Researching the influence of policy instruments on the investment climate for renewable energy generation

by

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Preface

Dear reader,

This thesis concludes my master Complex Systems Engineering and Management at the Delft University of Technology. The research has been conducted in cooperation with ENGIE N.V.

Working on this project for the past six months has been a challenging but rewarding experience, which I could not have done without the help and support I have received along the way. I would therefore like to thank those that have stood by me throughout the writing of my thesis as well as the rest of my studies.

First of all, I would like to thank my TU Delft supervisors, Daniel Scholten and Martijn Warnier, for helping me throughout the entire process. Daniel helped me shape my thesis to what it is today, and was always available to provide a fresh batch of constructive criticism or to lend a helping hand in moments of sheer panic. Martijn, thank you for helping me kick-start my thesis and for your feedback and reassurance.

I would furthermore like to thank my supervisor at ENGIE, Joyce Post, who was always available for a brainstorm session and made me part of the New Business Factory team. I have thoroughly enjoyed writing my thesis at ENGIE, where, despite the challenging circumstances of the pandemic, I have been inspired, included, helped, and supported throughout the process.

I would like to thank my family and friends for their unyielding support throughout the last few years. My parents, for their unwavering expressions of pride and their encouragement, and my sisters for keeping me sane. To my flatmates and Marloes, thank you for the laughter and the support. And, finally, to my fellow COSEM students Willemijn and Marthe, I would like to say thank you for making these past two years as fun as they were challenging.

Sabina van Driel
Amsterdam, August 2021

Executive Summary

As the threat of climate change continues to rise, society is put under an increasing pressure to produce less greenhouse gas emissions. However, the Netherlands is struggling to make progress in the energy transition, with only 8,6% of the final energy consumption being generated by renewables in 2019 (CBS, 2020b). To fix this renewable energy generation lag, it is crucial that a thorough understanding is created of how the energy system works, and what its drivers and barriers are. Among others, literature research shows that two of the biggest barriers for the generation of renewable energy are governmental policy as well as investments costs. The fact that governmental policy is one of the biggest barriers is extremely counter-intuitive as it is also one of the biggest drivers. Furthermore, although renewable energy generation requires substantially high investment costs, other countries have been able to overcome this barrier, which raises the question as to why this has not yet been the case for the Netherlands. Due to their contradictory nature and their high level of influence, the decision was made to focus on the two barriers by researching the relationship between governmental policy and the investment climate surrounding renewable energy generation. This was done by analysing the effectiveness of policy instruments on the investment climate for two specific technologies, namely small-scale solar photovoltaics (PV) and thermal energy from surface water (TEO). This led to the following research question:

How can policy measures create a good investment climate for small-scale solar photovoltaics and thermal energy from surface water in the Netherlands?

To answer this question, the multi-level perspective framework as described by Geels (2002) is used for a case study of the Netherlands to obtain information, from which a multi-criteria analysis is performed. This multi-criteria analysis measures the effectiveness of certain policy instruments according to a number of criteria that describe the risks associated with renewable energy investments.

Case study of the Netherlands

In 2019, the Climate Act was passed, which aimed to provide a legislative framework for the development of energy policy regarding the reduction of GHG emissions by setting a target to reduce 95% of the GHG emissions by 2050 compared to the 1990 emission levels. To achieve this, a safeguarding cycle was put in place, which consists of a Climate Plan that must be revised every five years, a Climate and Energy Outlook report that must be published annually, and the climate memorandum, which is to report on the progress of the policy written in the Climate Plan on an annual basis (Ministerie van EZK, 2019). The Dutch energy policy is characterised by its liberalisation policy and path dependencies that focus on security of supply and increasing energy efficiency. Although the Climate Act gives a more promising outlook on the Dutch energy transition, it is still unclear whether the Dutch government will be able to pick up the pace sufficiently enough to overcome previous policy choices and eventually reach its targets.

Results

The criteria that were assigned the largest weights are both financial criteria, as well as those related to policy and regulatory risks. The policy instruments that prove most effective for bettering the investment climate for small-scale solar PV and TEO are those that provide the highest financial support. Ranking the policy instruments from most effective to least effective, yields the following list: EIA, SDE++, ETS, GOs, energy tax and Climate Act for solar PV, and EIA, SDE++, ETS, GOs, Climate Act and energy tax for TEO.

Implication of results

The results are in line with previous findings in that they show that financial and policy risks are the most important criteria, and it therefore follows logically that the instruments that alleviate these risks the most score the highest. Looking back at the research question, it can thus be concluded that policy instruments are able to create a good investment climate for small-scale solar PV and TEO by decreasing the most important risks associated with renewable energy investments, which are financial and policy-related risks. It is recommended that market players use the discussed policy instruments to their advantage; the EIA and the SDE++, for example, can be combined to substantially lower financial risks, and the ETS and GOs can be used to generate more revenue and increase policy stability.

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Introduction

1.1. Problem introduction

The imminent threat of global warming is pressuring society to switch from fossil fuels to renewable energy in order to lower greenhouse gas emissions (Arent et al., 2011). As countries scramble to meet targets set in the Paris Agreement (2015), some quickly take the lead whilst others fall behind. According to Ludovico et al. (2020), the Netherlands can rightfully be considered one of the leading European countries in the energy transition. This statement is based on the fact that in 2019, the World Economic Forum (2019) awarded the Netherlands ninth place in the global Energy Transition Index (ETI), which is based on several parameters such as the current energy system performance and the transition readiness. Other sources, however, tell a different story.

According to Eurostat (2020), which is the EU statistical office, the Netherlands ranks second lowest when looking at its overall share of energy from renewable sources. It is not only the country that produces the second smallest share of renewable energy, but it also ranks second lowest in meeting their 2020 targets. Figure 2.1 shows the overall share of energy from renewable sources for every EU country. By 2020, the Dutch government aimed to have at least 14% of all consumed energy come from renewable sources, in 2030, the aim is at least 27% and, by 2050, it needs to be close to 100% (Rijksoverheid, n.d.). However, in 2019, only 8,6% of the final energy consumption was generated by renewables (CBS, 2020b).

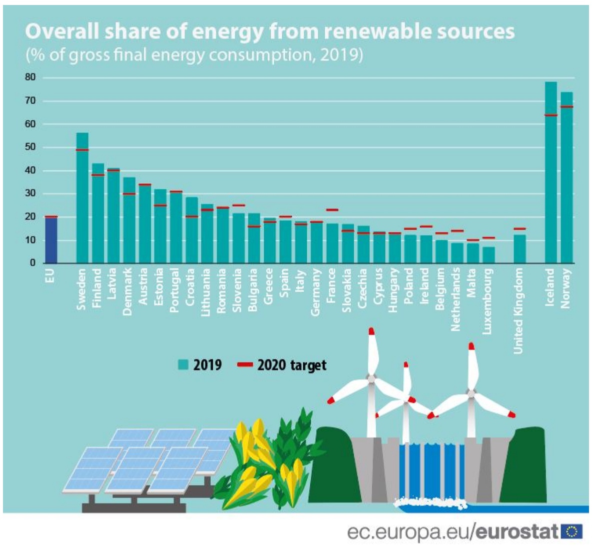

Figure 1.1: Overall share of energy from renewable sources per EU country (source: Eurostat (2020)).

Such contradicting perspectives raise the question of how it is possible that the Netherlands can rank ninth best on the global ETI, if it ranks second worst in generating renewable energy? One would think that in order to do well on the ETI, the country in question would also need to meet their own, as well as the EU's, targets for generating renewable energy. Taking a closer look at the ETI, some interesting observations can be made. First of all, the Netherlands ranks ninth in the world for Energy Access & Security; second, it ranks an astounding sixty-third place for Environmental Sustainability;

third, it ranks highest in the world for Infrastructure & Innovative business environment; and fourth, it ranks eighty-fifth for Energy system structure. This shows how well the Netherlands does in certain areas and could also be construed as showing further high potential. Nonetheless, the question remains as to why the Netherlands is producing so little renewable energy.

Previous research has shown there to be a number of answers to this question, such as that the Netherlands has previously always relied heavily on natural gas, which makes the transition to renewables more challenging (Deloitte, 2015), and that the investment costs are too high (IEA, 2020a). There are also a number of reasons why the Netherlands should be performing better: it is one of the richest countries in the world and has the world's most favourable infrastructure and innovative business environment (World Economic Forum, 2019). It is thus of interest to gain a more detailed understanding of the renewable energy generation in Netherlands by researching its drivers and barriers. To do this, an initial focus is laid on researching both governmental and market-based drivers and barriers, to not only research what exactly they are but also to research whether there is some kind of overlap, i.e., how they influence each other.

1.2. Literature review

The following section contains a literature review which analyses the numerous drivers and barriers in Dutch renewable energy generation. From this, a knowledge gap in the available literature is identified. A research question is subsequently devised to fill this knowledge gap. The methods as to how the relevant literature is found is discussed below.

1.2.1. Methods

The purpose of this literature review is to give an objective and scientifically accurate account of the policy-related drivers and barriers in the Dutch energy transition. To achieve this, searches are conducted on several databases such as Scopus, Google Scholar, the TU Delft Library and Web of Science. The search terms used can be found in Table 1.1, ranked according to which search type they belong. After using the search terms as shown below, further searches are done using the same terms with the addition of the words driver, barrier, and failure. The snowballing method is additionally used to find relevant literature. Articles are selected on the basis of their relevance, number of citations, publication year and overall quality. A total of 15 scientific articles were used for the literature review. A summary of the assessment of the numerous drivers and barriers found during the literature study can be found in Appendix A, and are further elaborated in the following section.

Search type	Search terms
General	- Dutch energy transition
Governmental policy	- sustainability policy Netherlands
	- sustainable policy Netherlands
	- energy transition Netherlands
	- role of Dutch government in energy transition
Market-based	- role of corporates in Dutch energy transition
	- role of energy suppliers in Dutch energy transition
Societal	- role of society in Dutch energy transition
	- roles of citizens in Dutch energy transition

Table 1.1: Search terms used for literature review.

1.2.2. Assessment of the drivers and barriers of the Dutch energy transition

This section describes the findings of research done on the drivers and barriers of the Dutch energy transition. For both the drivers as well as the barriers, the findings are split into three categories: governmental, market-based, and societal. Within these three categories, numerous drivers and barriers have been found, a summary of which can be found below.

Drivers

When looking at the drivers for the Dutch energy transition, literature leans heavily towards governmental policy as being one of the most important enablers in the energy transition (IEA, 2020a, 2020b). The Climate Agreement is seen as the driving force for achieving EU targets (IEA, 2020b), with the EU directives also being seen as a key driver (IEA, 2020a). Further governmental drivers include the EU Emission Trading System (Deloitte, 2015), the energy efficiency policy (Deloitte, 2015), subsidy schemes (Jansma et al., 2020), tax exemption schemes (Backhaus, 2019), the creation of awareness (Ministry of Economic Affairs, 2016) and the encouragement of cooperative-based projects (Ministry of Economic Affairs, 2016).

Market-based drivers consist of new entrants that compete against incumbent actors (Verbong & Geels, 2007), the creation of jobs (Bulavskaya & Reynès, 2018), as well as increasing awareness (Verbong & Geels, 2007) and participating in cooperative-based projects (Backhaus, 2019). An important aspect of these drivers is that they should lead to an increase in market demand for renewables.

Barriers

Although governmental policy is often mentioned as one of the key drivers in the Dutch energy transition, it is also starting to emerge as one of the key barriers. As Dutch energy policy is prone to changes (Kemp & Rotmans, 2009), a stable investment climate cannot be achieved, which stops people from investing in renewables (Bosman et al., 2014). Literature furthermore mentions that numerous policy mechanisms are seen as faulty as they often contain loopholes or are not full-heartedly implemented (Deloitte, 2015). Besides policies, regulation is also mentioned as another governmental barrier (Bosman et al., 2014).

Market-based barriers are often mentioned in the literature and are therefore recognized as weighing heavily. Rather than frontrunners, incumbent actors continue to dominate the sector, which significantly slows down progression (Kern & Howlett, 2009). A crucial barrier is the Netherlands' dependence on natural gas; the Netherlands is the second largest natural gas exporter in the world; in 2012, 64% of final energy consumption relied on natural gas (Deloitte, 2015). Due to the need to phase out gas, the Netherlands will become heavily reliant on other countries for energy, which is not only politically challenging but also economically unfavourable, as it causes a significant drop in government revenue as well as requiring further investments and long-term decisions (Deloitte, 2015). Whilst other countries tend de use natural gas as an intermediate step towards the phasing out of coal, the Netherlands will need to use a different energy source to support its energy transition (Akerboom et al., 2020). The last market-based barrier encompasses the investment costs, which are seen as one of the most obvious barriers in the energy transition (IEA, 2020a). Due to shifts in policy, an unattractive and uncertain investment climate is created, making companies hesitant to invest in renewables (Verbong & Geels, 2007). Although a faulty investment climate exists in a market, it derives from flawed policy. According to (Kern & Howlett, 2009), the government's liberalisation policy ultimately reduces reserve capacity, leads to underinvestment in new capacity, reduces R&D investment and leads to short-term strategies of energy companies. Transition experiments furthermore focus on cost effectiveness and potential economic success, also labelled as "strength of market demand", which is counterproductive seeing as more radical innovations that could lead to system changes often have no pre-defined market (Kern & Howlett, 2009). This makes it difficult for them to break through and diffuse more generally, which is thus what is happening with renewables in the Netherlands (Kern & Howlett, 2009).

1.3. Knowledge gap

Looking at the above analysis, it becomes clear that there is substantial literature on the subject of drivers and barriers for the Dutch energy transition. However, there are some drivers and barriers that weigh much heavier than others and it is furthermore evident that there are far more drivers than there are barriers. As mentioned in the problem statement, the Netherlands continues to be one of the countries with the lowest percentage of renewable energy generation as well as one of the countries that is furthest from meeting its targets. The question thus remains, if there are so many drivers for the energy transition, why does the Netherlands not generate more renewable energy? The literature review identified two crucial barriers, namely that of governmental policy and investment costs. Interestingly enough, governmental policy was also labelled as one of the main drivers. It is understandable that investment costs would pose as a barrier, however, as mentioned in the problem statement, there are more than enough other countries that have overcome this barrier.

Although there is substantial literature on the subject of how governmental policies pose as a barrier to the Dutch energy transition, a knowledge gap is identified as to how exactly the policies are able to influence the energy sectors' investment climate, and through which policy instruments. How policies influence the ability for market players to make good investments in RE technologies is often discussed from an extremely broad point of view, or by analysing only one policy instrument. This thesis will therefore focus on researching how governmental policies aid in creating a more positive investment climate by researching the relationship between the policy makers and market players, as well as analysing the effectiveness of numerous crucial instruments implemented in the Netherlands.

1.4. Research objective and research questions

1.4.1. Research objective and scope

Seeing as the Netherlands is falling behind in RE generation, it is important to look at why this is and how it can be overcome. From the literature review, it was found that policy and investment costs are two of the greatest barriers in the Dutch energy transition. The objective of this thesis is to explore the relationship between these two barriers by *analysing how governmental policies influence the investment climate for RE generation.* From this analysis a recommendation will be given for companies as to which policy instruments are the most effective and can therefore best be used to invest in new projects.

There are many different technologies and many different policy instruments that can be applied per technology, however, this thesis will focus on two technologies, namely small-scale solar PV and thermal energy from surface water (TEO in Dutch). The reason for choosing these two technologies is because whilst the technologies are vastly different, there are a number of policy instruments that can be applied to them both which means they are easier to compare to one another. Besides differing from a technological aspect, the niches are in opposing stages of development: whereas solar PV has existed in the Netherlands since the 1990s (Verhees et al., 2013), TEO is a relatively new and small niche. It is therefore of interest to see if these differences in stages influence the effectiveness of the policy instruments. It is important to note that in this thesis, the term *market players* can be understood to mean large energy companies with over 1000 employees situated in the Netherlands, such as Eneco, Vattenfall and ENGIE. The terms *market players*, *(energy) firms (energy) businesses* and *(energy) companies* will furthermore be used interchangeably throughout this thesis.

1.4.2. Research questions

From the research objective and the analysis of the knowledge gap, follows the below research question:

How can policy measures create a good investment climate for small-scale solar photovoltaics and thermal energy from surface water in the Netherlands?

From this, the following sub-questions have been devised to aid in answering the main research question.

- SQ1: What policy measures are available to create a suitable investment climate and how can we assess their effects / performance?
- SQ2: What does the Dutch energy regime look like and what are the drivers and barriers regarding the investment climate of the energy transition?
- SQ3: How do policy measures influence the investment climate of renewable energy technologies?
- SQ4: How does the effectiveness of policy measures on the investment climate differ for solar PV and TEO in the Netherlands?
- SQ5: How can energy companies in the Dutch energy market better respond to governmental policy measures?

