Overcoming barriers to the transition to renewable energy sources:

A study on the barriers to and support mechanisms for the implementation of PV solar plants in the Netherlands

By

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Abstract

To combat climate change, the transition from fossil fuels to renewable energy sources is key. A mature source of renewable energy is PV solar, which therefore plays an important role in the energy transition of EU Member States. This research focuses on the Netherlands, which aims to generate 35 TWh renewable energy on land by 2030, for which PV solar plants play an important role. The Dutch government has put both economic as well as non-economic support mechanisms in place to support this transition. However, barriers to the implementation of PV solar plants persist and threaten the achievement of the Dutch climate goals. This research has identified key barriers to the implementation of PV solar plants in the Netherlands and has assessed the support mechanisms of the Dutch government in order to answer the research question of '*how does government support help to overcome the barriers to PV solar implementation?'*. To answer this question, qualitative semi-structured interviews were held with developers and close stakeholders to the development of PV solar plants in the Netherlands. With the field-knowledge of these interviewees, this research was able to identify key barriers, the phases of implementation in which these barriers occur and lacunae in the Dutch policies. In the results, it became apparent that the economic support of the Netherlands is quite sufficient, but non-economic barriers, such as a lack of grid connection and capacity, scarcity of space to accommodate the plants, delays in the permit process, qualitative and quantitative shortcomings of local administrations and the NIMBY phenomenon hamper the achievement of the 2030 targets. Therefore, governments should pay equal attention to the non-economic barriers to the transition to renewable energy sources. This research has put forward several recommendations to the Dutch government on how to better tackle the barriers.

Acknowledgements

While COVID-19 put a stop to everyday life and confined the world to their homes for the most part of 2021, I stayed busy, spending the greatest part of the year writing this thesis and working as an intern for Arcadis Nederland. I could not have done this without the support and assistance I have received in these months, and I would like to express my gratitude to the following people. First, I would like to thank my supervisors Rob Bolder from Utrecht University and Filip Černoch from Masaryk University for their guidance, patience, and time, and coordinator Marij Swinkels for her guidance of the thesis and internship process and the check-ups. Second, I would like to thank my colleagues at Arcadis for the great internship and in particular Hannes Sanders and Martijn de Ruiter for giving me the opportunity to write my thesis at Arcadis. Also from Arcadis I would like to specifically thank Jolijn Posma, who welcomed me into her team, and Frank Gierman, Stijn van Dijck and Ron Vreeker for their contributions to my research. I cannot wait to continue working at Arcadis, starting as a junior consultant this September. Finally, I would like to thank my girlfriend, my family, my friends, and the Brno group of the European Governance master's for their infinite care and support. The time and energy I have put into this work has been a valuable experience and a worthy ending of the fantastic European Governance master's program.

Table of Content

List of abbreviations

ACM:	Dutch Competition Authority
CCS:	Carbon Capture and Storage
DG:	Directorate General
EU:	European Union
FIP:	Feed-in Premiums
FIT:	Feed-in Tariffs
GHG:	Green House Gases
GW:	Gigawatt
IEA:	International Energy Agency
KWh:	Kilowatt Hour
LCOE:	Levelized Cost of Electricity
MB:	Marginal Benefit
MC:	Marginal Cost
MS:	Member States
NECP:	National Energy and Climate Plan
NIMBY:	Not In My Backyard
NP RES:	National Program Regional Energy Strategy
PV solar:	Photovoltaic solar power
R&D:	Research and Development
RED II:	Recast Renewable Energy Directive (2018)
RES:	Renewable Energy Sources
RES-E:	Renewable Electricity Sources
RET:	Renewable Energy Technology
SDE++:	Stimuleringsregeling Duurzame Energieproductie ++
TEU:	Treaty on European Union
TGC:	Tradeable Green Certificate
TWh:	Terawatt Hour

Introduction

Combating climate change is one of the major tasks of our generation. On all levels of governance, policies aiming to combat climate-change by reducing CO_2 and other pollutants have been introduced in recent decades. In 2015, the European Union (EU) launched its Energy Union Strategy, consisting of five dimensions. One of these dimensions is *'decarbonizing the economy: pushing for a global deal for climate change and encouraging private investment in new infrastructure and technologies'* (European Commission, 2015). As the sharpest decline in greenhouse gas (GHG) emissions can be achieved by transitioning to 100 percent renewable energy, the transition from fossil fuels to renewable energy sources (RES) is a key aspect of achieving the climate goals (SolarPower Europe, 2020). Directive 2003/54/EC concerning common rules for the internal market in electricity defined RES as '*renewable non-fossil energy sources (wind, solar, geothermal, wave, tidal, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases)*'. Part of the transition to RES is a transition to renewable electricity sources (RES-E). Within this transition, an increase of RES-E generation on land (wind or solar energy) is needed. An important RES-E is photovoltaic solar power (PV solar), as it is becoming cost-competitive with fossil fuels (IRENA, 2020). Between 2010 and 2019, the global weighted-average levelized cost of electricity (LCOE) of utility-scale PV solar fell with 82 percent (IRENA, 2019). PV solar has thus become a mature RES-E. Therefore, in order to achieve their national climate targets, EU Member States (MS) increasingly focus on PV solar. In their 2020 EU Market Outlook for Solar Power, SolarPower Europe (2020) write that the top 10 EU solar markets will install 98.5 GW in PV solar from 2021 until 2024 in their medium scenario, between 55.1 GW in the low scenario and 130.7 GW in the high scenario.

As part of the implementation of the Energy Union Strategy, the Clean energy for all Europeans package was published in 2018, wherein an EU-wide target was set by the recast Renewable Energy Directive from 2018 (RED II) at a share of at least 32 percent for renewable energy in the EU by 2030. Formally enshrined in the Treaty on European Union (TEU) from 1992, also known as the Maastricht Treaty, is the principle of subsidiarity. Renewable energy, as part of environment, is a shared competence between the EU and its MS. Therefore, while the EU sets targets, MS are free to design their own policies that contribute to meeting the EU-wide target. This has led to twenty-seven support schemes for renewable energy in the EU as well (Rusche, 2015). Regulation (EU) 2018/1999 does oblige MS to submit a National Renewable Energy Action Plan (NECP) before 2020, in which they explain how they intend to achieve their own targets, contributing to achieving the EU-wide target for 2030.

As an EU MS, The Netherlands aims to increase the total share of RES from 8.7 percent in 2019 to 27 percent in 2030. The Commission has deemed a Dutch contribution of 26 percent as reasonable (Government of the Netherlands, 2019). For the total share of RES-E the Netherlands aims for an increase from 18 percent to 75 percent in the same period. With regard to RES-E, as stated in their NECP, by 2030, The Netherlands aims to generate:

- ~ 49 TWh wind energy offshore;
- ~ 35 TWh of renewable energy on land (wind energy and solar power);
- ~ 10 TWh by small-scale renewable electricity generation from e.g. private solar panels.

PV solar experienced recent growth in The Netherlands, as the Centraal Bureau voor de Statistiek (2021) in Figure 1 below shows. In their ‘EU Market Outlook For Solar Power 2020-2024’, SolarPower Europe (2020) predicts that The Netherlands will remain to be in the top three European PV solar installation markets for the period of 2021-2024.

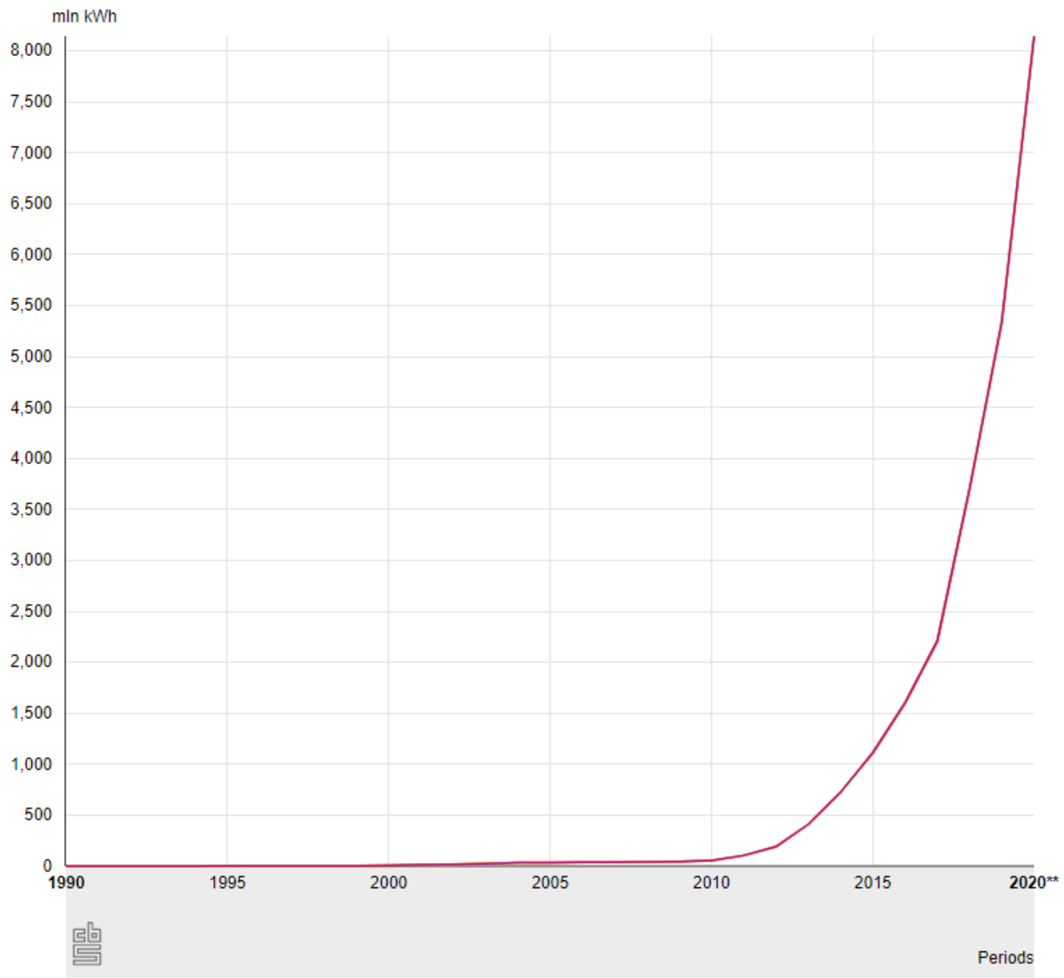


Figure 1: renewable electricity production in million kWh: PV solar (CBS, 2021)

However, in academic literature on implementation of PV solar, various barriers, that need to be overcome to achieve the climate goals, are identified. These barriers are of both economic as of non-economic nature. Interest group reports and media on the current state of affairs of PV solar development in the Netherlands write on these barriers as well. For example, SolarPower Europe foresees a lack of grid capacity, the availability of land and social acceptance as barriers (SolarPower Europe, 2020). PV-magazine (2019) sees the grid constraints as a serious threat to solar deployment as well. In addition, under the new SDE++ scheme, solar energy has to compete with more technologies, such as Carbon Capture and Storage (CCS), as well (SolarPower Europe, 2020; IEA, 2020). These concerns are realistic. On May 9th, 2021, the Dutch government announced that CCS projects would receive €2 billion in SDE++ subsidies (NOS, 2021). Therefore, while the Netherlands has increased its PV solar production in recent years and has become a European frontrunner, there are still barriers that need to be overcome in order to achieve the 2030 targets.

First of all, this begs the question of what barriers exist in the transition to RES-E and specifically the implementation of PV solar. Moreover, in order to tackle these barriers, it is necessary to understand in which implementation phase these barriers occur. Finally, the question of what the role of the Dutch government is in overcoming the barriers is raised. The problem statement leads to the following research question:

How does government support help to overcome barriers to PV solar implementation?

In order to answer this research question, the following sub-questions need to be answered:

1. What barriers exist in the transition to renewable electricity?
2. What barriers exist in the implementation of PV solar plants in the Netherlands?
3. Which implementation phase do these barriers in the Netherlands occur in?
4. What is the role of the Dutch government in overcoming these barriers?

This research aims to identify the barriers for the implementation of RES on land projects. In order to overcome these barriers, it is important that stakeholders and policymakers understand these barriers. The research will thus provide a description of the most important barriers to the implementation of PV solar plants and tailor this to the Netherlands. Via Arcadis, a global engineering, design and consultancy company, this research has unique access to implementation projects of PV solar in the Netherlands. In addition to academic literature on barriers for RES implementation, this research will thus provide unique experiences from developers of PV solar plants in the field. This research will therefore firstly add specific evidence to the academic literature on barriers to the transition to RES and specifically PV solar for the Netherlands. Moreover, once the key barriers and causes of these barriers in the Netherlands have been identified, this research will assess the government response to the barriers and give recommendations to better the governance framework in order to tackle the identified key barriers.

This research is organized as follows. After this introduction, the first chapter introduces a literature review, which includes the theoretical framework, on barriers to RES implementation, support mechanisms to overcome the barriers and on the climate policies of the Netherlands. The second chapter lays out the methodology that is used to conduct the research. The third chapter presents the results of the interviews. Finally, the fourth chapter provides a discussion of the results with academic literature and Dutch climate policy and policy recommendations for government support for RES. Moreover, the limitations of the research and suggestions for future research are presented.

Chapter 1: Literature review

The aim of this study is to identify barriers hindering the implementation of PV solar plants in the Netherlands and to evaluate the Dutch government's support mechanisms. In order to understand which barriers could potentially be obstructing, a literature review on RES barriers is conducted first. Subsequently, a literature review wherein government support mechanisms aiming to overcome the aforementioned barriers is set out. Finally, the Dutch climate policy is discussed.

1.1 Barriers to RES implementation

In academic literature on RES, authors have written on barriers and drivers for its deployment. Painuly (2001) established a framework for analysis. For this framework, Painuly (2001) developed several categories of barriers: 'market failure/imperfection', 'market distortions', 'economic and financial', 'institutional', 'technical', 'social/cultural/behavioral' and 'others'. He notes that this categorization is not rigid, as some barriers could belong in multiple categories. After Painuly, various other scholars have categorized barriers that prevent RES from competing with traditional energy sources differently, whereby some focused on RES in general, such as Seetharaman et al. (2019) who focused on RES in general and distinguish between social, economic, technological and regulatory barriers, while others focused on specific countries and/or specific RES. For example, Eleftheriadis and Anagnostopoulou (2015) focused on the diffusion of wind and PV solar power in the Greek electricity sector and differentiate between barriers affecting resource mobilization, guidance of search and market formation barriers and legitimization. Nam Do et al. (2020) have conducted a case study on PV solar in Vietnam and differentiate between technical, institutional, economic, and social barriers. Zhang et al. (2012) conducted a case study on PV solar in Hong-Kong and differentiate between technical, economic, social, and political barriers. Nasirov et al. (2015) have focused on renewable energy deployment in Chile and differentiate between legal and regulatory framework barriers, economic and financial related barriers, technical and infrastructure barriers, and public awareness and information barriers. Haas et al. (2018) conducted a case study on Chile as well, with specific focus on PV solar. They differentiate between economic and financial barriers, market barriers, system integration barriers, solar-technical barriers, regulatory barriers, and information barriers.

