Feito no Brasil? Made in South Africa?

Boosting technological development through local content requirements in the wind energy industry

ENERGY RESEARCH CENTRE

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Abstract

How can local content requirements (LCR) boost technological capability for renewable energy? This question calls increasing attention among researchers, firms and decision-makers. This paper investigates the implementation of LCR in the wind energy in Brazil and South Africa. Brazil tried to grow a local wind industry requiring 60% in each installation since 2004. South Africa demands up to 45% in its recent procurement program. These requirements are heavily debated. Many governments in developing countries intervene in new markets with the intention of creating jobs in new industries and accelerating technological development. An academic debate about localization questions whether these requirements are a form of protectionism or an effective development policy. Our paper presents evidence from Brazil and South Africa. We find that LCR fall short as a single technology policy instrument and requires additional innovation policy support in order to advance technological capability. The Brazilian case shows that LCR incentivized the domestic production of low and medium technology content. These are the obvious heavy parts, like the towers, which are difficult to transport. Recently, parts of the nacelle, hubs and blades have increasingly been manufactured locally. High technology-intensive components continue to be imported. Boosting local industries requires not just restrictive measure as content requirements, but more importantly active support to technological capability.

Keywords: Renewable energy, energy technology policy, emerging markets

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1. Introduction

Requirements for domestic content are a popular policy instrument for stimulating local technology development, especially in developing countries. Local or domestic content requirements (LCR) have recently reappeared in the renewable energy sectors. They were common interventions in the classical heavy industries like in the oil or automotive sectors. Do domestic content requirements actually contribute to technological development? In the research literature, most economic research classifies the local content requirement as a protectionist distortion to free trade. In technology and innovation research, the subject has been under researched. Most of the economic research comes from the 1970s and 1980s. However, domestic content requirements are experiencing a revival in current policy making. In the technological race for renewable energy technologies, emerging economies require domestic content to ensure that local producers benefit from the incentives program for renewable energy. This research paper investigates the case of the Brazilian and South African wind energy industry to assess the impacts of domestic content requirements in renewable energy technologies on low carbon technological development. The Brazilian case is more mature, because renewable incentives programs, which require local content, came into place seven years earlier than in South Africa.

This analysis contributes to the academic debate whether local content requirements are a harmful form of protectionism or an effective low carbon technology policy. Our analysis focuses on the technology policy aspect in this debate. To answer the research question, we interviewed 40 representatives from the Brazilian and the South African wind energy sectors. The findings of this research should be relevant for decision-makers in developing countries, who consider promoting low carbon technological development through local content requirements.

2. Incentivizing technology development through requiring local content

Domestic content requirements can be defined as policies, which specify percentages of the value, weight and/or size of certain technologies to be produced locally. 'A content protection scheme requires that a given percentage of domestic value added or domestic components be embodied in a specified final product' defines Grossman (1981). Localization indices determine the actual content through formulas, which consist of components in manufacturing, material input and production.

Theories in the research literature on domestic content differ about their effectiveness in generating welfare. Macroeconomic analysis speaks against domestic content requirements, as overall welfare decreases. Some evidence from case studies shows that the requirements can have positive employment effects.

Neoclassical economic theory suggests that domestic content requirements are 'unorthodox' policy interventions, which complement or as opponents would say 'distort' perfect trade and prevent market clearance. This rests on the idea that most welfare derives from self-clearing markets under the principle of non-intervention. This theory suggests that localization interventions reduce the overall welfare. Protection schemes increase the production of the domestic content (Grossman 1981) and reduce the output of the foreign company in its home country (Davidson et al 1985). However, it may or may not result in the opposite, and hinder a local export industry rather than boosting it (Grossman 1981).

Although writing in economic theory and trade economics argues against local content requirements, and there is not much knowledge on the conditions under which they have positive impacts, governments continue to apply this popular instrument. These interventions were frequent in the 70s and 80s, along with import substitution strategies mostly in the automotive sectors (Cimoli et al 2009). Recently, governments revived localization as a key component to industrial development in the renewable energy sectors.

Other scholars acknowledge the need for state intervention and recognize local content instruments as possible industrial policy measures. Rodrik (2004), Rodrik and Hausmann (2004) make strong arguments for industrial policy intervention in developing countries. In their view, non-traditional sectors generally need support in new technologies, training and information as production diversifies with economic development. Furthermore, Rodrik argues that convergence between developing and developed countries requires structural economic changes, which is difficult to achieve with 'orthodox', conventional policies. None of the success stories of industrial development in Asia and Latin America in the automotive sectors, ICT or renewable energies occurred without massive industrial policy intervention (Rodrik 2011). Domestic content requirements fall under these 'unorthodox' policy measures, which some developing countries have successfully applied. Rodrik calls domestic content requirements the 'bane of trade economists', acknowledges that they might be necessary but never really speaks out to their favor.

However, Lewis and Wiser (2007) analyzed localization as industrial policies in twelve countries. Their findings present successful implementation of LCR in Spain, China and India. These countries succeeded in boosting local manufacturing industries, although the benefit of the first mover was missed out. Local content requirements successfully supported local wind turbine producers like Gamesa, Sinovel and Goldwind and other manufacturers, which now operate globally. The market size determines successes of failure, because small markets can lead to increasing technology prices, thus jeopardizing implementation.