SQ1 is used as a basis to create an understanding of the different types of policy instruments available to influence the investment climate, and to find a way to measure how successful the measures are or have been. Having one of the most considerable influences on the investment climate, *SQ2* looks at the Dutch energy regime, and what its drivers and barriers are regarding the energy transition. From the analysis of the drivers and barriers, it can be concluded that governmental policy and investment costs are two of the most significant barriers, which is why the rest of the study will focus on how they can be overcome. *SQ3* will research the theory behind the relationship between policy measures and how investment decisions are made, after which *SQ4* will apply this theory on the chosen technologies in the Netherlands. Finally, *SQ5* will provide a recommendation based on the information assembled from the previous questions on how energy companies in the Netherlands can better use the policy instruments to their advantage when investing in RE technologies.

1.5. Research approach

As previously mentioned, this research will analyse a complex socio-technical issue which focuses on the Dutch investment climate with regards to its energy transition. It will be of a qualitative nature, and therefore consist of qualitative research methods. Keeping the research objective in mind, it is important that the context of the Netherlands is first understood before analysing the effectiveness of the policy measures. The use of the MLP in this thesis will thus be twofold: to firstly aid in understanding the context of the Dutch energy transition, and, secondly, to gain information that is to be used in the MCA. This means that the research will start off with an exploratory case study approach, which is used to 'gain an understanding of the issue in real life settings and recommended to answer how and why or less frequently what research questions' (Harrison et al., 2017). Once the relevant information has been found, an MCA will be performed.

1.6. Research method

The following section describes a short methodology per research question. A more in-depth description of the MCA methodology will be described in Chapter 4.

SQ1: What policy measures are available to create a suitable investment climate and how can we assess their effects / performance?
The answering of this research question consists of two parts: identifying the policy measures and finding a method to assess their effectiveness. The former will be answered through a literature review, looking not only at scientific literature but also at grey literature. The search terms to be used will consist of a combination of the words socio-political, policy measures, policy AND investment climate, investment costs AND renewable energy generation, energy transition, sustainable energy. Once the policy measures have been found, the multi-criteria analysis method used to assess their effectiveness will be chosen and executed.

SQ2: What does the Dutch energy regime look like and what are the drivers and barriers regarding the investment climate of the energy transition?
This section will provide the basis for understanding what the Dutch energy sector looks like at the hand of the MLP. The information will be retrieved from a literature study and will be a subsection in the MLP chapter, consisting of an explanation of the drivers and barriers within the regime. The search terms to be used will consist of a combination of the words Dutch, the Netherlands AND energy AND sector, regime, actors AND/OR drivers, incentives AND/OR energy transition, renewable energy generation, investment climate.

SQ3: How do policy measures influence the investment climate of renewable energy technologies?
In this section, the theory behind how policy measures are able to influence investment decisions will be researched. The theoretical framework will be built upon the adjusted MLP and by using the key concepts as defined in SQ1. Data will be collected through literature research. Once this is done, the data will be analysed, and the sub-question discussed as part of the MLP chapter.

SQ4: How does the effectiveness of policy measures on the investment climate differ for solar PV and TEO in the Netherlands?
For this question, an MCA will be performed. This will be done by comparing a number of policy measures against a number of criteria, for both small-scale solar PV as well as TEO. Seeing as different criteria carry different weights, the weights will be calculated by using the Best-Worst Method (BMW). The ranking of the weights will be done by a number of experts, who will be chosen based on their expertise in the field of investment decisions for RE generation. Once the weights have been determined, the effectiveness of the policy instruments will be calculated using the weighted summation method (WSM), after which the differences per technology will be discussed. A more detailed explanation of the MCA can be found in Chapter 4.

SQ5: How can energy companies in the Dutch energy market better respond to governmental policy measures?
Once the effectiveness of the different policy measures has been calculated and analysed, a recommendation will be made for energy companies in the Netherlands as to which policy instruments they can best use to their advantage to create a better investment climate. This recommendation will analyse the differences in effectiveness between the instruments, as well as how they can best be used.

2

Literature Review / Investment Climate from a Multi-Level Perspective

In this chapter, a literature review on the theoretical framework of the MLP is performed. Section 2.1 will analyse the MLP as defined by Geels (2002). Section 2.2 will discuss the investment climate, as well as what defines a good investment climate. Section 2.3 discusses the analytical framework which combines the MLP and the investment climate.

2.1. The Multi-Level Perspective

When analysing the transitions in a system as complex as that of the Dutch energy transition, which impacts both social and technical components, it is beneficial to approach the issue from a multi-layered systems perspective, also known as the Multi-Level Perspective (MLP). The MLP builds upon the importance of radical innovations, whilst creating an understanding of how numerous social groups, such as policy makers and energy market players, engage in activities such as investment and goal-setting, that trigger socio-technical transitions in the context of rules and institutions (Geels, 2019). The MLP identifies three analytical levels, who's interactions drive system transitions: the socio-technical landscape, the socio-technical regime and the niche-innovations (Geels & Schot, 2007).

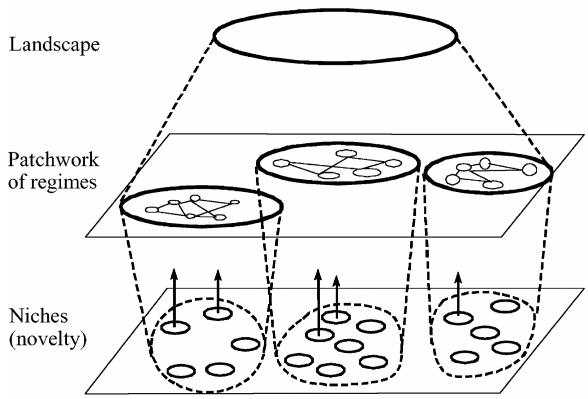

Figure 2.1: (Static) Multi-Level Perspective (Geels, 2002).

- **Landscape (macro-level):** The landscape forms an exogeneous environment which stands above the direct influence of niche and regime actors, and consists of broader political, economic and demographic trends (Geels & Schot, 2007). Changes at the landscape level usually take place slowly, but can also be triggered by faster-changing 'shocks' such as elections, economic crises, and wars (Geels et al., 2017).
- **Regimes (meso-level):** Regimes are established systems consisting of incumbent actors who are guided by deeply rooted rules and institutions to contribute to the patterning of technological development (Geels & Schot, 2007). These systems are developed over decades, making them path-dependant and resistant to change as the actors aim to maintain, defend and incrementally improve the existing system (Geels et al., 2017).

- **Niches (micro-level):** Niches form the layer in which radical novelties emerge, which are initially unstable sociotechnical configurations with low performance (Geels & Schot, 2007). Seeing as the novelties are radically different from the dominant existing regime, the niches act as a protective environment against the mainstream market selection so that they can eventually gain a foothold in particular geographical areas or market niches (Geels et al., 2017). These niche-innovations are furthermore carried and developed by small networks of dedicated actors (Geels & Schot, 2007).

Over time, transitions are able to take place through the alignment of processes within and between these three levels. These processes consist of an increasing momentum of niche innovations, the weakening of existing regimes, and the strengthening of exogenous pressures. Once aligned, the processes can create windows of opportunity, enabling the adoption of new technologies as well as the inclusion of investment in new infrastructures, establishment of new markets, development of new social preferences, and adjustment of user practices (Geels et al., 2017). A dynamic structure of the three levels and how they influence each other can be seen in Figure 2.2.

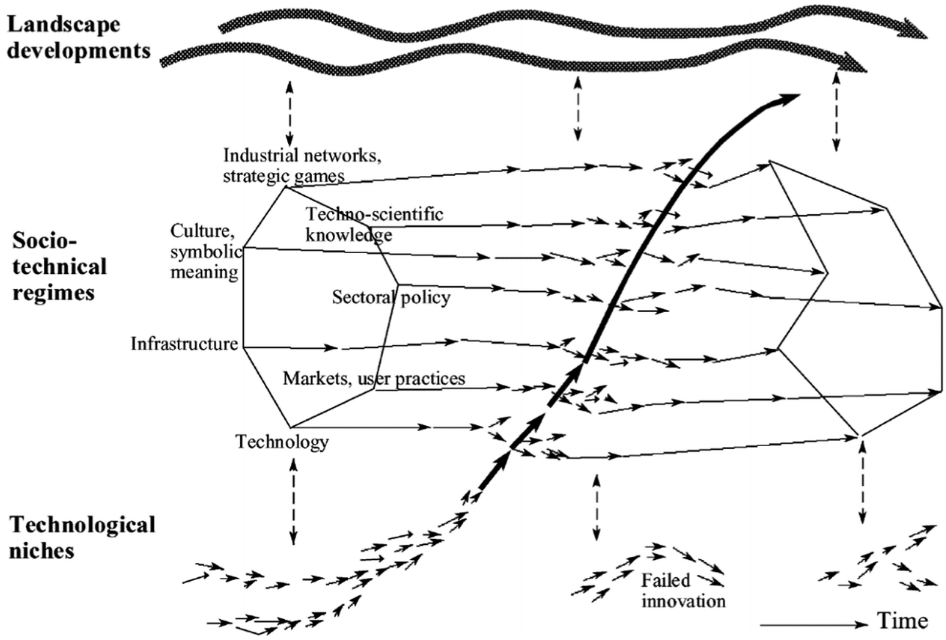

Figure 2.2: Multi-Level Perspective on transitions (adapted from Geels and Schot, 2007, p. 401).

Although the MLP is an excellent tool for understanding change processes, scholars argue that the framework says less about sustainability impact or outcomes (Gillard et al., 2016). Especially when assessing green innovations, they rarely address how much sustainability improvement is offered and whether or not this improvement is significant enough (Geels, 2019). Further criticism of the MLP states that the framework insufficiently analyses policy-relevant dimensions and processes (Weber & Rohracher, 2012). Because of this, many scholars have chosen to adjust the framework, or add certain elements from various social sciences, or through modelling, for example, to create a more thorough understanding of certain transitions. Geels lists seven major points of criticism of the MLP, namely: (1) Lack of agency, (2) Operationalization of regimes, (3) Bias towards bottom-up change models, (4) Epistemology and explanatory style, (5) Methodology, (6) Social-technical landscape as residual category, and (7) Flat ontologies vs. hierarchical levels (Geels, 2011). Geels (2011) subsequently gives a number of suggestions on how to best overcome these limitations. Looking at transition research, for example, Geels (2011) suggests that it could benefit from using other methods such as comparative or nested case studies, event-sequence analysis, network analysis, even-history methods, and agent-based modelling.

2.2. Investment climate

Literature shows that there is no one way to define the term ‘investment climate’. In general, however, it consists of a combination of factors such as the socio-political climate, macroeconomic and financial factors, which can be described using a number of criteria (IFC, 2016). These criteria include regulation of economic life, the quality of the tax system and the tax burden, the level of development and the availability of infrastructure, the availability of credit, political stability and predictability, and can be assessed as ranging from favourable to unfavourable (IFC, 2016). Per sector, the criteria that define a functioning investment climate differ greatly.

Looking specifically at the energy sector, there are a number of characterising criteria that negatively impact investment decisions. According to Bergek et al. (2013), the evaluation criteria that influence RE investors are capital costs, perceived (market) uncertainty and political risk. Other scholars have additionally identified regulatory risks and the streamlining of the administrative process (grid access) as relevant decision criteria (Friebe et al., 2014; Lüthi & Prässler, 2011; Lüthi & Wüstenhagen, 2012). Chassot et al. (2014) confirm the importance of these criteria and emphasize the weight of the perceived risk caused by policies. Polzin et al. (2015) furthermore adds uncertainty regarding long-term viability of the technology, long payback periods, and public acceptance to the list, the last of which is similar to market uncertainty. From this, the following list of criteria can be identified:

- Capital costs
- Regulatory risks
- Policy risks
- Uncertainty long-term viability of the technology
- Long payback periods
- Public acceptance

2.2.1. A good investment climate

According to the World Bank (2004), a good investment climate is not just about generating profits for businesses, it is also about improving outcomes for society as a whole. Businesses tend to assess investment opportunities and related government policies and behaviours as part of a package, and the investment decisions they make reflect their expectations about the future, as well as current conditions (World Bank, 2004). Because of this, it is essential for policy makers to foster credibility and stability. A good investment climate thus encourages businesses to invest in new technologies by reducing unjustified costs, (government-related) risks, and barriers (World Bank, 2004). It furthermore also fosters competitive processes that Schumpeter called ”creative destruction” - companies test their ideas, strive for success, and prosper or fail (World Bank, 2004). A good investment climate makes it easier for firms to enter and exit markets in a process that contributes to productivity improvement and growth (World Bank, 2004). Looking at the energy sector, this is achieved by implementing policy such as the liberalisation of the market. Public acceptance is a crucial part of a good investment climate - good investment climates are nurtured by broad public support, by a social consensus that can support ongoing policy improvements regardless of the political party or group in office (World Bank, 2004). Finally, a good investment climate enables companies to expand, take advantage of international openness, and allow them to climb the technological ladder (World Bank, 2004).

2.3. Analytical framework

Literature on energy policy emphasises that because RE production is not yet competitive with conventional energy, in order to promote RE production, policy measures that level the playing field are needed to create a more attractive investment climate (Mignon & Bergek, 2016). According to Mignon and Bergek (2016), “no binding targets, no active policies and reliable instruments mean no markets.” Many researchers, such as Barazza and Strachan (2020), argue that it is crucial to take into account how the political and market players’ dimensions interact with one another in the transition of the energy sector. The purpose of this interaction is to create good energy policy to create incentives and get prices high enough so that market players make profitable investments and then further invest in RE technologies, but not so high so that the transition is exceedingly expensive for the government, the market players, and the consumers (Barazza & Strachan, 2020). This balance is in continuous movement, characterised by feedback loops as can be seen in Figure 2.3, which is a proposed combination of Geels and Schot’s (2007, p. 401) traditional MLP and Barazza and Strachan’s (2020, p. 5) framework, which is used to model the co-evolution of the electricity market structure, policies and investments.

As can be seen in Figure 2.3, policies affect investment decisions made by market players indirectly through four different elements: the energy regime, an NPV calculation, imitation and path-dependency. An NPV calculation captures the total value of an investment opportunity by looking at heterogeneous expectations of future cash flows, and imitation refers to scenarios in which market players see the growth of other market players and choose to imitate their investments (Barazza &

Strachan, 2020). This imitation is an essential part of competition, which encourages businesses to improve their efficiency more than customers, shareholders, or governments do (World Bank, 2004). Research shows that businesses that report strong competitive pressure are at least 50% more likely to innovate than those reporting no such pressure (World Bank, 2004). Finally, the path-dependency of investment decisions are taken into account, seeing as the performance of past investments influences future investment decisions taken by the market players (Barazza & Strachan, 2020).

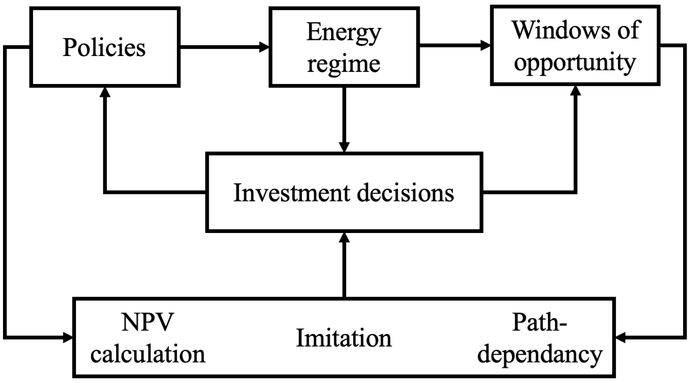

Figure 2.3: Investment climate within the socio-technical regime level of the multi-level perspective.

The reason for using Barazza and Strachan's 2020, p. 5 framework is not only because it is specifically designed to analyse how energy policy and investment decisions affect one another, but because it can be easily adjusted to fit in the regime level of the MLP. The proposed framework has critical components of the MLP, such as the policy and energy regimes, as well as the windows of opportunity. Additionally, the different loops between the elements show the dynamic aspect of system. In this case, the windows of opportunity are created by a good investment climate; if a good investment climate exists, it becomes possible for new technologies to break through and become a part of the new regime. The proposed framework is furthermore useful because, like the MLP, it can be used to provide a structured manner to analyse the differences between how numerous policy instruments work, and how they aid in created a good investment climate. As stated in Section 2.2, there are a number of different factors that define a good investment climate. Ideally, all of these factors are present in the investment climate for RE generation. However, it is important to keep in mind that only a few of these factors can be achieved through the influence of policy instruments, which is why when one speaks of a ”good investment climate”, it is more realistic to say a ”better investment climate”, consisting of a number of effective policy instruments.

Looking at literature on energy policy, it has been highlighted that policy can affect investments, or in this case the investment criteria, in two different ways. This can either be by imposing investors to invest, e.g., through mandatory targets or quota obligations, or by inducing investors to invest, e.g., through subsidies, or fixed feed-in prices (Mignon & Bergek, 2016). Imposing-type investments are made due to a change in policies, which is perceived as a burden or an undesired source of expenses by investors, whereas inducing-type investments are perceived as an opportunity or are realised due to a change in regulatory or incentive policy (Mignon & Bergek, 2016). Placing the two types of investments in the above proposed framework, imposing type-investments are those directly between policies and the energy regime, and inducing-type investments are between policies and the triggers for investments, i.e., NPV calculation, imitation and path-dependency.

