Polycentric governance for renewable energy policies?

A comparative case study of governance approaches and solar PV policies
in Switzerland and the Netherlands

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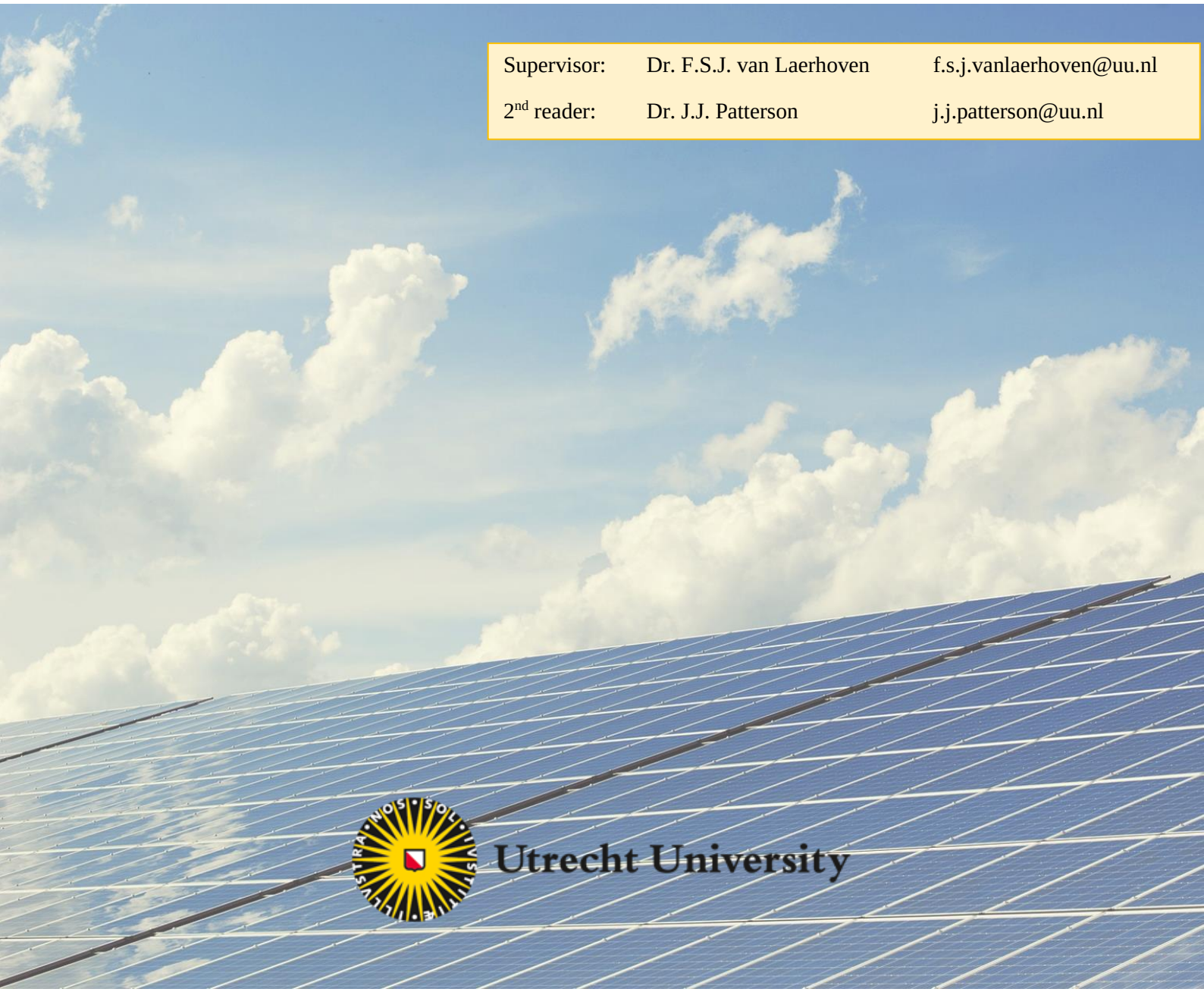

Summary

Polycentric governance, which refers to the steering process of multiple and overlapping centres of authority in a governance system, has been applied to several research domains including metropolitan areas and natural resource systems. However, the concept of polycentricity has not been extensively applied to other domains, such as energy. With the increasing share of renewable energy and in particular solar photovoltaics (PV), this thesis has explored the relationship between polycentric governance and the performance of solar PV policies. In a comparative case study between Switzerland and the Netherlands, the level of polycentricity and PV policy output were assessed. Based on a prior literature study, operationalised indicators were drafted for polycentric constructs and policy evaluation criteria. The indicators of *multiple centres of decision-making*, *overlapping centres*, and *autonomy* were used to measure the level of polycentricity regarding governance approaches. Furthermore, the indicators *adaptive capacity*, *mitigation of risk*, and *institutional fit* were used to evaluate the performance of PV policies on the national and subnational level. In addition, the collected data from Switzerland and the Netherlands were assessed by means of content analysis. The comparative analysis showed a rather unexpected result in Switzerland's low score on PV policy performance. In contrast, PV policy performance was considered high in the Netherlands. Moreover, regarding the level of polycentricity, the difference in total scores between the two cases was minimal. Unfortunately, this does not explain how polycentric governance approaches affect PV policy performance. Initially, the assumption was made that governance approaches in federal and unitary states would differ considerably from each other. Although this assumption was based on relevant and highly cited literature, the findings regarding polycentric constructs were found to be too similar for a comparative study. In the end, however, this thesis contributed to empirical and methodological developments of polycentric governance. Furthermore, the findings suggest new indicators for measuring polycentric constructs and underlining the importance of the indicators overlapping centres, autonomy, and the evaluation criterion policy experimentation. Although previous research has linked positive outcomes to polycentric governance, the advantages for the energy domain could not be confirmed in this thesis. Further research based on sophisticated assumptions is needed to increase empirical data in the fast-growing literature concerning polycentric governance.

Preface

Polycentric governance is a concept that has sparked my interest for some time. It is a governance approach that has a high level of complexity and operates at a large scale including multiple levels of decision-making. In my bachelor study at the University of Technology Eindhoven, I got introduced into the field of energy governance. More specifically, multilevel interactions such as the *multi-level perspective* by among others professor Frank Geels caught my interest. Later, in my master's study, I could find a way to delve deeper into the policy interlinkages between multilevel stakeholders. After I became familiar with the work on collective action problems by Nobel laureate Elinor Ostrom, I knew I wanted to include polycentricity as a research topic for my thesis.

Linking governance approaches to environmental issues makes this thesis highly valuable. In general, the way energy governance is shaped can affect the speed of the energy transition. Energy policy is established within the policy arenas of international, national, and subnational regions. With this thesis, I hope to give insights into the national and subnational scope of energy governance approaches and the effect on consecutive policies. Moreover, I expect that this might lead to a better understanding of energy governance on a polycentric scale. Polycentric governance is (yet again) an exciting concept among scholars in the quest to search for optimal ways to govern society.

Acknowledgements

I would like to thank my thesis supervisor Frank van Laerhoven for his continuous support and constructive feedback on both the process and content of my thesis work. Each meeting felt really productive and improved my academic and analytical thinking. Valuable lessons include the brainstorming about methodological issues, writing consistently and structuring the thesis in a logical way. Furthermore, I would like to thank my girlfriend and fellow students for reviewing parts of my master thesis.

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List of Abbreviations

AG	Aargau (canton)
ANP	Algemeen Nederlands Persbureau
BFE	Bundesamt für Energie
BFS	Bundesamt für Statistik
CBS	Centraal Bureau voor de Statistiek
CH	Switzerland (country)
CREST	Competence Center for Research in Energy, Society and Transition
EnDK	Conference Cantonal Energy Directives
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
NL	The Netherlands (country)
OECD	Organisation for Economic Cooperation and Development
PV	Photovoltaic
PwC	PricewaterhouseCoopers
RVO	Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland)
SCCER	Swiss Competence Centers for Energy Research
SFOE	Swiss Federal Office of Energy
UNFCCC	United Nations Framework on Convention Climate Change
VvE	Homeowner association (Vereniging voor Eigenaren)
ZH	Zürich (canton)

1 Introduction

Global greenhouse gas emissions should be strongly reduced in order to keep global warming 'well below' 2°C compared to pre-industrial levels, as agreed by all United Nations members in the 2015 Paris Agreement (UNFCCC, 2015). Electricity and generation of heat are the largest sources of emissions, accounting for 42% of the total global emissions (International Energy Agency (IEA), 2016). Therefore, there is a tremendous potential for renewable electricity to steer nation-states to low-carbon societies. One of these renewable electricity sources is solar photovoltaics (PV).

Solar PV development is governed on the national and sub-national level by, for instance, state regulation and regional energy policies. The design process of these policies is often top-down, from one central institution to lower levels of authority. However, in the past decades, researchers have observed a shift from hierarchical forms of government to multilevel forms of governance due to the increase in interaction patterns of a multitude of agents (Dewulf, Lieshout, & Termeer, 2010; Thiel & Moser, 2018). These multilevel forms of governance hereinafter referred to as governance approaches, have arisen as part of the critique towards hierarchal forms of governance (Biesbroek, 2014; Heikkila, Villamayor-Tomas, & Garrick, 2018).

One of the concepts used to describe multilevel governance approaches is polycentric governance, which is defined as the process of steering and controlling the societal agenda, policy goals, and policy implementation by multiple connected, formally independent, centres of decision-making (V. Ostrom, Tiebout, & Warren, 1961). Examples of these decision-making centres are local-, provincial-, and national governments, but also firms, families, and networks of local governments (E. Ostrom, 2010). Polycentric governance is best known for its application to metropolitan areas and natural resource systems (as in Andersson & Ostrom, 2008; Heikkila et al., 2018; Ostrom et al., 1961; Pahl-Wostl & Knieper, 2014), which have shown the benefits of using a polycentric approach. In short, advantages of polycentric governance over hierarchical modes of governance include: greater local access to decision-making; enhanced trust within decision-making centres; better institutional fit due to tailor-made arrangements; more opportunities for policy experimentation and adaptation; and a more flexible, less vulnerable institutional design (Carlisle & Gruby, 2017; Heikkila & Weible, 2018; Morrison, 2017). Based on these positive contributions of polycentricity to metropolitan and natural resource systems, this research focuses on the original application of polycentric governance to the energy domain. Does polycentricity also lead to better energy policies?

1.1 Problem description and knowledge gap

The urgency for decarbonisation is high (Jordan et al., 2015), but it is unclear to what extent the current governance approaches are most effective in solar PV stimulation. The potential of different governance approaches has been discussed to some extent in the past years (see for instance Jordan et al., 2015;

Kern & Bulkeley, 2009). However, practical implications of such governance configurations are not yet thoroughly researched (Di Gregorio et al., 2019; Morrison, 2017), which is mainly due to knowledge gaps regarding the concept, theory and methodology of polycentricity (Heikkila et al., 2018). This is especially the case for the application of polycentric governance in the energy domain (Bauwens, 2017). Therefore, this research is of explorative nature in describing the relation between polycentric governance and solar PV policy design.

1.2 Research objective and research framework

The objective of this research is to contribute to better policies in the renewable energy domain. One way is to build an understanding of the effects of polycentric governance on policy performance. This is done by making an assessment of polycentric characteristics and by evaluating criteria for policy performance. The research objective is outlined in the research framework, which is shown in Figure 1.

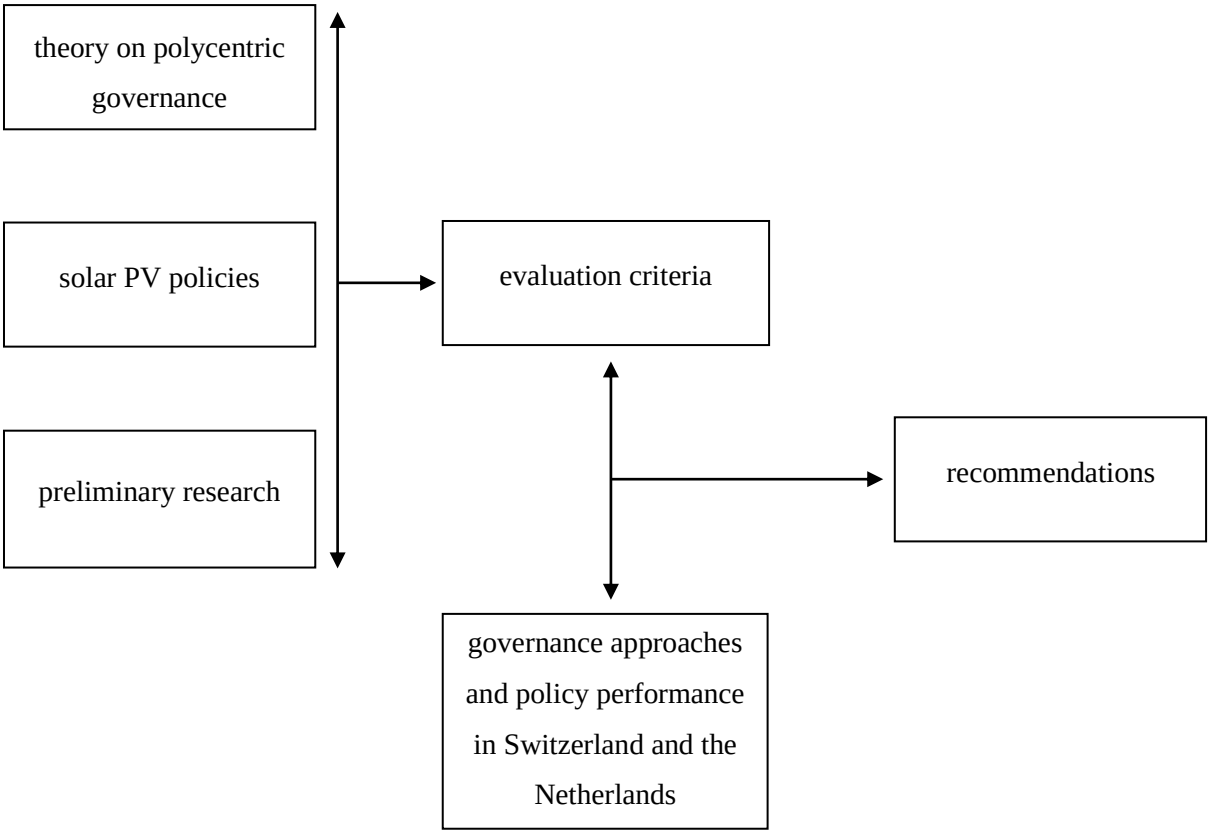

Figure 1. Research framework (structure based on Verschuren & Doorewaard, 2010).

(a) The research starts with a literature study of polycentric governance characteristics and solar PV policies. In addition, preliminary research on the conceptual model of energy policy evaluation is conducted. These three elements yield the evaluation criteria (b), on the basis of which current solar PV policies on the national and subnational level in two countries are evaluated. Notice that the choice for Switzerland and the Netherlands is elaborated in Chapter 3.2. The results of this assessment are

processed into (c) recommendations for national and subnational governments regarding polycentric energy governance.

This research focuses on solar PV policies only, rather than covering an extensive range of renewable energy policies for technologies such as wind, solar thermal, and hydroelectricity. By focusing on specific policy within a governance system, variation in polycentric governance design is teased out (Heikkila & Weible, 2018). Examples of policies include legislation and financial incentives for solar PV. Furthermore, for analysing solar PV policies development, the time frame is set from 1999 to 2019. The start year 1999 is chosen since the Swiss 'Old Energy Act' was introduced that year (IEA, 2018). The justification of the case study choices is explained in the methodology section (Chapter 3).

1.3 Research question

The research project is descriptive, evaluative, explanatory, and prescriptive based on the criteria of Verschuren & Doorewaard (2010). First, this research adds to the polycentric theory by describing the characteristics of energy governance approaches and criteria for measuring polycentricity. Second, solar PV policies are evaluated by criteria regarding policy performance. Furthermore, from the comparison of case studies, differences and similarities in solar PV policy design are explained. Lastly, prescriptive knowledge is required to fulfil the aim of providing recommendations to governments on the national and subnational level. From the research objective, the following main research question can be defined:

How do approaches to governance affect the performance of solar PV policies in Switzerland and the Netherlands?

1.3.1 Sub-questions

The main research question is divided into the following sub-questions:

1. Which governance approaches exist in Switzerland and the Netherlands, and to what extent are these approaches polycentric?
2. Which solar PV policies are implemented on the national and subnational level in Switzerland and the Netherlands between 1999 and 2019?
3. How can these policies be assessed?
4. From the comparison of governance approaches in the two case studies, how can the differences and similarities regarding solar PV policies be explained?
5. What are the opportunities and limitations of polycentric governance applied to the energy domain on the national and subnational level?

1.4 Societal and scientific relevance

This practice-oriented research contributes to the improvement of renewable energy policies by increasing the understanding of the interplay between national and subnational policies. It has societal implications for policymakers and energy actors on multiple levels of government.

On scientific relevance, this research adds empirical data to the theoretical and conceptual grounds of polycentric governance in the energy domain. Moreover, this research is relevant for the master's programme of Sustainable Development, as it contributes to policy developments and the functioning of governance arrangements on the national and subnational level. Especially the contribution of empirical data on polycentric governance to the energy domain will encourage further research on the research topic of institutional design. Therefore, this research aligns with the work of the Environmental Governance group of the Copernicus Institute for Sustainable Development (Utrecht University).

1.5 Reading guide

The outline of this research thesis is as follows: First, Chapter 2 elaborates on the origin and current scholarly debate on polycentric governance. In addition, it reviews the latest theories regarding polycentric constructs and policy evaluation criteria. Next, Chapter 3 includes the methodology, which outlines the case study description and selection, operationalisation of indicators, research materials, and data collection and -analysis. Furthermore, Chapter 4 highlights the main results of the comparative case study by explaining similarities and differences. Lastly, Chapter 5 reveals the conclusion of this research project and Chapter 6 discusses the limitations of the research and the theoretical and practical implications.

2 Polycentric governance theory

2.1 Polycentric governance: origin and current academic debate

The definition given by V. Ostrom et al. (1961) in the introduction chapter is regarded as one of the most cited interpretations of polycentricity in governance literature. Originally, the concept of polycentricity was introduced by Michael Polyani in 1951 and applied to the domain of metropolitan areas. After decades of limited publications around this topic, Elinor Ostrom (2008; 2009; 2010) reignited the concept with her application to the domain of climate change at the beginning of the twenty-first century. Ostrom's contributions boosted a prominence of the polycentricity concept in the academic debates about governance issues. This popularity also led to the application of polycentricity into new domains. For instance, Andersson and Ostrom (2008) applied polycentricity to natural resources management, while Galaz, Olsson, Hahn, Folke, and Svedin (2008) have focused on the relationships of polycentric actors in networks.

On the other hand, polycentric governance lacks empirical research. Supporting evidence in literature is only theoretical, anecdotal, or suggestive (Ba & Galik, 2019). In addition, scholars have found "*limited empirical evidence regarding the flexibility of polycentric systems, their ability to reflect local preferences better, or the greater extent to which experimentation and learning occurs as compared to centralized and hierarchically organized systems*" (Baltutis & Moore, 2019, p.3). Lately, the academic debate is about the complexity of polycentric networks (e.g. the paper by Sovacool & Van de Graaf, 2018) and the application of polycentricity to specific programs (e.g. the paper by Ba & Galik, 2019). However, Morrison et al. (2019) state that knowledge gaps in polycentric governance systems still remain due to the complexity of among others power dynamics (Morrison et al., 2017) and policy experimentation (Huitema, Jordan, Munaretto, & Hildén, 2018). In addition, Jordan, Huitema, Van Hasselt, and Forster (2018) stress in their latest book about polycentricity that polycentric theory's main strengths of breadth and openness are also the reason why it has been so difficult to apply the concept to other domains. Prescribing to which governance approach works best in specific situations seems not yet to be the case, which means that academics are still playing catch-up.

