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Master's Thesis

Barriers to Renewable Energy Development

A Chilean & Moroccan cross-country comparison

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Abstract

Renewable energy has the potential to become one of the most influential technologies of the present century. Leaps in technology development combined with significant cost reductions have helped to establish renewable energy on a competitive level with traditional sources. Emerging markets may turn out to be one of the main beneficiaries, given that their energy-hungry economies and a growing middle-class demand ever larger amounts of (decentralized) energy. However, several prevailing barriers to renewable energy development hinder some of these countries to utilize their full potential.

Chile & Morocco are two countries that have already identified the indisputable benefits of renewable energy diffusion, but yet are hold back by various critical barriers to development. As such, the guiding research questions of this thesis is as follows: *How can a cross-country comparison of barriers to renewable energy development help to understand and address those barriers?* The goal of the research is to first *identify* the prevailing barriers in both countries, to *connect* them with the main considerations of project developers and other stakeholders, to then finally *draft* a framework that allows for a more effective cross-country comparison method.

A comparative case-study approach is chosen and semi-structured interviews with industry insiders in both countries help to obtain the necessary insights. Secondary data is mainly complementing the research by providing a general market overview. The well-used and cited Painuly (2001) framework is utilized for the clustering of interview findings in the specific barrier groups.

The contribution to research is twofold. Firstly, an extensive country analysis contributes to the mapping of prevailing barriers in Chile and Morocco. Both countries show a remarkable number of similar barriers despite their different profiles. Secondly, the well-founded interview findings are turned into a method that helps to compare barriers to RE development. The author proposes a framework that builds on the Painuly (2001) framework and extends it by two further dimensions. The findings may not only be of interest for project developers, investors or energy planners. Also academics may utilize the proposed framework in future cross-country comparisons.

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> "To truly transform our economy, protect our security, and save our planet from the ravages of climate change, we need to ultimately make clean, renewable energy the profitable kind of energy" (Barack Obama, 2009).

1. Introduction

Renewable energy (RE) continues to attract significant attention with academics, policy makers and managers alike. The importance of alternative energy sources has been carved out through various studies, testifying them the potential to play one if not the most crucial role to reduce carbon emissions and the consumption of fossil fuels on a global scale (Meyer et al., 2009). In addition, several authors argue that the trickle-down effect of an increased RE diffusion would be substantial, as Masini and Menichetti (2012) discuss for instance the positive impact on unemployment and economic growth.

The efforts to make a sustained global change have once again been renewed in the Paris Declaration in 2015. All parties signing the declaration are for the first time required to compile regular reports on their emissions and efforts to reduce those (EC, 2016). The reduction in global emissions has been at the core of the conference and in line with earlier gatherings and reports. The International Energy Agency (IEA) stressed in its World Energy Outlook in 2009 that RE would need to exceed 50% of the primary energy supply in 2050 in order to half CO2 emissions.

The sustained attention, important policy changes as well as significant decreases in technology costs have put RE on a promising growth path, reaching an estimated 23.7% (9.1% when excluding large hydro) of total global electricity production in 2015 (REN21, 2016). Seeing RE projects making up 48% of the globally added net power capacity in 2014 is certainly confirming those, who are predicting that RE will have a promising future on a global scale (FS-UNEP, 2016).

Emerging markets or rapidly developing economies may be one of the main beneficiaries of the plunging RE costs and increased global diffusion. The majority of those markets are characterized by a considerable growth in electricity demand, fuelled by economic advancement and a growing middleclass (EPIA, 2010). The question of how to handle the demand surge might be at the core of discussion of many governments and energy planners. In addition, one of the striking arguments in favour of RE should be the fact that many of these markets lie in the so called “sunbelt” and therefore benefit from excellent renewable resources (EPIA, 2010).

However, public and private RE investments in certain emerging markets are behind expectations, despite the favourable geographic location and necessary additional capacity. The majority of the invested $270.2bn in RE in 2014 (excluding large hydro projects) was allocated to the established major markets, such as China ($83.3bn), Europe (57.5bn), the US ($38.3bn) and Japan ($35.7bn). Only few of the emerging markets are able to capitalize on their promising conditions by attracting large investments. In total of $48bn was invested in 2014 in these markets, with South Africa ($5.5bn), Mexico ($2bn) and Indonesia ($1.8bn) being among those in the front row (FS-UNEP, 2016).

The investment allocation can partially be explained by the fact that mainly the private sector needs to come up for RE investments, as it for instance contributed more than double compared to the public sector in 2011 (CNN, 2012). As private investors are generally driven by opportunity costs and certain yield requirements, investments into more proven, stable and advanced economies can be seen as a logical strategic decision. Governments may facilitate increased investments through accommodating public policies, such as tax breaks or feed-in tariffs. However, the nature of certain emerging markets, characterized by unpredictable political regimes and institutional voids, seems to outweigh the potential benefits of investing there.

Several authors, such as Painuly (2001 & 2004), Beck and Martinot (2004) and Verbruggen et al. (2009) analyse barriers to RE development in their studies. Their findings neatly present the different barriers on either a global level or with focus on a particular country. Their categorization of barriers helps to analyse a certain market and present the prevailing barriers. Masini and Menichetti (2010 &2012), Burer and Wüstenhagen (2009) and Edenhofer et al. (2013) discuss investor preferences for RE investments and elaborate on the concepts of opportunity costs and limited resources. These concepts ultimately steer the decisions of investors.

The author wants to combine three of the aforementioned themes in this thesis. Firstly, the focus is laid on emerging markets. The setting of emerging markets combines interesting growth opportunities with institutional voids and other barriers, which have to be circumvented when doing business there. The economic success and an aspiring middle class make these markets relevant for the near future and therefore an interesting research field. Secondly, many of these markets have excellent renewable resources, yet fail to utilize their full potential. Hence, the author identifies the still prevailing barriers to RE development in a cross-country comparison as another interesting and relevant research area. And lastly, given the key position private project developers take on in the RE development process, their role is looked upon in more detail throughout the thesis.

The revision of the relevant literature in the three mentioned research fields let the author conclude that an important field of research is yet to be explored in further depth. The research at hand addresses not only the various still prevailing barriers to RE development in two emerging markets. It also tries to generate lessons from the cross-country comparison of two seemingly very different markets in order to guide all relevant stakeholders in their endeavour to remove the prevailing barriers. Therefore, the guiding research question for this thesis is the following:

How can a cross-country comparison of barriers to renewable energy development help to understand and address those barriers?

1.1 Delimitations

Several delimitations shall be mentioned in this chapter in order to shed light on the deliberate decisions taken by the author.

The author has chosen two country cases for the research at hand. After having contemplated if a third case would add value to the research, the author decided to go forward with two cases in the comparative case-study. By focusing on two countries, the author was better able to ensure an in-depth study with relevant results. Moreover, the chosen qualitative research method is time consuming and involves vast market research and time to prepare and assess the conducted interviews. The semi-structured interviews entailed similar questions but were always tailored towards the particular interviewee in order to gain the most relevant insights.

Primary data was collected through semi-structured interviews. The author chose a qualitative research method, which allows the in-depth exploration of the chosen cases. An important step in the research process was the ability to interview relevant stakeholders and tailor the questions accordingly in order to get the most relevant insights. A quantitative research approach could have been valuable in order to generate data which then could be analysed with statistical tools.

However, the limited amount of cases and interviews did not allow for any meaningful quantitative method.

The two case-countries were deliberately chosen in two different regions, namely Latin America and Africa. Both regions are characterized by a high number of emerging markets. The author added this geographical dimension in order to have another comparison level in the case research. A third country in yet another growth region would have certainly be of interest as well. However, the findings of the two country cases have already allowed to draw interesting conclusions. Moreover, two countries were sufficient to draft the author's proposed framework.

The author decided to focus on emerging markets for a number of reasons. Firstly, the projected growth and surging electricity demand makes these countries interesting and relevant for energy planners and project developers in the decades ahead. Secondly, the author's background in business and development allowed for the incorporation of insights gained in the field of emerging markets and the prevailing institutional voids.

RE projects developers were chosen for the majority of interviews. They were not only chosen because they are approachable and have an intrinsic interest in the research at hand. But also, because they were identified as one of the key stakeholders when it comes to RE development. Nevertheless, in order to widen the audience of this thesis, the author structured the proposed framework in a way that allows investors, energy planners and also academics to gain valuable insights. Another interesting key focus group would have been the investors, who provide the financing for RE projects. However, the author identified project developers to be crucial in the planning and execution phase of projects and consequently tailored the thesis more towards them.

The author deliberately opted for a realist research philosophy, being convinced that that the world is shaped by complexity and that it is not always possible to distinguish the factors that lead to a certain result. The critical realist approach is well suited for a multi-level study with qualitative data (Easton, 2008). Moreover, critical realism accepts that insights generated through for instance interviews can likewise be treated as a form of data. Nevertheless, other research philosophies were considered as well. Positivism and Interpretivisim are two other well-used philosophies in research. The author however felt that they are too limiting for the research at hand, given for example the law-like generalisations that shape the philosophy of positivism. Critical realism neatly bridges both other theories and hence was chosen as the preferred philosophy for this study (Baghramian & Carter, 2015).

1.2. Structure of the Thesis

The introduction has given a brief overview of the research question, fields and the delimitations. Chapter two presents the methodology, including the philosophy of science, approach, strategy and data collection, among others. Chapter three presents a critical review of the relevant literature strands with the introduction to the Painuly (2001) framework. Chapter four gives a general introduction to the case countries. Chile and Morocco are then presented in chapter five and six, with a particular focus on their energy markets and the prevailing barriers. Chapter seven combines the interview findings in a cross-country comparison, carving out unique and shared barriers. Chapter eight entails the discussion of the findings, the research contribution as well as interesting future research opportunities. Finally, chapter nine presents the conclusion, including the main findings and an answer to the guiding research question.

2. Method, Approach and Research Design

This chapter outlines the research method, data collection, as well as the validity, reliability and credibility of the collected data (Matthews & Ross, 2014). The research onion (Saunders, Lewis & Thornhill, 2012) is applied in order to elaborate on the different choices and steps of the research at hand.

2.1. Research Purpose

This thesis aims to answer the research question by analysing the key findings of relevant primary and secondary data. The research question is of exploratory and descriptive nature. The goal is to first understand the most prominent barriers to RE diffusion in order to then draft a framework that lets project developers and other stakeholders compare several countries and the prevailing barriers. An exploratory approach is regularly utilized in new areas of research with the aim to generate ideas about a particular problem (Bhattacherjee, 2012). This form of research is valuable in the sense that it allows the researcher to ask open questions and gain insights about a topic of interest. In the research at hand it allows for a flexible research design when looking into the two case countries of the cross-country comparison.

2.2 Research Philosophy

The author takes on the view that the world is shaped by complexity and that it is often times hard to distinguish which factors lead to a certain result. One can observe such uncertainty not only in business, but also in politics or society. In addition, emerging markets are especially prone to uncertainty, given for example the typical institutional voids that project developers, investors and others face. Taking those issues into consideration, a realist research philosophy has been chosen (Baghramian & Carter, 2015).

More specifically, the author can relate well to the deliberations of Easton (2008), who describes critical realism as one of the approaches best suited in case-study research. Critical realists assume the existence of a real world and allow for the study of any situation, independent from the involved number of research cases. This research philosophy aims to thoughtfully analyse things in depth and understand why they occur as they do. The author has chosen two cases for the research at hand. By incorporating several dimensions on for instance stakeholder level, the author aims to paint a complete picture of the researched subject.

Easton (2008) also argues that the multi-level study in critical realism is fundamental to detect the essence of the researched phenomena. The incorporation of interrelationships and degrees of influence are likewise key to find this essence. The author can relate well to these statements as several dimensions are included in the research and the interplay of several parties are carved out as one of the key factors in the success of RE diffusion.

2.3. Research Approach

The author has chosen an inductive approach for the research at hand, but has likewise incorporated traits of abductive reasoning. The inductive approach can be described as the move from the specific to the general (Bryman & Bell, 2011). Observations and interview findings serve as a starting point to then generalize them in order to reach patterns (Beiske, 2007).

The inductive approach is commonly used in qualitative research, as the research process can be conducted relatively independent from certain theories guiding the researcher (Bryman & Bell, 2011). Interviews are conducted in order to examine a certain phenomenon. The data retrieved from the interviews shall then be compared to reach patterns between the respondents (Flick, 2011). The author conducted interviews in well-informed circles in the Chilean and Moroccan RE markets. The possibility to gain insights from two different countries helps to establish similar barrier patterns and establish a framework that can help project developers to efficiently compare the diffusion barriers of other nations.

In addition, the author also incorporated abductive reasoning. This form of reasoning is characterized by an incomplete set of observations, where the most likely conclusion is drawn from. Whereas inductive reasoning requires a rather complete set of evidence, abductive reasoning has no such criteria (Bryman & Bell, 2011*)*. Abductive reasoning has its advantages in this case as the author's observation set is incomplete for a number of reasons. Firstly, other non-observed barriers also decide over RE development. Secondly, the amount of time and hence ability to conduct further interviews and take on more case countries has been limited.

2.4 Research Strategy

The author has chosen a few-country comparison research strategy. Case study research is characterized by the research of a single or several units in order to come up with the key features in the attempt to then establish generalizations (Bryman, 2012). Not only can a case study be analysed in depth, but it can also establish the importance of context when analysing and comparing different cases (Silverman, 2013).

Easton (2008) describes the case study as a prime opportunity to research a complex set of relationships and factors, while only looking at a limited number of cases. One of the key advantages is the flexibility of the case study design, allowing the researcher to move back and forth during the stages of the research. This iterative research process and the incorporation of multiple data sources aids to reach a holistic view of the researched phenomenon (Easton, 2008). The author benefited considerably from the opportunity to incorporate earlier interview findings into later interviews. An advantage that survey based methods for instance do not have.

Few-country comparisons are useful when the context matters as in this case where the most relevant barriers to RE development in the specific countries are identified. Such direct comparison allows for a better overview and supports the decision making of project developer and other stakeholder. Hence, it would constitute a relevant piece of research for future projects in other countries. Few-country comparisons are also valuable if there are only limited cases available that do not allow for statistical analysis. Moreover, they are of value if the research time is limited and only few cases can be analysed (Bryman, 2012).

It is important to note that cases should be chosen out of rationale, not just convenience. Chile and Morocco were chosen for a number of reasons. Both countries proclaimed ambitious RE targets that are planned to be achieved within the next five to ten years. However, both countries face substantial barriers on their path towards their targets and hence constitute interesting cases for a study. The different geographical locations hold for further interesting insights that can be utilized in the analysis and later on in the conclusions and recommendations. In addition, the author's four months stay in Chile allowed him to analyse issues first-hand and directly speak to relevant insiders in the RE industry. Someone with extensive experience in the industry can be described as an insider. The number years in the industry as well as the position in the respective company shall be mentioned as two indicators, among others.

