Effects of Government Interventions in Alternative Renewable Energy Markets

A Comparative Case Study of the Wind Power Market Regulation in Germany and Brazil

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Disclaimer:

This document represents part of the author's study programme while at the Institute of Social Studies. The views stated therein are those of the author and not necessarily those of the Institute.

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Dedication

This research paper is dedicated to my beloved son Daniel Sampaio Meister, my soul, and to my beloved wife Deise Sampaio Meister, light of my way.

Acknowledgements

First of all, I would like to thank my dissertation Committee - Dr. Sunil Tankha and Dr. Lee Pegler for guiding and helping me in this interesting and challenging learning journey.

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My acknowledgment also goes to my parents for having always given me their best – I simply love you !

Finally, my deep gratitude goes to my wife Deise for sharing her life with me and helping my dreams come true.

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List of Acronyms

ANEEL	Brazilian Electricity Regulatory Agency
BNDES	Brazilian Development Bank
BMWi	German Federal Ministry of Economics and Technology
CEPEL	Brazilian Electric Energy Research Center
CMSE	Brazilian Electric Sector Monitoring Committee
CRESESB	Brazilian Solar and Wind Reference Center
DISCO	Electricity Distribution Company
ELETROBRAS	Centrais Elétricas Brasileiras S.A.
EPE	Brazilian Energy Research Office
FIT	Feed-in Tariff
GENCO	Electricity Generation Company
GDP	Gross Domestic Product
IEA	International Energy Agency
IAEA	International Atomic Energy Agency
IMF	International Monetary Fund
ISS	International Institute of Social Studies of Erasmus University Rotterdam
ISEE	Internal Supply of Electric Energy
kWh	Kilowatt-hour
MAE	Brazilian Wholesale Electricity Market
MME	Brazilian Ministry of Mines and Energy
MWh	Megawatt-hour
MW	Megawatt
NR	Normative Resolution
OECD	Organization for Economic Co-Operation and Development
ONS	Brazilian Power System Operator
PROINFA	Brazilian Program for Incentive of Alternative Sources of Energy
R&D	Research and Development
TWh	Terawatt-hour
UNDP	United Nations Development Programme
WWEA	World Wind Energy Association

Abstract

This research paper aims to analyse the effects of government interventions in alternative renewable energy markets, focusing on the regulation of wind power markets.

The research method is based on a comparative case study between the policy design and respective instruments applied by highly industrialized and emerging industrializing country economies to promote and develop such markets. Germany and Brazil were taken as the representatives to illustrate the policy strategies and implementation choices in the contexts of highly industrialized and emerging industrializing country economies, respectively.

The basic hypothesis underlying this work is that in spite of the similarities that may exist among the energy policies objectives, such as security of supply and import dependence reduction, there will be also particularities derived from the particular national needs, priorities and values.

The specific approaches adopted by German and Brazil enable the reflection upon lessons that may be shared in regard to the development of infant industries, such as the wind power market.

In this sense, the findings point out that the success of alternative renewable energy policies are influenced by special factors like: i)- government commitment to the policy stability; ii)- effective and continuous investments on R&D; iii)- integration of the energy policy with the industrial and scientific-technologic policies; iv)- awareness regarding the dynamic and evolutionary nature of the policy instruments; and v)- freedom to put into practice innovative and experimental policy instruments as part of the learning process towards national social and economic development.

Relevance to Development Studies

Due to its importance for social and economic development energy is not an ordinary commodity. Rather, it is a strategic asset in the sense that security of supply is a major concern of national States.

However, despite the existence of common targets such as energy security, the energy policy objectives of highly industrialized and emerging industrializing country economies have also some particularities due to the inner needs and values that shape the policy design and the corresponding implementation.

For instance, environmental compatibility would be a driver for government intervention in alternative renewable energy markets considering the context of developed countries like Germany. On the other hand, renewables could help to universalize the energy access and meet the energy demand in emerging economies such as Brazil.

Therefore, taking as reference the experiences of Germany and Brazil, this work aims to better understand and shed some light on lessons that may be shared amongst highly industrialized and emerging industrializing country economies, in their pathway to promote and regulate those alternative renewable energy markets in order to bring social and economic development.

Keywords

Government interventions, alternative renewable energy markets, energy policy, policy instruments, regulation, wind power markets, case study, Brazil, Germany, development.

Chapter 1
Introduction

This research paper analyses the effects of government interventions in alternative renewable energy markets by means of a comparative case study of the German and Brazilian experiences in regard to the regulation of wind power markets.

Therefore, the study will be centred on the analysis of the specific wind power policy design and implementation, taking Germany and Brazil as representatives of a highly industrialized and an emerging industrializing country economy, respectively. The focus will be on the particular policy objectives and instruments used in these two different contexts to promote wind power industries.

After the discussion of the approaches taken by Germany and Brazil to promote and regulate wind power markets, the paper investigates whether there is an opportunity for sharing lessons among Germany, Brazil and other emerging and industrializing country economies.

In order to address the above mentioned issues, this research paper is organized as follows:

a) Chapter 1: Introduction

- The introduction sheds light on the reasoning underlying this research, i.e., its nature, purpose and relevance. In other words, this initial chapter will give subsidies to understand two basic questions: i)- What is this a case of ?; and ii)- Why is it worth doing this case study ?

- Thus, it provides an overview of the key issues regarding the present study: i)- the research objective and hypothesis; ii)- the research question; and iii)- the literature review.

b) Chapter 2: Research Method

- The research method chapter starts with the justification for selecting a multiple case study as the main research technique to address the effects of government interventions in alternative renewable energy markets.

- Moreover, this chapter clarifies the reason for choosing Germany and Brazil as the reference country economies to be analysed in this comparative case study.

- Finally, the chapter ends with the presentation of the corresponding procedures for data collection and analysis.

c) Chapter 3: Alternative renewable energy policies design and wind power markets regulation: the case of Brazil

- The third chapter deals with the issue of alternative renewable energy policies design considering the context of an emerging industrializing country economy and taking Brazil as a reference case study.

- Moreover, it tackles the question of policy instruments used for regulation of wind power markets in the Brazilian experience. The analysis will be focused on the respective policy instruments objectives, design, outcomes and impacts.

d) Chapter 4: Alternative renewable energy policies design and wind power markets regulation: the case of Germany

- The fourth chapter has a structure which is analogous to the previous one. In this sense it starts also with the issue of alternative renewable energy policies design, but considering this time the context of a highly industrialized country economy and taking Germany as a reference case study.

- Finally, it tackles as well the question of policy instruments used for regulation of wind power markets in the German experience. The analysis will also be focused on the respective policy instruments objectives, design, outcomes and impacts.

e) Chapter 5: Lessons that may be shared among Germany, Brazil and other emerging industrializing country economies

- In this chapter it will be discussed the opportunity for sharing eventual lessons among Germany, Brazil and other emerging industrializing country economies.

f) Chapter 6: Conclusions

- This chapter will present the conclusions derived from the present case study research, i.e., what can be drawn from the specific policy approaches taken by highly industrialized and emerging industrializing country economies to promote alternative renewable energy markets, focusing on the regulation of wind power markets.

1.1 Research Objective and Hypothesis

Do government interventions influence the operation of alternative renewable energy markets ? By considering a comparative case study of two different scenarios: i)- a benchmark industrialized country economy (Germany); and ii)- an emerging industrializing country economy (Brazil), the paper aims to shed light on the strategies adopted by the German and Brazilian Governments and the corresponding effects in the respective alternative renewable energy markets.

Thus, the study will discuss the particular energy policy objectives that were chosen, the reasoning for their selection and the consequent direct and indirect effects of those policies, ranging from the energy matrix diversification to the development of industrial and technological national policies.

In particular, the comparison will be focused on the effects of the regulation mechanisms used to promote wind power markets, which is the alternative renewable energy source that has been most successful in Germany and Brazil in terms of energy market share and competitiveness gain.

Since energy policy is shaped by the particular values, needs and priorities of each country economy, the research hypothesis is that the design of policy instruments and the effects in the promotion and regulation of wind power markets will have particular characteristics in the contexts of Germany and Brazil. For instance, the issues of environmental compatibility and energy demand meeting have different levels of relevance in terms of energy policy targets in the cases of Brazil and Germany.

1.2 Research Question

The second section of this introduction chapter is associated with the research question and its respective primary and secondary case study questions, which will be taken as reference to pursue the research objective.

As stated in the previous section, the research boundary lies within the effects of government interventions in alternative renewable energy markets, taking as reference wind power markets regulation in the context of highly industrialized (Germany) and emerging industrializing country economies (Brazil).

The research question is "what have been the effects of government interventions in the setting up and development of alternative renewable energy markets, considering the particular policy objectives and associated instruments of highly industrialized and emerging industrializing country economies ?".

In the following, it will be presented the primary and secondary research questions.

1.2.1 Primary Case Study Question

- What have been the effects of government interventions in wind power markets setting up and operation in the contexts of highly industrialized and emerging industrializing country economies, namely, Germany and Brazil ?

1.2.2 Secondary Case Study Question

- Why governments intervene in alternative renewable energy markets ?

- What have been the strategy and the corresponding outcomes in regard to policy instruments adopted by Germany and Brazil in order to promote and regulate wind power markets ?

- Are there opportunities to share lessons among Germany, Brazil and other emerging industrializing country economies in regard to alternative renewable energy markets promotion and regulation ?

1.3 Literature Review

This section deals with the literature review, i.e., the presentation and discussion of the major theories and concepts associated with the scope of the research paper. In this regard, 3 major issues will be focused: i)- alternative renewable energy sources; ii)- the rationale for government intervention in alternative renewable energy markets; and iii)- the global wind power market – facts and figures.

The first section presents the fundamental concepts regarding the issues of alternative renewable energy sources, in order to clarify and limit the work boundaries.

Following, the second section encompasses the global wind power, which is the selected alternative renewable energy market chosen for case study analysis, focusing on the facts and figures of this market, encompassing for instance its economic relevance in terms of size, major players, average production costs and levels of investments.

Finally, the third section investigates the rationale for government intervention in alternative renewable energy markets, which is at the heart of this research paper.

1.3.1 Alternative Renewable Energy Sources

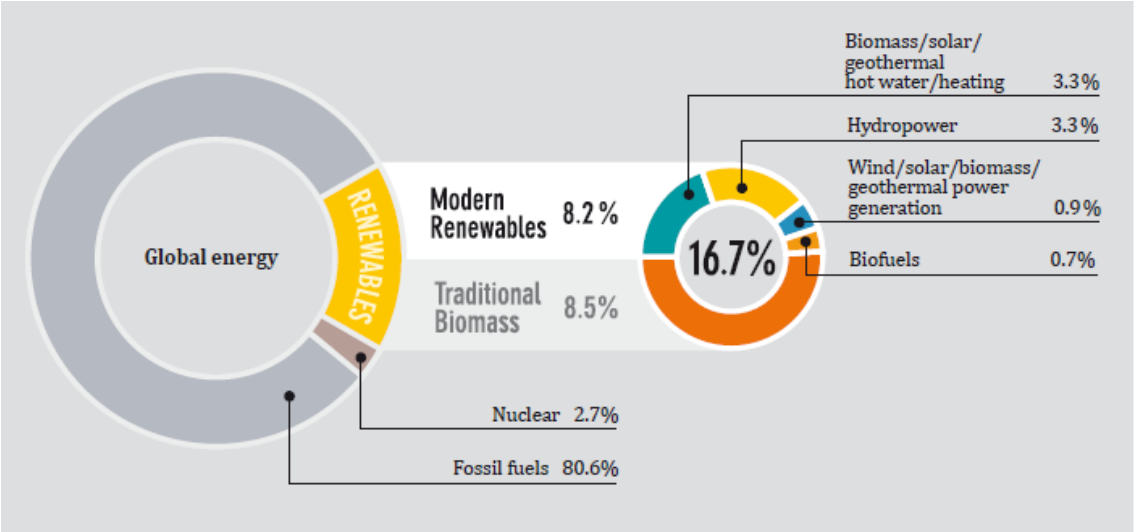
In this section we will highlight the major concepts related to alternative renewable energy sources, especially wind power, since it lies at the core of this research.

Renewable energy sources encompass those energy sources that are not fossil fuel based and, thus, are not subject to limitations of resources capacity. The set of renewable energy sources are commonly divided in two main subgroups: alternative and conventional renewable energy sources.

The first subgroup called "alternative" encompasses energy sources like wind, solar, biomass, geothermal and ocean power, whereas the second subgroup of "conventional" renewable energy sources includes other sources such as hydropower.

Despite its strategic importance to energy security by means of diversification of the energy matrix, and also to environment protection through reduction of the greenhouse effect, the participation of alternative renewable energy sources on the total global final energy consumption is still minor when compared to fossil fuel based energy sources, as can be seen on Figure 1.1:

Figure 1.1: Share of renewable energy sources on global final energy consumption (2010)

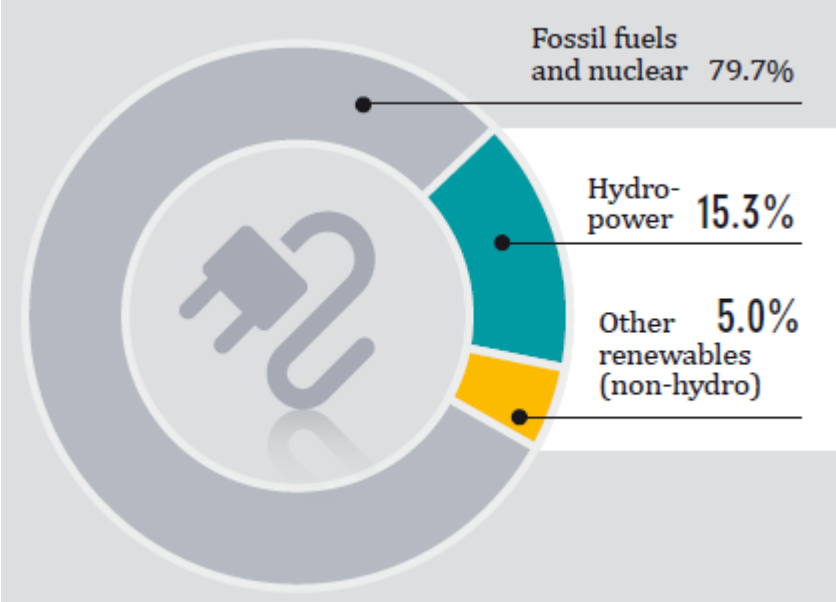


Source: (Ren21, 2012: 21)

The dominance of fossil fuels on global energy consumption is mostly related to the considerable lower costs, rather than a matter of availability. Indeed, the current technology stage of renewables is not yet sufficiently mature to allow a competitive industrial scale production when compared with fossil fuels based energy sources.

This pattern of fossil fuels dominance is also noticed on the supply side of global electricity. As shown on Figure 1.2, the share of renewables on the global electricity production reached the amount of 21.3% against 79.7% of fossil fuels participation (Ren21, 2012: 23).

Figure 1.2: Renewable energy share of global electricity production



Source: Ren21, 2012: 23

Nevertheless, according to the latest report of the International Energy Agency (IEA) on the global energy outlook, the present growth rate of renewables is such that they are expected to roughly double their participation and account for almost one-third of total electricity output by 2035 (IEA, 2012a).

