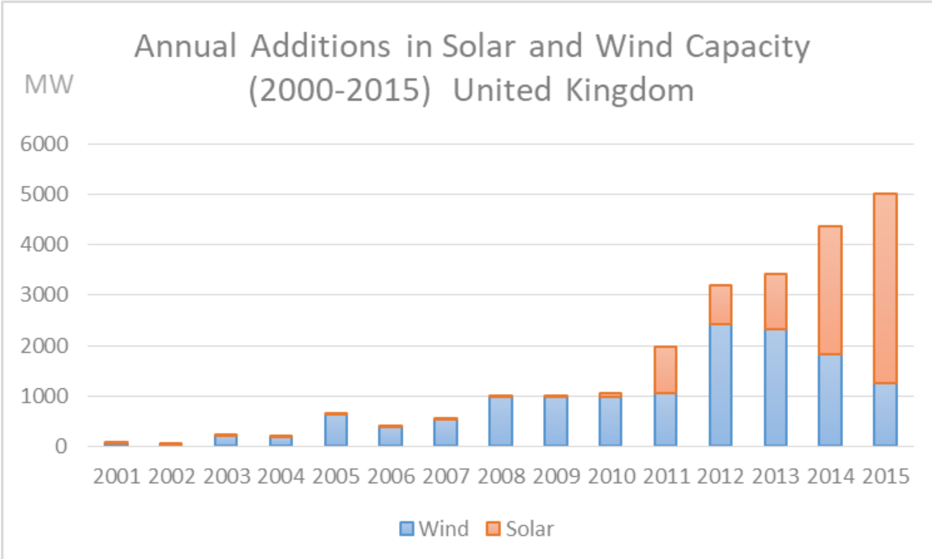

Figure 16 Yearly additions in UK renewables (2000-2015)

Over the first four years of the twenty-first century, growth in British RE was minimal and almost entirely composed of wind power additions. The pace of additions grew consistently but moderately over those few years, but in terms of overall electricity capacity, renewables were somewhat negligible in size. The next seven-year period from 2004 to 2010 saw more robust growth in renewables, still composed largely of wind power. From 2010 onwards, however, the mixture of annual additions ceased to be dominated by wind and renewables in total began growing at a notably faster pace. As can be seen in the policy timeline below, the acceleration in solar adoption beginning starting in 2011 concurred with the introduction of FiTs for small producers.