Not only academic scholars focused on RES barriers, but institutions as well. In 2011, the International Energy Agency (IEA) developed a framework for barriers to Renewable Energy Technology (RET) deployment. The framework firstly distinguishes between economic and non-economic barriers. For economic barriers, it is the costs of RETs that are the barrier to their market introduction, as RES have to compete with fossil fuels on the energy market. Non-economic barriers are the barriers that persist even when economic barriers have been addressed, but their financial impact can be significant. These barriers are categorized by the IEA as: regulatory and policy uncertainty barriers, institutional and administrative barriers, market barriers, financial barriers, infrastructure barriers, and public acceptance and environmental barriers. However, as Figure 2 shows, barriers can lie in multiple barrier categories. These barrier-categories are schematized in the following figure:

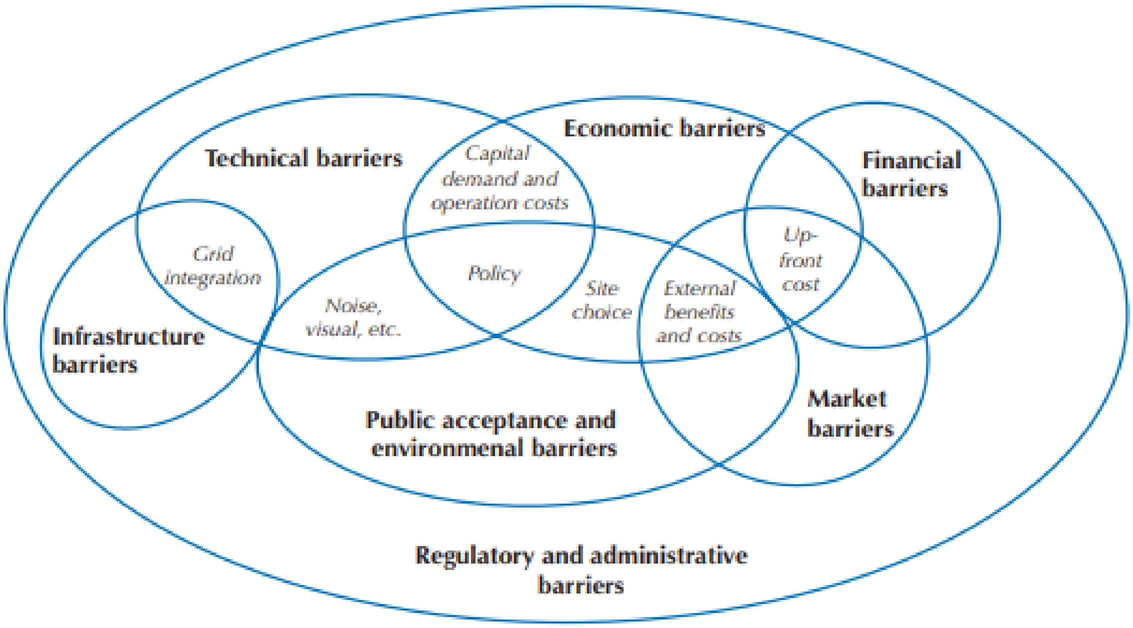


Figure 2: Barriers to RET deployment (IEA, 2011)

Examples of economic barriers include high up-front capital costs for investors (Nam Do et al., 2020; Nasirov et al., 2015; Painuly, 2001; Zhang et al., 2012; Eleftheriadis & Anagnostopoulou, 2015) and insufficient financing schemes (Haas et al., 2018; Eleftheriadis & Anagnostopoulou, 2015). Examples of non-economic barriers include a lack of competition (Painuly, 2001). grid connection constrains and a lack of grid capacity (Nasirov et al., 2015; Eleftheriadis & Anagnostopoulou, 2015; Haas et al., 2018), a lack of technically skilled personnel (Painuly

(2001), Zhang et al. (2012), Nasirov et al. (2015), Haas et al. (2018), Eleftheriadis & Anagnostopoulou (2015), Seetharaman et al. (2019), local opposition to the development of projects (Nasirov et al., 2015; Eleftheriadis & Anagnostopoulou, 2015), and delays in the issuance of building permits (Nasirov et al., 2015; Eleftheriadis & Anagnostopoulou, 2015). As a large number of barriers were addressed in academic literature, barriers mentioned in the various academic articles are schematized in the table added as an Annex to this thesis.

1.2 Overcoming barriers to RES implementation

Government and industry share many objectives in establishing a market for RES. According to the IEA (2011), government objectives of RES policy are firstly to stimulate RES activity as part of a broad energy strategy, which in the EU's case is the Energy Union, and secondly, to do this as cost-effectively as possible. Based on the Intergovernmental Panel on Climate Change report on technology transfer (Metz et al., 2000), Painuly (2001) argues that government intervention is necessary to promote RETs. Intervention is multifaceted and includes actions such as building human and institutional capacity, R&D infrastructure, establishing an environment that encourages investment, generic actions to remove barriers and providing information that promotes RETs.

In 2013, the European Commission put out a guidance for the design of renewables support schemes in which it argued in favor of more market exposure for renewables producers. The aim of government support is to promote positive externalities and assist infant industries, in which there is little involvement of the private sector (White et al., 2013). As governments rely on industry investments and on other stakeholders to deliver the projects, it is a government task to establish an environment in which these actors are confident to earn a return on their investment. As there are economic and non-economic barriers, policies intended to overcome barriers can be distinguished in the same way. Mostly, support policies focus on the reduction of economic barriers, however, non-economic support in the form of legislation and a regulatory framework that supports the diffusion of RES is often required as well (IEA, 2011).

1.2.1 Economic support

The cost of RES is oftentimes a barrier to their market introduction, as they have to compete with less costly fossil fuels on the energy market. To achieve the transition to RES, as part of their climate goals, governments have implemented support policies to make RES cost competitive. The figure below this paragraph from the IEA (2011) demonstrates the role of policy intervention. On the left, the price difference between conventional (fossil) energy sources and RES is demonstrated. Without policy intervention, RES are not cost-competitive and will thus not be used, and in turn, its environmental benefits will not be obtained. On the right, two policy interventions are demonstrated. Firstly, the negative externalities of conventional (fossil) energy sources are taxed, thus increasing its cost. Secondly, the cost of RES is reduced with subsidy schemes for RES. This thus leads to RES becoming cost-competitive.

Figure E.2 **Factors influencing RE competitiveness and the role of policies**

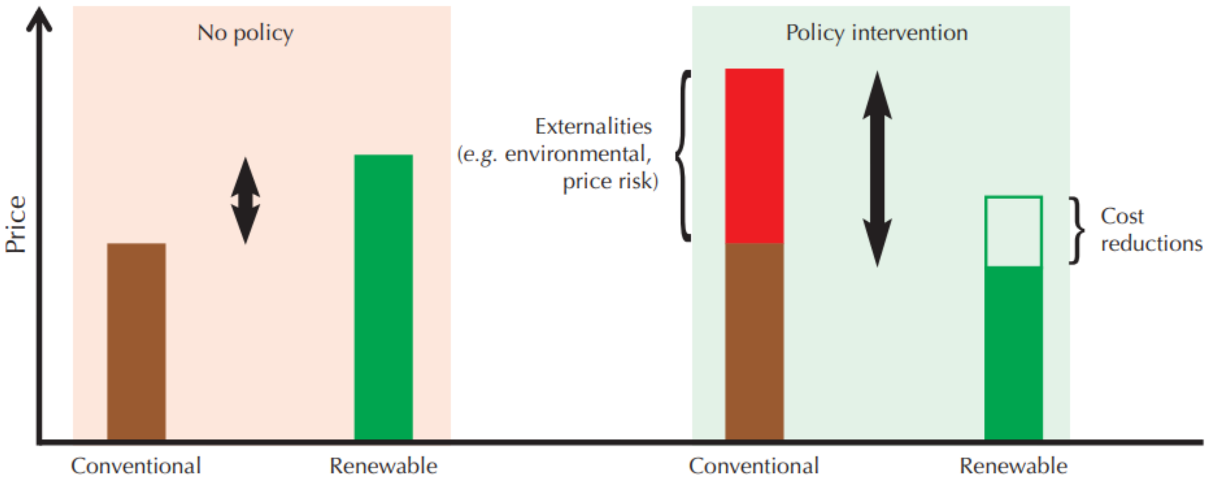


Figure 3: the role of policy intervention (IEA, 2011)

Therefore, to promote the positive environmental externalities of RES and combat the negative environmental externalities of fossil fuels, governments have implemented Pigouvian subsidies and taxes respectively (Lambert, 2017). Pigouvian price-based instruments are thus the basis for market-based instruments of regulation to promote RES (Rusche, 2015). The following figures demonstrate the effects of Pigouvian taxes and subsidies. Figure 4 demonstrates the effect of Pigouvian taxes. Due to the tax increasing the marginal cost (MC) of fossil fuels, the break-even point shifts from Q_X to Q_C. Therefore, the cost price of fossil fuel production increases, which in turn leads to a decrease in production of fossil fuels and thus to a decrease of its negative environmental externalities.

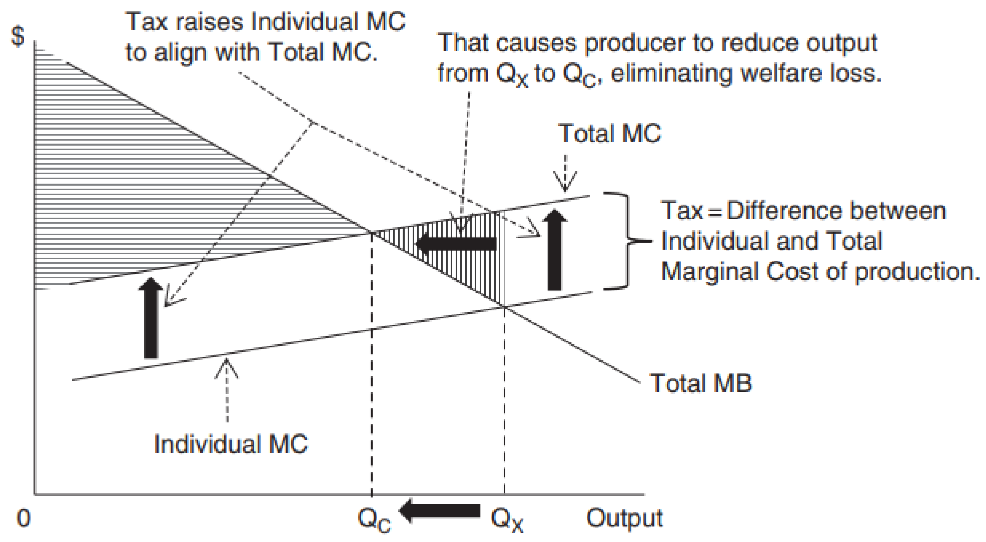


Figure 4: the effect of Pigouvian tax (Lambert, 2017)

Figure 5 demonstrates the effect of Pigouvian subsidies. The aim of the subsidy is to stimulate the production of RES by lowering its cost price. With the subsidy, the marginal benefit (MB) of producing RES is increased. This increase of the benefits of producing RES leads to an increase of production of RES, which is seen by the break-even point shifting from Q_X to Q_C. Therefore, subsidies increase the cost-competitiveness of RES, which leads to positive environmental externalities.

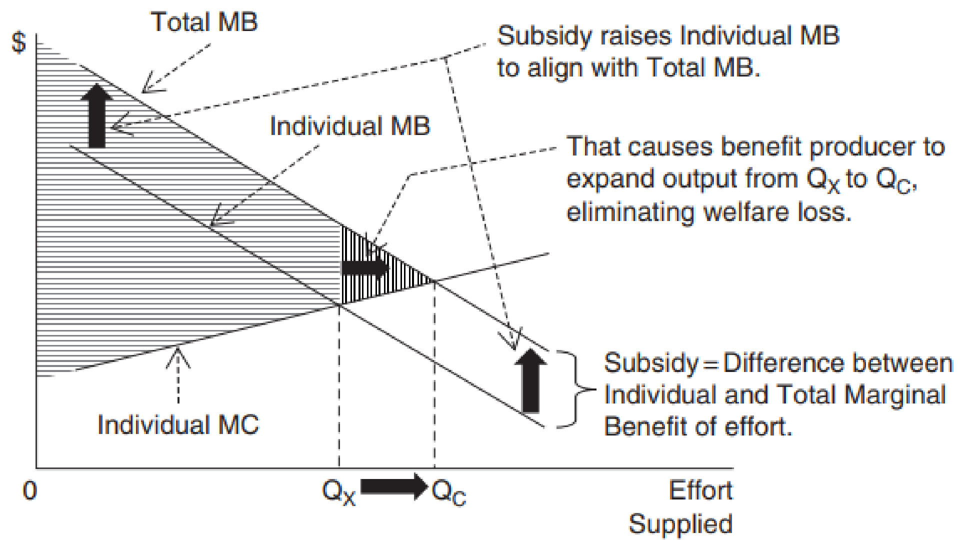


Figure 5: the effect of Pigouvian subsidy (Lambert, 2017)

With regard to Figure 5, in order to promote an increase of RES in the energy mix, thus to overcome economic barriers, MS have implemented support schemes. As different designs for support schemes exist, it is up to MS to consider the one that fits best. Options for support mechanisms include Feed-in Tariffs (FIT) and Feed-in Premiums (FIP), Tradeable Green Certificates (TGC), tenders, tax incentives, and capital grants (IEA, 2011). With FIT, a fixed payment for each unit of electricity generated, independent from the market price of electricity, is provided (ECOFYS, 2014). The generator of RES-E is thus guaranteed a fixed price per KWh electricity generated for a long period of time. FIP is a similar scheme, but instead of a fixed payment, an additional payment (premium) on top of the electricity market price is provided (IEA, 2011). Quota obligations are a different scheme compared to FIT/FIP, whereby certificates for green energy (tradable green certificates (TGCs) are given, which can be sold to actors that are obliged to meet a quota obligation. In this way, the certificates provide another source of income for power plant operators, on top of the market price for electricity (ECOFYS, 2014). A fourth type of economic support is tenders. In this scheme, developers apply to the tender and name the price for which they can build the project. With tenders, governments can set a certain capacity of certain RETs it wishes to have installed, whereby it can ask for specific requirements. Oftentimes, the bidder is chosen based on cost-efficiency (IEA, 2011). Tax incentives or credits are another scheme whereby tax credits can be traded. These tax credits can be used by companies to deduct the amount from their taxes (IEA, 2011). A final scheme mentioned by the IEA (2011) is direct capital grants, whereby developers receive a percentage of their investment back. In their 2011 report, the IEA schematized characteristics of various support schemes, as shown in Figure 6 below.

	FIT/FIP	TGC	Tender	Tax incentive	Capital grant
Deployment volume management	Difficult unless designed with capacity cap.	Built-in but not technology specific.	Good.	None.	Possible via cap on grant volumes.
Price control	Very specific control possible; frequent reviews required.	Price capped by buy-out fee and set by market; price floors can be introduced.	Good.	None.	Possible by setting maximum grant levels.
Investor security	High, some exposure to electricity market fluctuations for FIPs.	Exposed to electricity and certificate market risks; can be mitigated by floors.	High once concession is obtained, very low during bidding phase.	High but susceptible to budget cuts.	High but susceptible to budget cuts; especially attractive at high discount rates.
Transaction costs/ complexity	Relatively simple if procedures streamlined and applicable to small developers.	Complex, best for larger developers; can be mitigated by introducing public buyer for small projects.	Relatively straightforward but best for larger projects; risk of too aggressive bidding and "gaming".	Relatively simple as part of overall tax management.	Relatively simple.

Figure 6: RES support schemes analysis (IEA, 2011)

While MS and academics agree on the need for support of RES, both between MS and academics there is no consensus on which support scheme promotes RES the best. Part of this debate is whether the support should be technology-neutral or technology-specific. Technology-neutral policies often aim to price externalities or subsidize deployment of the technology and research and development (R&D). Technology-specific policies promote selected technologies, sectors or projects and is based on differentiated support levels. FIT is often adopted as a technology-specific support scheme (Lehmann & Söderholm, 2018). The frequent criticism of technology-specific policies is that it is too costly. Technology-neutral policies on the other hand promote the least costly technologies first (Lehmann & Söderholm, 2018).