In summary, this means that the scenario of fossil fuels dominance has already started to change due to the increase of renewable energy sources penetration in the energy matrix. The major factors supporting these changes are mostly associated with reduction of costs, as a consequence of technology improvement, and also with continuous government subsidies (IEA, 2012a: 6).

The next session will tackle the facts and figures of the global wind power market which was the chosen focus of analysis of this research paper amongst the alternative renewable energy sources.

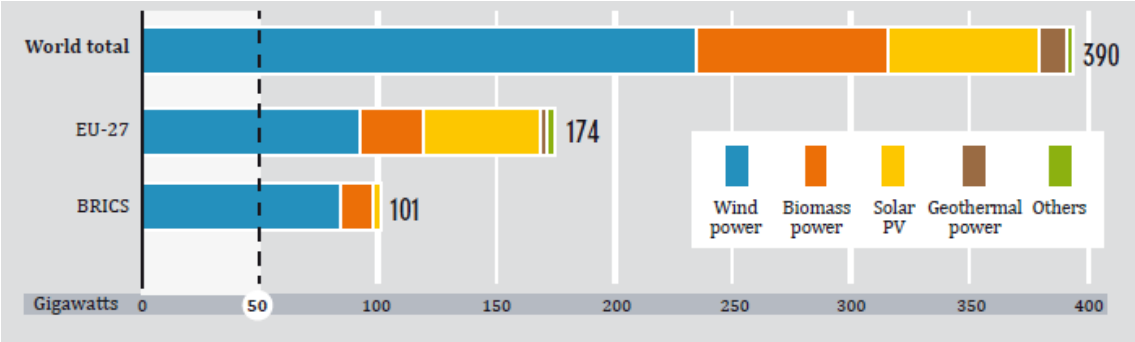
1.3.2 The Global Wind Power Market – Facts and Figures

This section will present the major facts and figures regarding the global wind power market in order to shed some light on its corresponding structure and operation.

First of all, it is important to highlight the issues related to the market size and its insertion on the world provision of energy. As already shown on the previous section, the participation of renewables is still minor when compared to fossil fuels in terms of participation on the final global energy consumption, as well as on the global electricity production.

Excluding hydropower, which is estimated to account to a share of roughly 15% of total electricity production (Ren21, 2012: 23), the largest participation of renewable energy sources on the global power capacity is represented by wind power, as shown is the next Figure 1.3.

Figure 1.3: Renewable Energy Sources share on global power capacity, excluding hydropower



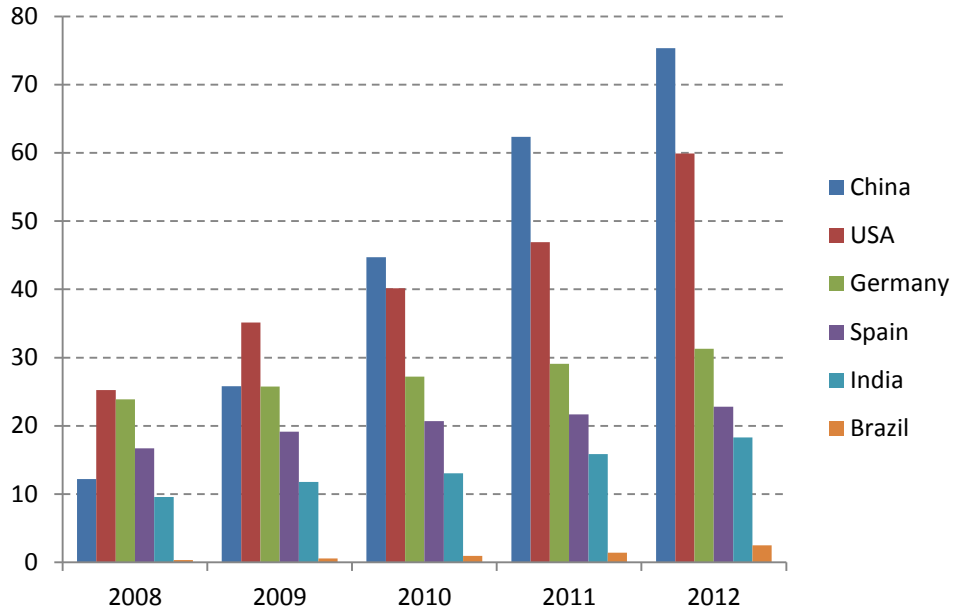
Source: (Ren21, 2012: 25)

In this regard, the 2011 IEA Wind Executive Committee Annual Report points out that the total wind power installed capacity reached the amount of 238 GW, which accounts for 3% of the world electricity demand (IEA, 2012b).

Another important feature to better understand the global wind power market is related to the issue of major players. In this regard, the top 5 country economies in terms of installed wind power capacity are by order: China, U.S.A., Germany, Spain and India. These countries summed up together are able to generate a total of approximately 178 GW or roughly 75% of the global wind power generation, according to the 2012 Report of the World Wind Energy Association (WWEA, 2012: 18).

It is interesting to notice that the growth rate of wind power generation is sharply increasing not only on major player countries like Germany, but also in emerging industrializing country economies such as Brazil, as can be noticed by the last 5 years trends shown on Figure 1.4.

Figure 1.4: Wind power installed capacity (GW) – last 5 years series



Source: Graph of ours. Data provided by (WWEA, 2012).

It can be verified that Germany continues to be the most important player in Europe, although China took the lead of global wind power installed capacity from 2010.

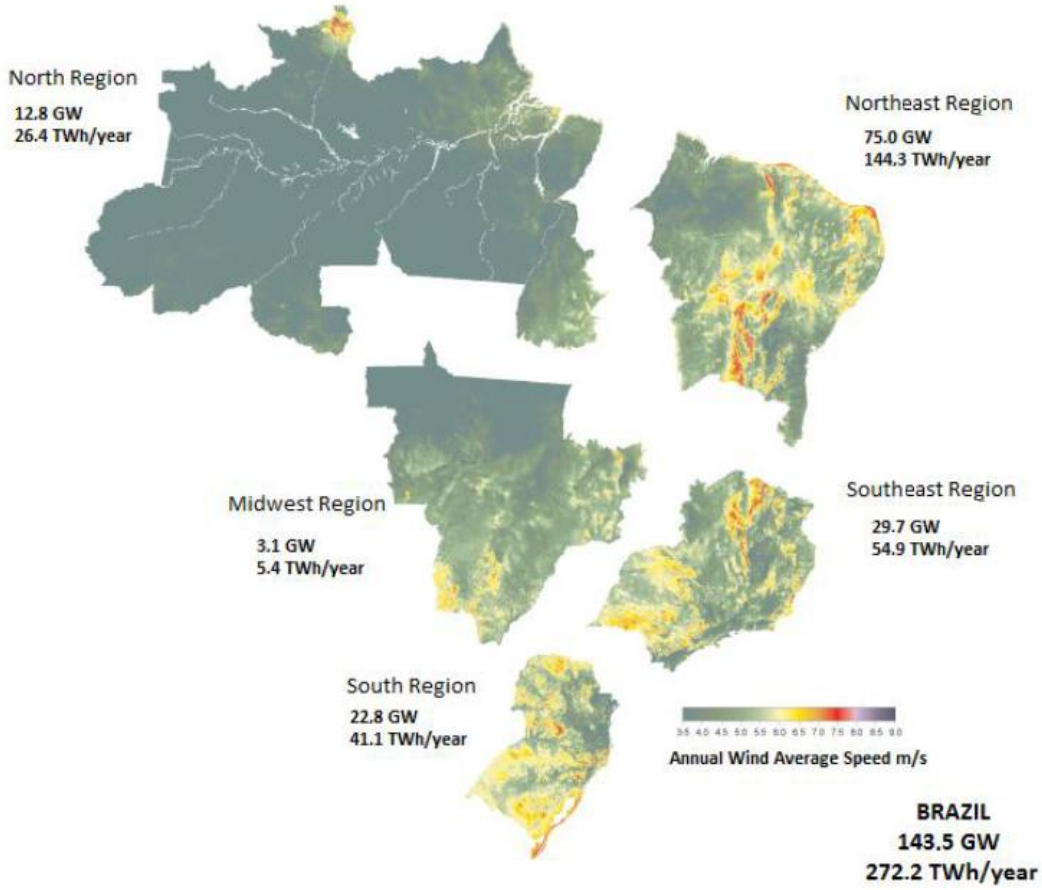
On the other hand, the importance of emerging country economies is growing in relation to renewable energy markets size in terms of installed power capacity, as also illustrated in the previous Figure 1.4 by the case of Brazil. Despite the fact that the Brazilian wind power installed capacity is still minor compared to the 5 leading countries, its participation has sharply grown and now Brazil figures in the 15th position amongst the largest wind power installed capacity countries (WWEA, 2012: 18).

The significant growth rate of wind power in Brazil can be illustrated by the fact that in last 20 years the national wind power installed capacity has increased from 0.075 MW (experimental project located at Fernando de Noronha Island) to the amount of 2,045 MW, supplied by 92 wind power plants, according to data provided by (ANEEL, 2013: 4).

Moreover, there is a huge potential to be explored since the estimated wind power generation capacity in Brazil is of 143.5 GW, according to the Atlas of the Brazilian Wind Energy Potential, published by the Brazilian Centre for Electric Energy Research (CEPEL, 2001).

Indeed, this is a huge potential when we notice that it is larger than the total present installed power capacity in Brazil of 123 GW (ANEEL, 2013). The majority of this potential is concentrated in the Northeast Region of Brazil, as shown in Figure 1.5.

Figure 1.5: Brazilian Estimated Wind Power Potential

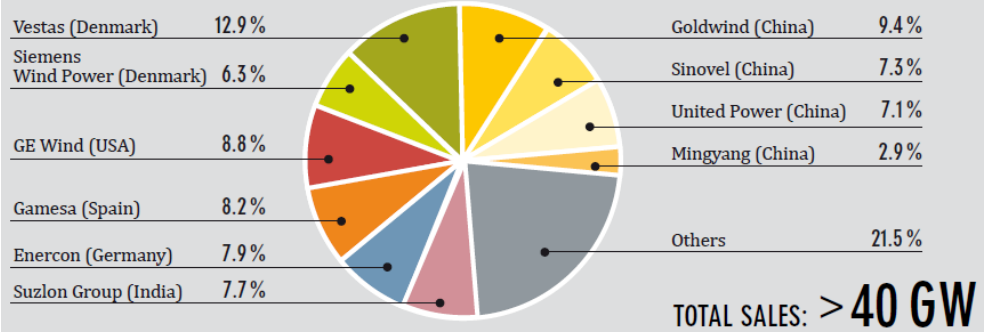


Source: (CEPEL, 2001). Figure edited by the author.

Although wind power currently accounts only for 1.7% of the total installed power capacity (ANEEL, 2013: 4) and 0.6% of the national energy supply (ANEEL, 2013: 6), the perspectives for wind power development in Brazil are positive due to the huge energetic potential to be explored, falling production costs and the support of specific policy instruments, which are contributing to develop the Brazilian wind power market.

Besides the question of market size in terms of installed wind power capacity, it is also worthy presenting the major players in relation to the manufacturing of wind turbines, which is the core equipment of a wind power plant in regard to technology and value added. According to (Ren21, 2012: 58), the market shares of the top 10 wind turbine manufactures include industries from Denmark, Spain, Germany, U.S.A., China and India, as shown in Figure 1.6.

Figure 1.6: Market shares - top 10 wind turbine manufactures, 2011



Source: (Ren21, 2012: 58).

It can be verified in the previous Figure 1.6 that Danish company Vestas has the largest share of global wind turbine manufacture (12.9%), while China is the country with the biggest quantity of companies among the top 10 wind turbine manufactures (Goldwind, Sinovel, United Power and Mingyang), accounting for 26.7% of the global wind turbine production. In fact, these top 10 wind turbine manufactures have great power market since they amount alone for approximately 80% of the global wind turbine supply.

Following this characterization of the wind power market economic relevance, it is important also to present the level of investments on this sector. According to (Ren21, 2012: 61) investments on renewables as a whole are increasing sharply and accounted for US$ 257 billion on 2011, with wind power contributing with the amount of US$ 84 billion, i.e. approximately 33% of the total investments on renewables worldwide. The expressive share of wind power investments over total renewables investments shows that this market represents a big business.

Another interesting feature of the global wind power market is related to the capacity of jobs generation in the productive chain (industry and associated provision of services). In this regard, according to (Ren21, 2012: 27), it is estimated that the global wind power market enables the generation of 670,000 jobs. As shown in Figure 1.7, this labour force is concentrated on the European Union, especially Germany and Spain, along with China, U.S.A. and India.

Figure 1.7: Estimated jobs in the global wind power market

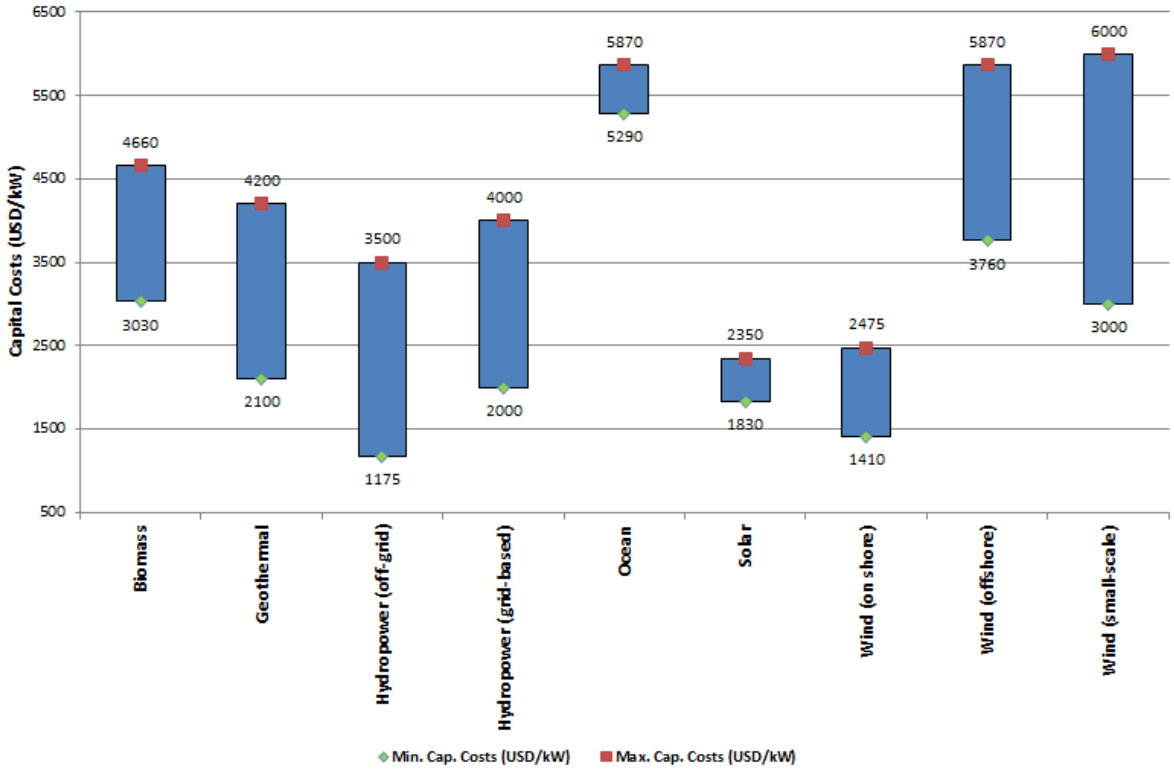
	Global	China	India	Brazil	USA	EU[7]	Germany	Spain	Others
	Thousand jobs								
Wind Power	670[4]	150	42	14	75	253	101	55	33[11]

Source: (Ren21, 2012: 27). Figure edited by the author.