According to Polzin et al. (2015), literature that analyses the relationship between energy policy and RE production has identified four different types of policy measures that influence investments in RE production. First of all, fiscal and financial incentives can be provided. Feed-in tariffs (FIT) have been known to be a superior tool to incite RE production and technological diversity, by lowering risks for investors (Bolkesjø et al., 2014). Grants and subsidies can be provided to not only help with overcoming high capital costs, but also to reduce overall costs for RE development (Bergek et al., 2013). Government loans or loan guarantees can additionally be used for a more long-term approach (Bergek et al., 2013) as well as tax-based incentives (Barradale, 2010). The second type of incentives are market-based instruments such as carbon cap and trading systems, such as the previously mentioned ETS (Rogge et al., 2011), and the tradability of green certificates (Jensen & Skytte, 2002). Third, policy makers are able to provide funds to local authorities such as sub-national governments, or directly invest in complementary assets such as infrastructure (Polzin et al., 2015). Fourth, investment decisions can be influenced by policy instruments that do not have a direct impact on the risk and return structure of RE production (Polzin et al., 2015). Literature has found that surrounding institutions can be a major incentive, which means that foreseeable changes to regulations and policy consistency are crucial to investing in long-term RE projects (White et al., 2013). According to the World Bank (2004), reducing government-related risks can increase the probability of making new investments by more than 30%. Therefore, although liberalisation is currently a preferred energy policy in the EU, stable regulatory measures are needed to stimulate the energy market so that market failures are avoided and path dependencies can be overcome (Polzin et al., 2015). From this, the following list of policy instruments can be identified:

- Feed-in tariffs
- Grants
- Subsidies
- Government loans
- Tax-based incentives
- Cap and trade systems
- Green certificates
- Direct investments
- Policy consistency
- Stronger regulation

Seeing as this thesis aims to research what the effect is of policy instruments on the investment climate for RE generation, an analysis will be made between the above instruments and the criteria pertaining to the investment climate. Assembling the instruments and criteria results in a matrix as can be seen in Table 2.1. In order to solve this matrix, a multi-criteria analysis will be performed.

	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Feed-in tariffs						
Grants						
Subsidies						
Loans						
Tax-based						
Cap and trade						
Green certificates						
Direct investments						
Policy consistency						
Stronger regulation						

Table 2.1: Matrix of the investment climate criteria versus the policy instruments.

The above list of policy instruments was derived from general literature on the effect that policy instruments can have on the investment climate. This thesis consists of a case study of the Netherlands, which means that further research will have to be done to see which instruments are currently implemented by the Dutch government. The chapter on the MLP framework will thus not only explain the characteristics of the Dutch energy regime, but also devise a final list of alternatives to be used in the matrix.

3
Case Study of the Netherlands

This study focuses on the investment climate of renewable energy generation in the Netherlands. In this chapter, the MLP is used as an explanatory tool to perform a case study of the Netherlands to obtain information about the energy sector. This information will further be used to perform the MCA. Section 3.1 describes the landscape developments, after which Section 3.2 describes the socio-technical regimes and Section 3.3 describes the solar energy and thermal energy from surface water niches. Finally, Section 3.4 describes the final matrix to be used for the MCA.

3.1. Landscape developments

Although the Netherlands is relatively small in size and is one of the most densely populated countries on Earth, it has an extremely rich and competitive economy (IEA, 2020a). In 2018, the Netherlands had the 17th largest economy in the world and, in 2018, it ranked fourth in the World Economic Forum's Global Competitiveness Report (IEA, 2020a). Just like every other country in the world, it is currently facing enormous environmental challenges to reduce GHG emissions due to climate change. Although economic and environmental factors play an important role in the Dutch energy transition, the most influential pressures that are destabilising the energy regime are the global policy pressures and the geographical developments, which will be further explained below.

Global policy pressures
The climate change movement started to gain momentum in 1995 when the Third Energy White Paper was written, signalling the first Dutch renewable energy policy in which the first targets were set for energy conservation and renewable energy generation. Global pressures increased when the Kyoto Protocol was reached in 1997, which signified the beginning of international cooperation on climate change (Barrett, 1998).

In 2013, the climate change movement gained real momentum in the Netherlands when the Energy Agreement for Sustainable Growth was reached(Ministry of Economic Affairs, 2016). The principal goal of the Dutch energy policy was to create a safe, reliable, and affordable energy supply for the public and businesses. Whilst this is still, to this day, their main goal, global pressures to become more sustainable have increasingly been destabilising the energy regime . In December 2015, the Paris Agreement was reached, in which the Netherlands and other European Member States made several international agreements on reducing GHG emissions (Ministry of Economic Affairs, 2016). The target for 2030, for example, is a reduction of a minimum 40% in comparison with 1990 levels (Ministry of Economic Affairs, 2016).

Geographical developments
There are two main geographical characteristics that are crucial to the development of the Dutch energy system, namely that of the Groningen field and the Netherlands' relationship with water. In 1959, the Groningen natural gas field was discovered, which quickly became an essential part of the Dutch energy sector, not only as a nationally consumed energy source, but it has also provided a crucial stream of income for Dutch companies as well as the State. However, in January 2018 and May 2019, natural gas production activities caused earthquakes in Groningen (Ministry of Economic Affairs, 2016). Because of this, the Dutch government decided to aim to end gas production from Groningen by mid-2022 (IEA, 2020a). This development had, and will continue to have, a tremendous impact on both the security of energy supply and the national treasury, strongly reiterating the need for renewables.

The Netherlands has an extremely pressing, although impressive, relationship with water. Not only does it have a coast line of 451 km on the North Sea, around 19% of the countries' area consists of water (CBS, 2016). Roughly one-third of the Netherlands is located below average sea level, whilst another one-third has to be protected against flooding by rivers in periods of high discharges (VanKoningsveld et al., 2008). The rising of the sea-levels due to the heating of the Earth form a threat to low-laying countries such as the Netherlands, further increasing the need to lower CO_2-emissions and generate more renewable energy. As RE technologies continue to develop around the world, the possibilities to use water for RE generation in the Netherlands also grows. Although it cannot use water for hydropower, due to its abundance there is a substantial potential for the implementation of numerous aquathermal technologies.

3.2. Socio-technical regimes

3.2.1. Policy regime

Short history of the Dutch energy policy

The Dutch renewable energy policy started in 1995 by means of the 'Derde energienota', also known as the Third Energy White Paper, in which the first targets were set for energy conservation and renewable energy generation: by 2021, energy efficiency must be improved by 25% and 10% of generated energy must be from renewable sources (EZ, 1995). The memorandum furthermore focussed on policy instruments such as internationalisation and liberalisation (EZ, 1995), which can be regarded as working simultaneously due to the fact that the EU initially proposed the liberalisation policy, which was then adopted by the Netherlands (PBL et al., 2017).

The first steps of the Dutch liberalisation were made in the electricity supply sector, which consisted of separating the electricity generators, network operators and suppliers (PBL et al., 2017). Here, the question was raised whether or not electricity should only by generated by Dutch companies, but the choice was eventually made that foreign companies would be able to produce electricity for the Netherlands, as long as the network companies remained in Dutch hands (PBL et al., 2017). The second choice that was made was that network operators should remain public property instead of being privatised. The separation of supply and network operators was further implemented than was demanded by the EU, which caused a societal and political discussion as people urged the government to take on a stronger overseeing role with clearer laws (PBL et al., 2017). The Electricity Act of 1998 was passed to further the liberalisation agenda, which meant that numerous producers and suppliers were able to offer electricity and that consumers had the ability to choose their own supplier (Netbeheer Nederland, n.d.).

The Gas Act of 2000 ensured that numerous gas suppliers could be active on the gas market (Netbeheer Nederland, n.d.). The liberalisation of the gas sector, however, proved to be more of a challenge, seeing as natural gas was, and remains, an important source of income for the Dutch treasury. Thus, although the reason for liberalisation was to benefit consumers, in the case of natural gas, it was apparent that liberalisation policy should not hinder the treasury (PBL et al., 2017). The choice was made to separate the 'Gasgebouw,' which is now a public-private partnership between the Dutch government, Shell and ExxonMobil in the extraction and selling of natural gas (PBL et al., 2017). Initially, the policy on gas focused predominantly on obtaining government income and facilitating the energy-intensive industry. Seeing as the Netherlands was not only the biggest European gas producer but was, and still is, a key player in the purchasing and selling of gas, in 2005, the government decided that they had the ambition to become the main European hub for the transportation, storage and transit of natural gas, also known as the 'Gasrotonde' (PBL et al., 2017). However, seeing as the extraction of natural gas has had to be scaled back due to the earthquakes in Groningen, a bigger focus has currently been laid on the further development of the natural gas hub, which could potentially be transformed into a hydrogen gas hub at a later stage (PBL et al., 2017).

The first few years after the Third Energy White Paper consisted of a trial-and-error search for the best way to promote renewable energy generation, which resulted in the implementation and abolishment of a number of instruments. Initially, tax incentives were created for consumers to purchase renewable energy. This, however, proved to be unsuccessful as it did not incentivise extra renewable energy generation in the Netherlands. From 2003 to August 2006, the MEP subsidy scheme was implemented, which allowed renewable electricity producers to apply for a subsidy (CBS, n.d.). This subsidy was generally awarded for a period of ten years (CBS, n.d.). In August 2006, due to the flood of applications, the Minister of Economic Affairs stopped the scheme for new applications as it threatened to become out of control budget-wise (CBS, n.d.). In April 2008, the Stimulation of Sustainable Energy Production and Climate Transition (SDE) subsidy scheme was introduced, which differs from the MEP in that it also offers a compensation for the supply of green gas to the gas network (PBL et al., 2017). Since then, the SDE has been replaced by the SDE+ and the SDE++.

In September 2013, the Energy Agreement for Sustainable Growth was reached between the Ministry of Economic Affairs and Climate Policy and, among others, employers, trade unions and environmental organisations (Rijksoverheid.nl, n.d.). This agreement focused on increasing energy efficiency, renewable energy generation and employment opportunities (Rijksoverheid.nl, n.d.). Finally, in June 2019, the Climate Agreement was reached, which will be further discussed in the following section.

Current energy policy

In May 2019, the Climate Act was passed, which aimed to provide a legislative framework for the development of policy regarding the reduction of GHG emissions ("Klimaatwet [Climate Act]", 2019). In this act, the following targets were set:

- The Netherlands must reduce 95% of the GHG emissions by 2050 compared to the 1990 emission levels,
- 49% of the GHG emissions must be reduced by 2030,
- By 2050, all electricity produced should be 100% CO2-neutral.

In order to monitor whether or not these targets are met, the Climate Act created a 'safeguarding cycle', for which the Minister of Economic Affairs and Climate Policy is ultimately responsible (Rijksoverheid, 2019). The first element in this cycle is the Climate Plan, which contains the outline of the cabinet's energy policy to be pursued for the next ten years (Rijksoverheid, 2019). The first Climate Plan was based on the Climate Agreement and was first published in 2019. The Climate Plan may be adjusted in 2021 and must additionally be revised at least once every five years (Rijksoverheid, 2019). Per EU regulation, the Netherlands must also submit a 10-year integrated national energy and climate plan (NECP) to the European Commission, which is similar to the national Climate Plan. The second element of the safeguarding cycle is the Climate and Energy Outlook (KEV), which is published by the Netherlands Environmental Assessment Agency (PBL) to provide a report of the actual as well as forecasted CO2-emissions (Rijksoverheid, 2019). The first KEV was published in 2019 and will continue to be published on a yearly basis. Finally, the third element of the safeguarding cycle, namely the climate memorandum, is to report on the progress of the policy written in the Climate Plan (Ministerie van EZK, 2019). This memorandum is to be submitted to the House of Representatives annually together with the KEV (Ministerie van EZK, 2019).

Looking at the goals for the generation of renewable energy, the EU Renewable Energy Directive states that each Member State should achieve a 32% share of renewable energy by 2030 (Ministry of Economic Affairs and Climate Policy, 2019). However, the European Commission has indicated a 26% share to be reasonable for the Netherlands, to which the Netherlands responded by saying they aim to achieve an ambitious 27% share by 2030 (Ministry of Economic Affairs and Climate Policy, 2019). According to the KEV2019, the Netherlands will be able to achieve a 25% share of renewable energy in 2030, not taking into account a number of measures that should help achieve this goal such as planned offshore wind parks. All in all, taking the extra measures into account, a 27% share should still be achievable.

Policy instruments

The following section identifies the main policy instruments deployed by the Dutch government to incentivise companies to invest in renewable energy generation.

Feed-in tariffs

A feed-in tariff (FIT) essentially consists of offering guaranteed prices for fixed periods of time for electricity produced from RE sources (Couture & Gagnon, 2010). These prices are usually offered for every kWh of electricity produced and can be differentiated according to the type of technology, the size of the installation, the quality of the resource, the location of the project, as well as a number of other project-specific variables (Mendonça, 2012). This has a positive impact on the investment climate because it enables a greater number of investors to participate whilst simultaneously stimulating RE deployment in a wide variety of different technology classes (Couture & Gagnon, 2010). In the past, FITs have been considered one of the most effective policy instruments for RE deployment, as they have consistently delivered new RE supply more effectively, and at a lower cost, than alternative policy mechanisms (Couture & Gagnon, 2010).

In the Netherlands, FITs are applied in the SDE++ subsidy scheme. The SDE++ is an operating (feed-in tariff) subsidy, which means that RE producers receive a guaranteed payment for the energy they generate from RE sources (Netherlands Enterprise Agency, 2020). Because RE production is not always profitable, the SDE++ subsidises the 'operating shortfall', which is the difference between the cost price of the technology and the market price of the energy product, also known as the 'base amount' and the 'correction amount', respectively (RVO, n.d.-b).

Small-scale solar PV

In the Netherlands, the smallest category for solar PV generation is "building-installed, ≥ 15 kWp and <1 MWp". From the SDE++ scheme, the following information can be found regarding the techno-economic parameters of this category of solar PV panels. The reference system is building-installed system with a capacity of 250 kWp.

Parameter	**Unit**	**SDE++ Advice 2021**
Size of installation	[MWp output]	0,25
Full-load hours years 1-15 (years 16-20)	[MWh/MWp/year]	900 (845)
Investment costs	[€/kWp output]	590
Fixed O&M costs	[€/kWp output/year]	15,8
Variable O&M costs	[€/kWh]	0,0019
One-time maintenance costs in year 12	[€]	4250
LCOE	[€/kWh]	0,0724
Economic lifetime	[year]	20
Duration of subsidy	[year]	15

Table 3.1: Techno-economic parameters of small-scale solar PV (source: (Lensink et al., 2021)).

Thermal energy from surface water
In the Netherlands, there are two categories for TEO, with and without baseload. The TEO with the baseload has a higher number of full-load hours than without the baseload, which can happen when the TEO is connected to a larger heat network in which the heat pump at baseload. The choice was made to look at the TEO with baseload, as the assumption is made that it will be connected to a larger network, and therefore have a higher number of full-load hours. Due to the higher number of full-load hours, the setup is able to supply a larger amount of heat on a yearly basis. It is furthermore important to note that although TEO can extract both heat and cold, the SDE++ is only awarded to systems that extract heat due to the fact that cooling systems are seen as profitable and therefore do not need to be subsidised (Netherlands Enterprise Agency, 2020). From the SDE++ scheme, information regarding the techno-economic parameters of this category of TEO can be found in Table 3.2. The reference system has a capacity of 880 kW$_{th}$.

Parameter	**Unit**	**SDE++ Advice 2021**
Thermal power	[MW$_{th}$ output]	0,88
Full-load hours years	[hours/year]	6000
Electricity usage	[MWh/year]	1748
Investment costs	[€/kW$_{th}$ output]	2780
Fixed O&M costs	[€/kW$_{th}$ output/year]	198
Variable O&M costs	[€/kWh$_{th}$]	0,0019
LCOE	[€/kWh]	0,0918
LCOE at 300 €/t	[€/kWh]	0,0823
Duration of subsidy	[year]	15

Table 3.2: Techno-economic parameters of thermal energy from surface water (source: (Lensink et al., 2021)).

Tax-based incentives
Taxation incentives are financial incentives which aim to encourage RE generation through a number of different measures such as tax reductions, exemptions, deductions or allowances. In the EU, tax measures always occur in accordance with European Commission competition and environmental rules for the energy sector, which balances the needs for environmental protection and competition rules of the energy sector Cansino et al., 2010. In the Netherlands, there are multiple environmental taxes, such as the coal tax and the energy tax, that aim to reduce CO□-emissions as well as the amount of energy consumed. The main energy-based tax incentive is the Sustainable Energy Storage (ODE), which is an energy tax on the generation of natural gas and electricity (Belastingdienst, 0). Because the tax is applied to generation, the market prices for natural gas and electricity go up. The tax works in such a way that consumers are incentivised to use less power, but also to switch from natural gas to electricity, which has lower tax-rates and thus lower prices as it can be generated from renewable sources (Belastingdienst, 0). No energy tax needs to be paid for electricity which is generated from RE sources by the company itself, and it is possible to receive a tax return on electricity that was used to generate electricity in an installation that generates electricity solely from renewable energy and electricity sources (Belastingdienst, 0).