The economic support for RES depends on the cost-competitiveness of RETs. Throughout the transition from fossil fuels to RES, RES depended on government support in order to compete with fossil fuels. However, as RES are becoming increasingly competitive, the justifiability of economic RES support is becoming more debatable. There are three factors that determine whether or not economic support is justifiable (IEA, 2011, 78).

- Firstly, by calculating the levelized cost of energy (LCOE), various technologies can be compared. However, the LCOE does not consider the benefits of reducing of negative externalities from fossil fuels by transitioning to RES. Those are not internalized in the calculation. Therefore, with economic support for RES, environmental benefits are obtained (IEA, 2011; ECOFYS, 2014).
- Secondly, RES and fossil fuels have different patterns of expenditure. For many RETs, there are one-time, high up-front costs, but the operational costs are less. Therefore, once invested in RES, costs for energy generation are stable. For fossil fuels, the opposite is the case, as capital costs are lower, but operational costs are more fluctuating (IEA, 2011).
- Finally, as there are different RETs, there are different levels of maturity among the RETs. In turn, for different RETs, different levels of support are justified. As the benefits of RETs lie beyond the short-term, support to be able to enter the market is necessary. PV solar and wind are seen as mature RETs (IEA, 2011; Commission, 2013).

Subsequently, it is important to note that in the EU, economic support for RES also cannot be unlimited. The EU has a strict competition law. The European debt crisis that started in 2010 forced MS to reconsider their RES support. In response, DG Competition seized this moment to issue Guidelines for State Aid for Energy and Environmental Protection in 2014. In the European Commission Guidance for the design of renewables support schemes (2013), the Commission called for more market exposure to be imposed on RES producers. Support schemes with more market exposure are for example competitive allocation mechanisms, such as tenders and auctions, and leads to preference for FIP rather than FIT for mature RES. Subsequently, in the 2014 Guidelines, instead of the FIT schemes that MS implemented, the Commission required a FIP as aid for electricity and that *'aid is granted in a competitive bidding process on the basis of clear, transparent and non-discriminatory criteria'* (European

Commission, 2014). In the guidelines, the Commission stated another important development. The EU expected RES to become grid-competitive between 2020 and 2030, which would mean that subsidies should be phased out degressively (European Commission, 2014).

1.2.2 Non-economic support

MS intend to overcome the economic barriers to transition to RES with financial and fiscal policies. However, even when the government provides sufficient economic support, non-economic barriers pose a threat to the transition as well, and require different support measures (IEA, 2011; Coenraads & Voogt, 2006). While these barriers are non-economic in nature, their consequences can have a large financial impact. According to the IEA (2011), non-economic barriers need to be tackled by maximally streamlining process and procedures, whereby it is key that issues are already identified at the early investment stages of the RES project development cycles. Investor confidence is namely important in RES transition. This can be achieved with supportive institutions, clear targets and policy measures that tackle both economic and non-economic barriers.

In their ‘assessment of non-cost barriers to renewable energy growth in EU MS’ from 2010, ECORYS ranked non-economic barriers in three groups: most severe, medium to severe impact and minor impact.

- Relevant barriers with the most severe impact are: administrative barriers, grid connection and access barriers, and information and awareness barriers;
- Relevant barriers with medium to severe impact are: barriers for the build environment, qualification, and the lack of reliable certification schemes for installers, and technical specifications included in support schemes.

A stable administrative framework is thus key to successful RES deployment. Regarding administrative barriers, ECORYS (2010) reports that, in multiple MS, local administrations oppose the deployment of certain RES, which can be categorized as a social barrier as well. This is a severe barrier, as deliberate opposition can have different causes and is difficult to overcome. Moreover, it is difficult to select administrative procedures as best practice, because of differences between MS. However, in order to form a stable administrative framework, ECORYS (2010) argues for discretionary power of the administration, transparent laws and clear law-enforcement, and an independent, efficient judicial system. Moreover, civil servants should possess clear guidelines and training and both citizens as the administration on the local level needs to be considered, as protest at the local level could lead to severe administrative blockage. Grid connection is another severe barrier. ECORYS (2010) sees best practice to tackle the barrier in Finland, where clear rules for grid operators and applicants exist, Sweden, where RES plants do not need a permit for grid connection, and Germany, which has an efficient sanctioning system when the grid operators deny grid connection. Regarding grid connection and access barriers, the ECORYS (2010) report also sees a connection with the awareness and information barrier, as public involvement in the decision-making process and clear communication and cooperation between stakeholders is the key solution to public opposition to grid development works. Best practice for awareness and information dispersion is to have professional, well-funded and targeted awareness campaign and to have information easily and widely available at all governmental levels (ECORYS, 2010). With regard to a lack of reliable certification schemes for installers, ECORYS (2010) sees the United Kingdom as presenting the best practice. This barrier is ought to be overcome with several certification bodies for RES installers and clear information on which technology can be certified and under which conditions. ECORYS (2010) sees problems with regard to spatial planning as well. Due to fragmented political competences, whereby an obligation is adopted at a higher political level than the administrative level that is tasked with the implementation of that obligation, enforcement can be complicated. To overcome this barrier, the report recommends coordination and agreement on effective enforcement mechanisms and rules.

1.3 Government support of the Netherlands

At the European level, with Regulation (EU) 2018/1999, MS were obliged to submit a NECP before 2020. The Netherlands submitted their NECP at the end of 2019. At the Dutch national level, the Climate Law was adopted in 2019 (Government of the Netherlands, 2019). In this Climate Law, general GHG targets were set in law. The Netherlands aims to reduce GHG emissions by 49% compared to 1990 levels in 2030 and a 95% reduction by 2050. The Climate Law required the Dutch government to draw up a Climate Plan, in which they specify which measures will be used in order to achieve the law's targets. The first Climate Plan applies to the period of 2021-2030. In addition, the Dutch government met with different industrial sectors and other societal partners and developed a Climate Agreement in 2019, in which is specified what specific sectors will do to achieve the climate goals. Therefore, this Climate Agreement is a part of the implementation of both the Dutch Climate Plan and the Dutch NECP. These three policy documents form the basis for Dutch climate measures, of which stimulating renewable energy is one. Article 3c of the Climate Law states that the Climate Plan contains '*measures taken to stimulate the share of RES (...)*'. Within these documents, the following measures relate to RES.

Currently, economic support for RES comes in the form of a tender-based exploitation subsidy scheme 'Stimuleringsregeling Duurzame Energieproductie ++' (SDE++). To overcome non-economic barriers related to the electricity grid infrastructure, spatial planning, public acceptance and regulation, the Dutch government set forth other forms of support. The earlier mentioned objectives of RES policy, namely the stimulation of RES as part of a broad energy strategy and doing this as cost-effectively as possible (IEA, 2011), thus apply to the Netherlands.

1.3.1 SDE++ subsidy

Economic support for RES in the Netherlands comes in the form of an exploitation subsidy. While the costs of generating PV solar energy decreased in recent years, a subsidy is still required to be competitive with fossil fuels. If the investment cannot be earned back, there will not be investors for RES projects. Therefore, the Netherlands has its SDE++ scheme. Prior to the SDE++, the subsidy schemes were called MEP, SDE and SDE+. Per 2020, the SDE+ changed to SDE++ and is aimed at decreasing CO_2, rather than generation of renewable energy. Subsidy-requests are chosen on the basis of cost-effective CO_2 reduction. The SDE++ subsidy is available up until 2025 (Government of the Netherlands, 2019). In the Dutch NECP (2019), the government states that it strives for fair competition between all market parties on the electricity market. However, it did not formulate separate objectives for this purpose.

SDE++ is a tender-based subsidy instrument, with technology-neutrality, competition, and multi-annual security for investors (Government of the Netherlands, 2019). With SDE++ available up until 2025, the government aims to have all projects given the subsidy account for at least 35 TWh before 2025 (Government of the Netherlands, 2019). However, to maintain investor security after 2025, the government will investigate alternative, non-financial instruments, from 2021. In the Climate Agreement (2019), stimulating RES-E demand and obligations for suppliers are mentioned as alternatives.

1.3.2 Electricity grid infrastructure

The Netherlands, as a small country with a large population density, has scarce space for PV solar plants. PV solar plants have a decentralized character, thus the transition from fossil fuels to RES-E means a transition from a few central, large-scale electricity generation locations to several small-scale locations throughout the country. Lesser populated areas of the countries are more suitable for PV solar plants. However, the existing electricity grid infrastructure has a lower capacity in lesser populated areas (Government of the Netherlands, 2019). Therefore, a lack of capacity on the electricity grid infrastructure is a barrier for the transition to RES-E in the Netherlands. The recent growth of renewable energy installations throughout the country thus requires that national and regional grid operators in the country need to create more capacity. In the Climate Plan (2019), the Dutch government states that grid operators will work on an 'integral energy infrastructure reconnaissance' for the period of 2030-2050. In addition, investment plans will be made to identify which investments are required to achieve the climate targets, against the lowest societal cost. However, the capacity of the grid remains a task of the grid operators.

1.3.3 Spatial planning

Municipalities in the Netherlands are responsible for the local spatial planning. If there is upper-local or regional interest, the province orchestrates the tasks. The responsibility of the national government is to set out long term goals. Therefore, in the Dutch climate policy, energy policy and spatial planning meet and therefore different layers of government are involved. The Dutch national government thus has a more marginal role in spatial planning. However, it is involved in the development of PV solar plants in a different way. The government owns land as well and in the Climate Agreement (2019), the government stated to research if property of governmental agencies should be used for RES generation. Since 2018, the Ministry of Economic Affairs and Climate has started a pilot program with Rijkswaterstaat (the Directorate-General for Public Works and Water Management), Rijksvastgoedbedrijf (the Central Government Real Estate Agency) and the Rijksdienst voor Ondernemend Nederland (Netherlands Enterprise Agency) regarding RES on governmental land. This program runs from 2019 to 2023 and aims to tender 10 projects on Rijkswaterstaat property to the market, in close cooperation with decentralized governments. The program researches how government property can be used optimally and with social acceptance for RES generation. Afterwards, a guide for 'RES on government property' will be written (Government of the Netherlands, n.d.).

The decentralized governments will issue the permits and, as written in the Climate Agreement, will together with the national government fulfil an exemplary role for other public service agencies and the private sector (Government of the Netherlands, 2019).

1.3.4 Public acceptance

The Dutch government recognizes the importance of involving social partners and local residents to the local plan making for RES projects, as this increases support. Therefore, the instrument of the 'regional energy strategy' was developed. There are thirty regional energy strategy-regions in the Netherlands, in which municipalities, regional water authorities and provinces form policy on how to shape the transition to RES. Regarding public acceptance and participation, these governmental actors have the primary role guiding the process participation, which involves the communication of the usefulness and necessity of the energy transition to citizens. Developers have the primary task of environment participation, which involves the shaping of participation for which there are different options, including process participation, financial participation, ownership participation and an environmental fund (Government of the Netherlands, 2019). Moreover, the government makes use of the Dutch Institute of Social Research' monitoring of citizens' perspective on the climate and energy transition and writes a 'broad public approach', which aims to raise awareness of the role of citizens in this transition. This broad public approach consists firstly of a public campaign, which is the targeted communication to citizens, and secondly, the network approach, which is aimed at citizens who want to participate (Government of the Netherlands, 2019). Participation is not only in involvement in the creation of plans, but also in the form of financial participation. Developers are urged to collaborate with the local environment, which shall result in a 50% ownership of the production of RES for the local environment (Government of the Netherlands, 2019).

1.3.5 Regulation and administration

A very important point in the development of PV solar plants in the Netherlands is the issuance of an environmental permit. According to the Climate Plan (2019), in order to timely realize the task, the goal is that on January 1st, 2025, all necessary permits have been given and tenders are finished. Municipalities give out permits for minimally 25 years. Moreover, the Dutch government and other regional energy strategy-parties aim to solve all legal and regulatory barriers as soon as possible. In addition, the National Program Regional Energy Strategy (NP

RES), will identify the spatial bottlenecks. As spatial planning is done at the local level, local civil servants are tasked issuing permits to the developers and thus tasked with the realization of PV solar plants. This requires a lot of knowledge. The Dutch government recognizes this in the Climate Agreement (2019) and states that fragmentation of knowledge needs to be prevented. Therefore, the expertise center of energy transition was established. There are also ecological bottlenecks that developers need to take into account, such as the bird and habitat directive (Climate Agreement, 2019). Finally, national politicians have voiced their opinion against PV solar plants on land. In the Parliamentary motion Dik-Faber, the government was urged to investigate putting more solar on rooftops and not on land (Climate Agreement, 2019). However, this is not the responsibility of the national government as spatial planning lies with decentralized governments.

Chapter 2: Methodology

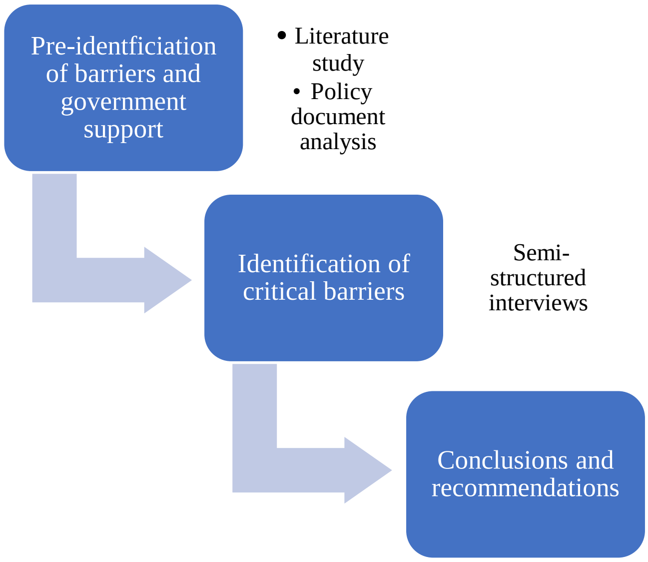
This chapter outlines the research design and data-collection and -analysis techniques used to answer this thesis' research question: *'How does government support help to overcome barriers to PV solar implementation?'*. In addition, practical limitations of the research are discussed. The approach chosen to research this question was qualitative research with a combination of desk-research and field-research. Qualitative research as a research strategy is interpretive, as it aims to understand the social world through the interpretation of that world's participants. In addition, the relationship between theory and research is inductive, with theory being generated out of the research (Bryman, 2016). The goal of this thesis is to gain deeper insight in the barriers to the implementation of PV solar plants in the Netherlands and evaluate the Dutch government's support mechanisms. Therefore, both barriers and government remedies in the Netherland needed to be identified. Painuly (2001) established a framework for analysis of barriers to the diffusion of RES, in which he states:

> *"Interaction with stakeholders is very crucial to identification of the barriers as the perception of stakeholders on barriers may reveal the lacunae in existing policies and help in identification of measures to overcome the barriers"*

Developers oversee the entire implementation of a PV solar plant, which makes them ideal candidates to identify key barriers. Therefore, for the identification of barriers to PV solar plants, in combination with a literature study, qualitative field-research in the form of semi-structured interviews with stakeholders to the development of plants is necessary. Especially since the RES transition is currently ongoing and the current climate policies in the Netherlands stem from 2019, qualitative research is appropriate in particular to identify barriers and evaluate policy in an explorative manner.

2.1 Data collection

The research was thus conducted with a combination of firstly desk-research in the form of a literature study and policy document analysis and secondly field-research in the form of semi-structured interviews. The desk-research aimed to pre-identify general barriers to and government support for RES. Moreover, barrier categories are identified with the literature review, which form the theoretical framework of this research. The field-research then identified critical barriers to PV solar plant implementation in the Netherlands. Moreover, recommendations for government support were made on the basis of this research.