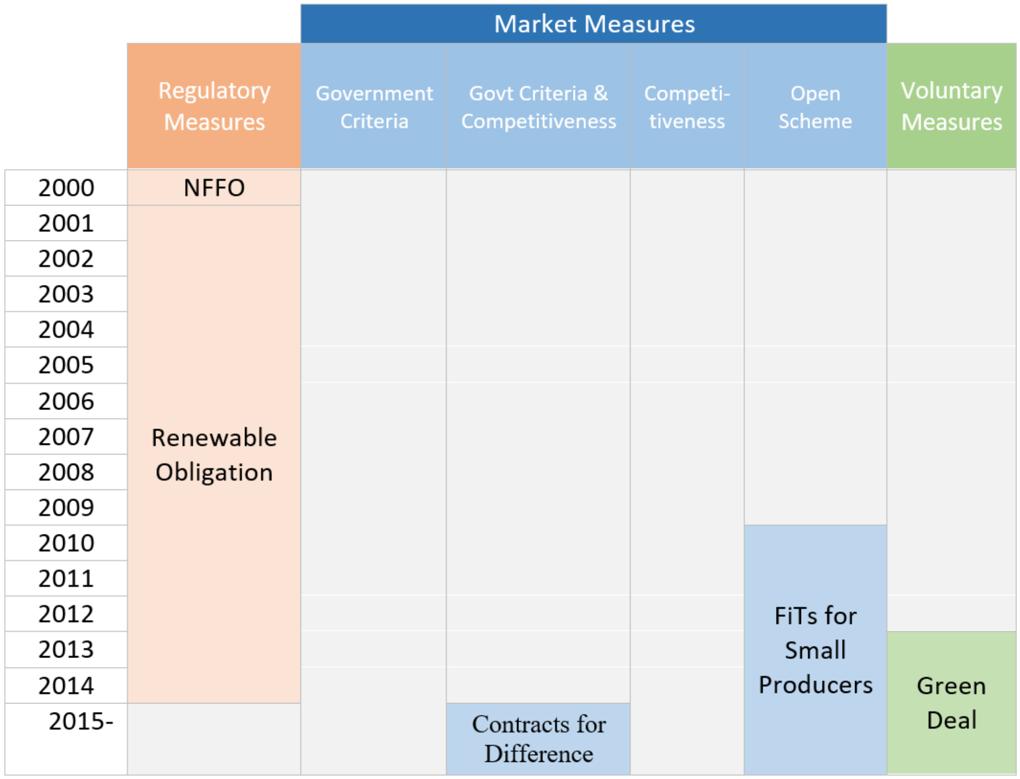

Figure 17 Policy instruments in support of British renewables (2000-2015)

Up until 2002, the United Kingdom had a Non-Fossil Fuel Obligation, which is essentially a command and control measure requiring grid operators to source some of their electricity from non-fossil sources, nuclear power was the predominant beneficiary from such a measure. This explains the meagre showings up until the first two years, when network operators could choose between nuclear and renewables to fulfill the obligation, naturally renewables could not compete with the (then-)cheaper and easily dispatchable nuclear power. Only with the coming of the successor renewables obligation (RO), which targets RE specifically, did the annual growth in renewable energy become more visible. The RO first began in 2002 and the introduction of this subsidy already becomes visible in the amount of installed capacity in the following two years and even more so in 2005. In general, it can be said that over the first ten years of its existence, the RO has coincided with steady growth in wind power additions (i.e. the amounts added each year are increasing). But only from 2010 onwards do solar power projects begin to form a sizeable portion of overall installed RE capacity. From 2010 to 2011, solar power capacity grew almost tenfold (936%) and continued to register large increases over the coming years. Of course, this high growth percentage is largely due to the low base effect, as the stated total PV capacity in the UK was no more than 100 MW in 2010. This rise in solar power seems to have coincided with the introduction of the Feed in Tariffs for small producers as well as the aforementioned dip in solar LCOE. This measure compensated producers at amounts according to their production size, smaller categories of plants received more money per kilowatt. Naturally such a measure favors investment in solar photovoltaics because the entry price for solar panels is much lower than it is for wind, and they are usually less intrusive and can be seamlessly deployed within more densely populated areas.

The Renewable Obligation in its initial form (i.e. as implemented in 2000) did not differentiate among technologies, granting the same compensation for a given amount of renewable-sourced electricity. Moreover, electricity suppliers in the UK could simply opt out of the obligation scheme by purchasing ROCs on the market or paying buy-outs directly to the State. Because some projects were faced with regulatory hurdles such as permit refusals, this meant that the costs of the support measure were not necessarily translated into installed capacity, the existing producers simply shared all the financial support from the buy-out fund, each according to the percentage of electricity they have generated. This lack of linkage between funds spent and physical installed capacity has stunted the growth of renewables in the same way that the option to acquire nuclear electricity in the previous NFFO made it a less effective support mechanism for RE support, albeit in a more indirect manner.

7 Analysis

Having discussed the governmental efforts to promote renewable energy in the Netherlands, Germany and the UK, as well as the actual performance of the solar and wind sector in these countries over the period from 2000 to 2015, it is now possible to compare the interplay between governance choices on one hand, and concrete performance on the other. And from then on work towards an answer to the main question of this research: How do governance modes affect the uptake of renewable energy?

The following analysis will expand on the multiple observations made and conclusions reached throughout this research, specifically in the findings section.