In the Chinese wind energy program, developers faced similar difficulties in implementing wind turbines, which were 100% locally manufactured. The main difficulties were that there weren't enough producers in the first place; secondly they could not produce reliably, and thirdly foreign firms were reluctant to transfer technologies. Technology learning, economies of scale and localization rates finally down the price of wind power in China. Technology costs were decreased resulting from a wind energy concession program, learning by doing, technology adoption, and increased domestic manufacturing (Qiu and Anadon 2012). In 2009, Chinese wind turbines were already 30% cheaper than the imported turbines (Han, Mol et al. 2009).

Lewis and Wiser (2007) identify four main benefits and four main barriers to local wind energy development. The main benefits, which governments seek in localization, which are economic development opportunities through sales of new products, job creation, growing tax base; opportunities of the export of locally made wind turbines to international markets; costs savings in both lower priced equipment and electricity through a nationally emerging industry and finally a locally owned wind industry. The main barriers to reaping these benefits are lack of experience for those who missed out on the first mover advantage, limited domestic technical capacity, lack of information from fear of new competitors as well as strict international trade regulation (Lewis and Wiser 2007). In energy technologies, there are additional political economic barriers from lock-in situations in large fossil, nuclear or hydro energy technology, which prevent support of alternative energy sources.

Rivers and Wigle (2011) find in their partial equilibrium analysis of the Canadian case that content requirements can backfire, if they increase the cost of renewable energy equipment and reduce the amount of renewable energy production and green job creation. This effect occurs if capital between sectors is not mobile. On the other hand, content requirements can have positive effects on employment and technology prices, if capital is mobile and if there are economies of scale or economies of learning in equipment manufacturing. In this case, content protection combined with a renewable energy subsidy can provide a local manufacturing sector with the capacity to become a dominant global supplier.

Both theoretical perspectives on local content requirements reflect a bigger political-economic debate on intervention, trade policy and the role of the state in the national economy. These two perspectives fuel the debates in the international trade regime whether and to what degree domestic content requirements are acceptable.

Internationally, domestic content requirements have been dismissed in the GATT agreement in the Uruguay Round in 1995. The Uruguay round affirmed existing practices and prohibits quantitative restrictions and 'performance requirements'. Local content requirements and trade-balancing requirements count as inconsistent with Article III. The WTO requires under the GATT agreement that industrial, developing and least-developed countries end these policies within two, five and seven year spans, respectively (Martin and Winters, 383). Under the WTO Trade Related Investment Measures (TRIMs) Agreements domestic content provisions and import subsidies remain illegal. The argument for prohibition is very much in line with the neoclassical assumption of market distortion:

'a local content requirement imposed in a non-discriminatory manner on domestic and foreign enterprises is inconsistent with the TRIMs Agreement because it involves discriminatory treatment of imported products in favor of domestic products. The fact that there is no discrimination between domestic and foreign investors in the imposition of the requirement is irrelevant under the TRIMs Agreement.' (WTO 2012)

The WTO is considered to be more rigorous as than the GATT, but in fact it tolerates the content requirements as long as other countries do not dispute them. Most of the disputes in the WTO on localization are mostly between industrialized countries and China. The Japanese disputed local content requirements in Ontario's Feed-in Tariff in Canada. Other countries pursuing domestic content requirements, like Spain, India, Brazil and the United States, have not become targets of trade disputes yet. The reason for the absence of any dispute is that there is no enforcement of the agreement per se. Countries only bother to dispute if there is a reasonable amount of money involved, according to Lewis (2005).

Table 1 Overview of elements in the debate on LCR in the research literature

Pro		Contra	
LCR can work in depending on the market size. LCR should be implemented gradually	(Lewis and Wiser 2007)	LCR reduce overall welfare	(Grossman 1981)
LCR can help to create a local industry along with technology learning, economies of scale and localization rates	(Qiu and Anadon 2012)	LCR can lead to increasing technology prices and decreasing production and overall green job losses	(Rivers and Wigle 2011)
No clear positions: "No developing country managed to catch up without "unorthodox" industrial policy interventions" (Rodrik 2004)			

Source: own compilation

The table above summarizes some key findings in the research literature, and illustrates the divide in academia as to whether they have positive or negative development impacts. Rodrik takes no clear position, but reminds us that all developing countries, which successfully caught up in producing higher technology content goods, used these considered as 'unorthodox' local content requirements (Rodrik 2004).

The theoretical literature shows that microanalysis find positive developmental impacts, whereas analyses from a macro-perspective find overall welfare losses. The empirical research literature has mostly focused on multiple case studies, or single case studies in developed countries (e.g. Spain, Canada). Our analysis contributes to the empirical literature with a comparative analysis of two latecomer countries in the renewable energies.