Besides energy-related tax incentives, there are also fiscal tax incentives for companies that invest in RE projects. The Energy Investment Allowance (EIA) allows companies to pay less tax on their investments by deducting 45.5% of the investment costs from their taxable profit (Netherlands Enterprise Agency, n.d.-a). The EIA requirements for the solar PV system is that it exists of multiple panels with a combined peak capacity of more than 15 kW, and are connected to the electricity grid via a connection with a total maximum transmission value of 3*80 A or less (RVO, 2021). To qualify for EIA with an investment in TEO, the system must use groundwater as a storage medium to store heat or cold which is then used for the heating or cooling of industrial buildings or processes, or the collective heating or cooling of houses (RVO, 2021).

Cap and trade systems
Around 450 companies in the Netherlands participate in the EU Emissions Trading System (ETS). Most participating companies receive an annual allowed quantity of emission rights for free, so that they can protect their international competitive position and prevent CO_2 emissions from moving to countries outside Europe without CO_2 regulations (NEA, 2015). For a full allocation of free emission rights, companies need to be able to prove that they produce energy both efficiently and CO_2 efficiently (NEA, 2015). Every year, the ETS companies must surrender the same amount of emission rights as the amount emitted. If a company emits more than it has the rights to, it must purchase additional rights through auctions or trade. If a company invests in RE measures and therefore emits less, it can sell the retained rights. The incentive thus works as such: companies can either invest in cleaner technology or buy additional emission rights at a higher price (NEA, 2015).

Green certificates
In 2009, the European Commission passed Directive 2009/28/EC, which aims to provide guarantees of origin (GOs) for the generation of renewable energy. This way, consumers can be sure to know that a given share or quantity of energy was produced from renewable sources. These certificates can be transferred, independently of the energy to which it relates, from one holder to another (Ragwitz et al., 2009). From this, a green certificate trade system was born, also known as the Renewable Energy Certificate System (RECS). Although the Dutch government initially was unwilling to participate on an international level, as it was concerned that imports of cheap renewable energy would decrease domestic investments and the greening of the national electricity production system, it eventually joined (Dinica & Arentsen, 2003). In the Netherlands, the green certificate system is linked to the energy tax exemption scheme, which means that final buyers of the green certificates are exempted from paying the energy tax for the electricity their green certificates represent (Dinica & Arentsen, 2003).

Policy consistency
As mentioned in Chapter 1, a major barrier for investing in RE sources is the inconsistency of the Dutch governmental policy. Policies are often too short-term minded (Kemp & Rotmans, 2009) and are prone to changes (Bosman et al., 2014), which creates an unfavourable investment climate. However, the Climate Act offers long-term goals and policies, which could perhaps decrease some of the uncertainties for investors.

3.2.2. Energy sector regime

In this section, the drivers and the barriers of the energy regime towards the investment climate for RE generation will be discussed.

Drivers of the energy regime
New entrants
Due to the liberalisation of the energy market in 2001, new players have been able to compete against incumbent actors (Verbong & Geels, 2007). These new entrants have consisted of small as well as large players, and have brought with them new technologies and are thus fostering market competition (Bosman et al., 2014), which is defined as bettering the investment climate. Ludovico et al. (2020) states that, even though it is usually on a local scale, new actors have become the drivers of innovation for a less carbon-intensive economy.

Cooperative-based
As mentioned in the governmental drivers, cooperative-based projects have a positive influence on the Dutch energy transition. Seeing as these cooperatives include commercial companies as well as governmental input, they are also considered to be a market-based driver as it allows policy makers to foster credibility and stability, as well as contributing to productivity and growth (Backhaus, 2019).

Awareness
Although it is not one of the main focuses of market-based policy, creating more awareness is an important aspect of furthering the energy transition as broad public support is necessary to create a good investment climate. This can be done through activism, or by creating a greener image, which can, in turn, stimulate the market demand for renewable energy (Verbong & Geels, 2007).

Job creation
Some sources, such as Bulavskaya and Reynès (2018), state that renewable energy has potential for stimulating growth and jobs for the Dutch economy; they expect an additional 0.85% of gross domestic product to be created by 2030 as well as 50,000 new full-time jobs. If this is indeed the case, it would be an improved outcome for society which could also create broader public support.

Barriers of the energy regime
Incumbent actors
Although new entrants were previously mentioned as a driver in the Dutch energy transition, their actual penetration in the market is lacking as incumbent actors remain in control. According to Kern and Howlett (2009), the knowledge, experience and entrepreneurship that are bundled in platforms are dominated by regime incumbents, which are the existing energy companies, rather than front-runners. Because of this, large-scale energy debates about the energy future in which the public is involved are not taking place, thereby jeopardising the goals of the energy transition and contributing to the focus on existing ideas and technologies Kern and Howlett (2009). In this way, productivity improvement and growth is slowed down, contributing to a lesser investment climate.

Natural gas
A crucial barrier that is not policy-related but must be mentioned is that of the Netherlands' reliance on natural gas. The Netherlands is the second largest natural gas exporter in the world; in 2012, 64% of final energy consumption relied on natural gas (Deloitte, 2015). However, due to earthquakes in Groningen, the decision was made to phase out gas. This has a significant impact on the Dutch energy transition for two reasons. Firstly, seeing as the Netherlands loses its main energy source and is a net importer for all other sources of energy, it will rely heavily on other countries for energy. This is not only politically challenging, but also economically unfavourable, causing a significant drop in government revenue as well as requiring further investments and long-term decisions (Deloitte, 2015). Secondly, as other countries transition towards more renewable energy generation and the phasing out of coal, they often use natural gas an intermediate step. Seeing as the Netherlands has already started to phase out natural gas, a different energy source will need to be used to support the energy transition (Akerboom et al., 2020).

Investment costs
Investment costs are seen as one of the most obvious barriers in the energy transition (IEA, 2020a). Due to shifts in policy, an unattractive and uncertain investment climate is created (Verbong & Geels, 2007). So, besides the fact that investments are extremely large to begin with, signifying unjustified costs, the presence of regulatory and policy risks decreases governmental stability and credibility, which damages the investment climate.

3.3. Technological niches

In the following section, the development of small-scale solar PV and TEO will be discussed.

3.3.1. Solar energy

Solar energy can be divided into two types of energy, namely solar PV and solar heat. Solar power is the generation of electricity through solar panels and the photovoltaic effect, whereas solar heat is generated by collecting thermal energy from the sun and utilising this collected heat to heat spaces or domestic water (Dincer & Abu-Rayash, 2020).

In the past few years, the generation of solar PV has seen a sharp increase; from 2018 to 2019, it grew by 37% to 18.6 petajoules, which is roughly 0.95% of the TPES (CBS, 2020a). This growth has mostly been due to subsidy schemes as well as technological advancements, such as the increased installed capacity of solar panels, and is expected to continue to grow at a similar pace in the next few years (CBS, 2020a). The subsidies that are awarded for the installation of solar panels are the EIA and SDE+, however, the applications for the EIA have recently been declining seeing as SDE+ has a bigger financial advantage. As for small consumers and prosumers, netting arrangements and high energy taxes on electricity remain an important incentive to purchase solar panels (CBS, 2020a).

3.3.2. Thermal energy from surface water

With thermal energy from surface water, heat is extracted from the surface water using a heat exchanger and can be from flowing as well as standing surface water. The temperature of the surface water depends on the season and thus typically varies between 5 and 20 °C (Lensink et al., 2021). Once the heat has been extracted from the water during the summer, it is stored in an aquifer thermal energy storage (WKO in Dutch, ATES in English) system. During the winter, the heat is extracted from the aquifer by means of a heat pump and used to heat buildings such as homes or offices. An illustration of this process can be found in the Figure 3.1.

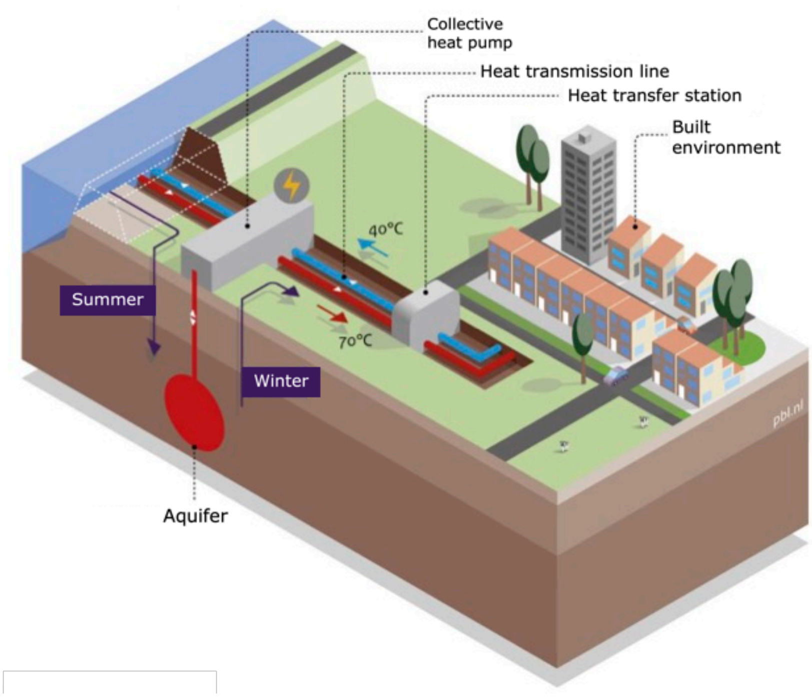

Figure 3.1: Thermal energy from surface water with an aquifer (Lensink et al., 2021).

Although solar PV is a RE technology that has been used for quite some time now in the Netherlands, TEO is a true niche. There is little to be found about existing projects, however, it has been calculated to have a significant potential for heat supply in the Netherlands, which can mostly be accredited to the fact that the Netherlands is saturated with water. According to a study executed by CE Delft, TEO has the potential to supply 40.1% of today's heat demand, and 43.4% in 2050 (Kruit et al., 2018).

3.4. Final MCA matrix

After having identified the most important policy instruments used by the Dutch government to better the investment climate for RE generation, the final matrix is adjusted to show the following:

	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
SDE++						
Energy tax						
EIA						
ETS						
GOs						
Climate Act						

Table 3.3: Final matrix of the investment climate criteria versus the policy instruments.

Alternatives
Although there is a wide range of energy policy instruments implemented by the Dutch government, the SDE++, energy tax, EIA, ETS, GOs and Climate Act were specifically chosen to use as alternatives for this study. The reason for this is because the instruments all differ in nature, but are applicable to the two technologies. They are furthermore all currently implemented, which means information on the subjects is readily available and the results from the study can be used to form relevant and realistic recommendations.

Additionally, some instruments, such as the SDE++ are extremely technology specific, which means they have a direct impact on the generation of small-scale solar PV. Other instruments, such as the ETS, are much broader and not technology specific, which means they have a different influence on the investment climate as a whole. The choice was made to use such varying instruments, as this research is a starting point to fill the knowledge gap on the effectiveness of policy instruments on RE generation in the Netherlands. The alternatives are thus used for the reasons of being currently implemented, being varying in nature, applicable to both technologies, and, most importantly, because they influence the Dutch investment climate for RE generation.

Investment climate
As explained in Section 2.2.1, a good investment climate encourages companies to invest by reducing unjustifiable costs, (government-related) risks and barriers, whilst improving outcomes for society as a whole. Looking back at Figure 2.3, the policy regime is able to influence investment decisions by affecting the NPV calculation, imitation, path-dependency and through the energy regime. The chosen instruments influence investment through these pathways. The SDE++ and the EIA, for example, influence the NPV calculation, whereas the Climate Act affects the path-dependency as well as the energy regime by slowly forcing change. Thus, the instruments represent a diverse number of tools, that, if effective, should alleviate some of the uncertainties defined as the criteria, to create a good investment climate.

Criteria
The criteria that are to be used in the MCA are those identified in Section 2.2. The criteria were initially found in general literature research on the investment climate, but are found to be applicable to this study as they correspond to the information found in Section 1.2 on the Dutch energy transition, as well as being confirmed by experts. Looking at the criteria, they also vary in nature, but are all related to the investment climate. For these reasons, they are seen as relevant criteria for this study.

4

Multi-Criteria Analysis

This chapter presents the multi-criteria analysis. Section 4.1 describes the methodology and Section 4.2 encompasses the execution of the first three steps.

4.1. Methodology

The following section will focus on the methodology of the MCA, showing how it will be applied to analyse which policy instruments have the biggest impact on the RE investment climate.

4.1.1. Multi-criteria analysis

When performing an environmental impact assessment in which different alternatives are compared with one another, an MCA is often used. Not only are there many different methods for MCA's, but they are also often adjusted and combined. The advantages of an MCA is that it provides a systematic, transparent approach that increases objectivity and generates results that can be reproduced (Bonte et al., 1997). The disadvantages of an MCA is that it is prone to manipulation, is very technocratic, and can provide a false sense of accuracy (Janssen, 2001). It is therefore important to avoid biases and to work accurately and objectively so that relevant results are obtained.

From the literature research on the investment climate and the MLP analysis, a set of criteria and alternatives is found. Seeing as these criteria do not have the same weights, i.e., not all criteria are equally important, an MCA is performed to determine the separate weights of the criteria. To do this, the Best-Worst Method is applied, which will be further explained below. Because the choice was made to focus on small-scale solar PV and TEO, the corresponding weights will have to be found separately for both cases. In order to determine the values of the alternatives, the weighted summation method will be used, which consists of the following steps:

Step 1: Define the policy alternatives which are to be compared with each other. The policy alternatives were identified using the MLP; they were first identified from general literature, after which the final alternatives were confirmed in the case study on the Netherlands.

Step 2: Select and define the criteria relevant for the decision. The criteria were found through literature research on the investment climate surrounding RE generation.

Step 3: Assign values to each criterion for all alternatives. The values are assigned on a scale ranging from -3 to 3, which is intuitively more attractive, and will be scored according to information found in relevant literature. The value thus serves as an index for the evaluated aggregate performance of the policy instrument; the greater its' value, the more the instrument is preferred, thus having the biggest positive impact on the investment climate (Kim et al., 1998).

Step 4: Standardise the scores in order to make the criteria comparable with each other. From this, the values for the performance are calculated.

Step 5: Weigh the criteria in order to assign priorities to them. The criteria are weighed using the Best-Worst Method.

Step 6: Calculate the total values of the alternatives and rank them. These total values are produced using the linear function

$$value(a_j) = \Sigma w_i v_i(s_{ij}), \tag{4.1}$$

where for each j instrument, value is measured as the weighted sum of performances $v_i(s_{ij})$ for this instrument on each of the i criteria, multiplied by their relative weight w_i (Konidari & Mavrakis, 2007).

Once the values have been determined for all the alternatives, the results will be analysed and validated with the same experts as used for the BWM. Finally, the implications for the differences, or similarities, between small-scale solar PV and TEO will be discussed.

Standardisation method

To calculate $v_i(s_{ij})$, the following linear function that presents interval standardisation is often used when performing environmental impact assessments:

$$v_i(s_{ij}) = \frac{s_{ij} - min_j(s_{ij})}{max_j(s_{ij}) - min_j(s_{ij})}, \tag{4.2}$$

in which the min and max are the lowest and highest scores for the set of criteria. The effect scores s_{ij} are then transformed according to their relative position on the interval between the lowest and highest score ([min, max]) and to their relative position on the interval [0,1] (Institute for Environmental Studies, n.d.).

The Best-Worst Method

The Best-Worst Method (BWM), which was introduced by Rezaei (2015) is applied to determine the relevant importance (weights) of the identified criteria. The BWM is an MCA method that uses pairwise comparison to quantify the importance of variables, e.g. decision-making criteria, that are not easily measurable. Due to its simplicity, reliability and more consistent results, the BWM has proven to have a clear advantage over other multi-criteria decision-making methods (Van De Kaa et al., 2017). Since the analysis of policy instruments requires a unique solution, the linear model for BWM is used (Rezaei, 2016). The BWM consists of the following five steps:

Step 1: Determine the set of decision criteria c1,c2,c3,...cn that are the relevant criteria which determine whether or not the investment climate has been improved. These are the same criteria that are defined in Step 2 of the WSM.

Step 2: Determine the best (most important) and worst (least important) criteria within each category of criteria, and among categories. These serve as reference points in the pairwise comparisons.

Step 3: Determine the preference of the best criterion over all other criteria by using preference scores from 1 to 9, in which 1 implies equal importance and 9 implies extreme importance. This results in a Best-to-Other vector, $A_B = (a_{B1}, a_{B2}, ..., a_{Bn})$ where a_{Bi} indicates the preference of the best determinant B over determinant i.

Step 4: Determine the preference of the other criteria with respect to the worst criteria using the same scoring as in step 3, to measure how all criteria are more important than the worst criterion. This results in a Others-to-Worse vector, $A_W = (a_{1W}, a_{2W}, ..., a_{nW})$ where a_{iW} indicates the preference of criterion i over the worst criterion.

Step 5: Calculate the optimal weights (w_1*, w_2*, ..., w_n*) and the consistency ratio, w_i* being the importance of every criterion, by solving the following linear programming problem. The BWM Solver in Excel is used as the optimisation program to solve the following model:

min ξ^L

s.t.

