Drivers and barriers for renewable energy investments in emerging countries – The case of wind energy in China, India and Brazil

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Abstract: Developing and emerging countries are gaining importance on the renewable energy stage due to their growth prospects in several areas and a strong investment increase in the recent past. This paper is dedicated to investigating the drivers and barriers to investments in renewable energies in developing countries. It explores these by using a unique dataset of institutional investors comparing wind energy investments in India, China and Brazil (as representatives of the BRICS countries) by means of a case study. Factors affecting the investments of large institutional investors include the legal framework (including policies), the institutional environment (including infrastructure), overarching macro-economic stability (including currency risk) and growth potential.

Keywords: Renewable energy investments, emerging economies, wind energy, India, China, Brazil, barriers, drivers, government policy

JEL codes: O33, O38, Q42, Q48

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1. Introduction

The world energy demand rose by roughly 68% from 1980 until 2009. This trend was especially pronounced in developing countries, whose share of global energy demand ascended from 41.3% to 54.1% over the same time period. However, the rising energy demand is mostly based on conventional energies. Conventional energies accounted for 86% of the world energy demand in 2009. Besides, conventional energies cause environmental pollution (International Energy Agency [IEA], 2011, pp. 74; 81). Consequently, an increasing energy demand, which results in an escalating energy generation, portrays adverse effects on the environment. Ramifications include global warming and thereof resulting a rising sea level and melting glaciers. Moreover, conventional energy is a finite resource (Jacobson and Delucchi, 2011). Governments recognize the problems associated with conventional energy generation and aim to integrate renewable energies in the energy generation process. Renewable energies are derived from natural sources, for instance, solar energy, wind energy, biomass energy, hydropower, geothermal energy, or tidal energy. Renewable energies are inexhaustible and environmental friendly since they provide almost zero air pollution and greenhouse gas emissions (Asif and Muneer, 2007).

Several measures have been undertaken to tackle accelerating emissions and shift more towards renewable energies. Most of these measurements target developed countries as they account for the majority of emissions (Polzin et al., 2015). However, renewable energies in developing countries have gained substantial importance as domestic governments support their diffusion. The increasing relevance of renewable energies also induces investors' attentions. Renewable energy projects offer long-term, stable cash flows with low risk. Hence, renewable energy projects present an attractive investment opportunity in developing countries (OECD, 2013; Urban et al., 2007).

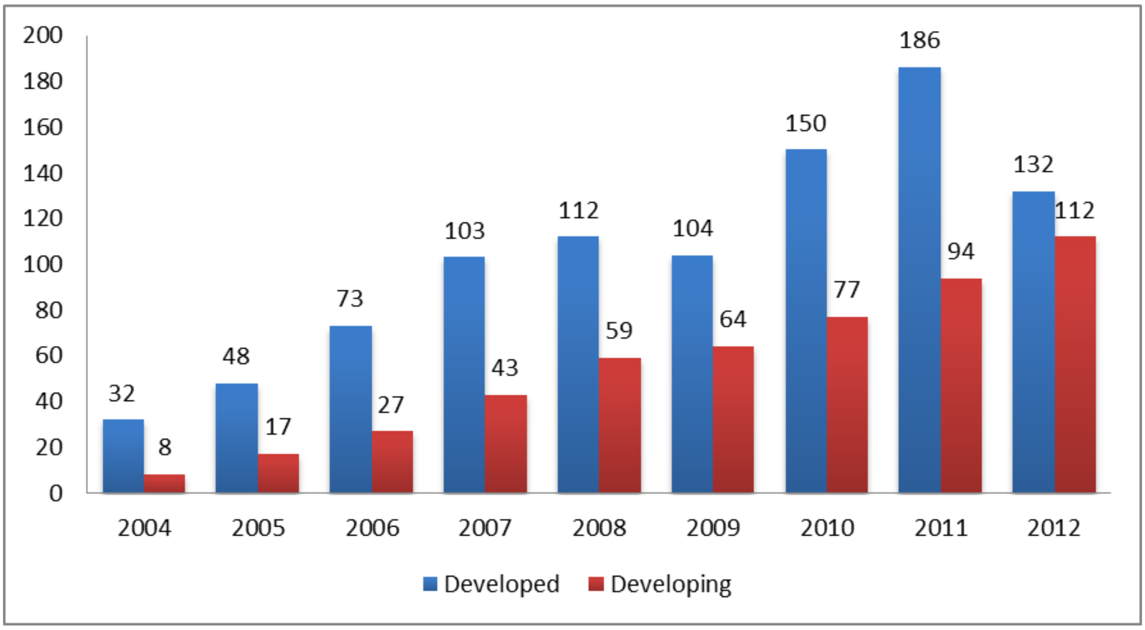


Figure 1: Renewable Energy Investments (in USD Billion) – Developed vs. Developing Countries (Source: UNEP Collaborating Center [UNEP]; Bloomberg New Energy Finance [BNEF], 2013)

Literature concerns the drivers for the diffusion of renewable energies in developing countries (Becker and Fischer, 2013; Pfeiffer and Mulder, 2013). Besides, research identifies barriers, which inhibit renewable energy diffusion (Eleftheriadis and Anagnostopoulou, 2015; Painuly, 2001; Reddy and Painuly, 2004). Further literature considers the financing of renewable energies in developing countries (Nelson and Shrimali, 2014; Shrimali et al., 2013). In this respect, institutional investors progressively play a key role because of their long-term investment horizons. Long-term investment horizons are crucial for renewable energy investments because renewable energies are characterized by high upfront costs (Nelson and Pierpont, 2013).

This paper is dedicated to investigating the drivers and barriers to investments by institutional investors in renewable energies in developing countries comparing India, Brazil and China. Therefore the subsequent research question arises: *What are the drivers and barriers for renewable energy asset finance of institutional investors in developing countries?*

The remainder of this article is structured as follows: Section 2 identifies the drivers and barriers for renewable energy investment in developing countries based on a literature review with a particular focus on financing of renewable energies by highlighting asset finance and institutional investors in the context of renewable energies. Section 3 introduces the case study concerning wind energy investments in India, China and Brazil defers on the drivers and barriers related to these investments which are then being discussed in section 4. The fifth section concludes the research, elaborates on policy implications, the limitations, and proposes future research potential.

2. Literature review

2.1. Drivers for RE deployment

2.1.1. Policies

A key driver for the diffusion of renewable energies is represented by governmental policies. Without the promotion of renewable energies, a technological lock-in would be likely as renewable energies are more expensive than conventional energies in their early phase of diffusion (Dinica, 2006; Foxon and Pearson, 2008). Hence, financial support policies can help to incentivize investments and make returns from investing in renewable energies more attractive. However the lack of supportive policy regimes due to the existing heterogeneity amongst investors often represents a major investment barrier. Energy policy aims to reduce that inequality by triggering the risk-return relationship for renewables (Polzin et al., 2015; Wüstenhagen and Menichetti, 2012). Major financial policy measures in developing countries include price driven policy mechanisms such as feed-in tariff (FIT) and quantity driven support mechanism such as auction-based tariffs (ABT) (Becker and Fischer, 2013).

For ABTs on the one hand, the tariff level is based on the bids of project developers in a competitive bidding process. The government opens a bidding window for certain projects, in which project developers define a price per unit of electricity at which they are financially able to accomplish the project. The project developers submitting the lowest bid execute the project. This process is assumed to be efficient since project developers submit the bids, being fully aware of their costs (Becker and Fischer, 2013; Lucas et al., 2013). However the ABT mechanism can also lead to risky bids, which are financially not sustainable. In order to avoid these circumstances, governments implement preventive measures, such as a proof of the financial capability of the project developers or the requirement of deposit guarantees of project developers (Lucas et al., 2013).

Feed-in tariffs on the other hand place a legal obligation on utility companies to buy electricity of renewable energy producers, at a premium price or rate, typically over a guaranteed period, in order to ensure that the investments by producers for renewable energy installations can be rated as stable. The extra costs are shared by all energy users. The responsible regulatory body sets the price whereas the quantity of generated renewable electricity is determined by market actors (Lucas et al., 2013). Since FITs are set by the government, they are assumed to be efficient if the government knows about the project developers' cost structures. The government needs to adapt the amount of the tariffs if the price of renewable energy projects decreases, for instance due to technological progress, in order not to overcompensate project developers and thereby create inefficiencies. As opposed to ABTs, FITs are confronted with information asymmetries between the government and the project developers (Becker and Fischer, 2013). The usage of these policy measures in developing countries varies, depending on the governments' preferences, as well as the type of renewable energy. China and India for instance rely on both mechanisms, whereas South Africa and Brazil implemented ABTs (Lucas et al., 2013).

Above all, variations in the level of risk that different policies imply for investors strongly influence variations in policy outcome (Usher, 2008). Therefore policy instruments lead to significant performance differences in form of actual investments and capacities, if investment risk is properly considered (Mitchell et al., 2006). Consequently policy makers need to influence investors strategic choices when deploying capital to influence them towards a decision for renewables when selecting amongst alternative energy projects (Wüstenhagen and Menichetti, 2012). Amongst the difficulties to judge the suitable support level for the policies, which requires adaptability to rapidly changing market size and environments, a further barrier for investment can be recognized when policies are inconsistent or provide unclear targets that are not maintained by the government (Polzin et al., 2015; Wüstenhagen and Menichetti, 2012). A very common tool used by governments in order to directly promote the development of a local renewable energy industry is the use of a local content requirement (Kuntze and Moerenhout, 2013). In a common form, this policy mandates a certain percentage of locally produced content for a specific installation of renewable energy projects within the country.

Early experiences from more mature renewable energy markets have shown that the guidance in early stages for the integration of renewables into the electricity system of a country is prerequisite for an appropriate development energy projects. The rapid obtainment of a grid connection authorisation confirmation as well as the necessary capacity to inject the power generation into the system are further drivers or barriers to RE investments (Friebe et al., 2014; IRENA and GWEC, 2013).

2.1.2.Growth potential

Another substantial factor fostering renewable energy investments in developing countries, are the countries' strong development prospects regarding population, economy, and electricity which are intertwined.

The population in developing countries is expected to increase from 5.54 billion in 2009 to 7.18 billion in 2035. In 2035, China and India are expected to account for 34% of the world´s population (IEA, 2011). An increasing number of population is connected with a rise in energy demand and since governments aim to reduce environmental harmful emissions, renewable energies become increasingly important to satisfy the rising energy demand (Asif and Muneer, 2007).