Finally, it is also important to highlight the issue regarding the relative costs of wind power based electricity generation since this is one of the most important factors influencing the competitiveness of this industry. In regard to this question, according to (Ren21, 2012: 59), the cost of wind power based electricity rose between 2005 and 2009 due to increasing global demand, as well as high prices of steel. After, the costs began to fall due to factors like technology improvement, higher level of competition and industrial scale gains.

Although the prices of wind power based electricity generation have fallen over the past recent years, the technology development stage is not yet sufficiently mature to enable fair competition with conventional renewables. For instance, as can be seen on Figure 1.8, the capital costs for wind power projects are on average much higher compared to other more mature technologies such as hydropower.

Figure 1.8: Average Capital Costs for Renewables (USD/kW)

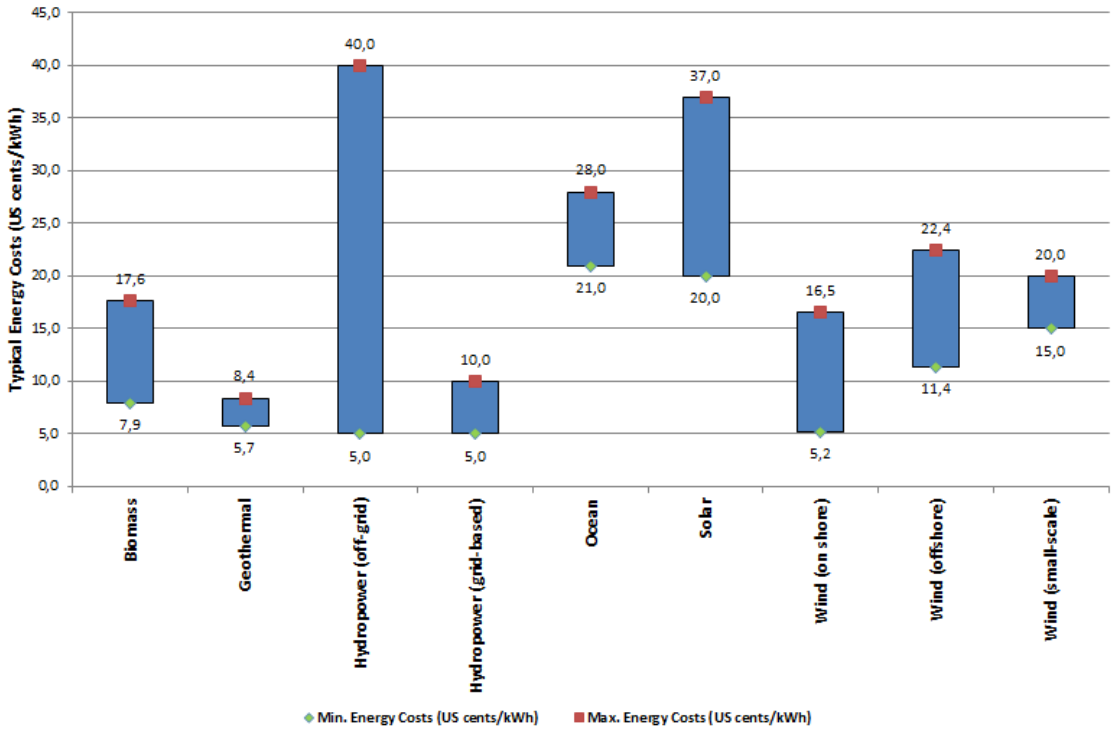


Source: Data from (Ren21, 2012: 28). Graph elaborated by the author.

Similarly, the typical energy costs for wind power are higher than hydropower, e.g. the typical energy costs for offshore wind power can reach up to 22.4 US cents/kWh, while the typical energy costs for grid-based hydropower ranges from 5 to 10 US cents/kWh, as shown on Figure 1.9.

Nevertheless, due to technology improvements and subsidies, the gap between wind power and other renewables energy prices tends to get smaller on the medium term.

Figure 1.9: Typical Energy Costs for Renewables (US cents/kWh)



Source: Data from (Ren21, 2012: 28). Graph elaborated by the author.

The next session will deal with the rationale for government intervention in alternative renewable energy markets such as the wind power market.

1.3.3 The Rationale for Government Intervention in Alternative Renewable Energy Markets

First of all, it is important to highlight the fact that until very recently the electricity sector used to be structured as a vertical integrated industry in which big firms alone controlled the generation, transmission and distribution subsectors.

This market configuration was justified by means of the natural monopoly rationale backed on economies of scale, i.e., the highest economic efficiency and lowest production costs would be achieved by one dominant firm instead of a free competition set up.

However, under such conditions, there was no incentive for the market itself to meet broader societal needs besides the profit making target and, thus, a market failure arises from this divergence of interests between the market and the society as a whole. The conflict is centred on the fact that benefits derived from the general public interest would be dispersed, whereas the costs to provide those benefits would be concentrated on the market agents.

This market failure caused by imperfect competition implies that the efficient outcome ("*pareto* optimal") will not be achieved solely by the action of the market forces themselves (Stokey and Zeckhauser, 1978: 292) in the context of a natural monopoly. Therefore, according to neoclassical economics, market failures present necessary conditions for market intervention (Brown, 2001: 1199).

In relation to this issue, it is important to emphasize that natural monopoly based electricity markets fail to achieve the *pareto* optimal point not only because of an inherent potential market power concentration, but also due to other market failures associated with information asymmetry (not perfect flow of information among the agents) and usual high transaction costs, which also provide rationales for government intervention in such markets.

Therefore, government intervention could be justified as a mechanism to promote efficiency and induce the maximization of social welfare in the situation where the markets fail to do so (Jaccard, 1995: 579-580). In this regard, (Stokey and Zeckhauser, 1978: 310) argue additionally that government action could take one of the following approaches in order to improve performance:

a) Government measures that attempt to improve the working of the market;
b) Government measures that require individuals and firms to behave in specified ways;
c) Government incentives that influence decisions of private individuals and firms; and
d) Government provision of goods and services.

Although the natural monopoly was a traditional rationale for government intervention in the electricity sector, this started to change due to the emergence in the late 1980s of liberal paradigms which praised deregulation, privatization, competition and free markets.

These liberal waves challenged not only the natural monopoly rationale, but the role of the State itself as a leader and major player in the economy. As argued by (Pollitt, 2012: 135) the liberalization occurred in the energy sector was an important manifestation of the more general trend towards liberalization of the economy. Consequently, the natural monopoly rationale was eroded in the generation subsector and nowadays, the majority of advanced country economies have developed electric power markets.

The liberalizing reforms of the 1990s promoted the unbundling of the former vertically integrated electricity industry and opened this market to free competition, including new players such as alternative renewable energy sources.

This support to renewables was strengthened, especially in the most industrialized country economies such as Germany, by the emergence of a new rationale associated with the need to diminish the negative externalities related to the environmental damages caused by the electricity industry, e.g. pollution (Jaccard, 1995: 582).

Nevertheless, the critical issue that arises in regard to alternative renewable energy sources is that their present stage of technology does not allow them to compete fairly with more mature and cheaper energy sources, e.g. hydropower and thermoelectric plants.

In spite of the fact that alternative renewable energy sources are still more expensive compared to traditional sources, there is interest of governments to and intervene in such markets due to positive externalities related for instance with security of energy supply, environmental compatibility and industrial policy strengthening. In emerging industrializing country economies, their importance is critical also to help energy demand meeting and as a key driver to general economic development.

However, the existing asymmetry in the technology stage among the different energy sources implies different production costs and consequent lack of full competitiveness in the electric power market. Thus, prices may be set by market power of dominant players, rather than the ideal law of supply and demand. This means that entry market barriers are actual threats to alternative renewables and, therefore, governments can play a decisive role in relation to the creation, protection and development of such less mature markets by means of effective regulation.

Therefore, government interventions, e.g. subsidies, are particularly needed to decrease market entry barriers and protect the infant industries of the alternative renewable energy sector (Goldemberg, 2006: 2188).

In the case of wind power industry, despite the fact that incentives to promote it were strengthened in the 1970s in response to the oil crisis, the transition from experimental scientific projects to feasible and market scale solutions began only in the 1980s, as highlighted by (CRESESB/CEPEL, 2001: 13).

In this regard, (Hashimura, 2012: 29) argues that alternative renewable energy policies are fundamental to promote technology improvements and capacity building that will induce costs lowering and consequent increase of the competitiveness of these energy sources.

To conclude this section it is important to highlight that while governance, in general, "*is about steering and the rules of the game*" [Kjaer, 2004: 7], this case study will focus on the governance approach related to the "*comparative political economy and concerns the role of state regulation in economic and social development. The task is to identify the rules guiding public policy-making and implementation*" [Kjaer, 2004: 17] in regard to alternative renewable energy policies.

The next chapter will tackle the methodological aspects regarding the major research technique and respective procedures for data selection and analysis in order to draw a comparative case study between the policy instruments and market regulation applied in the German and Brazilian wind power sectors.

Chapter 2
Research Method

This section deals with the procedure for data collection such as the specification of research method and sources of data necessary to properly answer the case study questions.

In relation to the research method issues, it is important to initially justify the selection of case study as the main research technique. In this regard, the justification for making a methodological choice for case study is deeply connected with the nature of research question itself, as will be explained in the following.

The rationale for choosing case study as a preferential method is defined by (Yin, 2009: 2):

> *"In general, case studies are the preferred method when (a) "how" or "why" questions are being posed, (b) the investigator has little control over events, and (c) the focus is on a contemporary phenomenon within a real-life context. This situation distinguishes case study research from other types of social science research."*

Thus, it is possible to verify that in this planned research the prerequisites defined by (Yin, 2009) are all met due to the following reasons:

a) The case study questions are associated with the issues of "how" and especially "why" wind power markets operation has been set up and regulated by governments representatives of highly industrialized and emerging country economies, namely, Germany and Brazil, and what have been the major effects of these government interventions;

b) The researcher has not control over events being studied (wind power markets operation and regulation);

c) The research is focused on contemporary phenomenon since the programmes designed by Germany and Brazil to promote and regulate the wind power sector are quite recent and are actually still being implemented as part of a continuous alternative renewable energy policy.

Moreover, the research question itself is associated with a comparison of policy strategies and markets operation in highly industrialized and emerging country economies demands a multiple case study, i.e., at least two different countries have to be chosen to make feasible the research comparison.

In this sense, (Gerring, 2007: 20) argues that although generally a case study is meant to study in depth a single case, it may encompass as well more than one case, i.e., multiple case studies, which is exactly the format of this comparative case study among Brazilian and German governments interventions in alternative renewable energy markets.

Another relevant methodological element has to do with the particular selection of Germany and Brazil as the country economies to be compared in relation to the wind power markets set up, operation and regulation, in despite of the different levels of development, wealth and technology access.

The main reasons for choosing Germany as the representative of the highly industrialized country economies in this comparative case study are:

a) Germany is the leading country economy in European Union.

⇨ Germany is the largest national economy in the European Union and the world's fourth largest economy, with a gross domestic product (GDP) of 3,478 billion US dollars (2012) , according to data provided by (German Federal Foreign Office, 2013);

b) Germany is a worldwide benchmark in relation to alternative renewable energy policies.

⇨ According to the 2012 Organisation of Economic Co-Operation and Development (OECD) Environmental Performance Review, Germany is a leader in climate policy and, besides, these environmental policies have generated spill overs such as economic growth, innovation and job creation (OECD, 2012).

On the other hand, the main reasons for choosing Brazil as the representative of emerging and industrializing country economies in this comparative case study are:

a) Brazil is the leading economy of Latin America and a recognized emerging country in the international context.

⇨ According to the 2013 United Nation Development Programme (UNDP) Human Development Report, it is expected that by 2020 the summed gross domestic products of leading emerging industrializing countries like Brazil, China and India will be bigger than the economic outputs of Canada, France, Germany, Italy, the United Kingdom and the United States (UNDP, 2013: iv).

b) Despite the fact that Brazil has already one of the world cleanest energy matrix (not fossil fuel based), the Federal Government is committed to the promotion of renewables.

⇨ The milestone policy was the launching in 2002 of a national policy strategy for promotion of alternative renewable energy sources called PROINFA - Program for Incentive of Alternative Energy Sources.

To summarize, Germany and Brazil would be the illustrative cases for comparison of the effects of regulation mechanisms on wind power markets structure and operation in the contexts, respectively, of a highly industrialized and an emerging industrializing country economy.

The idea is to analyse the effects of government interventions in alternative renewable energy markets, considering the influence of major issues such as the level of development, wealth and technology access on the energy policy goals and respective instruments.

In this sense, Germany would be a kind of "best scenario" reference case for Brazil since it has successfully implemented an alternative renewable energy policy relying on the support of: a)- consistent industrial policy; b)- fairly routinized technological-scientific research and development; c)- less political influence; and d)- minor cash flow restrictions.

In regard to the data collection procedures, the analysis will be based on secondary data, e.g. academic articles, thesis and reports. The objective is to enhance the validity and reliability of the case study by means of multiple sources of evidence.

Chapter 3
Alternative Renewable Energy Policy Design and Wind Power Market Regulation: The Case of Brazil

This chapter will focus on the specific strategies utilized by emerging industrializing country economies to promote alternative renewable energy policies, taking Brazil as a representative case.

The first section provides a brief and general overview of the Brazilian power sector history and its institutional framework, whereas the second section is meant to present the major elements that guide the design of these alternative renewable energy policies, considering the particular values, needs and priorities of emerging industrializing country economies.

Finally, the last section is intended to identify and to discuss the associated policy instruments that have been used to implement those policies in Brazil and the corresponding effects, taking the wind power market regulation as the reference.

3.1 The Brazilian Power Sector – Brief History and Institutional Framework

In order to better understand the further sections on the Brazilian alternative renewable energy policy and the respective policy instruments used to promote wind power markets, it is useful to first draw a brief history of the national power sector and the corresponding institutional framework.

The development of the national power sector in Brazil goes hand by hand with the urbanization and industrialization processes. Indeed, in the beginning of the last century Brazil still had the majority of its population living in rural areas and, on the other hand, there were few industries located basically at São Paulo and Rio de Janeiro States.

By this time, the energy supply was derived mainly from firewood and imported coal that were sufficient to meet the existing demand. However, the international crisis of the first half century (World War I, the 1929 financial crisis and the World War II), summed with continuous exodus from the countryside to the main cities forced the maturing of industrialization and, consequently, increased the energy demand.

Successive developmental governments set planning and infrastructure as national priorities. For instance, under the President Juscelino Kubitschek mandate (1956-1961), there was launched a program called "50 years in 5" in which roughly half of the investments were driven towards the energy sector (Leite, 2009: 12). As a consequence, the power sector increased in terms of size, complexity and corresponding inner capacity and technical skills.