To gain an understanding of potential barriers to the diffusion of RES, and in turn to PV solar plants in the Netherlands, secondary academic literature on barriers for the transition to and implementation of RES and specifically PV solar was studied and the identified barriers were categorized. In addition, in order to identify the way in which the Dutch government helps to overcome the barriers, policy documents from the Dutch government were studied. These policy documents are the Dutch Climate Plan, the Dutch Climate Agreement and the Dutch NECP. After the desk-research was conducted to a fair extent, enough information was gathered to draft up the interview guide.

With regard to the field-research, via Arcadis Nederland, this research has unique access to developers of PV solar plants in the Netherlands. In-depth, qualitative interviewing is often less structured, has more open-ended research ideas and emphasizes the interviewees' personal perspectives (Bryman, 2016, 466). In this research, qualitative, semi-structured interviews were conducted based on an interview guide. In order to understand the key barriers to the implementation of PV solar plants in the Netherlands, this way of interviewing leaves room for the interpretation issues and events of the interviewees. Nonetheless, the interview guide was followed during the interviews, thereby making it semi-structured. Nine semi-structured interviews were conducted between May 11th and June 23rd, 2021. The interviews lasted in between 39 and 58 minutes and the spoken language was Dutch. While face-to-face interaction is generally preferred when conducting an interview, due to COVID-19 restrictions, seven interviews were done via Microsoft Teams and one via phone call due to a failing internetconnection on the interviewee's side. One other interview was done in person, while keeping in mind the applicable COVID-regulations.

As to the selection of interviewees, purposive sampling was applied to select interviewees. With purposive sampling, the research goals were taken into account when selecting interviewees (Bryman, 2016, 410). The context of sampling was PV solar plants in the Netherlands. The participants where then stakeholders to this implementation, such as project leaders, developers, and consultants. Attention was paid to the size of the developer's company as well. Chint and Pure Energie are larger companies, while NRG2All, Nederland Opgewekt and TPSolar are smaller companies. In addition, projects developed by these companies are spread across the entire country. In order to gain access to interviewees, the technique of snowball sampling was applied (Bryman, 2016, 415). With this technique, the first interviewees were either from Arcadis or clients of Arcadis. After conducting the interviews, the interviewees proposed other candidates working in the implementation of PV solar plants in the Netherlands. The criterion for a good sample size is whether saturation is achieved. Sample sizes cannot be too small, as the goal of saturation is then difficult to achieve (Bryman, 2016, 417). After interviewing nine stakeholders, the same key barriers kept being mentioned. Therefore, saturation was achieved. The following table demonstrates information on the role and the company of the interviewees, and the date of the interviews conducted.

Interviewee	**Role**	**Company**	**Date interview**
1	PV solar plant developer	NRG2All	11 May
2	Project leader and consultant	Arcadis	02 June
3	Project leader	Various energy cooperations in North-Brabant, South-Holland, and Utrecht	04 June
4	Consultant	Arcadis	07 June
5	Project manager	Over Morgen	11 June
6	PV solar plant developer	Nederland Opgewekt	17 June
7	PV solar plant developer	TPSolar	22 June
8	PV solar plant developer	Pure Energie	23 June
9	PV solar plant developer	Chint	23 June

The interview guide was based on the IEA (2011) framework of barriers to RES deployment, in order to find out the key barriers. Moreover, the interviews sought to answer the question of in which phase the barriers occurred and discuss solutions to overcome the key barriers. The following topics respectively made up the interview guide. The topic marked with an asterisk was added after the first two interviewees brought up the recommendation:

- Financing PV solar plants in the Netherlands
  - Private versus government financing
  - SDE++ importance
- Technical and infrastructural barriers
- Not In My Backyard (NIMBY)
  - Public acceptance barriers
  - Awareness and dissemination of information to the public
- Government
  - Contributing policies
  - Hindering policies
- Other, unmentioned barriers
- Phases of implementation
- Most hindering barriers
- Recommendations for the Dutch national government's policies
  - Government property*

2.2 Data analysis

The semi-structured interviews were transcribed with Amberscript, an audio transcription software, and Microsoft Office Word. The transcriptions were coded with NVIVO, a qualitative data analysis and research software. The codes are the seven barrier categories from the IEA (2011) report mentioned in this research's literature review. The secondary academic literature on barriers was compared to the data from the interviews. This made it possible to identify the most relevant barriers that hamper the implementation of PV solar plants, thus hamper the achievement of the EU's and the Dutch climate goals. When the barriers were identified, the causes of these barriers could be identified, which might be the basis for recommendations to the Dutch national government on how to better overcome these barriers. Therefore, this research firstly gives insight into barriers in different stages of implementation of PV solar plants and secondly gives policy recommendations on how to overcome these barriers.

2.3 Practical considerations

With regard to practical considerations of the conducted research, firstly, general critique on qualitative research applies to this research. In Bryman (2016), the four main critiques listed are that qualitative research is too subjective, difficult to replicate, that there are problems of generalization and a potential lack of transparency. However, it is precisely the unique, subjective point of view of the interviewees that is of value of this research, as substantiated by the earlier quote of Painuly (2001). As a result, the other points of critique are applicable, but do not dismiss this research' contribution. Secondly, for the gathering of data for this research, qualitative interviews were conducted. Therefore, personal data and views were collected voluntarily, with consent of the interviewees before and at the point of doing the interview. Participants were allowed withdraw from the research at any point, which was a practical consideration for this research method. Moreover, the interview data was kept private and was accessible only to the interviewer. In addition, personal information from the participants was anonymized. Nonetheless, in some instances, interviewees answered questions in an evasive manner, potentially to protect the public image of the company, as the questions of these instances were politically salient. Thirdly, as the data is acquired with interpersonal contact, the researcher has to be aware of its own position towards the interviewees. Therefore, reflexivity, with the researcher being self-critical and self-conscious is key to combat this inherent bias.

Chapter 3: Results

In this subchapter, the results from the semi-structured interviews are discussed and categorized according to the seven IEA categories (2011). From this chapter's discussion of results, key barriers to the implementation of PV solar plants are distilled. In addition, in sub-chapter 3.9, the phases of implementation of PV solar plants wherein the most severe barriers occur are discussed.

3.1 Economic barriers

Various barriers of economic nature for the implementation of PV solar plants in the Netherlands were mentioned by the interviewees. In general, they stated that PV solar plants are a safe investment. It is fairly easy to get the business case done (interviewee 3). At this moment, investor interest is not a barrier. The sun will keep on shining and you can calculate the return on investment, which appeals to pension funds and investment companies, who require secure investments and have certain sustainable obligations (interviewee 1, 9). These investors are almost always private parties. Investments from banks are however often not from Dutch banks, but other European banks, such as German or Danish. The Dutch banks are not on the same level of understanding of the business case and are unwilling to finance the risks (interviewee 7).

Nonetheless, certain economic barriers do exist. Most importantly, in order to receive the investment from a bank, pension fund or other investment company, it is key that the SDE++ subsidy has been granted, because this gives the financer a guaranteed return on investment for 15 years (interviewee 2, 3, 5, 6, 8). Without the SDE++ subsidy, the exploitation, and thus the project as a whole, is not feasible, which means that the developer will not be able to pay its debt to the financer (interviewee 3). Due to the long payback period to investors, it takes a long time before the plant is profitable for the developer (interviewee 9). Moreover, the developer's return on investment depends on electricity prices as well, with lower electricity prices returning a lower profit. A sufficient SDE++ subsidy thus helps to overcome these risks. However, another barrier regarding investor interest in PV solar plants might lie ahead. The Dutch government expects the SDE++ to end in 2025. The question is raised what this will do for investor security (interviewee 5, 6, 7). While there is uncertainty, interviewees have different views of what this means for the 2030 targets. Interviewee 6 stated that: *'without a doubt, this will be problematic to achieve the [2030] goals'* and interviewee 7 said: *'there is no soft landing* *case at all'*. On the contrary, interviewee 8 stated that it will be possible and that the investor security will come from the electricity price and *'at most it will result into an increase of the percentage of the developer's equity'*. Interviewee 9 is unsure how banks will respond to this, but believes that it is unwise to determine a solution already, because it is unknown which solution it is going to be after 2025.

Other economic barriers were mentioned by interviewees as well. Firstly, high up-front costs for the development of PV solar plants could pose a barrier to a plant's implementation. These up-front costs are made without the guarantee that the plant will be developed, thus before the financial close. These costs are for example pre-investments for grid operators and environmental research (interviewee 6, 7, 8, 9). Interviewee 6 mentioned that a 20 percent increase of the price of solar panels, could mean that the project is not viable anymore and interviewee 7 knows competing developers, who decided to postpone the building of plants this year, due to an increase in construction prices. On the other hand, in the past years, construction costs have decreased (interviewee 5) and even though the price has increased, the price of the panels is still not too high, and they have increased in how much they can generate (interviewee 1). Secondly, interviewees mentioned issues with the lack of a domestic manufacturing industry. PV solar panels are mostly produced in China. Currently, prices for sea containers are high as well (interviewee 7, 9), which makes importing the panels more expensive. Interviewee 9 also mentioned that since panels are produced in China, an increase of demand for solar panels in China can also lead to higher prices. While its construction costs are not necessarily a barrier to PV solar plant implementation, it is market with large risks. Despite these results demonstrating that economic barriers are not the most severe in the Netherlands, the SDE++ subsidy is key to mitigate these risks, and issues regarding the subsidy could thus pose a threat to the implementation of PV solar plants.

3.2 Financial barriers

Chapter 3.1 highlights the importance of the SDE++ subsidy for the implementation of PV solar plants. In general, interviewees were positive about the SDE++ as the instrument to support RES. The process of requesting the subsidy is not too difficult and the subsidy scheme has a fairly good systematic (interviewee 6, 7, 8, 9). Interviewees 1 and 4 mentioned that foreign PV solar developers even move to the Netherlands, because of the subsidy climate. Interviewee 2 shares this perspective and sees it as positive that the Netherlands still has a subsidy for RES, while other countries' subsidy schemes were terminated. This interviewee is certain that we would have not seen the developments of the last five years regarding an increase in RES generation if it was not for the SDE++ subsidy and mentioned that these foreign investments are necessary to continue the energy transition in the Netherlands. Nonetheless, interviewees did mention issues with the SDE++ instrument. Firstly, in order to get the subsidy, you need to have an environmental permit, which is not as easy to acquire, as will be discussed in sub-chapter 3.7 (interviewee 6, 8). A second issue with the SDE++ systematic, mentioned by interviewees 6 and 7, is that the moment to request the subsidy changed from twice a year to once a year in the autumn. This moment does not match well with the summer break of civil servants, who give out the aforementioned required environmental permits.

Aside from a good systematic, sufficiency of the total amount of subsidy is important. A limited SDE++ budget means a lower subsidy, which means less security to get the return on investment (interviewee 8). Interviewees 6 and 7 mentioned that the price for which to register for the subsidy is always a guess for developers. Even when you have a good project with its necessary permits, you still do not know if the subsidy is over-registered (interviewee 6). Sometimes it is indeed strategic to register for a lower price because the certainty that you get the subsidy increases (interviewee 7). However, this could lead to the unrealizability of PV solar projects, due to developers registering too low for the SDE++ subsidy and finding out that they cannot realize the project financially, due to financial setbacks (interviewee 1, 6). Moreover, interviewees mentioned unfortunate changes in the calculation of the subsidy. Recently, the Dutch government decided that the costs of reimbursement for land, which are needed to compensate landowners for making their land available for PV solar plants, will not be weighed in the business case. However, interviewees 6 and 8 stated that this in fact does weigh heavy on the business case, especially due to the difficulty of getting land concessions, as mentioned in chapter 3.5. Interviewee 9 believes that you can calculate a business case without the reimbursement for land, but this leaves less room in the business case, which is useful for a good integration in the landscape or for moving further from the grid connection. Like interviewee 6 and 8, he argued that it should be re-added to the subsidy calculation.

Access to capital could pose another barrier, but interviewees state that if you comply to investors' requirements, have made the risks insightful, and bring 10 to 20 percent of own equity, this is not the case in the Netherlands (interviewee 8, 9). This own equity can be acquired from the local environment (interviewee 5). However, interviewee 9 stated that in recent years, the developer's own equity to loan at a bank has increased. In practice, the requirements mean that the developer has the building permit and the SDE++ subsidy. Interviewee 6 did mention that extra requirements are sometimes absurdly strict. The biggest risk threatening access to capital lies thus up until acquiring the SDE++ subsidy (interviewee 1). With the SDE++ subsidy, there is certainty for the investor (interviewee 6).

3.3 Market barriers

Interviewees did not mention any issues regarding the market design. The Netherlands also does not have a direct subsidy for fossil fuels. Fossil fuels are not the competition for PV solar plant developers regarding subsidies. However, PV solar is not the only RES which competes for the SDE++ subsidy. In addition, in 2020, the SDE++ method changed to reducing CO_2, leading to Carbon Capture and Storage (CCS) and other CO_2-reducing techniques to compete for the subsidy pot (interviewee 1, 2, 6, 7, 9). For last year's round, 2 billion euros of a 3-billion-euro total was reserved for CCS. '*That does not make us very happy as solar-developers*' (interviewee 7).

Another market related barrier for the implementation of PV solar plants concerns competition. Interviewee 1 mentioned that he cannot demand too much from municipalities, as there is tough competition to receive the permit to build a PV solar plant. This competition is mentioned regarding difficulties in getting land positions and a lack of grid connection as well (interviewee 8, 9). But as interviewee 8 stated: *'this competition is a good thing in itself, that is not the problem'*. It might be a burden for developers, but not for the 2030 targets. However, the competition for subsidy from CO_2-reducing techniques does threaten the implementation of PV solar plants, thus the target of 35 TWh RES on land.

3.4 Technical barriers

PV solar is a robust RES, technically simplistic and it is easy to increase the capacity of a plant (interviewee 2, 5). However, some technical barriers do exist. A first technical barrier mentioned by interviewees relates to resources for the solar panels. Firstly, there is a global shortage of resources (interviewee 5, 6). Secondly, some resources are won in political undesired circumstances, which causes public opposition. Interviewees 5 and 7 mention the discussion that plays in the Netherlands regarding silicon from Chinese mines in which Uyghurs are potentially forced to work. Therefore, this technical barrier has overlap with the economic and the public acceptance categories. However, these are not structural issues.

More structurally, a second technical barrier is a lack of technically skilled personnel, as less people choose for technical education in the Netherlands (interviewee 5, 6, 9). This is an issue on the developer's side. Interviewee 1 mentioned how there is a lack of cheap, competitive manpower in the Netherlands, thus manpower needs to be found in Central- and Eastern-European countries. Moreover, this is a large issue on the grid operator's side (interviewee 5, 6). Interviewee 9 notices how grid operators are overloaded with work. Interviewee 6 said: *'I deal with project leaders from the grid operator's side that work on 116 projects at the same time. That cannot possibly go well, and it does not'.* In this way, the lack of capacity at grid operators threatens the developer's projects, thus the existence of the developer's company, and thus the RES-E transition as a whole.

3.5 Infrastructure barriers

Every interviewee has mentioned limited grid capacity as a major barrier for the implementation of PV solar plants in the Netherlands and thus the 2030 targets, because without feed-in, there is no project. This is both a problem on the main grid as on the local grid. Interviewee 1 stated to not be able to connect about 70 percent of his portfolio of plants to the grid. This is a big economic issue as well, as reserving a connection to the grid, requires a lot of up-front capital, between several tons to one million euros. A project developer only wants to make these costs when they are guaranteed that the project will be developed (interviewee 2). This issue is partially created to the boom in RES projects (interviewee 2). Grid operators did not act adequately and did not anticipate what the energy transition meant for the electricity grid (interviewee 1, 6, 7, 8), and tend to act reactive, as their reserves are public funds, which is strictly regulated by the Dutch Competition Authority (ACM) (interviewee 4, 6, 8, 9). Interviewee 6 gave an example of having three projects near a small municipality in North-Brabant, that have a signed agreement for the transport of electricity and connection to the grid, where the grid operator did not realize the capacity on the grid.