GDP growth is a sign for a prosperous economy and indicates more reserves for investments, including renewable energy investments. The real GDP growth in developing countries is expected to roughly three and a half fold from USD 30.9 trillion in 2009 to USD 106.8 trillion in 2035 at an annual growth rate of 4.9%. Throughout this period, one can observe that the real GDP of China more than quadruples from USD 9.4 trillion in 2009 to USD 41.6 trillion in 2035, the real GDP of India more than quintuples from USD 3.7 trillion in 2009 to USD 19.4 trillion in 2035, and the real GDP of Brazil more than two and a half folds from USD 2 trillion in 2009 to USD 5.1 trillion in 2035 (IEA, 2011).

Electricity demand is an additional factor to assess renewable energy investments in developing countries. The electricity demand in developing countries is expected to more than double under the World Energy Outlook´s new policies scenario from 8,024 terawatt hours (TWh) in 2009 to 19,717 TWh in 2035. The share of the developing countries' electricity demand is expected to increase from 46.6% of the world´s electricity demand in 2009 to 62.2% in 2035. Under the new policies scenario, China´s electricity demand is expected to roughly triple from 3,263 TWh in 2009 to 9,070 TWh in 2035. India´s electricity demand is expected to roughly quadruple from 632 TWh in 2009 to 2,465 TWh in 2035 and Brazil´s electricity demand is expected to roughly double from 408 TWh in 2009 to 750 TWh in 2035. Since one can observe that the electricity demand in developing countries is expected to increase substantially they offer promising investment opportunities for renewable energies (IEA, 2011).

2.2. Challenges facing adoption RE technologies in developing countries

Barriers are defined as “anything that slows the rate at which the market for a technology expands” (Owen, 2006). When perusing literature, various potential barriers are identified. However, economic barriers, as well as infrastructural barriers appear extensively in the literature (Owen, 2006; Painuly, 2001; Pfeiffer and Mulder, 2013; Tsoutsos and Stamboulis, 2005).

2.2.1. Macro-economic instability and currency risk

First, volatile inflation rates create uncertainty in the financing market leading to increased risk premiums. Furthermore instability in inflation and nominal exchange rates causes a higher real exchange rate risk for investors (Bleaney, 1996). High expected interest rates demand high borrowing costs so that financial institutions and investors might reconsider investment due to the lack of feasibility.

A second variable is the currency stability of a country (IEA, 2011; IRENA, 2012). Countries experiencing currency risk are characterized by current account deficits due to more imports than exports, or borrow capital from foreign lenders, usually with short-term maturities in order to finance public deficits or long-term projects. Currently, the “fragile five”, namely the Brazilian Real, the Indonesia Rupiah, the South African Rand, the Indian Rupee (INR), and the Turkish Lira (Badkar, 2013). Currency risk evolves out of exchange rate fluctuations that restrict private sector engagement due to comparatively higher volatility of assets with stable and predictable returns in their own currency then when converted to the currency of the investor (Nelson and Shrimali, 2014). Despite the fact that hedging instruments exist for commonly traded currencies, the private sector is reluctant to provide these instruments for less frequently traded ones. A depreciation in a currency lowers investment returns for foreign investors and makes the purchase of foreign goods for domestic firms more expensive. Therefore currency risk presents an obstacle for attracting new investments.

Third, Low national debt relatively to the GDP is a variable that indicates if the government is able to flexibly use its tax revenues for the addressing domestic needs instead of paying foreign creditors.

Furthermore the government's ability of being able to service its debt decreases and the government would be consequently required to borrow at very high interest rates. This possible inability to access credit, public finance investments would be hindered, limiting the developments of the RE industry.

2.2.2. Infrastructural challenges, grid access and authorisation

Further barriers for renewable energy diffusion in developing countries are infrastructural challenges, such as electricity access, or distribution losses. Poor electricity access correlates with high upfront costs and considerable time in order to bring the electricity and distribution network to a level, where it reasonably supports the expansion of renewable energies. Distribution losses result for instance through blackouts or electricity theft. Both issues deter potential investors (Friebe et al., 2014, 2013; IRENA, 2012; Kessides, 2012). Hence some of the actual financially viable projects are abandoned as renewable energy investors' risk that alludes to the infrastructural challenges, is classified as to high for investments under these circumstances.

Furthermore it is often the case for developing countries that suitable areas for the generation of renewables quite often face vast distances from areas of consumption within the country. These remote locations on one hand are often not equipped with the required technical level necessary to deploy renewables and on the other hand these distances lead to transmission problems to effectively transfer the energy to demand centres (Farouk, 2011). Therefore new large-scale renewable energy projects require well planned financing of grid extension as well as having sufficient transmission components in place. Delays of grid accessibility can contribute to the investors' cognition of the representation of obstacles in this aspect. Therefore governments regularly provide priority access for grid connection for renewables in order to increase attractiveness for investors and enable dispatch to the grid without obstacles.

A difficulty, considering definition of authority, arises when several ministries within a country are a factor in coordinating administration and policy for renewables (Klagge et al., 2012). Therefore on one hand the involvement of too many authorities can lead to communication problems between institutions that may inevitably lead to inefficiencies, due to confusion amongst different authority levels as well as a lack of clearly defined policies that would maximize utilization of implemented energy levels (Ming et al., 2014). On the other hand, complicated procedures and assessments for planned projects can result in high transaction and pre-project costs as well as severe delays of new projects (IRENA, 2012). These stated factors have a great influence on the cognition of a countries risk profile for financiers and on the confidence of investors that in both cases will translate in demanded risk premia that will alter the attractiveness of investments (IRENA and GWEC, 2013).

2.3. Investors' perspective on RE in emerging economies

By comparing financing conditions between developed and developing countries significant differences can be asserted. These conditions often lead to a financing perspective that is limited, triggering a greater cognition of investment risks that are magnified by countries instabilities and iniquitous institutional frameworks. This perception translates into higher borrowing costs, shorter loan terms and higher equity requirements in the developing countries (IRENA, 2012).

The main stakeholders for financing renewables in developing countries are therefore the government, energy developers that are predominantly state-owned energy companies, manufacturers, banks and capital markets. The governments role is the conducting of the renewable energy market so that that on one hand it is responsible for the establishment of a market mechanism and on the other hand the government is the architect in creating participation of intended stakeholders (Ming et al., 2014). A further important government functions is the mobilization of capital by implementing policies and incentives that shift renewable energy investments in the developing countries to a macro-level. With the provision of funding, the government targets the prevention of financing gaps (Wüstenhagen and Menichetti, 2012)

Energy developers, in developing countries, generally state owned energy companies, have the role of an active participant in the energy market that benefits from participation. These benefits can occur in the form of preferential policies in form of tax or land utilization preferences (Ming et al., 2014). The energy developers' income usually stems from electricity sales and land revenue.

Banking and capital markets can be seen in the context of renewable energy investments as policy signal receivers. The government setting of policies and the long-term planning with regard to positioning towards renewables sends out signals to capital markets that influence their attitude towards financing of projects. It is often the case that governments encourage commercial banks to offer favourable financing possibilities for companies engaging in the financing of renewables (Ming et al., 2014). Therefore long-term decisions should be made in consonance with capital markets in order to offer a sound investment environment.

The stated circumstances in developing countries are however still not filled by classic commercial banks as the challenge of offering an attractive risk-return relationship cannot be provided as the conditions offered by the bank do not meet the requirements of investors. That justifies the great role of national development banks to be first movers when investing in developing countries (IRENA, 2012). Due to that observation, financing amount for RE projects by development banks increased from USD 4.5 billion in 2007 to USD 17 billion in 2011 (Frankfurt School-UNEP Centre and BNEF, 2014).

In order to make a fair assessment about the lifetime generation costs of different energy technologies, one approach is to evaluate levelised cost of electricity (LCOE). LCOEs are calculated by adding the lifetime costs of an energy project and dividing this sum by the project´s electricity generation over its lifetime. This results in a cost per unit of electricity generated, for instance USD per kilowatt hour (KWh). By having a closer look at the composition of LCOE, one regonizes that LCOE compose of two main parts, namely technology costs and financing costs. Technology costs cover investment costs adjusted for depreciation and operational costs, whereas financing costs cover cost of equity and cost of debt (Waissbein et al., 2013).

The overall costs for renewable energy projects in developing countries are usually higher than the ones for similar projects in developed countries. The factor, which majorly impacts this difference is the financing cost. Figure 2 displays the pre-tax LCOEs composition of an identical wind energy project in a developing country versus a developed country. It is assumed that the financing costs in a developed country compose of 10% cost of equity and 5% cost of debt, compared to 18% cost of equity and 10% cost of debt in a developing country. As a premise, the projects have a given capital structure of 70% debt and 30% equity (Waissbein et al., 2013).

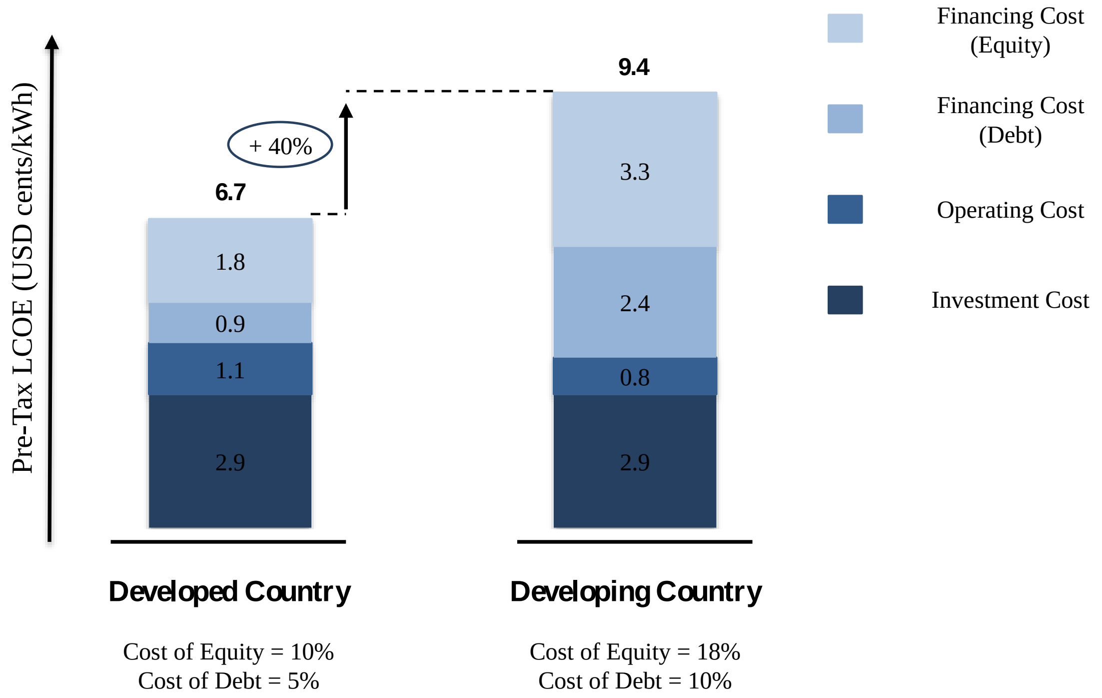


Figure 2: Cost Comparison of a Renewable Energy Wind Project in Developed Versus Developing Countries. (Adapted from Waissbein, Glemarec, Bayrakter, & Schmidt, 2013, p. 34)

By investigating the individual parts of the pre-tax LCOEs, one generally observes that investment costs for renewable energies in developed and developing countries are the same since the exact same project is executed in both types of countries. Operating costs tend to be smaller in developing countries due to for instance cheaper labor supply. Financing costs for renewable energy projects in developing countries drive up the total project costs for renewable energies since they are more than twice as high compared to developed countries (Waissbein et al., 2013).