$| w_B - a_{Bi} w_i | \leq \xi^L$, for all i
$| w_i - a_{iw} w_w | \leq \xi^L$, for all i
$\Sigma\, w_i = 1$

$w_i \geq 0$, for all i

The solution to this problem results in a unique set of weights for the criteria and a optimal objective value (ξ^*). The consistency ratio (CR) from Liang et al. (2020) is used to evaluate the consistency of the comparisons made by the decision-makers and therewith the reliability of the provided weights. The CR results in a number between 0 (full consistency) and 1 (full inconsistency). A lower CR is thus desired for higher reliability and acceptability of the results. It is furthermore of importance to note that the ranking of the criteria in steps 2, 3 and 4 will be done by interviewing a number of experts, who will rank the criteria through a survey. These experts will be chosen on account of their knowledge on the subject of how investment decisions are made in RE generation. An overview of the MCA method can be found in Figure 4.1.

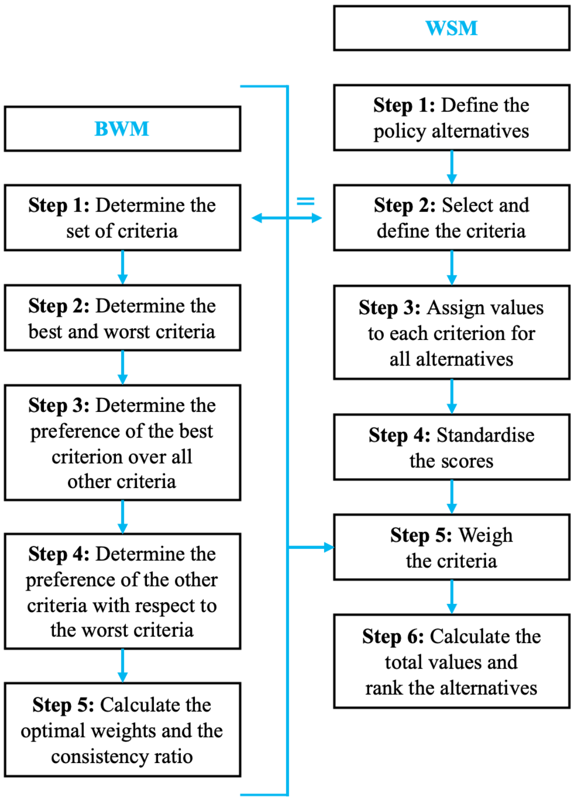

Figure 4.1: Process diagram of the multi-criteria analysis.

Consistency ratio of the BWM

To check the consistency of the answers given by the experts, a consistency ratio (CR) is calculated. A comparison is considered fully consistent when $a_{Bj} * a_{jW} = a_{BW}$, for all j, where a_{bj}, a_{jW} and a_{BW} are respectively the preference of the best criterion over the criterion j, the preference of criterion j over the worst criterion, and the preference of the best criterion over the worst criterion (Rezaei, 2015). However, since it is possible for some j not to be fully consistent, a CR is used to indicate how consistent a comparison is (Rezaei, 2015). This CR is calculated using the following equation:

$$Consistency\ ratio = \frac{\xi^*}{consistency\ index}, \tag{4.3}$$

where (ξ^*) is the optimal objective value as calculated in Step 5 above, and the consistency index (CI) is a fixed value per a_{BW}, which can be read below from Table 4.1.

a_{BW}	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
CI	0.00	0.44	1.00	1.63	2.30	3.00	3.73	4.47	5.23

Table 4.1: Consistency index table.

Seeing as the problem has an a_{BW} of 9, the CI is 5.23. According to Rezaei (n.d.), a problem with 6 criteria and in which the maximum value used in the pairwise comparison is 9, the threshold is 0.4225, which means that values of the consistency ratio that are below 0.4225 are considered acceptable.

4.2. Execution multi-criteria analysis

4.2.1. Identifying policy alternatives

The policy alternatives were found using the MLP case study of the Netherlands, and consists of the following list:

- SDE++
- Energy tax

- EIA
- ETS
- GOs
- Climate Act

The SDE++ and the EIA are both subsidies, however, the SDE++ is based on a feed-in tariff model, whereas the EIA is tax-incentive based. The energy tax is also tax-based, the difference being that with the energy tax instrument, investors can get a return on the energy tax they paid for electricity used to generate renewable electricity. With EIA, investors can get a return of 45.5% of the investment costs from their taxable profit. Whereas the first three policy instruments and the Climate Act are purely Dutch governmental policy, the ETS and GOs policies are part of EU policies. The ETS encompasses the trading of emission rights between companies, in which the number of emission rights decreases over the years so that the overall amount of CO_2-emissions is decreased in the Netherlands. GOs are an EU system in which companies that produce RE receive green certificates, or guarantees of origin, for the energy they produce, and can sell their certificates to other companies. The Climate Act is a more abstract instrument to be tested, because it encompasses the largest overall energy policy as implemented by the Dutch government, whereas the other instruments are more specific instruments. Besides the Climate Act, all other instruments offer fiscal incentives in some form or another.

4.2.2. Identifying criteria

The final criteria were previously found during the literature review and confirmed by Experts 2 and 7, which are experts in the field of the RE investment climate. Table 4.2 shows the found criteria and how they are to be assessed in the MCA.

4.2.3. Assigning values to each criterion for all alternatives

After having identified the policy alternatives and the criteria, the policy instruments are scored against the criteria on a scale ranging from -3 to 3. The reason for using a 7-point scale is because, in scientific research, 5- or 7-point scales are most often used as they are found to be most intuitive (Dawes, 2008). Although 10- and 11-point scales are also frequently used, they are not practical in this study as it is not possible to assign verbal meaning to the end points. In this case, a 5-point scale was deemed as providing too little options, which is why a 7-point scale is used. The verbal meaning of each score can be found in Table 4.3

A positive effect on the criterion signifies that the barrier to invest is somewhat alleviated, creating a better investment climate for the technology. A negative effect means that the policy instrument has worsened the criterion, which worsens the investment climate and makes a company less likely to invest. The assigned scores and their corresponding reasoning can be found in the following section.

Criteria	Description
Capital costs	RE technologies have characteristically high capital costs, which is a barrier for investors. A good policy instrument thus lowers the initial capital costs, making the investment climate more attractive.
Regulatory risks	Regulations are challenging and furthermore prone to changes, which creates risks for investors. In terms of small-scale solar, (fire-)safety and quality requirements of the PV systems cause the most issues, whereas one of the biggest regulatory issues for TEO is obtaining an initial permit for the project. A positive score on a policy instrument thus takes away some of this uncertainty, whilst a negative score does the opposite.
Policy risks	Policy risks focuses on the uncertainties that are formed due to the highly changing nature of governmental policy. As both solar PV and TEO have long payback periods, the risks that are run is that policy instruments that are essential to the return on investment are altered, affecting the financial outcomes of the project. The instruments are scored according to how susceptible they are to changes, a higher score means that the policy instrument is less likely to change and therefore positively affect the business case, a lower score means the policy instrument is susceptible to changes and therefore increases the risk to invest.
Uncertainty long-term viability of the technology	As RE technologies are fairly new technologies compared to fossil fuel technologies, they are constantly changing and improving. Because of this, some companies are hesitant to invest in the technologies because they are unsure whether or not the current technology works well enough, meaning it could be prudent to wait a few years until the technology has improved. A positive score means that the policy instrument decreases the uncertainties related to the long-term viability of the technology, whereas a negative score increases the uncertainties.
Long payback periods	Because RE investments have characteristically high capital costs, the projects have long payback periods. This requires long-term strategies and company policies, and some companies might be unwilling and/or unable to wait so long for a return on investment. Good policy instruments thus speed up the payback periods, whereas negative policy instruments create more uncertainties about the length of the payback period.
Public acceptance	Public acceptance encompasses the readiness of the market for the technology, and whether or not there is resistance against its implementation. With solar PV, for example, there is resistance against its implementation because people find it visually unappealing. For TEO, resistance could come from a more environmental viewpoint, in which people argue that the technology is damaging to the flora and fauna that exists in the water from which warmth is extracted. This criterion differs from the rest of the criteria as it is based on the viewpoint of the public instead of the companies, however, public acceptance indirectly affects the companies' business case.

Table 4.2: Criteria found in the literature and the description of how they are assessed.

+++	The policy instrument has an extremely positive effect on the criterion
++	The policy instrument has a substantial positive effect on the criterion
+	The policy instrument has a slight positive effect on the criterion
0	The policy instrument has an overall neutral effect on the criterion
-	The policy instrument has a slight positive effect on the criterion
–	The policy instrument has a substantial negative effect on the criterion
—	The policy instrument has an extremely negative effect on the criterion

Table 4.3: Verbal meaning of scores awarded to alternatives.

5

Results

This chapter presents the results of the MCA. Section 5.1 discusses the scores assigned to the alternatives. Section 5.2 standardises the scores found in the previous section. Section 5.3 encompasses the assigning of weights to the criteria, which is done using the Best-Worst Method. Finally, Section 5.4 consists of calculating and ranking the final values of the alternatives.

5.1. Values assigned to the alternatives

In this section, the third step of the MCA is performed, which entails the assigning of values to the alternatives. In subsection 5.1.1, Table 5.1 shows the scores assigned to the policy instruments against the criteria for small-scale solar PV, followed by reasoning behind the assigned scores. In subsection 5.1.2, Table 5.2 shows the same but for TEO, followed by the reasoning.

5.1.1. Small-scale solar PV

	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
SDE++	0	2	2	1	2	0
Energy tax	0	0	2	0	1	-1
EIA	2	1	3	1	3	0
ETS	0	1	3	0	1	0
GOs	0	0	1	0	2	2
Climate Act	0	1	-2	0	0	2

Table 5.1: Scores of the policy instruments against the criteria for small-scale solar PV.

SDE++

Capital costs

The working principle of the SDE++ is that it covers the difference in costs between the base amount and the correction amount (Netherlands Enterprise Agency, n.d.-b), which means that it has no influence on the capital costs of the investment (Expert 8, personal communication, June 15, 2021). For that reason, the SDE++ is scored at 0 for capital costs.

Regulatory risks

Seeing as the SDE++ conforms to governmental regulations, they are able to decrease some of the regulatory risks. This provides the investing party with a little more security, as they know that, if their PV system has received approval for subsidisation, it has already cleared a number or regulations (Expert 3, personal communication, June 11, 2021). The SDE++ also gives more regulatory security concerning the electricity price as operating shortfall is calculated beforehand (Netherlands Enterprise Agency, n.d.-b). However, there are still many regulatory risks that follow the initial investment, such as insurance and fire safety regulations, which is why the SDE++ is scored at 2 for regulatory risks.

Policy risks

For small-scale solar PV, the duration of the subsidy is 15 years. This means that once the subsidy has been granted, the risks relating to changing policies are decreased as the agreement stands for 15 years (Lensink et al., 2021). However, the exact amount of the subsidy changes every month according to the electricity prices (Expert 8, personal communication, June 15, 2021). Because this means that not all risk is gone, the SDE++ is scored at 2 for policy risks.

Uncertainty long-term viability of the technology

The SDE++ is not granted towards technologies that have a short-term viability, which gives slightly more assurance that the technology is viable long-term (Expert 3, personal communication, June 11, 2021). The duration of the subsidy also gives some certainty, however, overall, the SDE++ does not have a very significant impact on the uncertainty regarding the long-term viability of solar PV technology. Because of this, it scores a 1.

Long payback periods
The SDE++ subsidy guarantees that the operating shortfall is compensated (Netherlands Enterprise Agency, n.d.-b), which means that investors in small-scale solar PV earn more money at a quicker rate than without the SDE++. This means that their payback periods are shortened, which is why the SDE++ is scored at 2 for long payback periods.

Public acceptance
The SDE++ does not affect public acceptance, which is why it scores a 0.

Energy tax
Capital costs
Seeing as this policy instrument is based on a tax exemption or a tax return on electricity that is produced from renewable sources (Belastingdienst, 0), it has no effect on the capital costs.

Regulatory risks
The energy tax exemption or return has no effect on regulatory risks relating to the installation of small-scale solar PV systems.

Policy risks
For companies that generate renewable electricity, the tax return policy is a secure way of receiving part of the taxes back that were paid for the use of electricity (Belastingdienst, 0). Although the amount to be returned has been increased the past few years, not all risk is eliminated from the policy as it is prone to changes (Expert 8, personal communication, June 15, 2021).

Uncertainty long-term viability of the technology
Seeing as the instrument changes on a yearly basis and is not technology specific, it has no influence on the uncertainties regarding the long-term viability of the solar PV technology.

Long payback periods
Because investors receive a portion of their electricity investment back, their payback period is sped up (Belastingdienst, 0). However, seeing as the electricity costs are quite small compared to the other investments, the effect is quite small.

Public acceptance
By raising the energy tax, the government hopes to create an incentive for consumers to use less energy and to emphasise the need for energy from renewable sources (PBL et al., 2020). Although it should have an overall positive effect on the criteria, it has a negative effect on public acceptance as most consumers are unwilling to pay more for their energy bill, causing them to blame RE generation for a higher electricity bill (Blom et al., 2021).

EIA
Capital costs
EIA allows investors to deduct 45.5% of their investment costs from their taxable profit (RVO, n.d.-a). This means that they receive this return annually through tax returns, which provides a substantial incentive to invest as it decreases a large amount of their capital costs (Expert 8, personal communication, June 15, 2021).

Regulatory risks
EIA is a purely financial incentive. Because of this, investors need to adhere to several financially based regulations to receive the tax return. Thus, if the investor is granted the EIA tax return, some of the financial regulatory risks are decreased (Expert 8, personal communication, June 15, 2021). It does not, however, have any influence on technological regulations.

Policy risks
EIA is a strong policy instrument that, once granted, provides a 100% guarantee on a tax return in the next year. Although it is a short-lasting policy instrument, it is not at risk of changing so that the conditions of the investment change (Expert 8, personal communication, June 15, 2021).

Uncertainty long-term viability of the technology
As solar PV systems are covered by EIA, it provides some positive influence on the uncertainty regarding the long-term viability of the technology (RVO, n.d.-a). However, seeing as the EIA is so short-term, it does not have any long-lasting influence on the viability of the technology.

Long payback periods

As investors receive a large part of their investment back in the form of tax returns, the payback periods are significantly shortened. The EIA thus has a relatively positive impact on the issue of long payback periods (Expert 8, personal communication, June 15, 2021).

Public acceptance
The EIA has no direct influence on public acceptance (Expert 8, personal communication, June 15, 2021).

ETS
Capital costs
The ETS has no direct influence on overcoming high capital costs.

Regulatory risks
The ETS decreases some regulatory risks related to CO_2-emissions (NEA, 2015). According to a representative from the Dutch Emissions Authority, the rules and regulations surrounding the instrument are well understood by the companies that participate in the trading system, and they remain largely unchanged over the years. It does not, however, affect the regulations specific to the small-scale solar PV system (Expert 9, personal communication, June 11, 2021).

Policy risks
The ETS is a very stable policy in that investors know what to expect. Although the number of emission rights changes every year, the policy decreases uncertainties because the number of available emission rights will continue to decline at a steady rate, making it predictable (Expert 9, personal communication, June 11, 2021).

Uncertainty long-term viability of the technology
The ETS has no direct influence on the uncertainty regarding the long-term viability of small-scale solar PV systems.

Long payback periods
When an energy company invests more in renewable technologies such as solar PV, they emit less CO_2, which gives them the possibility to sell their CO_2-emission rights (NEA, 2015). As this is an extra source of income, it aids in shortening the payback period (Expert 9, personal communication, June 11, 2021).

Public acceptance
The ETS has no direct influence on public acceptance.

GOs
Capital costs
The GOs have no direct influence on the lowering of the capital costs made when investing in small-scale solar PV (Expert 9, personal communication, June 11, 2021).

Regulatory risks
The GOs have no influence on the regulatory risks.

Policy risks
The GO policy is a policy instrument that has come to exist from an EU directive. Because of this, it is mostly insusceptible due to changes in Dutch governmental policies (Ragwitz et al., 2009). However, because the policy is receiving quite some backlash as to its effectiveness (Dinica & Arentsen, 2003), it is still surrounded by a certain level of uncertainty.

Uncertainty long-term viability of the technology
The GOs have no influence on the uncertainty surrounding the long-term viability of solar PV.

Long payback periods
Energy companies that invest in small-scale solar PV systems and are able to obtain a GO, are able to trade the certificate (Ragwitz et al., 2009). These trades in certificates earn the RE generator money, which allows them to earn back their investment at a quicker pace.

Public acceptance
Green certificates are not only based on fiscal incentives, but they also influence how the public views the companies that buy the certificates. If a GO is granted, and a company holds a certificate, the public acceptance of that company is likely to increase due to the fact that they run on green energy (Ragwitz et al., 2009). Vice-versa, if large companies hold these certificates, the public acceptance towards green energy is increased as large companies often serve as role models.

Climate Act
Capital costs

The Climate Act has no direct influence on the capital costs related to investing in small-scale solar PV.