The level of polycentric governance is affected by the political system in which it is present. Governance approaches for consensual systems include at least one form of government. The condition in which political systems vary is the democratic way of sharing and dividing governmental tasks, which could be either federal or unitary. Federal states are characterised by high decentralisation, and higher levels of autonomy, while unitary states are characterised by a centralised form of government, to which tasks are mostly coordinated from one central decision-making centre. The level of polycentricity, therefore, is expected to have different outcomes for every other form of governance approach. In literature, by scholars such as Aligica and Tarko (2012), Jordan et al. (2018), and Schröder (2018), federalism is often linked with a high level of polycentricity. Based on V. Ostrom (1973) and Andersson and Ostrom (2008), the main expectation is that federal systems resembled polycentric characteristics more than unitary systems. Different governance approaches were examined based on these political, state formation definitions.

To answer the research question, this chapter elaborates on two main theoretical concepts: polycentric constructs (sub-question 1) and evaluation criteria for assessing solar PV policies (sub-question 3). First, the theoretical concept of polycentric governance is unpacked into so-called 'constructs', the characteristics of polycentricity. Based on the polycentric constructs, the level of polycentricity in each case study is studied. Second, the evaluation criteria consisted of the positive effects of polycentric governance in the energy domain. Lastly, the conceptual framework is derived from the relation between polycentric constructs and policy performance.

2.2 Polycentricity: constructs

From preliminary literature research on polycentric governance theory (among others Aligica & Tarko (2012), Carlisle & Gruby (2017), Pahl-Wostl & Knieper (2014), Schröder (2018), and Villamayor-Tomas (2018)), the following constructs of polycentric governance are derived: (a) *multiple centres of decision-making*; (b) *overlapping centres of decision-making*; (c) *autonomy*. First, the *centre* is a (non)governmental entity that, as a collective, has authority to make decisions. These entities could be public, private and non-profit organisations (Bissonnette, Blouin, Dupras, Chion, & Bouthillier, 2018; E. Ostrom, 2010). In polycentric governance, multiple of these centres are present. Second, *overlapping centres* indicate that multiple decision-makers share authority over a governance issue. Hereby, cooperation and competition between people and institutions, but also conflict resolution can be indicators for the level of overlapping. The third construct is *autonomy*, which refers to the level of independence of the decision-making centres. An overview of indicators for polycentric constructs can be found in Table 1. Moreover, the operationalisation of these indicators takes place in Chapter 3.3.

First, the number of *multiple decision-making centres* is a factor accounting for polycentricity. Although it is context-specific how many centres of decision-making make a system polycentric (Carlisle & Gruby, 2017), the number of decision-making centres can be used as a reference point for the comparison between the case studies.

Second, there exist four types of *overlapping*: the first two are functional and territorial. Functional overlapping occurs "where centres overlap in their sphere of influence" (Schröder, 2018, p.242). Or in other words, where centres share functional capacities or areas of responsibility (Carlisle & Gruby, 2017). In addition, territorial overlapping occurs when the jurisdictions of decision-making centres overlap in space, where the target areas of jurisdictions affect the joint decision-making between people and institutions (Schröder, 2018). Furthermore, this research differentiates between horizontal- and vertical overlapping. Horizontally overlapping centres includes coordination between government authorities belonging to the same governmental level (e.g. state or municipality level only), whereas vertically overlapping centres relate to cooperation on different levels (e.g. state with the municipality) (Pahl-Wostl & Knieper, 2014; Schröder, 2018).

Third, *autonomy* is conceptualised in the active exercise of diverse interests or opinions and in the degree of formal authority. By 'active exercise', Aligica & Tarko (2012, p.255) mean that policy ideas or methods to conduct something are "*actually implemented by at least one decision centre, rather than just being enounced by someone*". Moreover, formal authority is about the degree to which decision-making centres make operational decisions autonomously (self-organised) from the higher level (Aligica & Tarko, 2012).

Table 1. Overview of indicators for measuring polycentric constructs.

Indicators	Description	Source
Multiple centres of decision-making	*Number of decision-making centres*	Aligica & Tarko (2012)
Overlapping centres of decision-making	*Functional overlapping* *Territorial overlapping* *Vertical overlapping* *Horizontal overlapping*	Carlisle & Gruby (2017); Pahl-Wostl & Knieper (2014); Schröder (2018); Villamayor-Tomas (2018)
Autonomy	*Active exercise of diverse opinions* *Formal authority*	Aligica & Tarko, (2012); Schröder (2018); Villamayor-Tomas (2018)

2.3 Polycentricity: evaluation criteria

In general, polycentricity is considered to have advantages over other modes of governance. According to E. Ostrom (2010, p.552) this is due to "*their mechanisms for mutual monitoring, learning, and adaptation of better strategies over time*". Moreover, polycentricity helps to overcome existing barriers to cross-level interactions (Di Gregorio et al., 2019). The key assumption of polycentric governance is that governance arrangements are more effective when decision-making centres have the capability to self-organise governing bodies at multiple scales (Andersson & Ostrom, 2008).

From polycentric literature (Carlisle & Gruby, 2017; 2018; Cole, 2015; Marshall, 2015), the following three specific theoretical advantages of polycentric governance are used in the conceptual model: (a) *adaptive capacity*; (b) *mitigation of risk*; and (c) *institutional fit*. These advantages are used for the evaluation criteria, which are used to evaluate solar PV policies. First, *adaptive capacity* concerns the capacity to adapt to social and ecological change. This is for instance due to the decision-makers' experience, which can be gained by policy experimentation. Second, redundant or 'back-up' decision-making centres in polycentric governance are expected to *mitigate the risk* of policy failure. Third, *institutional fit* refers to "*the congruence between an institution and the problem or need it is meant to address*" (Carlisle & Gruby, 2018, p.230). In other words, institutional fit is about the spatial and social embeddedness of addressed problems in policies (McDermott & Ituarte-Lima, 2016).

An overview of the indicators of dependent variables is shown in Table 2, based on the conceptualisation of the variables *adaptive capacity*, *mitigation of risk*, and *institutional fit* by Carlisle & Gruby (2017), Carlisle & Gruby (2018), Cole (2015), and Marshall (2015). Also, in this case, these indicators are operationalised in Chapter 3.3.

First, for the variable *adaptive capacity*, the indicator of policy experimentation is used. It is a useful indicator as institutions and policymakers at various levels of governance might learn valuable lessons and increase their ability to adapt through policy experimentation (E. Ostrom, 2009). By continuous experimentation, the decision-making centres have the potential to adopt more successful policies (Carlisle & Gruby, 2017).

Second, redundancy of decision-making centres may increase the stability of the governance system, and therefore *mitigating risks* (Carlisle & Gruby, 2017). Due to the absorbing disturbance of redundant centres, the risks are spread (Galaz et al., 2008). For instance, parallel duplications of functions in decision-making centres can be across regional areas (Landau, 1969). Redundancy of these centres lowers the probability of simultaneous policy failure, which is more likely in a situation where one central government exerting sole authority over an energy issue (Carlisle & Gruby, 2017; 2018).

Third, *institutional fit* can lead to effective energy policy as those "*institutions better account for ecological and social conditions and the characteristics they seek to influence*" (Carlisle & Gruby, 2018, p.231). Institutional fit consists of two sub-indicators: ecological fit and social fit. Ecological fit is the degree to which decisions are aligned within institutions on the aspects of space, materials, and functionality. In addition, social fit is the degree to which decisions align on the bases of interests, values, beliefs, and psychological needs of groups (Carlisle & Gruby, 2018).

Table 2. Overview of indicators for measuring evaluation criteria.

Indicators	Description	Source
Adaptive capacity	*Policy experimentation*	Carlisle & Gruby (2017; 2018); Cole (2015); Pahl-Wostl (2009)
Mitigation of risk	*Redundancy of functions*	Carlisle & Gruby (2017)
Institutional fit	*Ecological fit* *Social fit*	Carlisle & Gruby (2017; 2018); Epstein et al. (2015); Folke et al. (2007)

2.4 Conceptual model

From the research questions and core theoretical concepts outlined in the first and second chapter, the following conceptual model is derived, see Figure 2. First, this means in practice that a governance approach resembles a certain extent to the polycentric constructs *multiple centres*, *overlapping centres*, and *autonomy* (indicators related to sub-question 1). Second, these governance approaches are related to a certain energy policy output (related to sub-question 2), which is assessed on the level of *adaptive*

capacity, *mitigated risk*, and *institutional fit* (indicators related to sub-question 3). Based on previous scholarly findings it is expected that a higher level of polycentricity leads to better energy policy output. The operationalisation of these indicators can be found in Chapter 3.3.

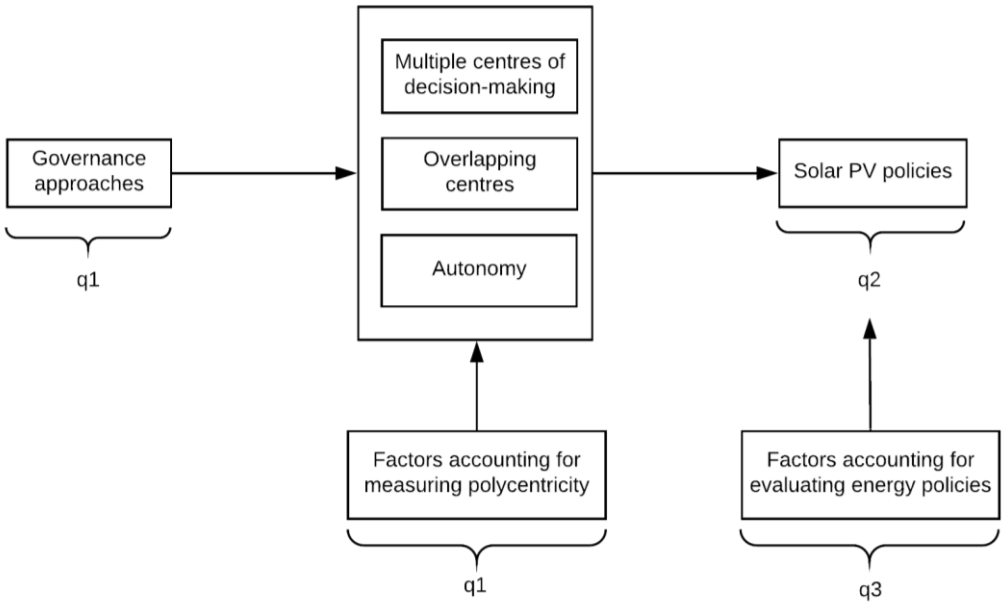

Figure 2. Conceptual model of the research project.

3 Methodology

3.1 Research strategies

To work towards the research objective, a comparative and explorative case study was chosen as the main research strategy. A case study is "*an intensive study of a single unit for the purpose of understanding a larger class of similar units*" (Gerring, 2004, p.342). The comparative case study was used to analyse and explain the differences and similarities of solar PV policies in regards to governance approaches. A hierarchic comparative case study has the advantage of studying cases independently from each other (Verschuren & Doorewaard, 2010). Heikkila et al. (2018) and Schoon, Robards, Meek, and Galaz (2015) highlight that comparisons might help unpack reasons behind the differences in institutional design of governance approaches and that it helps to explain the relation between polycentric governance and policy performance. In this research, the 'cases' include the research units of governance approaches and solar PV policies on the national and subnational level in two countries.

It should be noted that a case study with *N* of 2 can be considered small. This limited number of comparative analyses makes the general understanding of similarities and differences across governance approaches thin, but it can produce rich insights (Heikkila & Weible, 2018; Verschuren & Doorewaard, 2010). In addition, an in-depth case study leads to recommendations which are less likely to be generalised for a broader population (Verschuren & Doorewaard, 2010). Therefore, its external validity

can be considered low. On the other hand, this research has increased its external validity by setting a larger time frame and thereby analysed trends over a longer period of time.

For the case study input, desk research was conducted based on a literature study and secondary research. A literature study was used to map out the latest theories about polycentric governance theory and did include the study of existing literature such as reports, articles and conference proceedings (Verschuren & Doorewaard, 2010). In addition, secondary research was conducted by rearranging existing data on solar PV policies on the national and subnational level. Hereby, empirical data of mainly secondary data sources were used.

3.2 Case study description and selection

3.2.1 Description of national and subnational cases

The case selection was based on the minimal variation between the two cases in order to obtain general descriptive assertions (Verschuren & Doorewaard, 2010). The two countries had to be similar to each other regarding the dependent variables, but also needed an expected difference regarding the independent variable to be able to perform a comparative analysis. Hereby, the expected difference in governance approach was based on the definitions of state formation. The assumption was that a federal governance system would significantly differ from a unitary governance system. Finally, two European countries, Switzerland and the Netherlands were selected as sample for the comparative case study. The contrasting federal system of Switzerland compared to the unitary system of the Netherlands sets for interesting results. It is expected that the consensual-unitary Dutch policy process is dominantly monocentric versus the more polycentric consensual-federal Swiss policy process. These hypothetical observations were based on the academic perspectives discussed in Jordan et al. (2018), McGinnis and E. Ostrom (2011), and Schröder (2018) and derived by looking at national and subnational solar PV policies. The Netherlands is considered to have a centralized form of governance, while Switzerland is considered to have decentralised self-governing cantons (Swiss cantons are comparable to Dutch provinces in size and spatial jurisdiction). In the end, Switzerland and the Netherlands have been selected as samples for the comparative case study for three reasons: 1) similar solar PV share and spatial size; 2) similar policy commitments to solar PV growth; 3) expected variation in governance approach.

Switzerland and the Netherlands share similarities on the national level as both countries have set the goal of low-carbon societies by 2050 (Bundesamt für Energie (BFE), 2013a; Tweede Kamer der Staten-generaal, 2018). Although not part of the European Union, Switzerland has many bilateral agreements to achieve and work collectively towards energy goals. Preliminary search through strategic policy documents showed that solar PV plays a major role energy policy on the national and subnational level in both Switzerland and the Netherlands. Further similarities are found in the share of solar PV in total energy production. This share is relatively small, but the growth potential of solar PV is huge in the competitive electricity market for both countries (SCCER CREST, 2019; SFOE, 2018; TKI Urban

Energy, 2019). Currently, the solar PV shares of the total electricity production are as follows: 2.6% in the Netherlands (Centraal Bureau voor de Statistiek (CBS), 2019a) and 2.1% in Switzerland (BFE, 2017b). On the subnational level or regional level, the potential and small-scale adoption of solar PV in both the Netherlands and Switzerland is shown: in the Netherlands, solar PV has high potential on individual rooftops of buildings (TKI Urban Energy, 2019), whilst in Switzerland, the reason for small-scale solar deployment is due to the irregular landscape (IEA, 2018; Avenir Suisse Association of Swiss Electricity Companies (VSE), 2017).

Switzerland has the unique feature of having almost a CO2-emission free electricity production. Hydropower (59.6%) and nuclear (31.7%) take the largest part of the carbon-free electricity generation (BFE, 2017b). From general energy statistics, the share of solar PV in Switzerland (see Figure 3) has increased significantly in the past decade. This is a logical trend, as the Swiss Federal Council decided to phase out nuclear power after the Fukushima nuclear disaster in 2011. On the other hand, it is troublesome that the current share of solar PV, which is the best alternative to nuclear in the energy mix, still is surprisingly low. Although hydropower can be seen as a renewable energy source, the Swiss national government has taken different policy strategies towards hydropower and 'new' renewable energy sources such as solar PV, wind and heat cogeneration. Moreover, the solar PV development in the Netherlands (see Figure 4) shows a similar trend, to which the electricity production in ratio to the total production of renewables is relatively lower compared to Swiss statistics.

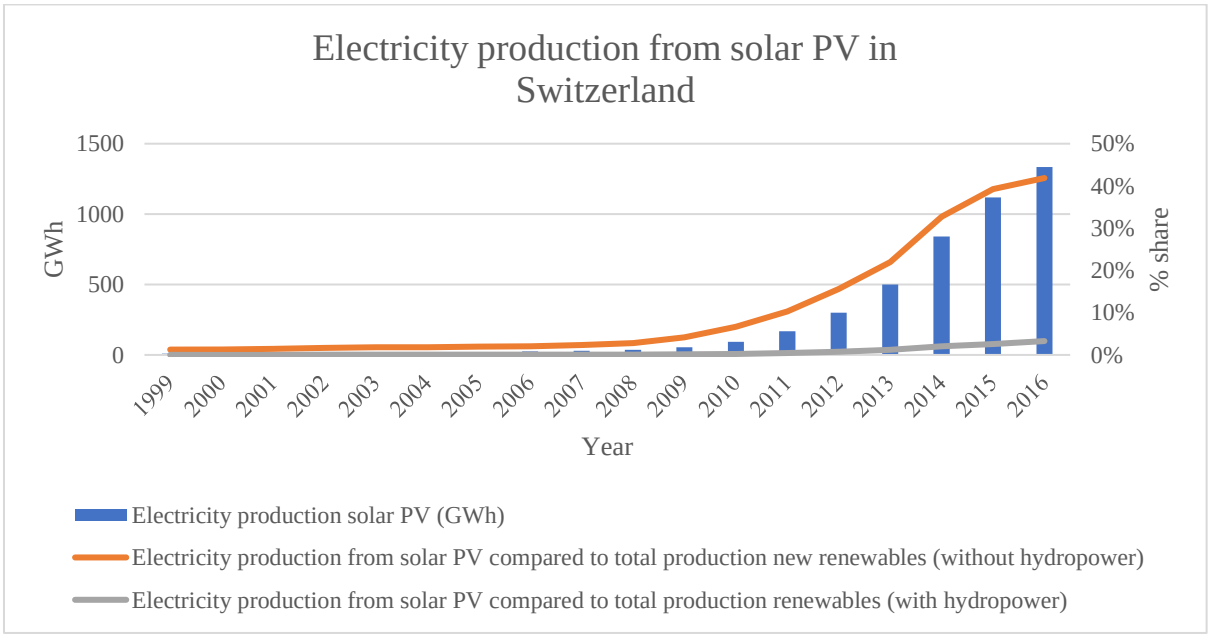

Figure 3. Electricity production solar PV in Switzerland (BFE, 2004, 2005, 2009, 2013c, 2017b).