Higher financing costs in developing countries result from higher risks, such as currency risk, political instability, or inflation risk. Since renewable energy projects typically face high upfront investment costs, high financing costs deter potential investors in developing countries by enhancing the overall project costs. A higher financing risk can also contribute to investors and financiers to hesitate in the provision of capital, which leads to illiquid markets for renewable energy project finance. Therefore, although in renewable energy project financing long-term loans are required, banks often only give out short-term loans in order to manage lending risk (Shrimali et al., 2013). The higher risks in developing countries make investors require higher returns and lenders require a higher share of equity in the projects as a buffer against losses. Since the cost of equity is higher than the tax deductible cost of debt, financing costs increase further. All these risk associated factors exacerbate the diffusion of renewable energies in developing countries (Nelson and Shrimali, 2014).

3. Methods

3.1. Research design

In order to derive the drivers for renewable energy asset finance of institutional investors in developing countries, the author conducts a case study in order to undermine theoretical findings and deploy new hypotheses. A case study aims to investigate a current phenomenon within its real-life context, especially when the limitations of the phenomenon are not clearly defined (Yin, 2009). It can be defined as “an intensive study of a single unit for the purpose of understanding a larger class of (similar) units”. When selecting a case, practitioners need to ponder between the dimensions of representativeness and useful variation of the sample (Seawright and Gerring, 2008).

3.2. Case study: Wind energy investments in India, Brazil and China

The selection of India, China and Brazil can be justified by the fact that these BRICS countries show great commitment and dynamics of investments in recent years that allow enough data to produce valuable results. The choice of the wind sector was undertaken as wind power represents a major renewable energy source whose investment development are sensitively triggered by external influences. Furthermore these countries engaged in wind industry to a comparatively great extent.

Concerning the new investments in renewable energies worldwide in 2012, China was ranked first with USD 64.7 billion, India seventh with USD 6.4 billion and Brazil nineth with USD 5.3 billion (Frankfurt School-UNEP Centre and BNEF, 2014). Considering asset finance of renewable energy, one recognizes that developing countries play an important role in terms of investment volume. This can be emphasized by the fact that among the top ten countries worldwide in terms of renewable energy asset finance investment volume in 2012, China, India and Brazil were ranked first, third, and sixth respectively. China denoted an investment volume of USD 57.7 billion, India´s investment volume amounted to USD 6.4 billion and Brazil registered an investment volume of USD 5.1 billion. These four countries alone accounted for around 50% of the total asset finance investments of renewable energies in 2012 (Frankfurt School-UNEP Centre and BNEF, 2014).

India accounts for the fifth largest power generation capacity worldwide. In 2013, India´s total installed power generation capacity amounted to 224 gigawatt. By having a closer look at the development of the installed generation capacity over time, one can observe a rapid growth of renewable energy production. Thereby, the government´s different five year plans, which were introduced after India became politically independent in order to trigger economic development, represent useful milestones for the observation. Figure 3 shows that over the years, renewable energy expansion proceeds rapidly and renewable energy plays an important role in the energy mix. Remarkably, over this period of 10 years, the capacity of renewable energies is projected to more than sevenfold from 7.8 GW in 2007 to a planned level of 54.3 GW in 2017 with a compound annual growth rate (CAGR) of 21.4%. In 2013, India denoted a total installed capacity of renewable energy at the amount of 28.1 GW. Wind energy is the predominating renewable energy source with 19.09 GW (67.9%).

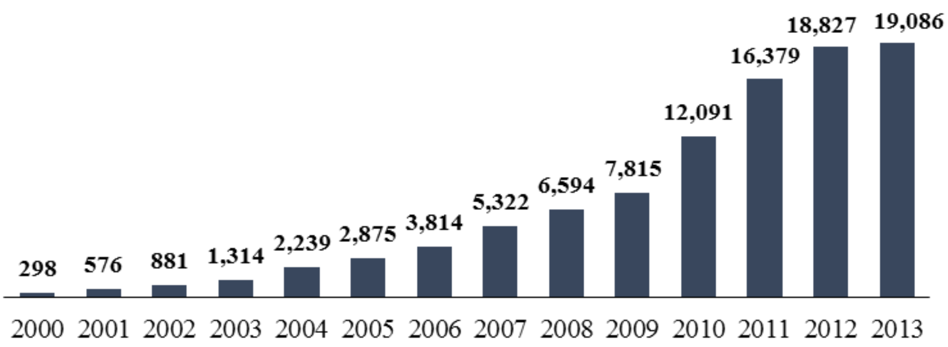


Figure 3: Total Aggregated Installed Capacity of Wind Energy by Institutional Investors in India From 2000 to 2013. Own illustration. Data based on Bloomberg New Energy Finance, 2013

Brazil possesses historically one of the cleanest energy matrices in the world with a RE share in electricity generation of 85% including large-scale and the world's fourth largest power capacity for renewable energies (IRENA, 2012). In the last decade Brazil has experienced strong economy growth with average GDP figures of about 4.3% since 2000. Main forces behind that GDP growth were a constantly growing population (World Population Review, 2014). Total energy capacity of installed plants amounts to approximately 96 GW. One of the main motifs why Brazil is aiming to diversify its energy portfolio towards wind energy was the energy crisis between 2000 and 2002. The crisis illustrated the present energy insecurity for the Brazilian market which represented a in the years of the crisis a major obstacle to investments and correlated growth figures (IRENA and GWEC, 2013). Furthermore it is expected that due to the stated growing and young population, the energy demand is expected to rise by 60% in the next decade, requiring a substantial amount of additional energy investments.

One important focus in order to diversify its RE matrix is the concentration on the wind energy sector. Brazil has accumulated wind capacities at a rapid pace between 2005-2012. Whereas in 2005 nearly no wind energy existed (29MW), the growth figures accelerated so that at the end of 2012 total installations amounted to 2,5 GW and the market is expected to continuously increase with annual installation growth figures of about 2 GW (IRENA and GWEC, 2013). The Brazilian National Development Bank is the dominant actor in RE finance. The BNDB provides financing at lower costs with the requirement for the borrowers to meet implementation deadlines and provide the required licenses for RE installation. The central role of the BNDB encouraged a rapid expansion of the local supply chain and is thereby a successful actor in Brazil's RE market. The relatively rapid development of Brazils wind industry has its origin in increased investments over the last decade. Figure 4 represents disclosed transaction values in the Brazilian RE market between the years 2002-2012.

