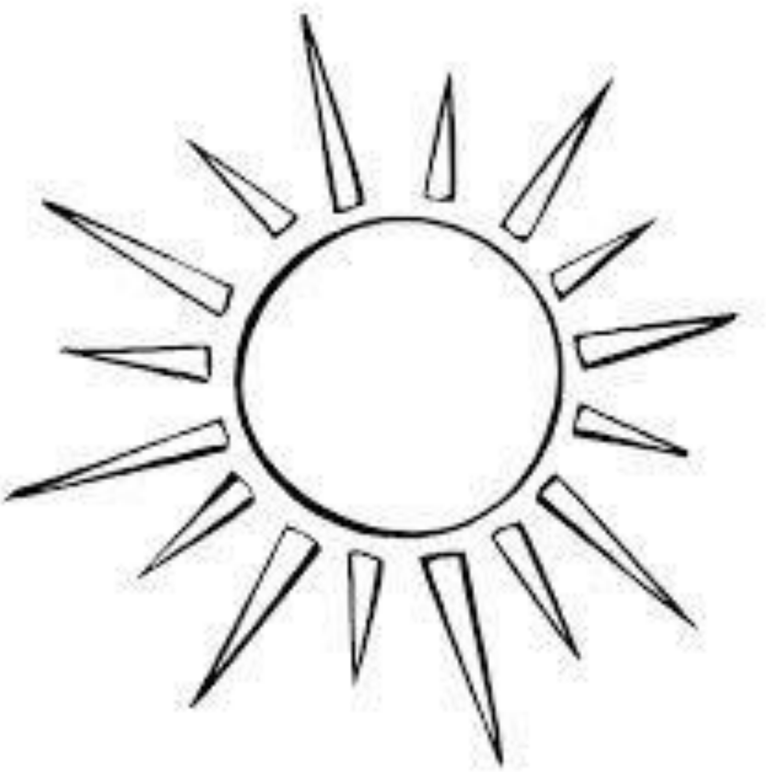
Solar energy policy transitions in Flanders, Belgium



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Solar energy policy transitions in Flanders, Belgium

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TABLE OF CONTENT

ABSTRACT

This study explores the changes in Flemish solar energy policy using transition theory. It aims to understand when and why changes in solar energy policy occur, and what the factors are behind these transitions in the light of the multi-level perspective. Such a study has never been explored in the existing literature on solar energy policy in Flanders, the second most producing country of solar energy per capita in the EU. This study aims to fill that gap. An extensive study on policy reports was done, with in addition to this six interviews with experts in the solar energy policy field in Flanders. The qualitative data consists of information on current and previous policy transitions, the public opinion, and what different factors behind change were. The data has been analysed to come to multiple conclusions.

In previous years, the initial lack of change of policies led to an increase in solar energy production because subsidies were high compared to the decreasing price of solar panels. The factors behind the lack of change were mainly the 'stop-and-go' course of action in the politics, which is the result of energy ministers that have a place in the niche (innovative) and regime (government) level. A more current increase in solar energy production can be explained by the decreasing prices of solar energy and a regained trust in the government. Due to this increase, there is no need for high subsidies and a flexible scheme that adapts to the market is sufficient.

TABLE OF FIGURES

TABLE OF TABLES

LIST OF ABBREVIATIONS

EU	European Union
FiP	Feed-in premium
FiT	Feed-in tariff
GHG	Greenhouse gasses
IRR	Internal rate of return
kV	Kilovolt
kW	Kilowatt
kWh	Kilowatt-hour
LCBP	Low carbon buildings programme
MLP	Multi-level perspective
MWh	Megawatt-hour
NPV	Net present value
PBP	Pay-back period
PV	Photovoltaics
TGC	Tradable green certificate
TWh	Terawatt hour
Wp	Watt peak capacity

1 INTRODUCTION

Human influence on climate change is clear, and the recent climate change has widespread impacts on human and natural systems. The atmosphere and ocean have warmed, and sea levels are rising (IPCC, 2014). Along with these problems arises the question how we can alter our way of living in order to sustain ourselves in the future.

Jacobson and Delucchi (2011, p. 1154) state that "a solution to the problems of climate change, air pollution, water pollution, and energy insecurity requires a large-scale conversion to clean, perpetual, and reliable energy at low cost together with an increase in energy efficiency". A form of clean, reliable energy is renewable energy like solar energy, which is one of the main drivers towards sustainable economic growth (Grijó & Soares, 2016). There is already growing importance given to renewable energy sources.

Rapid and broad implementation of renewable energy is needed to reduce greenhouse gas (GHG) emissions and meet energy security targets (Fouquet & Johansson, 2008). To achieve this, renewable energy has to be deployed as much as possible in all member states of the European Union (EU). Policies on renewable energy need to be motivating and not restrictive.

There is a possibility that converting to wind, water, and sun energy infrastructure will reduce 30% of the world power demand by 2030 in the EU. The amount of wind and solar power available in possible developable locations over land worldwide to power the world for all purposes exceeds predicted world power demand (Jacobson & Delucchi, 2011). The capture of 1% of the potential solar power would supply more than the world's power needs (Jacobson, 2009). Solar energy is one of the cleanest energy sources that does not compromise or add to the global warming. It is often called the 'alternative energy' to fossil fuel energy sources such as oil and coal (Solangi, et al., 2011).

The EU has proposed to reduce greenhouse gas emissions by 20% by 2020 while raising the share of renewable energy by 20% compared to the levels of 1990, also called the 20-20-20 targets (da Graça Carvalho, 2012). It is, however, not clear what the best way of implementing renewable energy in the EU is. In this dissertation, there will be a focus on solar photovoltaics (PV) as a renewable energy source that needs to be implemented more and more rapidly. The geographical focus of this study will be the Belgian region, Flanders.

Transitions in the energy policy in Flanders are studied by using the multi-level perspective (MLP). This theory states that transitions focus on movement from one equilibrium to another at three levels: niches (radical innovations), socio-technical regimes (established practices and associated rules), and the broader socio-technical landscape (Geels, 2014; Meadowcroft, 2009). The MLP is used because it provides a straightforward way of ordering structural transformations (Smith, et al., 2010).

1.1 GEOGRAPHICAL FOCUS

There are three different areas in Belgium with its own government (Wallonia, Flanders and Brussels), as seen in figure 1, with different policy structures (European Commission, 2013). In this study, there is a focus on Flanders.

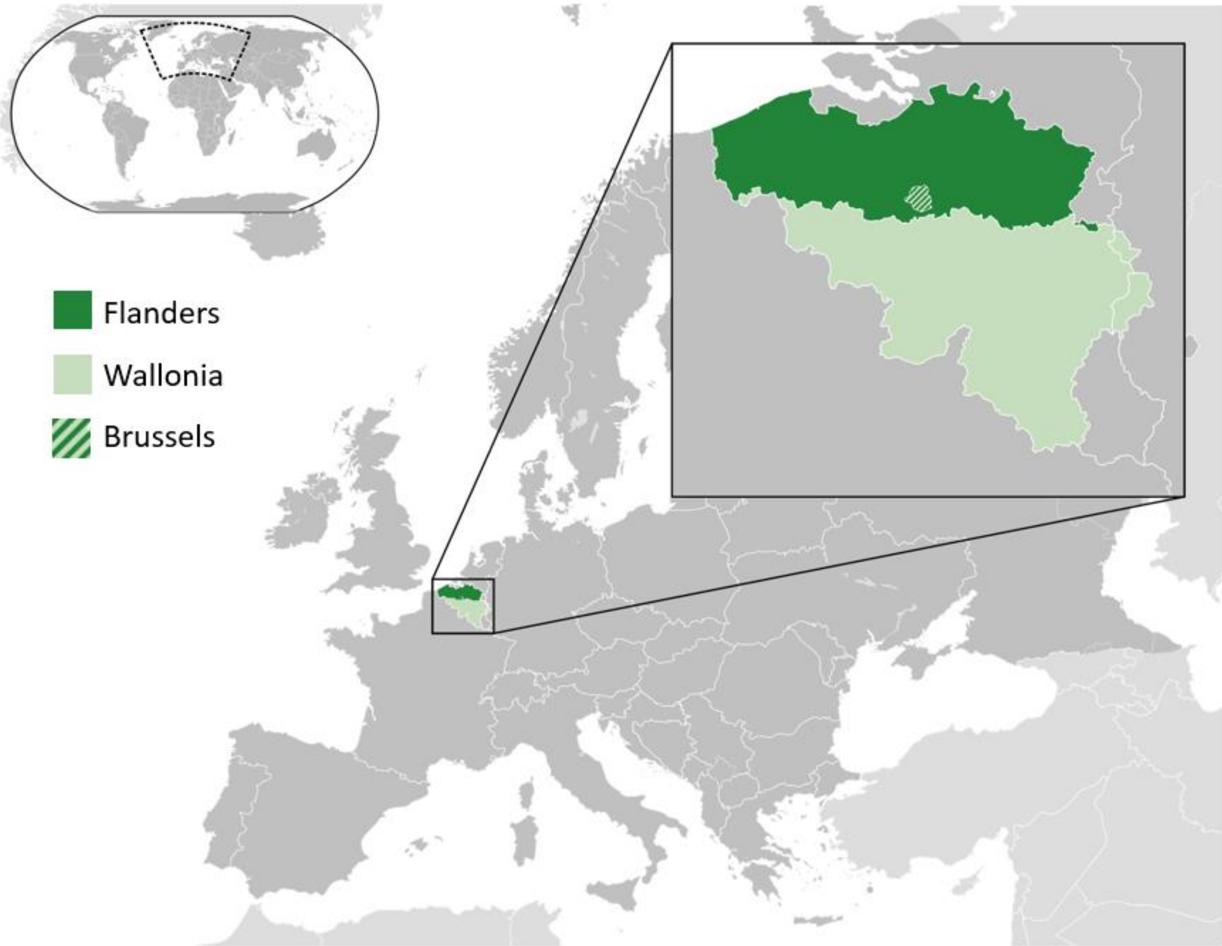

Figure 1: Flanders in Belgium and Europe (Wikimedia Commons, 2013).

Flanders has 350 Watt installed solar energy per person. This brings Flanders to a second place in the EU, after Germany (Vlaams Energieagentschap, 2018). In the numbers by EurObser'ER (2017), Belgium is counted as a whole, which brings the country to a third place (see figure 2). According to SERV (2017), the social and economic council of Flanders, there is an increasing amount of solar energy each year, with some years and some policies more compared to others. There is a high number of articles on the solar energy growth in Germany, but barely any on Flanders or Belgium. In this way, the study adds to the academic and societal relevance of this study by using this geographical focus.

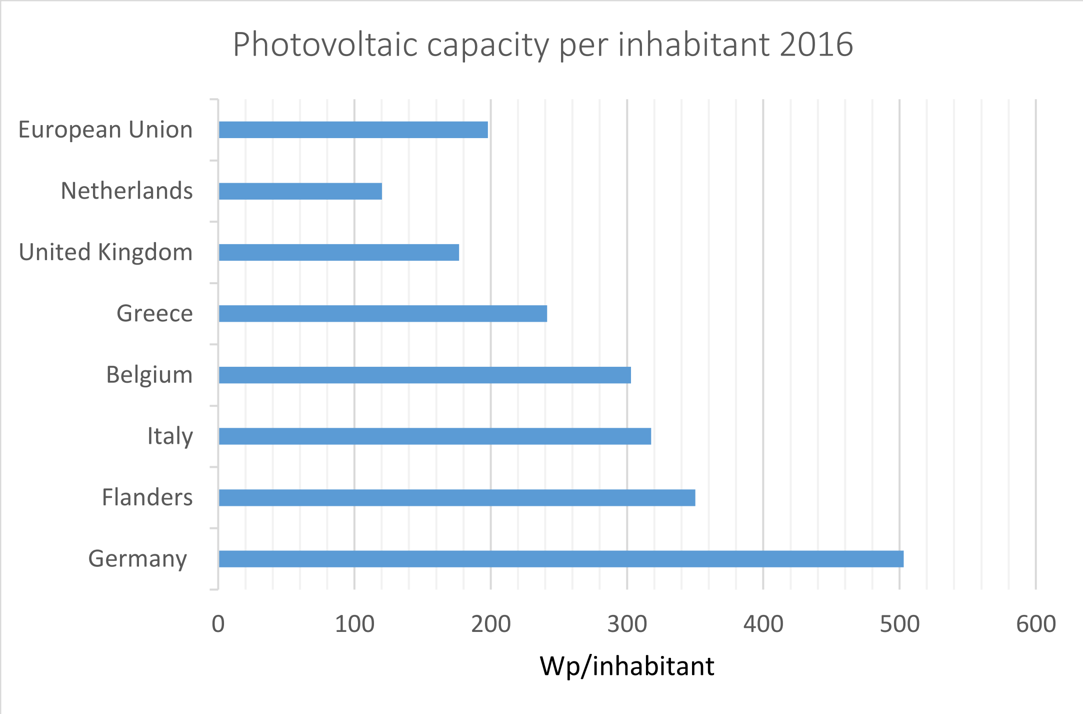

Figure 2: PV capacity per inhabitant in 2016. Adapted from (EurObserv'ER, 2017; Vlaams Energieagentschap, 2018).