3. Domestic content in changing incentive systems

Local content requirements became a key ingredient of the wind energy incentive systems in Brazil and South Africa. In both countries wind energy started through demonstration projects. Later, public policy began to support wind energy systematically. Two phases determine the policy process of wind energy industry support. In both countries, this support began with feed-in tariffs and changed to competitive auctions. The governments changed the rules in the prime incentive system in the middle of the game, and switched from a feed- in tariff to a bidding process. The Brazilian process is about seven years ahead of South Africa. In South Africa, the feed in tariff was abandoned before its implementation. Brazil, by contrast, paid feed in tariffs for five years. In Brazil, domestic content requirements remained a key second-row instrument in both incentives systems. The following section presents the local requirements embedded in the incentive programs.

Localization under the feed-in tariff PROINFA in Brazil (2002-2006)

The first wind energy incentive program began in the early 2000s, after a number of demonstration projects had already been in place. In 1992, Brazil's first wind turbine started to produce electricity in Fernando de Noronha, an Atlantic island, 500 km outside the major Northeastern city Recife, Pernambuco. Ten years later, a crisis in the overall electricity supply created the opportunity for a new legislation. The new law aimed to modify tariffs and to diversify the country's electric energy matrix. At this point, the Brazilian government began supporting wind energy.[1]

In 2002, the Incentive Program for Alternative Energies (PROINFA) [2] came into place to support renewable energies in Brazil in form of a feed-in tariff. Under the feed-in tariff required a minimum of 60% of local components in the new wind installations. The government intended to simulate a local industry through these requirements and offered a feed-in tariff. The PROINFA program for wind energy began to offer a price for 300 R$ to wind energy to power producers. Under PROINFA, Eletrobrás agreed to buy electricity from the wind power producers over 20 years.

PROINFA aimed to promote 3,300 MW of planned generation capacity consisting of 36% of Small Hydropower Plants, 43% wind and 21% of thermal biomass. Brazil's Development Bank (BNDES) approved to finance up to 80% of the construction costs of plants, with an interest rate of 0,9%. Within PROINFA, firms had to comply with 60% local content requirements.[3]

The localization index[4] for producer into PROINFA was calculated over the total value of the park, considering services and equipment. In the components value was considered the imported ones, plus the Free on Board value (FOB), with the profits of manufacturers and retailers (x) over the imported components value added to nationals components, national services, rents and taxes, (y).

The objective of this nationalization rate was

> *"to strengthen the Brazilian industry of electric power generation, developing the field of supply chain, having a structural character with economies of scale, technological learning, industrial competitiveness in domestic and foreign markets, identification and appropriation of technical benefits, environmental and socioeconomics in defining competitiveness and economic-energetic generation projects using clean and sustainable sources"* (MME 2012).

At the time, only one wind energy manufacturer produced local equipment in Brazil since 1996. A German company had installed the first wind parks in Brazil independently from any incentive policy. The motivation was to demonstrate that wind energy is a viable option for Brazil.[5] Firms struggled to fulfill these requirements.[6] The manufacturer installed five wind parks. The firm installed most of the parks commissioned through PROINFA. Yet, the newly created demand for locally produced wind turbines was higher than a single manufacturer could attend. The high requirements for domestic content under PROINFA led to significant delays in the production and installation of the wind turbines and high prices. In 2006, only six of the initially planned 75 turbines were up and running, which still increased the capacity dramatically.

Other factors contributed to the delay in the implementation of the local content requirements. Additional delay factors were the sluggish bureaucracy to issue the environmental licenses from the Environmental Agency (IBAMA), and its environmental assessments, declaration of public utility (DUP), and the grid connection.[7] The market was too small, and a single firm could not attend the demand for locally manufactured components, which then led to delays in the implementation, high technology costs, and less production. The import tariff was temporarily removed for wind turbines components from 2006 to 2009 in order to catch up on the delays in the installation and reduce the associated costs.

However, the current installed capacity of almost 2GW wind which energy still results from the projects, which were installed under PROINFA, which contributed to 1,4 GW of the 2 GW (ELETROBRAS 2006).

Localization under competitive bidding

The delays in the implementation of PROINFA pushed the government to a policy change in the regulation, which resulted in a competitive bidding process. The Ministry of Mines and Energy introduced the competitive bidding in form of a so called reserve energy auction (Decree 6.353/08) and others types of auctions. The auction system formally abolished the local content as a compulsory requirement. Domestic content requirements however continued to apply to those firms who request for financial support from the National Economic and Social Development Bank (BNDES). The BNDES played an important role in growing the sector. The bank's investment sums up to 3,4 billion R$ in 2011.[8] In fact, the domestic content requirements continued, because so far no single firm managed to install a wind farm without the support of the bank.[9]

The auction system brought more dynamic into the sector and attracted large foreign investments. Between 2008 and 2009 the installed capacity increased about 79%. The first auction 1.805,7 MW contracted for a price of R$ 148,39/MWh over 20 years. The most significant foreign participants were the Portuguese and Spanish. After the third auction, costs declined to about a third from the initial feed in tariff, to about 100 R$ per MWh. Efficiencies of the wind farms reached up to 50%, as opposed to the usual 20% in European countries.

The regulatory framework drove the investment. The fact that the Brazilian government had changed the rules in the middle of the game opened the market to foreign investors and brought the prices down. The literature shows that quota based systems are not necessarily cheaper that equal feed in tariffs (Sawin 2004, Butler and Neuhoff 2007). However, the Brazilian case suggests that the auction system brought the prices down to a third of the initial feed-in tariff.