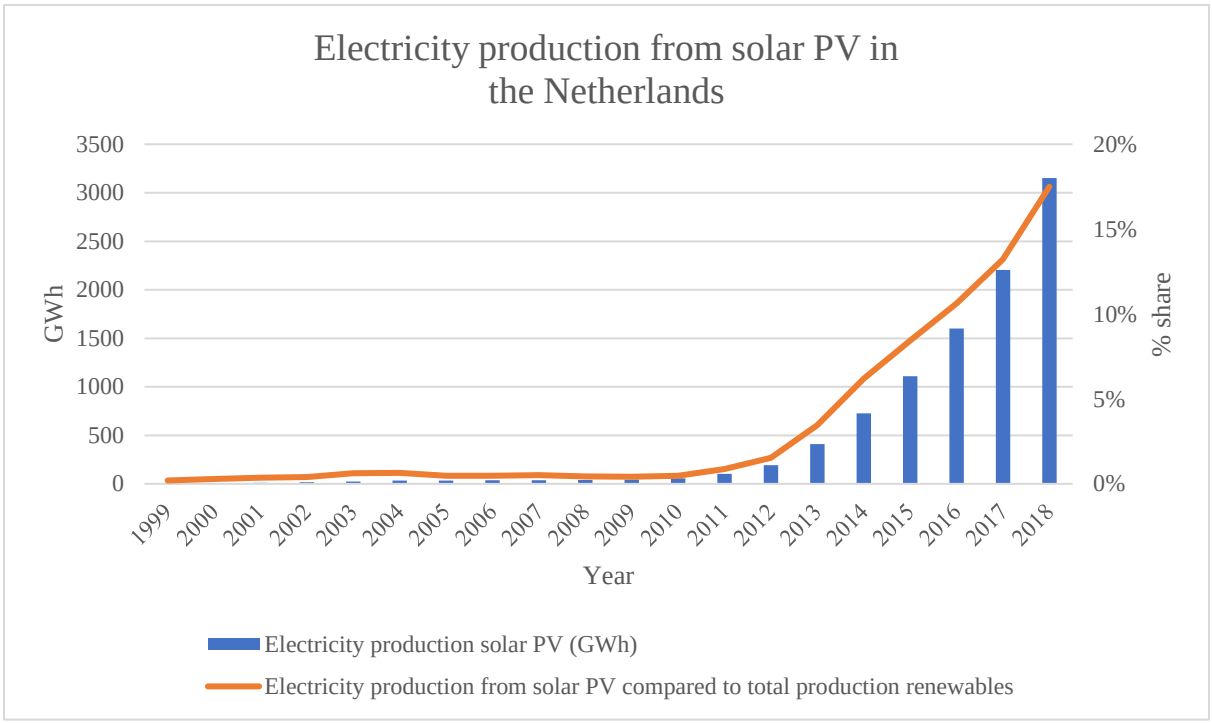

Figure 4. Electricity production solar PV in the Netherlands (CBS, 2019a).

3.2.2 Geographical scope and time frame

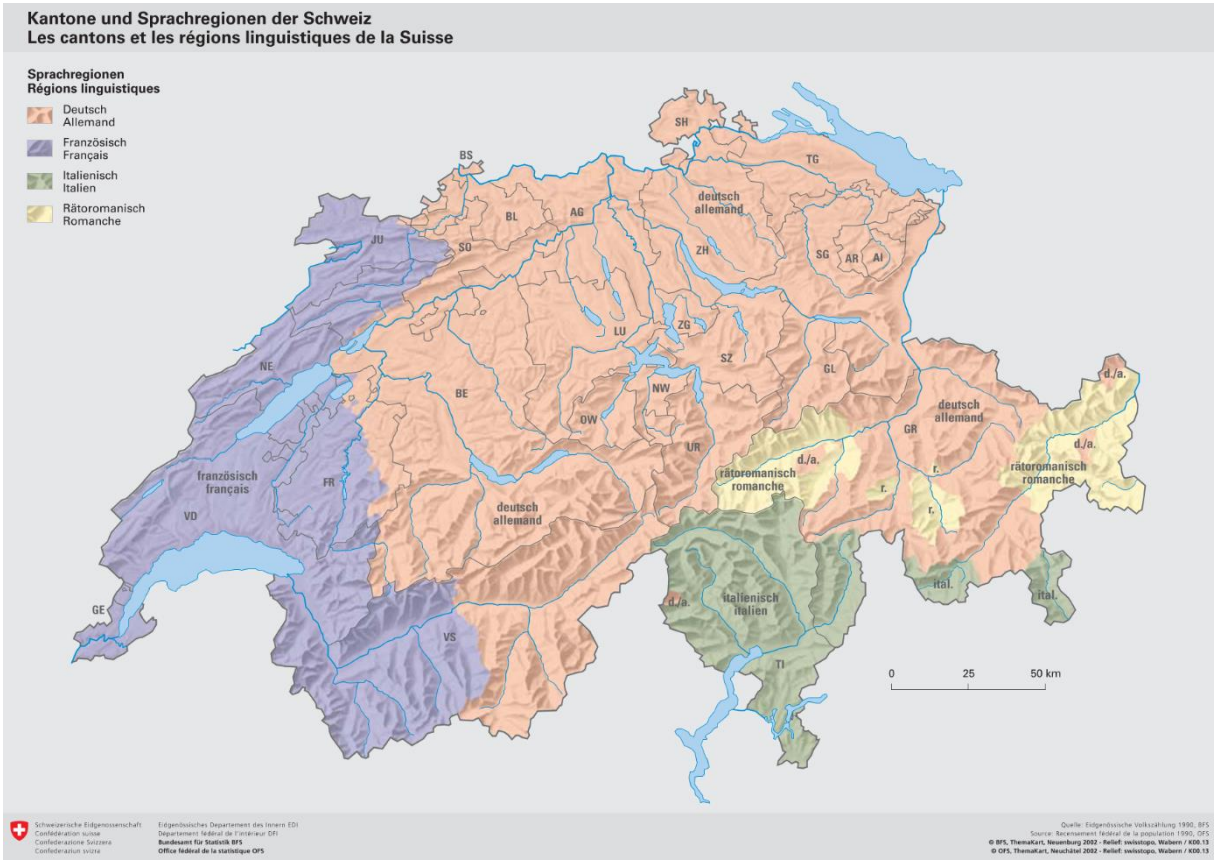

Figure 5. Language regions of Switzerland (Bundesamt für Statistik (BFS), 2017).

Considering the analyses of polycentric governance approaches on the national and subnational level, the scope of these levels is determined in this chapter. For the scope on the subnational level, there were some language barriers for the case study in Switzerland. This related to the fact that Switzerland has several language regions, ranging from German (63.5%), French (22.5%), Italian (8.1%), and Romansh (0.5%) (Switzerland Tourism, 2019). As a native Dutch speaker, reading and understanding German is a relatively doable task. In order to keep optimal effectiveness in executing research, only the German-speaking parts of Switzerland are studied (see the orange area on the map in Figure 5). This choice is justifiable, as German is by far the most spoken language in Switzerland. After this decision, all 18 (German-speaking) cantons in Switzerland and 12 provinces in the Netherlands were taken as possible samples for the two case studies. To limit the sample sizes, but disarming threats of validity, I used the method of stratified random sampling, which is elaborated in the next subchapter.

In addition to geographical scope, a time frame and search limits are set. First, as already mentioned, the time frame is set from 1999 to 2019. Two decades seems a proper time period and also takes into account large energy policies implemented around the end of the last century. Second, search limits are defined during the research to limit the number of policies and thereby preventing an excess flow of information. This thesis takes into account policies which stimulate direct purchases or adoption of solar PV by households, homeowner associations, energy cooperatives and companies. Furthermore, financial loans provided by the (local) government are also included in the analysis. On the other hand, I do not take into account policies concerning the stimulation of solar PV innovation, like subsidies incentivising innovation or Research & Development (R&D), which are mostly provided by the national government or national institutes (e.g. the Dutch Topsector Energy). Although these subsidies are supporting the development of solar PV and have an indirect impact on the adoption of solar panels, they go beyond the scope of this thesis.

Also, climate- and energy agreements on the national level are taken into account, but are analysed as part of specific solar PV policies and as long-term strategies. In addition, the role of municipalities is left out of the analysis due to time limitations. In this thesis, municipal examples are only used to underline relevant governance or policy context. Although municipalities would make the results on governance approaches richer, it is out of the scope of this six months research project.

3.2.3 Sampling

The aim of sampling is to achieve analytical generalisability (representativeness) and limit the research scope (Yin, 2011). Yin (2011) defines purposeful sampling as "*the selection of participants or sources of data to be used in a study, based on their anticipated richness and relevance of information in relation to the study's research questions*" (p. 311). In this perspective, time constraints led to the sampling of the total case study size. From the total 18 Swiss cantons and 12 Dutch provinces, only two subnational regions per case study were selected.

The method of stratified random sampling was used, in which random sampling limits any form of bias towards a region choice with the most available information about certain policies and governance approaches. As both Switzerland and the Netherlands are divided into subnational regions, each region has its own characteristics. To be able to generalise the results as best as possible, the Swiss and Dutch regions were sorted first on the characteristics of the population and the number of municipalities in the jurisdictions of the regions. After categorising the regions, one smaller region and a larger region were chosen for each country, making the samples comparable to each other. The stratified random sampling was operated in Excel, by random value generation and the ordering of regions from large to small. In addition, the canton Basel-Stadt was left out of the sampling as it was not a comparable region to other Swiss cantons or Dutch provinces. In the end, the random stratified sampling led to the choice of cantons Zürich (large region) and Aargau (smaller region) in Switzerland and to the choice of the provinces Noord-Brabant (large region) and Limburg (smaller region) in the Netherlands. An overview of general statistics about the sampled cases can be found in Appendix A, which shows the suitability of the selected cases for comparative analysis.

3.3 Operationalisation

In the previous chapter, conceptual indicators for polycentric constructs and factors accounting for energy policies evaluation were introduced. The next step was to measure these variables, by operationalising indicators for the independent and dependent variables under study. The assessment was based on ordinal scaled operationalised indicators, ranging from low to high scores regarding polycentric constructs and policy performance. During the analysis, examples within the operationalised framework in Table 3 and 4 were searched for. These tables not only show a ranking but also differentiate examples by additional conditions or criteria. Notice that the terms high/strong and low/weak are used interchangeably for assessing the indicators. As the operationalisation of polycentric governance in academic literature has not been developed thoroughly yet, the operationalisation in this chapter had an explorative nature in finding the best ways of measuring indicators to answer the research question. During the iterative process of data collection, relevant data were adjusted to the scope of the indicator's measurement. In the end, this process led to small changes in the measurement of the evaluation criterion *redundancy of functions*.

3.3.1 Operationalisation indicators independent variables

Table 3 shows the operationalisation and assessment indicative scores for the analysis of the independent variables. First, the *number of decision-making centres* (hereinafter abbreviated to 'centres') is counted by the multiplicity and diversity of centres on an ordinal scale. It is not just about the largest number of centres, but also about the variety of decision-making centres on multiple levels. Second, *functional* and *territorial overlapping* were operationalised by the existence of interlinkages and joint policy decision-making. The analysis of the indicator overlapping centres was strengthened by the operationalisation of

vertical and *horizontal overlapping*, also in ordinal variables. Third, for the indicator *active exercise of diverse opinions*, the level of initiating potential of centres was measured, which is a crucial condition for self-organisation. Moreover, the *degree of formal authority* was measured to the extent of fiscal sovereignty and the involvement of the national government.

3.3.2 Operationalisation indicators dependent variables

Table 4 shows the operationalisation and assessment indicative scores for the analysis of the dependent variables. First, *policy experimentation* can be measured by sequential policy changes. In addition, establishing causality between experimentation and policy implementation is a second criterion. Second, *redundancy of functions* was measured in the number of examples regarding vertical and horizontal duplications of institutions These two forms of redundancy are a result of the explorative process of operationalising the indicators. Third, institutional fit is measured by *ecological* and *social fit*. Ecological fit is concerned with the degree of fit between PV policies and spatial (local) characteristics, while social fit is concerned with the fit between PV policies and social preferences of energy stakeholders.

Table 3. Overview of operationalised indicators for polycentric constructs.

Indicators	Description	Operationalisation			Source
		Weak	Medium	Strong	
Multiple centres of decision-making	*Number of decision-making centres*	Number of centres <4	Number of centres 4<x<10	Number of centres >10	Aligica & Tarko (2012)
Overlapping centres	*Functional overlapping*	No functional overlap	Functional interlinkages	Joint policy design and implementation	
	Territorial overlapping	No territorial overlap	Jurisdictional overlap	Joint decision-making in spatial overlapping jurisdictions	Carlisle & Gruby (2017); Pahl-Wostl & Knieper (2014); Schröder (2018); Villamayor-Tomas (2018)
	Vertical overlapping	No vertical overlap	Vertical interlinkages	Joint decision-making on vertical level	
	Horizontal overlapping	No horizontal overlap	Horizontal interlinkages	Joint decision-making on horizontal level	
Autonomy	*Active exercise of diverse opinions*	No inclusion of stakeholders	Diverse opinions and interests in subnational levels	Diverse opinions without overruling power national government	Schröder (2018); Villamayor-Tomas (2018)
	Formal authority	No self-organisation	Self-organisation showing fiscal sovereignty	Self-organisation without involvement national government	Aligica & Tarko (2012); Villamayor-Tomas (2018)

Table 4. Overview of operationalised indicators for energy policies evaluation.

Indicators	Description	Operationalisation			Source
		Weak	Medium	Strong	
Adaptive capacity	*Policy experimentation*	No policy experiments	Sequential policy change	Policy change due to policy experiments	Carlisle & Gruby (2017; 2018); Cole (2015); Pahl-Wostl (2009)
Mitigation of risk	*Redundancy of functions*	No functional duplications	Vertical or horizontal policy redundancy	Vertical and horizontal policy redundancy	Carlisle & Gruby (2017); author's own interpretation
Institutional fit	*Ecological fit*	No policy matching with local and spatial characteristics	Spatial fit within national PV policies and solar PV adoption	Spatial fit within national and local PV policies and solar PV adoption	Carlisle & Gruby (2017); Epstein et al. (2015); Folke et al. (2007)
	Social fit	No policy matching with local and social characteristics	Social fit within national PV policies and solar PV adoption	Social fit within national and local PV policies and solar PV adoption	

For the two cases, it was determined to what extent governance approaches are either polycentric or monocentric and to what extent policy making and implementation of solar PV was high or low. The results were compared by placing the cases in quadrants (see Figure 6). This overview is similar to the approach by Vaas, Driessen, Giezen, Laerhoven, and Wassen (2017). It is expected that Switzerland would score higher on the level of polycentricity and on policy performance. Therefore, Switzerland is expected to be placed in Quadrant 2. Moreover, it is expected that the Netherlands would score lower on the level of polycentricity and policy performance. This, in turn, leads to an expected score of the Netherlands equivalent to Quadrant 4.

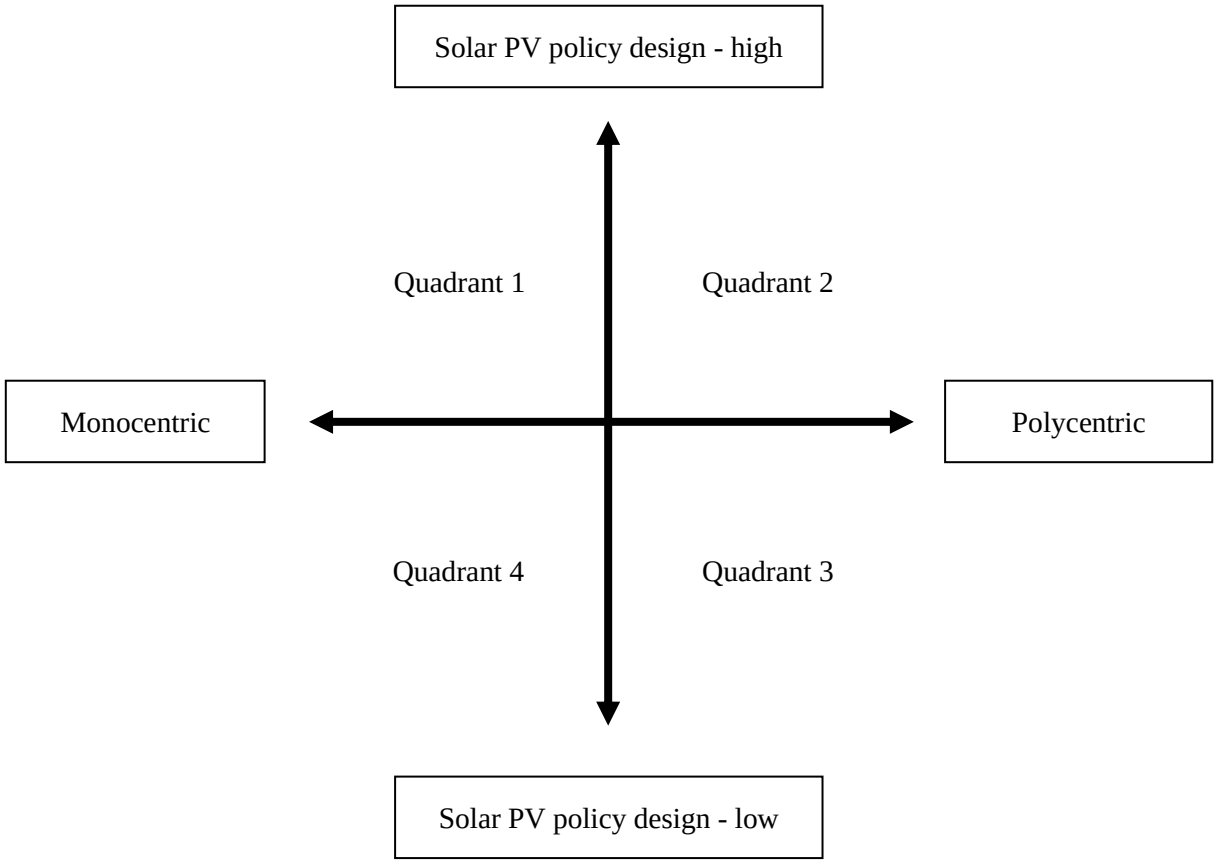

Figure 6. Quadrants in which governance approaches (x-axis) and solar PV policy design (y-axis) can be placed (based on Vaas et al., 2017).

3.4 Data sources and data collection

A structured data collection approach was used to find relevant results regarding governance approaches and solar PV policies. This included two search cycles of desk research, which were executed in mid-April and mid-June (see Appendix B). Sources for answering the research questions include data sources and knowledge sources. This research started with the knowledge source of a preliminary literature study on solar PV policies and governance approaches in Switzerland and the Netherlands. Next, a content analysis was conducted for the two case studies using qualitative (secondary) empirical data sources. The content analysis consisted of a document review of the following sources: scientific articles, policy

documents and webpages, which were collected through desk research. Table 5 gives an overview of the range of research materials.

Table 5. Research materials.

Type	Sources	Accessing	Answering sub-questions
Documents	Scientific articles	Literature study; content analysis	q1; q2; q3
Documents	National and subnational policy documents	Content analysis	q1; q2
Media	Regional and local (news) websites	Content analysis	q1; q2

First, a literature study was conducted to answer the first three sub-questions. Specifically for sub-question 3, the literature study added knowledge to the operationalisation of the indicators. The literature review based on searches in Scopus and Google Scholar iteratively added more specific keywords to the search list, such as the German words *Einspeisevergüting, Einmalvergüting, gemeinden, kantone, Energiepolitik, Solaranlagen, Photovoltaikanlagen, Sonnenenergie, Finanzielle Förderung*. In addition, during the review and with the help of specific search words I became more familiar with the experts in this field, which brought many more relevant policy documents to analyse. Swiss and Dutch policy documents were mainly from related government institutions or reports by consulting agencies and companies. In addition, governmental policy databases such as IEA/IRENA (international) and Energiefranken (Switzerland) were used.