With RES, instead of one central point of electricity generation, several points of generation are established. In addition, these new locations are often in lesser populated areas. However, because the demand is lower in these areas, there is less infrastructure (interviewee 2, 7). There is thus a barrier of distant supply and demand centers. Interviewee 3 mentioned this too: there is a transition from the traditional, central generation and distribution of electricity to decentralized generation with centralized balancing. An infrastructural change is thus ongoing on the Dutch electricity grid. However, the interviewees do believe that this problem will be solved at some point in the future (interviewee 1, 4). Nonetheless, it takes years before the whole process of strengthening the grid capacity is completed (interviewee 2, 4), which threatens the 2030 goals.

Another major infrastructural barrier relates to spatial planning in the Netherlands. As mentioned above, new locations of PV solar plants are often in lesser populated areas, because space is scarce in the Netherlands. This leads to a barrier of a lack of adequate, affordable ground to accommodate PV solar panels (interviewee 1, 2, 3, 4, 7). With the regional energy strategies, search areas for developers to find space for plants were determined. However, grid connection was not always taken into account during this process (interviewee 9). Moreover, relating to the regulatory and administrative barrier category, prices of land have increased because of the scarcity and the determining of search areas. This led to developers contacting farmers in these areas for their land and this competition led to high prices for land. Farmers were promised large sums of money for their land, which many developers are unable to pay (interviewee 1, 2, 3, 9). This has skewed the market and relates to the barrier of difficulties of getting land concessions.

> *'There are plenty of developers, cowboys, who ruin it for the rest by going to farmers and by promising mountains of gold, making agreements that seem fantastic to a farmer, but which simply cannot be fulfilled.' – interviewee 3*

3.6 Public acceptance and environment barriers

'You can count the amount of people that want a PV solar plant in their backyard on one hand' (interviewee 1). *'Everyone wants renewable energy, everyone wants a cold beer from their fridge in the evening, but nobody wants that energy to be generated directly in their backyard'* (interviewee 5). These quotes speak to the phenomenon of 'not in my backyard' (NIMBY). Local opposition to the development of projects is mentioned by every interviewee as a large barrier to the PV solar plant implementation. '*Overcoming societal opposition is the key to the energy transition*' (interviewee 6). Due to the decentralized way spatial planning is done in the Netherlands, the local environment has a large say in the location of PV solar plants. Without the support of the local environment, local civil servants often do not want to give out permits

(interviewee 1, 5, 6, 8). Therefore, the barrier behind the barrier of getting a permit is a lack of local support, and as a developer you have little influence to combat it (interviewee 1, 9).

Interviewee 5 said that it is the task of the initiative taker of a project to create support. However, support from a municipality for a location is helpful. To overcome opposition, good communication is key, as a lack of dissemination of information and a lack of public awareness is an often-mentioned barrier for PV solar plants (interviewee 1, 2, 3, 4, 6, 7). Communication is done in local newspapers, with a trajectory of information evenings for local residents and home visits (interviewee 1, 2, 3, 7). Communication should be broad, in different outlets, and continuous, as it is difficult to reach the 'silent middle' (interviewee 4, 9). However, this is often not enough and more active communication with residents in search areas is necessary (interviewee 1, 6). Interviewee 7 would have preferred a larger involvement in the communication from municipalities and the national government, which should focus more on mass-media communication. On the contrary, interviewee 8 stated that the role of informing the local environment is and should be the task of developers and that often the local environment is quite well informed in his experience. A large issue is that the communication is often done after the location has already been determined (interviewee 1, 3, 8). Interviewee 8 mentioned this as well, and in his projects, he does not receive a lot of negative responses from the local environment, as he involves local residents as early as possible in the project, before requesting the environmental permit.

Local opposition might be caused by a lack of community participation in the energy choice. Interviewee 3 was very vocal regarding this barrier. According to this interviewee, it was a 'governmental festivity', whereby (especially local) governments chose locations in the regional energy strategies, and the local environment and market participants were not included in the process. The triangle between government, citizens and the market was imbalanced. This has led to local opposition for the locations of PV solar plants. Participation from the environment is not only by having a voice, but financial participation as well. Financial participation could help push local support in the right direction (interviewee 1, 4). Interviewee 6 argued that small projects are fairly easy to do with crowd funding. However, it should easily be accessible to participate in (interviewee 2). There are various options for financial participation. One of them is an environmental fund, but interviewee 1 mentioned that it is difficult to determine how much it really contributes to the local environment. Interviewee 8 mentioned also how the environmental fund is used too broad and not for the direct environment. Interviewee 4 did believe that it helps to increase support. Another option is making residents for 50 percent owners of the park via a local energy cooperation. Interviewee 5 believes that this should be easy, but developers are not eager to share their park. On the contrary, interviewees 4 and 9 believe that this is not easy to realize as PV solar projects are expensive, so a cooperation needs many members to acquire the capital, thus the capital sometimes does not come from the local environment anymore. Another problem with ownership is that sometimes a few local businessmen buy op the ownership share, which thus does not benefit all local residents (interviewee 2). Mostly, the local environment is still figuring out how to shape financial participation. Even when there is good financial participation, with 50 percent ownership, you still have to bash through all these [social] barriers (interviewee 6). Interviewee 7 and 8 also mentioned that the government remains vague regarding financial participation, as it is written in the policy plans for climate, but it is not mandatory.

3.7 Regulatory and administrative barriers

Regarding the legal and regulatory framework that applies to PV solar plants, the regional energy strategies were mentioned most frequently. Interviewees have mixed views towards these strategies. On the one hand, interviewees believe that the idea behind the regional energy strategies helps to raise awareness for the energy transition that lies ahead (interviewee 6), the determination of search areas helped to organize municipalities in finding locations for plants (interviewee 3) and it has increased communication between different municipalities and stakeholders (interviewee 7). However, the instrument is not good enough for the large task that is the energy transition and municipalities can differ from the agreements reached during its discussions. Interviewee 1 called it a nice idea, but as it has no legal ground, it leads to slowing down, not speeding up. Interviewee 9 argued this as well saying that the strategies do not have authority, which means that municipalities can disregard the agreements made. Interviewee 6 called it a paper tiger and argues that more central steering is needed. Interviewee 7 said that right now the regional energy strategies focus on 35 TWh of RES on land, but in reality, there is more needed after 2030. Interviewees mentioned a lack of policy certainty as well. Interviewees 2 and 5 said that municipalities are re-discussing the regional energy strategies, which interviewee 2 calls *'from the regional energy strategies to the local energy strategies'*. Interviewee 5 said that while at least we have something now to guide the energy transition, 2030 comes close when the regional energy strategies are re-discussed. This uncertainty at the local level was mentioned often (interviewees 2, 3, 5, 6). Relating to the infrastructural barrier category, a location check for grid capacity was discussed with interviewees as well.

Interviewee 7 sees that grid operators are now taking on the coordinating role regarding locations and grid capacity, and that municipalities are making use of this as well. Interviewee 8 does not believe that the location check is useful, as every developer is taking up land positions around the locations that have grid connection, and there is only so many connections possible.

In addition to issues regarding the legal and regulatory framework for RES, interviewees berated the lack of influential involvement of the private sector in the decision-making process. Some interviewees mentioned how they sat at the table with politicians and government officials to discuss the RES-E transition and PV solar plants in particular (interviewee 1, 7). However, both mentioned that nothing came from those talks. Interviewee 1, 8 and 9 also mentioned how the PV solar branch organization 'Holland Solar' sits at the at the political level, but argued that they are not listened to enough and are fairly small. The field-knowledge of developers and other stakeholders was not used in the discussions of the regional energy strategies (interviewee 3). Moreover, in many regional energy strategy-regions grid operators joined only these discussions recently or not at all (interviewee 7, 9). This is at odds with the clash between search areas and grid connection. Mostly, interviewees wish that the government would listen to the market more. Especially, as the government leaves a large part of the energy transition to the market.

Not only communication between the government and market participants receives criticism from the interviewees, communication between different governments as well. As the RES-E transition has never been done before and is a task for the entire country, integral collaboration is needed (interviewee 3). Both vertical communication as horizontal communication between governments was criticized. Vertically, interviewees mention how the national government is unaware of issues at the local level (interviewee 1), the national government is passive in supporting and steering local governments (interviewee 3, 5, 7, 8), the national government and the regional energy strategies do not have the authority to force municipalities to choose locations (interviewee 9), and provinces are against PV solar plants (interviewee 6, 7). Municipalities are in turn passive as well, and waiting for steering from the national government. In addition, they are not talking amongst themselves and learning from each other's plans (interviewee 7). This can be seen in the re-discussion of the regional energy strategies (interviewee 2).

The issue of communication touches upon another issue, which is a critique on the capacity of governments to tackle the complex task of the RES-E transition. As spatial planning lies in the hands of municipalities, and as the national government has delegated large parts of the implementation of PV solar plants to the local level, local civil servants have a large role in the RES-E transition. However, interviewees mention quantitative and qualitative shortcomings from mainly local and also provincial civil servants. There is a lack of knowledge and knowhow about developing a PV solar plant (interviewee 1, 3, 4, 5, 6, 7, 8, 9) This issue is especially prevalent at the smaller municipalities, who often have one civil servant working on the dossier. As mentioned earlier, PV solar plants are often developed in smaller municipalities as space is scarcer in large municipalities (interviewee 1, 5, 6, 7, 8, 9). Often, this leads to municipalities hiring costly advisory companies (interviewee 8, 9). Interviewees mention how the national government does not support the local level enough and that more, continuous local capacity and capital is necessary (interviewee 3, 5). Interviewee 6 argued that it is time to give definitive guidelines to local civil servants. Therefore, the lack of quantitative and qualitative capacity at the local level is a large barrier.

These regulatory and administrative barriers create problems in the timely and cost-effective implementation of PV solar plants and are the largest regarding the issuance of the environmental permit by the municipalities (interviewee 6, 9). Barriers regarding permits can be social in nature, as local opposition can lead to non-issuance of a permit (interviewee 5, 9), they can be infrastructural in nature, when a suitable location is not agreed on (interviewee 2), and they can have large financial consequences, such as causing the SDE++ subsidy to not be granted (interviewee 2, 6, 7). Due to the aforementioned quantitative and qualitative shortcomings, the permit issuance can strand and making municipalities the cause of issues in the implementation of PV solar plants (interviewee 4). As part of the permit process, legal barriers can occur as well. Interviewees 1 and 6 mentioned cases in which local residents appealed the permit, which takes so long, that the project is not interesting economically anymore, as the developers cannot acquire SDE++ subsidy, if the permit is not issued. This thus relates to the public acceptance category as well. Aside from the general requirements for the environment permit, interviewees noticed that municipalities increasingly add requirements, which are not all possible to realize (interviewee 5, 7, 8, 9). The SDE++ is aimed at cost-efficiency, thus the cheap realization of PV solar plants, but the extra requirements do not all fit in the business case (interviewee 9). Firstly, financial participation requirements regarding local environmental funds are not always feasible (interviewee 5). Secondly, municipalities are asking for better landscape technical fitting and multifunctional use of land (interviewee 2, 5). Thirdly, nature preservation organizations are involved more, making the process even more complex (interviewee 7, 8). Interviewee 7 and 8 also mentioned the problem with nature that municipalities want to maintain the nature after the removal of the plant 25 years later. However, the plant-owners do not have an agreement with the landowner after that period, which is thus impossible to agree with for developers. Therefore, municipalities are not aware of the limitations to their additional requirements.

In addition to these regulatory and administrative barriers, with regard to policy certainty, political instability around the topic of energy transition forms a barrier for the implementation of PV solar plants as well. Various political actors, at the national, provincial, and municipal level have voiced their opinion against PV solar plants (interviewee 2, 4, 8, 9). This mixed message has an effect on public opinion and local civil servants. In practice, this has led to a parliamentary motion Dik-Faber, which called upon provinces to stop building PV solar plants (interviewee 2, 8). In addition, the motion of Leijten, that did not pass, with a similar standpoint was issued recently (interviewee 8). Interviewees also mentioned how elections have an effect on the implementation of plants (interviewee 4, 9). Next year's municipal elections bring uncertainty, as it on the one hand could speed up projects, to prevent the new city council to disagree with the plant, but on the other hand hinder the implementation, if local civil servants, who wish to get reelected, do not want to make unpopular decisions (interviewee 4, 9). Moreover, interviewees have voiced their critique on provinces, who increasingly act against PV solar plants (interviewee 6, 7, 8, 9).

In conclusion to the many and diverse regulatory and administrative barriers, as the RES-E transition is complex, regulation regarding it is complex as well. Due to the Dutch way of democratic governance, a lot of actors are involved, which makes the task even more complex (interviewee 5, 7). Therefore, interviewee 3 calls for an interpreter. Developers, municipalities, and local representations do not understand each other well enough.

3.8 Key barriers

Based on the results of the conducted semi-structured interviews, many barriers to the implementation of PV solar plants in the Netherlands are identified. On the basis of the expertise of interviewees and the frequency of barriers being mentioned by interviewees, academic literature on barriers to RES diffusion and the climate policy documents of the Dutch national government, barriers that threaten the achievement of the 2030 goals of the Netherlands are pointed out. These key barriers are highlighted in this sub-chapter and will be discussed in chapter 4. During the identification of the most important barriers, a division was made between barriers that have the most severe impact and barriers that have medium to severe impact. This division is based on structure of the ECORYS (2010) report mentioned in this thesis' literature review.

The barriers with the most severe impact are:

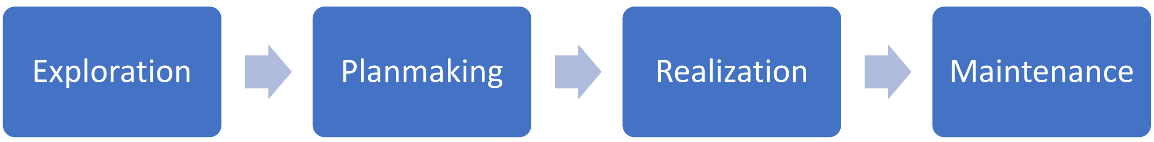
- Lack of grid connection and capacity;
- Scarcity of space to accommodate PV solar plants;
- Local opposition to PV solar plants;
- Delays in the issuance of environmental permits;
- Quantitative and qualitative shortcomings of local administration.

The barriers with medium to severe impact are:

- Insufficiency of SDE++ subsidy;
- Issues regarding investor certainty post-SDE++ subsidy;
- Difficulties in getting land concessions;
- Shortage of technically skilled personnel;
- Ambiguous requirements regarding financial participation;
- Unrealistic requirements from local governments;
- Lack of influential private sector participation.

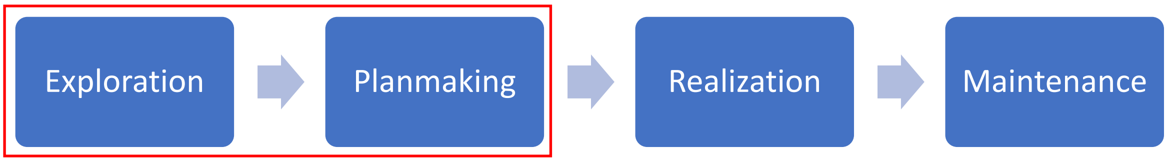
3.9 Phases of implementation

Interviewees were asked in which phase of the implementation of PV solar plants they experience the most barriers and the heaviest barriers. The first phase involves exploration of a location and meetings with local environment. The second phase involves permit issuance and receiving the SDE++ subsidy. The third phase is the construction of the PV solar plant and the final phase is the maintenance of the plant afterwards.