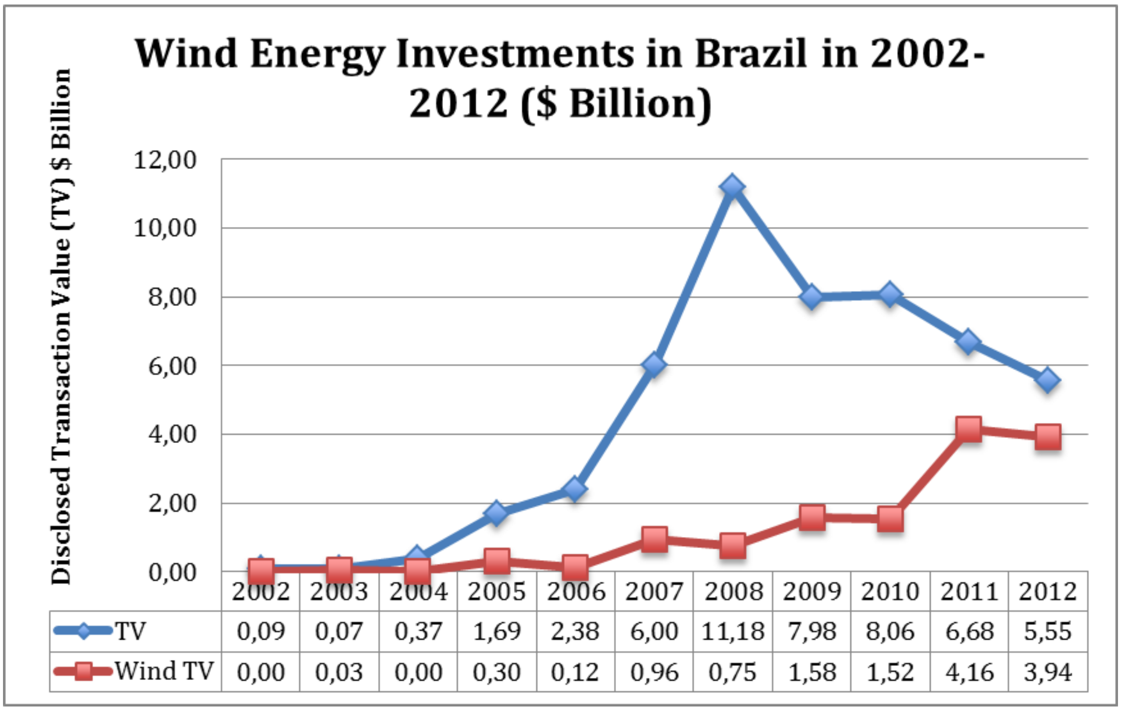
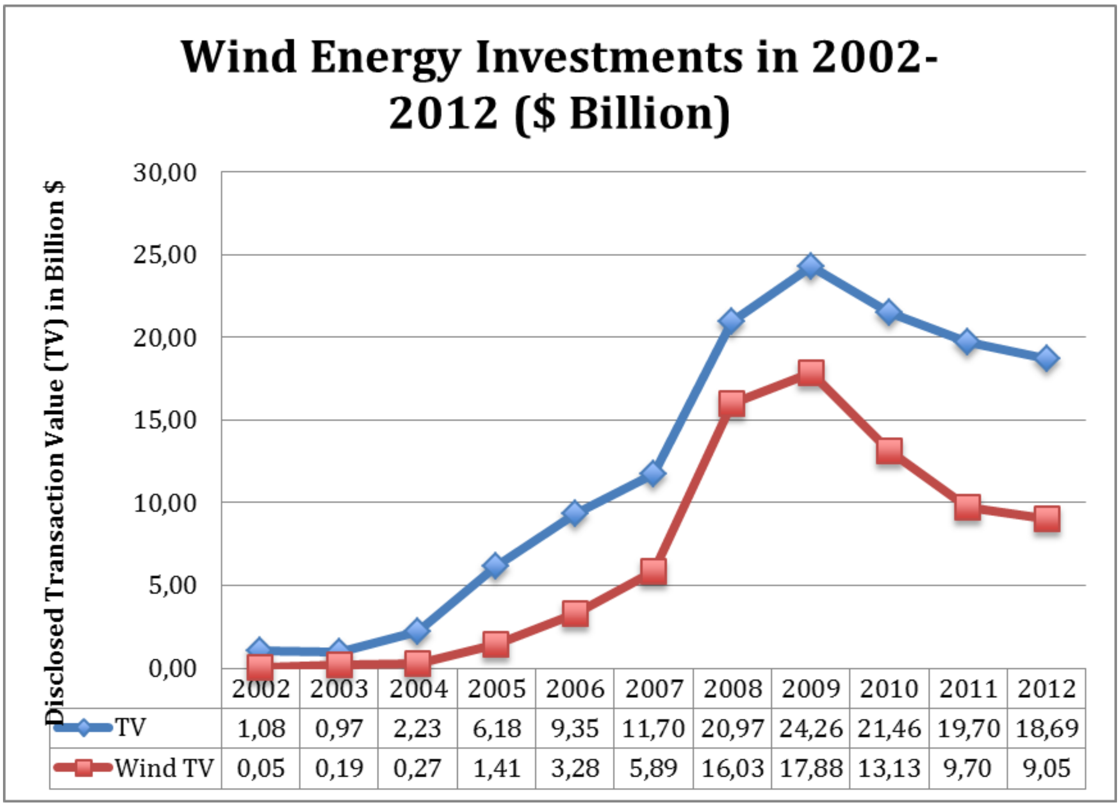


Figure 4: Wind energy investments in Brazil 2002-2012 (in bn USD) Source: BNEF, 2013

The wind energy sector of China has grown at an extraordinary pace during the last decade. Hence the world's largest producer of carbon dioxide also became the biggest wind energy market of the world. The significant accumulating capacities in the recent years. By the end of 2012, Chinas wind power installation size amounted to 75 GW and contributed to 28,9% of new global installed capacity in 2012 (IRENA and GWEC, 2013). The wind power and manufacturing sector has been developed under the guidance of the central government for a long time explaining why China's wind power financing mode is typically government oriented (Ming et al., 2014). The rapid cycle of technological and institutional learning in wind energy is confirmed by the fact that by 2011 four of the ten biggest wind turbine manufacturers originate from China. Public banks supply approximately 74% of financing. China Development Bank plays a consistently important role in the wind energy sector, demonstrated by the fact that more than a third of currently installed capacity, originates from it. The main financing channels for its wind power sector are bank loans, stock market and bonds (Ming et al., 2014). The significant growth figures of the Chinese wind industry and their correlated capacity increases have their origin in growing investment amounts over the past years (Figure 5).



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
TV	1,08	0,97	2,23	6,18	9,35	11,70	20,97	24,26	21,46	19,70	18,69
Wind TV	0,05	0,19	0,27	1,41	3,28	5,89	16,03	17,88	13,13	9,70	9,05

Figure 5: Wind energy investments in China 2002-2012 (in bn USD) Source: BNEF, 2013

3.3. Data Collection

This case study is primarily based on data about asset financed projects of institutional investors in the wind energy sector. Data was collected primarily from two sources: First archival documents and country reports as well as data on RE investments drawn from Bloomberg New Energy Finance, one of the most comprehensive database in the field (BNEF, 2013; Frankfurt School-UNEP Centre and BNEF, 2014). The overall goal of the case study is to figure out potential drivers and barriers for renewable energy asset finance of institutional investors in the wind energy sector in India, China and Brazil by comparing these drivers and barriers against the dependent variable aggregated installed capacity (BNEF, 2013; Frankfurt School-UNEP Centre and BNEF, 2014).

The comparative method allows the intensive analysis of a finite selection of cases that can be compared and evaluated in an in depth manner. The sample is investigated with respect to wind energy, which is especially interesting since these types of renewable energies accounted for the largest share of asset finance in developing countries in 2012 (Frankfurt School-UNEP Centre and BNEF, 2014).

3.4. Data Analysis

The case study is structured in a way that it firstly depicts the patterns of institutional investors in the Indian, Chinese and Brazilian wind energy sector. The patterns focus on the aggregated installed wind energy capacity, as well as on elucidating the three largest institutional investors in the solar and the wind energy sector in more detail. Thereafter, the case study identifies potential drivers and barriers. The examined drivers are policies, and electricity generation, whereas the barriers are currency risk, and infrastructural barriers (financing and institutional structure).

We systematically evaluated the collected archival documents and investment data. We analysed the material according to the research question concerning drivers barriers to the uptake of innovative RE. In this process we identified the following main topics as drivers respectively barriers:

- Legal framework (including policies)
- Institutional framework (including infrastructure)
- Macro-economic factors (including currency risk, debt and growth potential)

4. Results: Factors affecting the RE investments in India, China and Brazil

4.1. Legal framework (including policies)

4.1.1. India

One of the first measures for the promotion of renewable energies in India was set by the Electricity Act, which was ratified in 2003. This legislation aims at transforming the domestic electricity sector (Bhattacharyya, 2005). Next to consolidating the laws related to generation, transmission, and distribution of electricity, or promoting competition in the Indian electricity sector, the Electricity Act also summons the state electricity regulatory commissions (SERCs) to "promote cogeneration and generation of electricity from renewable sources of energy by providing suitable measures of connectivity with the grid and sale of electricity to any person" (Thakur et al., 2005). Morevover, the Electricity Act requires a certain percentage of the energy consumption to come from renewables and it creates the base for further policies, which are among others the National Electricity Policy and the National Tariff Policy (see Table A.1).

The National Electricity Policy was passed in 2005. It emphasizes the importance of renewables in the energy generation and states that efforts need to be made in order to reduce the capital costs of renewable energy projects. Besides, the National Electricity Policy mentions that this can be achieved through increased competition in the projects by making use of competitive bidding mechanisms. Since renewable energy technologies are not yet able to compete on a price level with conventional energies, the SERCs set differential tariffs for renewables (Abdullah, 2011).

The National Tariff Policy, which came into being in 2006, further elaborates on the Renewable Purchase Obligations (RPO) for renewable energies. The RPOs have been previously referred to in the Electricity Act and in the National Electricity Policy, however the National Tariff Policy firstly becomes concrete about it. RPOs necessitate "distribution licensees, captive power consumers, and open access consumers to purchase or generate a certain percentage of their total electricity requirement from appropriate renewable sources" (E&Y, 2013). The National Tariff Policy requests the SERCs "to fix a minimum percentage for purchase of energy from such sources taking into account availability of such resources in the region and its impact on retail tariffs" (Ministry of Power, 2006).

In 2008, India released the National Action Plan on Climate Change (NAPCC), which consists of eight missions, confronting environmental issues concerning greenhouse gas emissions and emphasizing India´s need to adapt to the climate change and promote ecological sustainability. The NAPCC declares a renewable energy purchase target of 5% (total grid purchase) by 2010, which should be enhanced by 1% per annum until 2020. This implies that India would generate 15% of its energy from renewables by 2020 (Prime Minister´s Council on Climate Change, 2008).

Additionally, the Renewable Energy Certificate (REC) was established in 2011. RECs try to overcome the mismatch between availability of renewable energy resources and the requirement for several parties to meet the RPOs. A REC is a tradable certificate for each MW of renewable energy fed into the grid and is traded via an exchange. One certificate is valid for one year. The RECs help the obligated entities to fullfill their RPOs (Kumar and Agarwala, 2013).

One generally observes that the introduction of new policies leads to increases in the installed capacity of wind energy. When the Electricity Act was for instance introduced in 2003, the installed wind energy capacity rose in the year after by roughly 70%. In the year after the introduction of the National Electricity Policy and the National Tariff Policy, the installed wind energy capacity increased by around 33% and 40% respectively. In the year after the ratification of the NAPCC, installed wind energy capacity increased by 19%. In the year after the introduction of REC regulation in 2011, installed wind energy capacity rose by 15% (BNEF, 2013).