Another reason why a case study of Flanders is interesting is because Flanders has had multiple policy structures to increase renewable- and solar energy in the last years. The transitions in renewable energy policy are not overlapping, like for example in the Netherlands (European Commission, 2013).

1.2 Societal and academic relevance

A solution to the climate problem is to use more renewable energy (Jacobson & Delucchi, 2011). Solar power is considered the most expensive renewable energy source worldwide. At the moment the share of PV power of the total energy demand is found to be between 36-42% on a global average, but with the capture of 1% of the potential solar power the worlds' power needs would be solved (Jacobson, 2009; Breyer, et al., 2016). A more effective solar energy policy can contribute to an increase in renewable energy.

Next to this, the energy system is not only evolving technologically but also socially and behaviourally (Mitchell, 2010). In this study, there is a focus on social changes in the changing energy system. It may contribute to a better understanding of positive transitions of solar energy policy in Flanders, and how Flanders can increase its solar energy share.

Energy decisions are too frequently made in a moral vacuum, resulting in a strong normative case for combining the literature on sociotechnical transitions with concepts arising from energy justice. One social element missing from transition frameworks is practice-oriented engagement (Jenkins, et al., 2018). In this study, the literature on transitions is connected to existing transitions in Flanders, Belgium to add practice-oriented engagement and look at a real-life case study. This case is chosen because, although in the top of the solar energy field in the EU, not much is written about its policies and transitions.

Understanding how knowledge, perceptions and practices are shaped and influence; what finance and markets can and cannot do; and how a society's 'social contract' enables or detracts from problem-solving are areas where scholarship can contribute (Araújo, 2014). In this study, there is a focus on understanding how policies are shaped in Flanders. This is done with a perspective from transition theory and the multi-level perspective (MLP); what politics and society contribute to the transitions in energy policy instruments.

There is a need for contributions towards the socio-technical transitions debate. According to Geels (2014), there should be a focus on regime dynamics, conceptualising existing regime actors and introducing power and politics in the multi-level perspective (MLP). In this study, there is a focus on the different actors in solar energy policy transitions in Flanders, Belgium. In particular, there is a focus on the politics (regime level), and energy ministers that have a significant share in the changing Flemish solar energy policy.

The suggestion Smith, et al. (2010) give for relevant research is to incorporate the analysis of policy processes as part of the study of innovation in socio-technical systems. In this study, this will be done with research on policy reports and expert interviews to make a connection between the policy processes of the transitions towards the different policy structures in Flanders, and the socio-technical systems.

1.3 Research questions

Based on the reasons and social and academic relevance explained above, one main and three sub-questions are formulated for this dissertation. The main research question is:

> *"How can the rapid per capita uptake of solar power in Flanders, Belgium be explained in the light of transition theory?"*

To answer this, three sub-questions are formulated:

1. How can the current state of development of solar energy policy in Flanders be compared with wider European trends?
2. How do the key solar energy policies evolve in Flanders, Belgium?
3. What factors can explain the transition of solar energy policy structures in Flanders, Belgium?

To answer these research questions, empirical research is done in Flanders. This included secondary data such as policy reports. Next to this, semi-structured interviews with experts in the field were held.

1.4 Reading guide

Multiple different chapters build up this dissertation. *Chapter 2* includes the literature review that gives a theoretical background to transitions theory, the multi-level perspective (MLP), solar energy and policy instruments for the rest of the dissertation. In *chapter 3*, the methodology on secondary data and semi-structured interviews is given, as well as limitations and ethical considerations. *Chapter 4* consists of the analysis and discussion of the outcomes of the empirical and secondary data research set out in *chapter 3*. This includes an overview of solar energy (policy) in different member states of the EU, the state of development, and factors behind change in Flanders. *Chapter 4* also explains the limitations of this dissertation. Finally, *chapter 5* concludes by highlighting the conclusions by answering the research questions and gives recommendations for future research.

2 LITERATURE REVIEW

The first chapter of this dissertation involves an in-depth literature review to understand the structure of transition management, its different stakeholders, different theories, and different possible policies for governments to implement. This chapter is organised in six sections. First, an overview of transition theory is given. Second, a more in-depth description of the multi-level perspective is given. The third section consists of ways to test different policy structures. Next, an overview of solar photovoltaics is given. Fifth, an overview of different policy structures to stimulate renewable energy is given. Finally, conclusions and a research gap are given.

2.1 TRANSITION THEORY

Jacobsson and Lauber (2006, p. 257) state that:

> *"Policy-making is not a rational technocratic process but rather one that appears to be based on such things as visions and values, the relative strengths of various pressure groups, perhaps on beliefs of 'how things work' and on deeper historical and cultural influences."*

Governing is complex because policies have to work together. Governments do therefore have to have principles of government as a way to ensure good governance (Mitchell, 2010).

Social embedding of technology and socio-political legitimacy are important, for both early market formation and further in the process. Policymakers often fail to handle this challenge or only recognise its importance when it is too late. This might be caused by sticking to a short-term, incremental process (Geels, et al., 2008). It is very rare that a 'perfect' policy can be designed and implemented, even if there were one (Mitchell, 2010).

There are multiple objectives behind the increasing amount of solar energy. Deshmukh, et al. (2012) have identified four different main objectives. (1) Decreasing carbon emissions and other pollutants, (2) improving energy security and reducing the dependence on imports, (3) creating political symbols to provide evidence of the environmental values of the government, and finally (4) ensuring access to energy in under-served regions.

The process of the political paradigm makes it even harder to achieve change if that change does not fit with the fundamental principles of the current paradigm. Short-term steps dominate the political agenda. It also explains why as a result of this, policy change tends to occur in incremental steps, building on what is in place before (Mitchell, 2010; Meadowcroft, 2009). Transitions within the regime tend to be incremental and path dependent according to the multi-level perspective (MLP) (Smith, et al., 2010). 'Transitions' are understood as processes of structural change in major societal subsystems (Meadowcroft, 2009).

The challenge is to avoid the temptations of a linear process and adopt a broader conceptualisation that addresses the multi-dimensionality of technological niches, technological innovations systems or other terms that analysts use to highlight the intrinsic interrelatedness of socio-technical change (e.g. seamless webs, socio-technical ensembles) (Geels, et al., 2008).

The problem in this process is not just everyday policy, but the everyday politics that stand behind that everyday policy. Broader coalitions must be made for the transformation of politics, to cater for social change. Although the government can change policy, developments in the societal and political regime mainly determine the ideas that gain momentum and acquire practical force (Meadowcroft, 2009).

The question is if who pays (i.e. consumers, taxpayers, industry), also decides, and how this is settled (Araújo, 2014). Next to this, there can also be questioned whether strategic interests such as jobs, science and technology leadership, relevant timelines, flexible response, and responsible stewardship are prioritized. In other words, citizens do matter, and through markets and politics they can help to shape the landscape in which the reproduction and transformation of socio-technical systems take place (Meadowcroft, 2009).

Throughout a transition process, the costs of technologies should be reflected in the prices (Kemp & Rotmans, 2005). Market-based environmental policy measures such as eco-taxes and tradable quotas, can internalise the social costs of environmental degradation as for example market externalities, and thereby provide a more balanced price incentive for innovating goods and services in this way (Smith, et al., 2010).

The challenge is to create energy policy processes that encompass the envisioning, designing, deliberating, choosing, and making of future socio-energy systems and render possible partnerships between the energy industry and communities at all of the stages (Miller, et al., 2015). Fostering cooperation between social actors, companies, and governments to leverage the human and market capital are necessary for technology to take root (LaBelle & Horwitch, 2013).

Political motivations are the most relevant aspect to the promotion of renewable energy. Financial benefits to the promotion and use of renewable sources through price regulation, like feed-in tariffs (FiT), capital subsidies and tax mechanisms, are instruments that potentially favour the use of renewable energy (Marques, et al., 2010).

Consistent and stable policy frameworks are important for innovation journeys because entrepreneurs need stability to make cost/benefit calculations of strategic investments. An example is the relative stability of the German policy regime, focused on a FiT scheme and is associated with a reduction of uncertainties for investors (Geels, et al., 2008).

Public support is important in a transition process to avoid resistance (Kemp & Rotmans, 2005). A way to create public support is by participatory decision-making, but it can also be created in a bottom-up manner.

The most effective way might be to take away fears around the changes taking place. This is an important role for the government; it can mobilise and inspire actors to increase public support (Rotmans, et al., 2001).

Only by redefining energy policy in terms that are more social, the energy transformation conflict can be reduced. Reframing energy policy debates as debates not just about how to produce energy, but about what energy production and consumption mean for diverse groups and communities is necessary *(Miller, et al., 2015)*.

The lack of long-term planning and systems governance becomes particularly apparent when we look at questions of socio-energy design in the context of energy resource innovation. Whether the subject is vehicle charging stations, power plant siting, or mineral rights leases, the common tendency to approach energy policy transitions on a short-term case-by-case basis often leads to problematic outcomes from the perspective of socio-energy system design (Miller, et al., 2015).

European member states may also have a clear objective of promoting technology innovation in renewables to ensure the cost-effective medium-term transition to a sustainable energy system (European Commission, 2013).

One of the limitations of transition management is the chance of a 'lock-in'. Transition management is focussed on system change, but it is also against specific commitments that seem to happen too soon and might turn out to have false leads (Meadowcroft, 2009). Transition management looks for options that are both viable in the existing system and in an innovative system where transition is prioritized (Rotmans, et al., 2001). Ways to prevent a lock-in situation are (1) relying on markets and context control instead of on planning, and (2) by exploring multiple options, both incremental and radical. In general, an incremental, as well as a long-term improvement plan, should be followed (Kemp & Loorbach, 2003).

2.2 Multi-level perspective (MLP)

The multi-level perspective (MLP) states that transitions focus on movement from one equilibrium to another at three analytical levels: niches (radical innovations), socio-technical regimes (established practices and associated rules that enable and constrain incumbent actors in relation to existing systems), and an exogenous socio-technical landscape. Transitions come about through interacting processes within and between the three levels (Geels, 2014; Meadowcroft, 2009). Niches and regimes have similar types of structures with certain rules, although there are major differences. The communities in the regime are large and stable, in the niche they are unstable and 'in the making' (Geels & Schot, 2007).

Transition management is presented as an alternative to established governance approaches (Meadowcroft, 2009). Kemp and Rotmans (2005, p. 33) define transition management as "a deliberate attempt to bring about structural change in a stepwise manner".

The appeal of the MLP for sustainability research rests in its engagement with the dynamics of large-scale socio-technical systems that are considered to present persistent sustainability challenges (Smith, et al., 2010). Socio-technical systems consist of actors, institutions, as well as material artefacts and knowledge. The systems as a whole provide specific services for society (Markand, et al., 2012).

The multi-level perspective (MLP) is typically a global model that maps a transition process in a straightforward way (Geels & Schot, 2007). However, a potential pitfall is that it can become counterproductively simplistic (Smith, et al., 2010). In figure 3, a transition pathway is mapped out.

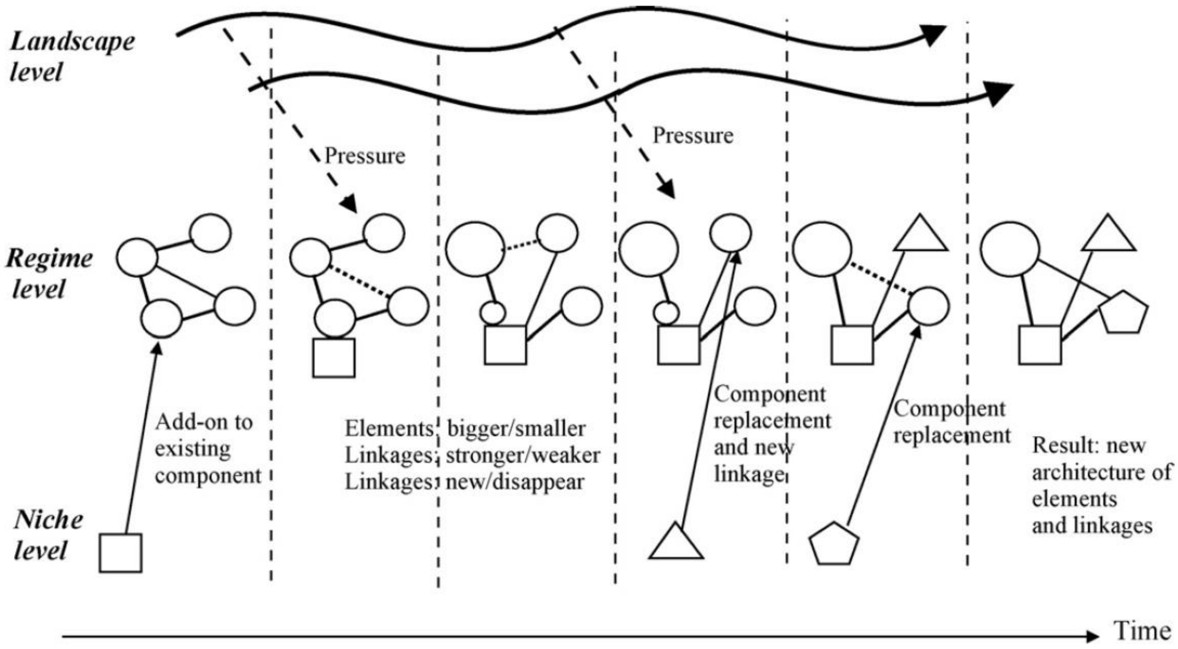

Figure 3: Reconfiguration pathway (Geels & Schot, 2007).