2.5 Data Collection Method

The data collection process and subsequent analysis are key tasks in research and both depend on the chosen methodological approach. Depending on which process is chosen at this stage of the research, the overall validity and reliability of the study can be altered significantly (Bryman, 2012).

Both primary and secondary data were utilized, with a particular focus on semi-structured interviews with relevant stakeholders in the industry. The validity and credibility of data was established through the interviewee's positions in their respective organizations and their relevant insights into the RE industry. The author placed great value on speaking with industry insiders that have worked many years in or with the researched markets. Research reliability was taken care off by interviewing several project developers dealing with various renewable energy sources. However, the complete replicability of case study results are of course difficult to ensure, especially if only two countries are analyzed in a cross-country comparison. Nevertheless, the author is confident to have obtained relevant data that can be utilized for future cases as well. And finally, research relevancy was achieved through the direct interviewing of RE project developers. This group is at the core of the RE development process and hence contributed relevant insights to the research at hand.

Interviews were conducted in person or over the phone. Secondary data helped especially in the early process to establish the relevant problems in the two countries and to get acquainted with the distinct country characteristics. All conversations were guided by a question set that was established beforehand, in order to cover the most relevant questions and ensure comparable data for the analysis thereafter. However, depending on the interview process and generated insights, questions were adapted accordingly to gain the best possible insights from each individual interview. The table below lists the interviewees, their function, as well as other general information.

Abbreviation	Viewpoint	Job Title	Selection	Date	Format	Length	Recording
C1	Academic & Practical	Economist & Former vice president of the Chilean state mining company	Direct Contact	07.10.2015	Semi-structured interview	0:46:12	yes
C2	Electrical Engineer	Associate	Direct Contact	21.10.2015	Semi-structured interview	1:02:35	yes
C3	Project Developer	Commercial Strategy Department	Direct Contact	01.11.2015	Semi-structured interview	0:57:22	yes
C4	Programme Director	Director, Renewable Energy Programme Chile	Direct Contact	03.11.2015	Semi-structured interview	0:45:54	yes
M1	Project Developer	Managing Director	Direct Contact	08.06.2016	Semi-structured interview	0:36:14	yes
M2	Project Manager	Project Manager, Morocco	Direct Contact	30.06.2016	Semi-structured interview	0:34:41	yes
M3	Project Manager	Project Development Manager, Africa	Direct Contact	06.07.2016	Semi-structured interview	0:20:15	yes

Table 1: Overview of the semi-structured interviews

3.6 Limitations

As with most other studies, this study also comes with certain limitations. One of the key limitations of a comparative case study is the fact that it compares various cases but does not transparently or systematically establish and analyze causal propositions (Bryman, 2012). Moreover, the selection of cases is often done in order to cover different regions, not necessarily to establish a causal analysis. Chile and Morocco were also chosen in order to represent two of the largest regions globally with plenty of neighboring emerging markets and opportunities for RE development. The comparison of these two countries in two very different but highly interesting regions is certainly value-adding and results can be used for future studies and comparisons. However, it is of course arguable to which extent findings can be applied to other regions or non-similar countries. This constitutes an interesting starting point for future research. Additionally, the comparison of only two countries is another possible limitation. More time and resources would have allowed for a third country to be incorporated in the comparison as well.

Similarly, the amount of conducted interviews could have been increased with more time at hand. And lastly, the lack of quantitative data and hence statistical backing shall be mentioned as another limitation. The inclusion of quantitative data could enrich the findings. A complementing survey based method could help to achieve further valuable insights through the utilization of statistical analysis. However, this method would need a considerable increase of respondents in order to be meaningful.

3. Literature Review

The purpose of the following literature review is to provide an overview of the already existing research on the main themes of this thesis. Several authors have looked at the barriers to RE development. The several angles of research are presented in turn. Moreover, the mechanisms that help to mitigate such barriers are also incorporated in this overview.

Reddy & Painuly (2003) argue that shifting from conventional towards renewable energy technology should be among the top priorities when transforming towards a sustainable energy system. According to them, the two main reasons are the steadily increasing energy demand which needs to be met as well as the need for a reduced environmental impact. However, despite these clear advantages and motivation of governments to initiate such transformation, substantial barriers remain that need to be analysed in order to overcome them (Reddy & Painuly, 2003).

3.1. General Barrier Theory

Several authors have discussed RE diffusion barriers from a general standpoint, shedding light on what hinders the increased utilization of these technologies. One of the most prominent authors in the field is Painuly (2001), who neatly explains the wide spectrum of barriers to diffusion in his paper. He argues that a variety of barriers hinder the diffusion of RE in developing as well as developed markets. In order to utilize the countries' RE potential one needs to first identify and then overcome the prevailing barriers. He recommends literature surveys, site visits as well as the direct interaction with stakeholders in order to identify the prevailing barriers. His framework allows a holistic view of the existing barriers by clustering them into for instance *Market Failures, Institutional Barriers, Economic/Financial Barriers* and *Technical Barriers*. The application of several barrier levels enables the user to deal with a chosen barrier in more depth. It is a useful framework for an in-depth country analysis, as it very much encompasses all types of barriers. The framework is applied throughout this thesis, given its simplicity and applicability. A template of the framework is shown in table 2.

Barrier Category	Barrier
Market Failure/imperfection	
Market Distortions	
Economic & Financial	
Institutional	
Technical	
Social, Cultural & Behavioural	
Other Barriers	

Table 2: The Painuly (2001) framework illustrating the various barrier categories

Jacobsson & Johnson (2000) also address various diffusion barriers in their paper. They stress for instance the institutional failures that hinder the diffusion of RE and the development process of RE in a country. Such failures could be the lack of guiding institutions and personnel, as well as an insufficient information sharing mechanisms with regard to permits or tender processes. The favouring of incumbent technology is one of the key barriers according to them. This is for instance done through national energy planners, but likewise through the capital market in case it restricts the financing of RE projects. Hence, a multitude of forces seems to hamper the diffusion of new technologies. Verbruggen et al. (2009) take on a somewhat different view by first stating several long-established barriers. One of them is for instance the limitations to diffuse new technologies on a wide scale, which results in REs having only marginal contribution potential. However, they also urge to rethink established barrier patterns, given that faster technology advancements, cost reductions and grid integration possibilities have paved the way for a better development of RE (Verbruggen et al., 2009).

3.2. Financial Perspective

Given the ongoing cost reductions for RE technologies, several authors have focused on the investor's perspective and which barriers are still hindering an increased RE diffusion. The concept of levelized costs of energy is commonly used to compare different technologies. An investor and other stakeholder have a comparison method for the various generation options, by dividing all of the system's expected lifetime costs (e.g. construction, financing and maintenance) with the system's lifetime expected power output, (Ueckerdt et al., 2013).

Darling et al. (2011) argue that such comparison methods are crucial as investors need to know the expected returns on their investments. However, they also stress that LCOE calculations are often times biased towards conventional energy sources, as many hidden costs associated with fossil fuels are not incorporated in the calculation. Typical hidden costs are for instance related to pollution or climate change. They call for a more robust method of data collection for both conventional as well as renewable sources in order to decrease the uncertainty for project developers and increase the share of RE. Lantz and Hand (2012) argue similarly by stating that only a reliable global data collection would enable developers and investors to make grounded decisions and to reduce uncertainty.

Ueckerdt et al. (2013) are not only suggesting the incorporation of more robust data in the calculations, but also to not rely on LCOE alone, as these numbers do not reveal anything about economic efficiency or competitiveness. They argue that energy demand is varying and the storage of electricity is still costly. This added uncertainty can therefore resemble a substantial barrier to investments into new technologies. Resource availability is addressed as another limitation, as RE can only be utilized when the natural conditions allow so. Conventional generators on the other hand are able to produce throughout the whole day and might hence be favoured over RE (Ueckerdt et al.,2013).

Another interesting angle is discussed by Hirth (2013). He elaborates on the effect that an increased share of RE can have on electricity prices and hence on the feasibility calculations performed by RE developers beforehand. According to him, the value of RE sources decreases with an increased market share as RE usually produce energy at the same time, more specifically when natural conditions allow so. If demand is not sufficiently high or storage options unavailable, energy prices will consequently fall and reduce the estimated value and payoff of RE sources. Hence, uncertainty for developers and investors is once again increased and can only be mitigated through an increased grid integration or the diffusion of efficient storage options (Hirth, 2013).

3.3. Technological Perspective

Efficient energy storage options and other technologies are also addressed by a number of authors. The lack of such options on a wider scale constitutes a serious barrier for increased RE diffusion. Ibrahima, Ilincaa & Perronb (2008) stress that "storage is the weakest link in the energy domain" but at the same time a "key element for the growth of renewable energy". This especially holds if the source is intermittent and located in a remote area. The findings of their paper are discussed in further detail later on. Sutanto and Lachs (1997) point out similarly that storage options would be able to reduce the uncertainty that needs to be faced because of daily and annually peak demands. Not only would these options reduce operational difficulties of the grid, but they likewise reduce costs and ultimately can contribute to the reduction in greenhouse gas emissions through the higher share of RE in the system.

3.4. Social and Cultural Perspective

Many emerging markets with only moderate rural electrification rates aim to increase the rate by utilizing small-scale rural RE applications. Byrne, Shen & Wallace (1999) identify that off-grid RE applications are crucial to decrease the "electricity gap in rural parts of the developing world". However, several barriers exist in this domain as is pointed out by a number of authors. Byrne et al. (2007) emphasize that the high initial costs, an underdeveloped enterprise sector as well as lacking loan opportunities constitute some of the main barriers to implement such rural projects. Hain et al. (2005) argue that governments are often times failing to sufficiently support small-scale community RE projects through the necessary policy, as policies are often focused on large-scale projects with higher impact. In addition, as the cost per unit of energy increases with a decreasing project size, policies should take this into account and help to counterbalance the effect through incentive schemes. Therefore, the lack of suitable policies and incentives schemes poses another critical diffusion barrier (Hain et al., 2005).

The issue of trust and acceptance to change is likewise addressed by a number of authors. Rogers et al. (2008) elaborate on the "high awareness of energy-related problems" but at the same time clarify that only few people are willing to accept significant changes in their daily lives. Communities would also need a certain amount of trust into governments to accept such projects on or around their lands. Walker et al. (2009) argue similarly by stating that trust resembles one of the most important ingredients when developers work together with local people on RE projects.

3.5. Energy Planning & Policies

Government policies can have a substantial impact on the diffusion of RE. Several authors researched the importance of policies and how governments can actively steer the diffusion of certain technologies. Their work is analysed subsequently. It is important research as inefficient or wrongheaded policies and programmes may discourage project developers and investors from engagements in that country.

Johnstone, Hascic and Popp (2008) argue that public policy has a significant influence on the development and diffusion of new technologies in the RE realm. R&D programs, tax/investment incentives or preferential tariffs all help to steer investments. However, governments must in the first place be able to understand the technology itself and the implications for the country in order to make grounded policy decisions. Bergmanna, Colombob and Hanleya (2007) note likewise that the various RE technologies have different implications on prices and consequently different penetration levels. They mention that governments usually need to decide which type of RE technology to promote the most. A finding, which can at least be argued with and which are addressed later on in this thesis, particularly in the case of Morocco.

Masini and Menichetti (2012) emphasize that it is crucial for governments to understand the behavioural context of investors. They state that "the effectiveness of a policy is dependent upon its impact on investors' behaviours". They argue that investors seek an established performance record or technical feasibility of a certain technology before they invest in it. The government could hence foster this through the support of R&D programs both in the private and public sector (Masini & Menichetti, 2012). However, understanding the behavioural context of investors is not a simple task as is pointed out by Burer and Wustenhagen (2009). Certain investors such as fund managers prefer feed-in tariffs as it reduces uncertainty. Masini and Menichetti (2010) argue similarly that a certain "group of investors with extremely short investment horizons" prefer policies that are very short-term and offer high levels of monetary incentives for a limited amount of time. As opposed to this, other investors are highly sceptical about any government involvement at all and prefer the market to steer the development (Burer & Wustenhagen, 2009). Kumbaroglu, Madlener & Demirel (2008) take on a different research angle and observe that market players cannot really be expected to invest in more costly RE technologies if government subsidies or other promotional instruments are not in place. They argue that the diffusion of RE can only take place if targeted policies exist.

3.6. Learning Curves

Another field of study deals with learning curves, which help to understand and estimate the cost reductions of RE technology. Learning curves are utilized to "empirically quantify the impact of increased experience and learning on the cost of a given technology" (Soderholma & Sundquist, 2007). Reduced costs are ultimately one of the biggest RE diffusion promoter. Köhler (2007) accredits R&D to be one of the key factors to drive technological change and RE diffusion. Papineu (2004) argues that R&D activities and hence RE learning lag far behind compared to other technologies. R&D funds would need to receive much more capital and publicity in order to close the funding gap.

Nemet (2006) observes that the comparison between different technologies is best made on the basis on prices and not costs. His findings show that next to learning a variety of other factors have led to the rapid cost reductions for RE technology. Some of those factors are general market dynamics and knowledge spillovers. Taking those into account helps to decide in which technology and market to invest (Nemet, 2006).

Soderholma and Sundquist (2007) emphasize that once R&D and learning is taken into account in energy models, implications for energy planners can be substantial in terms of cost and timing of governmental policies. If learning rates are still high as with for instance new technologies, larger upfront investments are justified to harvest the economic benefits of the subsequent technological learning. Ferioli, Schoots and van der Zwaan (2009) stress that learning curves may also help to estimate the necessary investments needed to enable a new technology to be on competitive level with incumbent energy sources. Such competitiveness is seen as a key condition to diffuse the technology on a large scale in the country (Ferioli et al., 2009).