However, this pattern of high economic growth and state led investments was to be drastically changed due to the impact of the oil crisis of 1973 and 1979. Although the need to enhance energy security through diversification of the energy matrix and consequent reduction of the dependence on fossil fuels arose during the 1970s, the design of policies for development of alternative renewable energy sources, like the wind power, is a much more recent concern of the Federal Government. Indeed, these alternative renewable energy policies were strengthened mostly after the severe energy shortage of 2001, as will be shown in the next section.

During the 1980s, called the "lost decade" for Latin America, the financial crisis got even worse with an increasing foreign debt and stagflation that culminated in a declaration of moratorium to the International Monetary Fund - IMF in 1987.

At the time of the country re-democratization (1989), influenced by neoliberal ideas, many blamed the State for the little economic growth and debt crisis and, thus, advocated the need of its retrenchment (Tankha, 2008: 7). As part of the structural adjustment programs, the chosen solution in the 1990s was to implement an agenda of privatization and deregulation, which affected main infrastructure sectors such as the electric power industry.

In order to promote competition, free markets and an adequate environment for private investments, there were made significant changes in the institutional framework. In this sense, it was created an electricity regulatory agency – ANEEL, in 1996, an independent operator of the national power system - ONS and a wholesale electricity market – MAE, in 1998.

Along with the guarantee of free access to the distribution and transmission networks and privatization of state owned electric utilities, these initiatives aimed to provide the adequate environment to promote competition, liberalize markets and attract private investments.

Under the macroeconomic stability and inflation control provided by the economic "Real Plan", privatization proved to be very successful in the beginning. For example, between 1995 and 1998, the majority of the state owned electricity distribution companies (DISCOs) were sold, representing roughly 80% of the retail energy traded (Tankha, 2010: 187).

Nevertheless, the financial crisis of Asia (1997) and Russia (1998) deeply damaged the national currency value. This affected the DISCOs privatization process since it was much dependent on foreign investments and high levels of hard currency debt (Tankha, 2008: 11). As a consequence, the privatization process of the DISCOs stopped and that one planned for the generation companies (GENCOs) collapsed.

The macroeconomic stability provided by the "Real Plan" was eroded by the international financial crisis and the associated sharp reduction on the foreign inflows of exchange. This led to the privatization failure since it was backed on the assumptions of sustainable economic stability and growth (Tankha, 2008: 34).

A great change occurred during the two consecutive mandates of the former President Luiz Inácio Lula da Silva, from the Worker's Party (2003-2010). During this period, the privatization process was stopped and a new legal and institutional framework for the electricity power sector emerged.

The enactment of Federal Laws n.° 10,847/04 and 10,848/04 established the legal framework for the new model of the power sector based on the pillars of security of supply and affordability of the electricity tariffs.. In this new institutional framework, the central government took again the lead in respect to the long term planning of the energy sector. In this sense, it was created in 2004 a body for research and planning studies, the Energy Research Office – EPE, directly attached to the Ministry of Mines and Energy – MME.

In order to address the issue of security of supply, it was created in 2004 the Electric Sector Monitoring Committee – CMSE, with the purpose of monitoring and evaluating the continuity and the security of national electricity supply.

As a consequence of this new regulatory framework there were created two different markets for energy trading: the "Regulated Contracting Environment" or "Captive Market" (ACR) and the "Free Contracting Environment or "Free Market" (ACL). As pointed out by (Souza and Legey, 2010: 1716), the ACR was meant to protect small consumers while on ACL environment there was free choice of energy suppliers for large consumers. This new environments for energy trade liberalized markets and allowed competition to be set in former pre-existing natural monopolies.

Another distinguishing characteristic was that on the ACR the distribution agents must purchase the energy to meet their respective planned demands in advance by means of mandatory previous auctions, whereas, on the ACL bilateral energy contracts were freely negotiated among the agents.

In terms of policy instruments to promote renewables, it is worth mentioning that auctions were chosen as the mechanism to help achieve the target of tariff affordability, basically from 2007 on, due to the inherent competitive process and consequent costs reduction.

On the other hand, the security of energy supply was to be enhanced through contracting in advance the planned energy demand of distribution agents which was backed by long term power purchase agreements.

This strategy provided a safer climate for investments since information asymmetry and risks were lowered due to in advance guarantee of energy purchase for suppliers and energy demand meeting for customers.

Following this narrative, the next section will deal specifically with the issues of alternative renewable energy policy design in the Brazilian context.

3.2 Alternative renewable energy policy design

The present Brazilian energy policy is regulated by the Federal Law n.° 9,473/97. According to this legal instrument, the national policies for the rational use of energy sources will seek, among others, the following objectives:

II - promote the development, enlarge the labor market and enrich the energetic resources.

III - protect the consumer interests regarding prices, quality and supply of products.

IV - protect the environment and promote the energy conservation.

VIII - use alternative energy sources by means of economic utilization of available inputs and the applicable technologies.

XVII - promote the research and development related to renewable energy.

Thus, it is possible to notice that the Brazilian energy policy encompasses some targets that are equally pursued by highly industrialized countries such as security, quality and affordability of energy supply, as well as environmental compatibility.

In 2004, a new model was established for the Brazilian electric power sector through the enacting of Law n.º 10,848/2004 and Decree n.º 5,163/2004. The new model was based on two pillars: the delivery of energy at the minimum tariff and the security of energy supply.

Therefore, the range of energy policy objectives is not restricted solely to energy matters since it is expected that this policy contribute to the broader social and economic development.

In relation to this issue, the current President of the Brazilian Energy Research Office – EPE while comparing the energy policy objectives of developed and developing countries concluded that (Tolmasquim, 2004: 1439):

> *"A developing country like Brazil has some of the same objectives and interests as the United States and other industrialized nations with respect to energy policy - namely to diversify its energy sources, reduce its import dependence, and cut inefficiency and energy waste. But Brazil and other developing countries also have some differing objectives and priorities - namely to ensure adequate energy supplies and avoid energy shortages, limit investment requirements for meeting energy service needs, and foster social development".*

Moreover, he claims that in the specific case of Brazil renewables could contribute to the diversification of energy supply, as well as to the promotion of new industries, jobs creation and social and economic development of poorer regions (Tolmasquim, 2004: 1440).

Therefore, it can be noticed that the intervention of the government in alternative renewable energy markets is not justified solely on the basis of promoting competition or providing adequate environment for markets development. Rather, the government motivations and incentives may be translated into policies designed to meet objectives that go far beyond the immediate energy issues themselves.

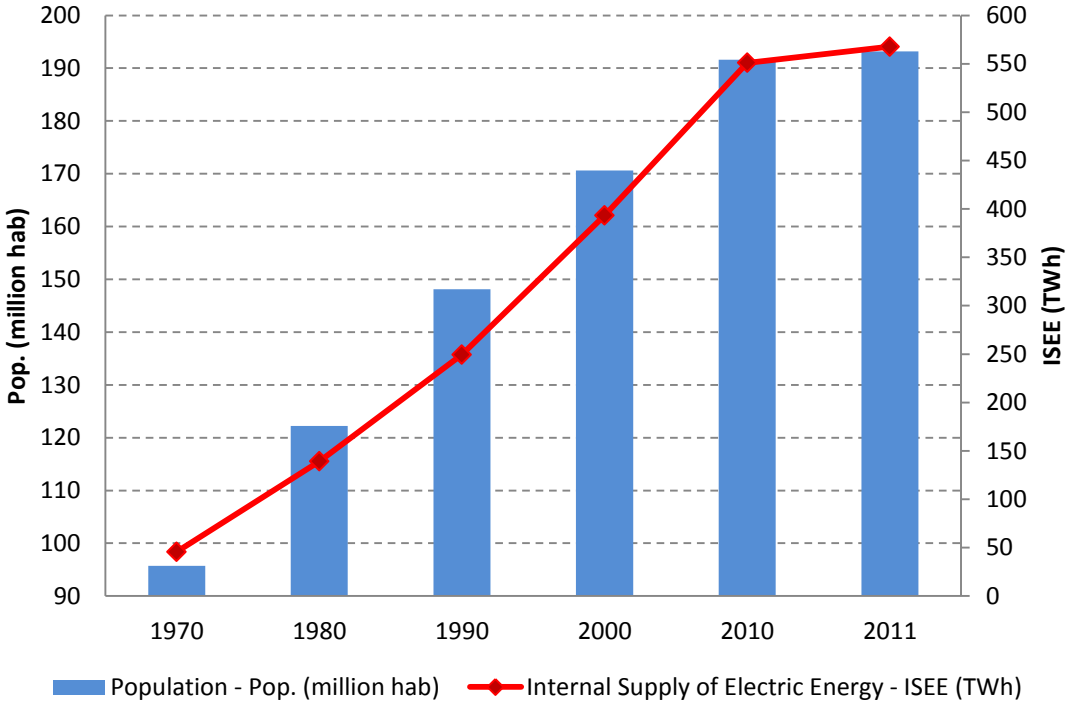
According to (Goldemberg, 2004: 1145), other factors such as the concern associated with climate change summed with an increased awareness in regard to sustainable development have also contributed to strengthen the support for renewables in Brazil.

In spite of the fact that energy security is a major issue, alternative renewable energy sources have also an important role associated with the energy supply complementarity. In the words of (Goldemberg, 2008: 26), renewables are critical to meet energy demand especially in developing countries.

In this regard, it is important to highlight that the participation of renewable energy sources in the Brazilian energy matrix is expressive, accounting for 44.1% in 2011, whereas it accounted only for 8% among OECD countries in 2009, according to the Synthesis of the 2012 Brazilian Energy Balance, elaborated by the Brazilian Energy Research Office (EPE, 2012: 15).

Another distinguishing feature of the Brazilian electric sector is the increasing energy demand, which is a characteristic pattern of emerging country economies, where population growth and intense industrializing process put pressure on energy supply. This issue is illustrated on the next Figure 3.1 where the demographic changes and the respective impacts on the national supply of energy are shown, over the last 4 decades, taking as reference the data provided by (EPE, 2012: 45).

Figure 3.1: Demographic growth and internal energy supply of electric energy – Brazil (1970 – 2011)



Source: (EPE, 2012). Graph elaboration of ours.

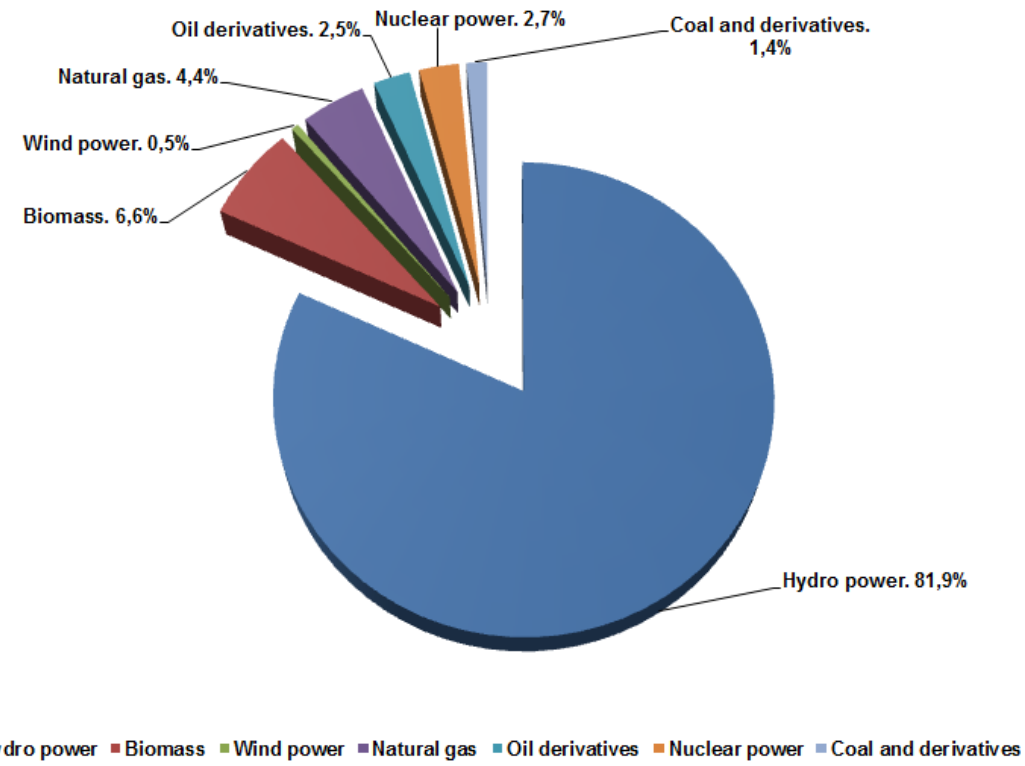
According to (Tolmasquim, 2012: 250), the total energy demand will have an annual growth rate of 5.3% during the next decade and, by 2020, it is estimated that the electricity consumption will reach the amount of 730 TWh, which is 61% higher than that one registered in 2010. Thus, it can be noticed that the increasing population size and the intense process of industrialization put pressure on the necessity of enlarging the energy supply.

On the other hand, the question of "cleaning" the energy matrix, i.e., turning it less dependent on fossil fuels, is secondary to Brazil when compared to OECD countries, due to the fact that there is already a predominance of renewable energy sources in the Brazilian energy matrix.

Therefore, (Tolmasquim and Wachsmann, 2003: 1033) argue that since Brazil has already mostly a renewable based energy supply, the main challenge is to meet the rising energy demand, rather than reducing fossil fuel utilization. In this sense, wind power could play a relevant role in regard to energy complementarity in Brazil.

According to (EPE, 2012: 32) the participation of renewables in electricity generation has reached in 2011 the level of 88.9% in Brazil, whereas the participation in OECD countries and on a global scale, by 2009, were of 18.3% and 19.5%, respectively. The Brazilian electric energy matrix is detailed on Figure 3.2 by source of energy.

Figure 3.2: Brazilian Electric Energy Matrix composition by source



Source: Data from (EPE, 2012). Graph elaboration of ours.

According to the Brazilian Decennial Plan of Energy Expansion, it is estimated that renewable energy sources will account for 46.3% in the total primary supply of energy by 2020, i.e., Brazil will continue to figure as the country with the most clean energy matrix in the world (Tolmasquim, 2012: 249-250).

In summary, regardless of the policy objective, alternative renewable energy sources are considered of strategic importance and, thus, the promotion of renewables economic utilization was specifically highlighted in the aforementioned legal framework. Amongst the reasons for renewables strategic importance, we may cite the following: i)- state sovereignty enhancement by means of diversification of the energy matrix and consequent strengthening of the national energy security; ii)- complementary of energy supply for demand meeting; iii)- negative externalities decrease in regard to pollution and consequent threatens to climate change; and iv)- spillovers on other government policies such as scientific and industrial policy promotion.

In light of the present discussion it is possible to verify that the design of effective alternative renewable policy instruments is strategic due to the fact that they may have potential spillovers for instance on the industrial policy, on the scientific-technological policy, on exports and on jobs generation, as will be shown in the next section.

3.3 Policy instruments for wind power market regulation

This section will present and discuss the main policy instruments chosen by the Brazilian Government in order to promote and regulate wind power markets:

a) The Program for Incentive of Alternative Energy Sources – PROINFA;
b) Auctions;
c) Fiscal and Financial incentives; and
d) Regulatory incentives.

Then, this chapter will be finalized with an analysis of the effectiveness of those applied policy instruments, i.e., the extent to which the associated policy objectives were realized and, also, eventual positive spillovers in terms of impacts and outcomes on the industrial and scientific-technologic Brazilian policies.