In the reconfiguration pathway, a new regime grows out of the old regime. An example for this pathway is the American transition from traditional factories to mass production. This transition happened with many small incremental changes. The main actors in this pathway are the regime actors and suppliers, where the regime actors adopt the innovations (policies), and there is competition between the old and new suppliers. There are changes because of economic and functional reasons (Geels & Schot, 2007).

Processes are sequences of events by different actors, timing and conjunctures in event-chains. This is process theory. Gioia and Pitre (1990) state that there are four foundational paradigms to conceptualise these processes in different ways: interpretive, radical humanist, radical structuralism, and functionalist. Geels and Schot (2007) translate these to rational choice, interpretation, power and deep structures. They also mention that most transitions involve multiple different paradigms and causal processes that may alternate.

The four paradigms can each be connected to four transition pathways. The reconfiguration pathway is connected to a traditional power approach with a focus on formal rule changes. This happens through, for example, lobbying and institutional entrepreneurship from collective actors and social movements. Transitions show mixes of rational, interpretive, power based and routine actions. Transitions can be caused through rational action, as well as through changing interpretations or power struggles in, for example, the government (Geels & Schot, 2007).

There are four different transition phases: the pre-development, take-off, breakthrough and stabilisation phase (Rotmans, et al., 2001). The role of the government is the most effective in the pre-development and take-off phase of a transition (Kemp & Rotmans, 2005). These are the phases where change is not visible yet, but the system begins to shift (Rotmans, et al., 2001).

An energy transition most broadly involves a change in an energy system, usually to a particular fuel source, technology, or prime mover (Sovacool, 2016). Three types of innovation can change an energy system: disruptive, discontinuous and incremental. A disruptive innovation introduces the market for a product or service (policy) that is distinctive from any other. A discontinuous change is a shift of an existing learning curve to enhance the product or service. Finally, an incremental change follows continual improvement of the product or service to maintain its uniqueness and competitive advantage (Walsh, 2012).

2.3 Testing policy structures

One of the challenges in sustainability transitions is to improve the understanding of policies and politics of transitions (Markand, et al., 2012).

The effectiveness of policies is complex and can be evaluated in many ways. For example, by whether states are in legal compliance with (European) treaties, whether monetary and other resources are spent on programmes, or by the real numbers of the policy measures in terms of environmental improvements. Different policies are learning processes in that the actors involved continually gain new knowledge about problems and engage other parties in parallel efforts to achieve goals; this may lead to incremental changes in policy systems (Axelrod, et al., 2011).

The lack of an immediate problem makes it difficult to grasp the effectiveness of different policy instruments. It is hard to determine whether a policy instrument is improving a problem unless said problem exists. As such, policymakers tend to construct surrogate measures of success, like checklists and scorecards, in order to demonstrate progress towards a policy focused on renewable energy (DeLeo, 2017).

Fri and Savitz (2014) state that there are a few necessary conditions for creating a policy framework that is both durable and adaptable. They are:

- A stable objective that institutions take seriously as a basis for planning;
- Systematic and rigorous evaluation of new technology and policy initiatives;
- A mechanism for assessing new information and incorporating it into policy;

- Creation of a constituency that has a stake in preserving the policy in question.

There are multiple factors of a transition towards a sustainable energy system in the different levels of the MLP that can help to increase the amount of solar energy. The following lists, based on Mitchell (2010), European Commission (2013) and Kemp and Rotmans (2005), will be the foundation of the analysis of the energy system in Flanders further in this study:

Regime level:

- Government taking long-term commitments (at least 25 years) when shaping short-term policy;
- The announcement of automatic reductions in support depending on specified caps and lower technology costs;
- Planned review periods and no unannounced interim changes;
- Stable scheme financing in line with the EU directives linked to consumption and off-budget financing to avoid fiscal impacts and uncertainty;
- Keep costs transparent and separate from other system costs;
- Government viewing climate change as an opportunity;
- The government being determined to make it straightforward to develop renewable energy;
- Wide and public consultation on scheme design;
- A focus on learning-by-doing and doing-by-learning.

Landscape level:

- Understanding that the transition to sustainability is a ‘system’ issue;
- A fundamental change in the attitudes towards energy use. This requires clarifying the roles of the different actors within the energy system and clarifying the relationships between them.

There is no list focused on the niche level, because this is an unstable, ‘in the making’ community, where there are little rules (Geels & Schot, 2007).

A move from the current carbon-based energy system to a low carbon one will only start when the momentum of the current energy system is not only threatened but also actively altered by changing the underlying costs, revenues and risks of the necessary energy companies. Altering these costs, revenues and risks will affect the energy companies’ bottom line that will have series of domino effects, throughout the energy companies and eventually to customers. All the lobbying strength that the energy companies have is to keep these costs, revenues and risks under their control. They may change them or agree to them being changed, or it is their interests to do so, but these changes must always occur at the companies’ pace and in their favour (Mitchell, 2010).

From a broader public policy perspective, civil servants who develop or intervene in policy change are themselves in a system that has its own internal momentum. When set out in this way, it seems almost impossible that the needed changes necessary to enable the challenge of climate change to be met will occur at society and system level. Simply achieving any change from a public policy point is difficult, unless pushed by overpowering events and consecutive change to legislation (Mitchell, 2010).

2.4 Solar Photovoltaics

Solar energy is one of the cleanest and most promising energy sources that does not add to global warming. The sun radiates more energy every second then people have used since the beginning of time (Solangi, et al., 2011). Solar energy refers to sources of energy that can be directly attributed to the light of the sun or the heat that sunlight generates (Timilsina, et al., 2012). There are seven main advantages to solar energy:

1. No emissions of greenhouse and toxic gasses;
2. Reclamation of degraded land;
3. Reduction of transmission lines from electricity grids;
4. Improvement of water resources;
5. Increase in energy independence;
6. A more secure and diverse energy supply;
7. Acceleration of rural energy supplies in developing countries (Solangi, et al., 2011).

However, there should be noted that during the production process there are emissions and that PV installations use land when not placed on roofs.

According to Timilsina, et al. (2012, p. 450), solar energy technologies can be classified along the following key factors:

> *"(1) Passive and active; (2) thermal and photovoltaic; and (3) concentrating and non-concentrating. Passive solar energy technology merely collects the energy without converting the heat or light into other forms. It includes, for example, maximising the use of daylight or heat through building design. In contrast, active solar energy technology refers to the harnessing of solar energy to store it or convert it for other applications and can mainly be classified into two groups: (1) photovoltaic (PV) and (2) solar thermal."*

In this study, there is a focus on active photovoltaic (PV) systems.

There are also some limitations to implementing large quantities of PV energy into a grid. A key limitation is a fundamental mismatch between supply and demand. PV energy is produced during the day, but electricity is mainly consumed in the evening. Next to this, there is a limitation in the conventional (non-renewable) energy generators to respond to rapid changes in the amount of PV energy produced (Denholm & Margolis, 2007).

One of the current limitations is that the energy payback time for solar PV is generally longer than that of other renewable energy systems, and although there has been a drop in capital costs, solar PV is not competitive with conventional energy production technologies yet (Jacobson, 2009; Timilsina, et al., 2012). Another limitation is the performance of the system components such as batteries and inverters, and an inadequate supply of silicon, the main component of a PV cell (Timilsina, et al., 2012).

2.5 POLICY INSTRUMENTS

The policy landscape for solar energy is complex with a broad range of policy instruments driving market growth (Timilsina, et al., 2012). These instruments play a big role in the development and implementation of renewable energy sources in the EU. Feed-in tariffs (FiT), Feed-in Premium (FiP), quota obligations, investment subsidies, soft loans, tradable green certificates, tenders, tax exemptions or reductions, net metering and self-consumption schemes are one among the most effective instruments (Reiche & Bechberger, 2004; Buttler, et al., 2016; Martins, 2017). The vast majority of European Member States use feed-in tariffs (FiTs) or premiums to promote renewable energy sources (Canton & Lindén, 2010).

Economists argue that economic instruments are usually more cost-effective than direct regulation, mostly because they give producers and consumers more flexibility as to how they achieve resource productivity and prevent carbon pollution (Gunningham, 2013). In table 1, Haas, et al. (2004) give an overview of fundamental policy models sorted by different principles of stimulating renewable energy.

	Price-driven	Capacity-driven
Investment focused	Rebates	Bidding
	Tax incentives	
Generation based	Feed-in tariffs	Quotas/TGC
	Rate-based incentives	

Table 1: Fundamental types of regulatory strategies (Haas, et al., 2004).

The rapid market growth of solar energy in Germany and Spain can be attributed to the FiT system that guarantees attractive returns on investment along with the regulatory requirements. On the other hand, federal and state incentives get credit for the rapid deployment of solar energy in, for example, the United States. In both markets, the policy landscape is in a transitional phase (Timilsina, et al., 2012). In the following paragraphs, different policy instruments are described.

2.5.1 Feed-in Tariffs (FiT)

Campoccia, et al. (2007, p. 1982) define feed-in tariffs (FiT) as:

> *"The price paid by the utilities to the renewable energy producers per kWh of electricity generated or sent to the electricity grid."*

FiTs are amongst the most simple of schemes to implement, making them suitable for markets with a large number of households (European Commission, 2013).

FiTs have been the primary mechanism used for supporting renewable energy development in Europe (Campoccia, et al., 2009). More than 75 countries, states, and provinces have adopted and implemented the FiT mechanism (Bakhtyar, et al., 2017). In 2012, they were being applied in 19 EU member countries (European Commission, 2013). With FiTs, the financial burden does not fall upon the taxpayer, but it is distributed across the utilities company its customer base (Campoccia, et al., 2009). Currently, FiTs plays a significant role in renewable energy development in the EU (Bakhtyar, et al., 2017).

The most common price-based support scheme is the FiT, under which the electricity production from renewable energy sources is paid a fixed price per unit injected in the grid. Next to this is the feed-in premium (FiP), which involves a fixed uplift on the electricity price for renewable electricity sales (Pineda, et al., 2018). The European Commission (2013) recommends that FiTs should be phased out and support instruments that expose renewable energy producers to market price signals such FiP schemes should be used. On the other hand, Timilsina, et al. (2012) state that the decrease in FITs, which is the primary basis for investors' confidence, could drive them away from investing in solar energy.

FiP systems are an evolved version of the FiT system with varying degrees of market exposure for producers (European Commission, 2013).

The FiPs allow renewable energy to be sold on different marketplaces (energy exchange, bilateral contracts), which can increase its value. The effectiveness of the FiP in terms of market exposure varies depending on whether premiums are fixed or variable, and on what timescale the premium is adjusted and whether there is a cap and floor price (European Commission, 2013).

2.5.2 Net metering

Net metering is a policy method by which owners of PV installations can receive compensation for their electricity production through their reduced electricity consumption bills. The difference with a FiT is that in a FiT scheme, owners of PV installations can sell all their produced electricity, and still have to pay for the electricity they use. With net metering, the owner is more directly compensated for their energy production (Eid, et al., 2014). Net metering works by using an electricity meter that is able to spin and record energy in both directions. Another way is by using a smart electricity meter where each way is metered separately, and one is subtracted from the other. The consumer will only be billed for the net electricity used (Poullikkas, 2013).

Stoutenborough and Beverlin (2008) distinguish three key positive assets of a net metering policy. Firstly, net metering never ends. In comparison, tax incentives or subsidies are short-term. Second, net metering moves the cost of the incentive to the energy company. Lastly, net metering allows the public to feel as if the state is correcting a social injustice by preventing energy companies from taking advantage of their consumers by using their renewable energy free of costs.

If more energy is produced than consumed, producers can receive a benefit for this positive balance. If there is a surplus at the end of the year may be paid or compensated for the extra electricity produced (Poullikkas, et al., 2013).

2.5.3 Tradable green certificates (TGC)

The most important difference in establishing the best support scheme between FiT, FiP, and tradable green certificates (TGC) support schemes is the exposure to risk for producers. Pineda, et al. (2018) state that if power producers were risk-neutral, TGCs would have a higher expected social welfare compared to FiT or FiP schemes. However, when there are high levels of risk, FiT or FiP schemes are more efficient than TGCs in finding the investments needed.