4. Country Cases

	CHILE	MOROCCO	DENMARK
Demographics			
Population	17.8 Mio.	33.9 Mio.	5.6 Mio.
Rural Population	10.47%	39.8%	12.32%
Urban Population Growth	1.26%	2.23%	0.77%
Density	23.89 per sq. km.	76.01 per sq. km.	133.8 per sq. km.
Median Age	33.7 years	28.5 years	41.8 years
Economy			
GDP	$258B (42nd)	$100B (62nd)	$342B (33rd)
GDP Growth Rate (5 year average)	4.6%	3.8%	0.7%
GDP p. Capita Growth (5 year average)	3.5%	2.4%	0.3%
Unemployment (2014)	6.4%	10.2%	6.6%
Inflation (2012-2014)	3.1%	1.2%	1.3%
GINI Index	50.45	40.72	29.08
Environment			
Proven Natural Gas Reserves	98bn m^3	1.44bn m^3	79bn m^3
Proven Oil Reserves	150m barrels	680,000 barrels	611,000 barrels
Electricity Generation	Coal: 33.31% Natural Gas: 15.92% Oil: 9.12% Nuclear: 0% Hydro: 28.15% Renewables: 13.50% - Wind: 4.57% - Solar: 3.79% - Mini-dams: 2.8% - Biomass: 2.34%	Coal: 25.26% Natural Gas: 16.29% Oil: 26.45% Nuclear: 0% Hydro: 26.37% Renewables: 5.63% - Wind: 5.11% - Solar: 0.52%	Coal/Other: 31.56% Natural Gas: 9.78% Oil: 1.07% Nuclear: 0% Hydro: 0.03% Biomass & Waste: 15.84% Renewables: 5.63% - Wind: 39.93% - Solar Tide Wave: 1.80%
Renewable Energy Aspirations			
National Energy Plans	20% by 2025 2014: 70% from renewables in 2050	42% from solar, wind & hydro by 2020 (each 14%)	30% share of energy generated from RE sources in gross final consumption by 2020 100% RE supply by 2050
Energy Demand Growth (3y)	6% p.a.	7% p.a.	2% p.a.
Energy Imports	60% (maj. natural gas)	96% (maj. oil/petr.)	11% (maj. hydro)
Coast Line	ca. 4000km	ca. 3500km	ca. 7130km
Average Wind Speeds	5-13 m/s (Punta Arenas)	6-11 m/s	5-7 m/s

Table 3: Key Characteristics of Chile, Morocco and Denmark as a benchmark (Source: World Bank)

Chile and Morocco were chosen as case-countries for a number of reasons. Firstly, both expressed ambitious RE targets to be achieved by latest 2025, with further targets to be more concretely specified for the decades after. Moreover, not only the targets unite these two countries, but also the difficulties in achieving them as several critical barriers to development exist in both nations. Table 3 shall carve out the main similarities and differences of both nations. Chile and Morocco are subsequently presented with a particular focus on their energy history, government policies and the barriers to RE development.

5. Chile: Case Presentation

5.1. The Background: Energy

Chile is one of the fastest-growing countries in South America, with its GDP having tripled since 1990. The economic success has benefited the broader population with poverty levels having decreased to 7.8% in 2013. Chile has had one of the lowest inflation rates in South America for a considerable time, which created a relatively stable investment climate. In addition to that, Chile is the only OECD member in South America (World Bank Group, 2013). However, it still faces large social inequalities which holds back faster growth and creates internal problems. Chiles Gini coefficient has only been modestly reduced in the last decades and the country had the highest income inequality of all OCED countries in 2013 (Wold Bank Group, 2013).

The impressive economic growth has not only led to an overall increase in welfare, but it has come along with a sharp increase in energy demand. Looking ahead, the Ministry of Energy in Chile estimates an annual 6% demand increase from now onwards, which would result in an additional capacity of 8000MW/15,000MW needed until 2020/2030, respectively (Ministry of Energy, 2012). In general, energy consumption per capita in Chile is the highest in Latin America, driven by the economic success of the last decades and the on average richer population. On the one hand, the demand driver is the large metropolitan area of the capital Santiago, which is home for almost 40% of the population. On the other hand it is massive mining sector in the North, which accounts for a large chunk of Chiles GDP, with copper being one of the main export goods. In line with the rising energy demand, one needs to consider the steadily increasing CO2 emissions. However, so far they are only a fraction from world emissions, amounting to only 0.2% in 2013 (World Bank Group, 2013).

Chile's development and its increasing energy consumption set the stage to take a closer look at existing RE opportunities. The country is often cited as "the promised land for renewables" for a variety of reasons. The constantly growing energy demand, combined with above average OECD prices (Table 4) holds potential for new technologies that are able to undercut current prices.

Table 4: Household electricity prices in USD/MWh (PPP converted)

	1990	2000	2006	2010
Chile	81.41	162.22	198.48	264.93
OECD	94.50	104.72	131.34	152.73

Source: IEA/OCED 2012

Project developers and investors benefit from low tariffs on imported technology, as Chile has signed several free trade agreements worldwide (CNE, 2015). In addition to that, foreign investors enjoy the perks of a transparent and open economy. Chile's unique geographical location makes it to one of the most interesting countries for RE in terms of variability of renewable resources. Chile has over 4000km of coast with lots of potential to capture wave and wind energy. The South is characterized by strong winds throughout the year. The Atacama Desert in the North is a region with one of the highest radiation levels globally, with at least double the amount one can find in for instance Germany, France or Spain. The desert is characterized by very low humidity and few cloudy days throughout the year (Agostini et al., 2015). Hence, conditions for solar energy are outstanding.

Chile has recently climbed the Top 10 in the RE country attractiveness index, which is published on a yearly basis by Ernst&Young (EY, 2015). However, it remains to be seen if Chile's evidently outstanding renewable resources can be adequately utilized in the years ahead. An auction in December 2015 gave hope that RE can make a big leap forward, as bids from RE projects considerably outcompeted conventional generators. Two wind farms in central Chile will supply 65% of the tendered total energy with a bid price of $79/MWh. The remaining 35% will come from three solar projects with bids between $65 and $68/MWh. The second largest Chilean power generator AES Gener bid $85/MWh for a coal power plant and was hence unsuccessfully trying to snatch some of the business. There is hope for electricity prices to come down further in Chile as this auction already decreased the average bidding price by 40% compared to the auction in 2013 (MRP, 2016).

Table 5: 1200 GW Tender Bids (November 2015)		
Solar	Wind	Coal
65-68/MWh	$79/MWh	$85/MWh

Source: MRP, 2015

Following the change in laws allowing bids on smaller energy blocks, RE projects successfully participated in bidding rounds for two years in a row now. However, grid connection problems and an overload at peak time dampen expectations and make clear that several obstacles still need to be removed before Chile can fully utilize its RE potential (EY, 2015)

Solar Energy in Chile

Solar powered energy is of particular importance for Chile and will play a major role in future project development. The global solar photovoltaic (PV) industry has seen strong growth during the last decade or so with nearly all worldwide capacity being installed after 2004 (Nasirov et al., 2015). A number of reasons can explain the recent growth. Firstly, the advances in technologies allowed a more efficient and cheaper utilization of solar technology. Secondly, several policies promoted the technology through for instance fiscal instruments, such as tax breaks or market promotions. Some instruments have been introduced in Chile over the years. One included feed-in-tariffs (FIT), which try to facilitate the entry of new companies by guaranteeing fixed rates on the produced electricity. However, a number of critics are opposing such measures. Germany implemented a similar scheme, but was not successful to achieve the targeted results, such as an increase in employment in the RE industry and an accelerated innovation (Agostini et. al. 2015).

The Potential of Solar Energy in Chile

The mapping of radiation levels throughout the country and during the different seasons is extensive and nearly complete (Interview C3). The data set has been established over the years and is publicly available. In comparison, wind data is less comprehensive and several regions still lack research and data collection. In addition to that, wind speeds are harder to predict. Investors lack confidence to invest large sums of capital in wind projects, even in very Southern places with great conditions, such as the areas around Punta Arenas (Interview C3). This is unfortunate, because many viable wind projects could be established in the South, given that many communities and local industries still lack reliable energy supply. Investors will only then become less cautions, if more extensive and reliable studies are being published (Interview C3).

Chile could theoretically produce all its energy from solar plants in the Atacama Desert. And if transportation and storage would allow, the Atacama Desert could even supply all countries in South America with energy (Interview C3). However, grid restrictions, the limited utilization rates of solar plants and the unavailability of efficient large-scale storage options are the main barriers on national and international level. However, projects such as the discontinued 'Desertec' project in Africa, which plan was to supply parts of Europe's energy one day, show the existing developments in this direction (DESERTEC, 2015).

Three factors need to be improved for solar to become better utilized in Chile. First, the capacity of the grids and especially the connection between the main grids needs to be tackled. Secondly, improvements in storage opportunities would allow generators to store peak time supply and inject energy into the market at later times and to higher prices. Improvements in large-scale battery technology and the enhancement of solar thermal plants could play a crucial role. And thirdly, Chile's economic structure and GDP is made up to a large extent from agriculture and mining and little resources are allocated to R&D of technology. The dependency on foreign technology is not necessarily negative, however it is important that Chile creates the right business ties and imports adequate technology (Interview C4).

Beneficiaries of Solar Energy in Chile

One of the main beneficiaries of a higher solar utilization in Chile would be the mining industry, given their electricity gulping operations at all hours. Plants would not only benefit from a more stable electricity supply, but also from reduced prices as has been shown by recent bidding rounds. Until now the cost of electricity makes up to 20% of total costs in the copper industry due to the high energy prices. This markedly reduces the competitive advantage of Chilean firms compared to competitors in other countries that are able to produce at lower costs (Zeballos, 2013). Chile's government should have an interest in supplying its mining industry with cheaper electricity as it makes up around 50% of Chiles total exports. Firstly, the government could substantially reduce the costs for their own state-owned miner named Corporación Nacional del Cobre (Codelco). And secondly it could also attract further investments of foreign miners such as BHP Billiton, which would result in an increase of tax revenue (Interview C1).

A higher RE utilization would bring along several economic and environmental benefits for Chile. A study from the Natural Resource Defense Council (NRDC) concluded that GDP, employment numbers, CO_2 emission and the use of Chile's resources (e.g. abundant land) can be greatly improved if a 20% RE penetration of can be achieved from 2020 onwards (Nasirov et al., 2015). Moreover, the empowerment of many rural areas and communities, which have so far not been able to make use of a stable energy supply, would constitute another substantial social and economic improvement (Interview C2).

5.2. The Background: Policies & National Energy Strategy

Chile's Energy Mix in a Historic Perspective

Chile's energy supply was characterized by hydroelectric power up until the 90s. It was mainly generated in the South due to the geographic characteristics with various rivers and mountain ranges (Agostini et al., 2015). However, several droughts and a growing energy demand showed that other sources of energy needed to be capitalized on in order to secure a stable energy supply in the future. Chile's government took fossil fuels into consideration, but had to import them from abroad. Being its direct neighbour, Chile went into long-term supply agreements with Argentina and focused its investment on the extension of natural gas pipelines at the same time (Nasirov, 2015). It was an economically sound decision back then, as the cheap prices for natural gas made this option more attractive compared to coal based energy and hydro plants in Chile. The number of agreements with Argentina increased over the years and ever larger amounts were imported up until a point in 2004, when around 80% of energy came from such agreements. New Argentinian price regulations came into play in this year, creating gas shortages which resulted in a decreased export to Chile and finally a complete export halt. Chile was facing a massive undersupply and had to switch to more expensive diesel fuel. The shortages in 2004/2005 were one of the main reasons for the Chilean government to actively consider and discuss alternative energy sources. Other reasons were the overall increased fuel prices, as well as environmental concerns (AS/COA, 2015).

Changes in Laws and Legislations

Following the dramatic situation in 2004, Chile introduced the *Short Law I* in 2005, which enabled small-scale projects to participate and inject energy into the spot market. These projects were now also able to receive a simplified commercial treatment, which made the trading process much easier. A guaranteed access to the grid was agreed upon to attract further small-scale projects (Central Energía, 2015).

In 2008, the government introduced the *renewable portfolio standard (RPS)*, which is a quota-based obligation, based on a 16 year horizon. The scheme included the rule that energy generators of more than 200MW needed to produce at least 10% from renewable sources by 2024. A transition period between 2010 and 2014 was established with an intermediate target of 5%.

The government reviewed their latest target in 2013 and adapted it to the increasing energy demand in the years ahead. 20% of energy generation was planned to come from non-conventional renewable source by 2020. This resulted in the Law 20/25, which is based on the RPS scheme from 2008. Next to the increased production target, an auction system was put into place that would initially award 10-year contracts for the supply of energy to the auction winner (Central Energía, 2015).

Another important law has been introduced in 2014. The *Net Billing Law* was signed in order to better incorporate small-scale projects and private households and give an incentive for installing private solar panels. Regular households are able to produce energy for their own consumption and inject any additional capacity into the grid for a fixed tariff. The production of one's own electricity is especially interesting in Chile due to the high energy prices. However, until now the effect of private households on overall RE supply is only marginal. Mainly also because legislation is still missing and no clear structure exists on how and in which intervals utility companies will compensate customers that inject energy into the grid (Central Energía, 2015).

Nevertheless, it is an important potential supplier group to look at, as traditional energy generators could lose exactly these customers later on, if power generation on residential level will expand. These customers might then even stop paying a fixed fee to the generator, which usually covers part of their fixed costs. It is not surprising that large utility providers lobby against such residential producers, in order to secure their customer base and to cover their fixed costs (Central Energía, 2015).

5.3. Barriers to RE Development

Despite the discussed RE potential Chile has due to its favourable conditions in terms of its geographic location and above-average energy prices, the utilization of RE has been somewhat disappointing, despite a general upward trend in investments with a spike in recent years.

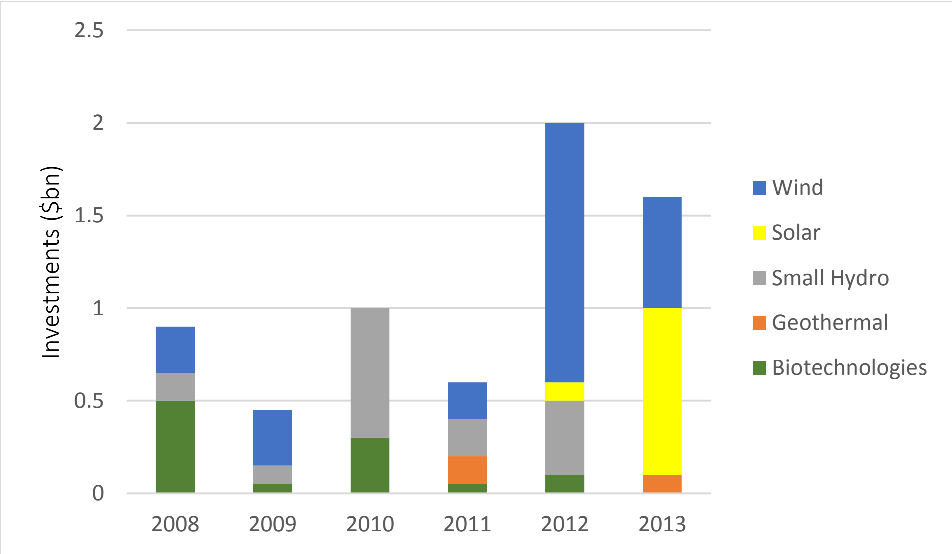


Figure 1: Annual investments in RE in Chile from 2008-2013 (Climatescope, 2015)

Many projects have received the approval from the relevant authorities. However, only a fraction of those is actually under construction (Climatescope, 2015). The following section tries to shed light on the different barriers that hold back increased investment and project development in Chile.