3.3.1 Program for Incentive of Alternative Energy Sources - PROINFA

The Brazilian Program for Incentive of Alternative Energy Sources - PROINFA was designed to diversify the Brazilian energy matrix in the context of the severe energy crisis of 2001, as can be seen in its official legal motivation statement, (Brasil, 2001: 1):

> *"2. The Federal Government has been sensitive to the current energy crisis situation that has demanded the intervention of the Executive in order to match the demand and the supply of electric energy"*
>
> *"13. Due to the critic situation of the energy sector of this year that has been faced by the country with sacrifices of all Brazilian citizens, there is an urgent necessity of promoting investments and incentives to the production of electric energy that is independent of meteorological issues (…)"*

The issue of lack of competitiveness of this infant industry and the need of creating an adequate respective market were also matters of concern of the government (Brazil, 2001: 4):

> *"17. The high unitary initial cost and the high risk perception of the potential entrepreneurs have inhibited the investments in alternative energy sources. Since the market growth of these energy sources is reduced in this condition, it is not possible to achieve adequate scales of equipment manufacturing and its capital unitary costs do not decrease in a scale sufficient to turn these technologies competitive as an emergent industry. This perverse cycle has to be broken"*
>
> *"18. In these conditions, it is important to create an initial market guaranteed with sufficient size to finally generate scale gains and relevant unitary capital costs reductions"*

These were the major motivations that pushed the enacting of PROINFA, in 2002, by Law n.º 10,438/2002, with the objective of increasing the participation of alternative renewable energy sources, supplied by wind power, small hydro and biomass plants, on the national electric grid system (Brazil, 2002).

According to this Law, the PROINFA program was structured in two different phases whose main characteristics are described below:

a) Phase 1:
   - ⇨ The objective was to install an additional power capacity of 3.3 GW, equally shared among the chosen alternative renewable energy sources (wind power, small hydro and biomass plants);
   - ⇨ This additional amount of installed capacity was to be contracted by means of previous Public Calls;
   - ⇨ ELETROBRAS, the biggest electric power company in Latin America, whose majority of stocks is owned by the Brazilian Government, was in charge of celebrating the long term power purchase agreements (20 years);

- ⇨ The alternative renewable energy plants to be built had to have a mandatory minimum nationalization index of 60%, i.e., the value of the respective Brazilian equipments and services should account for a minimum of 60% in relation to the total.

b) Phase 2:
   - ⇨ After the accomplishment of the first phase goal regarding the installing 3.3 GW additional power capacity, the second phase was designed to guarantee that 10% of the total annual electric energy consumption would be met by the chosen alternative renewable energy sources (wind power, small hydro and biomass plants); and
   - ⇨ Minimum nationalization index of 90% in relation to the equipments and services of the alternative renewable energy plants to be built.

Besides the specific objective of increasing the share of wind power, biomass and small hydro energy sources in the total supply of electric energy, PROINFA was created to achieve the following strategic objectives (Planalto, 2002, as cited by Hashimura, 2012: 73):

a) Diversification of the national energy matrix;
b) Enhancement of the internal supply security;
c) Generation of jobs and capacity building; and
d) Reduction of greenhouse gas emissions.

The design of PROINFA was based on the Feed-in Tariff (FIT) system adopted by Germany, as further explained in depth in Chapter 4. Since Germany is a well-recognized benchmark country economy in this field, it represented a conservative but safe strategy in the sense that Brazil was following the path of the leader, a natural tendency in worldwide renewable energy programs (Dutra and Szklo, 2008: 67).

Although Brazil adopted in general the FIT system as the main design of PROINFA, there were also some distinguishing features. In this sense, as argued by (Costa, 2006: 138), one particular characteristic was that in the Brazilian case there was a limitation of 3.3 GW in the power capacity to be contracted. Moreover, another specificity of the program relied on the fact that the Public Calls decision criterion was based on the issuing seniority of the respective environmental permits.

The original timeframe for implementing the Phase 1 of PROINFA was set to end on December 30th, 2006. Nevertheless, successive delays forced the change of this schedule. The last modification was introduced by the Law n.º 12,431/2011 which determined that the deadline for beginning of operation of the generation plants related to the first phase of PROINFA ended on December 30th, 2011. Up to now, only the Phase 1 of PROINFA has been implemented and, thus, its major results will be discussed in the following.

As it was mentioned before, Public Calls were the chosen instruments to provide competition in the process of selecting the supply agents that would be in charge of installing the additional power capacity of 3.3 GW, based on alternative renewable energy sources. In this regard, the Table 3.1 below summarizes the results of the two Public Calls conducted in 2004 in order to select projects:

Table 3.1: Results of PROINFA "Phase 1"

Source	Number of Power Plants	Contracted Power (MW)	Share (%)
Small Hydro	63	1191,24	36,10
Wind	54	1422,92	43,13
Biomass	27	685,24	20,77
Total	144	3299,40	100,00

Source: (Prado et al. 2008: 2). Table edition of ours.

It can be noticed that the initial planning regarding balanced share among the three chosen alternative renewable energy sources was not achieved. In this sense, while the wind energy source was the most successful in terms of selected projects (43%), the biomass energy source accounted only for approximately 20% of the total contracted power in the two Public Calls promoted by the Federal Government in 2005.

In this regard, (Oliverio, 2004, as cited by Dutra and Szklo, 2008: 68) points out that the tariff defined by the government did not guarantee the economic feasibility of new biomass projects considering their opportunity costs. As a consequence of the lack of market interest towards biomass projects in the Public Calls, the original quota reserved for biomass projects was redistributed between wind and small hydro plants.

Despite this imbalance in terms of contracted power share, the Public Calls enabled the contracting of the planned amount of 3,300 MW power based on alternative renewable energy sources.

According to (ELETROBRAS, 2012) the power plants built under PROINFA accounted for a total installed power capacity of 2,649.87 MW encompassing 41 wind power plants (963.99 MW), 59 small hydro plants (1,152.54 MW) and 19 biomass plants (533.34 MW). These results show that the original targets defined for each alternative renewable energy source were partially achieved (Table 3.2).

Table 3.2: PROINFA Phase 1 results – installed power capacity

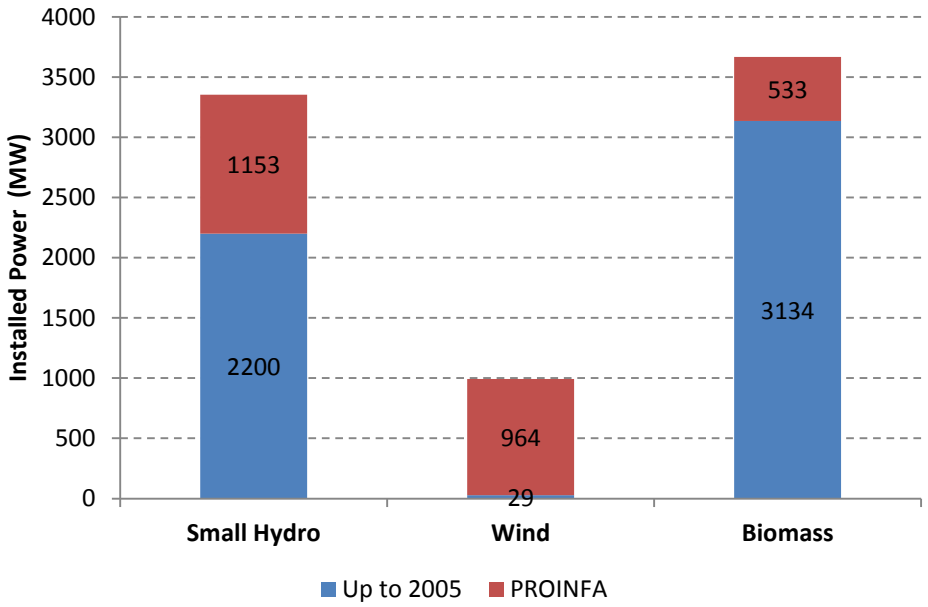
Source	Contracted Power (MW)	Installed Power (MW)	Target Accomplishment (%)
Small Hydro	1191,24	1152,54	96,75
Wind	1422,92	963,99	67,75
Biomass	685,24	533,34	77,83
Total	3299,40	2649,87	80,31

Source: (ELETROBRAS, 2012). Table elaboration of ours.

It can be noticed in Table 3.2 that the wind power based projects had the smallest level of target accomplishment (68%) when compared to the small hydro (97%) and biomass projects (78%).

Nevertheless, PROINFA contribution to the national installed wind power capacity was the most significant since it accounted for an increase of 935 MW or 3324% in relation to the installed power capacity that existed in 2005 (29 MW), as shown in Figure 3.3.

Figure 3.3: PROINFA contribution to the Alternative Renewable Energy Installed Power Capacity in Brazil



Source: (ELETROBRAS, 2012 & MME, 2009). Graph elaboration of ours

Besides the energy matrix diversification, (ELETROBRAS, 2012) informs that PROINFA had other spillover effects on other policies since the program is acknowledged to have promoted the creation of roughly 150,000 direct and indirect jobs and, additionally, to have enabled the reduction of greenhouse gas emission corresponding to approximately 2.5 million tons of CO_2 eq/year.

In relation to PROINFA effectiveness (Amorim, 2013: 34) argues that regardless of the fact that the original program schedule was delayed and, moreover, the initial goals were not fully achieved, this program was a fundamental initiative for the creation and development of a renewable energy market in Brazil, especially for wind power.

The next section will tackle the issue of how auctions have contributed to promote renewables and strengthen the associated industry competitiveness.

3.3.2 Auctions

The motivation to choose auctions as preferential policy instruments to promote renewables in Brazil arose from the necessity to guarantee more affordable prices by means of market competition, along with the aim to provide price disclosure and procurement efficiency (Barroso, 2012: 9).

This view is also shared by (World Bank, 2011: xi) which argues that auctions are effective instruments to promote competition in a more transparent way, enabling greater affordability of the energy tariff prices and also attracting new players for the market.

In order to contribute to the target of lowest energy prices, there were established 4 types of energy supply auctions in the regulated contracting environment - ACR (Acende Brasil, 2012: 3-4):

a) New Energy Auction:

   ⇨ The expansion of the energy supply is promoted by means of New Energy Auctions, i.e., energy purchase auctions from new generation plants;

b) Existing Energy Auction:

   ⇨ The contracting of energy from already operating power plants is made through Existing Energy Auctions;

c) Reserve Energy Auction:

   ⇨ The government may choose to contract new generation power plants to enable a "reserve capacity" in order to increase the security of energy supply by means of Reserve Energy Auctions;

d) Alternative Energy Source Auction:

   ⇨ The Alternative Energy Source Auctions have the objective of promoting the contracting of energy exclusively from biomass, wind power and small hydro power plants.

Amongst all types of auctions, the Alternative Energy Source Auction is regarded as the most important policy instrument to promote these kinds of energy sources, since they have contributed to turn renewable energy technologies fairly competitive with lowering prices arising from the tendering processes.

In this regard, it is important to highlight that the first Alternative Energy Source Auction was held only on 2007. In this occasion the purchased energy came solely from biomass and small hydro plants due to still non-competitive energy prices for wind power.

On the other hand, the first auction directed exclusively towards wind power based plants occurred on 2009 in the form of a "Reserve Energy Auction". This technology driven auction was very successful since there was purchased the relevant amount of 1,8 GW of wind power at a very competitive price. In this sense, as argued by (Pereira et al, 2012: 3799), the average discount in this auction was of 21.5% when compared to the ceiling price of US$ 114 established by ANEEL.

According to this author, the lowering energy prices for the auctioned wind power benefited from various factors such as: i)- fiscal and financial incentives, e.g. tax liability of roughly 30% of the investment and special financing conditions established by the Brazilian Development Bank (BNDES); and ii)- the excess of supply in the European wind power industries motivated by the economic crisis that reduced the demand for new wind power plants in Europe.

This positive result motivated the realization of other auctions in the following years when wind power competitiveness was tested in auctions open to other energy sources. The strategy proved to be right since wind power had an excellent performance in these auctions.

In this regard, in 2010, according to (Barroso et al, 2012: 27), wind power alone corresponded to the impressive amount of approximately 80% of all contracted energy, with average prices of, respectively, 80 and 73 US$/MWh in the regular and reserve auctions.

Moreover, in 2011, wind power proved to be even more competitive with an average price of 60 US$/MWh, outclassing traditional and usually less expensive energy sources like natural gas that presented a higher price of 62 US$/MWh.

In the overall, the impact of auctions in regard to renewables promotion in Brazil can be measured for instance by the fact that, according to (Barroso et al, 2012: 26), they were responsible for contracting the amount of 31 GW in terms of new power capacity since 2005, encompassing 40% of conventional hydro based projects and 20% of non-conventional renewables. In terms of investments, they have accounting for the expressive amount of US$ 300 billion in long-term power purchase agreements.

Finally, in relation specifically to wind power, it is possible to conclude that it has been the most successful when compared to the other auctioned alternative renewable energy sources. For instance, this leadership may be noticed by the fact that wind power had a relevant share of 11% over the total purchased energy until the end of 2016, whereas biomass and small hydro accounted for 4.8% and 1.6%, respectively (Acende Brasil, 2012: 30).

In light of the previous discussions, the next subsection will present a brief comparative analysis between FIT and auctions deployment in Brazil. The objective is to analyze potential trends for emerging industrializing country economies in regard to preferential policy instruments to promote renewables.

3.3.2.1 Brief comparison between FIT and auctions in Brazil

In spite of the well acknowledged importance of PROINFA to the creation of an initial market for renewables, auctions performance is such that nowadays they are regarded as the most effective policy instruments for the promotion of non-conventional renewable energy sources in Brazil, especially in regard to wind power (Barroso et al., 2012: 25).

Moreover, due to the fact that PROINFA and auctions have similar objectives and since there is not yet an official decision regarding the continuation of this program, some authors believe that Alternative Energy Auctions have already been chosen by the Federal Government as the main mechanisms to promote the expansion of renewables (Acende Brasil, 2012: 6).

Indeed, as cited before, the second phase of PROINFA has not yet been initiated and there is no official government information associated with the continuation of the program. In this regard, authors like (Hashimura, 2012: 76-77) argue that the second phase may even be cancelled due to the perceived advantages of specific auctions to promote these alternative energy sources.

The critical issue arose due to the fact that although PROINFA was fundamental to establish an embryonic market structure for renewables, e.g. 1,3 GW of wind power contracted capacity, the corresponding wind power energy prices were not competitive compared to other technologies. For instance, by 2005, wind energy prices were as high as 170 USD/MWh, whereas small hydro plants and biomass had significantly lower prices of 70 and 96 USD/MWh, respectively (Barroso, 2012: 7).