Regulatory risks
The Climate Act relieves some regulatory risks as, from the Climate Act's existence, many more rules and regulations are born and further clarified. However, the Climate Act is still too broad and prone to many changes, which is why it only has a small positive effect (IEA, 2020a).

Policy risks
The Climate Act is the foundation for all policy related to renewable energy generation and its goal is clear. By implementing the safeguarding cycle, policy is continuously adjusted to better attain the goal. Both the KEV and the climate memorandum are published annually, which means that policies can change on an annual basis ("Klimaatwet [Climate Act]", 2019). Whilst this should have a positive effect on RE generation, it is this continuous adjustment of policies that causes uncertainties and hesitations for investors.

Uncertainty long-term viability of the technology
The Climate Act has no direct impact on the uncertainty regarding the long-term viability of solar PV.

Long payback periods
The Climate Act has no direct impact on the payback periods of investments in small-scale solar PV systems.

Public acceptance
The Climate Act has one of the largest positive influences on the public acceptance towards RE generation. By making RE such an intricate part of governmental policy and increasing further commitment, more awareness is raised towards climate change and the public acceptance of RE generation increases (Verbong & Geels, 2007).

5.1.2. Thermal energy from surface water

	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
SDE++	0	1	2	1	2	0
Energy tax	0	0	0	0	0	-1
EIA	2	1	3	1	3	0
ETS	0	1	3	0	1	0
GOs	0	0	1	0	2	2
Climate Act	0	1	-2	0	0	2

Table 5.2: Scores of the policy instruments against the criteria for thermal energy from surface water.

SDE++
Capital costs
The working principle of the SDE++ is that it covers the difference in costs between the base amount and the correction amount, which means that it has no influence on the capital costs of the investment (Netherlands Enterprise Agency, n.d.-b). For that reason, the SDE++ is scored at 0 for capital costs.

Regulatory risks
As with solar PV, the SDE++ alleviates some of the regulatory risks. However, because TEO is a fairly new technology with very strict regulations, the positive effect of the subsidy is comparably lower. Because of this, it scores a 1.

Policy risks
The SDE++ has the same effect on policy risks for TEO as for small-scale solar PV. Although it alleviates some of the uncertainties, the amount subsidised still fluctuates which means that there are still some uncertainties (Expert 8, personal communication, June 15, 2021). The SDE++ is therefore scored at 2 for policy risks.

Uncertainty long-term viability of the technology
TEO is still quite a new technology which brings a substantial amount of uncertainty with it. Although the SDE++ is able to provide some security through the financial incentive it provides, the effect is quite small (Expert 4, personal communication, June 11, 2021).

Long payback periods
The SDE++ has a positive effect on the long payback periods of TEO as the operation shortfall is

compensated, which means that investors earn more money than they would do without (Expert 4, personal communication, June 11, 2021). Because of this, the SDE++ scores at 2 for long payback periods.

Public acceptance
The SDE++ does not affect public acceptance, which is why it scores a 0.

Energy tax
Capital costs, regulatory risks, policy risks, uncertainty long-term viability of the technology and long payback periods
Tax return or tax exemption is currently only applicable for electricity (Belastingdienst, 0). Seeing as TEO works with heat and cold, companies that apply the TEO technology cannot ask for tax exemptions, which means that it has no effect on capital costs. The same applies for regulatory risks, policy risks, uncertainty regarding the long-term viability of the technology and long payback periods.

Public acceptance
Although tax exemptions do not apply to businesses that generate energy using TEO, the policy instrument still has an indirect effect on public acceptance, as the subsidisation of technologies such as TEO cause the energy tax to increase. A higher energy tax causes a lower public acceptance (Blom et al., 2021).

EIA
Capital costs
The EIA is equally effective in the reduction of capital costs for TEO as for small-scale solar seeing as it is based on a percentage of the investment costs (RVO, n.d.-a).

Regulatory risks
The influence of EIA on regulatory risks for TEO is equal to the regulatory risks for small-scale solar PV.

Policy risks
The EIA has the same effect of certainty on TEO as for solar PV, as it is not susceptible to change over a long period of time (RVO, n.d.-a).

Uncertainty long-term viability of the technology
The EIA provides some incentive for businesses to invest in TEO, however, it has no direct effect on the uncertainty surrounding the long-term viability of the technology (RVO, n.d.-a).

Long payback periods
For TEO, the EIA also has a large positive influence on the long payback periods due to the decrease in capital costs, which shortens the payback periods (RVO, n.d.-a).

Public acceptance
EIA has no influence on the public acceptance towards TEO.

ETS, GOs and Climate Act
As the ETS, GOs and Climate Act are not technology specific, the scores awarded to them for TEO are the same as those awarded to small-scale solar PV.

5.2. Standardising the scores and calculating the performances

Once the instruments are scored, the scores need to be standardised in order to make the criteria comparable with each other. This is done by calculating the performances using Equation 4.3, so that they range from [0,1]. Here, the ([min, max]) values equal ([-3, 3]). The final performances can be found in Table 5.3 and Table 5.4, for small-scale solar PV and TEO, respectively.

5.3. Assigning weights to the criteria

In this section, weights are assigned to the chosen criteria. The reason for doing this is because not all criteria are equally as important for the investment climate, as some criteria have a larger influence on investment decisions and some lower. Thus, in order for the results to be realistic, weights must be assigned to the criteria. The method for doing this is the BWM, which is explained in Section 4.1.1.

	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
SDE++	0,50	0,83	0,83	0,67	0,83	0,50
Energy tax	0,50	0,50	0,83	0,50	0,67	0,33
EIA	0,83	0,67	1,00	0,67	1,00	0,50
ETS	0,50	0,67	1,00	0,50	0,67	0,50
GOs	0,50	0,50	0,67	0,50	0,83	0,83
Climate Act	0,50	0,67	0,17	0,50	0,50	0,83

Table 5.3: Final performances for small-scale solar PV.

	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
SDE++	0,50	0,67	0,83	0,67	0,83	0,50
Energy tax	0,50	0,50	0,50	0,50	0,50	0,33
EIA	0,83	0,67	1,00	0,67	1,00	0,50
ETS	0,50	0,67	1,00	0,50	0,67	0,50
GOs	0,50	0,50	0,67	0,50	0,83	0,83
Climate Act	0,50	0,67	0,17	0,50	0,50	0,83

Table 5.4: Final performances for thermal energy from surface water.

Experts 1 to 6 were asked to rank the criteria, from which the average weights were calculated. The rankings provided by the experts can be found in Appendix C, and the average weights can be found in Table 5.5 and Table 5.6 for small-scale solar PV and TEO, respectively.

Criteria	**Average weights**
Capital costs	0,19
Regulatory risks	0,13
Policy risks	0,21
Uncertainty long-term viability of the technology	0,060
Long payback periods	0,32
Public acceptance	0,089

Table 5.5: Average weights for the criteria calculated using the BWM for small-scale solar PV.

Criteria	**Average weights**
Capital costs	0,16
Regulatory risks	0,25
Policy risks	0,16
Uncertainty long-term viability of the technology	0,096
Long payback periods	0,27
Public acceptance	0,069

Table 5.6: Average weights for the criteria calculated using the BWM for thermal energy from surface water.

Consistency ratio
To check the consistency of the weights assigned by the experts, the consistency ratio was calculated using equation (3), with a threshold of 0.4225. The ξ^* was calculated by solving the linear problem with the constraints as defined in the BWM subsection, by using the Solver function in Excel. The ξ^*-values and their corresponding CR's can be found in Table 5.7. As can be seen in this table, all CR's are well under the threshold-value, which means that the weights provided by the experts are considered valid and can thus be used for the MCA.

5.4. Calculating and ranking the total values of the alternatives

In this section, the final step of the MCA is performed. The final values for the policy instruments are calculated using Equation 4.1, which combines the values of the final performances and the

Solar PV	ξ^*	CR	**TEO**	ξ^*	CR
Expert 1	0,097	0,019	Expert 1	0,041	0,0079
Expert 2	0,085	0,016	Expert 2	0,041	0,0079
Expert 3	0,12	0,024	Expert 3	0,12	0,024
Expert 4	0,094	0,018	Expert 4	0,081	0,015
Expert 5	0,060	0,012	Expert 5	0,069	0,013
Expert 6	0,12	0,023	Expert 6	0,081	0,015

Table 5.7: ξ^*- and CR values corresponding to answers provided by experts.

assigned weights. Once the final values are calculated, the instruments are ranked according to their effectiveness on the investment climate. The final values can be found in Table 8.1, and the ranked instruments can be found in Table 5.9.

Solar PV	Values	**TEO**	Values
SDE++	0,73	SDE++	0,70
Energy tax	0,61	Energy tax	0,49
EIA	0,86	EIA	0,83
ETS	0,68	ETS	0,67
GOs	0,67	GOs	0,64
Climate Act	0,48	Climate Act	0,51
Overall score	*4,04*	*Overall score*	*3,83*

Table 5.8: Final values of alternatives.

	Solar PV		**TEO**
1.	EIA	1.	EIA
2.	SDE++	2.	SDE++
3.	ETS	3.	ETS
4.	GOs	4.	GOs
5.	Energy tax	5.	Climate Act
6.	Climate Act	6.	Energy tax

Table 5.9: Policy instruments ranked according to their final values.

6
Analysis and Evaluation

In this chapter, the results from the MCA are analysed. In Section 6.1, the final scores of the policy instruments are analysed to see how they attribute to a good investment climate. Section 6.2 analyses the weights assigned to the criteria following the BWM, and Section 6.3 analyses how logical the results are and whether they match findings from the literature review.

6.1. Analysis of final instrument scores

Keeping the factors of a good investment climate in mind as defined in Section 2.2.1, the final scores of the instruments are analysed as to what their effect is on the investment climate.

The *EIA* provides the biggest support for the capital costs and the long payback periods, and as they also carry the biggest weights, the instrument scores significantly higher than the rest. Combined with the fact that it scores extremely well on reducing policy risks, the instrument affects the investment climate in a positive way as it has a positive influence on generating profit for firms, as well as fostering policy-related stability. It also has a slight positive effect on the uncertainties regarding the long-term viability of the two technologies, which allows firms to climb the technological ladder.

The *SDE++* is similar to the EIA except that it scores slightly lower for policy risks and payback periods, as well as having no influence on capital costs. It does, however, still contribute to a better investment climate in the same way the EIA does, in a slightly less effective manner.

The *ETS* is most effective because it is a stable long-term policy that is unlikely to change in the next few years. The amount of emission rights will continue to decrease over time, which means that companies know what to expect and are also able to earn money by selling emission rights. Because of this, its biggest strength lies in bettering the investment climate by creating policy-related stability. The ETS additionally influences the investment climate as it creates competition and imitation between businesses; as firms are forced to emit less CO_2, they will start competing for the best ways to do this by investing in new technologies.

GOs score relatively well as they aid in shortening the payback periods, which are seen as very important. Together with the Climate Act, GOs score the highest for public acceptance, which is an essential aspect of a good investment climate.

The *Energy tax* also shortens the payback periods for small-scale solar PV somewhat, which makes it slightly more effective than the Climate Act. The reason it scores lower for TEO than for solar is because it does not apply to TEO. The energy tax is the only instrument that scores negatively for public acceptance, which has a negative influence on the investment climate.

Although the *Climate Act* increases public acceptance, it also increases policy risks which carries significantly more weight than public acceptance. As a good investment climate requires credible and stable policy, the uncertainties caused by the Climate Act cause it to be quite an ineffective instrument.

Small-scale solar PV vs. TEO
Overall, the scores for the instruments are very similar for both small-scale solar PV and TEO; small-scale solar PV has a slightly higher final score of 4,04 compared to TEO's final score of 3,83. The difference in score can mostly be accredited to the fact that the energy tax has little to no effect on TEO, whereas it has a positive effect on solar PV. This thus means that whilst the instruments themselves differ in effectiveness, the investment climate is extremely similar.

6.2. Analysis of weights assigned to criteria

Long payback periods is awarded a weight of 0,32 for small-scale solar PV and 0,27 for TEO, making it the most important criterion by far. Although there are multiple aspects that define a good investment climate, this weight shows that generating profits is considered the most important criteria for a good investment climate. Interestingly enough, almost all experts working at ENGIE scored the criterion as being the most important, some as a 2, whereas the only expert from outside ENGIE scored it a 6. This shows that for a company such as ENGIE, financial incentives are considered most important, which also follows from the initial literature review in 1.

Regulatory risks is the second highest scoring criterion for TEO (0,25) and the fourth highest criterion for solar (0,13). As previously mentioned, the most important regulatory risk for TEO is receiving a permit for the project, without which the project cannot exist. One of the TEO experts added that besides being policy dependant, TEO is also extremely geographically dependant, which causes additional regulatory risks. All experts scored regulatory risks as extremely important for TEO, except for one of the solar experts, who scored it as being very important. According to one of the solar experts, regulatory risks are much less important for solar PV systems because they come into play after the initial investment, and whilst there are strict regulations on solar PV systems, they are usually not the decisive reason for whether or not an investment is made in a solar PV project.

Policy risks is considered the second most important criterion for solar PV (0,21), and third most important for TEO (0,16). The solar experts both scored policy risks as being quite unimportant, stating that once the initial agreement has been made (for a subsidy, for example), the policy risks decrease significantly and are unlikely to change in a way that is harmful for the investor. It was additionally also said that for solar PV, the SDE++ subsidy is currently still very important, however, seeing as the business case for small-scale solar PV is positive and continues to grow in a more positive direction, the importance of subsidies will decrease. TEO, however, is a fairly new technology which is why its' experts scored it a 1 and 2 in importance, as it is still reliant on policy support.

Capital costs is the third most important criterion for solar PV (0,19), and the fourth most important criterion for TEO (0,16). The TEO experts (4 and 6), scored the criterion as being quite unimportant, whereas all the other experts scored it between a 1 and 3. Expert 6, who does not work at ENGIE, scored it the lowest out of all experts, saying that if a technology works and the ambition is right, then the capital costs do not matter as there is currently enough capital in the Netherlands. Expert 4, who works at ENGIE and had scored payback periods as extremely important, interestingly enough scored capital costs as quite unimportant, saying that the size of the investment does not matter as much as how long it takes before it is paid back.

Uncertainty long-term viability of the technology is fifth for TEO (0,096) and lowest for solar PV (0,060). For solar PV, the criterion was consistently scored as being extremely unimportant, due to the fact that the technology has now been around for quite some time, which means that its viability is quite stable and unlikely to improve much in the future. For TEO, however, the scores differed not only throughout all experts, but also between the two TEO experts. Some experts said that because the technology was quite new and unused, it was likely that there were still many improvements to be made, whilst others said that the technology was already quite stable and that it was unlikely to change much more.

Public acceptance is the fifth for TEO (0,096) and the lowest for solar PV (0,069). For TEO, it was continuously scored as extremely unimportant by all experts except for the TEO expert outside of ENGIE, who scored public acceptance as very important for both technologies. According to the expert, public acceptance is extremely important when investing in a new technology because it is highly susceptible to changes, and because the public decides whether or not there is demand for the RE source in question. In the case of biomass, for example, it was first widely accepted by the public as a sustainable source of energy, but due to media articles and documentaries the public acceptance changed very quickly. There is currently quite a lot of resistance against solar PV parks that are on the ground, less so for those built on roofs, and TEO could also receive resistance as it is possible that it affects the flora and fauna in the water.

6.3. Initial hypothesis and logic

Looking back at the barriers found in Chapter 1.2 in the initial literature review, the biggest governmental barriers were the policies themselves, as they were prone to changes and not thorough enough, and the lack of a good investment climate for the investors, causing financial doubts. Another governmental barrier found in the literature was regulation. It is therefore logical that the criteria relating to these barriers are continuously scored as most important, and the instruments that best solve these barriers are scored as being most effective, which is consistently done throughout the MCA.

As analysed in the previous subsection, the policy instruments that scored best were those which provided the biggest financial support and reduced regulatory and policy risks. This matches the assigned weights, as well as what was found in the literature in sections 1.2 and 2.3. It therefore follows logically that the instruments that had the least financial support and had the least effect on regulatory and policy risks would score least effective, which is the case with the energy tax and the Climate Act. The scoring of the Climate Act matches what was found in the literature review with regards to policy barriers, namely that there are not enough thorough pathways and that it is too susceptible to change, causing instability and incredibility. Looking back at the drivers found in the literature review, such as subsidy schemes, the ETS and tax exemption schemes, these also score the highest in the MCA. Although the MCA was executed independently from the first literature study, the information from both is consistent. The initial hypothesis found in the literature review therefore matches the results.

7

Discussion

In this chapter, several aspects are discussed that should be taken into account when analysing this study. Section 7.1 discusses the contribution of this thesis to the scientific community. Section 7.2 discusses the societal value of this thesis. Section 7.3 discusses the limitations of this thesis.

7.1. Scientific contribution

The scientific contribution of this thesis is divided into three categories, namely that of the MLP, the investment climate and the policy instruments.

The multi-level perspective
The MLP is a method that is often used to describe socio-technical transitions, and the weighted sum method is often used to measure environmental impacts. Usually, however, they stand alone as a main method, and are therefore never used together. The lessons learnt from this thesis is that they complement each other well, using the MLP as a case study to gain information about a socio-technical context in a structured manner, after which the necessary information is extracted and used to execute the MCA. The BWM furthermore also works well with the weighted sum method, as a tool to weigh the found criteria and validate results whilst interviewing the experts.