Second, empirical data was drawn from scientific sources such as (peer-reviewed) journal articles. The first step included the search for governance approaches and specific policy implementation or evaluation of Swiss and Dutch solar PV policy using and combining the following keywords in all three languages (English, German and Dutch) in Google Scholar: *energy governance, polycentric energy governance, photovoltaic, solar PV, solar panels subsidy, renewable energy policy*. These keywords were linked with case study descriptions such as *canton Zürich, canton Aargau, province Noord-Brabant, province Limburg, Switzerland, Netherlands*. In addition, for the peer-reviewed journal articles, the Scopus database was searched using the same keywords. The reason for choosing Scopus was that it contains a constantly updating database (Burnham, 2006). Moreover, Scopus has a wider journal range in comparison to, for instance, Web of Science (Falagas, Pitsouni, Malietzis, & Pappas, 2008). For an overview of all relevant sources used in the analysis, see Appendix B, C and D.

Third, regional and local webpages were sourced to gain more knowledge about the decision-making centres on the subnational level in the two case studies. Examples of webpages include national and provincial government websites and other related webpages of energy stakeholders.

The data search was primarily based on secondary data sources, as this research project did not include broad surveys and expert interviews due to time limitations. Academic articles were reviewed on both the content of governance approaches and descriptive texts of solar PV policies. Moreover, policy documents and websites were the main sources of data collection. Collecting data was an iterative process and led to continuously improving search words and combinations. Saturation of searches was reached when additional searching did not yield any new scientific articles or other sources of information.

3.5 Data analysis

A qualitative content analysis was used to analyse the collected data. Content analysis is about which data are analysed; how the data are defined; from what population the data are drawn from; what the relevant context is about; what the boundaries of the analysis are; and lastly, what is measured (Krippendorff, 2004). The study of documents is part of content analysis. The reason for using document analysis is the efficient and effective way of gathering data: documents are very accessible and descriptive information can be collected quickly (Bowen, 2009). "*Also, documents are stable, 'non-reactive' data sources, meaning that they can be read and reviewed multiple times and remain unchanged by the researcher's influence or research process*" (Bowen, 2009, p.31).

The analysis was based on an assessment of the operationalised indicators as discussed in Chapter 3.3. "*Data analysis consists of examining, categorising, tabulating, testing, or otherwise recombining evidence to draw empirically based conclusions*" (Yin, 2009, p.126). A combination of inductive and deductive processes was used to collect and analyse the data. From a deductive perspective, the operationalised indicators were formed by theoretical contributions on polycentric governance. In addition, inductive processes took place by analysing data and adding to the operationalisation of specific indicators.

Per case study, the documents were scanned systematically e.g. by reading abstracts of academic papers and were categorised per subject. After the categorisation, each document was read and pieces of texts were labelled into categories. This process of manual coding placed documents, descriptive information and quotes into several categories, among others '*polycentricity*', '*energy act*', '*financial incentive*', '*loan*', '*governance approach*', '*energy stakeholder*', etc. During the coding process, themes were added, removed, merged or changed, which shows the iterative process of data analysis (Saldaña, 2013).

4 Results

The results are presented per case study. Each case study shows the assessment results regarding governance approach (independent variable) and solar PV policy performance (dependent variable). The assessments are based on the operationalised framework discussed in Chapter 3 and include quotes for

supporting arguments. Next, the results of the two case studies are compared in the upcoming Chapter 4.3. Furthermore, explanations and a discussion about these results are included in Chapters 5 and 6.

4.1 Case study of Switzerland

4.1.1 Assessment level of polycentricity in Switzerland

4.1.1.1 Multiple centres

[Number of centres]

In addition to governmental stakeholders as the Swiss federal government, cantons and municipalities, (private) entities such as energy firms and distribution network operators play an important role in the establishment of the Swiss solar PV landscape. Energy firms have "*the legal form of public private partnerships (PPP), where the cantons are majority shareholders and/or delegate people to the board of executives*" (Strebel, 2011, p.468). One example of a PPP on the provincial level (without federal government involved) includes the collaboration between Elektrizitätswerke des Kanton Zürich (EKZ), and Elektrizitätswerke der Stadt Zürich (EWZ) (Kanton Zürich, 2010). Another example is that canton Aargau is the majority shareholder of the energy firm AEW Energie AG (Kanton Aargau, 2015). Moreover, net operator Swissgrid (with subsidiary Pronovo) serves as an intermediary between energy consumers and the government. Specifically, federal regulation and the function of monitoring utility compliance ties federal commissions such as Bundesamt für Energie (BFE) and Federal Electricity Commission with the utility and energy firms (Kohlhoff, Nickerson, Choi, & Rellstab, 2017). Furthermore, the number of Swiss energy cooperatives has been growing extensively in the past two decades:

"*In addition to the often* ***close interaction*** *with these two actors* [respectively **energy cooperatives and utilities**]*,* ***municipalities and energy supply companies, cooperatives*** *receive* ***active support from citizens and companies*** *in various areas (financial, personnel, infrastructure, etc.)*" (Rivas et al., 2018, p.8).

Rivas, Schmid, and Seidl (2018) argue about a 'third wave' of energy cooperatives, pointing towards the prior developments of cooperatives at the beginning of the 20th century; between 1980 and 1999; and from 2000 onwards. They identified 289 energy cooperatives in commercial registers from 2016. Solar PV is the widespread technology used for power generation in the vast majority of Swiss energy cooperatives (Rivas et al., 2018). In particular, in Switzerland 48 cooperatives are focused solely on solar PV technology (Swissolar, 2018). From these cooperatives, five are nationally focused, while the others are region-specific. Most of the regional cooperatives can be considered small, but that is also because of the smaller sizes of respective municipalities.

"*The cooperatives take up new developments in the energy system and contribute to supplying consumers with renewable energy and bringing current social values into the energy sector. However, the **Swiss energy cooperatives** are small and are hardly mentioned in the public political debate. This contrasts with their often **close cooperation with municipalities, utilities and the local population***" (Rivas et al., 2018, p.8).

The total number of decision-making centres are plenty. From the analysis, it is observed that Switzerland has a high diversity of centres, which make Switzerland score **high** on the criterion *number of centres*.

4.1.1.2 Overlapping centres

The interplay between solar PV stakeholders on several levels is discussed in this subchapter. As a federal republic, the Swiss Federal Constitution allocates power between the confederation, the cantons and the municipalities (*communes*). Concerning the multilingual and -cultural population, the decentralised competencies on cantonal and municipal level seem a logical fit (Wasserfallen, 2015).

[Functional overlap & Territorial overlap]

The national government, also called *Confederation* or *Bund*, is the 'highest' level of power. Switzerland resembles dual federalism, in which power is allocated across the confederation, cantons and municipalities by the subsidiarity principle, which means that the higher level only intervenes if it cannot succeed at a lower level (Federal Constitution of the Swiss Confederation, 2013; OECD, 2019; Strebel, 2011).

Each canton has its own constitution, parliament, government and courts (Federal Constitution of the Swiss Confederation, 2018). The national constitution guarantees the cantons' high degree of legislative and fiscal autonomy (Schnabel & Mueller, 2017; Strebel, 2011). The cantons exercise all rights which are not vested in the Confederation. "*Basically, the federal government enacts framework laws, while implementation is a matter of cantonal legislation*" (Strebel, 2011, p.468). Cantons are also divided into districts, so-called *Bezirke*, but these districts do not have jurisdictional power and only conduct tasks regarding administration and court organisation. Although some cantons have different structures concerning power in a district area, this is not the case for cantons Zürich (ZH) and Aargau (AG). The lowest level of power is situated on the municipal level and each canton determines the responsibilities of its municipalities, which mainly consist of administrative tasks. For instance, municipalities are responsible for smaller infrastructure matters and granting financial incentives for adopting solar PV such as an one-off payment or an energy loan. In addition to funds, municipalities provide information regarding energy developments and opportunities (Kanton Zürich, 2018). Some municipalities offer free advice or discounted energy consulting (Amt für Abfall Wasser Energie und Luft (Kanton Zürich), 2019).

Furthermore, Switzerland has next to subnational energy cooperatives also five national oriented cooperatives (Swissolar, 2018). This shows evidence of small overlap between cooperatives on the national and regional level. However, membership and PV installations within energy cooperatives often remain local: "*Only around 10 per cent of the cooperatives own energy-generating capacity outside of their or neighboring municipality, and only 3 per cent expand to another canton*" (Broughel et al., 2019, p.461).

The subsidiarity principle clearly underlines that functional interlinkages exist between centres, but that does not mean that there is a direct overlapping in functions between the governmental levels and other energy stakeholders. In addition, the jurisdiction is clearly divided with almost no territorial overlap between the decision-making centres. Therefore, both *functional* as *territorial overlapping* are considered **low**.

[Vertical overlap]

The subsidiarity principle here shows the vertical interlinkages between the different energy stakeholders. The joint responsibility in the energy transition ensures the multitude of vertical interactions and therefore extensive vertical coordination between federal and cantonal governments, which is even considered 'business as usual' in Swiss policy-making (Steurer, Clar, & Casado-Asencio, 2019). In contrast, there are also signs that the existing vertical coordination between centres is weak. For instance, energy cooperatives are only horizontally coordinated and do not interact with other levels of (higher) decision-making centres. In the end, these contrasting arguments lead to a **medium** score on *vertical overlapping*.

[Horizontal overlap]

The *horizontal overlapping* between governments and energy stakeholders regarding solar PV can be considered **very high**.

"*At the cantonal level, **horizontal integration** follows a similar pattern of formal and informal negotiations: each Swiss canton has collegial executive bodies that negotiate policies with sectoral, communal and civil society organisations*" (Casado-Asencio & Steurer, 2016).

Already since 1979, intercantonal coordination of energy policy has existed (Steurer et al., 2019). Switzerland had become more horizontally organised, which led to the introduction of 'intercantonal conferences of directors' (*conferences* in short) in 1993 (Strebel, 2011; Wasserfallen, 2015). The formalised conferences, such as the Conference Cantonal Energy Directives (EnDK), are a way of establishing institutional cooperation among cantons. These institutions do not have coercion power, but create an identity and produce norms (Füglister, 2012). This is highlighted in the following quote:

"*Before vertical negotiations kick off, the* ***Conferences coordinate cantonal positions vis-à-vis the federal government****. To ensure effectiveness, the Conferences have agenda-setting and monitoring powers in virtually all policy sectors, and decisions are taken under majority rule. In practice, however, decisions are usually unanimous* ***non-binding prescriptions later turned into binding cantonal laws*** *in order* ***to avoid federal interventions***" (Casado-Asencio & Steurer, 2016, p.263).

In addition to the conferences, there is another interesting formal cooperation between cantons in the form of treaties. These 'intercantonal treaties', also known as *concordats,* have existed for a long time and set formal agreements between cantons (Füglister, 2012):

"…***intercantonal concordats*** *add to the dense and growing net of institutionalized forms of* ***horizontal cooperation****, in which cantonal decision-makers exchange experiences, coordinate intercantonal activities, and organize cantonal interests vis-à-vis federal actors*" (Wasserfallen, 2015, p.541)

Concerning the energy domain, the relation between the confederation and the cantons is generally not vertical, but more horizontally oriented: the tasks of designing solar PV policy are divided between the confederation and cantons, and are not assigned from a higher level of government to a lower level of government. The confederation establishes principles for the use and production of renewable energy sources and issues regulation regarding the energy consumption of plants and equipment, while cantons are foremost responsible for the energy consumption measures in the building sector (Kanton Zürich, 2018; Strebel, 2009).

Another example of horizontal cooperation can be found in the joint decision-making between cantons and between energy cooperatives. Energy cooperatives are locally embedded, which is "*due to the location of the facilities, most of which are located within the community of the cooperative's headquarters*" (Rivas et al., 2018, p.7). In addition, cooperatives are strongly interlinked with municipalities, which represent political interests and provide legal permits for PV systems (Rivas et al., 2018).

4.1.1.3 Autonomy

[Active exercise of diverse opinions]

The indicator *active exercise of diverse opinions* is about "*methods or ideas about how to carry out an action*" (Aligica, 2014, p.60). In this way, giving an opinion is therefore not just a proposal, but an active implementation of a decision by at least one centre (Aligica, 2014). Switzerland shows with the existing PPPs on the subnational level that centres can collectively make and implement policy decisions within their jurisdictions, which is a crucial criterion for assessing this indicator (Aligica & Tarko, 2012). On the other hand, the document review does not completely outline the level of autonomy for energy stakeholders such as citizens, utilities or grid operators. Namely, the federal government does not allow

all Swiss citizens to choose their utility company. Furthermore, the Federal Council's decision to phase out nuclear power after the Fukushima tragedy in 2011, led to forced changes of utilities' strategy. Therefore, the autonomy of lower-level centres should not be overestimated. Because of the mixed results, the Swiss score on this indicator is considered **medium**.

[Degree of authority]

In an ordinary federal system, *autonomy* of the decentralised regions is often **high**. Also, the Swiss Federal Constitution delegates extensive legal and political autonomy to the cantons (Füglister, 2012; Strebel, 2009). This is especially the case for the application in energy policy (Kriesi & Jegen, 2001). According to Strebel (2009; 2011), cantons have fiscal sovereignty, however, in reality, fiscal jurisdiction takes form in public-private partnerships, but not in large financial funds owned by lower levels of government.

Linked to autonomy is the way policy is diffused across levels of government. The extent to which lower governmental levels make their own solar PV policies and collaborations regarding solar PV implementation is large, which follows from this quote:

"[…] *the key instruments of Swiss building policies (i.e. building standards and subsidy programs) have traditionally been* ***in the hands of the cantons****, or less colloquially: the cantons are the ones who have '****the right to decide****' and '****the right to act****' on* ***building-related policies in Switzerland*** *that are relevant to the present study*" (Steurer et al., 2019, p.259).

Regarding building-related policies, Steurer et al. (2019) indicate that cantons in Switzerland have both the 'right to decide' and the 'right to act'. Schmid and Bornemann (2019, p.8) even highlight that "*despite more recent tendencies to* ***centralize competences****,* ***cantons still maintain considerable autonomy within their energy policy development***". […] *Currently, securing energy supply is a joint task of the federation and cantons, and the use of renewable energies falls within the competences of both. The* ***degree of autonomy*** *and* ***self-determination*** *of the* ***cantons*** *is reflected in* ***diverging administrative structures and resource endowments***".

The higher degree of authority on the cantonal level also shows in the form of many public-private partnerships. As discussed earlier, cantons are majority shareholders to the board of executives in large electric power companies. Therefore, cantons play a central role in the production of (renewable) electricity in the regional area (Lange, Bornemann, & Burger, 2019), supporting the argument that private companies provide the financial budget for the local regions (Breunig, 2017).

4.1.2 Assessment of Swiss solar PV policies

In Table 6, the national solar PV policies in Switzerland are listed. The Swiss policies are shortly discussed individually, after which the subnational policies follow in Table 7 and 8. Energy policy

focused on solar PV slowly became more integrated into Swiss energy acts and subsidies provided by the national government. While the Old Energy Act in 1999 already mentioned a financial incentive for solar PV adoption, the first active subsidy application regarding the feed-in tariff (KEV) had to wait until the year 2009. This first time gap between ideation and implementation seems large, but it did occur for a second time, as in 2017, the second wave of renewable energy policies was introduced. This second wave started with the Federal Energy Directive (EnV), which changed some financial incentives. The EnV was followed by the formal Energy Act, changing its energy strategy away from nuclear power and increasing the focus to renewable energy sources. However, large changes occurred late in 2018 in the form of a one-off investment subsidy as an alternative incentive for the feed-in tariff; and the feed-in premium (EVS) which will substitute the KEV. Below, short descriptions per national policy are given.

Old Energy Act

In January 1999, the Old Energy Act ('Energiegesetz des Bundes, Vollzugsregelung') was entered into force. At that time, it was a revolutionary act that set ambitious goals for the year 2030. Furthermore, it aimed to establish an adequate energy supply, promote energy efficiency and encourage renewable energy use (Grantham Research Institute, 2019; Swiss Confederation, 2017). Most importantly, the act defined the responsibilities towards the confederation and the cantons, in which the degree of freedom (autonomy) for cantons was considered high. Hereby, local 'Kantonales Energiegesetz' was created. In addition, the feed-in tariff (KEV) was already introduced in this act, but only got implemented in 2009. This energy act was superseded in 2018 by a new act under the same name.

Feed-in tariff (KEV)

The feed-in tariff ('Kostendeckende Einspeisevergütung', KEV) was the first subsidy promoting solar PV systems which could be used by both businesses and private homeowners. The KEV can be considered as the most popular financial incentive from the Swiss national government (Schmid & Bornemann, 2019). Already announced back in 1999, this subsidy scheme consisted of a cost-covering remuneration for feed-in to the electricity grid. Solar PV generation could, therefore, be transferred back to the grid for which the owner of the panels gained a compensation fee. The surcharge for energy consumption was paid for a period of 20 years. The 'first come, first served' subsidy was so successful, that the number of subsidy applications exceeded expectations. A waiting list had to be introduced, but the list of applications only kept increasing. To offer an alternative financial incentive, the national government introduced the one-time allowance (EIV) for photovoltaic systems in 2014 (Pronovo, 2019b). Furthermore, the KEV funding will be maintained until the end of the compensation period, which is in 2022 (BFE, 2019).

Federal Energy Directive (EnV)

The Federal Energy Directive ('Energieverordnung') was presented in 2017, which included regulation regarding compensation rates of photovoltaic systems. Among others, the photovoltaic feed-in tariff was reduced by up to 28 per cent and the one-time fee for photovoltaic systems was reduced up to a capacity of 30 kW, both in two stages from 1 April 2017 and 1 April 2018 (BFE, 2016).

Energy Act

The most recent Energy Act ('Energiegesetz') includes the roadmap 'Energy Strategy 2050', which includes a strategy towards the goal of low carbon emissions in 2050 (SFOE, 2018). The energy act was announced in 2016 and was considered the most ambitious energy strategy at that time (Grantham Research Institute, 2019). The new energy act included climate goals for sustainable security of energy supply, efficiency, and consumption. It also included the plans for replacing the KEV subsidy with the feed-in premium (EVS) and elaborates on details about the EIV subsidy (BFE, 2017a). The most striking strategic shift of the national government was the decision to phase out nuclear energy. After the nuclear meltdown in Fukushima in 2011, the national government has steered towards an energy mix without nuclear energy (BFE, 2013b). Apart from this grand challenge to downsize the large import of uranium (Broughel et al., 2019), this policy change gave other renewables the chance to grow, in particular, solar PV.

One-off investment subsidy (EIV)

The one-time allowance 'Einmalvergütung (EIV)' is equivalent to an investment grant (Suisse Next, 2019). As discussed earlier, the EIV was introduced because of a long waiting list of applications for the feed-in tariff KEV. Furthermore, the EIV is divided into two categories: one for small <100 kW solar PV (KLEIV) and one for larger solar 100 kW – 50 MW PV(GREIV). In addition, applicants have to choose between the GREIV or KEV, as one cannot apply for both subsidies. The EIV reimburses 30% of the investment costs and will be available until 2030 (BFE, 2019; Broughel et al., 2019).

Feed-in premium (EVS)

The KEV expires at the end of 2022 (BFE, 2019). The successor of the KEV will be the feed-in premium 'Einmalvergütingssystem (EVS)', which will be available from 2020 onwards (Broughel et al., 2019). The EVS consists of a feed-in premium with direct marketing, which means that the electricity generated from renewable sources will be directly marketed by the electricity producers themselves (Pronovo, 2019a).