Economic & Financial

RE projects require large upfront investments. Given that RE is still rather new in Chile, project developers have a harder time to find and attract investors at favourable rates. One potential investor group could be local financial institutions. However, they are not yet familiar with these type of investments and cautious to finance large-scale projects. In addition to that, Chilean banks have been historically very conservative (OLADE, 2015). Foreign investors might be a better funding source for such projects. Spanish, German or British investors have already considerable experience with project funding abroad. Microfinance plays a smaller role in Chile, although it would be particularly important for smaller projects that do not yet receive the same attention as the larger project proposals (Nasirov et al., 2015).

Mentioned uncertainties with regard to RE projects in Chile put up several constraints for project developers. They need to be prepared to pay a risk premium to those investors willing to put their money into the projects. A high risk premium may turn the project unviable (Interview C2). Project financing with several investors makes the structure itself more complex, resulting in higher financing costs. Especially small projects face a burden as certain fixed costs need to be paid regardless of the project size and hence affect their budget to a comparatively larger extent. A government agency named CORFO has been set up to provide low-interest loans, especially to small and medium sized projects. Some success has been observed, however it is still far from resolving the problem of limited access to project financing (Nasirov et al., 2015).

Project developers and investors receive fewer incentives from the Chilean government opposed to countries such as Germany, where subsidies and tax credits have been common for a long time. Therefore, as the energy market in Chile is very competitive, developers from countries that have enjoyed government subsidies might have a harder time to actually compete in this environment. This poses a disadvantage compared to project developers that are already acquainted to markets where no subsidies are given (Interview C4).

Institutional

Project developers face several institutional obstacles with regard to the planning and implementation of RE projects in Chile. These obstacles shall be separated into challenges regarding institutional capacity and resource management.

Lack of Institutional Capacity

In comparison to other countries such as Germany, the private sector is the dominant player in the energy market in Chile, which leaves less power to the government to influence the developments. The role of the government is one of mainly facilitating the market exchange and setting the rules between the different parties. However, it lacks real enforcement power (Moya, 2007). Two other important institutions are present in the energy market in Chile, namely the Electricity and Fuels Commission and the Center of Economic Dispatch. The Center of Economic Dispatch is basically controlled by a consortium of private companies. The setup and distribution of tasks between these three institutions generally favours the status quo in energy policy and makes changes to be implemented slowly, if at all (Agostini et al., 2015). Figure 2 illustrates the Chilean energy sector structure in further detail.

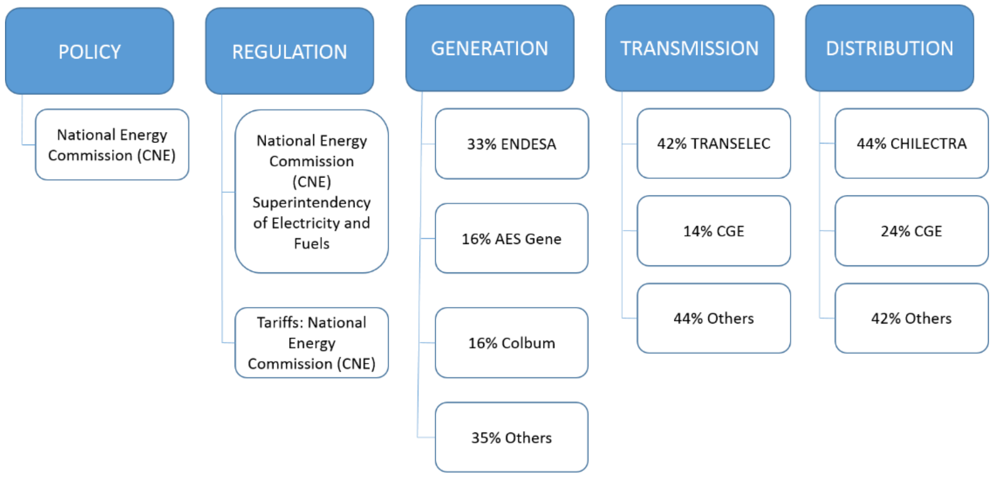


Figure 2: Structure of the Chilean Energy Sector (Source: MaRS, 2015)

It is questionable if the energy target can be achieved, if the state continues to have weak planning and regulatory roles. The current setup leaves the government authorities with limited power to regulate the sector effectively. Moreover, technical capabilities hinder the efficient management of the energy market. Firstly, lobbying remains common in the energy market. Secondly, the relevant institutions do not have sufficiently high budgets to commit their work to real changes in the industry. And thirdly, the employees in those institutions receive relatively low salaries, which results in the attraction of not sufficiently qualified personnel and may even give rise to bribery (Agostini et al., 2015).

Resource Management

The Environmental Impact Evaluation System (SEAI) approval is necessary for large projects of more than 3MW. However, the assessment framework of the SEAI is inconsistent and does not treat all cases equally. This creates an ongoing conflict between companies, the government and communities. Critics say that the SEIA has been established to rather serve as a political instrument and not to protect citizens and the environment (Interview C1).

Agostini et al. (2015) argue that citizens should be more actively involved in the discussion of energy projects and their final approval. In several instances, projects were approved and project developers advanced into final planning stages when opposition by communities and other stakeholders halted the projects, turning them to be costly and time-consuming. In addition, economic costs due to for instance tourists staying away from areas where plants are blocking the views, have not been sufficiently addressed as SEIA and project developers mainly focus on the natural environment impacts (Agostini et al., 2015).

Processing Time and Permits

The time until permits are obtained and projects actually erected varies widely and may present a major uncertainty for investors. Information search costs are high, as administrative requirements on how to obtain the various permits, are not well distributed (Interview C2). The process is characterized by a high level of bureaucracy, as several authority levels need to be passed before final permits are obtained. Some studies show delays of more than 700 days on average (Nasirov et al., 2015). This increases the uncertainty for investors and developers as they are not able to predict when permits will be obtained. In addition, some of the most important permits are issued by the SEIA. This constitutes another uncertainty for developers as SEIAs processing time varies widely, depending on the project.

Land and Water Lease

Even if projects are finally approved by SEIA, the areas often times lie in land legally owned or claimed by indigenous groups. The relationship between those groups and the government has been marked by conflict in the past and a general distrust exists on behalf of the groups towards the government. In addition, communities have never really been incorporated into the process of project development and implementation and no clear compensation schemes have been put in place. As a result, projects are often subject to great delays due to protest of indigenous communities (Varas et al., 2013).

Large parcels of land are often times owned by several landlords. This complicates negotiations for land compensation substantially (Interview C2). Mining concessions are another factor to consider. Due to Chile’s history as a mining country and the importance for its economy, mining concessions are issued rather quickly. Speculators hence secure mining permissions to later trade and sell the land to RE project developers for a decent profit. This gives rise to speculative land ownership and prolongs the process for project developers even further (Nasirov et al., 2015).

Other

Grid Connection & Capacity

The process of actually connecting a new generator to the grid is long and tedious. Generators often times experience delays to such an extent, that costs and complexity are too high to further pursue the project. Any generator should enjoy open access to the grid according to law. However, reality shows long delays and further procedural requirements (Nasirov et al., 2015). This is due to a number of reasons. Firstly, the high concentration of generators in the market plays a crucial role as conventional generators make use of their bargaining and lobbying power and set up barriers to entry. Secondly, large generators are often times vertically integrated and hence control the transmission part as well, which increases their power even more. They show little interest of letting new entrants into the market. Thirdly, new entrants have insufficient information about how the gird costs are shared between the generators and grid owners. This increases the uncertainty in terms of the projects total cost structure (Nasirov et al., 2015).

The not yet existing connection between the Northern and Southern grid (SINC/SIC) constitutes another barrier as excess energy cannot transported in other parts of the country. Generators in the Northern grid face the problem that the spot market price is going towards zero during the solar radiation peak at midday. The ability to transport the energy further south would be very much welcomed during those times (Interview C4). The two main grids are announced to be fully connected in 2017/2018. However, it will take more time until generators from the North can easily supply all access electricity to other parts of Chile. Moreover, the grid mainly consists of alternating current (AC) voltage lines, which results in energy losses when electricity is transported over long distances. The uncertainty about who will compensate for the transmission losses adds further uncertainty for generators (Interview C4).

Barrier Category	Barrier
Economic & Financial	Limited access to project financing & conservative Chilean banks
	Investors demand high risk premiums
	No schemes for subsidies and tax credits
	Distribution of transmission costs is unclear
Market Failures	Incumbents defending fossil fuel market share
Institutional / Politics	Information & data is at times insufficiently distributed
	Incumbents control most of the energy market
	Chilean government lacks real enforcement power
	Public institutions lack budget & qualified personnel
	Lobbying remains common
	Long delays in permit approval
Cultural	Several land owners & conflicts with indigenous tribes
Other	AC voltage lines do not allow long transportation
	Transmission line capacity is insufficient in certain places
	Grid connection of two main grids only in 2017/2018

Table 6: Barriers for increased renewable energy development in Chile; Painuly (2001) framework

6. Morocco: Case Presentation

6.1. The Background: Energy

Recent economic growth, an advancing industrialization as well as a growing middleclass, have increased Morocco's total primary energy supply (TPES) to 18.8 Mtoe in 2012. Three large groups account for the energy consumption in Morocco, namely the transportation sector (33.2%), the general industry (26%) as well as the commercial and residential sector with 20.4% (Germanwatch, 2016). Looking ahead, the Moroccan Ministry of Energy, Mines, Water and the Environment (MEMEE) estimates that the future energy demand could get close to 26 Mtoe in 2020 and even 43 Mtoe in 2030, which would constitute more than double the current levels (Germanwatch, 2016).

The total primary energy supply (TPES) is clearly dominated by oil (67.6%), followed by coal (16.1%), waste and biofuels (7.4%) as well as natural gas with 5.7% (Germanwatch, 2016). The reliance on fossil fuel for energy and electricity generation is an important aspect, as Morocco is endowed with only very few fossil fuel resources. Morocco has considerable reserves of unconventional oil shale and shale gas, amounting to 200 million barrels and 20 trillion cubic feet respectively according to the EAI (2013). However, those cannot be easily exploited due to the lack in industrial processes that would be able to produce gas and oil from such sources (Reegle, 2014). The lack of own easily extractable fossil fuels is the reason for Morocco importing up to 95% of its energy from Algeria and Spain, resulting in considerable pressure on the trade deficit. In 2011, Morocco's petroleum imports alone accounted for 20% of total imports and in turn constituted 50% of the trade deficit (WFC, 2015). Energy subsidies are gradually removed, but have put further pressure on the national budget in recent decades.

Moreover, a general increase in electricity demand is further putting pressure on prices, placing them among the highest in the region. The industry sector is the largest consumer of electricity (43.6%), followed by the residential sector (32.8%) and finally the transportation sector with a minor 1.2% share of total electricity demand (Germanwatch, 2016). Remarkably, continuous government efforts have pushed the theoretical electrification rate already in 2009 up to 97%, giving the residential sector an increasing share in total demand (Reegle, 2014).

The rise in energy demand will eventually have a substantial effects on greenhouse gas emissions in Morocco (WFC, 2015). Several studies have looked at the effect of climate change in Morocco.

Tekken et al. (2009) studied the north-eastern Morocco and forecast vegetation to further disappear, drinking water to be scarce with droughts to become more likely. Such scenarios will affect the agricultural sector in Morocco, on which a large number of the Moroccan population is still dependent on. Schilling J. et al. (2011) estimate in their study that the agricultural production may shrink 15%-40% within this century, potentially leading to food price shocks and general social instability.

The energy sector needs to receive particular attention with regard to greenhouse gas emissions, as it contributed half of Morocco's total emissions in 2011 (WRE, 2011). As most of the energy needs are served through imported hydrocarbons, it is inevitable that Morocco's energy mix changes, putting a greater weight on renewables. And given the excellent endowments for RE in Morocco, it seems that an increased utilization is only a matter of time. The average yearly solar radiation levels of around 2300 kWh/m²/y lie around 30% above those for the best sites in Europe (Reegle, 2014). Moreover, Morocco has roughly 3500km of coastline with wind speed averages of up to 11 m/s, making Morocco one of the most attractive locations for wind energy on a global scale (WFC, 2015). The total wind power potential is estimated at 25,000 MW (Moroccan Government, 2016).

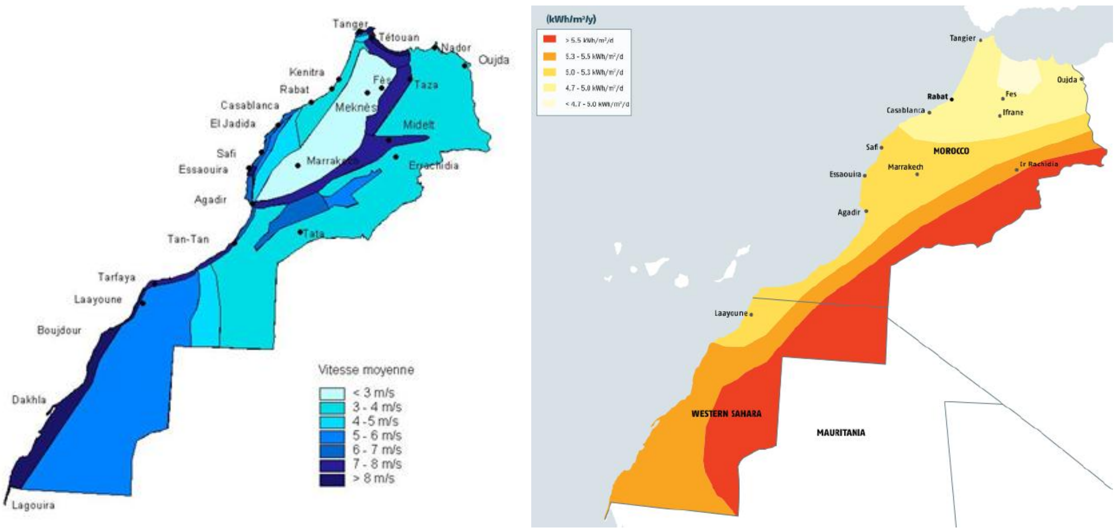


Figure 3: Average wind speed and solar radiation in Morocco (Source: Moroccan Government & MASEN, 2015)

Germanwatch (2016) has defined a number of challenges that need to be tackled in the years ahead, if Morocco wants to successfully stem the rise in energy demand, while at the same time diversify its energy mix. The challenges include the increase in CO2 emissions, grid stability, electricity prices, subsidies as well as the reduction in dependency on energy imports. The government seems to be aware of the issues at hand, not only because of the large trade deficit putting pressures on the budgetary planning. Several laws and policies have already been implemented in the past years and various others are currently in discussion (Germanwatch, 2016).