The main changes in terms of local content between PROINFA and the reserve energy auction (LER) are summed up below:

Table 2 Overview: Local content requirements under PROINFA and the reserve energy auction (LER) or alternatives sources auction (LFA)[1] and new energy auctions (LEN).

PROINFA 2003-2007	LER 2009- e LFA e LEN
Obliged all firms to fulfill DCR requirements of 60% of the total project's value Implementing agencies: R$ 6.21 billions to be invested in wind energy (R$ 5.5 billion from BNDES and the rest is from Constitutionals Funds from Midwest and Northeast Brazilian regions)[2]. Difficulties with the project's implementation create the Resolution 37 CAMEX, 24/06/2009, that import tax free to wind turbines. 54 Sold projects with 1.422,92 MW, with 48 planed to be projects installed until the end of 2010.	Requires DCR only from those firms who want financial support from BNDES Implementing agencies: - ANEEL (preparation of bidding documents and supervision) - Câmara de Comercialização de Energia Elétrica - CCEE (execute auctions) - BNDES (funds, coordinate and audits) Certification System (Credenciamento Informatizado de Fabricantes- CFI) Calculates localization with an index: FINAME (Index 60% of weight and 60% of value) Allows gradual localization, which starts at a lower percentage and increases over time up to 60% (required) or more

Source: own compilation

[1] LFA – Decree 6.048 de 27/07/2007; LER – Decree 6.353 de 16/01/2008 (Brasil, 2007 e Brasil, 2008).

[2] Resources from Northeast Development Agency (ADENE)/ Northeast Development Fund (NDF), financed through Northeast Bank (Banco do Nordeste) (ELETROBRAS, 2011).

With the auctions, BNDES began a certification system (CFI) of the main global wind turbine producers, which BNDES supported in installing wind energy parks. BNDES finances most of the wind parks, with a payback rate of 16 years.

Actually, 60% nationalization in value and weight are the basic criteria[10] to enter the products into the catalogue of the CFI BNDES, which enables firms to sell their products as domestic content. So, the firms need to prove the origin, value and weight of each component (machines and equipment). The main parts produced under those requirements are the nacelle, the towers, the blades and the hubs. The BNDES also allows comprises with manufacturers who agree to reach 60% of localization within the next three years.

A tower, 100% locally produced, can already meet 40% of localization of the whole turbine.[11] The towers are usually made of concrete or steel and about 100 m high for three MW installations. BNDES certifies these towers and other products according to its norms so that they count as local content. BNDES's focus is on a firm's production process. However, the bank has no responsibility over the quality of the product, it only certifies the local origin.[12]

A new tax import rate of 14% was introduced in 2010[13] (Energia e Mercados 2009). Further regulations allowed imports of wind turbine components with a power rating greater than 2 MW, but subsequently this value was reduced to 1.5 MW in order to achieve the technical qualifications for participation in the auctions. BNDES has plans to increase the local content requirements again, this year, but there is no concrete information about the way this will be done (Jornal da Energia 2012).

Is important to remember that the law 9.991/2000 about R&D investments and energy efficiency says that a percentage of the Net Operating Income (ROL) of the of generation, transmission and distribution of electricity companies (excluding the alternatives energies) must be distributed between the National Fund for Scientific and Technological Development (FNDCT), R&D projects regulated by ANEEL and for the Ministry of Mines and Energy – MME[14], in order to contribute to development programs for energy efficiency, conservation and combating energy waste, research and technological development of the electricity sector (Brazil, 2000). In 2010, the value of the obligation investment in R&D of electric companies was 315 million R$ (ANEEL, 2012).

Local content requirements in South Africa's shifting renewable energy incentive programs

The incentive schemes in South Africa also shifted from a feed in tariff to a competitive bidding program. In 2009, the National Energy Regulator (NERSA) announced guidelines for a long awaited renewable energy feed-in tariff (REFIT), which supposed to guarantee the payment of a fix price per kwh produced through seven renewable energy technologies including wind. The South African government's accelerated shared growth initiative (ASGI-SA) identified public expenditure on infrastructure, which include new electric energy power station as a focus area. ASGI-SA requires local content, black economic empowerment and skills development targets as additional evaluation criteria for public procurement, besides price. The ASGI-SA requirements identifies five areas on a scorecard: firstly, percentages of local content; secondly, percentage of local content established through "large black suppliers" (LBS), a firm with an annual turnover of more than 35 million ZAR and a Black Economic Empowerment Contributor (Level 4), thirdly, percentage of procurement from "Black Woman Owned Enterprise" (BWO) defined as business owned more than 50% by black women, fourthly, percentage of procurement from "Small Black Enterprises" (SBE), at least 50% black owned with a turnover below 35 Million ZAR, and fifthly, skills development as a commitment of the "tenderer to train certain individuals in specific trades"…"and qualify[ing] as an artisan, or the equivalent for any other required skill."