Mostly, interviewees stated that barriers occur in the early stadium of implementation (interviewee 1, 2, 3, 5, 6, 7, 8, 9). Interviewee 1 stated that most projects fail in the early stadium, which has the benefit that at that point, less costs have been made. Interviewee 6 shares this view saying that, while you have put a lot of time and energy in it, the money at risk is lower. A critical point mentioned by interviewees is the moment of permit issuance. The most and heaviest barriers occur before the permit is given (interviewee 5, 6, 7, 9). Interviewee 5 said: "*acquiring the permit, acquiring the SDE subsidy, that is really a champagne-moment*". Interviewee 9 said: "*after acquiring the permit, everything goes pretty smooth*".

However, as interviewee 7 mentioned: "*every project is different*". While interviewees have stated that the realization phase is fairly easy (interviewee 3, 5, 9), some barriers occurring after the permit was given out were mentioned. After the permit issuance, there is a six-week appeal period (interviewee 1, 6). Interviewee 1 said how several times, plants did not get the permit due to an appeal process that took so long, that the project was not economically viable anymore. Interviewee 4 mentioned how the lack of technically skilled personnel could be an issue during the realization phase. And interviewee 6 said that if everything is dealt with, but the grid connection is not being delivered, that is a real costly barrier.



Chapter 4: Discussion

This thesis researches how government support helps to overcome barriers for PV solar plant implementation. The literature review has identified various barriers that exist in the transition to RES-E. Within this transition, PV solar plants are key. Focusing on the Netherlands as an EU MS, interviewees have shed light on the barriers existing in the implementation of PV solar plants in the country and in which implementation phase the barriers occur in. Furthermore, the role of the Dutch government was discussed. In this research discussion, the research question and its sub-questions are answered. First, the key barriers identified in the interviews and related government support are combined with academic literature. Second, recommendations for future Dutch policy to better tackle the identified key barriers are given. Third, this thesis' research process is reflected on. Finally, conclusions for this research are drawn and suggestions for further research are given.

4.1 Key barriers and support

This research's literature review has identified various barriers that exist in the transition to RES-E, which are categorized on the basis of a framework of the IEA (2011). In the results chapter, key barriers to the implementation of PV solar plants in the Netherlands have been identified. In their climate policies, the Dutch government has recognized several barriers and agreed on economic and non-economic measures to overcome these barriers.

4.1.1 Economic barriers and support

Economic support for RES on land in the Netherlands mainly comes from the SDE++ subsidy scheme. Interviewees were fairly positive about the systematic of the SDE++, which is a tender-based subsidy scheme with the characteristics of technology-neutrality, competition amongst developers and multi-annual security for investors (Government of the Netherlands, 2019). According to Figure 6 in the literature review, a tender-based subsidy scheme has:

- Good deployment value management;
- Good price control;
- High investor security, once concession is obtained, but very low investor security during bidding phase; and
- Relatively straight-forward transaction costs, but it is best for larger projects. There is a risk of too aggressive bidding and 'gaming' (IEA, 2011).

The SDE++ has good deployment value, as it can tender for set levels of capacity and as the available amount of capital support is variable (IEA, 2011). The scheme has good price control as well, as a competitive bidding situation is created between developers and the lowest offer is selected (IEA, 2011). This competition for the subsidy was frequently mentioned by interviewees. With regard to investor security, tender schemes provide high security to developers and investors once the concession is obtained. (IEA, 2011). This research has found that the greatest risks for developers lie before the subsidy is acquired and interviewees confirmed that it is difficult to get investments before the environmental permit and the subsidy are acquired, which confirms that with tender-schemes, investor security is low during the bidding phase. Nonetheless, interviewees stated that there are always ways to find investors, however, this is often foreign capital. Finally, according to the IEA (2011), tenders are best suited for larger-scale developers and investors, because of the complexity of the procedures and the transactions costs. The risk of aggressive bidding and gaming was confirmed by interviewees as well, stating that the price for which to register for the subsidy is always a guess. Interviewee 6 estimates that only 30 percent of the projects will be realized, due to developers registering too low for the subsidy to acquire the subsidy, but because of financial setbacks finding out later that the project becomes unrealizable. This is thus the greatest disadvantage of the SDE++ as tender-based scheme.

While interviewees were generally satisfied with the scheme, they did voice criticisms about the Dutch subsidy scheme. Firstly, there is only one round of appliance per year in the autumn. This adjusted the planning of developers as they have to comply to all requirements before that moment, which comes right after the local civil servant’s summer break (interviewee 6, 7). If that window is missed, developers have to wait another year. Secondly, land reimbursement has been omitted from the weighing in the business case. Where municipalities increasingly add requirements (interviewee 5, 7, 8, 9) that require extra capital, the room for these requirements has become smaller in the business case. Here, the financial barrier of insufficiency of the financing schemes (Haas et al. (2018), Eleftheriadis & Anagnostopoulou (2015) meets the regulatory and administrative barrier of unrealistic government commitments (Seetharaman et al. (2019). Thirdly, since 2020, the scheme changed its aim from generating RES to reducing CO_2. Other technologies could therefore apply for the subsidy, such as CCS projects. The SDE++ is a technology-neutral scheme. According to Lehmann & Söderholm (2018), the least costly technologies are promoted first, which is beneficial for PV solar as a mature RET. Nonetheless, in 2020, a large chunk was reserved for CCS projects. This leaves less subsidy for PV solar projects, who still need the SDE++ subsidy in order to be profitable and thus interesting for investors. The SDE++ subsidy is namely aimed at subsidizing the unprofitable top of PV solar.

The Dutch government expects to end the subsidy by 2025 as RES-E will be able to compete with the market value of electricity (Government of the Netherlands, 2019). While this is market-conform, interviewees had mixed views regarding investor certainty post-SDE++. Interviewee 6 believed that this threatens the 2030 goals and interviewee 7 stated that there is no soft-landing case at all. On the other hand, interviewee 8 believes that the certainty will come from the electricity generated. In the Climate Agreement (2019), the Dutch government recognizes this issue:

> *"With a view to the continued growth of renewable electricity required beyond 2030, it is vital that the extent be ascertained to which investment security for renewable electricity projects can also be guaranteed without financial support from the government"* (p. 185).

In the Climate Agreement (2019), it is stated that in 2021, the government will launch a survey to analyze various, non-financial instruments, which, if necessary, should start in 2023. This instrument has to be non-financial, due to state aid rules. The government lists 'a form of suppliers' obligation' and 'further stimulation of the demand for RES-E' as examples of options (Government of the Netherlands, 2019). Interviewee 9 stated that this instrument should not be chosen too soon, as it is unknown what solution will work by then. The Climate Agreement does not expand further on the survey. However, as interviewees were critical about the involvement of the private sector in the decision-making process (interviewee 1, 3, 7, 8, 9), which was mentioned in the literature by Painuly (2001) and Eleftheriadis & Anagnostopoulou (2015) as well, the effectiveness of the survey can be questioned. Nonetheless, if well executed, this could combat two issues at the same time.

Aside from these critiques on the Dutch economic support, the market for PV solar plants is still large and maturing and many plants are being realized now. Capital can be acquired, even though often from foreign banks and investment entities, such as pension funds, and the RES-E will be able to compete with the market value of electricity in the near future. Investor interest (Nam Do et al. (2020), Eleftheriadis & Anagnostopoulou (2015) is thus not a problem in the Netherlands. As, interviewee 9 said: "*everyone says that there is a lot of money to be made.*

And yes, it is indeed a market where a lot of money is earned. We would not enter the market otherwise. However, it is also a market with great risks". Therefore, keeping in mind the environmental benefits of RES and climate targets, a good economic support mechanism for RES is necessary.

With regard to other economic barriers described in the literature, interviewees firstly spoke on construction costs, and as part of that the fluctuating costs of (the import of) PV solar panels due to a lack of domestic manufacturing industry (Haas et al. (2018), Zhang et al. (2012), Eleftheriadis & Anagnostopoulou (2015). Moreover, interviewees a barrier frequently found in the literature, namely the high up-front capital costs (Nam Do et al. (2020), Nasirov et al. (2015), Painuly (2001), Zhang et al. (2012), Eleftheriadis & Anagnostopoulou (2015), Seetharaman et al. (2019). As mentioned in the IEA (2011) report, the expenditure pattern of RETs has high-up front costs, but less operational costs. Interviewees substantiate that this is the case for PV solar plants, stating that these high up-front costs are made without the guarantee that the plant will be developed (interviewee 7, 8, 9).

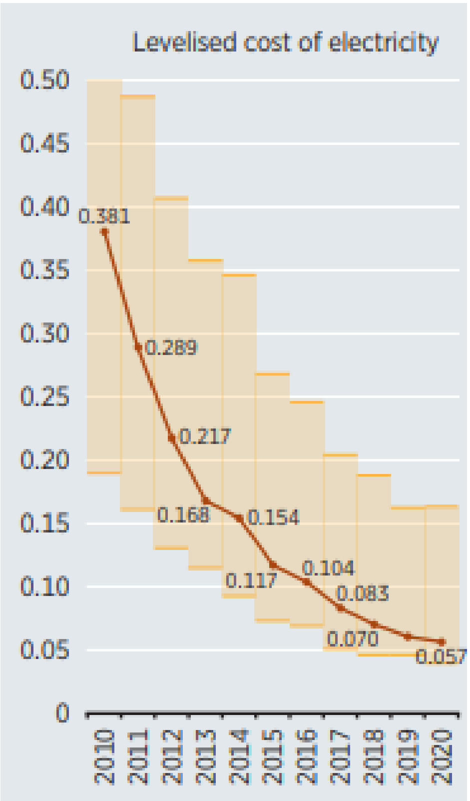


Figure 7: LCOE between 2010-2020 (in $ per KWh)

Regarding the volatility of electricity prices (Nasirov et al. (2015), data on PV solar states that it has become a mature RET. The LCOE of PV solar has steadily declined in the past decade. As shown in Figure 7, between 2010 and 2020, the global weighted-average LCOE declined by 85%, from $0.381/KWh to $0.057/KWh (IRENA, 2021). However, the price of electricity is never a certainty, which is a risk for developers, especially as interviewee 9 mentioned how negative electricity prices are becoming more common.

Currently, even though the LCOE of PV solar generated electricity has declined, the SDE++ subsidy is still needed for PV solar plants to be profitable. Therefore, when looking at the level of maturity of PV solar and its LCOE, the ending of the subsidy by 2025 seems market conform, and economic support would not be justifiable. However, a third factor that determines the justifiability of economic support for RES by the IEA (2011) relates to different patterns of expenditure. The barriers occur in the early stadium of implementation as PV solar plants are capital intensive and its up-front costs are high. This brings risks and the subsidy is thus key to maintain investor interest. This thesis identifies the greatest economic risk for PV solar plant development as its investor interest, which is threatened by the ending of the subsidy in 2025.

4.1.2 Non-economic barriers and support

Not all barriers to the implementation of PV solar plants in the Netherlands are of economic, financial, or market-technical nature. However, as the IEA (2011) notes, most support policies focus on the reduction of these barriers. This research demonstrates how non-economic barriers are a greater threat to the achievement of the 2030 targets than economic barriers are. It is key to tackle these barriers in the early phases of the RES project implementation cycle (IEA, 2011). The Dutch national government has formulated policies that aim to tackle non-economic barriers and support the RES-E transition. In this sub-chapter, key non-economic barriers and their respective government support are discussed.

With regard to the technical barrier category, interviewees confirmed that PV solar is a robust, easy-to-use technology, which thus experiences few technical difficulties. Two technical barriers were still identified in the interviews. Interviewees firstly mentioned a shortage of resources, mainly due to the COVID-19 pandemic (interviewee 5, 6). However, this shortage is not only relevant for PV solar plants, and the interviewees believed that this is issue will be overcome. A more structural barrier is the lack of technically skilled and experienced personnel in the Netherlands, which is mentioned as a large barrier for RES in academic literature (Painuly (2001), Zhang et al. (2012), Nasirov et al. (2015), Haas et al. (2018), Eleftheriadis & Anagnostopoulou (2015), Seetharaman et al. (2019). This barrier hinders the implementation of PV solar plants severely on two fronts, both construction of plants and the upgrading of the electricity grid. This barrier relates to the infrastructural category of barriers as well, namely one of the largest barriers to the implementation of PV solar plants: the lack of grid connection and access, which was mentioned by all interviewees and frequently in academic literature as well (Nasirov et al. (2015), Eleftheriadis & Anagnostopoulou (2015), Haas et al. (2018), Seetharaman et al. (2019), Nam Do et al. (2020). Already in 2010, ECOFYS mentioned this barrier as one of the non-economic barriers with the most severe impact. The following map of the Netherlands demonstrates the issue, whereby:

- Transparent = no transport scarcity (yet);
- Yellow = threat of transport scarcity, altered tender regime in place;
- Orange = advance notice of structural congestion at ACM;
- Red = structural congestion, new requests for transport are not honored (Netbeheer Nederland (2021).

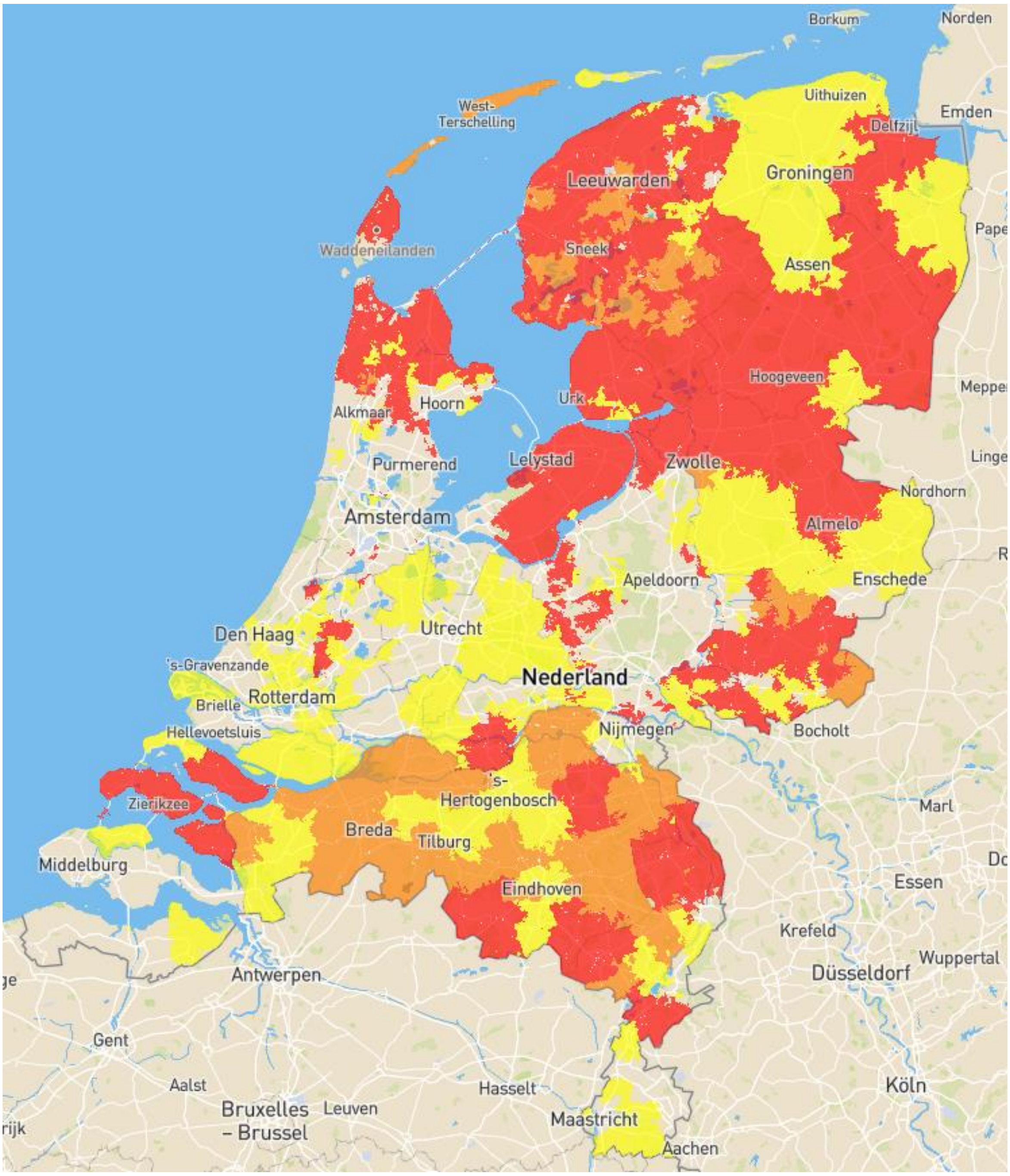


Figure 8: Grid capacity in the Netherlands (Netbeheer Nederland, n.d.)