6.2. The Background: Policies & National Energy Strategy

Laws & Regulations

In the past years, several reforms have been undertaken by the Moroccan government in order to implement a regulatory, legal and institutional framework, which is capable of promoting RE. The framework both focuses on electricity consumption but mainly on electricity generation. An overview of the different laws and reforms is given in Table 7. These efforts can be seen as an important groundwork for a more liberalized energy market, which allows renewable energy players to enter, regardless of their size. Law 13-09 should be mentioned in this regard, as its aim is to allow any private producer to sell electricity to the national grid (ONEE), using RE sources. The elimination of several fuel subsidies, as stated in the fossil fuel subsidy reform of 2011 for instance, intends to make RE more competitive and relieve the national budget at the same time.

Name	Year	Content

"EnergiPro" project	2006	- Officially, a feed-in tariff does not exist in Morocco
		- However, "EnergiPro" by ONE resembles such tariff (Currie, 2012)
		  o RE producers receive a fixed rate
		  o Surplus repurchase agreements

Self-Generation law 16-08	2008	- Huge industrials shall be able to generate their own power up to 50MW, instead of only 10MW as previously
Law 13-09	2010	- Promotion and liberalization of the renewable energy sector - Market entry facilitator for small- & medium-sized players - Any private producer shall produce and export electricity using renewable energy sources - Right to sell electricity to the national grid (ONE), but excludes from building own distribution network (only for exports)
Fossil Fuel Subsidy Reform	2011	- Liberalization of fuel prices - 2013: Elimination of the effective gasoline subsidy - 2014: Elimination of the effective fuel oil / diesel fuel subsidy - 06/2014: Elimination of the fuel subsidy for electricity generation

		- Poorer sections of the population receive offsetting cash transfers
Energy Efficiency Law 47-09	2011	- Aims to increase the efficiency in energy consumption - Promotes cost savings through a number of ways - Energy strategy aims for energy consumption savings of 12% (by 2020) and 15% (by 2030) compared to 2011 levels

Table 7: Overview of Moroccan energy related laws and reforms

However, other fields such as infrastructural development, employment or fiscal policies still lack behind and indicate that there is still considerable potential to align different policies areas in order to come up with one coherent framework that promotes renewables (WFC, 2015).

Morocco's National Energy Strategy

Morocco's government set ambitious target in 2009 for the incorporation of renewable energy in the energy mix in 2020. 42%, or about 6000MW, of the overall capacity to generate electricity shall be coming from renewables by then. It is important to mention that this concerns the installed capacity and not the actual electricity demand served through renewables. Solar, Wind and Hydro all shall have equal shares and contribute 14% each to the total capacity.

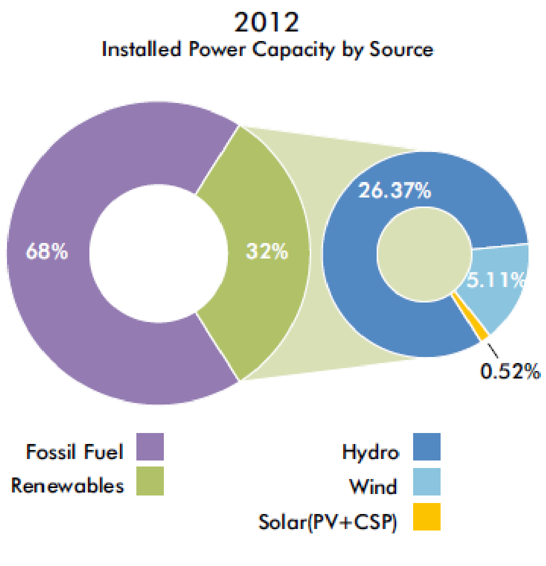


Figure 4: Currently installed power capacity and targeted renewable energy capacity in 2020 (Picture: WFC, 2015)

Moreover, the government is already planning ahead by figuring out ways to export energy. This might be an option in the future as there are already existing grid connections to Spain and hence further to Europe as well (WFC, 2015).

The 42%-target should be achieved by the following three main pillars, namely

1. Laws and regulations that promote the expansion of renewable energy
2. Setting up institutions with the ability to promote, oversee and manage renewable energy projects in the country
3. The implementation of government projects and the provision of financial vehicles to build the necessary facilities (WFC, 2015)

Morocco's Energy Institutions

Several public agencies and institutions have been established in the past years for the promotion of renewable energy. Much like the laws and regulations that serve as the first pillar, their aim is to promote the electricity generation through renewables and ease the incorporation of small- and mid-sized players. The Moroccan Agency for Solar Energy (MASEN) was founded in 2009. Their task is to overview the national and regional projects related to solar power and give guidance if necessary. Shortly after in 2010, the Societe d'Investissements Energetiques (SIE) was established to provide the necessary funding for energy projects that were not or only partially funded by the private sector. The different agencies and institutions and their main functions are summarized in Table 8.

Name	Abbreviation	Content
Agency for the Development of Renewable Energy and Energy Efficiency	ADEREE	- Taking on the deployment of energy management policies - Operating on national and regional level
Moroccan Agency for Solar Energy	MASEN	- Founded in November 2009 to overview the activities and projects to achieve the aimed for 2000MW solar capacity by 2020
Societe d'Investissements Energetiques	SIE	- Established as an investment fund in 2010 with the aim of providing liquidity and promote the diversification in the energy mix
Research Institute for Solar Energy and New Energy	IRESEN	- Founded in 2009 In order to drive R&D activities, provide financing to research projects and act as a connector between research groups and universities

Renewable Energy University Network	REUNET	- A 2013 formed network, comprised out of scientists, academics and researchers - Aiming to foster research, training and innovation within Morocco

Table 8: Overview of Morocco's public agencies and institutions

Morocco's Renewable Energy Programmes

Several projects and programmes have been launched in the last years, with the goal to achieve the ambitious target of 42% installed renewable energy capacity by 2020. The Moroccan Project of Solar Energy is an integrated development project that spans over five major sites, namely Ain Bni Mathar (400 MW), Boujdour (100 MW), Foum Al Oued (500MW), Ouarzazate (500 MW) and Sebkhat Tah (500 MW). Both CSP and PV applications are being utilized in these sites to reach the target of 14% installed capacity by 2020 (Moroccan Government, 2016). Likewise, the Moroccan Integrated Wind Energy Project, which spans over 10 years with an estimated total investment of US$3.5 billion, aims

Name	Year	Investments	Target

Integrated Solar Projects	2009	US$9 billion – public, private & international funding	- 2000MW installed capacity until 2020 across 5 sites with photovoltaic facilities and large-scale concentrated solar power
			- Cater for 18% of Morocco's electricity needs (4,500 GWh)
			- Projected yearly savings
			  ○ 1 million Toe (tons of oil equivalent)
			  ○ 3.7 million tonnes of CO2 emissions

Integrated Wind Energy Programme	2010	US$3.5 billion – public, private & international funding	- 2000MW installed capacity until 2020 across 5 sites
			- Cater for 26% of Morocco's electricity needs (6600 GWh)
			- Projected yearly savings
			  ○ 1.5 million Toe
			  ○ 5.6 million tonnes of CO2 emissions

Hydropower projects	2009		- 2000MW installed capacity until 2020 through the construction of two new large facilities and several off-grid applications

Table 9: Overview of Morocco's renewable energy programmes and projects

to increase the installed capacity from only 280 MW in 2010 to the targeted 2000 MW in 2020. So far 1720 MW of new wind energy projects are planned, with 720 MW already under development in five sites and another 1000 MW to be accomplished in five additional sites (Moroccan Government, 2016). A summary of the different renewable energy programmes and projects is presented in Table 9.

6.3. Barriers to RE Development

There are still various prevailing RE diffusion barriers in Morocco. This is despite the efforts of the Moroccan government to establish supporting institutions and ambitious energy targets and programmes. The general barriers are presented in the following through the application of the Painuly (2000) framework.

Economic & Financial

The shortage of local investment funds and experienced financial institutions, able to provide effective financial instruments, results in restrictions to access the capital market (WFC, 2015). In addition, the Moroccan BBB- country rating of S&P (2016) increases lending costs, as the perceived risk is higher. The majority of the funding for renewable energy projects in Morocco is coming from the government itself, as well as international funds. The lack of local private investors and the missing engagement of regional banks is hindering the development considerably, as it further increases the risk perception of projects (Whitley & Granoff, 2014). Especially small-scale projects are underfunded, as most financing is directed to large-scale ventures (WFC, 2015). Moreover, the typical investor is seeking investments with high return on investment and an investment horizon that does not span over too many years. The long investment horizons of renewable energy projects does not appeal to the short termism of mentioned investors (WFC, 2015). And lastly, as the grid connection agreements with ONE need to be negotiated on a project basis, uncertainty regarding connection costs is further increased (ECOFYS, 2013).

Market Failures

Subsidies on fossil fuels continue to represent one of the most striking impediment to increased renewable energy utilization. As renewable energy technologies receive much lower subsidies, their competitiveness compared to fossil fuels is markedly reduced. Bridle et al. (2014) show in their study to which extent fossil fuel subsidies are distorting the market. In 2011, the Moroccan government spent 5.1 % of GDP on mentioned subsidies, which is particularly worrying given the budget deficit of 6.8% of GDP in that year (WFC, 2015).

In addition, large monopolies are present in the energy sector, creating a fossil fuel path dependency, much like in Chile. Given their still existing scale advantage, they refrain from promoting new technologies that would eventually reduce their control over the system. And lastly, the promotion and diffusion of renewable energy is hindered as the renewable penetration in Morocco is still relatively low, and hence specialized industries, businesses as well as skilled workers are rare (WFC, 2015).

Institutional

Several laws and regulations that have been introduced for the promotion of renewable energy have not yet been as effective as intended. Law 13-09 for example, which was passed for the inclusion of small-scale players, is said to favour large-scale projects and investors instead of increasingly focus on communities. Moreover, investors fail to see a clear national strategy apart from the ambitious renewable targets that were proclaimed in 2009 for the first time (WFC, 2015). The lack of stable policies and regulations and the lack of involvement of the regional financial sector increases the uncertainties for investors and hence lowers their interest in the country. Cross-institutional communication and transparency seems to be lacking as well, as the different stakeholders, political groups and institutions are not united through one common strategic vision. In addition, lobbyism of the strong monopolistic energy sector seems to influence decision making and the speed of new technology adoption considerably.

Investments in RE are rather novel in Morocco. The available information and so far collected data is insufficiently distributed among project developers and investors (WFC, 2015). This results in high information search costs. And lastly, no effective scheme exists for the promotion of investments in small-scale ventures. Only large-scale projects are guided by a public tender scheme (ECOSYF, 2013).

Other

Many key stakeholders seem not yet fully aware about the opportunities the new technologies hold and about the main benefits and challenges of diffusing RE on a wider scale (Interview M1). Likewise, it seems that public support and social acceptance is not yet at the needed level, which would allow a significant scaling up of RE (Interview M1).

Another important impediment deals with the technical difficulties of introducing RE on a wider scale and incorporating the plants into the existing transmission grid. Intermittency issues hold back the diffusion of RE as the high penetration of intermittent sources is not yet absorbed by the transmission grid due to technical errors. In addition, the Southern part of the grid is currently not prepared to integrate the fluctuating nature of renewable energy power, which could be of substantial importance once wind plants are scaling up (Interview M1). And lastly, the lack of skilled workers does also impact the operation and maintenance of RE sites (WFC, 2015).

Barrier Category	Barrier
Economic & Financial	Lack of credit and capital access
	High up-front capital needed and high perceived risk
	Short termism of certain investors
Market Failures	Still heavily subsidized fossil fuels
	Few specialized industries, businesses & skilled workers
	Energy monopoly defending fossil fuel market share
Institutional / Politics	Ineffective laws favouring large-scale plants
	Clear strategy next to ambitious renewable targets is lacking
	Lack of stable policies and common strategic vision increases uncertainty
	Lack of cross-institutional communication and transparency
	Lobbyism of the strong monopolistic energy sector
	Information, knowledge & data is insufficiently distributed
	Lack of small-scale tender schemes
Others	Lack of RE awareness from key stakeholders
	Lack of public support and social acceptance
	Intermittency issues when integrating RE into the grid
	Insufficient scale and features of the Southern grid for large intermittent sources

Table 10: Barriers for increased renewable energy development in Morocco; Painuly (2001) framework

7. Analysis and Findings

The project considerations which were identified during the semi-structured interviews will now be elaborated upon in order to carve out the main barriers to increased renewable energy utilization. Painuly's barrier framework (2001) is utilized to structure the analysis. Secondary sources will likewise be incorporated in order to present the findings in the context of previous research.

Abbreviation	Viewpoint	Job Title	Selection	Date
C1	Academic & Practical	Economist & Former vice president of the Chilean state mining company	Direct Contact	Semi-structured interview
C2	Electrical Engineer	Associate	Direct Contact	Semi-structured interview
C3	Project Developer	Commercial Strategy Department	Direct Contact	Semi-structured interview
C4	Programme Director	Director, Renewable Energy Programme Chile	Direct Contact	Semi-structured interview
M1	Project Developer	Managing Director	Direct Contact	Semi-structured interview
M2	Project Manager	Project Manager, Morocco	Direct Contact	Semi-structured interview
M3	Project Manager	Project Development Manager, Africa	Direct Contact	Semi-structured interview

Table 11: Overview of the conducted semi-structured interviews

7.1. Project Choice & Opportunity Costs

One of the main considerations of project developers and investors is the choice of which project to pursue, given the multitude of options on country as well as on technology level. Opportunity costs play a major role, given the limited resources project developers have and the sometimes strict loan requirements of those providing the financing for the projects.

Institutional Barriers

Several institutional barriers have been identified as major obstacles to increased renewable energy utilization in Chile and Morocco. Interview C1 sheds light on the situation in Chile. First, developers face a tedious information search about which permits are necessary for project approval. Once the necessary permits are handed in, long processing times delay the project process and court trials regarding the for instance re-location of opposing communities are not unusual. Further barriers await the project developer once the project finally advances to the grid connection stage. Grid connections are often times delayed due to technical and bureaucratic issues. Given the multitude of institutional barriers developers face in Chile, it is likely that other countries are then chosen instead where developers find themselves in better institutional set-ups (Interview C1). This is in line with the findings of Johnston et al. (2008), who describe the major impact that public policy has on the development and diffusion of renewable energy in a country. They stress the importance of understanding the needs of project developers and investors to then implement the appropriate public policy. Likewise, Kumbaroğlu et al. (2008) elaborate on the successful diffusion of renewable energy, which can be facilitated if strong institutions and targeted policies are in place.