The benefits of TGC mean that the producers can choose to use the electricity they produce themselves or sell to an electricity supplier at the current electricity prices (Dusonchet & Telaretti, 2010). Although there is potential for this policy structure, quota-based TGC systems show low effectiveness, but comparably high-profit margins are possible (Haas, et al., 2011).

There are two main features of TGC systems. (1) Renewable energy producers receive tradable certificates corresponding to the amount of renewable electricity they supply to the grid, and (2) that some type of obligated actor (electricity suppliers, consumers or producers) are legally required to buy a certain amount of certificates over a certain period, connected to electricity sales, consumption or production respectively (Jacobsson, et al., 2009).

Sweden, the UK and Flanders have all experimented with different forms of TGCs. The lessons so far from these experiments are (1) they tend to favour energy companies (e.g. large utilities), (2) most investments concern relatively mature technologies and that there is little or no domestic demand that can stimulate the industrialisation of more innovative technologies, and (3) TGCs tend to induce high levels of excess profits which, primarily benefit energy companies and relatively mature renewable energy technologies (Jacobsson, et al., 2009).

2.5.4 Other instruments

Policy instruments that are not used that often are, for example, capital subsidies, quota obligations, investment subsidies, tax reductions and self-consumption schemes.

2.5.4.1 Capital subsidies

Capital subsidies mainly consist of subsidies that national governments give out to refund part of the cost supported by the owner of the PV system for its installation (Campoccia, et al., 2007).

2.5.4.2 Quota obligations

In several European member states, there is a scheme where energy suppliers are obliged to purchase a quota of renewables, or green certificates (TGCs) representing the production of renewable energy (European Commission, 2013).

TGCs are normally based on a quota obligation. In many cases, the government imposes an obligation on consumers or suppliers to have a certain percentage of the electricity sourced from renewable sources. The authorities give certificates to producers, which are sold separately from the electricity. The quota obligation on electricity suppliers ensures that there is a demand for certificates, as they need to buy certificates to complete their quotas. The main advantage of this system is that it allows competition between renewable producers as the certificate price will depend on demand and supply of TGCs (Canton & Lindén, 2010).

2.5.4.3 Investment subsidies

To cover initial capital costs, investment subsidies can be used. They are different from operating support, which covers operating or production-based costs. Investment support consists of different forms of subsidies, the main types being grants, preferential loans and tax exemptions or reductions (European Commission, 2013).

Investment subsidies are granted at the beginning of the project lifetime and can be calculated as a percentage of the renewable energy output, or the specific investment cost, although this latter version is more common (Mir-Artigues & del Río, 2014).

2.5.4.4 Tax exemptions/reductions

Tax exemptions and reductions are used in many cases in the energy sector. In the renewable energy industry, they are used at industry level often to encourage biofuel production, and at the household level to encourage household investments such as rooftop PV installations (European Commission, 2013).

Investment tax credits can cover just the cost of a system or the full costs of installation. They can be helpful early in the diffusion of technology when costs are still high. Tax exemptions directly reduce the cost of investing in renewable energy systems and reduce the level of risk (Sawin, 2004).

2.5.4.5 Self-consumption schemes

Under a self-consumption scheme the prosumers (consumers that are producing energy) are financing the electricity system, as they are giving electricity to the grid for free, which is later sold at retail price to other consumers (Prol & Steininger, 2017).

An all-encompassing requirement of an energy system focused on renewable energy is a determination to do things differently from what is in place. This means that instruments which support the momentum of the status quo of the current ‘carbon’ system have to be removed, and new incentives which promote investments in renewable energy have to be introduced, for example by implementing a FiT scheme (Mitchell, 2010).

2.6 CONCLUSION AND KNOWLEDGE GAP

In general, there can be said that there is no perfect policy to increase renewable energy production.

The MLP shows that in most policies, change happens in an incremental pathway. These incremental, short-term changes mainly happen due to politics. One of the key factors of a transition towards an energy policy focused on increasing renewable energy production is having a long-term policy.

Solar energy (PV) can be seen as one of the cleanest renewable energy sources, but there are some downsides too. The needed materials (mainly silicon) are scarce and the availability may be inadequate. There is also a potential mismatch in supply and demand when large amounts of PV power are implemented into the grid.

The policy instruments most used to promote renewable energy, or solar energy in particular, are FiTs, FiPs, quota obligations, TGCs, tax exemptions or reductions, net metering and self-consumption schemes. Overall, the FiT scheme is most used, with the best-known example Germany. Although a FiT scheme is most used, a TGC scheme is potentially more effective in risk-free situations.

The key gap in the literature is that it is not clear how important a long-term policy is. A long-term policy is almost impossible with the incremental changes that are made by the politics. The need for a long-term policy and the incremental changes made contradict each other.

Next to this, there is no literature on how policy structures behave in regions in comparison to countries. This scale difference is apparent in Flanders but is not this clear in other regions. In this case Flanders, and Belgium as a whole is a unique case study.

3 METHODOLOGY

This chapter aims to outline the research strategy and design used to carry out this study in order to answer the main and sub-research questions:

"How can the rapid per capita uptake of solar power in Flanders, Belgium be explained in the light of transition theory?"

1. How can the current state of development of solar energy policy in Flanders be compared with wider European trends?
2. How do the key solar energy policies evolve in Flanders, Belgium?
3. What factors can explain the transition of solar energy policy structures in Flanders, Belgium?

This chapter provides an explanation for the different features of the chosen research questions and methods, as well as offer justifications for all and their limitations, concluding with the ethical considerations that are required for this study.

Flanders, Belgium is chosen because it is in the top of the field for solar energy and has had different policies in the last decade, but not much is written about the solar energy policy in the region (Haas, et al., 2011).

3.1 RESEARCH STRATEGY AND DESIGN

The epistemological and ontological approaches considered for the methodology of this study are the foundation of this study.

Quantitative research methods are selected to establish general laws or principles, which is called a nomothetic approach. The ideographic approach is focused on the importance of the subjective experience of individuals, with a focus on qualitative analysis (Burns, 2000). Because there is a focus on a single case (Flanders), rather than general lawmaking, this study has an ideographic approach.

Where interpretivism seeks to understand human behaviour through the perception of individuals, positivism seeks to explain human behaviour by discovering external laws that condition it (Bryman, 2012). May (2011) states that positivism explains human behaviour in terms of cause and effect and data are collected on the social environment and people's reactions to it. Realism shares the aim of explanation with positivism, but the parallel ends after this point. Realism argues that the social world does not simply exist independently of knowledge, and that the social world affects behaviour, unlike positivism.

Positivist and interpretivist ontologies can both be identified with case study research (Burns, 2000). This study seeks to understand the social aspects of policy transitions and explain what human behaviour adds to this, hence a positivist ontology is most suitable for this study.

To ensure the outcomes of the research are reliable and valid, triangulation is used. In this study, there was looked at a combination of semi-structured interviews and desk research. In table 2, there can be seen that for most of the research questions a combination of secondary data and semi-structured interviews was used. This multi-method was used so that when different methods of assessment or investigation produce the same results, the data is more likely to be valid (Burns, 2000). Here, there will be a focus on confirming and non-confirming data and considering alternative explanations (May, 2011).

Research questions	Method
Q1	Secondary data
Q2	Secondary data / semi-structured interviews
Q3	Secondary data / semi-structured interviews

Table 2: Triangulation in the research questions.

3.2 Secondary data

Secondary data research was done, next to semi-structured interviews. This desk research is mainly focused on policy documents from Belgium, next to EU-wide documents and documents focused on Germany, Italy and Greece. The main sources are governmental reports on the different solar energy policies through history and statistical data from European data sources. These can be found on the websites of the Flemish government, at online databases such as 'European Sources Online', and the European statistics database 'Eurostat'.

In addition to governmental reports, reports from the field were used. Another main source were journal articles. These can be found through search engines such as Scopus and Google Scholar.

Four cases were set out to find trends in the European Members States (research question 1). Next to the European wide trends, Germany, Italy and Greece were studied. These countries were chosen because they have the highest amount of solar energy per capita, as can also be seen in figure 2.

3.3 Semi-structured interviews

In order to find underlying or less visible outcomes of the different policies, multiple semi-structured interviews with solar energy policy experts from Flanders were conducted. Semi-structured interviews were used because these are used to find clarification and elaboration in addition to the policy documents found. In this form, there is a way to probe beyond the answers and start a dialogue with the interviewee (May, 2011).

The interviews were held with insiders in the solar energy field, with a focus on policy to find information based on experiences (Wisker, 2001). The participants were found using google, groups on LinkedIn, government websites, via personal contacts and the snowball method. The interviews were held via telephone or skype. The interviews were recorded to allow for transcription later in the process. At the beginning of each interview, each participant was asked for his or her consent to use and record the interview. A fixed set of questions was used as an interview guide, but additional questions can be introduced to clarify where necessary (Cachia & Millward, 2011). The topic list consisted of questions that help to answers the research questions. The topic list was focused on previous and current policy transitions, what the stakeholders were and how the transitions were received. The topic list can be found in annex 1.

May (2011) states that only by comparing a series of interviews, the significance of any one of them can fully be understood. Because of this, six interviews were conducted. Each interview takes around 30 minutes, to increase the participation rate while still acquiring enough information. A list of (anonymised) interviewees can be found in annex 2.

The analysis of the interviews was done by transcribing and coding in the programme 'Nvivo'. This programme is available at every computer at Cardiff University. A pre-set code list was made, with the possibility to add more codes during the analysis.

3.4 LIMITATIONS

The problem of good validity and reliability is a major criticism on qualitative methods in a study (Burns, 2000). This is one of the main limitations with the semi-structured interviews that were conducted in this study because answers given by the interviewees might not be the opinions of the people themselves. Next to this, they can be lying or can recall things that happened years ago differently than they happened.

As with all interviewing methods, the interviewer should not only be aware of the content of the interview but also be able to record the nature of the interview and the way in which they asked questions (May, 2011). This was to be kept in mind because the interviewees were asked about opinions on how policy has worked/is working. Next to this, the interviewer needs to watch out for unconscious signals that make the interviewee give certain answer. The interviewer should be as objective as possible.

A main limitation in conducting these interviews was most likely the issue of accessibility. It was difficult to find the right people and get in contact with them. Next to this, there can be a sampling bias. People that know the reason of the interview might be more or less willing to be interviewed.

Another limitation was the issue of cognition. Although the interviewer speaks Dutch, the interviewee from Flanders might use different words in their dialect. Language differences, even if researchers have a proficient understanding of a language, require a cultural understanding of words to allow for the equivalence of meaning. This is particularly important when dealing with dialects where the meaning of words vary (May, 2011). The interviews were recorded. When something is not clear, some research could be done to clarify this.

The main limitation with using policy documents is that documents do not stand on their own, but need to be situated with the contexts in which they are produced (May, 2011). Connecting the policy documents to the interviews conducted can overcome this limitation. Next to this, documents are written with a specific purpose and for a specific audience. This might result in a not fully accurate document or one with a lack in bias.

3.5 ETHICAL CONSIDERATIONS

The interviews were treated with full privacy and confidentiality. Names were anonymised, although it may be necessary to know from which organisation the interviewee is. At the beginning of the interview, the interviewee was informed about the recording that was made, and was asked for his or her consent. This recording will not be made public and is for the use of the writer and the administration of the university only.

The interviews were based on full voluntary participation, and the interviewees were informed about the purpose of the study before the interview starts. The interviewee also had the right to discontinue at any time. Participants will be debriefed at the end of this study. In annex 3, forms are attached regarding the ethics of this study.

The interviewer speaks Dutch but does not have direct relations to Flanders. In this way, the interviews could be held in the mother tongue of the interviewee and there was no need to translate the outcomes. The governmental reports in Dutch were also usable in this study in this way. Because there are no direct relations between the interviewer and Flanders, the interviewer was able to stay objective while talking with the respondents.

4 ANALYSIS AND DISCUSSION

In this chapter, the empirical data is analysed in order to answer the research questions. The data is analysed in different sections. The first part describes the state of development in the EU, Germany, Italy and Greece. The second part describes the state of development in Belgium, and Flanders in particular. Next, the different support instruments and factors behind change, positive and negative, are analysed. Finally, the limitations in this study are described.

4.1 STATE OF DEVELOPMENT IN THE EU

First, an overview of the general increase in solar energy in the EU is described. Next, the solar energy policy and its transitions in Germany, Italy and Greece are described.

4.1.1 European Union

Between 2005 and 2015, the installed solar PV power in Europe has increased 50 fold. This development appears to be a success, but the analysis of annual installations show that Europe's share is not only declining in relation to a growing global market, but also in actual installation figures (Arantegui & Jäger-Waldau, 2018).

The rapid technological progress, cost reductions and relatively short project development times are among the key drivers for the growth of solar PV energy in the last ten years. After the peak years 2011 and 2012, the market slowed down because of increased taxes on self-consumption and new policies reducing financial support. As a result, the annually installed solar PV energy has slowed down since 2011, as can be seen in figure 4 (European Environment Agency, 2017).