Early Deployment of Regulatory instruments:

Alternatively referred to as command and control instruments involve the government intervening in the power distribution among actors in the electricity sector, have been a feature of renewable energy policy in the two more successful case studies. Both Germany and the UK intervened to ensure electricity from renewables is taken up preferentially by the grid, and that RE producers are compensated properly. Evidently there are significant differences in the approaches of the two countries which can hold explanatory power regarding the difference in performance.

In Germany, the Feed-in Tariff simply guarantees producers preferential dispatch and a defined price for their output over a certain period. There is no legally prescribed limit on the amount of renewable energy that can benefit from such a guarantee because the costs of it are simply passed on to the consumers. In the UK, however, the Renewable Obligation policy meant the government would oblige electricity distributors to either source a percentage of their electricity from renewables or pay into a buy-out fund. For the actual producers, there were two streams of revenue. The first is the revenue they acquire through selling electricity at market price, which is naturally variable. The second stream of revenue is through the sale of renewable energy certificates to electricity suppliers, which are provided to generators based on the amount of electricity they produce. These certificates are also within a market, in which the buyers are the electricity distributors who are required to present these certificates in lieu of having sourced their electricity from renewables. The market price of ROCs is also variable depending on supply and demand. At this point one can identify some differences between the German and British policy. In addition to the significantly more complex British scheme it's notable that German producers could operate unaffected by market forces and have a reasonable forecast of their earnings and return on investment, whereas in the UK market prices of conventional energy and other forms of renewable energy were a factor in the expected revenue. Therefore, even though the German and British cases can be described partially within the same governance mode, one of the key differences in the substance of governmental intervention is the degree to which it has insulated unestablished technologies from market forces. Perhaps more importantly, by allowing the possibility of a buying out of the obligation the British Renewable Obligation fails to create a link between the costs of the support measure and the amounts of additional RE capacity that it generates.

During this same time period, the main measure that the Netherlands instituted was the MEP, which was a subsidy funded by the national budget. Overwhelming demand was halted after four years of operation. This was followed by a period in which there was no major support policy for renewables in the Netherlands. Predictably, Dutch renewables did not perform well compared to its eastern and western neighbors.

Economic/market instruments:

As we've established, the pre-2012 German EEG, under our framework, qualifies both as a regulatory and an economic instrument. One can argue that its initial success is a direct result of the co-existence of both characteristics. Its "command-and-control" aspect resides in the requirement for priority dispatch and remuneration placed upon electricity distributors who forward these costs onto consumers. This, of course, results in higher electricity prices for consumers but from a government perspective it means the absence of a specified budget ceiling. And from a deployment point of view, no limit to potential growth. This is in contrast with the heavily regulatory British RO which specifies in advance the amounts of megawatts that are to be sourced from renewable sources, and with the MEP in the Netherlands which as an open scheme subsidy funded by the national budget had to be halted as soon as its costs rose above expected levels.

A market instrument is one by which the government attempts to direct the behavior of actors using economic resources, with the assumption that said actors seek to maximize profits (Park, 2013). In that sense, the cases reviewed in this research have featured a wide variety of market instruments.

Only Germany has deployed a succession of large-scale economic instruments aimed at supporting the investment (as opposed to the operation) portion of renewable energy production. It is highly likely that the successive loan programs by KfW are at the core of the German success story in terms of renewables in general, and particularly its early adoption of solar power. The low interest loans which could cover up to the entire cost of new projects, in conjunction with the guarantees provided by the EEG feed-in tariffs, would understandably make renewables a very attractive investment. Given that these programs began in 2000, a time when solar was still a very expensive method of electricity generation, it is safe to assume that, as the Dutch case illustrates, such programs would not have been very effective as standalone measures. Presently, however, with the levelized cost of electricity from solar and onshore wind becoming lower than coal, measures such as these may become enough.

As costs dropped quickly, purely economic instruments became more feasible. There is an eventual convergence towards competitive feed-in tariffs across the board. Besides the main policy that is RO, the UK in 2010 began a program of Feed-in Tariffs for smaller installations, which can be credited with the exponential increase in solar that becomes visible the following year. Also in 2010 the first signs appeared that Germany's EEG will be updated into a Feed-in tariff designed to decrease costs and enhance competitiveness, this transition takes place in 2012, the same year SDE+, a largely similar policy, becomes the main support mechanism in the Netherlands.