4.1.2.China

The Chinese government also set significant laws and targets either specifically or inter alia, for the development and the investments into the wind energy sector (see Table A.2). In 2001 the government halved the value-added tax for renewables from 17% down to 8,5%, however the wind industry continued to develop slowly due to unclear policy support and costs that exceeded the ones by conventional energy investments so that disclosed transaction values were still very low (Figure 4). In 2003 the government started to initiate the market-based mechanism of concessions tendering by commercializing the domestic wind energy sector by competitive bidding, thereby guaranteeing demand and competition among wind power operators (Liu and Kokko, 2010). The bidding process specifically promoted domestic investments by requiring 70% of local content requirement for the wind projects. The problem related to the implemented bidding system was that it favoured companies that placed bids at extremely low prices, mostly stated owned enterprises, that placed bids at such low prices that outrivaled and prevented private or foreign companies to stay in the market as prices were economically unfeasible so that it came to severe investment delays (Junfeng, 2012). On the other hand the high requirements of domestic contents strengthened the domestic early stage wind industry as 2004 18% of all wind turbines were produced domestically (IRENA and GWEC, 2013). The introduction of the Renewable Energy Law in 2006 provided the first legal framework for the operation and developments of RE in China. The law paved the way for grid companies to prioritize in renewable energy rather than other power sources and provided the basis for follow-up supporting regulations. In 2007 the Medium and Long-Term Development Plan illustrated intensified government commitment by setting renewable energy targets, including wind. The ambitious setting of targets stipulated that by 2010 (10%) and 2015 (15%) of energy consumption should be provided by renewables, and 30 GW of wind power. The maintenance of 70% local content requirement lead to an establishment of international companies, setting up their independent manufacturing facilities or their joint ventures with local companies in China (IRENA and GWEC, 2013). These structural changes combined with the setting of ambitious targets, that enhanced investors confidence towards risk, were followed by strong increases in RE investments that are visible via the nearly exponential rise in disclosed transaction values after 2006 as the figure approximately doubled within two years from USD 9,35 billion to USD 20,99 billion in 2008 (Figure 5). The amendment of the Renewable Energy Law in 2007 restated that the grid companies should absorb the full amount of renewable energies that is produced and will subsequently have the option to cover their extra integration costs via a newly established Renewable Energy Fund. This fund should ease financing of renewable energy projects by a surcharge per kWh. This surcharge is then pooled (with other national funding sources) into the RE fund to finance renewable energy projects inter alia for wind energy (Xinhua, 2009).

In 2010, the Chinese government introduced a feed-in tariff for wind power generation. The experience gained from the competitive bidding processes in the previous years set the basis for the introduction of suitable tariffs. Hence, tariffs were established in four different categories, ranging from USD 0,08/kWh – USD 0,10/kWh, according to the wind endowment of the region. The prices were significantly higher than prices experienced by the bidding system. Despite a successful implementation of the feed-in tariffs and the removal of the 70% content requirement, the global financial crisis and the experienced problems when connecting completed projects to the grid lead to a decreasing level of disclosed transaction values after 2010.

In 2012 the government continued their ambitious target setting by the planned accumulation of total capacity of 138 GW of wind power by 2020 (IRENA and GWEC, 2013). Further targets were the share-increase of renewable energies of primary energy consumption to 11,4% and even to raise the share of installed generating capacity to 30% by the end of 2015. Furthermore the government recently doubled the Renewable Electricity Generation Bonus to $2,40/kWh increasing the attractiveness for RE investments even more.

By the end of the 1990s the Chinese government recognized that the institutional framework was too bureaucratic and lead increasingly to coordination failure and investment constraints. Structure of the energy factor had policy processes implemented that have been perceived as “protracted, disjointed, and incremental” and had a fragmented authority level in place. This “fragmented authoritarianism” led to inter-ministerial competition and disjointed policymaking (Lieberthal, 1992). Furthermore purchase power agreements (PPA) were negotiated on a plant by plant basis that intentionally should reduce risk for investors that engaged in wind power development as the grid companies were obliged to purchase electricity output (Lema and Ruby, 2007). However the risk reduction did not occur due to the fact that the majority of developers were state-actors, so that the risk was simply transferred within respective government units. As the PPA did neither have sanctions implemented for grid companies that were unwilling to pay the higher prices nor the PPA had formal law status (Lema and Ruby, 2007). These consequences lead to an investment environment that has been perceived as uncertain and fragmented, so that 95% of power project investments in 2003 originated from the government. The consequences of the uncertain environment were directly translated into a perceived unfavourable risk-return relationship by investors so that disclosed transaction values for wind energy showed nearly no increase until 2004 (Figure 4). The government reacted to the lack of investor's confidence by the innovative reformation of the power sector (Lema and Ruby, 2007). Therefore the power sector reform transformed the centrally planned and state owned industry towards an industry with ownership varieties in power generation as well as introduced competition gradually (Cherni and Kentish, 2007). On the transmission side the two nationally owned grid companies, the SGCC and the CSPGD, were formed. On the power generation side, the CSPC was dissolved into five large power generation companies: Huaneng Group, Huadian Corporation, China Datang Corporation Guodian Corporation and China Power Investment Group. As part of the restructuring it came also to a recentralization of the administrative authority so that created the NDRC (today NEA), with full responsibility to move away from fragmentation towards a "coordinated policy model" (Lema and Ruby, 2007).

Today, despite the reformation, bureaucratically insufficient processes such as the wind project approval system are still in place. This approval system is not only multifaceted and complicated it is also expensive and time consuming. Average costs of pre-project installations are estimated to amount to 2-3 million Yuan and the approval process at least requires one-year time (Ming et al., 2014). Until 2009 the transmission networks were not fully utilized and hence the barrier was not recognizable, signified by steady and rapid investment growth rates (Figure 4). However especially in the last three years the situation concerning the stated long lasting and expensive approval requirements deteriorated as partly finished projects were left unused or were even abandoned. This occurred as the issue of accessing the grid, was never considered by any level of authority (Ming et al., 2014). Consequently investors awaited for future developments of the situation so that the last three years showed a stagnating investment trend as risk-return judgment occurred with the inclusion of the path dependent events of transmission capacity constraints.

4.1.3. Brazil

In 2002 it came to a major breakthrough in legal orientation of the Brazilian energy sector towards the promotion of RE (Table A.3). The implementation of the Programme of Incentives for Alternative Electricity Sources (PROINFA). The scope of PROINFA extended to wind power, biomass and small hydropower plants and was divided into two respective stages. Stage one contained the introduction of a feed-in tariff scheme with a capacity volume of 3,3 GW that were equally distributed amongst the three renewable sources, thereby offering the first legal basis for wind energy investments in Brazil. The programme was based on a guaranteed 20-year PPA with the dominant energy operator Eletrobas. Eletrobas guarantees in the long-term electricity purchasing contracts a minimum purchase price for wind energy of 70% of contracted energy during the financing period as well as a full coverage to exposure risks to the short-term market, thereby setting up a sustainable base for investors confidence. Furthermore the nationalisation index required that at least 60% of manufacturing equipment for the newly installed wind power projects came from the domestic market (IRENA, 2012). The efforts to especially encourage the investments of national origin appeared to be quite ineffective as disclosed transaction values did not increase at all until the year 2006 (Figure 3). Amongst the barriers were complex bureaucratic issues as well as difficulties in grid connection, which were already discussed in previous sections. The high local content requirements lead to increased demand of locally produced wind turbines the Brazilian steel industry, dominated by a single supplier, experienced a great upward pressure on steel prices, so that imported steal would have provided the wind turbines at much lower costs. The upward price pressures and administrative barriers and the lack of clear long-term commitment policies to wind energy undermined the investments visibly.

However the global and local industry attempted to identify the bottlenecks and barriers to wind energy development and investments by working closely together with regulators so that in 2009 the Electric Power Auctions for Wind Energy have been established. The introduced auctioning system represented directive government change from the aim of the increased diversification of the energy matrix to the aim of the provision of energy security via a cost-effective auctioning system. Initiated by that auction the investments into wind energy showed their fastest growth ever experienced, visible by more than doubling the disclosed transactions of $1,52 Billion in 2010 to $4,16 billion just one year later (Figure 3). The auction commercialized 1.8 GW of wind power that was implemented by the end of 2012 (Frankfurt School-UNEP Centre and BNEF, 2014). The competitive price bidding by the auction significantly indicated that wind power in Brazil were underpricing natural gas-fired power projects by three US-dollar ($62/MWh) due to the offering of the globally lowest tariffs for wind generators on a market-wide basis. Despite the fact that the architecture of the bidding system had the consequence that only serious players were able to compete in the market with its very low prices of winning bids, it appeared to be a milestone for energy investments in the country. As the wind industry became more mature, the government dispensed the domestic manufacturing requirement.

Despite this undertaken step, the disposition of still high import tariffs of wind turbines encouraged major foreign producers to establish their business within Brazil, contributing to the reduction of project development costs. Furthermore the lack of investors confidence has been overcome by the establishment of the *Plan for Energy Expansion* by the MME that sets in increase in wind energy capacity target to 6 GW by 2019.

4.2. Institutional framework (including infrastructure)

4.2.1. India

In India distribution losses in absolute terms increased by 36% until 2010 from a level of 155 billion KWh to 211 KWh, which matches a CAGR of 3.1%. Since the CAGR of total net electricity generation in India was higher, with a value of 5.8%, total distribution losses relative to total net electricity generation decreased throughout the observation period. In 2000, percental distribution losses amounted to 29.3% and decreased by six percentage points to 23.3% in 2010 (EIA, 2014). Distribution losses portray a sign of grid inefficiency and impede renewable energy investments if the value is as high as in India, where on average roughly 25% of electricity generated does not reach the final consumer (EIA, 2014; Kiss, 2009, p. 23).

Furthermore, one can observe a correlation between low growth rates of distribution losses and sharp increases of installed wind energy capacity and positive growth rates of distribution losses and extenuated increases of installed solar and wind energy capacity. In 2004 and 2007, total distribution losses slightly rose by 1.1% and 1.6% respectively. In these years, installed wind energy capacity ascended by 70.4% and 39.5% respectively, denoting years of strong increases (EIA, 2014; BNEF, 2013). Above all, there seems to exist an inverse correlation between distribution losses and installed solar and wind energy capacity. Hence, author assumes distribution losses as a barrier for renewable energy investments of institutional investors in India.

4.2.2. China

China can be regarded as a country with favourable natural conditions for the production of wind energy. These potentials 253 GW per year (China Meteorological Administration [CMA], 2006) are mainly located in the north of China. As the distance between the main production (north) and consumption areas (south-east) are enormous, China faces capacity transmission problems (Liu & Kokko, 2010). The transmission and distribution networks extension is not reaching all RE areas and is partly also too weak. Even where a connection exists and a purchasing power agreement (PPA) has been agreed, bottlenecks that prevent RE dispatch to the transmission network (Westlake, 2004). A further problem is associated to the reluctance of the grid companies to invest further into extensions of the grid due to fixed sales prices by the government that are too low to pass on the costs and to make network enhancements. This consequently resulted in the delay of some projects by several months before being connected to the national grid.