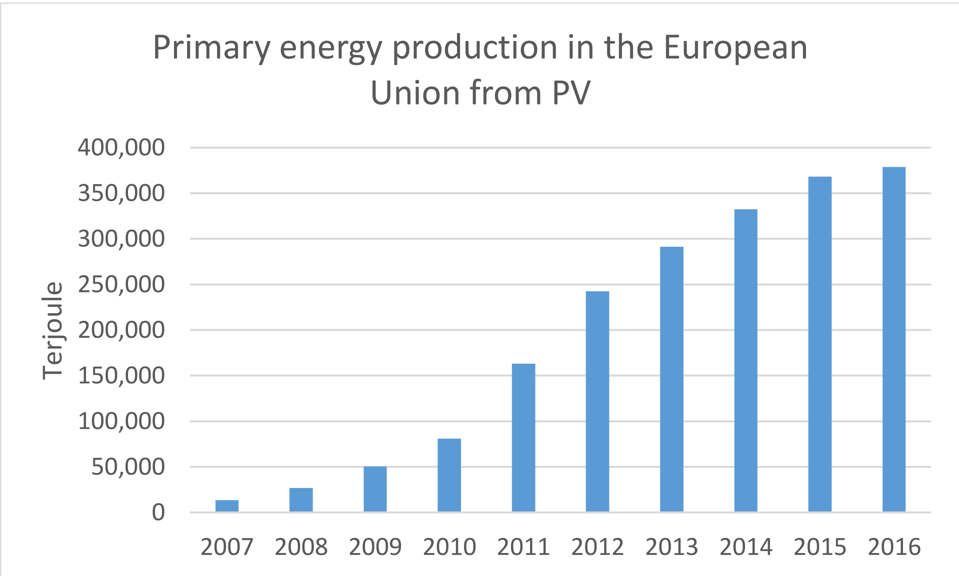

Figure 4: Primary energy production in the European Union from PV (Eurostat, 2018 A).

4.1.2 Germany

In the second half of the 1980s, Chernobyl, acid rain and the emergence of climate change as a political issue led to strong demands for change from the landscape level in Germany. These demands were not mediated by the government, but by the political parties who were unusually cooperative and 'green' on these issues. They also learned to pressure and if necessary to bypass the government (Jacobsson & Lauber, 2006).

Germany started introducing renewable energy policies earlier than most other countries, providing a low-risk environment for investors (Karneyeva & Wüstenhagen, 2017). Today, Germany is in the middle of a fundamental energy transition (Energiewende), which involves a complete phase-out of nuclear energy and a deliberate policy of reliance on renewable energy sources (Pegels & Lütkenhorst, 2014).

In 2000, the renewable energy act replaced the previous law, stating that the FiT prices would no longer be linked to electricity retail prices, but a fixed tariff would be set for a period of 20 years, which made investing in PV even more attractive (Pyrgou, et al., 2016).

As shown in figure 5, the highest increase in installed PV was from 2011 to 2014, but since 2013 the amount of annual new PV installations is on the decline (Arantegui & Jäger-Waldau, 2018).

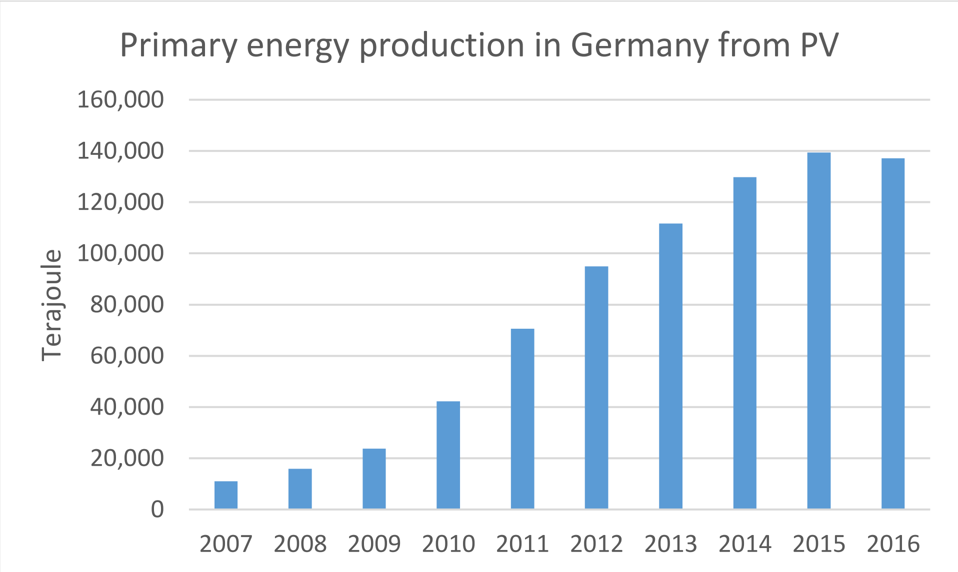

Figure 5: Primary energy production in Germany from PV (Eurostat, 2018 A).

The German renewable energy policy can be characterized as:

> *"A combination of a robust legal and policy framework, sustained funding of a diversified set of research institutions and an emphasis on price-based rather than quota-based investment incentives" (Pegels & Lütkenhorst, 2014, p. 523).*

4.1.3 Italy

From 2005 until 2013, the main policy mechanism used in Italy for the promotion of renewable energy was a FiT scheme (Karneyeva & Wüstenhagen, 2017; Orioli & Di Gangi, 2017). After the fifth energy bill ended in July 2013, the only support mechanism was via a self-consumption scheme (Arantegui & Jäger-Waldau, 2018). The FiT policy was then replaced by a tax credit programme. There were pessimistic expectations at first, but there was a steady increase of PV electricity generation in the last years. By the end of 2015, PV energy reached 9% of the national power production (Orioli & Di Gangi, 2017). Solar PV dominates in Italy's renewable sectors, due to high solar radiation attracting developers from across the globe, especially in southern Italy (Sahu, 2015).

Around 2011, Italy was among the top PV installers in the world. Italy had already met its 20-20-20 renewable electricity production goal from the EU at the end of 2011, nearly eight years ahead of schedule (Sahu, 2015). After this peak, an unstable regulatory regime, which included retrospective policy transitions, created a downwards cycle in the diffusion curve (also see figure 6) (Karneyeva & Wüstenhagen, 2017). PV installations came down by more than 50% in 2012 as compared to the installed capacity of 2011 (Sahu, 2015).

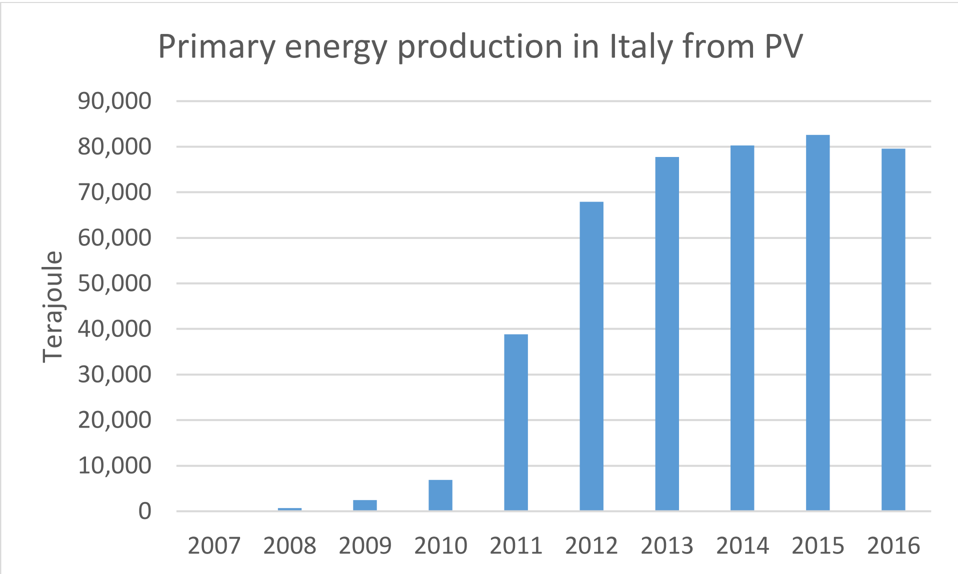

Figure 6: Primary energy production in Italy from PV (Eurostat, 2018 A).

Currently, installations up to 200 kW can benefit from a net metering scheme and tax deductions. Net metering in Italy allows the electricity produced to feed into the grid as a payment for the electricity consumed over a year (Karneyeva & Wüstenhagen, 2017).

4.1.4 Greece

The first governmental support scheme for PV installations in Greece started in 1997, with considerable subsidies of 50 to 55% of the investment costs covered. From 2001 to 2007, subsidies were given for between 45 and 50% of the initial investment. In 2006, a FiT scheme was introduced with the aim to stimulate the market. The FiTs were guaranteed for 10 years, but with the possibility of a 10-year extension (Martinopoulos & Tsalikis, 2018).

In figure 7, there can be seen that 2012 and 2013 were years with the most energy produced by PV, but that the production has barely seen any growth in the last years. The rapid growth ended in May 2013, when the Greek ministry of environment, energy and climate change announced retroactive changes in the FiT scheme, see also figure 7 (Arantegui & Jäger-Waldau, 2018).

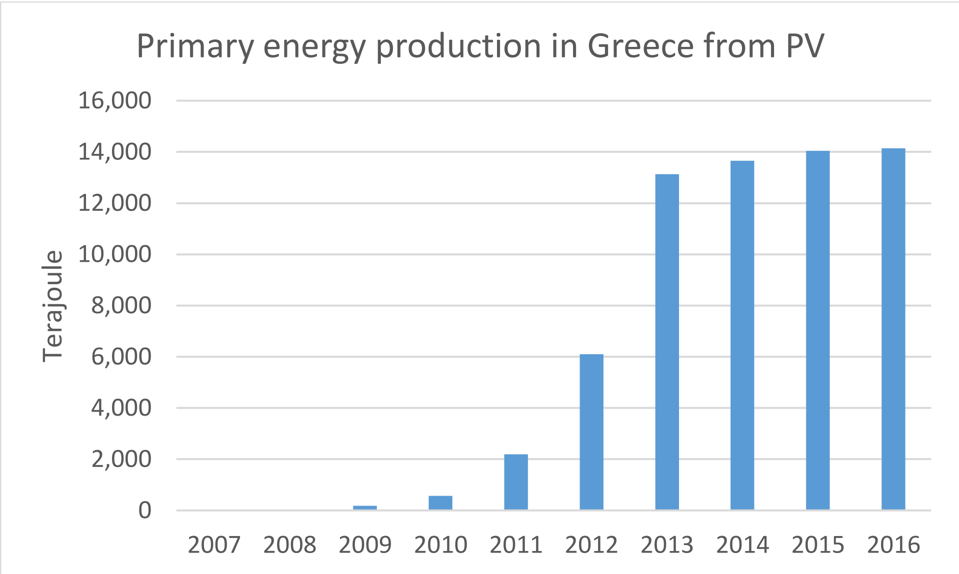

Figure 7: Primary energy production in Greece from PV (Eurostat, 2018 A).

The positive results obtained for Greece can be explained by the good characteristics of some locations of the country concerning solar energy (Martins, 2017). The financial crisis had more implications for the renewable energy sector in Greece than any other European country (Eleftheriadis & Anagnostopoulou, 2015). Next to this, the lack of a long-term energy policy added extra risk to renewable investments.

4.2 STATE OF DEVELOPMENT IN BELGIUM

In Belgium, ‘energy’ falls under the responsibility of both the federal and the regional authorities (Brussels, Wallonia and Flanders). The federal authorities are responsible for

1. The national equipment programme in the electricity and gas sector;
2. Electricity generation (excluding renewable energy);
3. Electricity transmission (high-voltage lines);
4. Nuclear energy;
5. Maximum prices (Verbruggen, 2004; VREG, 2018 B).

The regional authorities are responsible for

1. Local transmission and distribution of electricity (under or equal to 70 kV);
2. Public gas distribution;
3. Cogeneration;
4. Promotion of renewable energy sources;
5. Rational use of energy;
6. Distribution tariffs (Verbruggen, 2004; VREG, 2018 B).

Each of the regions has their own energy policy, but there is only one electricity market. This leads to different regional and national energy regulations. In all three regions, there is a net metering scheme in place. The scheme in Brussels is only available for installations up to 5 kW, where in Flanders and Wallonia it is available for installations up to 10 kW. In Wallonia, there is a subsidy system in place next to the net metering scheme, in Brussels and Flanders there is a TGC scheme. In the whole of Belgium, PV power provided about 3.6% of the country's total electricity needs in 2015 (Arantegui & Jäger-Waldau, 2018). In general, there was a high increase in solar energy production in Belgium in 2010 to 2012, see also figure 8.