Local content is defined as "value added in South Africa by South African resources. […] Local content is total spending minus the imported component. This is calculated by subtracting the cost of imported goods and services in respect of the Works from the total Contract Amount" (ESKOM, p.4). The REFIT made provisions for sellers and buyers to procure through the obligations of the ASGI-SA program.

The REFIT was never implemented in its original format, which NERSA had proposed. A number of political and regulatory problems stalled its implementation. This resulted from lack of political backing for the program, which was a result of mostly NERSA's efforts and lacked the National Treasury and the Department of Energy's political support. In 2011, the sector was awaiting more clarity on the implementation of the REFIT, after the DoE's integrated resource plan (IRP) was revised towards a higher share of renewable energy (revised policy adjusted scenario, DOE 2011). Instead, the Department of Energy announced a new program for renewable energy through procurement from independent power producers. The REBID, or REIPPP program invites independent producers to submit bids for renewable energy production to the DoE. The National Treasury supports the process through its public private partnership unit. NERSA continues to issue licenses for independent power producers.

Local content requirements are also part of the REBID. The REBID defines local content as "the total costs attributed to the Project at the Commercial Operation Date, excluding finance charges, land and mobilisation fees of the Operations Contractor" (DoE 2011 Econ Development, p 8). Local content and localization appear almost interchangeably: "Localisation […] is defined as the capital costs and costs of services procured for the construction of the Facility excluding finance charges, land and mobilisation fees of the Contractor undertaking Operations." (DoE 2001, Annex 5). The procurement documents request close policy alignment with the industrial policy plans (IPAP), and the Industrial Policy Framework, which comprises the ASGI-SA requirements, as well.

The government states the main purpose of the local content requirements repeatedly, as key to create jobs through increasing local manufacturing (DoE 2011, p 16). In the bidding process local content falls under the economic development requirements of the program, defined in a scorecard. The scorecard sums up numerous criteria, for jobs created among specified population groups in communities in the radius of 50km near wind farms. The community development benefits and job creation in the wind farms are much clearer specified in the South African tender documents than in the Brazilian case.

Finance and local content

The role of local content in the financial incentive scheme is another major difference between the two systems. In Brazil, the local content requirements only apply for those firms who request the financial support scheme from the National Development Bank. BNDES can finance 80% of the project, 0.9% interest rate through its subsidiary *Special Agency for Industrial Financing* (FINAME). FINAME finances projects through various funding lines. The FINEM Alternative Energy line finances alternative energy projects worth over 10 million Reais (R$), with a payback rate of 16 years. BNDES provides for other special funds for alternatives energy sources, which support small-scale projects in isolated areas and for residential use.[15] This fund has not been used much for wind energy yet (BNDES 2012).

BNDES's financial support mechanisms create a clear incentive for the use of wind energy, despite the obligation to fulfill local content. All Wind parks have been financed through the BNDES scheme. Only one company plans to bring own funding through a Chinese development bank, for a park in Aracaju. Fiscal reductions create an additional incentive to the BNDES financial scheme. Reductions Tax on Imported Products (IPI) and the Tax on Sale of Goods and Services – ICMS16 of numerous components for the solar and Wind industries including generators and motor blades, make attract foreign investment to Brazil (Nogueira 2011).

In South Africa, financial support comes from the IDC and the DBSA, and the commercial banks. The Industrial Development Corporation (IDC) provided financial schemes for 19 preferred bidder projects with an approved investment of R7.5 billion.[17] The DBSA approved approximately R9.6 billion for 896.5MW capacity installed under the RE IPPPP.[18] The IDC will support 725MW of renewable energy generation by 2016 (Engel 2013).

Local content requirements do not link to any of the financial schemes of these banks, as it the Brazilian case. In South Africa, localization is compulsory independently from the sources of finance. The interest rates for loans from the IDC and DBSA are similar to the market rates between 11-14% (White 2010, Engel 2013). These interests rates does not compare to the 0,9% offered by BNDES and allows to conclude that the South African REIPPPP lacks a clear financial incentive.

Institutional arrangements and mandates for implementing local content requirements

In both countries, centralized institutional arrangements characterize the governance of the local content requirements. Except, the central institutions act on different levels. In Brazil, the BNDES is the designated implementation agency, which is a public enterprise under the supervision of the Department of Industrial Development and External Commerce. The BNDES has a powerful mandate for the implementation of local content requirements. The bank is responsible for the selection of the bidders, inspections and approval of the sights for future wind park, as well as the financial support and enforcement of compliance with the requirements. Two units within the bank implement these tasks together. These responsibilities give the bank a powerful position for the implementation of the content requirements, which the bank checks through individual negotiations with the manufacturers. This approach created some tensions in the sector in the past, when some manufacturers delayed building local factories, while others were complying with the content requirements. Eventually BNDES withdrew the accreditation from those firms temporarily. Yet, this wasn't a transparent process and let to surprises and confusion in the sector.[19]

In South Africa, the mandates for the implementation of the content requirements are less clear. The Department of Energy is the principal procurer in the renewable energy program. The Department signs the contracts with the power producers who then procure through the manufacturers of components and reserves rights to dissolve the contracts in case of non-compliance with the procurement obligations (DoE 2011). The Department of Trade and Industry has developed the requirements with support from TIPS and other consultants, but is not responsible for the compliance. It is still unclear whether the DoE or another institution will take the responsibility to control compliance with the requirements in the South Africa.