Not only is the MLP combined with the MCA, but it is also adjusted to form a newly proposed framework, as seen in Figure 2.3. An important take-away from this thesis for the scientific community is that the MLP is an extremely efficient explanatory tool to use as a starting point for a study, after which it can be adjusted and combined in numerous ways. It should thus be seen as a highly versatile framework, that can meet the needs of several studies.

Analytical framework for the investment climate
In Chapter 1, a literature review was executed which revealed a knowledge gap towards the investment climate of the energy sector. This thesis thus focused on filling in this knowledge gap as a contribution to the scientific community. Initially, research was done to analyse the relationship between policy makers and market players, and how they influence the investment climate. A new framework was proposed, using a combination of Geels & Schots' (2007, p. 401) traditional MLP and Barazza & Strachan's (2020, p. 5) framework, which consists of feedback loops that analyse how energy policy and investment decisions affect one another. This theoretical framework is advantageous as it allows us to interpret the results in such a manner that it is possible to differentiate between the multiple pathways to investment decisions. Some policy instruments, for example, influence investment decisions through the energy regime, such as the ETS, whereas other instruments, such as the SDE++ and the EIA, influence investment decisions by affecting the NPV calculation. Understanding the numerous ways that policy instruments affect the investment climate contribute to the knowledge gap. As the MLP does not include the investment climate, this new proposed framework can thus be used by other scholars wishing to add a financial element to their research. Furthermore, in this thesis, the analysis was made from the viewpoint of the policy makers. However, it is also possible to use the analytical framework when focusing on a different element, such as the energy regime or the windows of opportunity.

Policy instruments
The second part of the knowledge gap entails the lack of research done towards the effectiveness of numerous policy instruments on the Dutch investment climate. In this thesis, the most important policy instruments were described and tested through an MCA, giving a detailed but broad overview of their effectiveness. The policy instruments had not previously been tested in this manner, therefore contributing to the knowledge base of the scientific community. Furthermore, although policy measures have often been compared in the literature, the comparison is rarely made with regards to two

specific technologies. The goal of this comparison was to choose two completely different technologies and to see how the investment climates differed between the two.

As discussed is Section 7.3, there are a number of limitations to this study, which influences the information obtained to fill in the knowledge gap. The biggest limitation, that of the missing environmental criteria, is both an addition to the knowledge gap as well as an omission. It is an addition because the knowledge has now been gained that future research must always include environmental criteria, and an omission because, without the environmental criteria, the results are less realistic. Another important limitation that influences the scientific contribution to the knowledge gap is that of the subjectivity, as well as the consistency and viewpoint. As mentioned, the scoring of the instruments is susceptible to bias and inconsistencies. Whilst the results of the MCA can be used by the scientific community, it is important to keep these limitations in mind.

7.2. Societal value

The societal value can be split into three categories, namely the value for governmental actors, market-based actors and society as a whole. For the governmental actors, the information gained on both the policy instruments and the criteria can be of use. As this thesis researches the effectiveness of policy instruments, the results can be used by policy actors to revisit their policies and perhaps adjust them, lengthening those that scored best and improving those that scored worst. Besides evaluating the policy instruments, the criteria were thoroughly analysed. By finding criteria in the literature, having them validated by the experts and assigning weights to them, a clear and meaningful image is drawn of what market players in the Dutch energy market consider to be the most important criteria. This information can be used to adjust policies so that they better meet the criteria that weigh the most.

The value that this thesis holds for market-based actors is that they can use the knowledge when looking for investment opportunities in RE technologies. Every company has its own set of criteria, but the policy instruments apply to everyone. Besides the policy instruments and the criteria, the difference between small-scale solar PV and TEO were also researched. As they are both extremely different technologies, the information on how the effectiveness of the instruments compare to one another can be used by companies that are looking to invest in new technologies. Furthermore, the fact that solar PV has been around in the Dutch market for quite some time and TEO is only just being adopted, means that there is an abundance of information to be found on solar PV, but not as much to be found on TEO. This thesis thus adds to the knowledge base on TEO.

The overall value this thesis holds for society is that it is a step in gaining information in a specific part of the energy transition. The more information that is gained, the more knowledge policy actors and market players have surrounding the investment climate of the energy transition. As this continues to grow, more progress is made in policy instruments which leads to more investments in RE technologies, which is ultimately advantageous to society.

7.3. Limitations of the research method

7.3.1. Overall method

Perspective of the thesis

Throughout the study, an economic perspective was upheld. In Section 2.2.1, one aspect of a good investment climate was defined as not only generating profits for businesses, but also improving outcomes for society as whole. Although it can be argued that economic success positively contributes to society, there are many other ways that a good investment climate can have a positive impact on society. This raises the question whether the perspective taken in this thesis was not too narrow, and whether additional or other perspectives had achieved different results.

If one were to add an environmental perspective, for example, the results of the MCA could potentially have been different. Looking at the SDE++, a guaranteed payment for the energy generated from RE sources is received, which means that the amount of the subsidy is adjusted according to how much CO_2-emissions are avoided. The SDE++ is thus based on economic and environmental factors, in which the financial compensation is adjusted according to how well it performs environmentally. Due to the positive effect the SDE++ on the investment climate, businesses are significantly more likely to invest in RE technologies, which is the definition of a good investment climate. GOs, on the other hand, score relatively well according to the financial criteria, but are often described in the literature as having a negative effect on the investment climate. Due to the existence of the Renewable Energy Certificate Systems, the imports of cheap RE are decreasing domestic investments and the greening of the national electricity production system, which causes a lesser investment climate as it does not really improve society. Therefore, if another perspective had been added to the study, the results would have been more realistic.

Choosing the criteria
When developing the method for this thesis and choosing which criteria to use, some literature on similar studies chose to incorporate environmental criteria as well as financial criteria. Initially, the set of criteria were to include environmental criteria. However, it was felt that the method of scoring environmental criteria would differ too much from the method of scoring financial criteria, and, seeing as this thesis encompassed a financial perspective, the choice was made to use financial criteria. However, as mentioned above, the study would have profited from the addition of environmental criteria, which was furthermore mentioned by Expert 6.

Choosing the policy instruments
The policy instruments that were used in the MCA were chosen for three reasons. First, because they are the main instruments used in the Netherlands. Second, because they are all diverse in the way they work; the SDE++ is a subsidy, whereas the EIA is tax-based and GOs improves a company's image as well as providing financial incentives. They therefore all contribute to a good investment climate in a number of ways. Third, all instruments deemed suitable for solar PV and TEO; the SDE++ and the EIA were both technology-specific and applicable to small-scale solar PV and TEO, and the rest of the instruments are not technology-specific. Although the chosen policy instruments are a good representation of the Dutch energy policy, it is important to keep in mind that they are not the only policy instruments available for solar PV and TEO, if all existing policy instruments were used as alternatives then the results would be different.

Validation through experts
Besides the fact that ENGIE is one of the largest energy utilities companies in the world, with an extremely diverse portfolio of projects and expertise, their experts were easy to approach and willing to help. Because of this, the choice was initially made to only select experts from ENGIE to question for the BWM and for validation. Seeing as TEO is a relatively new technology, the first TEO expert recommended an expert from Ennatuurlijk be used as a second TEO expert, as they would have more information on the subject than a second project manager from ENGIE. Whilst ranking the criteria as part of the BWM, it quickly became apparent that the expert had an opposing opinion on the weights of the criteria compared to the experts from ENGIE. As explained in Section 6.2, Expert 6 gave significantly less importance to financial criteria and said that money did not play a role when investing in RE projects, the most important criteria is the regulatory and political feasibility and becoming more sustainable.

After having spoken to Expert 6, it is clear that the research would have been less biased and more realistic if the experts came from a wider range of backgrounds. Unfortunately, due to a lack of time, it was not possible to arrange this. Although this bias does not make the results less valid, it is nonetheless important to keep in mind that the criteria were, for the most part, weighed by experts all working at the same company. It is furthermore important to note that although the final results follow logically from what was found in the literature research and because the intermediate steps were validated by experts, the results themselves were not validated by experts. This too, was not possible due to a lack of time.

7.3.2. Multi-level perspective

As previously mentioned, the MLP is a tool used to analyse socio-technical transitions. In this thesis, however, it was used as a basis for a case study of the Netherlands. Whilst this provides a clear and thorough framework to gain information that is to be used in the MCA, it is not the way the MLP is intended to be used. As the focus lies on the policy and energy regime, literature outside of the MLP literature was used to incorporate the investment climate into the MLP. In the case study section, a short summary is given of the landscape and niche developments, whilst a more detailed account is given of the regimes. In a complete MLP, all three levels are discussed with more detail, as well as how they influence each other to create windows of opportunity for new technologies to break through. Since that is not the objective of this thesis, no further analysis was made.

7.3.3. Multi-criteria analysis

Assigning the values
In Section 5.1, values were assigned to the alternatives. This step of the MCA forms the basis for the rest of the MCA and is therefor extremely important. However, there are two main flaws in this method that will be discussed below, namely that of its subjectivity and the consistency and viewpoint from which it was executed.

Subjectivity
As previously mentioned in the methodology section, the biggest disadvantage of the weighted sum method is that it is a highly subjective method. The scores given to the alternatives were based on literature research and by consulting experts from the RVO and the NEA, and were treated as objectively as possible. Nevertheless, because the research is of a qualitative, and therefore not exact nature, the scores are sensitive to mistakes and biases. Although this is not uncommon for qualitative research, it is important to take into account that if someone else were to duplicate this study, they could very well yield different results depending on the literature they found, how they interpreted it, and the experts they consulted. Especially concerning the consulted experts, although they aimed to answer the questions objectively, there is always an element of bias as people are influenced by past experiences and the places they have worked. If other experts had been approached, the weights of the criteria and the values assigned to the alternatives could have differed greatly.

Consistency and viewpoint
Another element that goes hand in hand with subjectivity is the viewpoint from which the research is executed and the consistency throughout. In this thesis, the choice was made to score the alternatives based on how well the instrument alleviated the risks belonging to each criteria, looking only at the instrument itself. Looking at the SDE++, it scored a 2 for policy risks for small-scale solar PV because little risk was associated with the policy itself. However, one could also say that it would have been more effective to score the instrument based on how well it decreases the overall policy risks of investing in small-scale solar PV, as the SDE++ covers only a fraction of the whole policy-related risks. If that were the case, it would perhaps have been awarded a much lower score. Therefore, if one were to take the policy instruments and the criteria used in this thesis and carry out a second MCA, the results could be different because the criteria and how well the alternatives score according to the criteria could be interpreted from a different angle. Although a conscience effort was made to be as consistent as possible in this viewpoint/interpretation, inconsistencies cannot be ruled out. The Climate Act, for example, is a much broader policy instrument and therefore looks at how it affects the policy risks as a whole, which has a different scoring viewpoint than the SDE++.

Standardisation method
The equation used to standardise the scores in step 4 of the MCA meant that the performances of the instruments ranged from 0 to 1. Because of this, instruments that scored negatively, which meant that they worsened the risks associated to the criteria, still managed to score positively in the final performance. This was done consistently throughout the MCA, which is why the final ranking is consistent and would not have yielded a different result if the performance could score negatively. However, the difference between the final values of the instruments could have been greater if negative numbers where used. Now, the values of the alternatives lie much close together than they should, which is incorrect.

Weights of the experts
When performing the BWM to assign weights to the criteria, all experts were treated as weighing the same. The choice was made to approach 6 experts from a range of different backgrounds: a subsidy specialist, a finance manager, two solar PV projects managers and two TEO project managers. Although Experts 1 and 2 have a high level of expertise in matters related to finances and subsidies, their knowledge on the specifics of small-scale solar PV and TEO is not as extensive as the project managers. Similarly, the solar PV experts' knowledge on TEO is not as reliable as the TEO experts' knowledge on TEO, and the TEO's experts' knowledge on solar PV is not as reliable as the solar PV experts' knowledge on small-scale solar PV. This is confirmed when looking at the ranking assigned by the experts, which are sometimes contradicting depending on the area of expertise. Looking at experts 3 and 4, who are solar PV and TEO experts, respectively, the rankings of the criteria for TEO differ greatly. It would therefore have been possible to assign weights to the different experts, weighing more where their level of expertise was highest. Because this was not done, some of the weights given by the experts could be seen as less reliable.

8
Conclusion

In this final chapter the thesis is concluded. Section 8.1 answers the main research question, followed by the sub-questions. Section 8.2 encompasses the recommendations for policy measures, followed by recommendations for ENGIE in Section 8.3. Finally, 8.4 presents the recommendations for future research.

8.1. Answering the research questions

The main research question is presented below.

How can policy measures create a good investment climate for small-scale solar photovoltaics and thermal energy from surface water in the Netherlands?

The sub-questions will first be answered, from which the main research question will follow.

SQ1: What policy measures are available to create a suitable investment climate and how can we assess their effects / performance?
Literature research has identified four types of policy measures that are able to influence investment decisions in RE generation and therefore create a more suitable investment climate. These four categories consist of fiscal and financial incentives, market-based incentives, direct governmental funding or investments, and policy and regulatory-related incentives. In terms of fiscal and financial incentives, feed-in tariffs, grants, subsidies, government loans and tax-based incentives are the most commonly used measures to influence the investment climate. Market-based instruments include cap and trade systems, and green certificates. Policy and regulatory-related incentives are needed due to continuously changing policies and regulations, which is why the instruments consist of creating more consistent policies and stronger regulations.

The effectiveness of these instruments can be assessed by performing a multi-criteria analysis, in which the instruments are used as the alternatives, and are tested against a number of criteria. The criteria are found in the literature as relating to barriers that characterise RE investments, and consist of the following: high capital costs, policy risks, regulatory risks, uncertainties regarding the long-term viability of the technology, long payback periods and public acceptance. By using the weighted summation method to calculate the values of the alternatives against the criteria, the effectiveness of the instruments is calculated.

SQ2: What does the Dutch energy regime look like and what are the drivers and barriers regarding the investment climate of the energy transition?
The Dutch energy regime is characterised by three main elements, namely the liberalisation policy, the focus on energy efficiency and the countries' history with natural gas. Due to the liberalisation policy, the energy regime is missing stricter regulations and more thorough policies. As the Netherlands is a relatively small and densely populated country with challenging geographic characteristics, it has long been the government's main energy policy to focus on a stable supply of energy, and to work on energy efficiency instead of generating renewable energy. Due to these path dependencies, the energy regime is hard-set in its old ways and sluggish to respond, which have a negative impact on the investment climate.

Although there is a significant oligopoly in the energy regime, one of the most important drivers for a better investment climate is the arrival of new entrants. Since 2001, new players have been competing against the incumbent actors, which has created more competition to innovate and put a higher priority on environmental impact instead of a purely economic priority. Through the creation of green labels and certificates, companies are increasing awareness and becoming more influenced by the need for public acceptance. This new competition and (somewhat) forced importance in public image is influencing energy companies to rethink their strategies and invest more in RE technologies.

SQ3: How do policy measures influence the investment climate of renewable energy technologies?
Using the proposed framework in Figure 2.3, policy measures influence the investment climate indirectly through four different elements, namely: through the energy regime, the NPV calculation, imitation and path-dependency. Financial or fiscal measures are able to influence the expectations of future cash flows, which creates a better investment climate through more positive NPV calculations. Through policy measures such as liberalisation, new entrants are able to enter the market and cause a healthier competition between the market actors. A more positive and dynamic investment climate is created, as actors observe how other companies are growing and thus choose to imitate their investment decisions. In terms of path-dependency, it is up to the government to help market players to break through old strategies, either by implementing enforcing instruments such as regulations, or through incentivising instruments such as subsidies or green certificates. Barazza & Strachan's (2020, p. 5) framework separates the NPV calculation, imitation, and path-dependency from the energy regime. However, each of these elements also influence the energy regime and cause it to reform. Through liberalisation, the regime has welcomed more market players and decreased the power of the oligopoly; through changing policies and regulations companies have been forced to think about sustainable entrepreneurship. Thus, by changing the characteristics of the energy regime, policies have also influenced how the regime makes investment decisions.

SQ4: How does the effectiveness of policy measures on the investment climate differ for solar PV and TEO in the Netherlands?
As can be seen in the table below, the effectiveness of policy measures for solar PV is slightly higher than for TEO, which is mostly due to the energy tax return policy, which does not apply to TEO. Besides that, most policy measures work equally well for both technologies.

Solar PV	Values	**TEO**	Values
SDE++	0,73	SDE++	0,70
Energy tax	0,61	Energy tax	0,49
EIA	0,86	EIA	0,83
ETS	0,68	ETS	0,67
GOs	0,67	GOs	0,64
Climate Act	0,48	Climate Act	0,51
Overall score	*4,04*	*Overall score*	*3,83*

Table 8.1: Final values of alternatives.