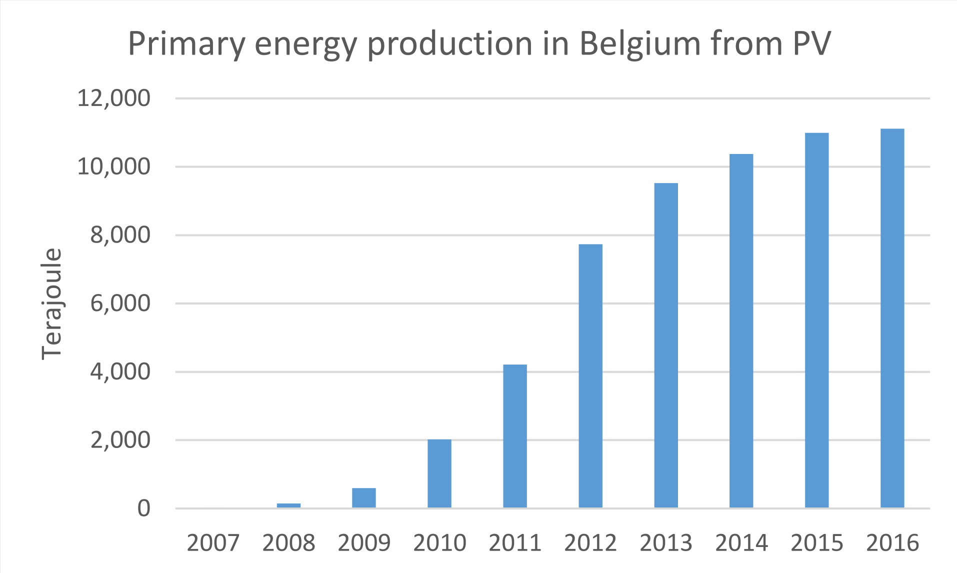

Figure 8: Primary energy production in Belgium from PV (Eurostat, 2018 A).

4.2.1 Federal government

In 2004, the Belgian federal government introduced a tax credit of 40% to individuals undertaking certain renewable energy investments, including PV. This percentage and the maximum allowed tax credit has varied over time until it was abandoned in 2011 (De Groote, et al., 2016). In general, the interviewees say that the federal government does not contribute to the growth of solar energy in Flanders. Interviewee 5 even states that the current federal energy minister does not have a strategy and is only focused on the nuclear power plants. Interviewee 6 states that:

> *"The federal government has no competency regarding PV energy in Flanders. They are only responsible for their own territories, which is the North Sea."*

With the EU 20-20-20 targets, every country has to increase its renewable energy production by a specific amount. This is difficult in Belgium with the different regions; who has to install which amount of renewable energy. This is one of the challenges the federal government has to deal with.

4.3 State of development in Flanders

Between 2009 and 2012, the amount of PV installations in Flanders grew at a large rate. After the decrease of TGC support in a change of the policy system, this decreased again. Since 2015, the amount of PV installations is growing again due to a higher return of investments because of the decreasing costs of PV installations (and the increase in electricity costs) (SERV, 2017). This can also be seen in figure 9.

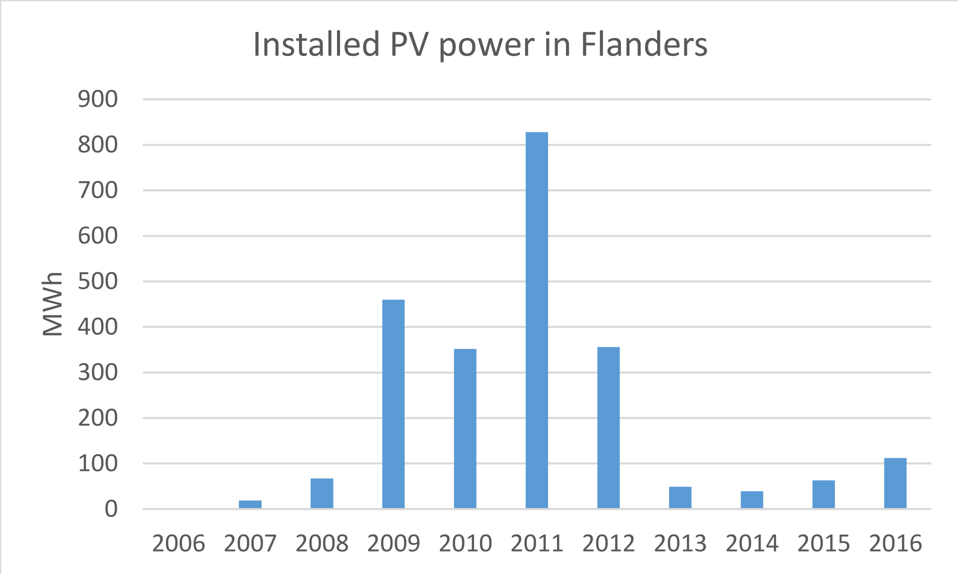

Figure 9: Installed power by year in Flanders, adapted from (SERV, 2017).

Until 2002, Flanders had a FiT policy scheme. After 2002, a system with TGCs was implemented. This meant that a fixed price was offered for every 1000 kWh energy produced. A minor change in the energy policy in 2009 meant that the government installed a minimum amount of TGCs energy suppliers have to buy. In 2012, there was a major change in the system where the price of TGCs are evaluated and adjusted to the market prices every six months (European Commission, 2013; SERV, 2017).

4.3.1 TGC until 2012

The introduction of TGCs has been highly significant for the growth of the Flemish PV market (Huijben, et al., 2016). The first TGC scheme consisted of a subsidy of 450 euro for every 1000 kWh produced, with support for 20 years. During this time, people were investing in PV systems because it seemed a good investment, the payback time was 6 to 7 years at this time. Interviewee 2 says that:

> *"This high subsidy is still relative. Even with the highest subsidies, the payback time was never shorter than 6 to 7 years. At that same moment, the subsidies for roof insulation meant this had a payback time of less than one year."*

The TGCs are not paid with tax money, but by energy suppliers that have to buy the TGCs from the producers. The Flanders TGC system started in 2002, with a quota of 0.8% of power sales and aiming at 6% by 2010. An analysis of the period 2002-2007 shows that the renewable energy production did increase by more than two TWh in 2007, which was 4.9% of all electricity sales. Most of the renewable energy was delivered from bio-waste flows exploited by incumbent power companies or waste processing companies. PV energy was still almost non-existent at this time (Jacobsson, et al., 2009).

The main feature of the energy system was the excess profit that it generated. Between 2002 and 2007, the Flemish renewable energy output cost consumers around 838 million euro. If the rules of the German FiT system had been applied, this would have been reduced to 301 million euro. The level of excess profits, thus, amounted to 64% of the turnover. In other words, the German FiT system is 2.8 times cheaper than the Flemish TGC mechanism. The main part of the excess profits (around 87%) went to biomass and waste combustion and the rest to wind power. The old TGC system thus has been throwing money at investors, rewarding them with huge excess profits. These have been associated with some investment in mature technologies, but little money had been spent on real renewable energy innovations during this time (Jacobsson, et al., 2009).

Since 2012, every energy company in Flanders needs to have a share of renewable energy in its energy mix for consumers. The minimum amount of renewable energy was 2% in 2004, and 6% in 2006. The energy supplier can reach this by producing renewable energy themselves, or by buying TGCs from the market. The energy supplier has to pay a fine if it cannot meet the quota. The Flemish regulatory authority for the electricity and gas market (VREG) gives TGCs to producers of renewable energy. The producers get one certificate for every 1000 kWh of renewable energy produced. Producers can put them on the market for energy suppliers to buy. Thus, the landscape level, instead of the regime level determines the price for one TGC that energy suppliers can buy (Ovaere & Proost, 2015 A).

Until 2012, the TGC support instrument was found to be the most important for market development. Related costs proved to be high and unevenly distributed over the different stakeholders, indicating the need for a careful assessment of cost-benefit allocation over the energy system (Huijben, et al., 2016).

4.3.2 TGC after 2012

From 2013 onwards, the TGC instrument is evaluated every six months to one year, and adaptations are reported shortly after the evaluation (Huijben, et al., 2016). Before 2013, one TGC was awarded for every 1.000 kWh produced. After 2012, there is a flexible price per for one TGC, and the amount of kWh produced that is needed for one TGC is flexible too (SERV, 2017). After 13 June 2015, PV installations smaller than 10 kW (residential size) do not get TGCs anymore (Vlaamse overheid, 2018 B). In general, the interviewees say that this new system is favourable over the old system. Interviewee 5 says:

> *"We were selling a lot of solar panels until there was said that there would be no subsidies anymore in 2012, because [it was perceived that] people that were buying solar panels are freeloaders. Those people would profit from subsidies, and that it was only accessible to rich people."*

A safety net is installed by the government to limit the risk of a decline in value of the TGCs for renewable energy producers. The certificates can always be handed in for a minimum value at the energy supplier. Since 2013, every renewable energy producer gets certificates of at least 93 euro per certificate valid for 15 years, for every renewable energy source. Before this new scheme, there was a difference in certificates for different energy sources (Ovaere & Proost, 2015 A).

The quota for TGCs for energy suppliers was fixed in 2009 in the energy decree, with its first adjustment on 13 July 2012. On 27 November 2015, there was a second change. The quota percentage for TGCs for 31 March 2018 was raised from 19.5% to 20.5% of the total amount of energy bought from energy suppliers in Flanders. In total, this means energy suppliers need 6.1 million TGCs to meet the demands of the government (VREG, 2016).

4.3.3 Net metering

The current system is that the energy meter turns backwards when energy is produced, with compensation at the end of the year. Starting 2021, the digital meter will be obligated. Interviewee 1 states that although the current energy minister says that there will be a compensation for 15 years, it is not clear if the next minister will execute this.

The prosumers tariff is a fee that needs to be paid to be able to profit from the net metering scheme. Because 'prosumers', energy consumers that produce renewable energy and feed this to the grid, use the energy grid to inject their renewable energy when they are not using it themselves, they have to pay for the usage of the grid through the prosumers tariff. The prosumers tariff is seen as an infamous part of the solar energy policy, as it is seen as a fine for homeowners with a PV installation. Interviewee 6 states that the prosumers tariff is costing him around 11 euro cents per kWh that he produces.

The prosumers tariff is in place since 1 July 2015 and is required for prosumers that produce less than 10 kW renewable energy (such as a residential PV installation and windmills). Next to this, the prosumers can use a net metering scheme by using an energy meter that can turn backwards to supply energy to the distribution network. The prosumers tariff is not a tax, but a fee to be able to use the distribution network (VREG, 2018 A).

The current flexible TGC system for residential installations (less than 10 kW) in Flanders is mostly profitable because of net metering. Because the energy meter turns backwards, taxes do not have to be paid either, which makes up the main part of the profit margin.

4.3.4 Other support

Other support mechanisms in Flanders included investment and financing support. These mechanisms are not in place anymore. Until 2007, there was an investment support mechanism in place in the form of subsidies that covered a certain amount of the investment costs for residential and commercial installations. There also was a premium in certain local municipalities that covered a part of the investment costs. Until 2011, there was a tax deduction system on investment in place for residential installations. Until 2012, there were different financing systems in place. These included interest reduction for farmers, green loans and tax deductions on mortgages for residential installations (Huijben, et al., 2016).

One of the most successful projects in 2017 was the solar map that was made by the Flemish government. The map shows how much potential there is for PV installations for every roof in Flanders. For more than 2.5 million roofs the surface, orientation and slope are determined (Energiesparen, 2018). This shows that not only policy instruments can increase the amount of PV installations placed, communication is also important. Interviewee 1 says:

> *"This was a huge success; installers have told us that they got a lot more phone calls from people that were interested in solar panels the days after the launch of the solar map."*

4.3.5 Discussion

Compared to other countries (Germany, Italy and Greece) with a high share of solar energy, Flanders has some differences and similarities. A key difference is that there is more sun in Italy and Greece compared to Flanders, which makes it easier for these countries to have a positive mindset towards solar energy, as it is more profitable (Martins, 2017). Most countries have a FiT scheme, such as the 'Energiewende' in Germany, compared to a TGC scheme in Flanders. All countries described, and the EU in general, have a peak in installed PV power around 2012. After the peak years 2011 and 2012, the market slowed down in all countries described because of increased taxes on self-consumption and new policies reducing financial support. This EU wide interest in solar energy production might play a more important role in the increase of solar energy in Flanders than policy instruments on their own.

The installed power in Flanders can have a different background than policy transitions alone, looking at the other countries and their installed power each year. One thing that stands out compared to the other countries is that the installed power is increasing again, while the installed power in Germany and Italy is declining. In the end, a certain policy structure might not be the reason that people implement renewable energy, but it can help to create incentives.

4.4 Factors behind transition

A factor behind the growth of the amount of solar energy is that the old TGC compensation (with a fixed price per 1000 kWh) was the main driver for the exponential growth of installed PV capacity in Flanders. However, net metering and self-consumption were also substantial factors. After 2012, when the TGC level dropped considerably, net metering and self-consumption of electricity became the major shielding instruments for small residential (<10 kW) and large industrial systems (Huijben, et al., 2016).