Voluntary Measures and Non-policy Factors:

Starting in 2011, despite significant differences in support measures across the three countries, solar power growth increases significantly across the board. This happened during a period in which the levelized cost of electricity from solar power has had its steepest decrease, becoming 44.2% cheaper in 2015 compared to 2010. Within the conceptual framework of this research this would intuitively be attributed to external factors other than governmental action. But there is merit to the argument that this decrease is an indirect result of past policies. This has been expressed as a "virtuous cycle of falling costs, increasing deployment and accelerated technological progress" (IRENA, 2018), which may allude to the decrease in cost being the result of economies of scale, the latter being fueled by higher demand from producers wishing to benefit from previous subsidies. More directly, this decrease in cost could simply have been achieved through R&D that took place within the framework of government sponsored research programs, which within the conceptual framework of this research qualify as voluntary or communicative instruments.

Oftentimes, the results of these voluntary and communicative agreements during the period from 2000 to 2015 are difficult to assess. The information collected within the scope of this research is insufficient to produce a causational judgment on their effectiveness. Because of their non-compulsory nature it is challenging to have an idea about the scope of programs such as the Dutch Green Deals and Energy Performance Advice schemes. This is especially true in cases where they run in tandem with other more substantial schemes such as feed-in tariffs or investment subsidies.

In other cases, the “academic” nature of some measures such as the successive German Energy Research Programs means any innovations or findings may take a significant amount of time to find their way into common practice. It also means they are not necessarily concerned with increasing renewable energy production, but rather with the overarching goal of decreasing emissions which may be accosted through a variety of ways. Also characteristic of research-based measures is that they tend to have an international character, and any potential benefits may not be limited to the country under whose supervision they take place, especially in the framework of the European single market.

8 Conclusion:

8.1 Revisiting the main and sub-Research Question

This research set out to answer the question of how governance modes affect renewable energy, to that regard, two intermediate sub-questions had to be answered regarding the evolution of renewables in the three case studies. Sections V and IV of this text, respectively, provide a detailed answer to the sub-questions. Below is a concise summary followed by a focus on the main research question.

Sub-question 1: ***How have the UK, Netherlands and Germany tried to promote renewable energy from 2000-2015?***

Germany's main support policy for renewables was the *Erneuerbare-Energien-Gesetz* (EEG), which provided feed-in tariffs to renewable energy producers for periods of 20 years. Periodically, the government would lower the offered feed-in tariffs for any new potential beneficiaries, in order to motivate a decrease in the costs of electricity renewables. These feed-in tariffs were reflected in the customers' electricity bills. Addiitonally, the EEG guaranteed preferential deployment of renewable energy. Moreover, Germany also provided multiple forms of financial assistance to renewable energy producers through the KfW bank, mostly through loans and grants. There were also successive Research Programmes through which the Federal government provided funding for scientific work aimed at ensuring a sustainable energy supply.

The United Kingdom relied mainly on the Renewable Obligation in order to promote renewables during the period from 2000 to 2015. This policy "places an obligation on UK electricity suppliers to source an increasing proportion of the electricity they supply from renewable sources." (OFGEM, 2017). This policy was targeted mainly at large scale production. For smaller producers, Feed-in Tariffs were later introduced in 2010.

The Netherlands's first direct support measure for renewables was the MEP, a feed-in premium which pays beneficiary producers a fixed sum on top of the market price of the electricity they produce. The MEP was an open scheme and lasted from 2003 to 2007 before it was judged too costly. From 2008 to 2011 a new policy was introduced, the SDE. Unlike MEP, SDE was only accessible through periodic tendering procedures. Under this measure, beneficiaries only get remunerated if the cost of electricity production from their specific technology are higher than the market price of electricity. This policy was then updated in the form of SDE+. The changes in this policy were meant to encourage competition and efficiency by giving priority for funding to cheaper producers.