The *Renewable Energy Promotion law*, which came into effect on January 1st 2006, partly addresses the perceived problem of grid infrastructure and transmission. Article 143 of the law mandates grid connections for suppliers of renewable power. The law can be seen with the focus on grid connection as an important step in order to reduce investor's uncertainty and to improve grid infrastructure seen by the accelerating increases in overall transaction value of RE investments in general as well as the wind energy sector after 2006 (Figure 4). However the law failed to specify a timeframe in which the grid companies should make grid enhancements. Furthermore grid companies became liable for extremely high costs for strengthening the network. Therefore in 2009 it came to amendments, such as the legal binding of electricity grid to buy the whole renewable electricity generation and to guarantee priority power dispatching to power from renewables. Furthermore the unspecified targets are revised with the responsibility of the State Council energy and finance departments to collaborate with the State Power Regulatory Agency to design annual renewable energy power generation targets. Despite further improvements of infrastructure that translate to investors attractiveness and related increases in investments (Figure 5), at the end of 2011, wind farms and transmission projects with a capacity of about 7,2 GW are under construction, did not meet the conditions of being connected to the grid (Ming et al., 2014).

Conclusively it can be said that the expansions of the electricity grid has not kept pace with the enormous developments and high rates of investments into wind power projects and the correlated annual wind turbine installations so that completed wind projects had no transmission access, which is one of the causes that lead to lower investment levels, a fall in disclosed transaction values, in the past three years compared to levels experienced in the years between 2007-2009.

4.2.3.Brazil

It is estimated that Brazil possesses a huge technical wind potential that accounts for the generation of about 143 GW compared to the currently installed amount of 2,5 GW. A further driver for prospective wind projects is the experienced energy insecurity due to several years of low precipitation. The historical high dependence of about 80% on hydroelectric power generation combined with the low rainfall periods as well as the difficulty to enlarge hydro-power capacities, highlighted the need for diversification to ensure consistent energy security (IRENA; GWEC, 2013). One of the most suitable endowments and advantages for wind energy in Brazil is, that low rainfall seasons coincide with high wind seasons and vice versa. Despite the theoretical perfect fit for the enlargement of wind power in Brazil's energy matrix, the infrastructure that apparently lacks the ability to connect the increasing wind projects developments to the grid, signifies a barrier that is considered by investors at capital expenditure. The discovery of this barrier results out of the fact that the majority of Brazils wind potential is located in the northeastern part and lacks necessary and sophisticated infrastructure so that until 2006 this was the main considered constraint for investments (Figure 4). Due to the lack of transmission lines, 600MW generation potential of established wind projects have been offline in 2013 so that the country was forced to use standby oil, diesel and natural power generators instead in order to ensure energy security. Furthermore the government was obliged to cover up the financial loss experienced by the contracted wind companies that were unable to sell the power, paying around $150 million (Spatuzza, 2013). Another problem that restricts transmission line installations are the skyrocketing leasing and land prices demanded by the landowners in the affected regions when installing wind turbines. Although developers receive government reimbursement for unsold capacity due to transmission line delays, costs for land leases are not covered. These two stated phenomena illustrate a definite barrier for RE investments and can be depicted as a major factor that lead not only to falling wind energy investments but also to overall declining renewable energy investment figures since 2011. The national wind power association *Abeeolica* estimated that at the end of 2014, 1.3 GW will not be connected to the grid. The infrastructure limitation is a major barrier from the perspective of potential future investments, already translated into auction limitations in 2013: The initially registered 16GW of wind power for the wind power reserve auctions were decreased by new grid rules down to 9GW of potential participation, to guarantee the connection of new wind projects to the grid by 2015 (Spatuzza, 2013). Due to that revised rules, it is estimated that investments of about $157 million have been lost as wind companies partly scale back their initial investment plans. The Brazilian developer Bioenerg*y*, for instance, abandoned their planned investments in the north-eastern state of Rio Grande do Norte because of lacking grid connection. Although the limitation of the auction in order to ensure full connection of new wind projects, a solution for the long-term planning towards raising the wind power capacities and related investments has not been found so far. In order to avoid further connection delays, the government plans that wind farm developers should be responsible for the development of new transmission lines in future auctions lead by the government.

Until 1995 the Brazilian electricity sector was predominantly run as a public sector monopoly, dominated by a single state-owned enterprise: Eletrobas. The reductions of the state-presence by partly privatizing previously state-owned companies, the monopolistic characteristics were replaced by the transformation towards a competitive market (Wanderley et al., 2011). Therefore on one hand the production chain has been divided the activities into Generation, Transmission, Distribution and Commercialization, and other hand the power sector reform privatized the respective sectors successively (Gastaldo, 2009). The new reform created two individual environments of energy trade: The Free Trade Environment (ACL) and the Regulated Trade Environment (ACR). In the ACL only free consumers can participate for renewable energy and are able to directly negotiate from whom they will buy their energy supply. In the environment of the ACR, which is specifically designed for distribution companies, energy supply is sold through auction systems. This transformation of the energy sector enabled the first participations of private companies and paved the way for investments since 2002 (Francisco, 2012).

A major barrier that is facing the investments environment of the wind industry is the necessary approval if environmental conditions are met. Here the ANEEL is required to verify whether the projects of successful bidders conform to environmental standards and are consequently able to get a required licensing. These strict and bureaucratic licensing processes are a key cause for delays of energy infrastructure projects, especially where transmission lines have to cross very long distances (Spatuzza, 2013). The state-controlled generation and transmission company *Chesf* for instance failed to deliver the majority of its transmission lines and was fined with a penalty payment $4 million by ANEEL. Overall the wind energy sector is facing a serious backlog of delays in recently auctioned transmission lines that are even expected to increase in the future. It is estimated that in June 2013, about two-third of 27.000 kilometres of lines under construction in due time were behind schedule in 2013 (Spatuzza, 2013).

Further administrative barriers due to the institutional framework that possibly prohibit investments have been experienced when obtaining the Declaration of Public Utility (DUP) for projects. The DUP is a qualification that initially has the aim to facilitate the use of the assets and rights affected by the projects (IRENA; GWEC, 2013). These implemented planned simplification tool to overcome the complicated terms of use, occupation and disputes between landholders and owners, illustrate an investment barrier: On one hand the DUP was not specifically enough adapted to local circumstances and on the other hand it leads to huge time delays of projects.

4.3. Macro-economic stability (currency risk) and growth potential

4.3.1. India

As delineated in the second section, population growth, GDP growth, as well as electricity demand seem to indicate enhanced renewable energy investments. Population growth translates in electricity generation growth since an increasing number of people demand more electricity. Furthermore, GDP is nearly perfectly correlated with electricity generation (IEA, 2011). Therefore this part particularly investigates electricity generation as a potential driver for renewable energy investments as a representative for the group of growth potential.

When comparing the development of net electricity generation with the development of aggregated installed capacity of wind energy by institutional investors, one recognizes increases in each year over the observation periods. Aggregated installments of wind energy capacity with a CAGR of 41.3% from 2000 until 2012 (BNEF, 2013). The higher growth rates for the renewable energies can be attributed to the fact that these technologies are still in an early phase where growth rates are generally higher as compared to more mature phases. A positive correlation between electricity generation and renewable energy installments can be further underlined by the fact that one can observe the largest absolute increases for electricity generation (81.31 billion KWh) and aggregated installed wind energy capacity (4,288 MW) in the same year, 2011, indicating that they move in line (BNEF, 2013; EIA, 2014).

When looking at the full picture of growth potential, one observes a population growth at a CAGR of 1.4% and a GDP growth at a CAGR of 11.9% in India from 2000 until 2012 (The World Bank Group, 2014). Due to the fact that energy and in particular electricity access is scarce in India (roughly 25% of the population did not have electricity access in 2011), people are likely to spend additional income on basic needs, such as energy, which contributes to poverty alleviation (Asif and Muneer, 2007; IEA, 2011). Since the Indian government targets through policies, such as the Electricity Act, to satisfy an increase in energy demand progressively through renewable energies, the intial GDP growth correlates with a higher demand for renewable energies (Shrimali et al., 2013). This in turn attracts renewable energy investors.

One potential risk for renewable energy investments in India is represented by currency risk, which was classified in the second section under economic barriers. Currency risk is significant for foreign investors who invest in projects with INRs or lend INRs for project financing. Moreover, currency risk arises for developers of renewable energy projects who are dependent on certain materials from other countries, which are not domestically produced, and hence need to be paid in another currency (Sergie, 2014).

From 2000 until 2013, the exchange rate of the INR against the USD rose from 43.6 to 53.3 and experienced major fluctuations. Overall, over the period from 2000 until 2013 the exchange rate increased by 22.2%. This shows that the INR depreciates concerning the USD and that the currency risk is inherent in India. The presence of currency risk in India can be further underlined by the fact that the INR was categorized among the “fragile five” by Morgan Stanley in 2013, representing the currencies of five of the most powerful developing countries, which are under severe pressure against the USD (Badkar, 2013). These extenuated growth rates for installed solar and wind energy capacity in the years of significant depreciation of the INR against the USD indicate that currency risk might impede renewable energy investments of institutional investors. When looking at the overall development of the installed capacity of solar and wind energy from 2000 to 2013, the currency risk does not seem to have significant effects on the investments of institutional investors. As analyzed in the patterns of renewable energy investments, this might be due to the fact that the majority of the largest institutional investors in the wind and solar energy sector are based in India and hence are not largely affected by currency risk.

4.3.2. China

The performance of the Chinese economy is primarily driven by the rapid development of China’s export and its dynamic investment environment. One of the causes triggering these developments of a stable investment environment was the gradual modification from a centralized and completely fixed exchange rate system towards a pegged exchange rate system (Paula, 2006). In this system the currency value of Chinas currency, the Renminbi (Yuan) is fixed against the value of another single currency, in Chinas case, the US-dollar. Starting in 2005, the Yuan was pegged to the US-dollar at 8.28. However pressures by Chinas trading partners demanded the Yuan to constantly appreciate. Despite the fact that this gradual slow appreciation was stopped for two years (2008-2010) due to the financial crisis as worlds demand for Chinese products collapsed, the Chinese Yuan is today pegged at 6.2 US-dollars. The currency is now allowed to fluctuate between a fixed band of 2% to the US-dollar. This stable currency offers a stable environment for investment decisions for the Chinese market and investors judged it as secure so that investments into wind energy and renewable energy in general enhanced (Figure 4). Nevertheless China managed to keep interest levels in a very stable range since 2000 (4% -7.5%) so that borrowing conditions for investing into renewables could be considered as favourable. Although inflation rates experienced a considerably higher degree of fluctuation, in most of the years above the set targets set by the Maastricht Treaty EU targets of 2%, the domestic target managed to overcome relative price increases and prevented the loss of purchasing power. Furthermore China was able to keep government debt to GDP at levels that signify the strong ability to service their debts with debt percentages under 20% until the years after the financial crisis. Overall, China succeeded in establishing a stable economic base that allows for profitable investments and does not represent a barrier when considering investing in the Chinese market.