In terms of compliance with international trade regime, South Africa and Brazil signed onto during the Uruguay Round (UR) of multilateral negotiations and set up the World Trade Organisation (WTO) at the start of 1995. Both governments did not sign up tp WTO specific Agreement on Government Procurement (WTO, GPA), which would impede local content requirements (WTO 2013). Brazil and South Africa have not become subject international trade disputes, because of local content requirements. The European Union disputed Canada's feed in tarrifs, because of local content requirements recently with other allies.[20] Existing disputes in Brazil and South Africa were all trade related, and mostly in the areas of pharmaceutical and agricultural products.[21]

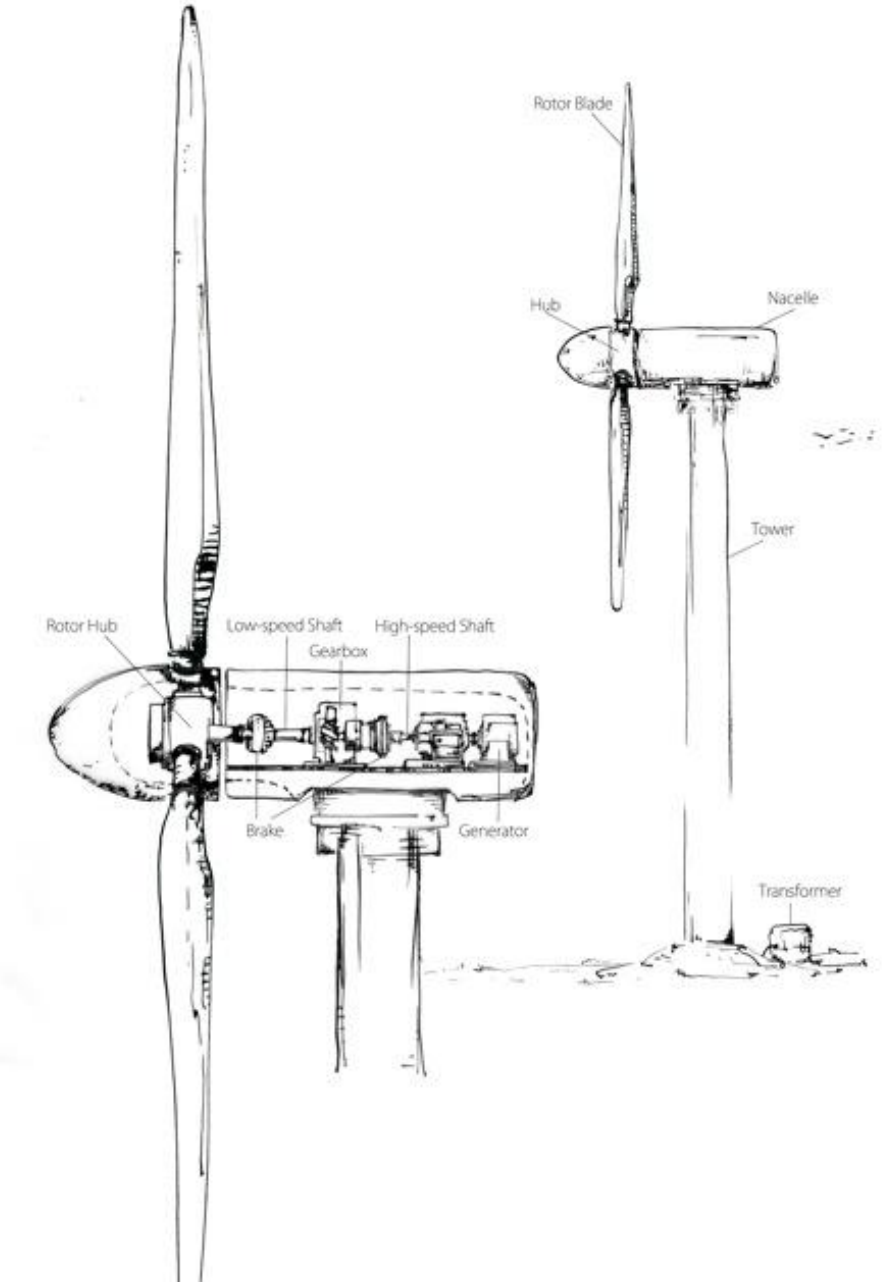
4. Made in Brazil? Locally produced wind turbines and industrial development

What is the actual local content, which technologies are actually produced, and what are the developmental benefits? The first part presents our findings on the locally produced components, their technological content based on firm interviews about the actual parts produced in Brazil, their experiences with BNDES local content policy and their technological content structure of the sector. In the South African case, we could only collect interview data on how the firms are planning to deal with local content requirements in the future, given that at the time of the research only the first and second bidding rounds had been closed with average commitments to local content of 21.7% and 36.7% respectively.[22] In the second part of the analysis, we present estimates on jobs created in the manufacturing companies who provide local content on the same database.