As this map demonstrates, the largest issues regarding grid capacity and connection can be found in the north, north-east, east, and south of the country. These are also the more agrarian parts of the Netherlands, where lesser populated municipalities can be found and where most PV solar plant projects are being developed, as these projects require the space that can be found there. This relates to a second large infrastructural barrier, namely the lack of adequate infrastructure to accommodate PV solar plants, which was again mentioned by various interviewees and described in academic literature (Nasirov et al. (2015), Painuly (2001), Zhang et al. (2012), Seetharaman et al. (2019). The paradoxical friction between PV solar plants requiring a lot of space and the lack of space in the Netherlands is enlarged by the fact that plants need to be constructed with nearby connection to the grid, but lower capacity of the grid is found in lesser populated areas. This combination of barriers comes together in the distant energy supply and energy demand centers barrier mentioned by Haas et al. (2018). The authors write that '*strengthening the transmission is a key aspect*' (p. 404). However, the national Dutch government neither has the competence to make changes to the grid infrastructure, which is in the hands of privatized national and regional grid operators, nor of local spatial planning, which is in the hands of municipalities. Interviewees 4, 6, 8 and 9 criticized this division of competences, as grid operators are forced to act reactive, because their public funds are strictly regulated by the ACM.

In chapter 5.9 of the Climate Agreement (2019), it is written that in the regional energy strategies, four spatial planning principles should be taken into account:

1. *"efficient and multiple usage of the space (where possible);*
2. *closest possible alignment of supply and demand of renewable electricity;*
3. *combination of tasks and targets; trade-offs and rezoning if necessary;*
4. *close alignment with area-specific spatial quality".*

Therefore, as municipalities are most knowledgeable about the local situation, the decentralization of spatial planning makes sense and as space is scarce in the Netherlands, the available space should be used most efficiently. However, interviewees have mentioned issues with regard to these principles. To fulfil these principles well, capital is needed. However, the SDE++ subsidy steers to cost efficiency. Moreover, as mentioned earlier in chapter 4.1.1, the omission of land reimbursement in the SDE++ weighing leaves less room in the business case. Therefore, it is not always possible for developers to meet them all. This is mainly why interviewees (2, 5, 7, 8, 9) spoke about a lack of realistic government commitments, which was listed as a barrier by Seetharaman et al. (2019) in the literature. This issue relates to the barrier of difficulties in getting land concessions (Haas et al., 2018). Due to the scarcity of space, private landowners raise the price of their land, and due to tough the competition mentioned in chapter 3.5, it is difficult for developers to acquire land and due to the high price of land, there is less room in the business case to comply to extra requirements and fit the plant well in the landscape.

Interviewees mentioned a potential way on how to overcome these infrastructural barriers in the use of government owned property. PV solar plants are often developed on private land, such as agrarian land owned by a farmer. However, the national government with Rijkswaterstaat and the Rijksvastgoedbedrijf, government agencies such as ProRail and TenneT, and decentralized governments own a lot of land. As mentioned in chapter 1.3.3, the Dutch government has stated in the Climate Agreement (2019) that it will research how its property and infrastructure can be used for RES generation by setting up pilots. In this way, the government can fulfil an exemplary role to other public service agencies and the private sector. In the interviews, this development was discussed. All interviewees were in favor of using government property for the development of PV solar plants. Interviewee 3 stated that:

> "*I am a proponent. If you propagate something as a central government, then show that you want to make it happen, by using that where you have something to say about*".

Interviewee 4 voiced a similar opinion regarding this exemplary role of the government. Various ongoing pilots were mentioned by the interviewees as well, such as solar on infra pilots (interviewee 2, 6, 9) and solar on dikes pilot (interviewee 2). Some advantages of using government property were discussed. Firstly, government property is often not nearby the built environment, thus these projects impact local environment less (interviewee 1, 4). Secondly, interviewee 2 mentioned how private landowners want the maximum price for their land, so developers need to use all the land for the panels in order to have business case. This leaves no room for open space for nature and biodiversity. In theory, the government does not need to make a profit and thus does not have to ask for the highest price for it land, so developers do not need a maximum of panels to have business case. However, there are some issues that need to be looked into carefully. Firstly, areas are far away and there is no grid connection possible, so not all property is suitable (interviewee 3, 8). Secondly, government agencies such as ProRail and Rijkswaterstaat have issues with PV solar plants on their infrastructure, due to safety requirements (interviewee 2). Moreover, interviewees voiced criticism regarding the current state of affairs of executing the pilots by the government. The national government writes a tender on the highest price, they want the best plan (interviewee 5). The Rijksvastgoedbedrijf selects on the basis of biodiversity and participation at the front, but grants purely on the basis of price, with maximum generation for the lowest price (interviewee 6, 7, 8). Interviewee 7 and 8 stated that the government should listen to the market more, because in reality, local participation, good incorporation in the landscape, public acceptance are all requirements, also often from municipalities, but the government goes past this. The market does not work like this anymore (interviewee 8). Interviewee 6 mentioned how the government asks for a market conform price, but there is no land reimbursement in the SDE. This does not solve the difficulties in getting land concessions and the problem of a lack of space for extra requirements in the business case. Logically, costs are part of it, but more qualitative steering then quantitative steering is needed (interviewee 9). In conclusion, this research finds that the national government is not exercising is exemplary role.

A further category of non-economic barriers was pointed out by all interviewees as having great influence on the implementation of PV solar plants. This is the category of public acceptance and environment barriers, which mostly speaks to the phenomenon of NIMBY, mentioned in literature on barriers to RES by various authors (Nasirov et al. (2015), Eleftheriadis & Anagnostopoulou (2015), Seetharaman et al. (2019), Painuly (2001). This barrier is recognized by the Dutch climate policies and the government has drawn up means to achieve broad public acceptance for the energy transition. In the Climate Plan (2019), this is called the broad public approach, which consists of a public campaign of targeted communication to citizens, mostly via mass media, and a network approach which is aimed at increasing citizen's involvement. Governmental actors are responsible for the process participation and developers are responsible for the network participation. A lack of dissemination of information and of public awareness is frequently mentioned in the literature as a public acceptance barrier (Nasirov et al. (2015), Haas et al. (2018), Eleftheriadis & Anagnostopoulou (2015), Seetharaman et al. (2019), thus highlighting the importance of clear government policy and division of responsibility. Interviewees 4 and 9 mentioned how the 'silent middle', who neither voice their opinion in favor of nor against the RES-E transition, is hard to reach. Therefore, communication should be broad and continuous and as interviewee 7 mentioned, the national government has a role in mass-media communication, which promotes RES.

Good communication is required at the local level as well. Involvement of the local environment is both the task of regional governments and developers. The regional energy strategies are the instrument that enable regional governments and societal partners to establish plans for public acceptance with maximal citizen engagement (Government of the Netherlands, 2019). However, interviewees voiced negative opinions regarding the adequacy of government's communication (interviewee 1, 6) and developer's communication with the local environment as well (interviewee 1, 3, 8). In the answer to sub-question three regarding the phases of implementation in which the barriers occur, this research has found that the barriers mostly occur in the early stadium of implementation, before the permit and SDE++ subsidy have been given out. Interviewees mentioned how public acceptance can lead to municipalities refusing to hand out the environmental permit, which is underlined by the ECORYS report (2010), which stated that *"protest at the local level could lead to severe administrative blockage"*. However, in the Climate Plan (2019), the Dutch government states that in order to timely realize the task of the RES transition, all necessary permits need to be given out before January 1st, 2025, and delays in the issuance of permits thus threaten the 2030 targets. Therefore, good communication from the start of a project, aiming to increase public acceptance, is key, but interviewees mention how communication is often done after the location has already been chosen. Interviewee 8 mentions how his company starts with communication with the local environment before the permit is requested. If the plan is made before and the permit has been requested, then local citizens have no influence on the process, which is no real participation. As mentioned in the work of Zhang et al. (2012), Haas et al. (2018), Nam Do et al. (2020), a lack of stakeholders or community participation is a barrier to RES implementation.

In addition, the local environment should be involved financially in the implementation of PV solar plants as well. The developer shapes this participation with the local environment, which should result in 50% ownership of the production of RES for the local environment (Government of the Netherlands, 2019). Interviewees were mostly positive about the effect of financial participation on public acceptance, but not about every type of financial participation. While PV solar plants are not cheap, making it sometimes difficult to acquire capital by the local environment, interviewees were positive about 50% ownership participation in their projects. However, if ownership participation with an energy cooperation is not possible, some municipalities require developers to donate to an environmental fund, which was critiqued by interviewee 1 and 8, who do not believe that this is to the benefit of the local environment of the plant and misses its target and merely fills the municipal funds. Moreover, interviewees critiqued how the national government is passive in clarifying how the financial participation should be shaped. While it was written in the climate plans, interviewees 7 and 8 mention how the government remains vague regarding financial participation and responsible minister of economic affairs Wiebes states how it is not mandatory. In answer to questions from the Dutch Parliament, Minister Wiebes indeed stated: *"I am not in favor of unambiguous legal standards with regard to financial participation at the national level"* (Parliament of the Netherlands, 2020).

This political inconsistency was mentioned more times by interviewees and relates to the barrier of political instability from Nasirov et al. (2015). Different political opinions being voiced regarding the energy transition and upcoming municipal elections influencing the behavior of local civil servants was mentioned. However, more structurally, the collision between the behavior of provinces, aided by the Dik-Faber motion of parliament, and the national government's climate policies harms the implementation of PV solar plants, as mentioned by interviewees 6, 7, 8 and 9. This political instability barrier bridges between the public acceptance and regulatory and administrative categories. Interviewees spoke broadly about regulatory and administrative barriers. The main instrument to accomplish the RES-E transition are the regional energy strategies, which has led to better cooperation and communication of governmental stakeholders, but due to its lack of legal authority, the coordination between institutions is still a barrier. The largest issue mentioned by interviewees 2 and 3 is the possibility for municipalities to deviate from agreements made in the discussions of the strategies: the move from the regional energy strategies to the local energy strategies. This speaks to Painuly's (2001) barrier of a lack of legal and regulatory framework. While the framework is there, there is a lack of implementation of the plans made, due to the instrument being inadequate to force implementation.

This lack of implementation of plans and inadequate communication with the local environment at the local level is caused by qualitative and quantitative shortcomings of local civil servants, which was mentioned by almost each interviewee and speaks to the barrier of a lack of professional institutions (Painuly (2001), Nasirov et al. (2015), Seetharaman et al. (2019). Similar to infrastructural barriers, the decentralized character of PV solar plants is an issue with regard to the capacity of small municipalities. As PV solar plants require space, and this space is found at the lesser urban areas of the Netherlands, oftentimes small municipalities are tasked with setting up requirements and handing out the permit. However, interviewees have argued that these small municipalities lack the human capacity to perform this task well. In addition, interviewees have mentioned how local civil servants are neither qualitatively equipped to perform this task, due to the complexity of the procedures, which in the literature was mentioned as a barrier by Nam Do et al. (2020) and Seetharaman et al. (2019). ECORYS (2010) has highlighted the importance of clear guidelines and training for civil servants and interviewees 3, 5 and 6 argued that the national government should support local governments more with capacity and capital. It is thus clear that the delegation of the implementation to PV solar plants to local governments, without further guidelines nor support is hindering the RES-E transition.

In relation to the regional energy strategy discussion, a further barrier that was both mentioned by the interviewees (1, 3, 7, 8, 9) and literature (Painuly (2001), Eleftheriadis & Anagnostopoulou (2015), is the lack of private sector participation. Firstly, interviewees 7 and 9 mentioned how grid operators were involved in the discussions about search areas for PV solar plants in a later stadium. This chapter's discussion on infrastructural barriers highlights the importance of adequate grid connection in these search areas. The involvement of grid operator is thus crucial in the determination of valuable search areas. Secondly, as Painuly (2001) has stated: interaction with stakeholders is crucial to the identification of barriers, which helps to establish measures to overcome the identified barriers. This does not only apply to academics, but to governments as well. If developers' expertise was considered more, the lacunae in existing and future policies could have been identified earlier. Therefore, the current state of affairs sees a friction between a large role for the market in the implementation of PV solar plants, but a small role for the market in effective strategizing on how to organize the implementation.

An apparent issue lies thus in the communication between levels of government, market participants, the local environment, and other stakeholders. Interviewee 3 therefore called for an interpreter. As so many actors are involved in the transition to RES-E, these actors have trouble understanding the entire scope and thus need to learn about each other's worlds. The strategizing task of the national government should play a key role in this, but the national government's passivity, mentioned by various interviewees, is no longer possible as the actors to which tasks were delegated, the municipalities, provinces, market participants and the local environment, fail to overcome all the barriers. Therefore, this thesis presents recommendations for the national government to combat this issue.

4.2 Recommendations

As several key barriers still persist, this sub-chapter will put forward recommendations to the Dutch government on how to better tackle certain identified barriers to the implementation of PV solar plants in the Netherlands.

4.2.1 SDE++ subsidy

In general, the Dutch government's economic support for RES in general, namely the SDE++ subsidy, is deemed a good mechanism to achieve 35 TWh RES on land. Nonetheless, this research has identified certain frictions between various policies. Firstly, developers experience difficulties with recent changes in the subsidy mechanism. The Dutch government's support is based on cost-effectiveness, however, in their climate policies, various requirements for PV solar plants are laid out, which are increasingly put into practice by decentralized governments. These sometimes-unrealistic government commitments relate to multifunctional use of space, integration of nature, and financial participation of the local environment. Moreover, due to the scarcity of adequate space to accommodate PV solar plants in the Netherlands, the price of land has risen, which has led to difficulties of getting land concessions. However, good local integration of the plant and participation of the local environment are beneficial for public acceptance, which, as this research has presented, is a key barrier in the RES-E transition. Albeit sensible to steer for cost-effectiveness, it causes friction with these additional requirements, which require capital and thus leave less room in the business case for developers. Therefore, this thesis recommends that land reimbursement is weighed into the business case again. In this way, there is more room in the business case to meet the additional requirements and successfully achieve a supported RES-E transition. Moreover, as interviewees have mentioned difficulties with only one round of subsidy per year, this thesis recommends the government to return to two rounds per year, as it better fits to the permit issuance process and combats delays in the timely implementation of PV solar plants.