In terms of governance modes:

The United Kingdom relied largely on a command-and-control approach in ensuring a portion of its electricity comes from renewables, later during this period, it began to diversify its efforts, before setting its renewables policy on a path towards a market-based mode governance.

Having had a head start in promoting renewables, by the beginning of the study period Germany had a hybrid mode of governance, which included instruments from all three categories meant to provide guaranteed market access and predictable incomes for producers, financial aid for potential investors and stimulate technological advancements for increased efficiency.

The Netherlands relied mainly on market instruments throughout the entire period. During the first half, the approach was reluctant and limited in scale. The second half saw the establishment of a stable support mechanism for renewables and a diversification into voluntary instruments.

Sub question 2: ***How has renewable energy progressed in the UK, Netherlands and Germany during the 2000-2015 period?***

The following chart illustrates the aggregate performance of solar and wind in the three countries from 2000 to 2015.

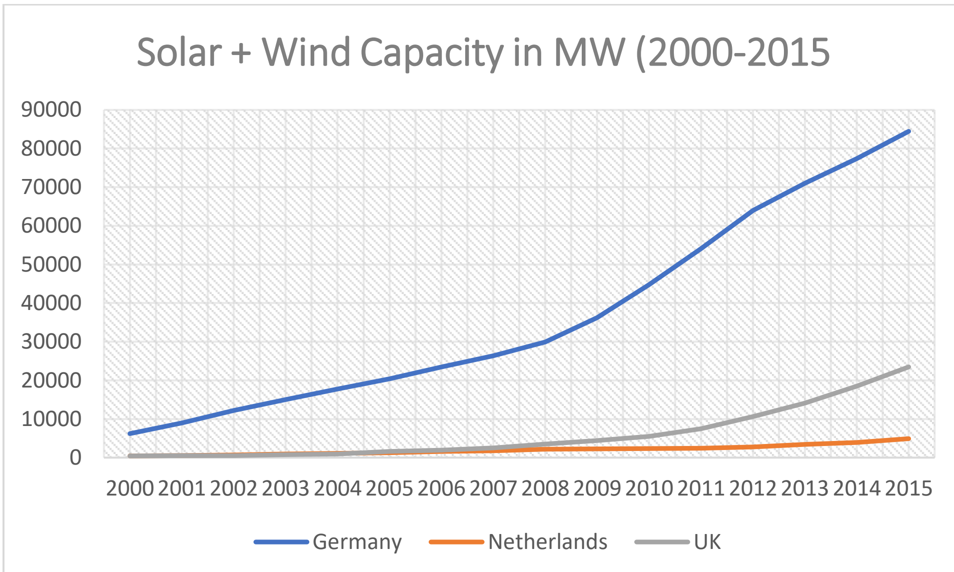

Figure 18 Solar and Wind Capacity in UK, NL and DE (2000-2015)

In general, solar and wind in Germany were already established before 2000, continued to grow at a remarkable rate, which further increased after 2008. Solar photovoltaics, in particular, grew unabated until about 2013 when the pace of additions slowed down. A slowdown which coincided with a rise in the pace of wind power additions. In the UK, solar capacity was negligible up until 2009 when it began to grow in significant numbers. Wind power was more established up until 2010 when additions in solar joined the general trend across all three countries and registered high growth. Nonetheless, additions in wind power capacity continued to surpass solar in the island nation until 2014. The table below shows the percentage of electricity that each country sourced from renewable throughout the period from 2000 to 2015. Similarly, the Netherlands also had a negligible solar capacity in the outset, which registered weak growth until 2010 when the pace increased at a rate comparable to the two other countries. Wind power grew at a steady but overall subdued pace throughout this entire period, except for 2014-2015. The illustration below shows the percentage of electricity sourced from wind and solar in the three countries during this period.