Table 6. National policies including financial incentives for solar PV in Switzerland.

Timespan	Translated from German	Policy	Type*
1999	Old Energy Act	Energiegesetz des Bundes (Vollzugsregelung)	A
2009 – 2022	Feed-in tariff	Kostendeckende Einspeisevergütung (KEV)	PI
2017	Federal Energy Directive	Energieverordnung (EnV)	A
2018	Energy Act	Energiegesetz (EnG)	A
2018 – now	One-off investment subsidy	Einmalvergütung (EIV)	PI
2018 – now	Feed-in premium with direct marketing	Einspeisevergütungsystem (EVS)	PI

** Types of national policies: A = act (incl. directives); PI = policy instrument (incl. subsidies, feed-in schemes, financial loans etc.).*

Table 7. Subnational policies in the canton of Zürich (CH).

Cantonal policy	Year	Budget (€)	Target group	Comments	Source
Funding program 'Förderprogramm' Kanton Zürich	2009-2011	Spend: €2.2 million	Businesses	Part of confederation's budget	(Kanton Zürich, 2017)
Tax credits 'Steuervergünstigungen'	-	-	Businesses and private homeowners	Tax deduction from maintenance costs	(Broughel et al., 2019; Kanton Zürich, 2018; Swissolar, 2015)

Regarding the subnational solar PV policies, the policies of cantons Zürich and Aargau are discussed here. In 2009, the confederation gave the cantons additional funds to support energy projects. The canton of Zürich supported the action with its own resources by steering its energy promotion programme 'Förderprogramm' between 2002 and 2015 (Kanton Zürich, 2017), see Table 7. However, Zürich did not have any additional funding for solar available in the years 2012-2019. Even in the period 2009-2011, where solar PV was financially incentivised, the contribution to solar PV has been minimal compared to other forms of renewables (see Figure 7). In the years after 2012, the canton did not provide any financial resources at all for stimulating solar PV (Kanton Zürich, 2019a). An additional search in several databases including Energiefranken and Lexfind also did not lead to any results.

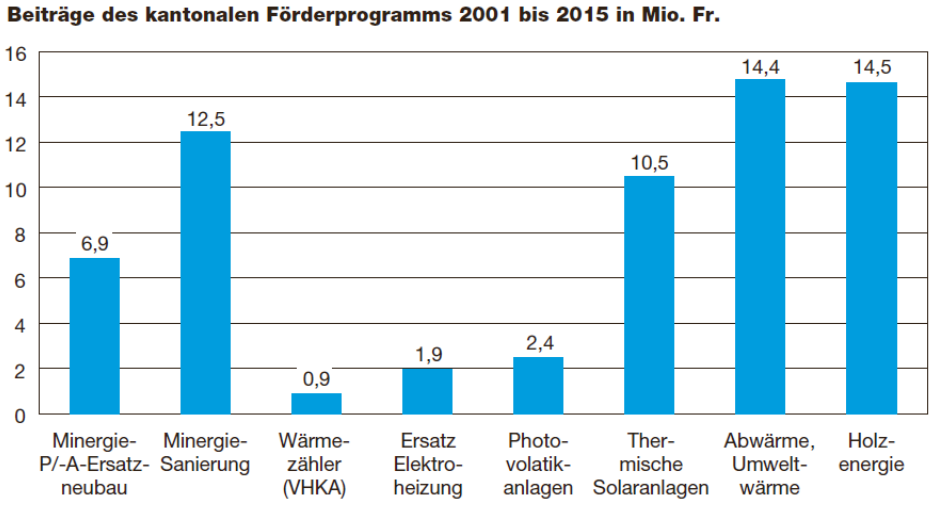

Figure 7. Contribution of energy programs in canton Zürich between 2001 and 2015 (Kanton Zürich, 2017).

For the canton Aargau, the policy output is even more lacking. The only financial benefit found was the compensation of part of the energy consulting costs for solar PV instalment. This tax credit system

‘Steuervergünstigungen’ is displayed in Table 8. Other financial incentives were not found on the subnational governmental level. The only example which includes financial elements is the PPP: it was found that canton Aargau has a strong hold of power regarding energy generation. Namely, canton Aargau completely owns the energy utility AEW Energie and is also the majority stakeholder of Axpo Holding AG (Axpo, 2018).

Table 8. Subnational policies in the canton of Aargau (CH).

Cantonal policy	Year	Budget (€)	Target group	Comments	Source
Tax credits ‘Steuervergünstigungen’	-	-	Businesses and private homeowners	Tax deduction from maintenance costs	(Broughel et al., 2019; Swissolar, 2015)

4.1.2.1 Adaptive capacity

[Policy experimentation]

The low solar PV policy output on the national level, as well as the subnational level, directly makes high policy experimentation unlikely. Sequential policy change did occur on the national level but was again limited. One example of policy learning was concerned with the one-time allowance ‘Einmalvergütung (EIV)’, which as implemented because of the long waiting list of applications regarding the prior feed-in tariff KEV. On the subnational level, both canton Zürich and canton Aargau did not show any experimentation in policy processes at all. Therefore, the score on *policy experimentation* is considered **low**.

4.1.2.2 Mitigation of risk

[Redundancy of functions]

The effect of redundancy is that it mitigates risk. In a system with multiple similar cantonal policy designs, failing policy experimentation in any of the decision-making centres do not have a significant effect on the whole national policy system. The resilience of such a system can, therefore, adopt the best practices of policy experimentation based on experience in other cantons. Moreover, redundancy in cantonal policy could increase the chances of Swiss energy stakeholders to adopt solar PV systems under favourable circumstances. Therefore, the risk of limited solar PV adoption is mitigated by the redundancy of PV policies across cantons.

Functional overlapping is a form of redundancy. However, this evaluative criterion of *redundancy of functions* relates to the redundancy in policy output. Hereby, there are redundancies on the vertical level

(e.g. federal government offers similar policy instruments as cantonal government) and on the horizontal level (e.g. similar policy design on cantonal level).

For Switzerland, the trend of low PV policy output on especially the subnational level relates to a low level of vertical policy redundancy. In addition, the subsidiarity principle leads to a minimum of functional interlinkages, and therefore tasks are divided (and not shared) between levels of governments. This results in limited redundancy on the vertical level. In contrast, the horizontal level of policy redundancy can be considered high, which is shown in the following quote: "*…the cantons adapted their policies during the period following the reform and that they implemented instruments already used in other cantons*" (Füglister, 2012, p.317). Furthermore, the cantons show horizontal redundancy of functions with conferences such as EnDK and Energiefranken. Finally, based on the low presence of vertical redundancy and the high presence of horizontal redundancy, the total score for the indicator of *redundancy of functions* is considered **medium**.

4.1.2.3 Institutional fit

[Ecological & social fit]

In general, the policymaking process in Switzerland can be described as "*implementation by federal delegation*" (Strebel, 2009, p.2), which means that cantons are responsible for the specification and execution of tasks, although the Federal Constitution provides financial resources and framework laws. In an ordinary Swiss canton, policy design is "*specific to **socioeconomic**, **demographic** and **political prerequisites in the cantons**. As a consequence, **policies are tailored** to the circumstances in the respective unit*" (Strebel, 2011, p.468). One example of social fit is found in the policy shift of phasing out nuclear power as part of the Swiss national energy strategy. Nuclear power has, next to hydropower, the largest share of electricity generation in Switzerland. After the nuclear disaster in Fukushima in 2011, the Swiss national government decided to act upon the social preferences of Swiss citizens on phasing out any form of nuclear power generation. Examples of ecological fit to which environmental characteristics are integrated into policy design are less clear. Only public-private partnerships, where local energy actors and regional share local knowledge, comes close to be an example of ecological fit. In the end, *social fit* is considered **high**, while *ecological fit* scores **low**.

4.2 Case study of the Netherlands

4.2.1 Assessment level of polycentricity in the Netherlands

4.2.1.1 Multiple centres

[Number of centres]

Next to governmental stakeholders, entities such as energy firms and distribution network operators play an important role in the establishment of the Dutch solar PV landscape. Energy firms are privatised and

operate at a national level, but grid operators are state-owned and serve as an intermediary between energy consumers and the government. The main grid operator in the provinces Noord-Brabant and Limburg is Enexis, which is one of the larger operators in the Netherlands (Netbeheer Nederland, 2019).

In addition, the number of Dutch energy cooperatives in Noord-Brabant has been growing fast since 2011, which is not a coincidence as the SDE subsidy got introduced in the same year. In Limburg, this growth started from 2013 onwards. Furthermore, most of these cooperatives focus solely on solar PV. In relation to other collective associations, the housing associations and the Association for Unified Owners (VvEs) are major players in the adoption of solar PV on collective roofs. VvEs are the groups of collective owners of a building complex and they are responsible for collective energy generation regarding solar panels on shared roofs. It is estimated that 104 VvEs are represented in Noord-Brabant and 54 in Limburg. From the analysis, it is observed that the Netherlands has a high diversity of centres, which make the Netherlands score **high** on the criterion *number of centres*.

4.2.1.2 Overlapping centres

As a consensual-unitary country, the Netherlands has a national government that determines the tasks of the lower-level decision-making centres. Provinces are in the middle of receiving tasks from the national government (Rijksoverheid) and delegating tasks to the lower level municipalities.

[Functional overlap & Territorial overlap]

The Netherlands is a decentralised unitary state which consists of 12 provinces and 380 municipalities (Rijksoverheid, 2019d). The power stays in the hands of the unitary national government, but tasks can be assigned to lower levels of government:

"*In a **unitary political system**, the constituent units (e.g. local municipalities) can only **exercise those powers that the central government has delegated to them** and the **national government can re-configure the dispersion of authority unilaterally**. In decentralised unitary states, political authority is delegated to the constituent units through devolution*" (Ehnert et al., 2017, p.5).

In addition, provincial governments are primarily responsible for the design of the rural area and regional economic policy, while municipalities are responsible for zoning plans, housing and local infrastructure (Rijksoverheid, 2019d, 2019e; Warbroek & Hoppe, 2017). Apart from national obligations in energy developments, provincial governments' ambitions regarding energy policy and climate change mitigation were voluntary. "*Although both provincial governments and municipalities run environmental policy, this typically concerns traditional command and control*" (Warbroek & Hoppe, 2017, p.11). Furthermore, territorial overlap occurs as the policy decision-making regarding VvEs often goes beyond the scope of one municipality. However, it should be noted that this was the only example found where decision-making is taking place across jurisdictional overlapping areas. In the end,

functional overlap is **low** as the tasks of decision-making centres are clearly divided, but *territorial overlap* can be considered **high**.

[Vertical overlap]

The national government monitors the provinces, and in turn, the provinces monitor the municipalities (Rijksoverheid, 2019a). In this way, the energy strategy of the Rijksoverheid is vertically integrated to the subnational level:

"*The Dutch political system, although unitary, has its own **institutional dynamics between levels**, in addition to a fragmented executive requiring cross-party and cross-ministry co-ordination. The process of including different societal elements is ingrained into the system. The policy frame that developed over time, internalisation, emphasises the essential role of target groups in being involved in the policy process*" (Zito, 2015, p.14).

In addition, municipalities co-rule ('medebewind') sometimes, which means that the municipalities follow tasks and directions from the provincial and national governments (Rijksoverheid, 2019d). The Dutch history of command and control in environmental policy and the co-ruling in between levels of decision-making make the *vertical overlap* in the Netherlands **high**.

[Horizontal overlap]

On the subnational level, cooperation between provinces does occur, but mostly in the form of voluntary agreements (Klok, Denters, Boogers, & Sanders, 2018). However, horizontal overlap at the subnational level has increased in the last decennium (Groenleer & Hendriks, 2018).

"[The] *Dutch give a substantial role to negotiated voluntary agreements, or covenants. The design of the agreements evolved from fairly loose agreements to covenants targeted at particular sectors and linked to regulation and the licensing system*" (Zito, 2015, p.13)

In addition, there is an interprovincial network called 'Interprovenciaal Overleg (IPO)', which stimulates the cooperation between the provinces regarding policymaking. On the municipal level, the horizontal overlap is eve higher: on this lower level, there are five options for inter-municipal cooperation, ranging from the appointment of an independent legal authority ('open lichaam') to a voluntary agreement called 'Regeling zonder meer' (Rijksoverheid, 2019b).

"*Municipalities and provinces, first of all, are involved in the national coordination process for new legislative proposals through their **umbrella organizations**, the **Vereniging voor Nederlandse Gemeenten (VNG)** and the **Interprovinciaal Overleg (IPO)**. This allows them to **exert influence at an early stage of the policy process**. Furthermore, particularly when it comes to subsidies from the*

*structural funds, **subnational authorities often seek to bypass 'The Hague'*** (Groenleer & Hendriks, 2018, p.13).

Overlapping, collaborative arrangements are formed when *"[…]municipalities frequently join forces voluntarily. Together, they have more capacity at their disposal, and can pool resources, allowing them to perform their tasks more effectively and reap the benefits of economies of scale*" (Groenleer & Hendriks, 2018, p.8). While this study focuses on governance approaches limited to the provincial level, the observation of strong horizontal overlap between municipalities in the Netherlands is considered less important for this assessment. Therefore, the horizontal overlap on the provincial level cannot be considered strong, and therefore scores **medium** on the indicator *horizontal overlap*.

4.2.1.3 Autonomy

[Active exercise of opinions]

As discussed earlier, the indicator *active exercise of diverse opinions* is about the active implementation of a decision by at least one centre (Aligica, 2014). On the other hand, the Netherlands has a culture of finding consensus in policymaking (Zito, 2015). This process of *polderen*, in which multiple perspectives of proposals are taken into account. It is a "*deliberative process of give and take, in which each party may have a great deal of responsibility and autonomy in part, but also substantial co-responsibility and interdependence in the whole*" (Groenleer & Hendriks, 2018, p.6).

"*Consensus democracy is basically indirect and integrative. Representatives of groups and sections of society are the prime decision-makers. […] **Collective decision-making** largely takes place through **co-producing, co-governing and coalition-oriented methods** and aims to establish **consensus and broad-based support**. Preferably, the majority will not overrule substantial minorities by simply counting heads; the **goal is to build policies on a broad platform of support**, both politically and socially*" (Hendriks, Lidström, & Loughlin, 2015).

Although there is a large variety of active opinions, the authority of centres to implement decisions is not highly present due to the overruling of the national government. Therefore, the *active diverse of opinions* is considered **medium** (high on diversity, but low on autonomous actions).

[Degree of authority]

According to theory, a decentralised unitary system has a centralised institution with the highest power, but autonomy is granted to lower levels of decision-making centres. This means that local decision-making centres are only allowed to perform tasks which the national government has delegated to them (Ehnert et al., 2018). The decentralisation of power and tasks has been increasing since the last decade and has led to more responsibility and collaboration on the regional scale (Groenleer & Hendriks, 2018). A useful example of autonomy was found in the fiscal sovereignty of the provinces Noord-Brabant and

Limburg. Because of the big budget of the national government, solar PV policies were amply implemented on the subnational level. Lower governmental levels can make their own solar PV policies and collaborations regarding solar PV implementation. However, the autonomy of lower level centres is, to a certain extent, undermined by the centralised power of the national government:

"*The role of the central state is far from straightforward, and the more pronounced role of subnational authorities, notably at the level of the region,* ***certainly does not signify a diminishing role of central government***" (Groenleer & Hendriks, 2018, p.2).

"*Formally,* ***municipalities have considerable autonomy*** *regarding public service provision. In practice, however, there exists* ***a lot of public and political pressure*** *to* ***provide an implicit 'minimum level' of public services*** […] *However, in the Netherlands, fiscal disparities are to a large extent equalized through an elaborate grant system*" (Allers, 2015, p.455).

One example of showing the degree of authority on the national and subnational level includes the 'Postcoderoosregeling'. This policy instrument is steered by the national government, but cooperatives are stimulated to provide local solutions regarding solar PV adoption. Supervision takes place in a top-down approach where the national government has financial supervision over provinces, which in turn have supervision over municipalities. This shows that provinces, as well as municipalities, have room to initiate own initiatives, however, they do not have full authority to implement policy decisions. The higher level of autonomy at the municipal level, but the constricted autonomy on the provincial level make the Netherlands score **medium** on the *degree of authority*.

4.2.2 Assessment of Dutch solar PV policies

Prior to scoring indicators, descriptive results of solar PV policy output on the national and subnational level were derived. In Table 9, the national solar PV policies are listed, which include energy acts and policy instruments. These Dutch policies are described individually, and the listed subnational policies can be found in Table 10 and 11.

Energy policy output focused on solar PV incentives got integrated consistently during the last two decades on the national Dutch level. Back in 1997, the Energy Investment Allowance (EIA) was introduced, which is still in use today. In contrast, the policies Energy Contribution Regulation (EPR), Environmental Quality of the Electricity Production (MEP), Stimulus Policy Renewable Energy Generation (SDE) and a support scheme for solar panels were only active for two to four years. Remarkable is the fact that so many national policies have stimulated solar PV adoption for diverse target groups and during the same time period. For instance, net metering (*salderen*) is applicable for almost every solar PV owner, but at the same time businesses had to choose between the financial benefits of the EIA or the SDE(+). While the SDE+ can be considered the most popular subsidy scheme from 2011 onwards, the Energy Agreement in 2013 set course in the energy policy landscape after 2013:

a tax return on the purchase of solar panels was introduced in 2013; energy cooperatives were able to receive a tax exemption based on collective PV generation within local ZIP code, and an energy-saving loan (‘Energiebespaarlening’) from a national fund was made available. Lastly, the target group of sports accommodations was able to receive financial incentives in the Energy Conservation and Sustainable Energy for Sports Premises (EDS) subsidy, which was later transferred under the broader subsidy scheme ‘stimulation of building and maintaining sports accommodations’. Below, short descriptions per national policy are given.

Table 9. National policies including financial incentives for solar PV in the Netherlands.

Timespan	Translated from Dutch	Policy	Type*
1997 – now	Energy Investment Allowance	Energieinvesteringsaftrek (EIA)	PI
2001 – 2003	Energy Contribution Regulation	Energiepremieregeling (EPR)	PI
2003 – 2007	Environmental Quality of the Electricity Production	Milieukwaliteit van Elektriciteitsproductie (MEP)	PI
2004 – now	Net metering	Salderingsregeling	PI
2008 – 2011	Stimulus Policy Renewable Energy Generation	Stimulering Duurzame Energie (SDE)	PI
2011 – now	Stimulus Policy Renewable Energy Generation+	Stimulering Duurzame Energie (SDE+)	PI
2011 – 2013	Support scheme solar panels	Stimuleringsregeling zonnepanelen	PI
2013	Energy Agreement for Sustainable Growth	Energieakkoord	A
2013 – now	Tax return on purchase solar PV panels	Btw teruggave op aanschaf zonnepanelen	PI
2014 – now	Regulation reduced tariff for collective generation	Postcoderoosregeling	PI
2014 – now	Energy-saving loan	Energiebespaarlening (Nationaal Energiefonds)	PI
2016 – 2018	Energy conservation and sustainable energy for sports premises	Energiebesparing en duurzame energie sportaccommodaties	PI
2019 – now	Stimulation of building and maintaining sport accommodations	Subsidieregeling stimulering bouw en onderhoud sportaccommodaties	PI

** Types of national policies: A = act (incl. directives); PI = policy instrument (incl. subsidies, feed-in schemes, financial loans etc.).*

Energy Investment Allowance (EIA)

The energy investment allowance 'Energieinvesteringsaftrek (EIA)' is in force since 1997. It is the oldest subsidy which is still applicable today. Entrepreneurs may use this subsidy as it concerns a reduction of the income- or corporation tax. Moreover, governmental institutions, foundations or associations may utilise the EIA if subjected to a corporation tax. The EIA gave a reduction of 40% on the tax but was increased to 55% in 2001. It used to be the case that applicants had to choose between the EIA subsidy or the SDE+ subsidy. From 2014 onwards, the EIA regulations regarding renewable energy generation were brought under the subsidy scheme of the SDE+ (Netherlands Enterprise Agency (RVO), 2015).