Morocco faces similar bureaucratic barriers, which hinder an increased RE diffusion. The importance of transparent and traceable public tenders was established in Interview M1. The apparently weak tender framework in Morocco has led to the petering out of various tenders, with project developers and investors being left with no tangible outcome, despite the commitment of substantial resources. This is very much in line with the findings from Interview M3, stating that renewable energy targets need to be accompanied by a relevant and credible institutional framework. Only the combination of both will attract project developers and investors for the long term. Burer & Wüstenhagen (2009) also find that relevant policies and frameworks are important to stimulate the interest of investors and at the same time reduce the investment risk. Especially those countries who are able to create these conditions will ultimately be successful in attracting foreign capital through project developers and investors.

Economic / Financial Barriers

Interviewee C2 stressed a number of important economic and financial barriers, which are to some extent responsible for the sluggish diffusion of renewable energy in Chile. Among the three options for selling energy in Chile, namely the spot market, PPAs, and public tenders, PPAs are considered the most desirable, as they provide a certain degree of security and predictability to investors. Interviewee C3 brought up a similar point. Developers seek to avoid the uncertainties with regard to grid connection costs and future spot market prices by signing the sought-after PPAs. Those entrants not being able to sign a PPA need to either bid on public tenders or sell through the spot market. However, the spot market is characterized by high volatility. This poses a considerable revenue risk, given the inability to predict spot market prices over the medium and long term (Interview C2). Interviewee C3 also pointed out that the lack of data and the inability to predict the spot price for the next 20 years or so is one of the major economic barriers for many developers.

Economic and financial constraints may also be an explanation why project developers increasingly turn their back on the spot market in Chile and move toward public tenders as well as PPAs. Interviewee C4 pointed out that the once very popular spot market in Chile has lost much of its attractiveness, due to a considerable increase of market players which put pressure on spot market prices. PPAs with private companies pose a viable and predictable alternative, yet these are subject to location and availability. This leaves public tenders (conducted twice a year) as the sales channel with the highest growth rates in Chile. The 2^{nd} round in 2015 led to 30 smaller renewable energy projects winning the bids, underlining the general competitiveness of renewable energy in Chile. The project developers were mainly from the United Kingdom and Spain. The origin of the developers is an interesting finding and interviewee C4 stressed that their home markets are relatively similar in terms of competition and lack of subsidies. This allows them to competitively develop projects and place winning bids on tenders in Chile, whereas developers from for instance Germany are less competitive, as they have been rather spoiled in the past with substantial subsidies in their home market (Interview C4).

Economic barriers can also explain the preference for certain technologies over others in a given country. Interviewee C2 explained that the basically non-existing offshore wind market in Chile is due to the fact that there are still plenty of accessible sites on land with excellent wind conditions. The same holds for Morocco as was stressed by interviewee M3. A market for offshore wind would only develop once those onshore sites are fully utilized and the costs for offshore wind projects are more competitive. This statement is in line with the elaborations of Kumbaroğlu et al. (2008) stressing that market players such as developers can hardly be expected to invest in more costly technology if they are not incentivized through subsidies or other promotional instruments. Interviewee C3 gave some important insights as to explain why the solar market is prospering better in Chile in comparison to the onshore wind market. As solar radiation levels are widely mapped throughout Chile and the prediction accuracy is much better compared to wind, investors and project developers continue to focus on solar projects, given the lower uncertainty. Even in places with high average wind speeds, such as in Punta Arenas, only a few investors have so far shown sufficient confidence to fund projects (Interviewee C3).

According to interviewees C1/C3/M3, both Morocco and Chile are countries where developers face financial barriers through the restrictions and requirements on bank loans and investor capital. How banks and other investors can limit the type and amount of projects taken on by project developers has been elaborated upon by interviewee M3. This particular project developer faces two constraints in this regard. Firstly, the company is listed on the stock exchange and has to adhere to certain shareholder expectations and demands. Secondly, due to its relatively small size, projects are normally purely project financed infrastructures with certain thresholds defined by the bank. It is therefore crucial to present a bankable procurement process, such as feed-in tariffs or public tenders, in order to secure the financing from the lender. The dependency on shareholders and external fund providers automatically limits the project developer in its ability to go for either more risky projects or those which are not secured through a PPA or public tender. These developers would face difficulties entering countries such as Chile, where feed-in tariffs are non-existent and the spot market continues to have a considerable importance.

Technical Barriers

Technical barriers pose another important constraint for project developers when they are choosing which countries and technologies to invest in. Interviewee C2 explained that the lack of necessary drilling equipment and skills in Chile would pose difficulties for those who are eager to accomplish offshore wind projects, as machinery and know-how would need to be imported. This would automatically drive up project costs, which may result in the project not being feasible anymore. Likewise, interviewee M3 mentions the lack of necessary technology in Morocco for offshore projects as it has only little experience in drilling given the lack of natural resources.

In addition, interviewees C1/C2/C4/M1/M2 mentioned energy storage applications, which are not yet widely available in Chile and Morocco, but could one day help to overcome the problem of depressed prices on the spot market during peak hours. However, until such storage becomes widely available, project developers rather stay away from engagements in for instance Chile's spot market, given its depressed prices. Along similar lines, Masini & Menichetti (2010) conclude in their study that the technical effectiveness of investment opportunities plays a significantly larger role than the market beliefs when it comes to investment decisions. It is hence important that the technology has an already proven reliability. Only then will an investor choose to invest in such projects (Masini & Menichetti, 2010).

Moreover, challenging country characteristics pose another significant hurdle in the technical realm. Interviewee C4 explained that the difficulty to attract developers and investors to Chile is increased due to the unique geography of the country, stretching over 4200km. Transmission and transmission losses are a major challenge, especially as most of the grid uses alternating current. In addition, interviewee C2 stressed that for a long time there has been a lag between the renewable project development and the development of the necessary transmission lines, delaying the completion of projects for several months or even years.

Other Barriers

Several other barriers were identified during the interviews, often focusing on uncertainties regarding politics and government programmes. Interviewee M1 explained that the usual due diligence incorporates the comparison of country risk ratings, as well as the corruption index. Countries with bad ratings or whose ratings have recently worsened are unlikely to be considered when it comes to decide which projects to pursue (Interview M1) This issue is particularly relevant for Morocco with a BBB- credit rating compared to an AA- rating for Chile (S&P, 2016). The concept of opportunity cost becomes obvious here, as investors generally prefer less risky countries with better investment climates. Interviewee M3 likewise named risk and investment indices as the usual parameters to look at before an investment decision is taken.

Certain government programmes can keep certain project developers and investors from entering the country, especially if the market for renewable energy is not yet reliable and government programmes are rather short-term focussed (Interview M1). This project developer made clear that it is unlikely that his company will enter Morocco in the upcoming years, as government programmes have a duration of only 12-15 months. The gap between the programme duration and the overall investment horizon of roughly 10 years would be too large and hence other countries would be preferred. The unsuitability of government programmes to project developer, as developers do not sufficiently trust the programme structure and declared benefits (Interviewee M1). Similarly, Masini & Menichetti (2012) describe in their study that investors have very little trust in government programmes that aim for direct support of renewable energy through for instance short-lived subsidies. Interestingly enough, Masini & Menichetti (2010) found out that certain renewable energy investors do have an extremely short investment horizon. These investors favour short term policies and government programmes with an immediate large financial incentive, instead of receiving the incentive over many years.

Another important barrier deals with the change in governments or the introduction of new laws and policies. Interviewee M1 explained that from a project developer and investor perspective, PPAs are not attractive if the current government is not able to ensure that PPAs will endure a change in government or the introduction of a new law. Only if investors are given such certainty will most of them enter a contract of some ten years, with the respective investments required.

Project Choice & Opportunity Costs			
Barrier Category	**Barrier**	**Market**	**Relevant Literature**
Institutional	Lacking institutions/mechanisms to disseminate information	Chile & Morocco	Johnston et al. (2008) Kumbaroğlu et al. (2008)
	Non-transparent tender process	Morocco	
	Ambitious RE targets are not supported by the necessary institutional framework	Morocco	Burer & Wüstenhagen (2009)
Economic / Financial	Spot market price risk	Chile	
	Non-competitiveness of offshore wind technology	Chile & Morocco	Kumbaroğlu et al. (2008)
	Constraints through shareholder demands & bank loan terms	Chile & Morocco	
Technical	Lack of necessary drilling equipment and skills	Chile & Morocco	
	Non-availability of widespread energy storage applications	Chile & Morocco	Masini & Menichetti (2010)
	Transmission losses due to geographical characteristics	Chile	
Other	Country risk ratings & corruption index	Chile & Morocco	
	Short-lived government programmes	Morocco	Masini & Menichetti (2012) Masini & Menichetti (2010)
	Risk of non-assurance of PPA contracts after changes in government or introduction of new laws	Morocco	

Table 12: Summary of barriers related to project choice & opportunity costs

7.2. Project Size

Another important consideration for project developers deals with the size and scalability of projects. The project size is of importance for several reasons. Firstly, government policies and the supporting mechanisms may for instance favour only small- or only large projects. Secondly, project developers might need to scale up projects in order to make them viable and receive the necessary funding from investors. And lastly, although small projects may contribute considerably to the energy mix and help particularly in rural areas, a lack of training and skilled personnel obstructs such developments.

Institutional Barriers

Several institutional and regulatory barriers have hindered small players to enter the market in Chile and Morocco as it was either not feasible or possible at all. Chile's tender bidding system has historically favoured large-scale developers and conventional energy plants, as only full 24h blocks were up for bidding. Renewable energy projects had no chance to enter this market, given their inability to ensure electricity supply throughout the whole day. However, the bidding process was changed in 2014, allowing the bidding on smaller 8h blocks. Since then, renewable project proposals have successfully taken part in the auctions and also smaller European firms have entered the market (Interview C1). In fact, all winning bids were coming from renewable energy projects in the November 2015 auction (MRP, 2016).

The promotion of small-scale projects in Chile and Morocco was discussed during the interviews. Considerable barriers have been identified in both countries. Interviewee C4 stressed that the Chilean government needs to establish more training facilities to train local mechanics and electricians, who would then be able to realize small-scale projects. Local staff is crucial, as international project developers and investors are not willing or able to take on small-scale projects on a community level (Interview C3). Interviewee M1 drew a similar picture by stating that small-scale projects, as on rooftops for instance, can most likely only be accomplished by local Moroccan firms. Such projects are just not feasible for international project developers and hence need local engagement. In order for such engagement to take place, engineering expertise and training needs to be given to local engineers for them to be able to execute the projects independently.

The Moroccan government seems to have an interest in promoting small-scale projects, as they for instance also passed law 13-09, aiming to promote those projects (Interview M1). Hain et al. (2005) elaborate similarly in their paper that the government can actively promote small-scale and community RE projects through the right policy, which does not only favour large-scale projects. They claim that too often small-scale projects are overlooked in favour of large plants. This is despite the fact that smaller projects can considerably contribute to voltage stability as well as increased security as grid outage conditions are not affecting everyone at the same time. In addition, they argue that incentive schemes or capital grant schemes should be put in place, as the cost per unit of energy is inarguably higher for small-scale projects (Hain et al., 2005). Interviewee C2 mentioned that several communities in the South of Chile are interested in small-scale RE projects for their communities, but fail to find suitable project developers and investors. Policies and incentives that attract national and international developers could change that. Rogers et al. (2008) raise the issue that a coordinated approach is needed. Community initiatives require both expertise in technical issues but in community development as well, in order to receive the support from the overall community.

The regulatory framework constitutes another hurdle for small-scale projects. Interviewee M2 illustrated the situation in Morocco by stating that the regulatory framework is in place for large-scale plants, but is at most fragmented for small-scale projects. Information about the technical requirements for small-scale ventures is lacking and there exists no fixed-tariff solution, which hence increases the uncertainty. Hain's et al. (2005) request for a more focused policy towards small-scale projects applies here as well. Only if some of the governmental attention is redirected from the prominent large projects towards the smaller and community projects, one could expect an increase of smaller ventures implemented in the years ahead.

Economic / Financial Barriers

Several economic and financial barriers can likewise be linked to the question of project scale. Despite the general belief that larger plants should benefit from scale advantages and a lower cost per energy unit produced, one could also consider another perspective, as did interviewee C1. The South of Chile has been characterized by several large hydro projects, some of them having failed in the conceptualization phase due to public resistance. During the interview it was pointed out that scale is not always beneficial as several small dams in the South would be a much better option as they allow for the same total capacity as one big project. In addition, smaller projects have lower costs in terms of finding suitable locations, relocating local communities and for the grants of permits. This is in line with the findings of Bergmanna et al. (2006), stating that renewable energy projects can have very different external costs in terms of impact on communities, landscape or wildlife. These costs need to be considered before deciding which project and which project size to pursue. Project developers in Chile, Morocco and elsewhere are well advised to incorporate these project cost differences into their calculations and planning (Interview C1).

Interviewee M1 gave interesting insights about which projects and project sizes they choose to implement. Many of the fixed costs, such as the obtainment of the necessary permits, remains the same, independently of a 10 MW or 100 MW project. They therefore tend to only deal with projects of 30 MW or larger. Moreover, size is of particular importance as they usually do not deal with turn-key projects but operate the projects themselves after completion. Hence, a preference for fewer but larger projects exists in order to keep administration and maintenance efforts under control. A country or PPA partner not being able to offer those minimum scale conditions erects an entry barrier for such project developers. In addition, it was stressed that as the projects are normally purely project financed infrastructures, the investors require a certain scale. Investors prefer larger projects where the average cost per unit of energy is smaller. They therefore restrict the financing for small-scale projects (Interview M1).

Technical Barriers

Technical barriers linked to the size of the projects became clear in a number of interviews. Interviewee C4 emphasized that not only small projects are disadvantaged. The two Chilean main grid operators SING & SIC face difficulties to prepare for higher fluctuating renewable energy feed-in. This is particularly relevant for RE projects that are larger than one GW. The grid needs to be prepared for higher renewable feed-in and at the same time need conventional power plants be run more flexibly. The coordination issues are expected to increase, once the two main grids are finally connected in 2017/2018 (Interview C4).