4.1. Assessing local content

Modern wind turbines consist of up to 6000 components, depending on the model and size. For our analysis we categorized the main components of the turbine in three simplified categories of component with low, medium and high technology content. Components with low technology content are simple concrete or steel components and cables, which are the tower, balance of plant and the foundation. Components with medium technology content are more advanced specialized components without electric or digital technologies, which include the rotor blades, the hub, the rotor hub and the nacelle box. High technology components are those components, which have electrical or digital components and advance specialized components, which are the electronic shafts, the gearbox, brakes and generators. These simplified categories help us to assess the technology content within the Brazil and South African wind energy sectors.

Figure 1: Technology components in the wind energy turbine



Classification of technology content of the turbine components

Low technology content:	tower, foundation and balance of plant
Medium technology content:	rotor blades, hub, rotor hub and nacelle box
High technology content:	electronics and mechanical components[3], transformer, low-speed shaft, high-speed shaft, gearbox, brakes and generator

Source: own compilation, drawing: kerstinunger.com

[3] Electric components: Wind detection sensor, automatic operation control, generator
Mechanical components: cranes, speed control, refrigeration system for oil and water, principal axis, blades rotor, hydraulic systems, support structure, disc break etc. (Montezano 2007).

Fifteen manufacturers mainly supply the Brazilian wind energy sector. These companies are mostly foreign and entered the Brazilian market at different stages. The PROINFA program attracted foreign manufactures in the early 2000s, the main influx came recently with the energy auctions in 2010.

Table 3 Overview: Wind energy manufacturers, products and production sides in Brazil

Firm	Origin	Active in wind energy in Brazil since	Annual capacity (MW)*, ** pieces	Products produced in Brazil	Factories	FINAME
Acciona	Spain	2011	-	Hub assembly	1 planned* in Bahia	Temporally accredited
Alstom	France	2009	400	Nacelles	1 in Bahia	Yes
Fuhrlaender	Germany	-	600	-	1 planned* in Ceará	Temporally accredited
Gamesa	Spain	2002	400	Nacelles	1 in Bahia	Yes
GE	USA	2009			2 in São Paulo, Bahia	Yes
Impsa	Argentina	2008	1000*	*Nacelles, blades	1 in Pernam-buco	Yes
Suzlon	India	2010	-	Nacelles	1* planned in Ceará	Temporally accredited
Siemens	Germany	2009	-	-	1* in São Paulo	Temporally accredited
Sinovel	China	2011	-	-	None	No
WEG	Brazil	2011	100	Nacelles	1 in Santa Catarina	Yes
Wobben	Germany	1995	500*, 1500**, 500**	*Nacelles, **blades, **towers	3 in Ceará, São Paulo, Rio Grande do Norte	Yes
Vestas	Denmark	2000	-	Nacelles	1* Ceará	Temporally accredited
Tecsis	Brazil	1995	8300	Blades	1 São Paulo	Yes

Finame – *Machine and equipments funding from BNDES*

Source: Own compilation based on interviews in 2012; Cenários da Energia Eólica (2012), p.77; COSTA (2012) and BNDES (2012).

Wobben's early investments into own factories during 1990s paid off, because the firm could provide the local content required under the PROINFA program, whereas Gamesa left the country temporarily and Vestas risked to lose the accreditation temporarily. Wobben reached about 1 GW of the implemented capacity in 2012.[23]

The auctions system attracted a new generation of manufacturers in the period between 2009 and 2012. The newcomers quickly needed to invest into factories to be able to catch up with the local content requirements, receive and maintain BNDES's accreditation.

Not all firms managed to produce quickly enough. Five manufacturers temporarily lost their accreditation, which harmed the manufacturers and also the developers who had sub-contracted the manufacturers for the reason that they could provide the certified components to fulfill the requirements for local content. The temporary withdrawal of the accreditation was a consequence of the banks inspections of the factories.[24] Some firms had delayed building new manufacturing sites. Other firms pushed the bank to taking consequences on non-complying firms, because they already produced locally at a higher price in Brazil and asked for equal rules for everyone.[25] Some firms continued to import materials to manufacture turbine components and did not pay import taxes on the final product. In this way they managed to sell imported equipment as local content. On this basis, the bank reverted the loans to those companies (Costa 2012).

The main components, which are produced locally as a result from the local content requirements, have low to medium technology content. The main components, which are manufactured or assembled locally, are nacelle boxes, hubs, blades and towers.[26] Additional civil engineering firms' supply locally produced towers mainly made of metal and steel, rather then concrete. Further suppliers, like the Swiss ABB, supply electric equipment, which count as local content because they have the certification for a certain product (FINAME).