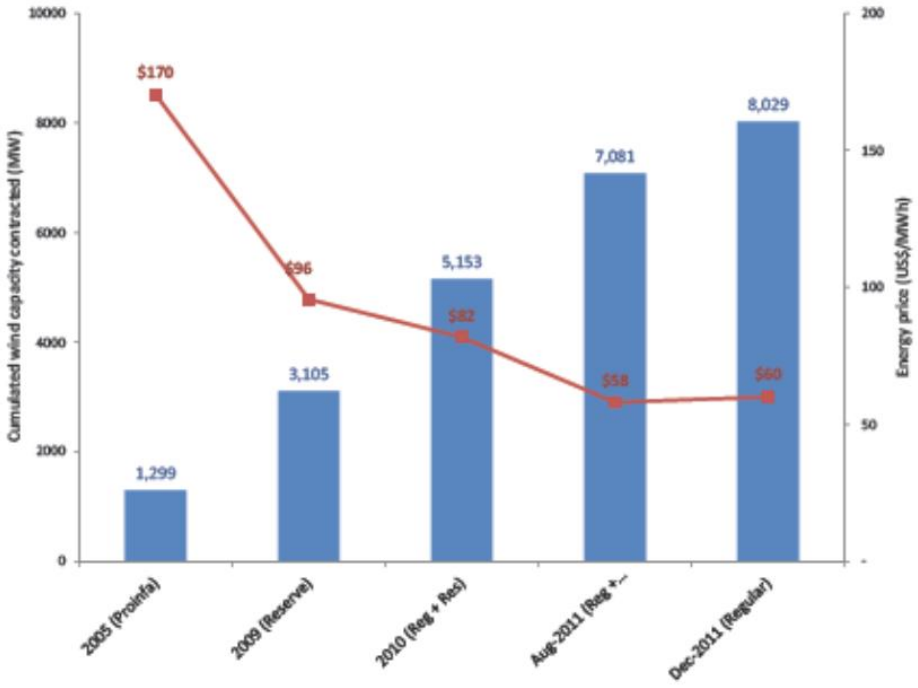
The design of PROINFA had some features that made difficult the broader deployment of renewables and, especially, their competitiveness gain. For instance, as argued by (Barroso, 2012: 8), among the major difficulties we may cite the existing information asymmetry between the government and the manufacturers in the determination of the economic value for renewables, and the constraint posed by the minimum nationalization index of 60% when there was only 1 supplier in Brazil at this time.

Thus, there was an urgent need of improving the existing design of the policy instrument in order to enhance the efficiency, which could be translated by higher deployment of renewables backed on more affordable energy prices.

For wind power, the turning point began in the auctions promoted in 2009 as discussed in the previous subsection. However, the success in terms of prices lowering cannot naturally be attributed only to the competition and transparency inherent to auctions. Indeed, auctions were benefitted by a joint effect that encompassed for instance: i)- technology improvements; ii)- excess of supply for the manufactures due to the financial crisis of 2008; iii)- specific financial lines provided by the Development Bank (BNDES); and iv)- regulatory incentives such as discounts in the tariff for use of the transmission and distribution systems.

An interesting comparison between PROINFA and auctions in relation to the promotion of wind power, considering the contribution to installed capacity and prices lowering, is shown in Figure 3.4.

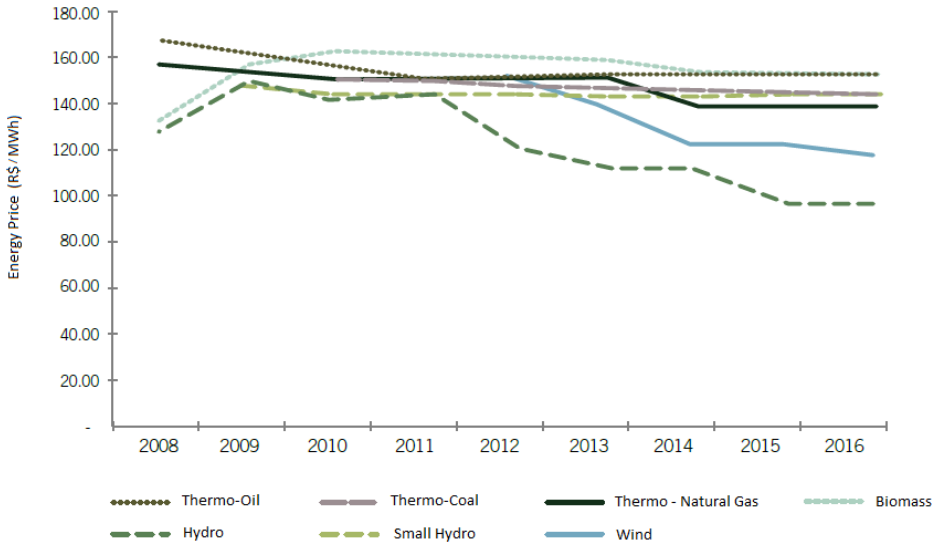
Figure 3.4: Wind power promotion in Brazil – comparison between PROINFA and the auctions



Source: (Barroso et al, 2012: 27)

It can be noticed that auctions contribution to the development of wind power in Brazil was very significant. For instance, until 2011, auctions have enabled an increase of 418% in the amount of cumulated contracted wind power and also an energy price reduction of 64% when compared with the initial PROINFA records of 2005. In fact, currently, the wind power energy purchase price auctioned for 2016 is the second lowest one, lagging just behind hydropower, as can be noticed in the following Figure 3.5.

Figure 3.5: Auctions Average Energy Price



Source: (Acende Brasil, 2012: 33). Graph edition of ours.

It is worth mentioning that the strategy adopted by Brazil to innovate and adjust the policy instrument to promote renewables was applied by other emerging industrializing country economies as well.

For instance, as argued by (Becker and Fisher, 2013: 446), India and South Africa also chose initially FIT as the reference design for renewables policy, following the benchmark model of Germany, and then moved to an auction based tariff system.

These emerging country economies have in common with Brazil the fact that renewables may play an important role in regard to energy demand meeting, which is boosted by an intense industrialization. Moreover, the policy costs of increasing the share of renewables are of vital importance since affordability of energy tariff is a social and political sensitive issue (Becker and Fisher, 2013: 446).

The results obtained so far by India and South Africa are encouraging this experimental approach to policy design since, for example, the energy policy targets for solar power are being effectively reached. This demonstrates that there is no "one size fits all" policy for renewables promotion in emerging country economies (Becker and Fisher, 2013: 453).

In summary, these valuable findings show the relevance of policy experimentation and innovation in order to develop adequate solutions to meet the national needs and priorities.

Finally, it is possible to conclude that auctions cannot solely by themselves contribute to the competitiveness gain of a specific technology, e.g. wind power. Indeed, as pointed out by (Barroso, 2012: 15), the success if function of other factors such as the integration with the overall energy policy, regulatory stability and transparency.

The next session will deal with the role of fiscal and financial incentives as policy instruments to promote alternative renewable energy sources, especially wind power in Brazil.

3.3.3 Fiscal and Financial Incentives

Along with PROINFA and auctions, the fiscal and financial incentives are also important policy instruments to enable the development of alternative renewable energy sources in Brazil.

In this sense, fiscal and financial incentives may contribute to the promotion of this infant industry by means of lowering the capital costs and, thus, decreasing the market entry barriers for alternative renewable energy sources.

Thus, incentives such as tax reduction and favorable lines of credit may induce investments and competitiveness through the creation of a more favorable market environment for these still immature technologies.

For instance, the Brazilian National Bank for Economic and Social Development (BNDES) offered special financial incentives to support the development of PROINFA. In this sense, as pointed out by (IAEA, 2006, as cited by Amorim, 2013: 23), BNDES provided financing that could reached up to 70% of the capital costs for alternative renewables energy projects.

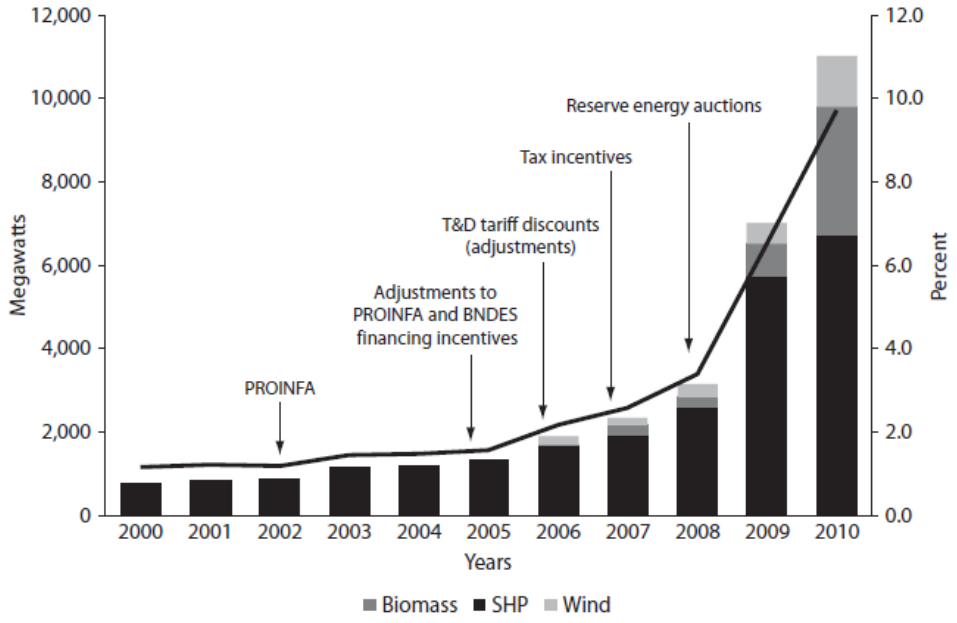
On the other hand, the fiscal incentives also play a relevant role in regard to the promotion of alternative renewable energy sources industries. In Brazil, the fiscal incentives are mainly related to the reduction of tax burden associated with the "Tax over Imported Products" (IPI) and the "Tax over Circulation of Goods, Products and Services" (ICMS).

For instance, according to (Hashimura, 2012: 82-83), there is an ICMS exemption for equipment such as wind power generators, towers for support of wind power generators and photovoltaic generators and a permanent IPI exemption for wind power generators.

In this case, the government objective is broader than the increase in the participation of alternative renewable energy sources in the energy matrix since there is also intention to strengthen the national industry.

The positive influence of these financial and fiscal incentives over the promotion of alternative renewable energy sources (wind power, biomass and small hydro plants - SHP), taking as reference the energy capacity and the share over the total power system, is shown in Figure 3.6.

Figure 3.6: Evolution of Renewable Energy Capacity and Share in Power System in Brazil



Source: (World Bank, 2012: 33).

It can be verified that fiscal and financial incentives helped to increase the contracting of power capacity, as well as the share of alternative renewable energy sources. In this sense, the power capacity almost doubled from 2005 to 2008 and reached the amount of 10 GW in 2010, while the share over the power system increased by a factor of 5 in the period from 2005 to 2010.

Following, the next session will tackle the impact of regulatory incentives used to promote alternative renewable energy sources in Brazil.

3.3.4 Regulatory Incentives

Alternative renewable energy sources have also been promoted by means of specific norms designed by the Brazilian Electricity Regulatory Agency – ANEEL. These regulatory incentives have been formulated to enhance the competitiveness of these energy sources and create an adequate environment for the development of their respective markets.

In this sense, it is worth mentioning the enacting of the Normative Resolution (NR) n.º 77/2004 (ANEEL, 2004) that will be detailed in the following.

The NR n.º 77/2004 established the procedures to reduce on the tariff use of transmission and distribution systems for wind, biomass, small hydro and solar power based plants.

The reduction factor was defined as 50% of the respective costs for use of the transmission and distributions systems, which represented an important incentive for these alternative renewable energy sources since these costs are relevant elements in the process of energy price definition.

Besides, these costs for use of the distribution and transmission systems are function of the distance between the generation plant and the associated load to be supplied and, thus, the tariff burden is sensitive to the location of the generation agent, to the network topology and to new network entrants. As a consequence, the annual tariff may have a volatile characteristic which represent an added risk to the entrepreneurs due to possible tariff prices variation.

In order to tackle this price risk, the norm was adjusted in 2007 through the NR n.º 267/2007 (ANEEL, 2007). According to this NR there was defined a mechanism to stabilize the tariff for generators participants of the auctions for a period of 10 years. Whenever there was a difference between the tariff established in the auctions and the annually defined one, this difference was to be supported by the consumers and not the generation agents. Thus, this norm enhanced the market security for new investments.

In June 27th, 2013 the NR n.º 267/2007 was modified by the enacting of the NR n.º 559/2013 (ANEEL, 2013b) which established new procedures to calculate the tariff for use of the transmission system. According to this new norm, there was defined a single tariff to be adopted during all the grant period for generators of the ACR (captive market).

The logic of these norms is based on the reduction of information asymmetry among the market agents. In this sense, since the generator agent has previous information regarding the future costs of the network use, the risks associated with tariff variation are decreased and, consequently, this will enable lower energy prices to the final consumers.

It is worth mentioning that the growth of wind power in Brazil has induced positive effects that go beyond the energy sector itself, i.e., energy matrix diversification and security of energy supply. For instance, (Pereira et al, 2012: 3800) argue that the spillovers can be noticed on the scientific and industrial sectors as well since it enabled technological capacity building in this field, along with the establishment of various multinational industries for manufacture of equipments and related services, promoting as a consequence the creation of new courses at the Academia and jobs opportunities in the labor market.

This chapter has presented and discussed the major policy instruments adopted by the Brazilian government in order to promote alternative renewable energy sources and regulate the corresponding markets, focusing on the case of the wind power which is the most successful initiative within this set of energy sources.

The next chapter will be centered on the analysis of the policy design and the respective chosen instruments that were applied by Germany, a highly industrialized benchmark country economy, to promote alternative renewable energy sources and intervene in the associated markets, taking again as reference the wind power market case.

Chapter 4 Alternative Renewable Energy Policy Design and Wind Power Market Regulation: The Case of Germany

This chapter will deal with the issue of government intervention in alternative renewable energy markets, taking as reference the wind power market regulation, by the perspective of a highly industrialized country economy.

The analysis will be focused specifically on the policy design and on the respective instruments that were applied by Germany, the selected country economy to compare the particular strategies adopted by highly industrialized country economies to promote, regulate and intervene on wind power markets.

4.1 Alternative renewable energy policy design

According to the German Federal Ministry of Economics and Technology - BMWi, which is in charge of the formulation and implementation of the national energy policy, the central aims of the German energy policy are economic efficiency, security of supply and environmental compatibility (BMWi, 2013a).

Firstly, the economic efficiency is understood as the means to guarantee the economic viability of energy supply and use based on "*market economy structures and effective competition*" (BMWi, 2013a). In this regard, the current energy reform known as *Energiewende* (energy transition) is based on the market principles and seek to promote full competition in the energy sector (BMWi, 2013b: 22).

Secondly, the security of supply is mainly related to the country energy demand meeting. In order to enhance security of supply the efforts are being concentrated not only on increasing the generation park, but also on other mechanisms such as diversification of the energy matrix and rational use of energy.

In addition to the reliability of energy supply there is a major concern in relation to the associated costs to provide competitiveness of German industry. Therefore, as stated by (BMWi, 2013b: 4), the affordability and reliability of energy supply are considered pillars of the German industry competitiveness.