Energy Contribution Regulation (EPR)

In 2001, the Energy Contribution Regulation 'Energiepremieregeling (EPR)' was introduced to compensate purchases of solar PV systems (Verhees, Raven, Veraart, Smith, & Kern, 2013). The compensation fee was 500-700 gulden per panel, which is equivalent to 230-320 euros (Algemeen Nederlands Persbureau (ANP), 2000). The EPR was shortly in force and was brought to an end in 2003. This change was abrupt because of outcomes in political elections. With new coalitions in 2007, the political landscape changed again, but this time with a boost for renewable energy.

Feed-in premium (Environmental Quality of the Electricity Production, MEP)

The 'Milieukwaliteit van Elektriciteitsproductie (MEP)' feed-in tariff was introduced in 2003 (Van Sambeek, Thuijl, & Roos, 2003). It was the first subsidy scheme and included total funding of 538 million euros. The subsidy compensated a vast tariff between 0 and 9.7 euro cents for every generated kWh, depending on type and year of application and technology. Eventually, it got replaced by the SDE regulation in 2008.

Net metering

In 2004, the national government made net metering legal. For energy producers with solar PV on their rooftops, it was made possible to send the overload of generated renewable electricity back into the grid. This means that the electricity a producer generates and returns to the grid is deducted from the household's energy consumption. In addition, the net operator gives a reduction on the energy tax in exchange for the electricity fed back into the grid. This benefit will slowly fade out, starting in 2023 and ending in 2031 (Rijksoverheid, 2019c).

While this policy is addressed to individual consumers, energy cooperatives also used this mechanism in collaboration with housing associations (Proka, Hisschemöller, & Loorbach, 2018). In 2011, the netting limit was increased from 3000 kWh to 5000 kWh because of the growing PV technology

performance. In 2012, this limit of 5000 kWh was cancelled in order to give also homeowner associations (VvE) the opportunity to net metering (PricewaterhouseCoopers (PwC), 2016).

Feed-in premium (SDE and SDE+)

As the successor of the MEP, the 'Stimulus Policy Renewable Energy Generation (SDE)' can be considered another popular grant scheme, which was primarily targeting companies, institutions, and non-profit organisations (RVO, 2019). The SDE was the first financial stimuli which changed the focus from the purchase of solar PV to the use of solar PV electricity. The budget of 2144 million euros was depleted quickly, as the number of applications for the SDE also exceeded expectations (Verhees et al., 2013).

The SDE and SDE+ both incentivised renewable electricity production per unit supplied to the grid (Verhees et al., 2013). Similar to the EIA, both policy instruments have excluded private producers, such as households, from the use of this scheme. Because of the similarities, an applicant had to make a choice between the SDE(+) or EIA. The SDE(+) compensated the unprofitable component ('onrendabele top'), which is the price difference of the cost price of renewable electricity and the market price (RVO, 2019). The subsidy scheme can be used up to 15 years after the application approval.

In 2011, the SDE was changed into the SDE+, which included a lower kWh fee and excluded subsidies for smaller solar PV systems. While some argue that the change embedded in the SDE+ was because it would give a fairer distribution of the benefits (SDE would only benefit large companies) (Proka et al., 2018), it could also be the political changes which lowered the ambition on renewable energy generation (Verhees et al., 2013).

Support scheme solar panels (under subsidy scheme 'Energy and Innovation')

The support scheme for solar panels came into existence in 2011. In contrast to the SDE scheme, this subsidy scheme targeted households and included a total budget of 50 million euros. The subsidy compensation was the same for small and large scale solar PV projects, namely a maximum of 650 euros (Ministerie van Economische Zaken Landbouw en Innovatie, 2012).

Energy Agreement for Sustainable Growth

The 'Energieakkoord' was a collaborative effort of over 40 organisations to make agreements regarding energy saving, renewable energy and creating more jobs. Specifically, this concerned changes in the budgets of the SDE+. This agreement can be seen as a cornerstone and stimulation for other energy policies which came into existence over the last years.

Tax return on purchase solar PV panels

Since 2013 it is possible to gain a tax return from the purchase of solar panels, which is handled by the Dutch Tax and Customs Administration (Belastingdienst, 2019). This tax return also had a retroactive effect: tax could also be returned if the solar panels were purchased before 2013 (Milieu Centraal, 2019).

Regulation reduced tariff for collective generation (Postcoderoosregeling)

The regulation reduced tariff for collective generation, also known as 'Postcoderoosregeling', is in force since 2014. The target group included collective energy generators such as energy cooperatives and homeowner associations (Tweede Kamer der Staten-generaal, 2013). The collective gets compensated with a reduced tariff on the energy tax. The regulation stimulates renewable energy generation on the local level, without the need to own a solar panel or -roof. The 'Postcoderoosregeling' provides tax rebates for residents of a specific ZIP postal code and the surrounding neighbourhoods. Since January 1, 2014, members of solar cooperatives and homeowner associations are eligible for a tax rebate of 9 cents/kWh on jointly generated renewable energy (HIER opgewekt, 2017). The collectives were granted for 10 years of tax exemption at first. However, the guarantee was extended to 15 years because of the consensus model of negotiating (Proka et al., 2018; Tweede Kamer der Staten-generaal, 2014).

Energy-saving loan (Energiebespaarlening)

The 'National Energy Fund' has been giving loans to homeowner and housing associations for adopting energy savings measures including solar panels. Only 75% of the total loan can be used for the purchase of solar PV. This limit is due to the broader energy strategy of the national government, which also includes the stimulation of other renewable energy measures. From June 2015 onwards, also homeowner associations are allowed to use this energy-saving loan (Stichting Nationaal Energiebespaarfonds, 2019).

Energy conservation and sustainable energy for sports premises and successor 'Subsidy stimulation of building and maintaining sports accommodations'

In 2016, the Energy Conservation and Sustainable Energy for Sports Premises subsidy was introduced (Ministerie van Volksgezondheid Welzijn en Sport, 2018). With this subsidy, sports accommodation are also stimulated to invest in energy-saving measures, such as the purchase of solar panels. Sports accommodations may apply for an additional subsidy of 15% for solar panels purchase. In 2019, this regulation was combined with another regulation into the subsidy 'stimulation of building and maintaining sports accommodations'. However, apart from the total available budget, the characteristics of the subsidy remained the same (Ministerie van Volksgezondheid Welzijn en Sport, 2019).

Table 10. Subnational policies in the province of Noord-Brabant (NL).

Provincial policy	Year	Budget (€)	Target group	Comments	Source
Subsidy 'Energy Noord-Brabant'	2018	50% of eligible costs* Max. €125,000	Businesses	Cooperation with at least one other party	(Provincie Noord-Brabant, 2018)
Energy Fund Noord-Brabant	2013	€60,000,000 (total)	Businesses	Duration: 24 years	(Provincie Noord-Brabant, 2014)
Subsidy 'Brabant saves' private homeowners Noord-Brabant	2010-2011	€500 per house per homeowner	Private homeowners	Material- and installation costs Very short application period (half year)	(Provincie Noord-Brabant, 2010)
Energy loan private homeowners Noord-Brabant	2009-2011	Min. €3,000 Max. €10,000	Private homeowners	Used for costs instalment, consultancy, or tax-related Duration: 10 years; fixed interest rate 2%	(Provincie Noord-Brabant, 2009a)
Energy loan homeowner associations Noord-Brabant	2009-2011	Max. €10,000,000	Homeowner associations	Eligible activities on >10 houses	(Provincie Noord-Brabant, 2009b)

**Eligible costs are the extra costs ('onrendabele top') compared to a traditional alternative energy source.*

Table 11. Subnational policies in the province of Limburg (NL).

Provincial policy	Year	Budget (€)	Target group	Comments	Source
Energy loan 'Duurzaam Thuis'	2019	Homeowners: €35,000 Renters: €25,000	Private homeowners and renters	Duration: 10 years Managed by Stimuleringsfonds Volkshuisvesting'	(Provincie Limburg, 2019a)
Subsidy 'Cooperative energy projects'	2018-2019	Max. €20,000	Energy cooperatives	Goal: improving communication and knowledge about renewable energy	(Provincie Limburg, 2018)
Subsidy 'Duurzame maat-schappelijke organi-saties'	2017-2019	25% of investments costs Max. €25,000 per building	Schools, associations and energy cooperatives	Wide range of sustainable technologies; covering new construction as well as existing buildings	(Provincie Limburg, 2019b)
Subsidy 'DuurzaamDoor'	2015-2016	Max. €50,000	Initiative with at least three** different stakeholders	Renewable energy projects in collaboration with social innovation	(Provincie Limburg, 2015)
Subsidy 'Sustainability measures'	2014-2015	Solar panels: €0.50 Wp***	School, associations, and community homes	Wide range of sustainable technologies; covering new construction as well as existing buildings	(Provincie Limburg, 2014)
Investment subsidy renewable energy sources	2012	45% of eligible costs*	Businesses	+10% for medium-sized businesses +20% for small-sized businesses	(Provincie Limburg, 2012b)
Limburgse Energiesubsidie	2012-2014	Solar panels: €0.80 Wp*** Max. €1,000	Homeowners	Wide range of sustainable technologies; covering new construction as well as existing buildings	(Provincie Limburg, 2012a)

Limburg Energy Fund	2012	€60,000,000 (total)	Businesses; swimming pools; nurseries; etc.	Duration: 20 years	(Limburgs Energie Fonds, 2019; Provincie Limburg, 2013; Stimuleringsfonds Volkshuisvesting, 2019)

**Eligible costs are the extra costs ('onrendabele top') compared to a traditional alternative energy source.*

***Including at least three of the following stakeholders: businesses, citizens groups, research institutes, governments, educational institutes, or socially responsible organisations.*

****Wp = Wattpiek; 1 Wp is equivalent to ~0,88 kWh* (Essent, 2019).

Regarding the subnational solar PV policies, the policies of provinces Noord-Brabant and Limburg are now discussed. Table 10 and 11 show the provincial solar PV policies of Noord-Brabant and Limburg. For the province of Noord-Brabant, results were found from the year 2009 onwards, due to the limited availability of online government sources. Similar data availability was found for the province Limburg, which showed findings from 2012 onwards.

First, the province of Noord-Brabant has currently two active financial instruments available for businesses: the energy fund 'Noord-Brabant' and the subsidy 'Energy Noord-Brabant'. The energy fund is an additional loan to the national energy-saving loan provided by the national government. The total budget of the fund is €60 million, which can be paid back within 24 years (Provincie Noord-Brabant, 2014). The more recent subsidy provided by the province has a total budget of €125,000 with the prerequisite of having at least one other business partner in the energy project (Provincie Noord-Brabant, 2018).

Second, the province of Limburg currently offers two loans which financially incentivise solar PV investments. The first is the Limburg Energy Fund (LEF), which was introduced in November 2012 (Provincie Limburg, 2013). It has a total budget of 60 million euros and the intended loan duration is 20 years (Stimuleringsfonds Volkshuisvesting, 2019). The target group includes small- and larger businesses and collective institutions such as swimming pools, nurseries etc (Limburgs Energie Fonds, 2019). The second loan the province of Limburg provides is the 'Duurzaam Thuis' stimulus loan for households. The loan is limited to €35,000 for homeowners and €25,000 for renters (Provincie Limburg, 2019a). It has a duration of a maximum of 10 years and is managed by the 'Stimuleringsfonds Volkshuisvesting'. Moreover, the province of Limburg offers a subsidy 'Duurzame maatschappelijke organisaties', which applies to schools, associations and energy cooperatives (Provincie Limburg, 2019b). The subsidy was introduced in 2017 and covers 25% of the investment costs. Both current policies as well as expired policies in Noord-Brabant and Limburg were listed in Table 10 and 11.

4.2.2.1 Adaptive capacity

[Policy experimentation]

The solar PV policy output on both the national and subnational level is high. This relates to a high level of policy experimentation. The development of the MEP into the SDE and its successor SDE+ show the process of policy learning. The SDE has been a very consistent policy instrument SDE(+) to which even a third version (SDE++) will start in 2020 (Tweede Kamer der Staten-generaal, 2019). Apart from the federal legislation regarding solar PV financial incentives, both provinces Noord-Brabant and Limburg show policy experimentation by superseding policy instruments and energy loans during the years. Therefore, the score on *policy experimentation* is **high**.

4.2.2.2 Mitigation of risk

[Redundancy of functions]

For the Netherlands, the trend of high PV policy output on both the national and subnational level relates to a high level of vertical policy redundancy. The existence of an energy loan on both the national and subnational level shows redundancy: the provincial funds in Noord-Brabant and Limburg exist parallel to the larger energy-saving fund of the national government. In addition, vertical redundancy is also found in the examples of similar solar PV policies on the national and subnational level. Moreover, elements of horizontal redundancy include interprovincial deliberation, of which Interprovinciaal Overleg (IPO) is one example. The total score on *redundancy of functions*, which includes vertical and horizontal redundancy, can be considered **high**.

4.2.2.3 Institutional fit

[Ecological and social fit]

The policymaking process in the Netherlands follows the consensus model, to which the perspectives of many energy stakeholders are taken into account. One example of ecological as well as social fit is the regulation *reduced tariff for collective generation* ('Postcoderoosregeling'). While initially designed by the national government, its implementation is in the hands of the local level. In this way, both the social and ecological preferences on the local level are assured. For instance, due to the consensus model of negotiating *polderen*, the guarantee of the 'Postcoderoosregeling' was extended to 15 years (Proka et al., 2018; Tweede Kamer der Staten-generaal, 2014). In this case, the high level of local integration leads to a **high** score of *social fit*. On the other hand, the environmental preferences in this example are not highlighted, which leads to a **low** score on *ecological fit*.

4.3 Comparative results case studies

This section begins by comparing the two case studies and then elaborates on differences and similarities between the cases. The results of the comparative analysis can be found in Table 12 and 13. Both cases do not show high scores regarding the indicators for polycentric constructs. This means that both governance approaches in Switzerland and the Netherlands are not fully polycentric, but show integrated elements of the concept. The scores of Switzerland regarding polycentric constructs show higher scores on *multiple centres* and *autonomy*, but lower scores on *overlapping centres.* Furthermore, the Netherlands scored higher on the indicator of *overlapping centres*. Overall, both Switzerland and the Netherlands can be considered polycentric to a certain extent.

Contrasting values were found in the sub-indicators *territorial-*, *vertical-*, and *horizontal overlapping centres* and *formal authority*. First, the greatest difference was found in the polycentric construct of *territorial overlap*. Switzerland exerts the subsidiarity principle, in which there is a clear division in tasks and power between higher and lower levels of decision-making centres. The jurisdiction in

Switzerland is clearly divided with almost no territorial overlap between the decision-making centres. This is in contrast with the high spatial overlapping areas in the Netherlands. In addition, the subsidiarity principle leads to less *vertical overlapping*, but this also leads to stronger *horizontal overlapping*, which can be seen in the examples of Swiss intercantonal treaties, conferences, and public-private partnerships (PPPs). In contrast, there is no evidence of similar PPPs on the local level in the Netherlands. The Dutch national government mainly exerts central supervision, but it allows local operationalisation (Groenleer & Hendriks, 2018). The horizontal network of Interprovinciaal Overleg (IPO) is only a weak form of horizontal coordination. On the other hand, the *vertical coordination* in the Netherlands is higher than Switzerland, because of more supervision between the national government, provinces and municipalities. Furthermore, the subsidiarity principle can also explain the difference in *formal authority*: In theory, the subsidiarity principle in Switzerland gives more formal authority to lower-level centres (Korthals Altes, 2002). In contrast, the Netherlands originally has a more top-down supervision approach with less autonomy for the provinces.

Table 12. Assessment scores independent variables case studies.

Indicators	Description	Switzerland	The Netherlands
Multiple centres of decision-making	*Number of decision-making centres*	[**high**]	[**high**]
Overlapping centres	*Functional overlapping*	[**low**]	[**low**]
	Territorial overlapping	[**low**]	[**high**]
	Vertical overlapping	[**medium**]	[**high**]
	Horizontal overlapping	[**high**]	[**medium**]
Autonomy	*Active exercise of diverse opinions*	[**medium**]	[**medium**]
	Formal authority	[**high**]	[**medium**]

Table 13. Assessment scores dependent variables case studies.

Indicators	Description	Switzerland	The Netherlands
Adaptive capacity	*Policy experimentation*	[**low**]	[**high**]
Mitigation of risk	*Redundancy of functions*	[**medium**]	[**high**]
Institutional fit	*Ecological fit*	[**low**]	[**low**]
	Social fit	[**high**]	[**high**]

On the assessment of policy performance, contrasting values were found in the sub-indicators *policy experimentation* and *redundancy of functions*. From the findings, it can be observed that the national policy output of the Netherlands is by far greater than its Swiss counterpart (see Figure 8 and 9). In these figures, the colour green marks the (still) active policies; yellow marks the expired policies; and blue marks the introduction of energy acts. On the national level, it was observed that several policy experimentations took place in the Netherlands within the last two decades. Furthermore, the differences on the subnational level are also large, showing barely any PV policies in the cantons of Zürich and Aargau, and many financial incentives in the provinces of Noord-Brabant and Limburg. The expectation that Switzerland is highly polycentric and the Netherlands only to a very low extent is not true. Moreover, the PV policy output was expected to be higher in Switzerland than in the Netherlands, which is also not the case.

Regarding the sub-indicator redundancy of functions, which was split into vertical and horizontal redundancy, the cases showed a difference in vertical redundancy. While horizontal redundancy was present in both cases, the vertical redundancy of solar PV policies was considered very high in the Netherlands because of the redundant existence of policy instruments, such as energy loans, on both the national and subnational level. These Dutch policies were redundant to each other, but energy stakeholders could use both measures for the adoption of solar PV. In contrast, the Swiss vertical redundancy was considered low, but this was also because of the limited findings of solar PV policies in Switzerland.

By comparing the case studies, similarities in polycentric constructs were found in the indicators *numbers of centres*, *functional overlapping*, *active exercise of diverse opinions*, *ecological fit*, and *social fit*. First, there is a diverse and large representation of energy stakeholders in both case studies, although both countries are relatively small in spatial size. Furthermore, the division of tasks in both case studies was very clear showing a similar degree of functional interlinkages between decision-making centres. Moreover, *active exercise of diverse opinions* was present in both Switzerland and the Netherlands, and in both cases, the national government has the power to overrule the decision-making process. On the other hand, the similarities regarding institutional fit are less clear. The high score on *social fit* in the Netherlands can be explained by the fact that the Netherlands performs a consensual decision-making model, which takes multiple proposals into account. Moreover, Switzerland also shows a high score on *social fit*, however, that is due to the acting upon social preferences, changing the main energy strategy after a nuclear disaster had struck in Fukushima in 2011. Lastly, the scores on *ecological fit* for both cases were low, because the findings did not show any policy matching with local and spatial characteristics at all.