Because the Flemish government subsidised PV energy significantly more in the early years than for example wind energy, the main factor cannot be found in economic objectives. Ovaere and Proost (2015 A), and the interviewees show that the discrimination of the subsidies can be explained from the electoral perspective. Because PV systems are placed on residential buildings, in contrast to wind energy, the subsidies for solar energy can be used to win votes for the next elections. When enough voters have PV systems on their houses, enough people will vote for a party that will guarantee them subsidies in the future too. This mechanism is not only driven by ideology; every party is looking for ways to bind voters with future subsidy systems. This explains why all Flemish governments since 2000 that are responsible for discriminatory solar energy support, are re-elected in the next elections (also see table 3). In table 4, there can be seen that Flanders is not the only region where this is happening, the same is happening in neighbouring countries. The first solar energy policy was set in place in 2002, because the energy minister at that time (Steve Steveart) wanted to start making progress to reach the 20-20-20 goals, but lacked knowledge and experience to do this.

Interviewee 4 says:

> *"The energy policy is a stop-and-go policy in general. It has to do with the lack of vision and because the politics have to resolve the problems that their predecessors left."*

Name government	Years	Party energy minister
Bourgeois I	2014 – now	Open Vld (liberal democrats)
Peeters II	2009-2014	Sp.a (different socialists)
Peeters I	2007-2009	CD&V (Christian democrats)
Leterme	2004-2007	CD&V (Christian democrats)
Somers	2003-2004	Sp.a (different socialists)
Dewael	1999-2003	Sp.a (different socialists)

Table 3: Flemish governments and energy ministers (Vlaamse overheid, 2018 A).

Country/region	Start support	Election date	Party/coalition (re-)elected?
Germany	2000	2002	Yes
France	2003	2004	No
Flanders (Belgium)	2002	2004	Yes
Wallonia (Belgium)	2003	2004	Yes
United Kingdom	2010	2010	Yes
Netherlands	2007	2010	Yes

Table 4: Re-election of parties introducing discriminatory support (Ovaere & Proost, 2015 B).

In Flanders, the government that introduced TGCs for solar PV was the regional Flanders government 'Leterme I'. The majority in this government was formed by the four parties; right-wing democratic VLD, the socialist SP, the Flemish Nationalists NVA and the Christian Democrats CD&V. The green party served in opposition (Ovaere & Proost, 2015 B). Next to the government, the parties, and the individual energy minister itself, lobby groups are also influencing the energy policy through the politics.

There will be new elections in 2019, and interviewees are hoping there will not be too many changes, but looking at previous governments, there is a real possibility. Two interviewees state that when the nationalist party NVA wins the next elections, subsidies might decrease. The NVA has links with the large industries, and are focused on keeping prices low. When this happens, there might be invested in nuclear power again. This will most likely not lead to a decline in solar power as seen in 2012 due to the current higher energy prices, but it can lead to a decline.

4.4.1 Positive factors

During the old TGC scheme, consumers had the idea that PV installations were heavily subsidized. This resulted in a steep incline in the installed PV power in 2010 to 2012.

After 2012, there was a decline, but in 2017 there was an increase in installed PV power again. Interviewees state that this stable growth gives perspective again. At this moment, the support scheme is the most positive for residential installations (<10 kW) that can use net metering. Where the sector was in crisis two years ago, there is a renewed demand for solar energy today.

The new TGC scheme is flexible, which is better because PV producers know beforehand that there will be a change every six months. Interviewee 1 says:

> *"The current policy is received positively, and it is also positive because it evolves with the market. When fewer subsidies are needed, fewer subsidies are given because all factors are taken into account all the time."*

Another positive factor is the current energy minister, Bart Tommelein. He is communicating in a positive way, with for example the solar map and the project 'solar panels everywhere' where people could nominate a roof that would be suitable for solar panels, such as school, libraries, swimming pools etc. Not only is the energy minister communicating in a positive way, also the rest of the government is doing this more and more. All political parties and societal actors are communicating that solar energy is the future and that we need it to reach the 20-20-20 goals. This mindset of the regime and landscape are positive factors in the increase in the amount of PV installations placed.

Interviewee 2 and 3 say that a significant change was made when plans were made to build two biomass power plants in Flanders. The subsidy needed to build these plants would be more than the subsidy that would be needed to produce the same amount of energy with PV installations. After deciding not to go through with the biomass power plants, there was a stronger focus towards solar energy in the government. Interviewee 3:

> *"What I appreciate is that they cancelled the subsidies for biomass power plants. With the same amount of money, a lot more solar power plants can be financed."*

Last year a solar map was published, where homeowners could see what the possibilities for solar panels in their own roofs were, and how much money they could save and what their payback period would be. This was a great success according to the interviewees, as installation companies could see a rise in phone calls from homeowners the days after the solar map was released.

Interviewee 1 concludes by saying that The Flemish energy agency (VEA) at the regime level is a stable factor in the Flemish energy policy. Where the government changes, the VEA mostly stays the same. The expertise and the communication with the politics is a positive factor.

4.4.2 Negative factors

The main negative factor, according to the interviewees, is that there is no long-term thinking from the government. During the old TGC scheme, the system was adjusted too abruptly. Some interviewees state that energy minister Freya van den Bossche, part of the socialist party ‘sp.a’, was responsible for this. Interviewee 3 states:

> *“They were very critical about Freya van den Bossche in the politics because she would have waited too long to decrease the subsidies.”*

After waiting for the policy to change, the abrupt change in subsidies was received negatively, especially by PV installers. Interviewee 5 states that:

> *“All people that owned solar panels were bandits by definition, according to Freya van den Bossche.”*

After the first changes in the system, many companies selling solar panels went bankrupt. The term ‘stop-and-go’ was used to describe the way the regime acted. Because of the fast-changing policies and lack of vision, companies cannot keep up to date and are sometimes working according to outdated policies. Next to this, consumers never know what their returns will be when buying solar panels because there will be different policies that will change the payback model. Interviewee 4 says:

> *“Because all these interventions it is difficult for owners of PV installations to know what their profit will be. The politics can install new regulations at any time that can change the payback period of your PV installation.”*

During the time of over-subsidising PV installations, the government gave out too many TGCs. This resulted in a debt for the government and the network operators that were obligated to buy the abundant TGCs. This debt affected the work of multiple energy ministers, and according to an interviewee, this paralysed the energy debate for years.

The offered returns are significantly lower than several years ago (before 2013), and it is uncertain how high they will be exactly. Another lack of long-term thinking is that for small installations the use of digital meters is announced, while the compensation policy until 2020 to compensate the missed advantages of not having a reversing meter is not available yet. This new policy might not even be feasible. It is not clear how much the announced decrease in support to 10 years (instead of 15) will facilitate the growth in larger installations.

Next to this, the investments in large-scale installations (>10 kW) has to grow from almost nothing to the amount at times of the over subsidising, or even higher (SERV, 2017).

Another part is that for larger installations where there is none, or not enough self-consumption, it is not as profitable to have a PV installation compared to residential installations, because the net metering policy does not allow for a negative energy usage. There is no system in place that considers larger installations in this sense.

For residential installations, it is not profitable to produce more than what is consumed, because the net metering scheme does not allow for a negative usage. This results in residential roofs that are not used optimal, because it is not profitable to do so.

Multiple interviewees say that the prosumers tariff was perceived as a punishment for owners of PV installations. The implementation of this tariff took away the trust in the government completely. People felt betrayed because they were encouraged to invest in solar panels, but a few years later, they had to pay a fee to be able to keep using them. The problem with this tariff was that it measured the fee according to the inverter used, and not according to the amount of energy injected into the grid. Next to this, the rates are too high compared to the costs to produce the energy. The communication about the tariff was not promotional either. There was said that people without solar panels were effectively paying those who had, what created a smear campaign against owners of solar panels. Interviewee 4 states that:

> *"Everybody felt deceived, in the sense that the solar panel owner that bought their panels in times of the subsidies felt deceived because everybody was angry with them because they made such a big profit on their installations."*

There was a missed opportunity on the federal level when the nuclear power plants were not shut down. Although there was made a decision to close them before 2025, the current energy system is too dependent on nuclear power. It is difficult for gas plants to sustain because the nuclear power plants currently produce cheaper energy. For an energy system with a large amount of solar energy, it is favourable to combine it with gas, because gas can easily be increased or decreased where necessary. Because the federal government did not close the nuclear power plants, there will be a problem in the energy supply around 2025, according to interviewee 3.

There is no rational economic argument for the small region of Flanders to have higher subsidies for solar energy than any other renewable energy source like wind energy. When the government wants to meet the minimum share of renewable energy in a cost-efficient way, there should be a uniform subsidy system for all renewable energy sources. Only in this way the most competitive technologies will get subsidies. The overall costs will be the lowest for the taxpayer this way. Opponents of this uniform subsidy system state that in this way there is no room for innovative technologies. This argument does however not count in a small region such as Flanders. The impact of Flemish investments is not high enough to stimulate the global change of renewable technologies (Ovaere & Proost, 2015 A).

4.4.3 Discussion

In the literature review (chapter 2), the multi-level perspective (MLP) theory was discussed. In figure 10, the MLP figure for energy policy transitions in Flanders can be seen. In the literature, niches are seen as unstable, 'in the making' communities where radical innovations occur, and where regimes are stable, established communities and rules (Geels, 2014; Meadowcroft, 2009; Geels & Schot, 2007). The main difference in Flanders, compared to the general idea of the MLP, is that actors from the regime, i.e. politics, are responsible for the radical innovations. Because the actors from the regime act as they are in the niche level in certain instances, the niche and regime level are very close to each other. There can be said that there is no standard niche level, but that this consists of specific actors that can be characterized in the regime and niche level at the same time. The interacting process between the niche and regime level sets the basis for transitions.

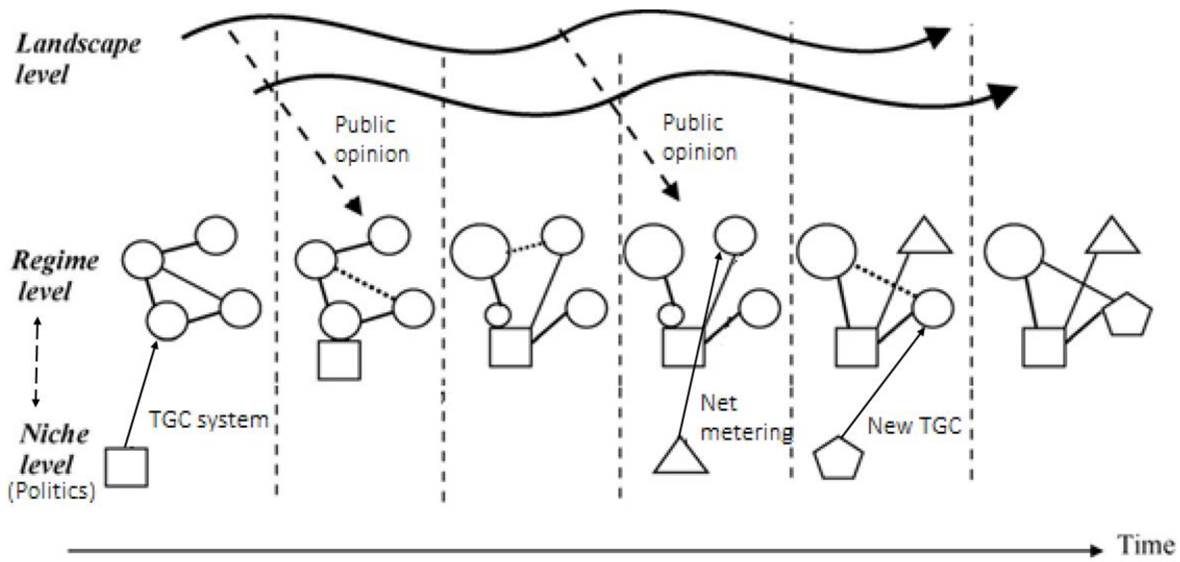

Figure 10: Reconfiguration pathway in Flanders, adapted from (Geels & Schot, 2007).

From the niche level, changes are implemented in the policy system. The pressure from society in the landscape level, especially for the prosumers tariff, makes the politics review their choices to change the system again. Also new techniques, (EU) trends, changing opinions about nuclear power and economic crises puts pressure on the politics to make changes in the system. This makes a system with incremental changes towards a more sustainable energy policy.

One important aspect of the increase in PV installations in Flanders is the positive communication by, for example, the current energy minister and the implementation of the solar potential map. It can be seen as a change of the public opinion (landscape level) influenced by the politics (regime level).

The main factors for the transitions in solar energy policy in Flanders are the politics. Every new energy minister seems to want to change something in the energy policy, which is not necessarily good or bad, although not in favour of long-term plans. Next to this, the individual energy ministers have the power to change the attitude towards solar energy by themselves. The current energy minister, Bart Tommelein, communicates in a positive way which results in a more positive attitude towards solar energy on a landscape level. According to the interviewees, the main shortcoming in the Flemish solar energy policy is the lack of a long-term plan. This also connects to the lists of factors of a transition towards a sustainable energy system seen in the literature review (Mitchell, 2010; European Commission, 2013; Kemp & Rotmans, 2005). Factors seen in Flanders are:

Regime level:

- The announcement of automatic reductions in support depending on specified caps and lower technology costs;
- Keep costs transparent and separate from other system costs;
- Government viewing climate change as an opportunity;
- The government being determined to make it straightforward to develop renewable energy;
- A focus on learning-by-doing and doing-by-learning.