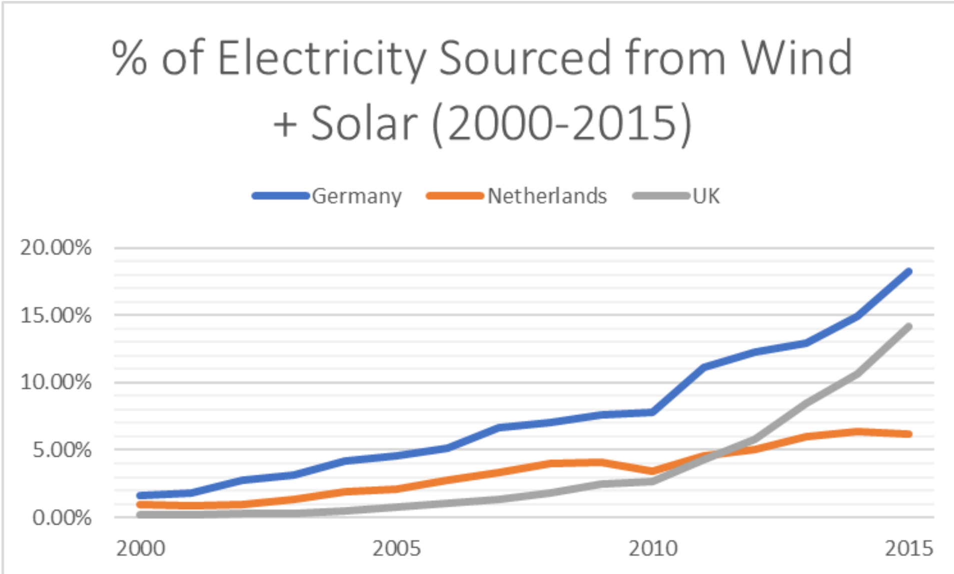

Figure 19 Percentage of electricity from W+S in NL, UK and DE (2000-2015)

This graph shows that despite differences in absolute numbers, the three countries started off with relatively similar portions of electricity from renewables. While the difference is visible since the beginning, from 2010 the percentages for the UK and Germany being to increase whereas the Netherlands stagnates around the 6% level.

The main research question of this thesis is ***How do governance modes affect the uptake of renewable energy?***

In short, what has transpired through this research is that a hybrid mode of governance featuring the comprehensive deployment of economic, regulatory, communicative and voluntary measures provides the most supportive environment for the development of renewable energy. Any of these types of instruments, deployed alone, would likely not have produced as good a result. However, these statements are only applicable in the context of the period of study of this research. The reality is that there is a complex interplay between governmental policies and results, which is prone to influences from historic developments, interior and exterior factors.

The hybrid mode of governance that is at the heart of Germany's success is evidently the most compatible with the calls for an energy transition that were quite prevalent at the time. The comprehensive mobilization that it entails helped tackle the challenges of the time. RE technologies in the early 2000's were still uncompetitive, their output was less efficient, and economies of scale had not been established yet. Moreover, due to the relative novelty of photovoltaics and, to a lesser extent, wind turbines at that time, public perception may have been skeptical and qualified technicians scarce. Overcoming such obstacles required the financial support, guarantees of income stability, research funding and knowledge dissemination.

The British approach, which for much of the study period featured a regulatory measure with relatively little in the way of supporting investment, rather than operation, in renewables produced medium results, especially in the first two thirds of this period. Afterwards, solar photovoltaics began to thrive in the UK when previously wind constituted the vast majority of the countries production. This change, however, may be in part thanks to factors that developed outside the country.

As the efforts undertaken by Germany bore their fruit conditions became much more favorable to investment in renewables, in Germany as well as abroad. This is evident through the rise in both solar and wind starting roughly around 2009 in all three countries and all over the world. This also translates into policy choices, which by 2014 began to converge in all three countries towards support mechanisms that only seek to ensure RE producers can operate profitably. By 2014 the schemes that offered constant premiums (regardless of market prices) and schemes that involved obligation and guaranteed dispatch were no longer open for new applicants.