4.3.3.Brazil

Since the beginning of the 1980s Brazil showed low and volatile growth with an average GDP figure of 2,2% until 2006. This slow economic growth has been the result of high inflation; external vulnerabilities caused by the financing needs of the balance of payments and has been the result of very high interest rates of about 11% between 1999-2006 (Paula, 2006). Brazil moved towards more market friendly liberalization policies such as the adaption of a floating exchange rate regime and an inflation-targeting regime. These adaptions resulted on one hand in lower interest rates than the former period (1995-1998) but on the other had in still high and volatile exchange rates (Paula, 2006). The energy crisis that severely hit the Brazilian energy sector as well as the whole economy in 2002 is also clearly visible: The currency experienced a devaluation of about a 100% from approximately USD 2 to USD 4 between the year 2002 and 2003. Interest rates amounted to 27% in 2003 which illustrates one of the major obstacles not only for investments in Brazil in general, but especially in the energy sector as nearly no investments into renewable energy investments have been recorded (Figure 4) and the government debt to GDP ratio amounted to 79,8%.

The public finance investments for wind energy did not exist until 2003 and the government fiscal debt increased, augmenting the chance of its ability to service its debt and consequently decreasing investment attractiveness due to stated public financing constraints. Conversely the government recognized that the efforts in macroeconomic stability can be an important catalyst in simplifying the investment environment, especially for wind energy, therefore in order to overcome investment barriers due to high interest rates, Brazil’s government makes significant strides in controlling inflation (IRENA, 2012). Although constant increases in disclosed transaction values for renewable energy can be recorded and the trend towards lower interest rates, currency volatility and government debt percentage to GDP can be seen, the costs of borrowing are still very high so that further efforts have to be undertaken in order to tackle that barrier.

Table 1 summarizes the drivers and barriers affecting the Investments of RE in the studied emerging economies.

Table 1: Summary of the results

Country	Legal framework (including policies)		Institutional framework (including infrastructure)		Macro-economic stability (currency risk), growth potential and foreign direct investments	
	Drivers	*Barriers*	*Drivers*	*Barriers*	*Drivers*	*Barriers*
India	Electricity Act/ National Electricity Policy / National Tariff Policy	Policy inconsistencies	Relative distribution losses declined	Distribution losses;	Population growth,	Currency risk; however most institutional investors based in India
	Renewable Purchase Obligations (RPO)	Ill-conceived policies			GDP growth	
	National Action Plan on Climate Change (NAPCC)	Competing policies			Electricity demand	
	Renewable Energy Certificate (REC)	Exhausting bureaucratic processes			Electricity access is scarce	
China	50% reduction in VAT for RE	Local content requirements	Priority power dispatching	No specific timeframes for grid companies	Currency is now allowed to fluctuate between a fixed band of 2% to the US-dollar	High inflation rates
	Bidding system	Fragmented authoritarianism		Capacity transmission problems	Government debt to GDP low	Fear of retaliatory actions due to "artificially" low currency levels
	Medium and Long-Term Development Plan / Target setting			Missing grid enhancements		
	Feed-in tariff					
	Coordinated policy model					
	Joint ventures with foreign companies					

	Incentives for Alternative Electricity Sources (PROINFA)	Nationalisation index (Local content requirements)	Energy insecurity due to low rainfall	Infrastructure / Developments of the grid	Floating exchange rate	Low and volatile GDP growth
	Feed-in tariff		Technical wind potential	Transmission line installations	Low government debt to GDP ratio	High interest rates
Brazil	Electric Power Auctions for Wind Energy		Privatization of state-owned firms	Leasing and land prices		
	Plan for Energy Expansion, however lack of clear long-term commitment			Expensive and long-lasting environmental licensing and administration procedures		
	Joint ventures with foreign companies					

5. Discussion

5.1. Factors affecting the investments in RE in emerging economies

The results of the case study are in line with the findings from literature. First, the literature outlines the importance of policies for new technologies (renewable energy technologies) in order to promote their diffusion, establish them in the market, and attract investments (Becker and Fischer, 2013). The case study unveils in every year after the introduction of a new major policy renewable energy investments of institutional investors to rise. Due to a strongly observed causal relation, the author identifies policies as a severe driver for renewable energy investments and asserts the findings from literature.

Despite local content requirements to support the previously immature local wind sector to grow, governments encouraged the build-up of joint ventures thereby transferring knowledge from expertized foreign companies into the Chinese and Brazilian wind market. The fact that today four of the ten biggest wind turbine developers originate from China signifies one of the steepest learning and shortest experience curves in the global wind industry. The prerequisite of the set nationalization index in Brazil to access funding by the BNDES was the source of rapid expansion of the local supply chain. Besides that the content requirement encouraged foreign investments in terms of establishing their manufacturing bases and supply chain in Brazil, thereby providing specific know-how and reduce unemployment in remote regions. Considering that, the Brazilian market offers an excellent potential of providing a manufacturing base for Latin America.

After that the reactive behavior of the government, in revising laws constantly was a key for optimizing investments environment. Furthermore governments implemented with the accomplishment of a series of auctions a mechanism that provided experience and data for the suitable definition of the feed-In tariff level. FITs prove to have a positive effect on RE investments in OECD and developing countries alike (Friebe et al., 2014; Polzin et al., 2015). The introduced auctions in Brazil offered globally the lowest tariffs to wind generators on a market-wide basis so that wind developers in Brazil underprized natural gas-fired power projects and showed that Brazil is able to generate an attractive alternative to fossil fuels and other traditionally implemented RE sources such as biomass and hydropower.

The combination of the government encouragement by the collaboration with commercial banks, to provide low interest debt financing loans with the focus of RE as well as the ability for state-owned commercial banks to provide lending to state-owned energy companies at very low risk signify an attractive investment for wind energy investors.

Secondly, Pfeiffer and Mulder (2013) highlight electricity generation and economic growth as drivers for renewable energies in developing countries. The case study endorses these findings for India, China and Brazil summarized under the group of growth potential. Electricity generation exhibits a positive correlation with renewable energy investments and GDP growth positively influences renewable energy investments via an indirect path. Therefore, growth potential represents a moderate driver for renewable energy investments of institutional investments.

Third, the literature identifies currency risk as a barrier for renewable energy investment in developing countries (IEA, 2011). The case study reveals that currency risk is present but affects renewable energy investments in the wind energy sector only in a very weak form since the majority of institutional investors are domestic and thereby not exposed to currency risk.

Fourth, according to IRENA (2012), infrastructural limitations such as distribution losses portray barriers for renewable energy investments in developing countries. The case study confirms these theoretical findings for India. Distribution losses in India are far above the world average and seem to indicate an inverse relation with renewable energy investments in the wind energy sector.

Similarly, one of China's inevitable weaknesses remains the vast distance between the centers of energy consumption and that of energy production, creating transmission problems. Furthermore huge capacities of wind power that are still not connected to the grid demonstrate on one hand the inability of the grid infrastructure to keep up with the rapid pace of wind capacity growth and on the other hand lead to reconsiderations of investors about future investments.

In Brazil, despite the possibility of offering wind energy at more than competitive prices in comparison to energy generated by fossil fuels, wind developers were partly required to supply energy at levels that were not able to generate sufficient returns. The heavy bureaucratic processes in attaining the necessary environmental licenses as well as the problems related to the obtainment of the Declaration of Public utility due to disputes between landholders and owners represented a great barrier towards wind energy investments The difficulties in attainment of the required licenses lead consequently to severe delays that caused huge financial burdens for the government and wind energy investors. Grid connection obstacles, particularly in the Central Western region represented a further weakness for wind energy capacity and the future investment environment.

Figure 6 summarizes the results of the case study and shows that policies are the strongest driver for wind and solar energy investments of institutional investors. The country´s growth potential is classified as a moderate driver. Concerning barriers, infrastructural limitations represent a moderate barrier and currency risk is classified as a rather weak barrier.

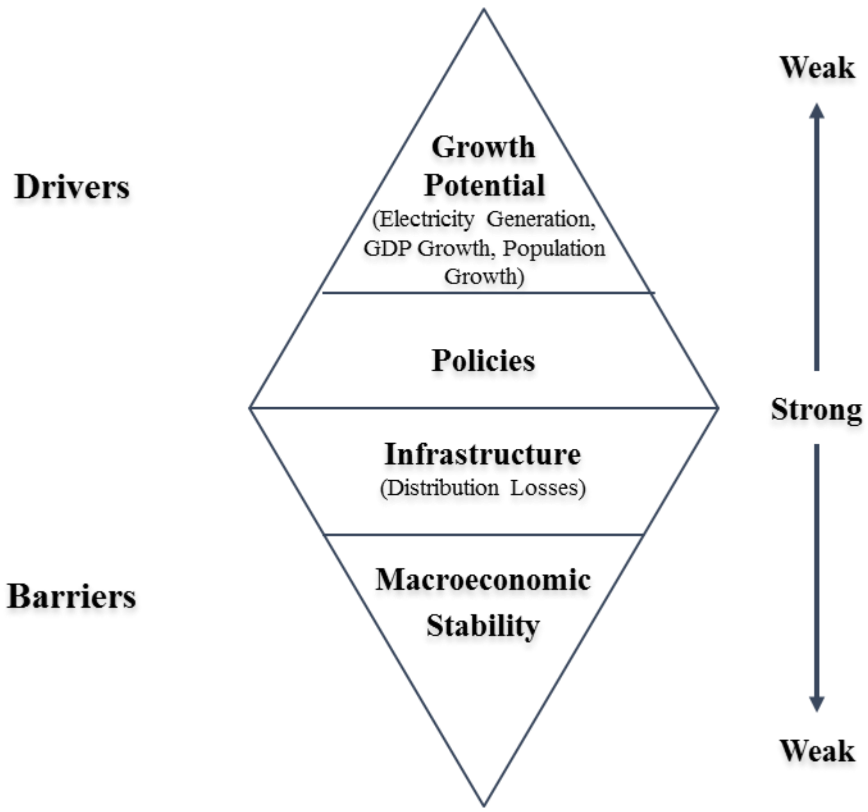


Figure 6: Drivers and Barriers for Wind Energy Investments of Institutional Investors in China, Brazil and India.