Secondly, this research has identified an issue with the ending of the subsidy by 2025. While the SDE++ subsidizes the unprofitable top of PV solar generated electricity, and while this is conform expected market prices of PV solar generated electricity, the subsidy also brings investor security. As mentioned by interviewees and in the literature, PV solar plant development has many capital-intensive risks in the early stadium of development and only once the subsidy is obtained, investor security is high. The ending of the subsidy threatens investor security and in turn threatens the development of plants post-2025. Due to EU state aid law, support cannot be of financial nature after 2025. The Dutch government has promised to launch a survey to identify non-financial forms of support. However, as this research has found that developers have experienced that they have not been listened to by the Dutch government, reasonable doubt can be expressed vis-à-vis this plan. It is important that the solution should not be decided on in advance, as the market will adapt to it too early, however, pilots with these alternative instruments, potentially in combination with the pilots of RES on government property, could be conducted. Therefore, this thesis recommends the Dutch government to increase its efforts in listening to market participants and research the possibility of pilots with alternative instruments to secure investor security post-2025.

4.2.2 Infrastructural barriers

Due to the general scarcity of space and in turn lack of space to accommodate PV solar plants in the Netherlands, municipalities require multiuse of space. The national government steers to this as well and interviewees agree to is usefulness, however, there are certain conditions that need to be met in order for this to be possible. A first recommendation vis-à-vis multifunctional use of space is already presented chapter 4.2.1. A second recommendation is based on an interesting development mentioned by interviewee 8, namely the construction of PV solar plants next to existing windmill plants and both plants sharing a single grid connection. This is called cable pulling and thus tackles the two key infrastructural barriers. This is a useful option when the location might be too expensive for a PV solar plant by itself, but as the wind park is already built. The largest risk is curtailment, which is the situation when both the wind park and the PV solar plant are at their peak generation at the same time and thus block each other's feed-in to the grid. However, cable pulling is a realistic option and curtailment is minimal (PV Magazine, 2021). Provided that developers of PV solar plants have access or can gain access to wind parks' location and grid connection, cable pulling seems to be a good solution for the lack of grid capacity and connection and the scarce space in the Netherlands. Therefore, this thesis recommends both the national government, local governments, and developers to explore this option.

A second recommendation of this thesis to the national government's policies vis-à-vis infrastructural barriers relates to the pilots for PV solar plants on government property. Interviewees were fully behind this idea, however, the current way the idea is executed is criticized. In the Climate Agreement, an exemplary role of the national government vis-à-vis other levels of government and the private sector was listed as a reason for the pilots. Moreover, the pilots could help to overcome infrastructural barriers regarding land concessions and a lack of space. However, interviewees mention how the government is not living up to this role, as written in chapter 4.1.2. Therefore, this thesis recommends the Dutch national government to meet with market participants and discuss how these pilots could be used for a better public-private collaboration and in overcoming existing barriers to the implementation of PV solar plants, as interviewees mention how the idea of using government property has a lot of potential.

4.2.3 Public acceptance and participation

A further recommendation relates to another key barrier to the implementation of PV solar plants, namely public opposition from the local environment and the NIMBY phenomenon. This research has identified participation, both in planning and financial participation as useful in overcoming this opposition. However, interviewees have criticized how there is no clarity on whether or not it is mandatory. On the one hand, it is written in the Dutch Climate Agreement (2019), on the other hand, the Dutch minister of economic affairs and climate leaves it to the local environment and municipalities to shape this form of participation. This unclarity hinders the process of participation and gives handles to the local environment to shape the financial participation well. Therefore, this thesis recommends the Dutch national government to make the 50% local ownership requirement mandatory.

4.2.4 Reinforcement of local governments

This research has demonstrated how the transition to RES-E, which includes the implementation of PV solar plants is a complex operation that includes many stakeholders and interests. Due to the decentralized nature of PV solar plants and their location at often lesser populated areas, it is no surprise that local governments are not always well-equipped to properly partake in the process. However, as spatial planning and thus handing out the environmental permit lie is their competence, it is crucial that they are both quantitatively as well as qualitatively equipped to fulfil this role. This research has found that this is often not the case, which is exemplified by municipalities rediscussing agreements reached in the regional energy strategy discussions, delays in the issuance of environmental permits and local civil servants being unable to adequately deal with local opposition. Therefore, this thesis recommends the national government and the NP regional energy strategies to set out guidelines as a blueprint on the successful implementation of PV solar plants, based on the experiences from other municipalities. Interviewees were positive about the regional energy strategies as a means of communication and learning between municipalities. These guidelines can serve as an interpreter between the different worlds of understanding of stakeholders.

4.2.5 Involvement of the private sector

A final recommendation to the national government relates to the barrier of a lack of private sector involvement. The field-specific knowledge and experience of developers is an underused, valuable resource to overcome the barriers this thesis has identified and overcome the revealed lacunae in existing policies. The crucial barriers for the Netherlands were identified with help from these developers and in a similar fashion, the national government should make use of their expertise. Moreover, specific to the infrastructural barriers, the expertise of grid operators should have been used earlier in the determination of search areas, as grid connection is a deciding factor in the location. The RES transition is partially left to the market; thus the government should take their views into account.

4.3 Research process

Certain limitations have unfortunately limited the depth and width of this research. A first cause is general time constraints and searching for the right angle to approach this topic. Nonetheless, nine interviews were conducted, from which a large amount of relevant data was derived. With more time, even more developers, and stakeholders to the development of PV solar plants could have been interviewed, which would have strengthened the arguments made in this thesis. Subsequently, as many barriers exist, the depth in which the barriers could be discussed has its limits. However, as many barriers are connected with each other, it is necessary to get an overview of the entire situation and this research has managed to paint a broad picture of the Dutch implementation of PV solar plants.

Conclusion

This research aimed to identify barriers to the implementation of PV solar plants in the Netherlands and evaluate the support mechanisms of the Dutch national government to tackle these barriers in order to answer the question of how government support helps to overcome barriers to PV solar implementation. In the literature review, various potential barriers concerning the transition to RES were found and categorized. In addition, government support measures aiming to overcome these barriers were discussed and specifically the measures addressed in the climate policies of the Netherlands. In order to identify barriers in the Netherlands, nine semi-structured interviews with stakeholders to the implementation of PV solar plants in the Netherlands were conducted and barriers were identified. These barriers were categorized according to the IEA (2011) categories and key barriers threatening the achievement of the 2030 targets set by the Netherlands in order to achieve the EU's target were highlighted. In addition, in the interviews, it was found that key barriers exist in the early stadium of the project cycle of PV solar plant development. Namely the exploration phase and the plan-making phase, which are the phases before the acquisition of the environmental permit and the SDE++ subsidy. Furthermore, this thesis has found gaps in the support for PV solar plants of the Dutch national government. With regard to barriers and support of economic nature, this thesis has found that in general the Netherlands currently has good economic support for RES with the SDE++ subsidy scheme. However, in order to ensure investor security when the subsidy scheme expectedly ends in 2025, additional, non-financial measures will likely need to be adopted and good consultation of the market is therefore essential.

However, while support for RES mostly focuses on tackling economic barriers, this thesis has identified barriers of non-economic nature to be the most threatening for the successful achievement of the 2030 targets. These non-economic barriers have economic consequences. One part of these non-economic barriers lies in the infrastructural and technical barrier categories. Firstly, there is scarcity of space in the Netherlands, which makes it difficult to determine locations for plants and rises the price of land. Moreover, these locations need to lie close point of connection to the grid. However, there is a lack of grid capacity and connection in the Netherlands, especially in the lesser populated areas where there is space for these plants to be constructed. This is major threat to the implementation of PV solar plants, as developers will not construct a plant, if there is no feed-in possible, even if the environmental permit or the SDE++ subsidy have been acquired. As grid operators are forced to act reactive and upgrading the grid takes years, this barrier will continue to persist, but interviewees believe that it will be solved at some point in the future. Nonetheless, it currently causes severe delays threatening the 2030 targets. A third technical barrier is the shortage of technically skilled personnel, which hinders the upgrading as well. It is key that grid operators are involved early in the discussions for search areas, which was not the case in discussions for the regional energy strategies 1.0, but as local governments are rediscussing the agreements reached during these discussions, an opportunity lies for grid operators to be involved.

A second part of the non-economic barriers lies in the interaction between local governments, the local environment, and other stakeholders to the implementation of PV solar plants. This thesis has identified delays in the issuance of environmental permits as a key barrier. On the one hand, this is caused by local opposition to PV solar plants. The importance of good plan- and financial participation was highlighted in the discussion of this thesis' results, however, as interviewees have mentioned, it is very difficult for opponents to accept the construction of a plant in their local environment, let alone support the plant. Therefore, local civil servants often halt the permit issuance because of local opposition. Moreover, while local governments have been delegated a key role in the RES transition, this thesis has identified quantitative and qualitative shortcomings of local administrations as another key barrier in the Netherlands. Interviewees expressed the lack of knowledge and knowhow of PV solar plants of local civil servants. This barrier relates to various other barriers such as delays in the permit issuance, ineffective dealing with local opposition, issues with appointing locations of PV solar plants, ambiguous requirements regarding financial participation and unrealistic extra requirements that developers must comply to in order to be able to build their plant.

A final key barrier in the Netherlands is a lack of private sector participation. While stakeholders to the development of PV solar plants have field-specific knowledge, which enables them to identify lacunae in the existing support policies, their expertise is currently underused. This is exemplified in the lack of involvement of grid operators in the regional energy strategy discussions, but interviewees expressed their frustrations about the passivity of the governments tapping into their empirical expertise.

Despite these barriers, SolarPower Europe (2020) predicts that the Netherlands will remain to be in the top three European PV solar installation markets for the period of 2021-2024. While threatening barriers persist and potentially threaten the timely achievement of targets, the Dutch national government has well-thought-out climate policies and good economic support until RES are able to compete with fossil fuels on the electricity market. Therefore, other EU MS could learn from the Netherlands as a frontrunner, both on how to increase the generation of PV solar and on how to tackle the barriers identified in the Netherlands in an earlier stadium.

As this thesis has focused on the Netherlands, further research on the topic of the implementation of PV solar plants could focus on other EU MS and compare the support schemes of and barriers in the Netherlands with other EU MS. Moreover, as this thesis has sought to establish an overview of all barriers in the Netherlands, future research could deepen the research on one specific barrier category.

Annex

Category	Specific barrier	Scholar
Economic	Economically not viable	Painuly (2001)
	High payback period	Painuly (2001), Nasirov et al. (2015), Zhang et al. (2012), Eleftheriadis & Anagnostopoulou (2015)
	High discount rates	Painuly (2001)
	High cost of capital	Painuly (2001)
	Lack of access to credit to consumers	Painuly (2001)
	High up-front capital costs for investors	Nam Do et al. (2020), Nasirov et al. (2015), Painuly (2001), Zhang et al. (2012), Eleftheriadis & Anagnostopoulou (2015), Seetharaman et al. (2019)
	Unstable prices in spot market	Nasirov et al. (2015)
	Low investor interest	Nam Do et al. (2020), Eleftheriadis & Anagnostopoulou (2015)
	Longer economic recovery periods	Nasirov et al. (2015)
	Lack of modeling externalities	Nasirov et al. (2015)
	Trade barriers	Painuly (2001)
	Does not add value to the property	Zhang et al. (2012)
	Insufficient local products, lack of purchasing opportunities, domestic manufacturing industry	Haas et al. (2018), Zhang et al. (2012), Eleftheriadis & Anagnostopoulou (2015)
Financial	Lack of financial institutions to support RETs, lack of instruments	Painuly (2001), Seetharaman et al. (2019)
	Lack of access to capital	Painuly (2001), Nam Do et al. (2020), Nasirov et al. (2015)
	Insufficient financing schemes	Haas et al. (2018), Eleftheriadis & Anagnostopoulou (2015)
	Taxes on renewable energy technology	Painuly (2001), Eleftheriadis & Anagnostopoulou (2015), Seetharaman et al. (2019)
	Lack of R&D capabilities	Seetharaman et al. (2019), Painuly (2001)
Market	Market design problems	Nasirov et al. (2015), Painuly (2001)
	High market concentration	Nasirov et al. (2015)
	Market size small	Painuly (2001)
	Fossil fuel subsidies	Nam Do et al. (2020), Painuly (2001), Eleftheriadis & Anagnostopoulou (2015), Seetharaman et al. (2019)
	Competition from fossil fuel	Seetharaman et al. (2019)
	Lack of competition	Painuly (2001)
Technical	Lack of technical information and assistance	Nam Do et al. (2020)

	Solar mapping and forecasting	Haas et al. (2018)
	Lack of standard and codes and certification	Painuly (2001), Zhang et al. (2012), Seetharaman et al. (2019)
	Lack of skilled/experienced personnel/training facilities	Painuly (2001), Zhang et al. (2012), Nasirov et al. (2015), Haas et al. (2018), Eleftheriadis & Anagnostopoulou (2015), Seetharaman et al. (2019)
	Lack of O&M facilities	Painuly (2001)
	Product not reliable	Painuly (2001)
	Lack of specialized technology/availability of equipment	Eleftheriadis & Anagnostopoulou (2015), Seetharaman et al. (2019)
Infrastructure	Backup flexibility	Haas et al. (2018)
	Distant energy supply and energy demand centers	Haas et al. (2018)
	Harsh environment	Haas et al. (2018)
	Access to water	Haas et al. (2018)
	Grid connection constraints and lack of grid capacity	Nasirov et al. (2015), Eleftheriadis & Anagnostopoulou (2015), Haas et al. (2018), Seetharaman et al. (2019), Nam Do et al. (2020)
	Inadequate infrastructure to accommodate renewables	Nasirov et al. (2015), Painuly (2001), Zhang et al. (2012), Seetharaman et al. (2019)
	System constraints	Painuly (2001)
	Lack of storage	Seetharaman et al. (2019)
	Difficulties in getting land concessions	Haas et al. (2018)
Public acceptance and environment	Lack of stakeholders/community participation in energy choice (insufficient incentives)	Zhang et al. (2012), Haas et al. (2018), Nam Do et al. (2020)
	Esthetic considerations	Zhang et al. (2012)
	High risk perception for RETs	Painuly (2001)
	Lack of consumer acceptance of the product	Painuly (2001)
	Local opposition to the development of projects (NIMBY)	Nasirov et al. (2015), Eleftheriadis & Anagnostopoulou (2015), Seetharaman et al. (2019), Painuly (2001)
	Lack of dissemination and public awareness	Nasirov et al. (2015), Haas et al. (2018), Eleftheriadis & Anagnostopoulou (2015), Seetharaman et al. (2019)
Regulatory and administrative	Complex procedures	Nam Do et al. (2020), Seetharaman et al. (2019)
	Regulation mismatch	Nam Do et al. (2020)
	Policy uncertainty	Nam Do et al. (2020), Painuly (2001)
	Entrenched fossil fuel industry	Nam Do et al. (2020)

	Delays in the environmental assessment process	Haas et al. (2018)
	Lack of political stability	Nasirov et al. (2015)
	Highly controlled energy sector	Painuly (2001)
	High investment requirements	Painuly (2001)
	Lack of institutions/mechanisms to disseminate information	Painuly (2001)
	Lack of legal/regulatory framework	Painuly (2001), Zhang et al. (2012), Eleftheriadis & Anagnostopoulou (2015), Seetharaman et al. (2019)
	Problems in realizing financial incentives	Painuly (2001)
	Unstable macro-economic environment	Painuly (2001)
	Lack of involvement of stakeholders in decision-making	Painuly (2001)
	Clash of interests	Painuly (2001)
	Lack of private sector participation	Painuly (2001), Eleftheriadis & Anagnostopoulou (2015)
	Lack of professional institutions, lack of coordination between institutions	Painuly (2001), Nasirov et al. (2015), Seetharaman et al. (2019)
	Lack of an integrated spatial planning	Eleftheriadis & Anagnostopoulou (2015)
	Delays in the issuance of building permits	Eleftheriadis & Anagnostopoulou (2015), Nasirov et al. (2015)
	Restricted access to technology	Painuly (2001)
	Unrealistic government commitments	Seetharaman et al. (2019)

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