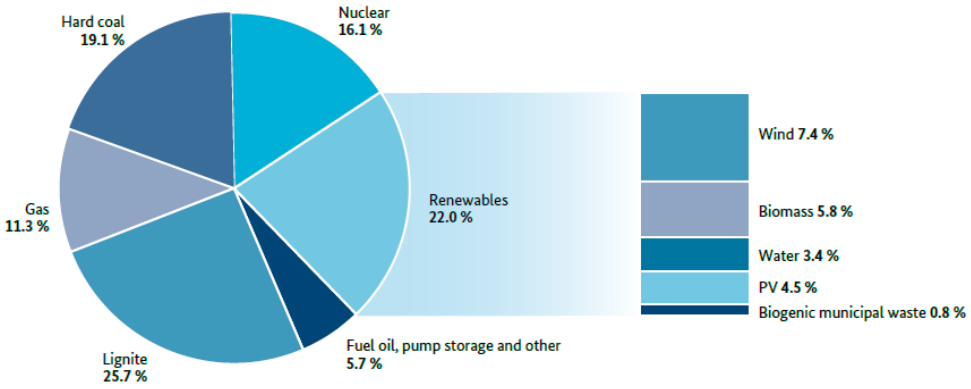
Finally, environmental compatibility means the rational and careful utilization of natural resources in order to enable an effective climate protection. In order to accomplish this target, the government is focusing on greenhouse emissions reduction and on the increasing of the participation of renewable energy sources on the energy mix.

In light of the aforementioned central aims of the German energy policy it is possible to notice that renewable energy sources promotion, based on a competitive and market led environment, is essential to the achievement of the national energy policy objectives since they may contribute to security of supply and to environmental compatibility.

This strategic importance of renewable energy is acknowledged in the current *Energiewende* where the challenge was identified as the design of an adequate market based regulatory framework that will enable a reliable and affordable energy supply, given a growing share of renewables that are expected to reach at least 80% of power generation by 2050 (BMWi, 2013b: 3).

In fact, renewable energy sources are even more crucial when we take on account that Germany is dependent on energy imports and has also a fossil fuel based energy matrix, as can be seen on Figure 4.1.

Figure 4.1: Gross Power Generation in Germany, 2012



Source: (BMWi, 2013b: 13)

Indeed it is expected that renewables which account nowadays for 22% of the gross power generation will increase their share sharply in the coming years, especially after the disaster at the Japanese Fukushima nuclear power plant and the consequent decision of the German government to phase out all nuclear power plants until the end of 2022.

It is relevant to emphasize that wind power has the largest share amongst the renewable energy sources, accounting for roughly 7.5% of the national electric demand.

Besides the energy sector itself, the wind power industry plays an important role to the German economy. For instance, in 2011, the investments reached the amount of 2.95 billion EUR and there were more than 100,000 people working in this business (IEA, 2012b: 104-105).

As will be shown in the following, the successful development of wind power industry in Germany is a consequence of more than 4 decades of government interventionist policies to promote renewable energy sources that led to the energy policy transition and reforms known as *Energiewende*, which is acknowledged as a major political and economic initiative (BMWi, 2013b: 3).

Indeed, as argued by (Jacobs, 2012: 223), the German efforts to make the energy transition from fossil fuel to renewables with an increasing energy efficiency has been started not after the 2011 nuclear disaster at Fukushima, but a long time ago.

In fact, the awareness regarding the necessity to seek an alternative for the dependence on fossil fuel based energy sources began in the 1970s as a consequence of the oil crisis of 1973 and 1979.

However, in spite of the fact that this scenario of energy crisis theoretically favoured options like the renewables, the creation of an initial market for these energy sources faced the opposition of powerful and dominant interests of coal and nuclear industries (Jacobsson, 2006: 261).

From 1974 until 1988 the major governmental initiative to support renewables relied on the allocation of resources from a research and development (R&D) energy fund. Despite the fact that the resources destined to renewables were much less than those invested in nuclear power projects, this funding was very important to the embryonic phase of renewables development.

A turning point in the energy policy occurred in the late 1980s due to the nuclear disaster at Chernobyl in 1986 and the ulterior pressure for increasing the share of renewables in the energy mix, especially wind power.

In response to popular claims and an increasing lobby of the wind power sector, the government launched in 1988 an experimental program aimed at installing an initial capacity of 100 MW based on wind power. This initial market was later expanded to 250 MW and represented a very ambitious initiative when we take on account that the installed wind power capacity in Germany in 1989 was of only 20 MW.

However, the most important policy initiative came on 1991 with the enacting of the "Electricity Feed-in Law" which in sum turned mandatory the purchase of renewable energy by utilities at a rate which represented 90% of the average tariff for customers (Jacobsson, 2006: 263).

These incentives enabled the creation, expansion and strengthening of wind power industry. For instance, the installed wind power capacity grew from 20 MW in 1989 to 490 MW in 1995 (Jacobsson, 2012: 264), i.e., an increase by a factor of roughly 25 times in the period of 6 years.

Following, the "Renewable Energy Sources Act" of 2000 was another crucial measure for the development of renewables. This norm reinforced the special tariff regime for renewables and established an associated guarantee for 20 years that did not exist before. Thus, there was great diffusion of renewables, especially wind power, due to the increase of security for investors.

This norm was amended in 2009 with the purpose of enlarging the support for wind power industry. Additionally to the priority already given to renewables in terms of network access and power dispatch, the new legislation included preferential feed-in tariffs (WWEA, 2011: 218).

A major regulatory framework was established in 2010 by the creation of a national long term energy plan called "*EnergieKonzept*" in order to design a sustainable energy strategy until the horizon of 2050. The major targets of the *EnegieKonzept* are shown on Table 4.1 below:

Table 4.1: Targets of the 2010 Energy Plan - *EnergieKonzept*

***EnergieKonzept* Objectives**	**2012 Status**	**2020 Target**	**2030 Target**	**2040 Target**	**2050 Target**
Greenhouse gas emissions reduction against 1990 (%)	25,9	40	55	70	80 to 95
Primary energy consumption reduction (%)	6	20	-	-	50
Renewable energies share of gross electricity consumption (%)	22,9	≥ 35	≥ 50	≥ 65	≥ 80

Source: Data from (BMWi, 2013b). Table elaborated by the author.

It can be noticed that the *EnergieKonzept* set ambitious targets in relation to environmental compatibility, energy efficiency and renewable energies share for the horizon of 2050. In this sense, the greenhouse gas emissions are expected to be reduced to at least 80% when compared to the reference level of 1990, while primary energy consumption should be reduced by 50% and renewable energies share should increase at least to 80%.

However, it is worth mentioning that there was a very controversial point in this new plan regarding the establishment of nuclear power phase out in Germany until 2036. Moreover, due to the nuclear disaster at the Japanese Fukushima nuclear power plant on 2011, this issue was submitted to a new consensus and, as a result of great popular and parliamentary pressure, the government agreed to phase out all nuclear power plants until 2022.

This section has discussed the German energy policy design and implementation, particularly in regard to the intervention of the government to develop renewable energy sources. Following this rationale, the next section will focus on the major policy instruments that were used to create, promote and regulate wind power markets.

4.2 Policy Instruments for regulation of wind power markets

As pointed out by (Daugbjerg, 2011: 297), the relevance of policy instruments is such that a "*policy is defined by the combination of policy instruments*". For instance, when analysing the Danish Government intervention strategy in green industries, Daugbjerg argued that the positive impacts of those policies were mostly the results of effective policy instruments. Specifically in relation to the wind power industry success in Germany, this author claims that it was due to government incentives (tariff structure) on the demand side, i.e., targeted at increasing the demand for this type of energy source.

Following this reasoning, this section will deal with the most relevant set of policy instruments that were used by the German government over the past 4 decades to intervene in alternative renewable energy markets in order to promote these energy sources, paying special attention to the case of the wind power market creation and regulation.

In this sense, the following policy instruments will be analysed:

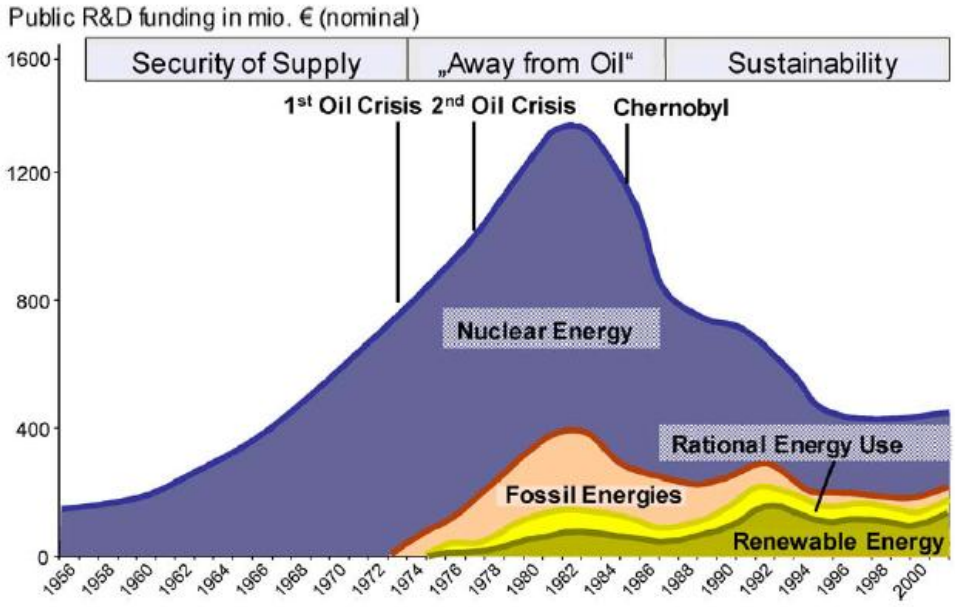
a) Financial incentives; and
b) Regulatory incentives.

4.2.1 Financial Incentives

The first policy instrument used to promote alternative renewable energy sources were financial incentives to allow the participation of these energy sources on the national R&D fund.

As shown in Figure 4.2, the allocation of resources of the public R&D fund had three different priorities: "security of supply" from 1956 to 1972, "away from oil" during the 1970s oil crisis and "sustainability after the 1986 nuclear disaster at Chernobyl.

Figure 4.2: Public R&D funding - allocation of resources



Source: (Wustenhagen, 2006)

It can be noticed that the allocation of resources to renewables began after the first energy crisis of 1973 due to threatens of energy supply security, and later they were increased as a consequence of the concerns over sustainability after the nuclear disaster at Chernobyl in 1986.

In spite of the fact that the amount of resources destined to renewable energies was variable and minor when compared for instance to nuclear power, these incentives were able to promote the initial stage of alternative renewable energy sources.

Moreover, these financial incentives enabled the creation of research groups in the Academia dedicated to renewables technology which contributed to further development of a renewable energy industry in Germany, initially focused on small niche markets (Jacobsson, 2006: 263).

Moreover, it is expected that the renewables share in public R&D funding will increase on the coming years due to the recent government decision to phase out nuclear power until the end of 2022. In this sense, renewables share on the total energy matrix will probably be increased in order to meet the energy demand and the ambitious targets of the *EnergieKonzept* plan for 2050.

These financial incentives have been crucial policy instruments to the promotion of alternative renewable energy industries and the respective markets. This can be verified by the increasing share of renewables in the energy mix, especially wind power that accounted on 2012 to approximately 7.5% of the gross power generation.

The next session will present the effects of regulatory incentives to create, promote and develop renewables in Germany, focusing on the wind power market.

4.2.2 Regulatory Incentives – The FIT system

Considering the broader context of the previous discussion on the *Energiewende*, the legal framework was fundamental to create, protect and develop an initial market for renewables.

Amongst all, the creation of the Feed-in tariff - FIT by the enacting of the "Electricity Feed-in Law", in 1991, was the most important regulatory incentive. The FIT system is the oldest and most spread type of policy instrument designed to interfere in the market price in order to reduce the barriers of competitiveness faced by renewable energy generators when compared to the smaller costs of conventional fossil based energy sources.

In terms of characterization, it is important to highlight that the FIT system encompasses both government and market actions since the first sets the renewable energy price while the latter determines the quantity of renewable energy that will be traded. In summary, (Martins, 2010: 42) understands that the FIT system can be classified as an indirect subsidy applied by means of a government program that turns mandatory the purchase of renewable energy and sets long term contracts with a special tariff, above market price, to be paid by all consumers.

For the sake of clarity, it is worthy presenting the concept of a FIT policy. According to (World Bank, 2012), a FIT policy is a market based mechanism which is part of the broader energy supply policy and aims to support and promote renewables by means of three distinguishing characteristics: i)- guarantee of access to the electric network; ii)- long-term power purchase agreements; and iii)- feed-in tariffs, i.e., preferential tariffs or premium above market prices in order to compensate the higher costs of renewable energy generation.

Thus, (PSR, 2010, as cited by Hashimura, 2012: 34) argues that in summary the functioning of a FIT mechanism depends on differentiated tariffs, on the guarantee of access to the electric network, and on stable long term power purchase agreements with known rules for price formation or adjustment.

Other authors like (Dong, 2012: 476) add that in this sense a FIT can be understood as a price regulation system by which renewable energy suppliers are guaranteed a pre-established rate for the produced electricity over a specific period of time, regardless of the produced quantity of electricity. However, the price may be set differently taking into account, for instance, the specific technology and the plant size ((Couture and Gagnon, 2010: 955)

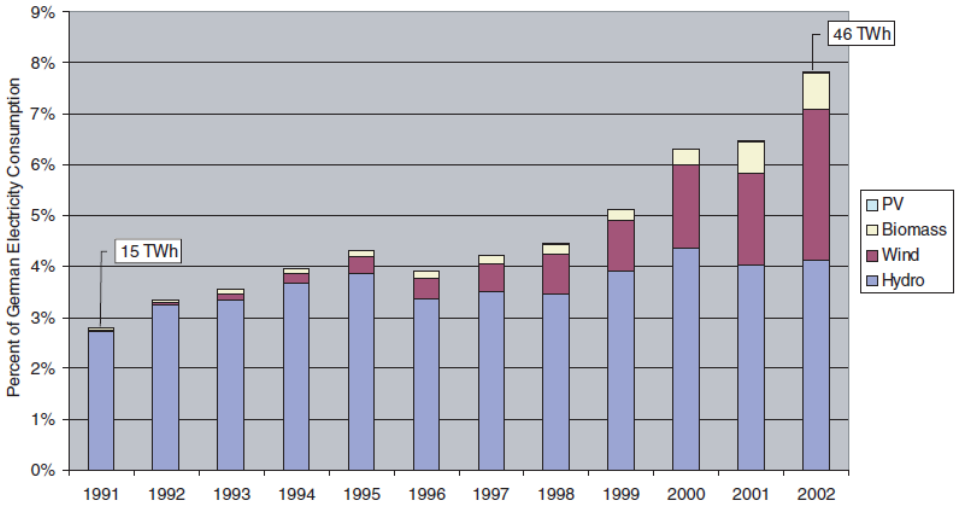
As highlighted by (Lesser and Su, 2008: 983), this guaranteed minimum price for renewable energy is an especial feature of a FIT system since it provides security for investors due to lowered risks associated with enhanced market stability.

However, the setting of the most efficient price is challenging because if the rates are overestimated, they will generate electricity prices rise, while unrealistic low rates will not induce investments on renewables capacity enlargement. As argued by (Couture and Gagnon, 2010: 955-956), the success of a FIT policy relies on the proper setting of prices in order to both satisfy costs recovery and provide adequate rate of return for the associated investments.

In fact, this policy instrument has been acknowledged as one of the best tools for promotion and regulation of renewable energy sources based on the successful experiences of countries such as Germany, Denmark and Spain.