SQ5: How can energy companies in the Dutch energy market better respond to governmental policy measures?
Looking at the policy instruments discussed in this thesis and the results from the MCA, there are a number of takeaway points. In order to create a better investment climate, energy companies should use the policy instruments that are most effective in relieving investment barriers. From the literature research and the BWM, it was found that policy and regulatory risks, as well as financial factors, are the most important factors when investing in new RE technologies. There are two ways to relieve regulatory- and policy-related uncertainties, the first of which is to use instruments that score well for these criteria and thus decrease some of these risks. In this category, the SDE++, the EIA and the ETS score highest. The second tactic is to better anticipate upcoming regulatory and policy changes by staying informed of Climate Act-related developments. Since the Climate Act was passed in 2019, the government has had to be much more transparent about its progress and changes in policies. As part of the safeguarding cycle, the KEV report is published annually, which provides a detailed overview of the actual and the forecasted CO2-emissions, as well as which policies are currently implemented, and which ones are going to be implemented. Thus, although the Climate Act is extremely prone to changes, the KEV report could provide more security about upcoming changes.

In terms of the financial factors, the most effective policy instruments are the EIA, the SDE++ and the GOs. The EIA and the SDE++ are both technology-specific and can be used simultaneously to increase their effectiveness. GOs provide an advantage because when a company produces energy from RE sources, the company can sell the certificate and thus generate revenue. Thus, by using combinations of effective policy instruments, energy companies can better respond to policy measures to aid in creating a better investment climate.

Main research question: How can policy measures create a good investment climate for small-scale solar photovoltaics and thermal energy from surface water in the Netherlands? The answering of this question encompasses three parts: first, of understanding what a good investment climate is; second, understanding how policy measures influence the investment climate; and third, analysing which policy measures policy measures are most effective in creating a good investment climate for small-scale solar photovoltaics and thermal energy from surface water in the Netherlands. These three steps will each be discussed.

As defined in Section 2.2.1, a good investment climate exits of the following:

- A good investment climate generates profits for firms, as well as improves outcomes for society.
- In a good investment climate, policy makers foster credibility and stability.
- A good investment climate encourages businesses to invest in new technologies by reducing unjustified costs, (government-related) risks, and barriers.
- A good investment climate fosters competitive processes.
- A good investment climate makes it easier for firms to enter and exit markets in a process that contributes to productivity improvement and growth.
- A good investment climate is nurtured by broad public support, by a social consensus that can support ongoing policy improvements regardless of the political party or group in office.
- A good investment climate enables companies to expand, take advantage of international openness, and allow firms to climb the technological ladder.

The second part of answering the main research question was answered in *SQ3*, and the third part can be answered using the analysis from Section 6.1. Policy measures can thus create a good investment climate for small-scale solar PV and thermal energy from surface water by alleviating some of the barriers that prevent a good investment climate from being achieved. From the policy instruments that were used for the MCA, the EIA and the SDE++ were found to be the most effective in decreasing policy- and regulatory-related risks, as well as long payback periods and high capital costs. This aids in creating a good investment climate as policy makers foster more stability and credibility, which is a direct influence from the policy regime to the energy regime in Figure 2.3, and also by generating more profit for firms, which influences the NPV calculation.

Although less effective overall, other instruments influenced the investment climate in a different manner. The Climate Act and the GOs, for example, had a positive effect on public acceptance, which aids in creating broader public support and thus a better investment climate. These instruments too, affect the investment climate by first influencing the energy regime which then influences investment decisions. Although the effectiveness of the instruments is similar for both technologies, they were found to be slightly more effective for small-scale solar PV than for TEO.

8.2. Recommendations for policy makers

As the problem owner of this thesis is the government, the general recommendations are aimed at the policy makers. Looking at the results from the MCA, it is apparent that there are a number of instruments that are effective in creating a good investment climate for RE generation, such as the SDE++ and the EIA. As mentioned by Expert 3, the importance of the SDE++ is decreasing for solar PV because the technology has been sufficiently subsidised and improved in the past, so that it will no longer need to be subsidised in the near future. This goes to show the impact of efficient instruments, which means they need to continue to be implemented for other RE technologies.

From the case study of the Netherlands, it is obvious that the red thread that ties together all energy policies and the energy regime is the financial prospect. Although the financial instruments are valued as most effective, there is something to be said about creating more effective instruments that are non-financial and tackle other criteria. Literature research showed that uncertainty surrounding the long-term viability of a technology as well as public acceptance are extremely important criteria for creating a good investment climate. The execution of the BWM showed that although the importance of these criteria differs per expert, they are still seen as relevant. Nevertheless, when looking at the Dutch energy policy, little can be found on measures that tackle non-financial barriers. Seeing as a good investment climate is defined as existing of numerous factors of which many are non-financial, it is highly recommended to implement policy measures that address these factors.

8.3. Recommendations for ENGIE

Although barriers towards investing in RE technologies will continue to exist, it is certain that firms, as well as the rest of the Netherlands, will continue to need to decrease their CO_2-emissions for the foreseeable future. It is therefore recommended to use the policy instruments to gain an advantage in the market and in the energy transition.

From the MCA, it is clear that many of the policy instruments have a positive effect on the investment climate. The SDE++ and the EIA can be used simultaneously to significantly improve the NPV calculation for the RE projects. Although the energy tax is slightly less effective, it too can be used as a financial tool to improve the NPV calculation. As the barriers to invest are lowered by the instruments, more investments are done, allowing the technologies to improve and become cheaper, once again lowering the investment risks. This is a continuous cycle, but as it begins with the support from policy instruments such as subsidies, it is important to use these instruments so that the technology can continue to improve, and the business case become more positive, as is the case with solar PV. It is therefore recommended to use the policy instruments to ENGIE's advantage to become early adopters of new technologies.

ENGIE can furthermore generate revenues through the ETS and by obtaining and trading GOs. As the CO_2-emission cap will continue to be lowered, in the next few years, the demand for emission rights will continue to grow. Thus, if ENGIE produces more RE, it will emit less and therefore be able to sell its emission rights. Seeing as public acceptance continues to grow in importance, companies strive to improve their public image, many of which do this by buying green certificates. ENGIE can profit from this movement by obtaining green certificates for their renewably produced energy and selling them.

When assigning the weights to the criteria, the weights assigned by the only expert outside of ENGIE stood out significantly against the weights assigned by the ENGIE experts. This was because the ENGIE experts assigned a lot of importance to the financial criteria, whereas the sixth expert assigned much less importance to financial criteria and much more importance to public acceptance. It could therefore be of interest for ENGIE to look into broadening the importance they place on certain criteria to include non-financial criteria.

8.4. Future research

This research focused on the effect of a broad number of policy instruments on the investment climate for small-scale solar PV. From this, further research should be executed to further contribute to the scientific community.

As mentioned in Section 3.4, there were a number of reasons for choosing the policy instruments that were used as alternatives in the MCA, the most important of which is because the instruments covered a range of criteria and were adequately comparable with each other, resulting in a broad contribution of information to the scientific community. There are a number of recommendations for future research that build on this thesis.

Now that the effectiveness of such a broad number of instruments has been researched, future research should analyse instruments of a more specific nature. This includes instruments that are aimed at specific criteria, such as decreasing regulatory risks or increasing public acceptance, so that policy makers can use the results to adjust policies according to the most persistent barriers. Similarly, future research should be done using instruments that are aimed at specific technologies. There are a number of policy instruments that are specific for the generation of solar PV, however, they were not used in this research because the aim was to analyse instruments that were applicable to both technologies. However, future research on the subject of the investment climate for RE generation should analyse the investment climate per technology, by including instruments specific to the technologies. This way, the knowledge-base per technology is increased.

Besides other instruments, further research should include different criteria. As mentioned in Section 7.3, one of the biggest limitations of this thesis was the economic perspective and the choice that was made to focus purely on economic criteria. It is highly recommended that, in the future, similar studies include environmental criteria, as well as other criteria that play a role in creating a good investment climate. It would also be of interest to perform the research from different perspectives that tackle different factors of a good investment climate, such as a social perspective on how to increase public support, or on how to increase the competitive processes between businesses. This way, other criteria would be analysed which would further contribute to the scientific community.

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Appendices

A

Literature review table

Literature	Drivers of Dutch energy transition												Barriers of Dutch energy transition								
	Governmental							Market-based				Societal	Governmental		Market-based			Societal		
	Policy	ETS	Energy efficiency	Subsidies	Awareness	Tax exemption schemes	Cooperative-based	New entrants	Cooperative-based	Awareness	Job creation	Citizen initiatives	Policy	Regulation	Incumbent actors	Natural gas	Investment costs	Investment costs	Mistrust	Social acceptance
("Energy Report," 2016)		X	X	X	X	X	X													
(Akerboom et al., 2020)					X											X				
(Backhaus, 2019)			X	X	X	X	X		X									X		
(Bosman et al., 2014)	X							X				X	X	X						
(Bulavskaya & Reynès, 2018)											X									
(Deloitte, 2015)		X	X	X		X							X							
(Hasanov & Zuidema, 2018)												X								
(IEA, 2020a)	X	X		X									X							
(IEA, 2020b)	X	X	X	X		X											X	X		X
(Jansma et al., 2020)				X														X	X	
(Kemp & Rotmans, 2009)													X							
(Kern & Howlett, 2009)													X		X					
(Ludovico et al., 2020)								X	X											
(PBL et al., 2020)	X		X	X									X							
(Verbong & Geels, 2007)	x					X		X		X							X	X		

Figure A.1: Literature review table of the drivers and barriers of the Dutch energy transition.

B
Experts

Expert 1 – ENGIE
Specialist in subsidy policy and the implementation of subsidies in energy/environmental-related projects.

Expert 2 – ENGIE
Specialist in finance management with expertise in the fields of business administration, corporate finance, sustainable assets, innovation & technology.

Expert 3 – ENGIE
Specialist in solar project development.

Expert 4 – ENGIE
Specialist as a business developer for a range of projects within the energy transition, such as thermal energy from surface water, local energy cooperates, and tender management.

Expert 5 – ENGIE
Specialist in solar project development.

Expert 6 – Ennatuurlijk
Specialist in the phasing out of gas in the Netherlands through project development related to making the heat network more sustainable by implementing renewable energy sources, such as thermal energy from surface water.

Expert 7 – ENGIE
Consultant on business development in the energy transition.

Expert 8 – Netherlands Enterprise Agency
Advisor at the NEA, specialist in all subsidies offered by the NEA.

Expert 9 – Dutch Emissions Authority
Lawyer at the DEA.

C
BWM scores

Criteria Number = 6	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
Names of Criteria	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Select the Best	Capital costs					
Select the Worst	Viability of					
Best to Others	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Capital costs	1	8	6	8	2	7
Others to the Worst	Viability of					
Capital costs	8					
Regulatory risks	3					
Policy risks	4					
Viability of technology	1					
Payback periods	7					
Public acceptance	4					
Weights	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
	0,44732577	0,068071313	0,09076175	0,04376013	0,272285251	0,077795786
Ksi*	0,097244733					

Figure C.1: Weights assigned to criteria for small-scale solar PV by Expert 1.

Criteria Number = 6	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
Names of Criteria	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Select the Best	Payback					
Select the Worst	Public					
Best to Others	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Payback periods	3	2	5	7	1	8
Others to the Worst	Public					
Capital costs	6					
Regulatory risks	7					
Policy risks	4					
Viability of technology	3					
Payback periods	8					
Public acceptance	1					
Weights	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
	0,1592719	0,23890785	0,09556314	0,068259386	0,39817975	0,039817975
Ksi*	0,07963595					

Figure C.2: Weights assigned to criteria for thermal energy from surface water by Expert 1.

Criteria Number = 6	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
Names of Criteria	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Select the Best	Payback					
Select the Worst	Viability of					
Best to Others	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Payback periods	3	6	2	9	1	7
Others to the Worst	Viability of					
Capital costs	7					
Regulatory risks	4					
Policy risks	8					
Viability of technology	1					
Payback periods	9					
Public acceptance	3					
Weights	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
	0,163286004	0,081643002	0,244929006	0,035496957	0,404665314	0,069979716
Ksi*	0,085192698					

Figure C.3: Weights assigned to criteria for small-scale solar PV by Expert 2.

Criteria Number = 6	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
Names of Criteria	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Select the Best	Payback					
Select the Worst	Public					
Best to Others	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Payback periods	3	2	5	7	1	8
Others to the Worst	Public					
Capital costs	6					
Regulatory risks	7					
Policy risks	4					
Viability of technology	3					
Payback periods	8					
Public acceptance	1					
Weights	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
	0,1592719	0,23890785	0,09556314	0,068259386	0,39817975	0,039817975
Ksi*	0,07963595					

Figure C.4: Weights assigned to criteria for thermal energy from surface water by Expert 2.

Criteria Number = 6	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
Names of Criteria	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Select the Best	Payback					
Select the Worst	Viability of					
Best to Others	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Payback periods	2	7	4	7	1	2
Others to the Worst	Viability of					
Capital costs	7					
Regulatory risks	2					
Policy risks	4					
Viability of technology	1					
Payback periods	7					
Public acceptance	7					
Weights	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
	0,215384615	0,061538462	0,107692308	0,041025641	0,358974359	0,215384615
Ksi*	0,071794872					

Figure C.5: Weights assigned to criteria for small-scale solar PV by Expert 3.

Criteria Number = 6	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
Names of Criteria	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Select the Best	Payback					
Select the Worst	Public					
Best to Others	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Payback periods	3	7	2	5	1	8
Others to the Worst	Public					
Capital costs	6					
Regulatory risks	3					
Policy risks	7					
Viability of technology	7					
Payback periods	8					
Public acceptance	1					
Weights	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
	0,167136965	0,071630128	0,250705448	0,100282179	0,378337313	0,031907966
Ksi*	0,123073584					

Figure C.6: Weights assigned to criteria for thermal energy from surface water by Expert 3.

Criteria Number = 6	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
Names of Criteria	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Select the Best	Payback					
Select the Worst	Viability of					
Best to Others	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Payback periods	5	3	3	8	1	4
Others to the Worst	Viability of					
Capital costs	5					
Regulatory risks	6					
Policy risks	6					
Viability of technology	1					
Payback periods	8					
Public acceptance	5					
Weights	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
	0,099722992	0,166204986	0,166204986	0,038781163	0,404432133	0,12465374
Ksi*	0,094182825					

Figure C.7: Weights assigned to criteria for small-scale solar PV by Expert 4.

Criteria Number = 6	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
Names of Criteria	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Select the Best	Regulatory					
Select the Worst	Capital costs					
Best to Others	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Regulatory risks	6	1	3	4	2	5
Others to the Worst	Capital costs					
Capital costs	1					
Regulatory risks	6					
Policy risks	3					
Viability of technology	4					
Payback periods	5					
Public acceptance	2					
Weights	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
	0,048439182	0,371367061	0,150699677	0,113024758	0,226049516	0,090419806
Ksi*	0,08073197					

Figure C.8: Weights assigned to criteria for thermal energy from surface water by Expert 4.

Criteria Number = 6	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
Names of Criteria	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Select the Best	Payback					
Select the Worst	Public					
Best to Others	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Payback periods	2	2	6	7	1	8
Others to the Worst	Public					
Capital costs	7					
Regulatory risks	7					
Policy risks	3					
Viability of technology	2					
Payback periods	8					
Public acceptance	1					
Weights	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
	0,2208413	0,2208413	0,073613767	0,063097514	0,381453155	0,040152964
Ksi*	0,060229446					

Figure C.9: Weights assigned to criteria for small-scale solar PV by Expert 5.

Criteria Number = 6	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
Names of Criteria	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Select the Best	Payback					
Select the Worst	Public					
Best to Others	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Payback periods	2	2	6	3	1	8
Others to the Worst	Public					
Capital costs	7					
Regulatory risks	7					
Policy risks	3					
Viability of technology	6					
Payback periods	8					
Public acceptance	1					
Weights	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
	0,206896552	0,206896552	0,068965517	0,137931034	0,344827586	0,034482759
Ksi*	0,068965517					

Figure C.10: Weights assigned to criteria for thermal energy from surface water by Expert 5.

Criteria Number = 6	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
Names of Criteria	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Select the Best	Policy risks					
Select the Worst	Capital costs					
Best to Others	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Policy risks	9	4	1	7	6	3
Others to the Worst	Capital costs					
Capital costs	1					
Regulatory risks	7					
Policy risks	9					
Viability of technology	3					
Payback periods	5					
Public acceptance	8					
Weights	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
	0,037234043	0,142730496	0,453014184	0,081560284	0,095153664	0,190307329
Ksi*	0,117907801					

Figure C.11: Weights assigned to criteria for small-scale solar PV by Expert 6.

Criteria Number = 6	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6
Names of Criteria	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Select the Best	Regulatory					
Select the Worst	Capital costs					
Best to Others	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
Regulatory risks	8	1	2	7	6	3
Others to the Worst	Capital costs					
Capital costs	1					
Regulatory risks	8					
Policy risks	7					
Viability of technology	3					
Payback periods	4					
Public acceptance	5					
Weights	Capital costs	Regulatory risks	Policy risks	Viability of technology	Payback periods	Public acceptance
	0,040462428	0,404624277	0,242774566	0,069364162	0,080924855	0,161849711
Ksi*	0,080924855					

Figure C.12: Weights assigned to criteria for thermal energy from surface water by Expert 6.