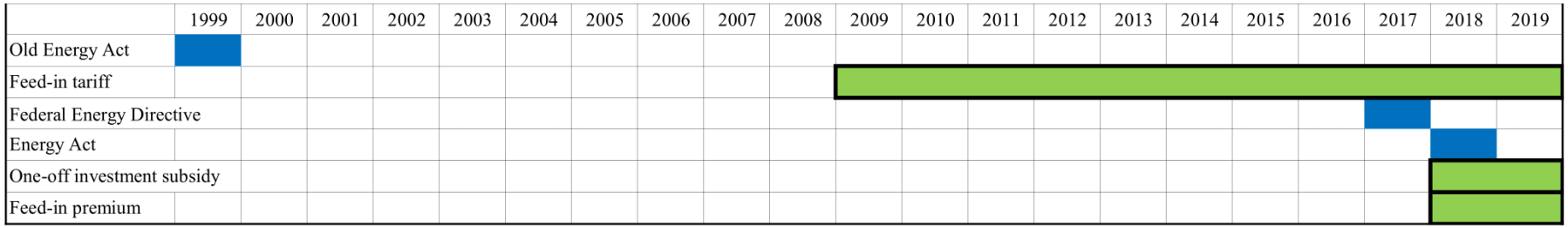

Figure 8. National solar PV policies in Switzerland (1999-2019)*.

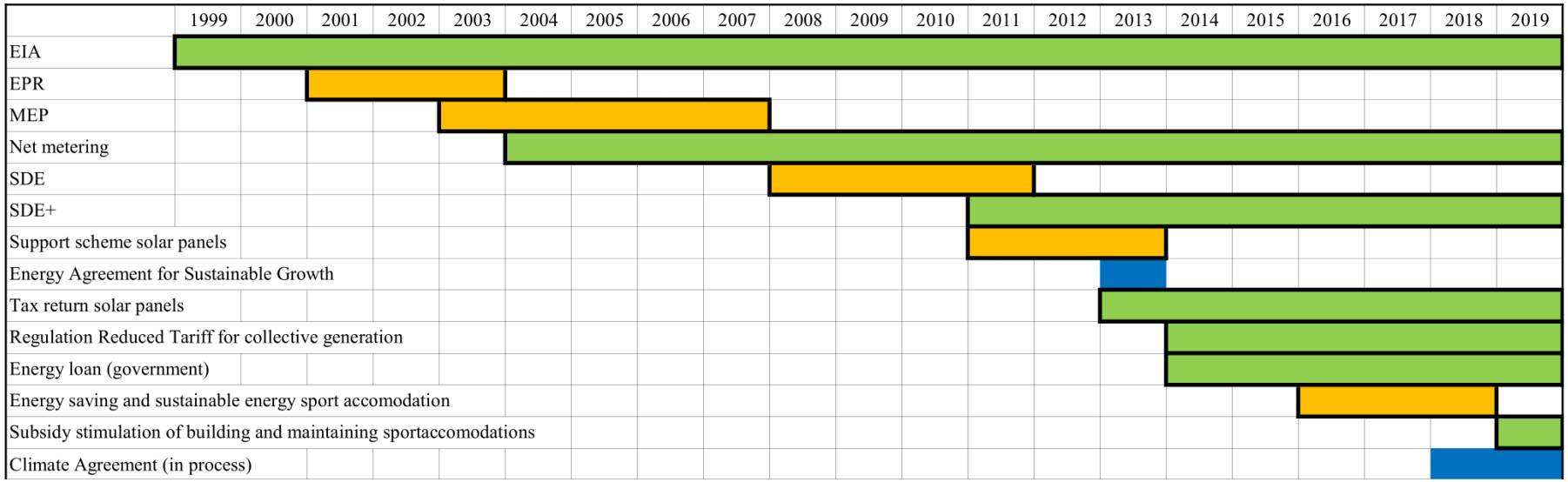

Figure 9. National solar PV policies in the Netherlands (1999-2019)*.

**green marks the (still) active policies; yellow marks the expired policies; and blue marks the introduction of energy acts*

The variation in PV policy output can be explained by contextual factors and the differences in governance approaches. The first reason of low policy output is that direct government subsidies are rare in Switzerland. It has been found that private partners give financial stimuli to regional stakeholders, for instance in the form of public private partnerships (PPPs). In addition, cantons only facilitate PV adoption, which means that subnational policies follow federal guidelines and nothing more. Lastly, Casado-Asencio and Steurer (2016) mention that cantons do not have the means to make their own ambitious energy policies. In contrast, the Netherlands shows a high PV policy output on the national level, but also on the subnational level. Both provinces of Noord-Brabant and Limburg have the means to create additional financial incentives because of their fiscal sovereignty. Moreover, the comparative analysis also highlights that the chosen countries for the case studies were found to be too similar regarding governance approach. The assumption that governance approaches between federal and unitary states were significantly different was proven to be wrong.

The comparative results are summarised in Figure 10. While the variation in the level of polycentricity between Switzerland and the Netherlands is small, the difference in policy performance is considerably larger. Therefore, the Netherlands fits best in Quadrant 2, while Switzerland fits best in Quadrant 4. In the end, the results cannot explain the effect of polycentricity on solar PV policy performance. In the next chapter, elaborate explanations of these results can be found.

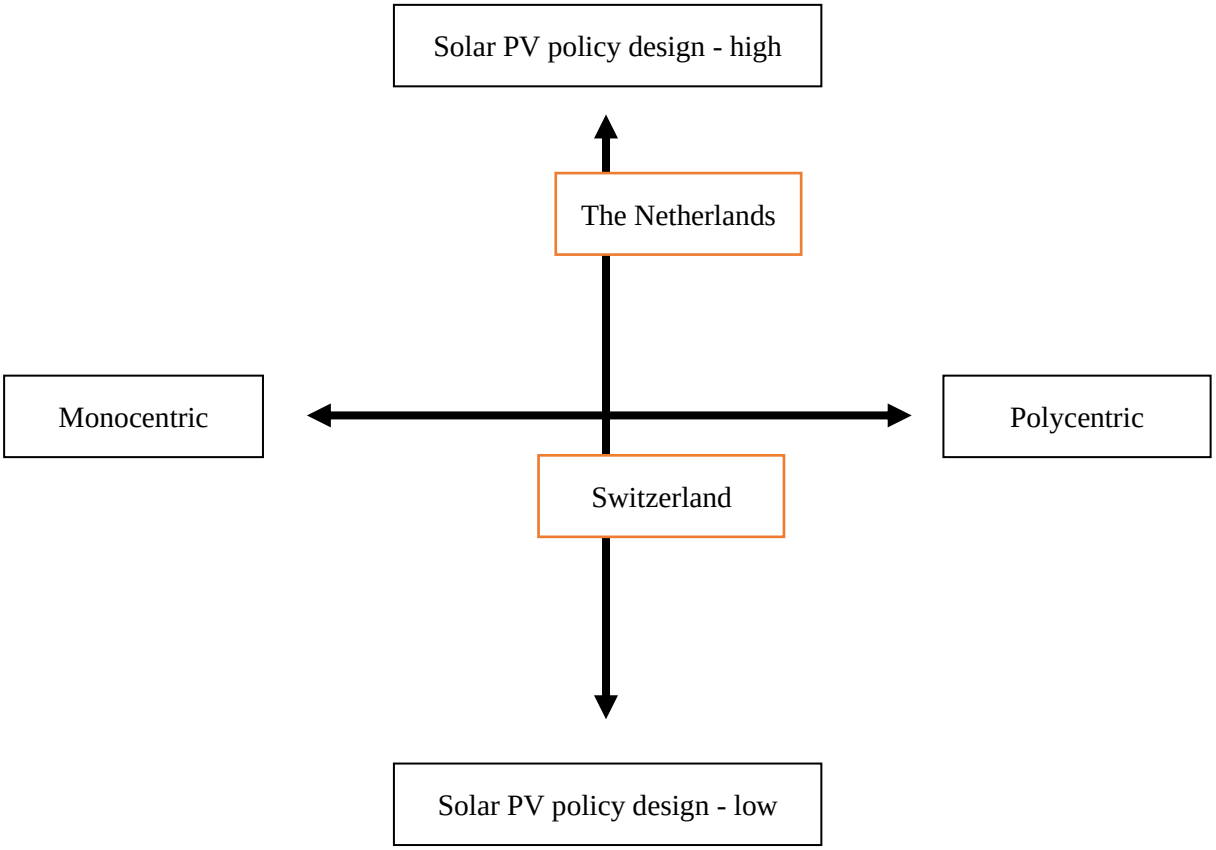

Figure 10. Summarised results comparative case study in quadrants.

5 Discussion

In this section, the implications of the results are discussed. First, the limitations of the research are elaborated upon. Second, the added value of the research concerning theoretical insights and venues for further research are identified. Lastly, this chapter elaborates on policy implications regarding the use of polycentricity.

5.1 Limitations of the research

[Reliability, validity, and suitability of results]

The key assumption made was that a federal state formation utilises a different governance approach than a unitary state formation. On the basis these definitions and the earlier works on the formal context of federalism by V. Ostrom (1973) and Andersson and Ostrom (2008), the main expectation was that federal states resembled polycentric constructs more than unitary states. Scholars such as Aligica and Tarko (2012), Jordan et al. (2018), and Schröder (2018) state that federalism shows similarities with the concept of polycentricity: Aligica and Tarko (2012) say that federalism can operationalise one aspect of polycentricity. This is supported by Schröder (2018), who argues that it is possible to frame polycentricity as an umbrella concept for federalism. Furthermore, Jordan et al. (2018) state that decision-making centres in a polycentric configuration show resemblance to federal or quasi-federal systems. In addition, Jordan et al. (2018) state the polycentric characteristics of multiple overlapping and interacting on different scales can be linked to the normative principle of subsidiarity, which is often applied in federal systems.

From the expected difference, Switzerland as a federal country and The Netherlands as a unitary country were chosen for a comparative case study. The expected result was that Switzerland would be more polycentric because of its federal system and that this also would result in higher performance on solar PV policies. However, the findings show that this is not the case: only small differences in governance approach between Switzerland and the Netherlands were found. Moreover, the Dutch performance on solar PV policies was by far greater than the Swiss policy performance. In the end, this shows that there is no significant difference in the level of polycentricity between a federal and unitary country for the case studies in this research project. While above-mentioned scholars argued that federalism shares elements of polycentricity, other authors have stated a clearer distinction between polycentricity and federalism. Regarding this distinction, McGinnis and Ostrom (2011) and Murtazashvili and Piano (2019) have argued that polycentricity encompasses federalism. Federal systems may consist of neatly nested jurisdictions on multiple levels, but polycentric systems also include crosscutting jurisdictions. Interestingly, the results show a difference in the polycentric construct of (territorial) overlapping. Although it resembles the crosscutting jurisdictions, this thesis cannot state significant conclusions based on only this difference.

Other limitations of this thesis include the small unit-number $N = 2$ of comparative analysis. An in-depth case study leads to recommendations which are less likely to be generalised for a broader population (Verschuren & Doorewaard, 2010). On the other hand, this research has increased its external validity by setting a larger time frame and thereby analysing trends over a longer period of time. Moreover, stratified random sampling was used to reduce the sampling bias, and thereby disarming threats to validity.

Another improvement to the methodology would be to include a triangulation of research tools. This could gain more (in-depth) results and would increase the credibility of this research. This research has differentiated by showing trends at a longer time period (20 years), which has increased the credibility of the data analysis. The last remark is regarding internal validity. Schoon et al. (2015) mention that coordination of polycentric governance networks evolves over time. For example, this is due to changing interests of stakeholders and external '*windows of opportunity*'. This means that replication of this specific study at a different time frame might lead to different results because of changes in governance arrangements over time.

[Limited results]

What could have played a role in the limited PV policy output is the handling of the literature study in the digitised presence of documents. On the national level, the availability and transparency of the documents are comparable. On the other hand, on the subnational level, the document sources of the Netherlands were richer and easier to find than the Swiss counterparts. In future research, a preliminary study on data availability can be part of a research project. In addition, local or online interviews could have enriched the data and could have given more information on solar PV and governance approaches on the subnational level. Of course, due to time limitations, it was deliberately chosen to not include interviews in this thesis process.

Furthermore, finding data on Swiss cantonal level was difficult, due to language barriers and the outdated online web sources. Also, it was harder to retrieve documents around the start of the time period in 1999. In addition, other general changes that made the data collection difficult were the alterations of institutions, which changed not only by name but also by size and functions. Moreover, the results for policy output in the Netherlands were higher on both the national and subnational level. However, the data collection on Dutch provincial level was also limited because of outdated web sources, in which the latest policy documents were found from 2009 onwards in the province of Noord-Brabant, and from 2012 onwards in the province of Limburg. Another explanation for the odd search results are the language barriers, which might have influenced the searching process. An alternative could have been to choose case studies which were not the researcher's native language. This would have limited the bias in search methods, such as browsing through governmental documents. Although German was not

a difficult language to review documents, it took longer to search for the right documents and policy information.

5.2 Theoretical implications

[Theoretical implications about polycentricity]

This research has a number of relevant theoretical implications for the scientific debate on polycentric governance, although the expected results were not based on the right assumption in hindsight. First, this research has added knowledge to the increasingly popular scientific debate on polycentric governance. The concept of polycentricity has been applied to other domains, but this research has tried to fill the knowledge gap by applying polycentricity to the energy domain. While studies on polycentric governance applied to metropolitan areas (V. Ostrom et al., 1961) or natural resources (Andersson & Ostrom, 2008; Pahl-Wostl & Knieper, 2014) show positive results, the research findings of this project are less clear. From the results, it cannot be concluded that polycentric governance leads to better energy policy. It requires a more thorough explanation and analysis to understand the effect of polycentric constructs on energy policy performance. On the basis of the findings in this thesis, it is therefore too early to prescribe how to govern the energy transition regarding the use of solar PV.

For a comparative case study, it is important to set up strong controls to isolate factors which could have an effect on the dependent variable. The methodology chapter made justifications for the choice of the two countries, but some factors cannot be diminished completely. One of these contextual factors is geographical landscape: Switzerland and the Netherlands contrast largely in geography, which makes it in some areas easier to install solar PV panels, and in other areas more difficult. Therefore, this might have had an effect on the policy choices regarding solar PV in certain areas. However, this does not change the operating way of governance approach in that specific area. The other contextual variable is the high renewable share in the electricity generation in Switzerland. While Switzerland relies on a current high share of hydropower and nuclear energy, this may have given Switzerland a lower incentive to invest, adopt and implement solar PV on a larger scale.

Second, methodological wise, this research can reflect on multiple decisions made in collecting and analysing data. The research has aided on how to measure polycentricity and is one of the first attempts to (exploratively) operationalise polycentric governance. Further research is necessary to improve the methodology of operationalising polycentric indicators and to gain more empirical data. Moreover, from the results, another scientific implication is the questioning of state formation definitions regarding its governance approach. While the research supports the statement by McGinnis and Ostrom (2011) that polycentricity encompasses federalism, the academic debate shows contrasting definitions. In the operationalisation of polycentric constructs and the case study selection, more attention should be given to draft highly valid and reliable criteria.

[Further research]

This research project has two main discussion points for the use of specific indicators in further scientific research: First, a high PV policy output does not directly imply *policy experimentation*, although the PV policy output in the Netherlands far higher than its counterpart in Switzerland. The process of the SDE(+) subsidy is certainly a form of policy experimentation, but the effect of irregular policy strategy among political administrations during the years should not be underestimated (Verhees et al., 2013). Second, as a result of explorative operationalisation of variables, I suggest adding a vertical and horizontal component to the indicator *redundancy of functions*, which falls under the main indicator mitigation risk as introduced by Carlisle & Gruby (2017). Although this thesis introduces these elements as a recommendation, it was also found to be suggested by Alexander, Armitage, Carrington, and Bodin in 2017.

Added-value of this research lies in above-mentioned suggestions, where the iterative process of continuously revising the collected data and search process led to the improvement of the research findings. This thesis went into a topic applied to a specific domain which was new, and less-explored. Therefore, venues of further research based on knowledge regarding polycentric energy governance are plenty. In addition, for further research, it would be interesting to include the political changes on both the national as well as the subnational level in the given time period. As policy output is determined by its policymakers, these influences can be taken into account.

5.3 Practical implications

Based on the comparative analysis, recommendations for policymaking are discussed here. First, the way in which polycentric constructs likely affect renewable energy policy is discussed. Polycentric governance might not always lead to better renewable energy policy performance, but from the findings, it is clear that the indicators *overlapping centres* and *autonomy* are likely to play an important role in the relation between these variables. However, the policy decision-making process of Switzerland is far from similar to the Netherlands: Switzerland showed strong horizontal coordination with intercantonal treaties and conferences, while the Netherlands seemed more vertically oriented by the territorial overlap between decision-making centres. In the end, it remains difficult to test the causality of governance approaches and policy performance on different scales. This is also due to the multitude of stakeholders and their relations with each other, which increases the complexity of the analysis.

Furthermore, the importance of *policy experimentation* and its relation to policy implementation is another key takeaway from this research project. Policy change occurs after policy implementation, however, the implementation of a policy can be the results of experimentation. From the findings, policy experimentation in the Netherlands took place by the introduction of the SDE subsidy in 2011, which led to another key policy implementation of the Energy Agreement in 2013. In Switzerland, this experimentation process was similar to the policy implementation of the feed-in tariff in 2009, which in

turn led to a new wave of national policy implementation in the years 2017/2018. In particular, the feed-in tariff has been an effective policy instrument for both the Netherlands as Switzerland. In the Netherlands, this introduction of the SDE(+) led to new financial incentives such as the tax return on the purchase of solar panels in 2013; energy cooperatives were able to receive a tax exemption based on collective PV generation within local ZIP code; and a national energy-saving loan ('Energiebespaarlening') was made available.

Lastly, a remark to policy experimentation is that is it often difficult to determine whether successful policies are the effect of policy experimentation or other contextual factors. Policy change does not have to be always about successful policy implementation. Scholars such as Verhees et al. (2013) argue that inconsistent policies have led to a higher uncertainty for energy market players and therefore led to a less integrated ecosystem for energy stakeholders. Vasseur, Kamp, and Negro (2013) even state that many policy changes have hindered the adoption of solar PV in the Netherlands. On the other hand, it can be argued that these policy experiments have shown the element of learning, to which financial incentives have increased the level of fit for national and subnational decision-making centres. One observation in the Netherlands is the trend of solar PV policies, where the focus in policy instruments have changed from stimulating the purchase of solar panels, to the stimulation of the use of solar power in general. In the end, this gave room to other initiatives such as energy collectives and financial measures by homeowners associations (VvEs) and therefore led to a higher inclusion of other energy stakeholders.

6 Conclusions

The goal of this research was to examine the relation between polycentric governance and solar PV policy performance in Switzerland and the Netherlands. Insights about the research process and results are given by summarised answers to the five sub-questions of this thesis:

1. Which governance approaches exist in Switzerland and the Netherlands, and to what extent are these approaches polycentric?
2. Which solar PV policies are implemented on the national and subnational level in Switzerland and the Netherlands between 1999 and 2019?
3. How can these policies be assessed?
4. From the comparison of governance approaches in the two case studies, how can the differences and similarities regarding solar PV policies be explained?
5. What are the opportunities and limitations of polycentric governance applied to the energy domain on the national and subnational level?