One element which may have had a certain degree of correlation with the success or failure of the overall effort to promote renewable energy is consistency. Specifically, consistency in terms of policy measures is a feature of the German and the British trajectory in supporting renewables. In both countries, the main policies in place have had a lifespan of more than a decade. This is in stark contrast with the Dutch experience which has seen successive measures replacing one another. However, this correlation may imply a causation in either direction. It could be that the poor performance of the Dutch renewable energy sector created the necessity for opting for different approaches and, conversely, the successes achieved by the German EEG motivated its continuity. On the other hand, it can also be argued that the perceived regulatory stability (or lack thereof) has been a crucial factor in incentivizing or discouraging investments in renewables.

8.2 Limitations

The development of this research presented some challenges, chiefly due to the choice of theoretical framework. Although there is undeniable merit to the idea of analyzing the extent to which "governance modes" as a concept is a determinant of the growth of the renewable energy sector, my conception of it, shaped largely by the prescribed scope for the research and the amount of accessible information, did not capture the full complexity of such a topic. One important realization I made as I proceeded with analyzing the data was that it would have been more explanatory to conceive of the development of renewable energy support measures in terms of shifts than to become preoccupied with characterizing which regulatory governance modes I could identify. This is because small changes to a policy may not necessarily reflect a complete paradigm change in the approach to supporting renewables, but they may nonetheless hold a significance in terms of the tangible results. Especially when the progression of State support for renewables is visualized over time, any identifiable patterns may be more interesting.

Despite my initial awareness of the huge number of external factors that can shape the growth of renewables besides policies and support measures, it remains that relatively few lessons can be learned from looking at policy instruments alone, and the interplay between the degree to which policy changes come about as a response to external development is prohibitively complex given the scope of this work. Similar research on the topic has taken in many other contributing factors, along with policy instrument choices, in order to arrive at a conclusion regarding the effectiveness of policy instruments alone. Namely, Park (2015) looks at 20 separate variables to identify the effects of policy instruments, electric power market, the State economy, political environment and natural resources endowment on the development of renewable energies.

One of the aspects in which I had to limit my analysis is the distinction between describing the governance modes that led to the creation of policies and measures, and the governance modes that the resulting policies created in the field of renewable energy. In other words, this research does not cover the actors and power distribution during the policy formulation process and focuses more on what I had initially interpreted as the governance modes within the electricity sector. These are two separate lanes of inquiry, but it would come as no surprise that the output of a policy formulation process reflected the interests and power dynamics among the participating actors.

Moreover, and as has been noted throughout the analysis, it would be inaccurate to assume that the interval between policy choices and their reflection in terms of performance is a uniform amount of time. It must be expected that some policies tend to bear fruit quicker than others, namely the ones aimed at financing the acquisition of production capacity (such as loans and grants). It can also be assumed that production subsidies also tend to have an identifiable reflection on output. However, the benefits of voluntary instruments, and R&D tend to be harder to detect based solely on output within one jurisdiction. It then follows that this disparity may have affected any visible causalities between governance modes and renewable energy growth in my analysis.

8.3 Future trends and recommendations:

All current evidence suggests a future in which renewables, most notably solar power, will be a highly competitive option compared to conventional methods of electricity production such as gas and coal. This is illustrated by Swanson's Law, which observes that the price of electricity from solar panels decreases by about 20% for every doubling of accumulated capacity shipped (Naam, 2011). The exact rate of decrease can be up for debate but what is relevant here is that the cost of running solar panels is set to become competitive with other conventional energy sources without the need for government support, apart from grid access guarantees.