Landscape level:

- Understanding that the transition to sustainability is a 'system' issue;
- A fundamental change in the attitudes towards energy use. This requires clarifying the roles of the different actors within the energy system, and clarifying the relationships between them.

Flanders does not have long-term plans, which is one of the main factors of a transition towards a sustainable energy system on the regime level. On the other hand, there is a long-term view from the landscape level with, for example, the European 20-20-20 goals that need to be met by the government. There can be argued how relevant long-term plans are on the regime level because political processes tend to happen in continuous and incremental steps (Meadowcroft, 2009; Mitchell, 2010; Walsh, 2012). Although it is an incremental process, this does not mean it is a slow-moving process. Because energy ministers can be placed at the niche level, while the politics as a whole are on the regime level, new innovations can be implemented very rapidly into regulations without much time to reflect on the possible implications. This is an explanation for the 'stop-and-go' policy seen in the politics, and the abrupt changes in policies.

There should be noted that the factors seen in Flanders now, can change after the next election, or when the public opinion changes. For example, in general there is an understanding that the transition towards more solar energy is a system issue, but this can be different for other potential energy ministers. One of the key factors in the current regime is the announcement of automatic reductions in the support system with the flexible TGC scheme every six months. This new support system is taking away some of the fears for investors.

This is an important role for the government; it can mobilise and inspire actors to increase public support in the landscape level, as also Rotmans, et al. (2001) state.

4.5 LIMITATIONS

In both the literature review (chapter 2) and the data analysis there can be seen that politics are an important factor in policy transitions (Meadowcroft, 2009; Deshmukh, et al., 2012; Mitchell, 2010; Marques, et al., 2010). It is, however, not tested how much power the major political parties have over the energy policy compared to the energy minister alone.

Only people that were willing to talk about solar energy policy were interviewed, and might have a positive bias towards solar energy. The people that think that there are too many transitions, or do not believe in solar (PV) energy might have not been willing to participate. Next to this, the amount of people interviewed (six) is not sufficient, even though it seems that a certain level saturation has been reached. The time of year where the interviews where held might have been a reason for this. In spring, many people notice the sun and start thinking about buying solar panels, and solar panel installers are too busy to participate in an interview. Finally, qualitative research, the structure of the interviews, and a subconscious subjectivity might have had an unintentional bias towards a positive view on solar energy.

Another limitation is that the increase in solar power in Flanders might be connected to other effects than studied in this dissertation. The media, communication from the government, or an EU-wide interest might have increased the amount of solar energy more than policy transitions can ever have.

Finally, the MLP is not comprehensive enough to encompass every aspect of the solar energy policy transitions in Flanders. The theory is too simplistic. In particular, there is no place for a niche/regime relationship as there is seen in Flanders. It also does not focus on the communication aspects between the public opinion (landscape level) and energy minister (niche level), while this is a vital part of the reason behind transitions in Flanders. The public opinion puts pressure on the energy ministers, not on the politics as a whole necessarily.

5 CONCLUSIONS AND RECOMMENDATIONS

This study has been carried out to explore the transitions behind the increase in solar power in Flanders, Belgium. This study has explored the literature and primary data in the form of policy reports and interviews. This chapter presents the key conclusions of the main- and sub-questions before giving final recommendations. The main research question of this study is “how can the rapid per capita uptake of solar power in Flanders, Belgium be explained in the light of transition theory?”. To answer this, the three sub-questions have to be answered first.

1. **How can the current state of development of solar energy policy in Flanders be compared with wider European trends?**

All discussed countries and the EU as a whole, have a peak in solar energy produced around 2012 and a decrease after that. This can mainly be attributed to increased taxes and reducing financial support after the initial boom in investments while there were plenty of financial instruments. This is also seen in Flanders after the initial boom in 2011/2012, with the decrease in installed PV power after 2012 when the tradable green certificate (TGC) system changed and the prosumers tariff was implemented.

The main difference between Germany, the country with the most PV power placed per capita in the EU, and Flanders is the policy structure that is used. In Germany, there is a feed-in tariff (FiT) scheme in place, where Flanders uses a TGC scheme. On average, a FiT scheme is the most popular policy instrument in the EU to promote solar energy. Next to this, Germany has a long-term policy where the policies in Flanders change every few years.

Italy uses a similar net metering scheme as there is in place in Flanders. Italy and Greece have good characteristics concerning solar energy, compared to the less sunny Flanders. In Greece, the financial crisis had more implications for the renewable energy sector than any other European country.

2. **How do the key solar energy policies evolve in Flanders, Belgium?**

The main solar policy structure in Flanders evolves around the TGC system. From 2002 to 2012, a TCG scheme was in place, which changed to a flexible TGC scheme that is evaluated every six months. In the first years of the initial TGC scheme, there were radical changes. With the new flexible TGC scheme in place, there are multiple small changes each year.

Next to the TGCs, there is a net metering scheme. This in the main policy that makes investing in solar energy in Flanders profitable. The public opinion viewed owners of PV installations as thieves that were getting money from people without a PV installation, and the energy minister was pressured to make a change. To level this out, the prosumers tariff was installed in 2015. This tariff has to make sure that owners of PV installations pay a fee to be able to use the energy grid.

3. What factors can explain the transition of solar energy policy structures in Flanders, Belgium?

The main factor that can explain the transition of solar energy policy in Flanders is politics and more specifically the individual energy minister that is in place. The different energy ministers have different ideas on how to stimulate solar energy, have different parties pressuring them. There are the European 20-20-20 guidelines that have to be implemented, or there is a need to minimize governmental debt. After the sudden implementation of the prosumers tariff in 2015, and changing the TGC scheme in 2012, it was the governments' focus to regain the trust of the public. The sudden and quick changes can be explained by the energy ministers' role as part of the niche and regime level in the MLP. By coming up with the radical innovation in the niche level, and being part of the politics in the regime level, ministers can implement new innovative policies quickly. The term 'stop-and-go' can be used to describe the transitions in policies.

The current flexible TGC scheme is focused on the market prices, and follows them by changing the amount of support is given every six months. This transition can be explained from the electoral perspective, as all ministers want to bind voters to their party by implementing favourable policies. Increasing or decreasing subsidies for solar energy can be used to win votes for the next elections.

In the light of the answers from the sub-questions, the main research question *"***How can the rapid per capita uptake of solar power in Flanders, Belgium be explained in the light of transition theory?***"* can be answered.

The rapid uptake in solar power was from 2009 to 2012. The amount of solar power produced during this time can be explained by the first TGC scheme and the lack of change in that scheme when prices of PV installations decreased. This was mostly due to slow-moving politics, and energy ministers that were part of the niche and regime level. This way, the minister was able to implement new instruments from the niche level in the regime level but were also able to not change anything.

There can be stated that the lack of a transition to decrease the amount of subsidies, led to an increase in the amount of PV installations. The increase in PV power can, therefore, be assigned to the lack of change made by the energy ministers. The decrease after 2012 can be explained by the 'stop-and-go' way of action and the sudden changes made by the ministers during this time.

The current increase in solar power in Flanders can be explained by the decreasing prices of PV installations, and the regained trust in the Flemish government at the landscape level. In general, there can be said that when the politics implemented the more long-term flexible TGC policy, the amount of PV installations increased again. This was due to the more stable regime level, but also due to the landscape level that felt a regained trust in the government, next to lower prices for PV installations.

Recommendations for future research are to conduct a multiple case study analysis to compare the TGC instrument with other policies in similar situations. The TGC scheme might be a favourable instrument over, for example, a FiT scheme in certain regions or situations. This study demonstrates that a TGC scheme can help to increase the PV installations placed in a region, but it is not clear if the same increase could be achieved with a different policy instrument.

Next to this, future research can be done on politics that act in the niche level of the MLP. As this is a single case study, it is difficult to evaluate what the implications are of the politics acting in the niche level of the MLP on a wider scale. Does this result in a faster implementation process of new policy instruments, compared to a niche level that stands further away from the regime level in general?

Lastly, future research can be done on the flexible TGC scheme after it has been in place for a longer time, to be able to reflect on this system and see the implications of using a flexible certificate instrument. An evaluation of this policy instrument in Flanders itself can help the government make less disruptive decisions in the future.

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7 ANNEXES

7.1 ANNEX 1: TOPIC LIST INTERVIEWS

Ten eerste: geeft u toestemming dat dit interview opgenomen wordt? De opnamen worden niet verspreid en zijn alleen voor de interviewer en de administratie van de universiteit.

1. Kunt u me wat over uzelf vertellen en wat u doet op het gebied van zonne-energie (beleid) in Vlaanderen?
2. Waarom verandert de overheid het beleid regelmatig volgens u?
3. Welke partijen/organisaties/personen zijn hier volgens u vooral verantwoordelijk voor?
4. Hoe worden deze veranderingen ontvangen in het algemeen?
   a. Waren er verschillen tussen verschillende veranderingen?
5. Welk beleid werkt het beste voor Vlaanderen volgens u?
   a. Welk beleid zorgt volgens u voor de grootste toename in zonne-energie?
   b. Waarom?
6. Wat zijn volgens u de positieve en negatieve punten van de manier waarom Vlaanderen zijn zonne-energiebeleid toe past?
7. Kunt u me wat vertellen over de huidige veranderingen in het beleid?
   a. Hoe krijgt u hiermee te maken?
   b. Wie zijn hier verantwoordelijk voor?

7.2 ANNEX 2: LIST INTERVIEWEES

#	Date	Organisation
1	09/04/2018	ODE/PV Vlaanderen
2	13/04/2018	Zero Emission Solutions
3	18/04/2018	VITO
4	18/04/2018	BBL Vlaanderen
5	09/05/2018	Solar Power Systems
6	22/05/2018	University of Antwerp

7.3 Annex 3: Ethical approval form

CARDIFF SCHOOL OF GEOGRAPHY AND PLANNING

Ethical Approval Form

Student Projects (Undergraduate & Taught Masters)

In the case of dissertations it is the responsibility of the student to complete the form, duly signed by their supervisor, and secure ethical approval prior to any fieldwork commencing. A copy of the form should be included with their final dissertation.

Title of Project: **Solar energy policy transitions in Flanders, Belgium. Dissertation**

Name of Student(s): Vera Stam

Name of Supervisor/Module Leader: Oleg Golubchikov

Degree Programme and Level: European Spatial Planning and Environmental Policy, masters

Date: 05/04/2018

Recruitment Procedures:

		Yes	No	N/A
1	Does your project include children under 16 years of age?		**x**	
2	Does your project include people with learning or communication difficulties?		**x**	
3	Does your project include people in custody?		**x**	
4	Is your project likely to include people involved in illegal activities?		**x**	

5	Does project involve people belonging to a vulnerable group, other than those listed above?		**x**	
6	Does your project include people who are, or are likely to become your clients or clients of the department in which you work?		**x**	
7	Does your project include people for whom English / Welsh is not their first language?	**x**		

Consent Procedures:

		Yes	**No**	**N/A**
8	Will you tell participants that their participation is voluntary?	**x**		
9	Will you obtain written consent for participation?		**x**	
10	If the research is observational, will you ask participants for their consent to being observed?			**x**
11	Will you tell participants that they may withdraw from the research at any time and for any reasons?	**x**		
12	Will you give potential participants a significant period of time to consider participation?	**x**		

Possible Harm to Participants:

		Yes	**No**	**N/A**
13	Is there any realistic risk of any participants experiencing either physical or psychological distress or discomfort?		**x**	

14	Is there any realistic risk of any participants experiencing a detriment to their interests as a result of participation?		**x**	

If there are any risks to the participants you must explain in the box on page 4 how you intend to minimise these risks

Data Protection:

		Yes	No	N/A
15	Will any non-anonymised and/or personalised data be generated and/or stored?		**x**	
16	Will you have access to documents containing sensitive[1] data about living individuals?		**x**	
	If "Yes" will you gain the consent of the individuals concerned?			

If there are any other potential ethical issues that you think the Committee should consider please explain them in the box on page 4. It is your obligation to bring to the attention of the Committee any ethical issues not covered on this form.

Supervisor's declaration

As the supervisor for this student project, I confirm that I believe that all research ethical issues have been dealt with in accordance with University policy and the research ethics guidelines of the relevant professional organisation.

Date Name Signature

15/4/2018 Oleg Golubchikov *Oleg Golubchikov*

[1] Sensitive data are *inter alia* data that relates to racial or ethnic origin, political opinions, religious beliefs, trade union membership, physical or mental health, sexual life, actual and alleged offences.

If any of the shaded boxes have been ticked the supervisor/module leader must explain in the box on page 4 of this form how the potential ethical issue will be handled

Please explain how the identified potential research ethics issue/s will be handled

Will gain verbal consent when interviewing people.