First, the governance approaches of Switzerland and the Netherlands were identified. The Swiss federal system and the Dutch unitary system were assessed by the polycentric constructs *multiple centres of*

decision-making, *overlapping centres of decision-making*, and *autonomy*. It was found that both countries showed polycentric characteristics regarding their governance approach. While the Netherlands scored higher on the indicator of *overlapping centres*, Switzerland scored higher on the indicator *autonomy*. In the end, the Dutch governance system is found to be slightly more polycentric than the Swiss governance system.

Second, an overview of national and subnational PV policies in Switzerland and the Netherlands was drafted. The Dutch PV policy output between 1999 and 2019 outnumbered the Swiss PV policy output on both the national and subnational level. The Swiss subnational policies of the cantons Zürich and Aargau were very limited, whereas the Dutch subnational policies in the provinces Noord-Brabant and Limburg showed a larger number and a greater variety in financial incentives and energy acts.

Third, the PV policies were assessed by the evaluation criteria *adaptive capacity*, *mitigation of risk*, and *institutional fit*, which were derived from a literature review. The explorative and iterative process of data collection resulted in the adjustment of operationalised indicators. Regarding the PV policy performance results, the two cases showed larger differences. The Netherlands scored high on policy, redundancy of functions, and social fit, whereas Switzerland only scored high on social fit.

Fourth, from the comparative analysis of the governance approaches and solar PV policy performance of the two case studies, it can be concluded that the difference in PV policy performance between the two cases cannot be explained by the level of polycentricity alone. The expectation was that Switzerland would score higher on the level of polycentricity and therefore would have a better solar PV policy performance. In contrast, the results show no supporting evidence for that a higher level of polycentricity leads to better energy policy output. The unexpected result can be explained by a false assumption regarding case study selection. Eventually, this research has shown that the case study selection cannot be based on state formation definitions alone. The definitions of federal and unitary states do not distinguish large differences in governance approach, which means that these governance systems were found to be too similar for a comparative case study.

In the end, there seems to be no exclusive evidence that governance approaches affect solar PV policies on the national and subnational level in the Netherlands and Switzerland. The comparative results show almost no difference in polycentric constructs and therefore it can be concluded that PV policy performance is not determined by the level of polycentricity. Although there was a large difference found in the polycentric construct *territorial overlap*, this indicator alone is cannot cause the large difference in PV policy performance between the two case studies.

Finally, it is challenging to thoroughly research the relation between governance approaches and policy performance because of the lack of literature and empirical research. A key next step in further research is to extend and further investigate the operationalisation of polycentric constructs. In addition, it might

be interesting to add political analysis to the study of governance approaches. Concerning the practical perspective on the policymaking process, the polycentric constructs *overlapping centres*, *autonomy* and the evaluation criterion *policy experimentation* are most likely to be important indicators determining the relation between polycentric governance and renewable energy policy performance.

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Appendix A: General statistics samples case study

General national and subnational statistics of the Dutch (NL) and Swiss (CH) case. The Dutch statistics are based on the national statistics database Centraal Bureau voor de Statistiek (CBS) (2019b) and Rijksoverheid (2019c). Furthermore, the Swiss statistics are based on the report 'Regionalportraits 2019: Cantons' from Bundesamt für Statistik (BFS) (2018; 2019a; 2019b; 2019c) and cantonal government sources Kanton Zürich (2019b) and Kanton Aargau (2019).

Table A1. General statistics samples case study.

	NL (total)	Noord-Brabant (NL)	Limburg (NL)	CH (total)	Zürich (CH)	Aargau (CH)
Population	17,282,163	2,544,806	1,116,137	8,484,130	1,504,346	670,988
Area (km^2)	41,543	5,082	2,209	41,285	1,729	1,404
Provinces	12	-	-	26	-	-
Municipalities	355	62	31	2,221	173	211

Appendix B: Data collection results (desk research)

To improve the credibility of this research, the chain of evidence regarding data collection is shown in this appendix (see Table B1 and B2). The first search cycle was conducted in Scopus and second cycle in Google Scholar and policy documents (doc.). The scope of the searches was on the national and subnational level for both case studies.

Table B1. Search cycles for the case study of Switzerland.

	First search in Scopus	Second search in Scholar & policy documents	
Switzerland	Data collection/ relevant sources	Data collection/relevant sources	Date (latest)
Governance approaches	113/9	38/23	26 June 2019
Solar PV policies			
• National	67/1	5/2 (Google Scholar) 15/15 (policy doc.)	26 June 2019
• Kanton Zürich	1/0	4/4 (policy doc.)	13 June 2019
• Kanton Aargau	0/0	1/1 (policy doc.)	13 June 2019

Table B2. Search cycles for the case study of the Netherlands.

	First search in Scopus	Second search in Scholar & policy documents	
The Netherlands	Data collection/ relevant sources	Data collection/relevant sources	Date (latest)
Governance approaches	84/6	32/9	28 June 2019
Solar PV policies			
• National	18/2	11/2 (Google Scholar) 16/16 (policy doc.)	28 June 2019
• Province Noord-Brabant	0/0	5/5 (policy doc.)	19 June 2019
• Province Limburg	0/0	10/10 (policy doc.)	19 June 2019

Appendix C: List of data sources case study Switzerland

Table C1. National energy documents used for the document analysis Switzerland.

Source	Title	Year	Type	Retrieved from
Broughel, Stauch, Schmid, & Vuichard	Consumer (Co-)Ownership in Renewables in Switzerland	2019	Scientific article	-
Bundesamt für Energie (BFE)	Bundesrat senkt Vergütungssätze für Photovoltaik-Anlagen und Kleinwasserkraft	2016	Webpage	https://www.bfe.admin.ch/bfe/de/home/news-und-medien/medienmitteilungen/mm-test.msg-id-64755.html
Bundesamt für Energie (BFE)	Direktvermarktung Faktenblatt	2017	Policy document	https://www.bfe.admin.ch/bfe/de/home/foerderung/erneuerbare-energien/einspeiseverguetung.html
Bundesamt für Energie (BFE)	Energieperspektiven 2050: Sensitivitätsanalysen Photovoltaik - Ergebnisse der Modellrechnungen	2013	Policy document	https://www.bfe.admin.ch/bfe/de/home/politik/energiestrategie-2050/dokumentation/energieperspektiven-2050.html
Bundesamt für Energie (BFE)	Einmalvergüting	2019	Policy document	https://www.bfe.admin.ch/bfe/de/home/foerderung/erneuerbare-energien/einmalverguetung.html
Bundesamt für Energie (BFE)	Einspeisevergüting	2019	Policy document	https://www.bfe.admin.ch/bfe/de/home/foerderung/erneuerbare-energien/einspeiseverguetung.html
Bundesamt für Energie (BFE)	Förderung der Photovoltaik Faktenblatt	2019	Policy document	https://www.bfe.admin.ch/bfe/de/home/foerderung/erneuerbare-energien/einmalverguetung.html
European Commission	PV Status Report 2017	2017	Report	https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/pv-status-report-2017
Grantham Research Institute	Energy Act 730.0 and related regulation	2019	Webpage	http://www.lse.ac.uk/GranthamInstitute/law/energy-act-730-0-and-related-regulation/
International Energy Agency (IEA)	IEA/IRENA Joint Policies and Measures database – Switzerland	2018	Webpage	https://www.iea.org/policiesandmeasures/renewableenergy/?country=Switzerland
Pronovo	Direktvermarktung	2019	Webpage	https://pronovo.ch/de/foerdermittel/evs/direktvermarktung/
Pronovo	EVS-DE	2019	Webpage	https://pronovo.ch/category/evs/

RES Legal	Feed-in tariff	2019	Webpage	http://www.res-legal.eu/search-by-country/switzerland/single/s/res-e/t/promotion/aid/feed-in-tariff-1/lastp/396/
SCCER CREST	Schweizer Energiepolitik zwischen Bund, Kantonen und Gemeinden: Zentralisieren, dezentralisieren oder koordinieren?.	2019	Scientific article	-
Schmid & Bornemann	What Political Settings Promote Renewable Energy Investments by Energy Utilities? — A Qualitative Comparative Analysis in Swiss Cantons	2019	Scientific article	-
SFOE	Energy Strategy 2050 Once the New Energy Act Is in Force.	2018	Policy document	http://www.bfe.admin.ch/energiestrategie2050/index.html?lang=en&dossier_id=07008
Suisse Next	Direktvermarktung von Strom in der Schweiz	2018	Web page	https://www.suisse-next.ch/de/wissen/direktvermarktung-schweiz/
Swiss Confederation	Energiegesetz (EnG) vom 26. Juni 1998 (Stand am 1. Januar 2017)	2017	Policy document	https://www.admin.ch/opc/de/classified-compilation/20121295/index.html

Table C2. Subnational energy documents used for the document analysis Kanton Zürich.

Source	Title	Year	Type	Retrieved from
Broughel, Stauch, Schmid, & Vuichard	Consumer (Co-)Ownership in Renewables in Switzerland	2019	Scientific article	-
Kanton Zürich	Energie in Gemeinden: Stand Mai 2018	2018	Policy document	https://awel.zh.ch/internet/baudirektion/awel/de/energie_radioaktive_abfaelle/veroeffentlichungen.html
Kanton Zürich	Förderprogramm Energie: Bilanz 2002 bis 2015	2017	Policy document	https://awel.zh.ch/internet/baudirektion/awel/de/energie_radioaktive_abfaelle/veroeffentlichungen.html
Kanton Zürich	Förderprogramm Erneuerbare Energien & Abwärme	2019	Webpage	https://energiefoerderung.zh.ch/internet/microsites/energie/de/geld-bekommen/erneuerbareenergienundabwaerme.html
Swissolar	Förderung	2015	Webpage	https://www.swissolar.ch/fuer-bauherren/foerderung/

Table C3. Subnational energy documents used for the document analysis Kanton Aargau.

Source	Title	Year	Type	Retrieved from
Broughel, Stauch, Schmid, & Vuichard	Consumer (Co-)Ownership in Renewables in Switzerland	2019	Scientific article	-
Swissolar	Förderung	2015	Webpage	https://www.swissolar.ch/fuer-bauherren/foerderung/

Appendix D: List of data sources case study the Netherlands

Table D1. National energy documents used for the document analysis the Netherlands.

Source	Title	Year	Type	Retrieved from
Algemeen Nederlands Persbureau (ANP)	Forse subsidie moet koop zonnepanelen stimuleren	2000	Newspaper (LexisNexis)	https://advance-lexis-com.proxy.library.uu.nl/document/?pdmfid=1516831&crid=4ee4f974-f3b3-4306-bd9a-937d310fe16e&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A41F4-55N0-00B0-71BX-00000-00&pddocid=urn%3AcontentItem%3A41F4-55N0-00B0-71BX-0
Belastingdienst	Opgaaf zonnepanelenhouders	2019	Policy document	https://www.belastingdienst.nl/wps/wcm/connect/bldcontentnl/themaoverstijgend/programmas_en_formulieren/formulier-opgaaf-zonnepaneelhouders
Blom, Vergeer, & Schep	Beleidsevaluatie Energie-investeringsaftrek 2012-2017	2017	Report	https://www.ce.nl/publicaties/2126/beleidsevaluatie-energie-investeringsaftrek-2012-2017
HIER Opgewekt	Postcoderoosregeling: regeling in het kort	2017	Webpage	https://www.hieropgewekt.nl/kennisdossiers/postcoderoosregeling-regeling-in-het-kort
International Energy Agency (IEA)	IEA/IRENA Joint Policies and Measures database – Netherlands	2018	Webpage	https://www.iea.org/policiesandmeasures/renewableenergy/?country=Netherlands
Milieu Centraal	Btw op zonnepanelen terugvragen	2019	Webpage	https://www.milieucentraal.nl/energie-besparen/zonnepanelen/zonnepanelen-kopen/btw-op-zonnepanelen-terugvragen/
Ministry of Health, Welfare and Sports	Energiebesparende maatregelen en duurzame energie bij zorginstellingen	2018	Webpage	https://www.dus-i.nl/subsidies/energiebesparende-maatregelen-en-duurzame-energie-bij-zorginstellingen
Ministry of Health, Welfare and Sports	Stimulering bouw en onderhoud van sportaccommodaties	2019	Webpage	https://www.dus-i.nl/subsidies/stimulering-bouw-en-onderhoud-sportaccommodaties

Ministry of Economic Affairs and Climate	Salderingsregeling verlengd tot 2023	2019	Webpage	https://www.rijksoverheid.nl/ministeries/ministerie-van-economische-zaken-en-klimaat/nieuws/2019/04/26/salderingsregeling-verlengd-tot-2023
Ministry of Economic Affairs and Climate	Zon SDE+	2019	Webpage	https://www.rvo.nl/subsidies-regelingen/stimulering-duurzame-energieproductie/categorie%C3%ABn/zon-sde
Ministerie van Economische Zaken, Landbouw en Innovatie	Subsidieregeling energie en innovatie, Pub. L. No. 3.11	2012	Policy document	https://wetten.overheid.nl/BWBR0026952/2014-07-01
Netherlands Enterprise Agency (RVO)	Energie Investerings-aftrek (EIA) - Energielijst 2015	2015	Policy document	https://www.rvo.nl/sites/default/files/2014/12/Energie%20investeringsaftrek%20-%20Energielijst%202015.pdf
Netherlands Enterprise Agency (RVO)	Stimulation of Sustainable Energy Production	2019	Webpage	https://english.rvo.nl/subsidies-programmes/sde
Proka, Hisschemöller, & Loorbach	Transition without Conflict? Renewable Energy Initiatives in the Dutch Energy Transition	2018	Scientific article	-
PricewaterhouseCoopers (PwC)	De historische impact van salderen	2016	Report	https://www.rijksoverheid.nl/documenten/rapporten/2016/12/15/de-historische-impact-van-salderen
Stichting Nationaal Energiebespaarfonds	Energiebesparing voor particulieren	2019	Webpage	https://www.energiebespaarlening.nl/particulieren/
Tweede Kamer der Staten-generaal	Wijziging van enkele belastingwetten en enige andere wetten (Belastingplan 2014)	2013	Policy document	https://www.tweedekamer.nl/kamerstukken/wetsvoorstellen/detail?cfg=wetsvoorsteldetails&qry=wetsvoorstel%3A33752
Tweede Kamer der Staten-generaal	Wijziging van enkele belastingwetten en enige andere wetten (Belastingplan 2015)	2014	Policy document	https://www.tweedekamer.nl/kamerstukken/wetsvoorstellen/detail?id=2014Z15823&dossier=34002
Van Sambeek, Thuijl, & Roos	De Europese context van het Nederlandse duurzame elektriciteitsbeleid	2003	Scientific article	https://publicaties.ecn.nl/PdfFetch.aspx?nr=ECN-C--03-040
Verhees, Raven, Veraart, Smith, & Kern	The development of solar PV in the Netherlands: A case of survival in unfriendly contexts	2013	Scientific article	-

Table D2. Subnational energy documents used for the document analysis Province Noord-Brabant.

Source	Title	Year	Type	Retrieved from
Provincie Noord-Brabant	Factsheet Energiefonds Brabant	2014	Policy document	https://www.brabant.nl/politiek-en-bestuur/agenda-voor-brabant/investeringsfondsen
Provincie Noord-Brabant	Subsidieregeling Brabant bespaart particuliere woningeigenaren Noord-Brabant	2010	Policy document	https://decentrale.regelgeving.overheid.nl/cvdr/xhtmloutput/Historie/Noord-Brabant/CVDR93043/CVDR93043_2.html
Provincie Noord-Brabant	Subsidieregeling energie Noord-Brabant	2018	Policy document	https://www.brabant.nl/loket/regelingen/cvdr613200_1
Provincie Noord-Brabant	Subsidieregeling energielening particulieren Noord-Brabant	2009	Policy document	https://www.brabant.nl/loket/regelingen/94816_1
Provincie Noord-Brabant	Subsidieregeling energielening woningverhurende partijen Noord-Brabant	2009	Policy document	https://www.brabant.nl/loket/regelingen/94817_1

Table D3. Subnational energy documents used for the document analysis Province Limburg.

Source	Title	Year	Type	Retrieved from
Limburgs Energie Fonds	Limburg Energie Fonds: partijen	2019	Webpage	https://www.limburgsenergiefonds.nl/partijen/
Provincie Limburg	Nadere subsidieregels coöperatieve energieprojecten 2018-2019, Pub. L. No. 76–2018	2018	Policy document	http://decentrale.regelgeving.overheid.nl/cvdr/XHTMLoutput/Historie/Limburg/608482/CVDR608482_2.html
Provincie Limburg	Nadere subsidieregels DuurzaamDoor	2015	Policy document	https://archief13.archiefweb.eu/archives/archiefweb/20171231000000/https://www.limburg.nl/e_Loket/Subsidies/Vervallen_subsidieregelingen/Vervallen_Subsidieregelingen/Milieu_en_Energie/Nadere_Subsidieregels_DuurzaamDoor_2015_2016

Provincie Limburg	Nadere subsidieregels duurzaamheidsmaatregelen scholen, verenigingen en gemeenschapshuizen 2014-2015, Pub. L. No. 071 2014	2014	Policy document	https://archief13.archiefweb.eu/archives/archiefweb/20171231000000/https://www.limburg.nl/e_Loket/Subsidies/Vervallen_subsidieregelingen/Vervallen_Subsidieregelingen/Milieu_en_Energie/2015_2014_Nadere_subsidieregels_duurzaamheidsmaatregelen_scholen_verenigingen_en_gemeenschapshuizen
Provincie Limburg	Nadere subsidieregels Limburgse Energie Subsidie 2012-2014, Pub. L. No. 111 2012	2012	Policy document	http://decentrale.regelgeving.overheid.nl/cvdr/XHTMLoutput/Actueel/Limburg/CVDR171365.html
Provincie Limburg	Nadere subsidieregels milieu Provincie Limburg, Pub. L. No. 79 2012	2012	Policy document	https://archief13.archiefweb.eu/archives/archiefweb/20171231000000/https://www.limburg.nl/e_Loket/Subsidies/Vervallen_subsidieregelingen/Vervallen_Subsidieregelingen/Milieu_en_Energie/2014_2012_Nadere_subsidieregels_milieu_Provincie_Limburg
Provincie Limburg	Subsidie Duurzame maatschappelijke organisaties (Nadere subsidieregels duurzame maatschappelijke organisaties 2017-2019)	2019	Policy document	https://www.limburg.nl/loket/subsidies/actuele-subsidies/subsidieregelingen-2/@1956/subsidie-duurzame/
Provincie Limburg	Stimuleringslening Duurzaam Thuis	2019	Webpage	https://www.limburg.nl/@1665/duurzaam-thuis/
Provincie Limburg	Verordening duurzaamheidsleningen Limburgs Energie Fonds, Pub. L. No. 100 2013	2013	Policy document	http://decentrale.regelgeving.overheid.nl/cvdr/XHTMLoutput/Actueel/Limburg/CVDR228169.html
Stimuleringsfonds Volkshuisvesting	Provinciale Duurzaamheidsfondsen	2019	Webpage	https://www.svn.nl/overheden/provinciale-duurzaamheidsfondsen