The same trend has been noted for the case of wind power. With the emergence of economies of scale and the increasing availability of expertise and infrastructure, the price of installed wind turbines has decreased by 30-40 % on average since 2009 (IRENA). This downward pressure is expected to continue over the years. Aside from the projected decrease in prices which is set to incentivize investments on all scales, this predictability is in stark contrast with the infamous volatility of fossil fuel prices. This eventually means that the new challenges for the propagation of renewables have less to do with market competitiveness and the price of producing a megawatt hour, and more to do with the fact that renewables such as wind and solar are not easily dispatchable or predictable. Output from solar and wind can vary drastically subject to weather conditions. Therefore, from a policy perspective, I suppose that once a critical mass (in terms of RE share of total energy) has been reached there will have to be a shift from production subsidies, loans and quotas towards mitigating these characteristics of RE.

The most evident potential route towards limiting the effect of the variability of renewables, in my opinion, is to push for further internationalization of the electricity market. This is a logical step for overcoming the localized variations in output from renewables. Under a synchronous grid, areas which are producing an excess of electricity from renewables (thanks to sunny or windy conditions) can supply those where conditions are not as favorable. Scaled up to a sufficient extent (especially over several longitudes), this synchronization can allow solar power production from areas where it is daytime to feed into areas in which it is dark. The beginnings of projects such as these are already taking shape. For instance, the European continent already boasts a unified super-grid (i.e. the national electricity grids of the block's countries are all linked to one another). There is still much left to be done with regards to improving the global electric connectivity. And in the spirit of this research, it will be interesting to observe, reflect and theorize on how best to approach this transnational, multi-sectoral effort from a governance perspective. The national electricity grid operators in most countries are either state owned or natural monopolies subject to strict regulation, therefore it is safe to assume that such a process will naturally be dominated by the States. The question then, from a governance modes perspective, is whether the development of a more integrated global grid should be left to be shaped by market forces, allowing for an efficient equilibrium to be attained, or is the prevalent conception of energy as a matter of national security going to dominate and hinder such a process. From the perspective of intergovernmental organizations, and assuming an international consensus on the positive nature of the integration of the worldwide energy grid, should the promotion of such a process rely on incentives/disincentives, prescriptive regulation or mere vocal support? These problematics would form the future continuation of the debate on governance modes in promoting sustainable energy.

In any event, and for better or worse, developments in the political arena all over the world will inevitably seep into the discourse and potentially the policy trajectory regarding renewable energy. The wave of right-wing populism that has characterized the past few years has been suspiciously correlated with cynicism towards the necessity of combatting climate change. From Donald Trump claiming that the noise from windmills [sic] causes cancer (Greenber, 2019), to Dutch political newcomer Thierry Baudet pledging to halt construction of solar and wind installations (FvD, 2018). There are many manifestations of this nexus between right-wing populism and climate skepticism. The mechanisms and financial flows behind such a trend are not exactly unknown or secret, it is widely known that fossil fuel interests spend large sums to preserve their sources of income. However, the issue of lobbying and campaign finance takes different shapes from one country to another and any potential solution would have to be adapted to the local institutional framework. One thing that would be beneficial across the board is ensuring a properly informed electorate both in terms of campaign finance transparency and conveying the true urgency of the perils presented by continued greenhouse emissions.

These concerns and most of the concepts this research is built on pertain to an environment in which scarcity is still a concern: solar panels, wind turbines and the operation of such installations are still costly goods and services just as are fossil fuels. And while alarming statistics on climate change stress the necessity of immediately curbing carbon emissions and switching to cleaner energy sources, in the medium to long term there could occur a radical change in the range of alternatives available. Recent technological research developments promise to usher in an age of energy abundance with the feasibility of nuclear fusion. Unlike classic nuclear *fission* which uses the somewhat scarce radioactive elements and is very prone to NIMBY attitudes, *fusion* relies on practically abundant elements and is theoretically devoid of such risks, making it environmentally friendly, sustainable and renewable. Already there are sizeable international efforts towards making such technology feasible, with 35 countries contributing to the International Thermonuclear Experimental Reactor, a €13 billion megaproject in France which is meant to realize nuclear fusion by 2035 (ITER, 2016). The implications of such a development and the adequate policy approach to it, however, is a debate for the future as not enough details are available presently and until then, efforts should focus on curtailing emissions based on proven and existing technologies.

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