The potential of RE to supply 100% of the electricity in a decentralized fashion with small-scale applications was looked upon by interviewee M2, who explained that such set-up would theoretically be possible in Morocco. However, looking at it from a technical side, the grid would need to be altered substantially, as it is only able to cope with conventional producers and large-scale fluctuating renewables. Decentralized fluctuating renewables would need to be better integrated in order for such vision to become reality (Interview M2). Combining the insights from interviewee M1 and M2, it seems that both small decentralized projects as well as very large RE plants have difficulties to be integrated smoothly into the transmission grid. This clearly constitutes another barrier for project developers and investors.

A last technical barrier regarding the project size deals with the difference among RE technologies. Interviewee M1 emphasizes that wind is not as scalable as solar. Solar plants have the considerable advantage of being flexible when it comes to plant location as well as plant size. Depending on where the demand is, such as a community or industry district, the solar plant can be erected in proximity to reduce transmission losses and grid connection costs. Wind however is very much location dependent and the most favourable locations are usually located on the coast. If the demand centre is elsewhere, a grid connection is vital, which can turn out to be costly.

In addition, as developers are not able to build an expensive grid extension for only one or a few wind turbines, they are pretty much pressured to scale up the size of the wind park to distribute the grid costs over several turbines. Only if the government, grid operator or the consumer bear the costs of the grid, RE developers would feel fewer pressure to scale up the wind park. However, scaling up can certainly have its disadvantages as well, as Hirth (2013) neatly analyses in his paper. His elaborations on the merit-order effect stress that the higher the capacity installed, the more depressed will the electricity price be. He finds the value of wind and solar to both fall to 0.5-0.8, once a market share of 30% and 15% is reached, respectively. This of course only holds for RE plants that feed-in the spot market and not for flat tariffs or PPAs (Hirth, 2013).

Project Size			
Barrier Category	**Barrier**	**Market**	**Relevant Literature**
Institutional	Tender bidding system favouring large-scale developers & conventional producers	Chile	
	At times lengthy environmental studies necessary for all projects above 3 MW	Chile	
	Government fails to create more training facilities to train local electricians for small-scale projects	Chile & Morocco	Hain et al. (2005)
	Insufficient regulatory framework for small-scale projects in e.g. communities does not attract developers/investors	Chile & Morocco	Hain et al. (2005) Rogers et al. (2008)

Economic / Financial	Large hydro dams bring along high location search costs, relocation costs, and lengthy permit approvals	Chile	Bergmanna et al. (2006)
	Certain fix costs remain the same – independently of a 10 MW or 100 MW project, hence clearly favouring lager scale projects	Chile & Morocco	
	Banks and other investors may pose certain restrictions on the project size, e.g. not funding too small projects	Chile & Morocco	
Technical	Grid challenges to incorporate the feed-in of RE projects of 1 GW and larger & upcoming grid connections	Chile	
	Grid is not yet ready for the inclusion of many decentralized fluctuating REs	Morocco	
	Wind with a lower scalability compared to solar, due to the higher location and grid dependency	Chile & Morocco	Hirth (2013)

Table 13: Summary of RE barriers related to project size

7.3. Resource Availability

This chapter analyses several effects on the costs and performance of RE projects. First, the LCOE and its various calculation approaches shed light on the selection of certain projects over others. Secondly, natural resource availability is incorporated in the analysis as changes directly affect the LCOE throughout the project's life span. And lastly, intermittency issues and the lack of widespread technology solutions to overcome them are discussed. Again, various factors that constitute possible barriers to RE utilization are carved out by utilizing the insights from the interviews.

Economic / Financial Barriers

As discussed in Chapter 3, the LCOE of a project supports developers in their decision when choosing certain projects over others. The LCOE is a composition of various cost drivers. However, construction costs are by far the biggest cost driver for RE projects and therefore the main concern when calculating the LCOE. Interviewee C3 stressed that the installed watt price can differ substantially between countries or regions. A 1 MW solar plant costing USD 6 million in the US, can easily add up to USD 12 million in Chile due to lengthy permit approvals and the expensive import of technology. This constitutes a key consideration for developers. However, the developer of course takes into account that the solar radiation levels and therefore utilization of the plant are likely to be higher in the prime locations in Chile compared to the US (Interview C2).

The minimisation of costs when erecting a plant and connecting it to the grid is not necessarily the only important factor for developers, as was stressed by interviewee M3. His company increasingly engages in projects with more remote plant locations, which are consequently more expensive to access and connect to the grid, but benefit from overall higher solar radiation levels. It is thus a trade-off between construction/connection costs and the payoff of a better plant utilization.

When comparing several countries, the sometimes stark differences in project costs can be partly explained by the availability of local technology. Chile’s economic structure relies heavily on agriculture and mining, putting R&D and technology development in the rear. Hence, Chile is dependent on foreign technology, which needs to be imported and therefore drives up project costs, despite the low tariffs mentioned in chapter 4 (Interview C2). Morocco is in a similar situation and has to import the needed technology, despite the fact that five-year research programmes have been introduced. However, these programmes often target natural science issues or the important fishing industry and are thus not contributing to the advances in RE technology (Interview M1). Yet, both interviewees stressed that the engagement in own R&D programmes and technology development does not necessarily be the better alternative, as they are costly and would have a hard time catching up to already established and well-funded programmes. Neij (1997) stresses the importance of R&D development in order to drive down PV module costs and enable the diffusion of RE, but he does not specify in how many countries such R&D should take place.

Several RE technology specific barriers can be established as well. Interviewee M1 explained that the best locations for wind turbines are naturally at the coast. However, industrial centres might be further inland. Examples are the metropolitan area of Santiago or the various bigger cities in Morocco. A project developer then needs to decide if to either accept higher transmission costs or to move closer to the demand. In this case one is again confronted with the trade-off between construction/connection costs and the optimisation of the plant location. A decision which is not often easy to take, especially if the transmission lines to for instance the coast are not yet well established.

Interviewee C3 added an important point, when stating that expensive and time-consuming studies are needed to map out wind farm projects in the South of Chile, which are not located in already mapped out prime locations. These research costs would add to the overall costs and drive up the LCOE. The interview findings are in line with the paper from Lantz & Hand (2012) who state on the one hand that the LCOE of wind energy will continue to decrease on a global level. On the other hand however, several factors will partially counteract this and create an upward pressure on prices. Those factors include the increasing utilization of lower wind speed sites as well as increased transmission needs.

Interviewee M1 stressed an important point with regard to hydro projects in Chile and Morocco. Both countries already utilise hydropower to a considerable extent. Therefore, many of the best locations are already taken, which results in the next best ones being harder to access and projects to be more expensive. If many people live in the drainage area, the costs for relocating them can be substantial (Interview M1). Generally speaking, hydro projects seem to become more risky compared to solar and wind ventures. Interviewee M1 argued that the short-term outlook is still promising in regions with high precipitation or amounts of melt water, such as in the South of Chile. However, climate change and recurring droughts result in the medium and long-term to be much more worrying. Not only because the plants produce fewer electricity, but also because the LCOE and feasibility studies of the projects have been based on near 100% capacity expectations over time spans of up to 40 years. The increased uncertainty in the years and decades ahead could turn many already erected projects unprofitable. Pawel (2014) addresses this uncertainty by concluding that project assessment must not be solely based on LCOE calculations, but should much rather incorporate the expected project revenue to then derive a project net present value. This would also take away some of the uncertainty project developers face in the particular case of hydro projects.

Interviewee M1 called for a new approach of how project developers forecast the renewable resource availability and the utilization of RE plants. Project developers need to be aware that even with new technologies only up to 80-85% of the produced electricity can be used and sold, in particular in countries without feed-in tariffs such as Chile. The remainder needs to be written off, as it is not sold due to an oversupply or lack of demand at certain times of the day. Large-scale storage solutions might improve the numbers further but will not suffice to achieve a utilization of 100% (Interview M1).

The issue of intermittency needs further focus as more RE projects will be constructed on not ideal sites and renewable resource availability is more and more characterized by uncertainty, taking for instance precipitation levels into account. Project developers will have the choice to refine the utilization levels, or to downsize the plants, as smaller plants need fewer precipitation and water speed to operate on high utilization levels. This would increase the capacity factors of the respective plants and would likely lead to an improved revenue/cost profile.

Technical Barriers

Intermittency is one of the key terms when discussing technical barriers. Electricity demand and RE supply are only partially overlapping in Chile and Morocco. Interviewee C1 explains that solar energy is an excellent source during daytime in Chile, however it needs to be backed up by other sources to serve the demand surge in the evening or even night, given that mines are usually operated around the clock. Intermittency costs need to be considered as it is costly to switch gas, coal or diesel plants on and off (Interview C1). Likewise, Morocco's peak demand is in the late afternoon/evening, with solar plants being able to serve most of this peak (Interview M2). The inability to serve the whole peak can hinder project developers in case that PPAs or public tenders would require that the winning projects are able to provide electricity throughout the whole peak.

One of the mentioned solutions to this problem is the energy storage technology. Ibrahima et al. (2008) conclude that storage is the weak spot in the energy realm, but at the same time constitutes a key factor for RE growth and diffusion. In theory, new storage technologies are able to cover peak demand periods until late at night. Interviewee M1 underlined that homes and the industry in Morocco's centres could easily be served by solar plants in the proximity. They would be able to supply the whole peak demand with the support of storage technology. However, as large-scale storage applications are not yet widely available, such vision remains out of reach for now. Similarly, interviewee C1 stressed that Chile's North could theoretically provide all of Chile and even South America with electricity, given the abundant opportunities for solar plants in the Atacama Desert. This would of course require the necessary transmission lines. However, the inability to store energy on a larger scale is preventing this vision to become true (Interview C1). Nevertheless, the vision remains worth striving for as storage would decrease the revenue risk for project developers. They would not be as affected by the spot market risk with prices approaching zero during the midday oversupply peak (Interview C1).

Fortunately, it seems only a matter of time and technology diffusion until such large-scale solutions are implemented throughout the markets. Spain for instance has a CSP plant, which utilizes storage applications and is able to supply electricity around the clock (bze, 2011). Similarly, Divya & Østergaard (2008) emphasize that storage devices do not only assist the operation of future electricity grids in a reliable fashion, but also promote the integration of fluctuating RE sources. In addition, large-scale battery storage would also boost the business case for wind farms and make them more independent from the predictability of wind speeds at certain times of the day (Interview C1).

Resource Availability			
Barrier Category	**Barrier**	**Market**	**Relevant Literature**
Economic / Financial	LCOEs differ substantially between countries & regions, expressing for instance plant cost differences	Chile & Morocco	Pawel (2014)
	Lacking technology and project skills drives up project costs considerably	Chile & Morocco	Neij (1997)
	If prime locations are already taken, LCOE is driven up due to higher construction/connection costs	Chile & Morocco	
	Expensive and time-consuming studies are needed to map out the feasibility in non-prime locations	Chile & Morocco	Lantz & Hand (2012)
Technical	Intermittency costs can add substantially to the LCOE in cases where peak electricity demand and supply do not overlap	Chile & Morocco	
	The lack of wide-spread storage applications hinders the full utilization of an abundant resource availability	Chile & Morocco	Ibrahima et al. (2008) Divya & Østergaard (2008)

Table 14: Summary of RE barriers related to resource availability & LCOE

8. Discussion

The previous section analysed both cases and compared the prevailing RE diffusion barriers with each other. The findings are subsequently discussed in order to establish the research contribution and give suggestions for interesting future research opportunities. In addition, the author proposes a framework that builds on the Painuly (2001) framework but extends it by two further dimension that should guide project developers in their analysis when weighing off several countries for their engagements. Moreover, policy makers and investors can likewise benefit from the framework and the presented information therein.

The analysis of the interviews carved out two main findings. Firstly, substantial RE diffusion barriers in several realms continue to exist in Chile and Morocco. And secondly, project developers and investors have limited resources and the concept of opportunity costs steers their decision making when opting for a certain country/project over another.

The insights of the interviews were backed up by relevant secondary literature and resulted in a fairly complete picture about the barriers to RE development. The Painuly (2001) framework turned out to be useful for the process of structuring the different barrier groups in each country. Being able to see all e.g. *institutional* or *financial* barriers clustered together is of great value for researchers, developers or investors, who are specifically looking into one country.

However, the interviews made also clear that developers need to weigh off the multitude of possible countries in order to find the few most suitable ones to their business model and long-term planning. This need for selection is not uncommon as developers are constrained by limited resources and hence need to find the most suited engagements. Having this in mind it became clear rather quickly that the Painuly (2001) framework is only useful to a certain point, namely to establish a stand-alone country analysis or to analyse a particular barrier in more depth.

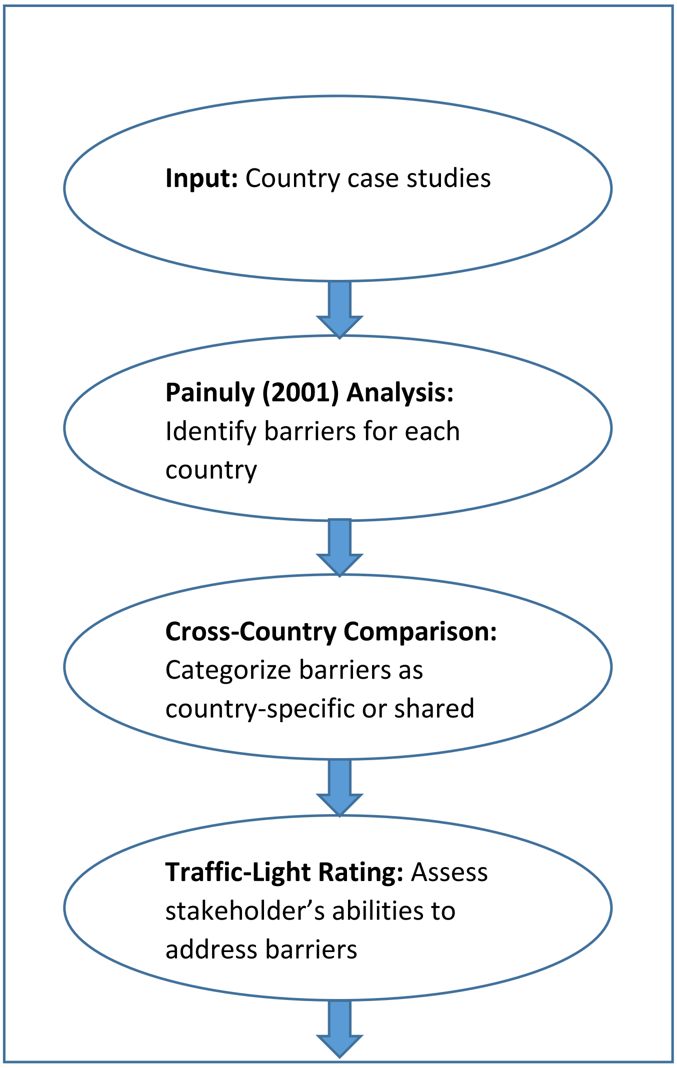
8.1. Framework Introduction

The author thus proposes another framework, which extends the Painuly (2001) framework in a way that allows developers to compare different countries and establish an even more precise barrier overview. This is accomplished by the incorporation of two further dimensions.