The impact of the "Electricity Feed-in Law" in the renewables promotion can be noticed by the significant growth of their share in the energy consumption meeting in the first decade after the enacting of this law, as shown in Figure 4.3:

Figure 4.3: Renewable energies share growth after the "Electricity Feed-in Law"

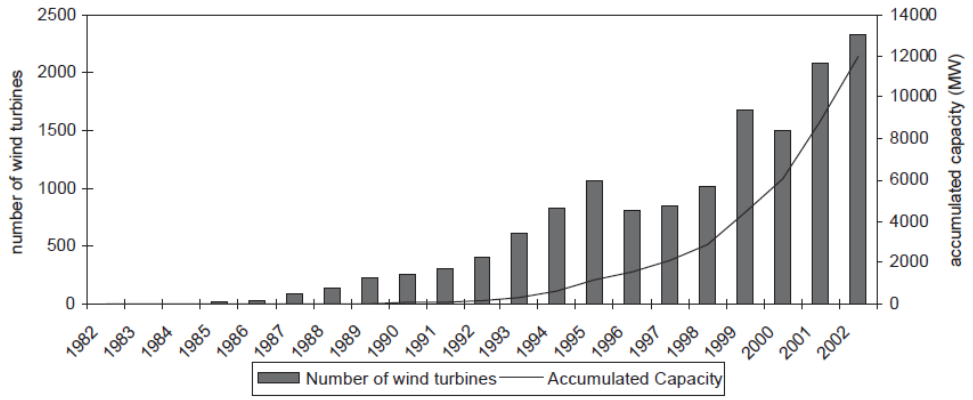


Source: (Wustenhagen, 2006: 1685)

The previous Figure 4.3 also shows that wind power was the alternative renewable energy source that had the biggest rate of growth in the German electricity consumption due to the establishment of the FIT.

This influence can also be noticed in the spectacular increasing of installed wind power capacity and number of wind turbines in the first decade after the enacting of the "Electricity Feed-in Law", as shown in Figure 4.4:

Figure 4.4: Wind power installed capacity increase after the "Electricity Feed-in Law"



Source: (Jacobsson, 2006: 260)

In this sense, the accumulated wind power capacity increased from the very little quota of 20 MW in 1989 to roughly 12,000 MW in 2002, while the annually installed number of wind turbines was increased approximately by a factor of 10 in the same period. In this sense, as argued by (Lesser and Su, 2008: 984), the Feed-In Law was fundamental to the development of renewables in Germany since it allowed the creation of an initial market protected by subsidized especial tariffs.

Along with the increase of wind power share in the energy mix, it is also important to emphasize that FIT together with R&D investments enabled scale gains and technology improvements that caused major costs reductions.

For instance, the influence of these policy instruments can be verified by the fact that wind power costs had a reduction of 30% in the first decade after the enacting of the "Electricity Feed-in Law", according to (Wustenhagen, 2006: 1689).

Although the original 1991 norm was later modified, the fundamental principle of FIT continues to be the basis of the regulatory incentive to renewables. In this regard, (Jacobs, 2012: 227) argues that after more than 20 years of implementation, FIT was amended in 2012, however, it is still based on preferential feed-in tariffs and purchase obligations which help to reduce to risks and provide an adequate environment for long term investments.

In this sense, the question of renewables competitiveness was strengthened by means of guaranteed fixed tariffs which were independent of market prices fluctuations.

On the other hand, the risks to investors were lowered through the establishment of mandatory and long term power purchase agreements (20 years). Additionally, the market entrance to new players was facilitated by preferential grid access, connection and power dispatch to renewables.

In sum, the FIT mechanism was of major importance to the creation and development of renewable energy markets in Germany, especially wind power markets, since it decreased the energy market entry barriers, enhanced the competitiveness of less mature renewable industries and provided the needed environment security for investments on renewables.

Chapter 5
Lessons That May Be Shared Among Germany, Brazil and Other Emerging Industrializing Country Economies

This chapter aims to discuss the potential lessons that could be shared among the different experiences of highly industrialized and emerging industrializing country economies in regard to the promotion and regulation of alternative renewable energy markets.

The first session will tackle the German experience, acknowledged worldwide as a reference model in relation to wind power industry development.

The second session will deal with the Brazilian experience since this was the selected case to represent the strategy of an emerging industrializing country economy in respect to alternative renewable energy market promotion.

5.1 Lessons from Germany

As stated before, there are some similarities among the energy policy objectives of highly industrialized country economies, such as Germany, and other emerging industrializing country economies, like Brazil. For instance, the issue of energy security and the aim of decreasing import dependence, inefficiency and waste can be cited as common policy targets.

Nevertheless, there are also specific policy objectives which have different priorities for highly industrialized and emerging industrializing country economies due to their particular national values and needs. In Germany, for example, the energy policy objectives encompass not only security of supply and economic efficiency, but also environmental compatibility as a major concern.

It is interesting that this issue of "greening the energy matrix" started in Germany in the 1970s as a consequence of the energy crisis likewise many other countries which were also very much dependent on oil imports. However, in spite of this fact, Germany was able to create and develop alternative renewable energy markets like no other in the last 4 decades due to some special factors that will be detailed in the following.

The first lesson that can be drawn from the successful German experience is the commitment of the successive governments with a perennial public energy policy that encompassed renewables promotion. In fact, this can be illustrated by the fact that although there were natural political alternations due to elections, this did not modify the support to renewable energy policy. In this sense, alternative renewable energy policies have been on the central stage for decades and is planned to continue like this for the coming years.

For instance, the 2010 *EnergieKonzept* plan established targets that will be pursued over the next 40 years, i.e., until 2050, in regard to greenhouse gas emissions reduction, primary energy consumption decrease and renewable energies share of gross electricity consumption increase. Thus, this less political influence is a beneficial factor to guarantee the policy stability.

Secondly, a major factor for the development of these alternative energy markets in Germany was the continuous and effective investments on R&D. Indeed, the pilot projects that were supported by the government since the 1970s were vital to generate new technologies which enabled the costs reduction and the consequent enhancement of competitiveness of these infant industries, especially the wind power industry.

Despite the fact that the resources allocated to renewables in the public R&D fund were minor compared to fossil fuel based energy sources, they were able to create academic research groups networks that in turn contributed to overcome some of the technological challenges of producing energy in an industrial scale, at lower costs, by means of renewables.

The third lesson is based on a holistic perspective regarding the various public policies. In this sense, the energy policy was not only deeply connected with the scientific-technologic policy, but also with the industrial policy in a virtuous cycle.

Therefore, the spillovers of renewables promotion were noticed far beyond the immediate effects on the energy matrix greening. Rather, the impacts are fairly recognized in the national capacity building to generate forefront knowledge in the Academia, along with competitive industries which are relevant in terms of jobs creation, exports, revenues and investments.

For instance, as stated before, the wind energy investments reached up to 2.95 billion EUR in 2011, whereas the turnover of all turbine and component producers located in Germany was 8.91 billion EUR, considering the German market and including exports. This big business is also responsible for employing more than 100,000 people in the productive chain and approximately 10,000 people solely in R&D and public administration (IEA, 2012b: 104-105).

In this regard (Ruiz, 2007: 2992) argues that one of the factors that enabled the successful experience of Germany in regard to alternative renewable energy sources development was the focus on the security of energy supply, combined with mechanisms to promote the associated renewables' industry. Moreover, he points out that other countries like Brazil should also follow this lesson in order to achieve simultaneously the targets of energy matrix diversification, technological learning and industrial development.

The fourth lesson is associated with the dynamic and evolutionary nature of the energy policy instruments. In this regard, despite the fact that the Feed-in Tariff system proved to be a very successful policy instrument, the original 1991 Law was constantly revised over the years in order to improve the mechanisms for promotion of renewables, especially wind power markets. For example, as explained before, the last amendment of this regulatory framework occurred in 2012, introducing a premium FIT model to enhance the competitiveness of renewables.

Finally, in light of the previous discussion, it is possible to conclude that there were several factors which contributed to the success of the German experience in relation to the promotion of renewables and development of the respective industries. However, amongst all, we may assure that the aforementioned factors were vital to the creation and development of alternative renewable energy markets, especially wind power, due to their contribution to decrease market entry barriers, enhance the competitiveness of less mature industries and provide the needed environment security for investments.

5.2 Lessons from Brazil

According to the Annual Report of the World Wind Energy Association (WWEA), wind power investments in Latin America had the highest growth rate worldwide in 2012, reaching the expressive amount of 56% (WWEA, 2012: 15). In this regard, solely Brazil had a substantial growth rate of 75% in the wind power installed capacity when compared with the previous year of 2011 (WWEA, 2012: 6).

In fact, the prominence of the Brazilin wind power market in Latin America is such that besides Brazil itself and Mexico, all other remaining markets are considered to be still in an infant stage (WWEA, 2012: 15). This relevance is mainly the result of the market size in terms of installed power capacity and energy trading, as well as the establishment in the last years of various wind turbine factories at Brazil.

The first lesson that may be drawn from the Brazilian experience is that the start-up of the national program for promotion of renewables, namely PROINFA, was based on the German FIT system. This was a clear attempt to follow the current leader and, thus, learn from existing successful policies already implemented worldwide in order to create, protect and promote the still less mature renewables industries.

In this regard, it is worth mentioning that other emerging industrializing country economies such as India followed the same strategy. In fact, India was a pioneer amongst developing countries to adopt regulatory incentives for renewables by means of FIT system in 1993, just 2 years after the launching of the German Electricity Feed-in Law.

Secondly, the Brazilian strategy encompassed also particular adaptations to meet the specific national energy policy priorities, considering the need to meet a rising energy demand boosted by the population growth, along with the necessity to provide quality, affordable energy supply and to develop the domestic wind power industry.

Indeed, successful renewable energy policies are deeply connected with the industrial policy. In relation to this last issue, PROINFA included a minimum nationalization index of 60% with the objective to develop the Brazilian industrial chain and contribute also to economic and social development by means of associated investments and jobs generation.

In this regard, other industrializing country economies such as India also provide an interesting example of the relevance of the domestic industry development for the success of the renewable energy policy. Indeed, the Indian domestic wind power industry has a prominence that goes far beyond its geographic frontiers. For instance, India is currently the world fifth largest market behind China, USA, Germany and Spain, encompassing big players like the Suzlon Group, which is ranked as the 6th top world wind manufacture and accounts for 7.7% of the global market share (Ren21, 2012: 58).

Thirdly, another important lesson that can be drawn from the Brazilian experience was the innovative experimentation that was put into practice during the initial phase of implementation of the renewable energy policy, which is a fundamental part of the learning process to improve the policy instruments effectiveness.

A relevant illustration of this innovative experimentation was the decision to move from the FIT system that characterized the first phase of PROINFA to the auction mechanism from 2007 on. As showed previously, auctions proved to be very effective in promoting renewables competitiveness, especially wind power which had an astonishing market share growth and relevant prices decrease as a result of this policy change, as well as technology improvements along with regulatory and financial incentives.

The fourth lesson is related to the fiscal and financial incentives that were provided through tax exemptions and especial credit lines to support renewables projects. For instance, as mentioned before, the National Development Bank (BNDES) financed up to 70% of capital costs for the renewable projects, which was of major importance to attract new private investments.

Finally, the fifth lesson is associated with the regulatory incentives that enabled the reduction of market entry barriers and the competitiveness strengthening for renewables. For instance, renewables were granted a discount of 50% in the tariff for use of the transmission and distribution systems.

In addition, the R&D fund, established by the National Electricity Regulatory Agency (ANEEL), has privileged renewable energy projects as can be noticed in the recent Public Call n.° 17/2013 (Strategic Project: "Development of National Wind Power Generation Technology"), which was fully dedicated to wind power projects (ANEEL, 2013c). These initiatives were vital to generate national knowledge and capacity building in the field of renewables.

In sum, there is not a single factor that is responsible for some good outcomes of the Brazilian renewable energy policy. Rather, a set of policy instruments composed together contributed to the achievement of some good outcomes of this policy.

Chapter 6
Conclusions

This research paper analyzed the issue regarding government interventions to promote alternative renewable energy markets. In particular, the case study questions' major interest relied on the strategies adopted by highly industrialized and emerging industrializing country economies to regulate wind power markets.

Despite the fact that the national energy policies of both Brazil and Germany have some similar objectives, e.g. energy security, import dependence reduction and waste decreasing, there are also particularities. Among these specificities, we may assure that environmental compatibility is a great concern of Germany, while energy demand meeting would be more critical in the Brazilian case.

Ultimately, it is possible to notice that these different priorities are also shaped in the respective policy instruments implemented by highly industrialized and emerging industrializing country economies.

The analysis of the German experience enables us to conclude that there were several factors that summed up together contributed to the success of the alternative renewable energy policy, especially, wind power markets development. Among these factors, we may cite the following:

a) Commitment of the successive governments with a perennial public energy policy to promote renewables which contributed to the policy stability;
b) Continuous and effective investments on research and development (R&D). The R&D efforts were vital to generate new technologies that enabled costs reduction and the consequent enhancement of competitiveness of these infant industries, especially the wind power industry;
c) Holistic perspective regarding the various public policies. In this sense, the energy policy was not only deeply connected with the scientific-technologic policy, but also with the industrial policy in a virtuous cycle; and
d) The dynamic and evolutionary nature of the energy policy instruments. In this regard, despite the fact that the Feed-in Tariff system proved to be a very successful policy instrument, the original 1991 Law was constantly revised over the years in order to improve the mechanisms for promotion of renewables, especially wind power markets.

Similarly, the existence of good outcomes and impacts of the Brazilian alternative renewable energy policy may be attributed as well to a combination of factors. Although there are some factors in common, this analysis case has proven that there is no "one size fits all" mechanism in terms of policy design and instruments.

Thus, there are some lessons that may be shared particularly with other emerging industrializing country economies such as:

a) The design of alternative renewable energy policies should first seek to learn from the leader, i.e., existing successful policies already implemented worldwide, e.g. the German Feed-in Tariff System;
b) The strategy should encompass also particular adaptations to meet the specific priorities of the national energy policy. Usually, there are particular objectives to be considered such as energy demand meeting, along with the necessity to provide quality and affordable energy supply;
c) It is essential to enable innovative experimentation during the implementation of alternative renewable energy policies, as part of the learning process to improve the respective policy instruments effectiveness. In this regard, the move from an initial FIT system design to an auction based policy proved to be much more effective in terms of renewables deployment and competitiveness gain, especially for the wind power competitiveness. It is worth mentioning that this divergent design choice in relation to the benchmark (German FIT) was also put into practice by other emerging country economies such as India and South Africa.
d) The existence of effective government support by means of fiscal, financial and regulatory incentives are vital to reduce the market entry barriers and enhance the competitiveness of infant industries like alternative renewable energy markets; and
e) The support to research and development by means of specific funding and R&D centers is fundamental to generate national knowledge and capacity building in the field of renewables.

In sum, it is possible to conclude that a successful developmental path regarding alternative renewable energy markets promotion and regulation should encompass a great coherence between the energy policy objectives and the national interests and values.

Finally, we believe that this work may be improved by means of complementary further research which may include the following research questions:

a) Comparative analysis of other alternative renewable energy markets promotion and regulation, such as solar power;
b) Enhancement of the research findings generalization capacity by means of a cross-case research analysis among a significant quantity of country economies. The increase in the number of cases to be compared would turn possible the creation of an actual sample and a consequent statistical approach to the population; and
c) Diversification of the evidence source through other mechanisms in addition to secondary data, such as interviews with major stakeholders, e.g. policy makers, industry sector representatives and recognized scholars and researchers.

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