Although all three countries show different challenges regarding the suitability of wind power generation, they face quite similar barriers: Transmission problems and the lack of grid access are hindering greater investment opportunities as the infrastructural network extensions have just not kept up with the rapid development pace which is also pointed out by Friebe et al. (2014). These stated obstacles are worsened by the existence of a high level of bureaucracy, in the case of India and Brazil, concerning complicated and long-lasting environmental licence approvals and in the case of China, enormously high pre-project costs that lead to significant delays.

When considering legal actions by the respective countries it can be generally said that governments have not only been actively encouraging the financing of wind energy projects by the countries respective national development banks, but also have been reactive when it came to legal enforcements and adaptations due to changing circumstances. In order to guard the immature wind industry at early stages, both countries used the protectionist tool by requiring the minimum integration of local content (Kuntze and Moerenhout, 2013). In both cases this step lead to an inflow of companies either establishing their partnership with local firms or outsourcing its manufacturing base into the respective market to participate in wind energy investments. However whereas Brazil used primarily the mechanism of auctions, China used the auctioning system to establish suitable adaptions for suitable feed-in tariffs and India adopted a renewable purchase obligation scheme. Hence Brazil and China followed the trajectory for wind power policy options, highlighted as positive in the literature (Friebe et al., 2014; Lucas et al., 2013; Polzin et al., 2015; Wüstenhagen and Menichetti, 2012)

Macroeconomic conditions vary between the three countries following out of the different political regimes. Whereas China is accused for keeping the currency at artificially low levels in order to be attractive in global markets, Brazil still faces great challenges in terms of high interest and borrowing rates which in turn represent a major discouragement for investments. Finally, currency risk in India represents only a marginal barrier as most wind energy investments are conducted by domestic firms.

5.2. Investors' perspective useful to mobilise private finance

The profound motifs for growing global investments into RE by developing and developed countries can be presumably given by their attempt to diminish reliance on energy imports, their enhancement of energy security or the adherence of long-term environmental agreements. However especially the RE sectors of developing countries moved in the focus of investors in recent years due to their possession of significant commercial potential. The developing countries investments are driven by the BRICS, whose governments show the greatest commitment to RE as on one hand their rapidly growing economies need to be stilled by increased energy capacities and the BRICS possess large unexploited renewable energy reserves that could significantly contribute to the diminishment of growing pressures on existing capacities and environmentally friendly energy sources. Investors, concerned with the risk-return relationship of their investments judge the risk involved in investments into renewable energies in developing countries as considerably higher (Nelson and Shrimali, 2014; Waissbein et al., 2013) as in developed countries due to risk involved in infrastructure, legal framework, bureaucracy levels within the institutional framework and macroeconomic conditions.

Although judgement for the perceived investment environment by investors cannot be universalized to every single developing country, the BRICS offered due to categorically similar environmental conditions a good basis for comparison of the respective wind industries of India, China and Brazil. In both cases it can be seen that the government showed early commitment towards wind energy, and adapted their institutional and legal frameworks accordingly to it. Despite the fact that major barriers existed in China as well as in Brazil and India, primarily in terms of wind sector developments that exceeded grid capacity potentials, both countries have managed to significantly increase their investment levels into wind energy projects.

India, Brazil and China, face a unique set of macroeconomic, infrastructural and historical conditions as well as political and natural constraints that need to be precisely considered when attempting to configure successful wind energy markets or markets of renewables in general. This is essential as investors react sensitively on worsening conditions so that the continuous adaption of regulations and market conditions is an inevitable prerequisite for success in RE markets (Ming et al., 2014; Wüstenhagen and Menichetti, 2012).

6. Conclusions and policy implications

6.1. Conclusions

In the course of the paper, major drivers and barriers for renewable energy investments in developing countries were identified based on literature. The drivers are, policies, and growth potential. The barriers are represented by economic barriers and infrastructural limitations. The identification of drivers and barriers was followed by an insight in the financing of renewable energies, where asset finance protruded as the largest part of renewable energy finance in developing countries. Besides, the paper highlighted the role of institutional investors, whose investment profiles match the investment characteristics of renewable energies. Additionally, the issue of higher financing costs for renewable energies in developing countries was sketched.

6.2. Policy implications

In terms of policy implications we highlight that two streams of drivers and barriers affect the willingness of institutional investors to engage in RE investments in developing countries (following Friebe et al., 2014). First RE specific drivers and barriers, consisting of targeted policies (in a stable policy framework to avoid confusion) and infrastructural barriers. Regarding policy requirements we encourage policy makers to set long-term gargets and fulfil the targets set which is achieved by an overall commitment and integration of the planned steps as well as releasing not too many policies in order to avoid confusion on the one hand and strict enforcement of policies on the other. Especially the facilitation of administrative processes to shorten times for project approvals is important to encourage investments. Too strict local content requirements might impede investments into more innovative technologies.

Second general drivers and barriers that impact the risk and return expectations of institutional investors need to be taken into account; however they are considered weaker influencing factors. Hence encouraging economic development and focussing on stable macro-economic conditions supports the capacity investments. In this regard fixed exchange rate mechanism and more generally creating a “level playing field” for conventional and non-conventional energy sources (e.g. the introduction of sanctions for pollution and set up a fund from this in order to finance other activities) are the ways to proceed. More specifically policy makers should create awareness for investment characteristics of renewable energies and tackle the issue of high financing costs by subsidizing low interest credits or project itself is enough as an equity buffer.

Beyond the field of grid-connected technologies to tackle poor electricity access rates in decentralized/rural parts policy makers could incentivize off grid renewable energy as a new field for investors as these exhibit attractiveness for investors due to lower up-front capital requirements and strong growth potential (see also Friebe et al., 2013).

6.3. Limitations and future research

The amount of drivers and barriers is limited to three main categories although many more exist. This is due to the fact that the author prefers an in-depth analysis of these factors as opposed to a broader analysis of multiple drivers and barriers.

The analysis is of qualitative nature, meaning that the authors can only establish assumptions or hypotheses about potential drivers and barriers but has no statistical evidence in order to prove its significance. The hypotheses about the impact and the verification of the drivers and barriers for renewable energy investments of institutional investors in India are conducted by solely comparing them with aggregated installed solar and wind energy capacity over the respective observation periods. In order to make qualitative inferences about renewable energy investments, aggregated installed solar and wind energy capacity is used as a benchmark instead of the transaction value for solar and wind energy projects, which is due to two reasons. Firstly, the data set exhibits a significant incompleteness in terms of transaction values for solar and wind energy projects. In contrast, aggregated installed capacity for solar and wind energy is obtainable for almost all projects throughout the observation period. Secondly, the costs for renewable energy technologies generally declined over the observation period due to technological improvements. Therefore, the author prefers aggregated installed capacity as a more objective and thorough benchmark.

Future research could concern the complementary part of this qualitative study and focus on a quantitative analysis, which conducts a statistical examination in order to prove significant correlations between the individual drivers and barriers with renewable energy investments by institutional investors in the solar and wind energy sector in India.

Future research could also devote to the investigation of different renewable energies, such as biogas, or thermal energy as different categories for renewable energy investments and conduct qualitative and quantitative analyses in order to ascertain whether these renewable energies are underlying to the same drivers and barriers. One could also analyze the drivers and barriers of this case study for other developing countries and see whether the findings are in line with the findings of this paper.

7. References

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9. Appendix

Table A.1: Overview of policy mechanisms in India (Source: International Energy Agency, 2014)

Year	Policy Name	Content
2001	Reduced VAT for Renewable Energy	- VAT Reduction of 50% from 17% → 8,5%
2003	Wind Power Concession Program	- Min. requirement of 70% local manufacturing content - Competitive bidding by international and domestic companies for large-scale potential projects (100-200MW)
2006	Renewable Energy Law	- Basis for following-up supporting regulations - Grid companies prioritize RE over other energies
2007	Medium and Long Term Development Plan for RE	- 10%/15% Requirement of RE by 2010/2015 of total energy consumption - 2020: Development/Installation of 30 GW by wind power
2007	Amendment of Renewable Energy Law (Special Fund for Industrialization of Wind Power Equipment)	- Allocation of funding to wind projects assessment, evaluation studies & technology R&D projects
2009	Onshore-Wind Feed-In Tariff	Varying Tariffs depending on suitability of wind endowment by categories (EUR 0.052 – 0,.062/kWh)
2012	China Energy White Paper	Target: Increase share of RE to 11,4% of primary energy consumption - Increase that of installed generating capacity of

		non-fossil fuels to 30 % by the end of 2015
2013	Renewable Electricity Generation Bonus	- Increase the bonus from $1,28/kWh to $2,40/kWh

Table A.2: Overview of policy mechanisms in China (Source: International Energy Agency, 2014)

Year	**Policy Name**	**Content**
2002	Programme for Incentives for Alternative Electricity Sources (PROINFA)	- Stage 1: Target: 3,3 GW of RE (wind, biomass & small hydro) will be installed before 2007 - Stage 2: Increase share of produced electricity by the three defined renewables to 10% of annual consumption within 20 years.
2008	Brazil National Climate Change Plan	- Plans focus: Reduce Amazon deforestation by 50% in 2017 with the larger aim of reducing greenhouse gas emissions - Therefore electricity share from wind energy should be expanded
2009	Electric Power Auctions - Wind	- First wind-power producer only auction in 2009. The auction allows wind power producers to sell excess energy to energy distributors and industrial buyers and intends to increase energy output - PPA began in 2012 and last 20years with an average final price of BRL 85/MWh
2010	Plan for Energy Expansions	- Installed capacity targets for wind energy: Expand Wind installations from 1.4 GW in 2010 to 6 GW by 2019

Table A.3: Overview of policy mechanisms in Brazil (Sources: Abdullah, 2011; E&Y, 2013; Kumar and Agarwala, 2013; Prime Minister´s Council on Climate Change, 2008; Thakur et al., 2005)

Year	Policy Name	Content
2003	Electricity Act	- electricity regulatory commissions - consolidating the laws related to generation, transmission, and distribution of electricity - promoting competition in the Indian electricity sector - RE minimum requirements
2005	National Electricity Policy	- reduce the capital costs of renewable energy projects - of competitive bidding mechanisms
2006	National Tariff Policy	- Renewable Purchase Obligations (RPO) - Energy market actors to purchase or generate a certain percentage of their total electricity requirement from appropriate renewable sources
2008	National Action Plan on Climate Change (NAPCC),	- renewable energy purchase target of 5% - enhanced by 1% per annum until 2020
2011	Renewable Energy Certificate (REC)	- tradable certificate for each MW of renewable energy