One of the dimension is of comparative nature with two additional barrier categories. The interview findings were key to carve out the two new categories that shall extend the Painuly (2001) framework. Firstly, the *country-specific barrier* category lists all barriers that are unique to a country when opposed to all other countries in that particular comparison group. And secondly, the *shared barrier* category sheds light on all barriers that are shared among the countries in the comparison group.

The second added dimension will serve as a traffic light rating system, which addresses all relevant stakeholders and their ability to remove or at least work on a certain barrier. The stakeholders included in the framework are the governments (G), the developers (D) as well as the investors (I).

Much like the well-known Painuly (2001) framework should the author's framework convince through its applicability and simplicity. Figure 5 depicts the logic of the framework and the different process steps



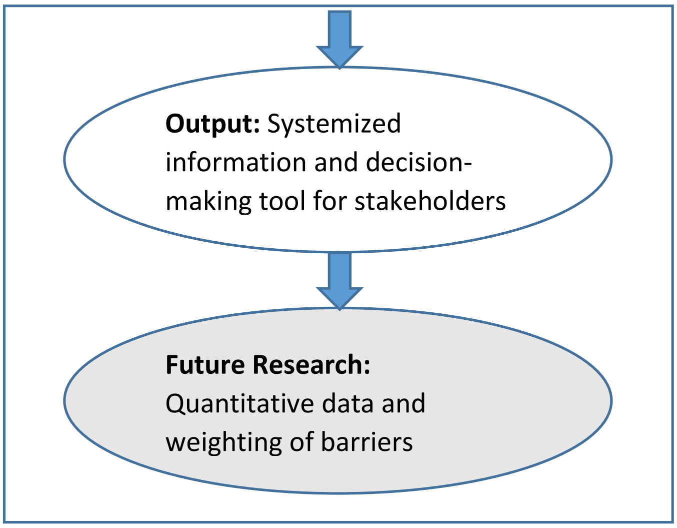


Figure 5: The proposed framework's process as an extension to the Painuly (2001) framework

The process of analysis is described in turn. Firstly, the comparison group is selected. It is advised to incorporate two to a maximum of four countries in the comparison group, as the overview will otherwise get too crowed and loose some of its key advantage, which is elaborated upon later on. It makes sense to choose countries that are similar on certain dimensions such as the stage of development or even geographic location. Secondly, the Painuly (2001) framework is utilized to cluster the respective barriers of each country. It is worth to mention that the author added *"natural constraints"* as a final barrier category following the Painuly (2001) barriers. Thirdly, the barriers will then be inserted into the author's framework. After having categorized the barriers according to Painuly (2001), the important decision is then to segment them into country-specific and shared barriers. As a final step, one incorporates all stakeholders by utilizing the traffic light rating system. A green light resembles a good ability to work on or even remove a barrier, whereas a yellow light indicates a moderate ability to do so. A red light demonstrates no or only limited ability. Table 15 depicts a template of the framework. The number of countries can be changed accordingly, depending on how large the comparison group is supposed to be.

Country-Specific Barriers						Shared Barriers	
Country X	G D I	Country Y	G D I	Country Z	G D I		G D I
Market Failure Barriers							
Barrier #1		Barrier #2		Barrier #3		Shared #1	
Market Distortion Barriers							
Economic and Financial Barriers							
Institutional Barriers							
Technical Barriers							
Social/Cultural/Behavioural Barriers							
Other Barriers							
Natural Constraints							

Table 15: Template of the author's proposed framework

The findings of the two-country case study at hand are filled in the author's framework and depicted in Table 16. The relevant Painuly (2001) categories for the cases at hand are included in the overview table as well. The applicability of the framework is addressed in the next section.

Country-Specific Barriers								Shared Barriers			
Chile	**G**	**D**	**I**	**Morocco**	**G**	**D**	**I**		**G**	**D**	**I**
Financial Barriers											
Revenue risk on the spot market	Yellow	Yellow	Red	BBB- credit rating of Morocco	Yellow	Red	Yellow	Bank loans & investor capital restrictions	Yellow	Yellow	Green
Institutional Barriers											
Obsolete tender bidding system	Green	Yellow	Red	Short-term focussed government programmes	Green	Red	Red	Bureaucratic barriers & lacking institutional framework	Green	Yellow	Red
Lack of data to predict spot market price	Yellow	Yellow	Red	Insufficiently backed up government claims	Green	Red	Red				
Complicated land ownership structures	Yellow	Yellow	Red					Lack of training facilities and local electricians	Green	Yellow	Yellow
Technical Barriers											
Grid problems with RE projects of >1GW	Yellow	Yellow	Red	Grid problems if too many decentralized fluctuating REs are injecting	Yellow	Yellow	Red	Alternating current (AC) grid poses transmission problems	Yellow	Yellow	Red
Other Barriers											
Lack of onshore wind mapping compared to solar radiation levels	Green	Yellow	Red					Non-prime locations drive up LCOE	Yellow	Yellow	Red
Transaction cost barriers for large hydro dam projects	Yellow	Yellow	Red					Unavailability of energy storage solutions on a wide scale	Yellow	Yellow	Yellow
Social, Cultural & Behavioural Barriers											
								Barriers in terms of language and business customs for certain developers	Yellow	Green	Red
Natural Constraints											
Country stretches over 4200km	Red	Red	Red								

*Legend on the next page

G = Government	🔴	No/limited ability to remove barrier
D = Developers	🟡	Moderate ability to remove barrier
I = Investors	🟢	Good ability to remove barrier

Table 16: Overview of the cross-country comparison results, applying the proposed framework structure

8.2. Applicability of the Framework

The applicability of the new framework becomes clearer once an actual summary output (Table 16) is consulted. The table is structured into the new two main barrier categories, as well as the traffic light rating system after each barrier group. Moreover, the established Painuly (2001) categories (in light blue) are still within the framework as financial, institutional, technical, cultural and other barriers are still separated from each other.

Several project developers stressed during the interviews that the preparation and planning phases of projects take up a considerable amount of their time. This is in line with theory stating that information search costs can be substantial, in particular in markets with limited available information and weak institutions (Jacobsson & Johnson, 2000). Engaging in feasibility studies, mapping out all necessary permits and securing the project financing are among the key tasks to be accomplished before a project can advance into the next stages. Needless to say, that these tasks are aggravated in certain emerging markets, which lack sufficient institutional support and a broad investor base.

Furthermore, the interviewed project developers pointed out that several countries are analysed at the same time to find the most suitable ones for their engagements. Several countries or even parts of continents, such as in the case of Northern Africa, are then screened to figure out the main opportunities but more importantly the barriers to project realization. The concept of opportunity costs steers the decision of developers in this phase. Most of the analysed countries are characterized by the same outstanding natural conditions to implement RE projects. However, the various types of barriers are the key factor when weighing off different options. A framework that helps developers to focus on and compare the prevailing barriers in several countries would thus be of valuable guidance to them.

A project developer is most likely interested in the country-specific barriers that are unique to a certain country in the particular comparison group. When consulting Table 16, one can easily access this information in the left main column. The column is horizontally separated by the Painuly (2001) categories. For instance, a project developer can easily spot that Morocco has a relatively low credit rating, which can result in higher risk premiums and financing costs. The refined clustering structure helps developers to access the relevant information with ease.

Moreover, shared barriers can be of interest for a developer as well. The barriers in this group are the same or very similar for all countries in the comparison group. All such barriers can be found in the right column of the table. The developer realizes for example that project financing is scarce in both countries and that bank loans come with certain restrictions. This is a helpful summary once the financial aspects of the project planning are discussed. However, this information should just serve as an overview and reminder. Further details of this shared barrier would need to be extracted from a more extensive table.

In addition, the inclusion of the traffic light rating system helps to present the stakeholder abilities in a simple yet easy-to-grasp fashion. Each barrier is followed by three traffic lights, representing the abilities of the government, developers and investors, respectively. All mentioned parties are hence able to recognize which barriers can be tackled by themselves and for which barriers the help of others are needed. This should guide the stakeholders and help to jointly remove the barriers that hinder an increased RE diffusion.

Two of the framework's key features are the ability to conduct a cross-country comparison while save valuable time by doing so. The further segmentation of barriers allows developers to work with a smaller but for them more relevant group of obstacles, given for example that a developer is indifferent between two countries. By sorting out the barriers that prevail in both countries, one can focus on the country-specific barriers, which are likely to be key when one decides in which country to engage in. However, not only project developers can benefit from the structured presentation of barriers. Governments and investors are likewise able to recognize which barriers prevail and moreover who is most capable of removing them. Hence, the traffic light system considerably increases the audience of the framework and its opportunities of application.

8.3. Limitations of the Framework

The author's framework has certain limitations, which are addressed in this section. A first limitation was already touched upon in the previous section. Only a certain amount of countries should be included in the comparison in order to keep the overview and to meaningfully separate the country-specific barriers from the shared barriers. The list of shared barriers would most likely be very small or non-existent if too many countries are included in the comparison set. Hence, a developer with a large set of interesting countries will face the difficulty of which countries to include in the comparison set. A possible solution to this could be to run several comparisons.

A further barrier deals with the amount of detail that can be depicted in such overview. It is certainly to be preferred to keep the listed information as precise as possible, especially if various countries are included. However, the risk to miss out on important details that have been established during the research cannot be avoided then. A solution for this problem would be the preparation of two summary tables. One would include the full information, serving as a back-up. And the other table could be used for high-level presentations with limited time and space.

The limitation of missing details can be further extended by arguing that the shared barriers could be certainly more specified in detail as even shared barriers will have certain differences between each other. One example from Table 16 would be "bureaucratic barriers", which has been placed in the right column. Both countries are facing bureaucratic barriers but one is not able to detect the differences in case that any exist. Again, a second and more detailed table would be of use in this case.

8.4. Future Research

The author identifies several interesting future research domains, given the limitations of the framework and the opportunities to further extend it.

Firstly, the incorporation of quantitative data would certainly be of value, as the framework would have better predictive power once numerical data and statistics are utilized as well. Surveys on a larger scale could collect data regarding the different barrier types and try to give further insights into their importance for project developers. This could be done on a country level for the country-specific barriers but likewise for the shared barriers that would be of importance in the whole comparison group.

Once quantitative data is incorporated one could attempt to weigh the different barriers in order to establish a ranking, which would further support project developers in their decision making. The ranking would for instance visualize which country-specific barriers in a certain country are the most severe and need to be considered with particular caution. Project developers can then target their resources more effectively, making those hurdles their priority.

Further, quantitative data could likewise help to establish a refined traffic light rating system. By incorporating data and experiences from other countries, one could rate the abilities of the relevant stakeholders with higher accuracy.

Another interesting realm of future research deals with the overall characteristics of emerging markets. Khanna, Palepu & Sinha (2005) discuss the institutional voids that project developers and investors will find themselves confronted with once entering emerging markets. These institutional voids usually exist in general and are not limited to a certain industry in a country. Hence, one could further specify which barriers in the framework are really common for the RE industry and which barriers are just typical barriers, which are usually found in the setting of an emerging market. Again, the result would be an even further barrier segmentation and hence would increase the focus on the most relevant barriers for RE project developers.

And lastly, the establishment of barrier patterns in certain countries or regions could be of interest to project developers as well. Project developers looking at whole regions could make use of the information if the majority of countries in the region show the same shared barriers. Other project developers looking at developing countries in early development stages would be interested in any barrier patterns that are common for these countries. Through the creation of several comparison groups, one could attempt to establish such patterns.

9. Conclusion

This thesis sets out to identify opportunities to increase the development of renewable energy technology by focusing on the prevailing barriers in the setting of emerging markets. The research was driven by the recent developments that have shaped the energy domain. Worth to mention are the significant cost reductions for RE technologies, the sustained increase in electricity demand in emerging markets as well as the favourable geographic locations these countries can capitalize on. However, substantial barriers to diffusion stand in contrast to these advantageous conditions. In line with these elaborations it has been the aim of this thesis to answer the following research question:

How can a cross-country comparison of barriers to renewable energy development help to understand and address those barriers?

The semi-structured interviews with industry insiders in Chile and Morocco generated valuable insights. It proved to be true that various barriers to RE development continue to exist in both cases. Moreover, it was remarkable to see the number of similar barriers, despite the different country profiles. The Painuly (2001) framework was utilized for the clustering of interview findings in the specific barrier groups.

During the interviews the author was able to identify two key considerations that project developers have in their search for the most compatible and profitable engagements. Firstly, limited resources restrict their capacity to engage in too many in-depth feasibility studies as well as to take on too many projects at the same time. Secondly, opportunity costs steer their decision making. The ability to meaningfully compare the available options is crucial to them in order to take on the most suited engagements.

Connecting both research findings, the author drafted a framework that shall serve as an extension to the well-used and cited Painuly (2001) framework. Its key strength are the ability to neatly compare the barriers in the researched cases by clustering them into country-specific and shared barriers. The proven segmentation of the Painuly (2001) framework remains in place through a horizontal clustering. Moreover, a traffic light rating serves as an additional complement by indicating the abilities of stakeholders to mitigate or even remove a certain barrier. This system ensures that a broad audience is able to benefit from the framework, as all three key stakeholder groups are included, namely project developers, investors as well as the government.

The interviews have shown that project developers could benefit from a simple yet effective cross-country comparison. The proposed framework is a useful guide to achieve that and can be further extended as has been suggested in the future research proposals. Quantitative data could help to weigh the different barriers and fine-tune the traffic light rating. Further research that segments RE specific barriers from those that are generally prevalent in emerging markets could further refine the barrier groups and increase the guidance for decision makers.

To sum up, the contribution to research has been twofold. One the one hand, an extensive country analysis contributed to the mapping of prevailing barriers in Chile and Morocco. Both countries show a remarkable number of similar barriers despite their different profiles. On the other hand, the various interview findings were turned into an effective method that helps to compare barriers to RE development. Hence, not only project developers, investors or energy planners shall make use of the findings and the new method. Also academics may use the proposed framework in future cross-country comparisons.

When Barack Obama demanded RE to become the profitable kind of energy in 2009, RE technologies were not as cost competitive as they are these days. If project developers and other stakeholders now manage to effectively detect, circumvent and remove the prevailing barriers to RE development, one could finally claim his endeavour having succeeded in most parts of the world. The research findings of this thesis might just be one more step in that direction.

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