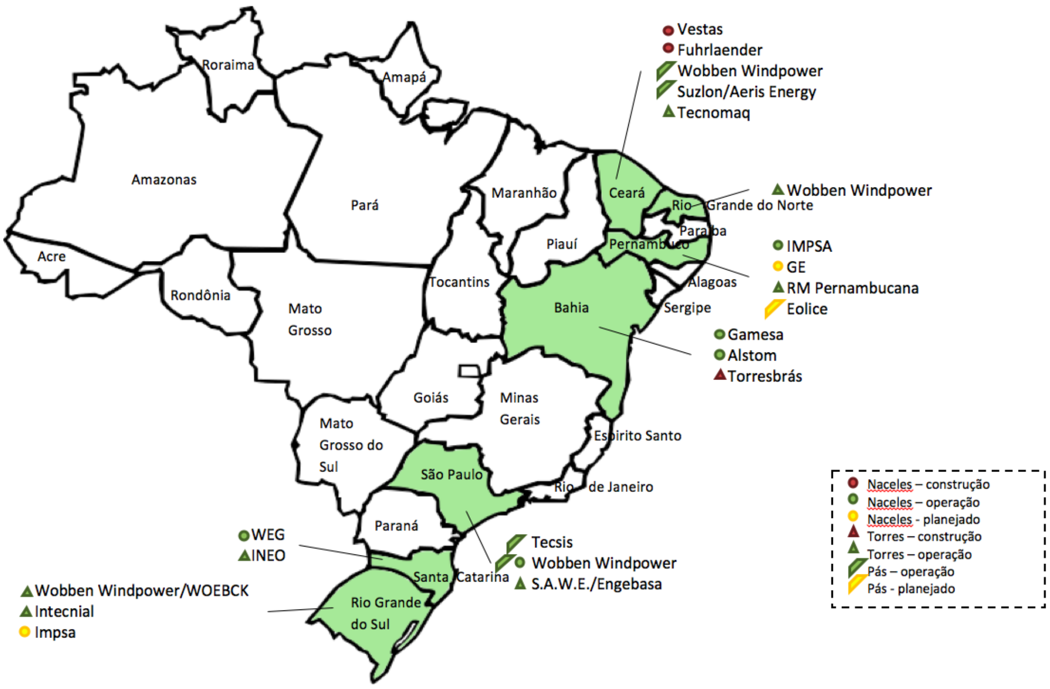
4.2. Developmental impacts

The Brazilian wind turbine-manufacturing sector is still relatively small, compared to other countries. There are 15 firms in the northeast, 17 firms in the southeast and 4 firms in the south (Brasil Energia, 2011 apud EPE 2012, Simas 2012). The international renewable energy agency IRENA recognizes the Brazilian market already as one of twelve mature market, although it emerged only over the last three years as the fastest growing market in Latin America (GWEC/IRENA 2011). Brazil has a unique wind power potential. The winds in the northeastern region blow constantly and allow a capacity of about 50%, as opposed to the usual average of 20%.

The best winds for electric energy generation are in Northeastern Brazil and those are likely to improve with climate change (Pereira 2013). At the same time, Brazil's Northeast is home to half of Brazil's poor population (Ipea 2011). Developmental challenges in the region remain daunting, because of few job opportunities and unequal divide of land. Therefore, developmental benefits of wind energy parks and job creation in this region have been a public concern.

The map shows the regional distribution of the wind energy in Brazil. Most firms settled in the South and South East, where most of Brazil's industrial infrastructure concentrates. 40% of the firms, however, invested in branches, factories or even headquarters in the Northeast, because most of their operations are in this region.[27]

Figure 2 Regional distribution of wind energy manufacturers in Brazil



Source: own compilation

The estimates for job creation in the sector vary. Simas and Pacca (2011) calculate emissions reductions and job creations for a) baseline scenario with 6 GW by 2012, which results in up to 96 million tons of CO2 reductions between 2011 and 2020 and 93,850 jobs, out of which, 83% are in the manufacturing and installation of wind farms. The second scenario b) estimates a capacity of 10 GW with 129 million tons of CO2 and generates over 143,000 jobs, 85% in manufacturing and installation. The most optimistic scenario c) estimates a growth of 1,5 GW per annum after 2013 which sums up to CO2 reductions up to 176 million tons and the employment of more than 225,000 people, 87% of which are in manufacturing and installation (Simas and Pacca 2011, p.2630). These estimates are for the overall Brazilian wind energy industry. The recent energy auction in December 2012 (Leilão de energia A-5 de 2012) paved the way for 525 projects, which sum up to 14,181 GW.[28] Wind energy makes 484 projects with a total capacity 11,879 GW by 2017, which is close to scenario b.

Brown (2012) investigated the development impacts in the state Ceará, which hosts the highest concentration of wind parks in all states and sum up to 5, 7 GW. Brown finds 10-50 temporary construction jobs per Project at the local level, minor increases on local hotel and restaurant business. Direct job creation estimates are 3-3.5 jobs per MW for construction, and 0.5 jobs per MW in manufacturing (Brown 2012, p.353ff). 7091 manufacturing jobs, 42543 construction and maintenance jobs roughly 50 000 jobs, 85% construction and maintenance, 15% skilled manufacturing.

The Brazilian Wind Energy Association calculates 15 jobs per MW, which sums up to 12000 newly created direct and indirect jobs since 2009. The estimate for 2020 is a total of 280000 jobs at 18,6 GW of wind capacity (Tavares 2012).

Our own research concentrated on direct jobs in manufacturing and sales. According to the interview data, there are 2746 direct jobs in the Original Equipment Manufacturers (OEM) in Brazilian wind energy sector at the moment. The main manufacturing jobs are in the tower, nacelle and blade manufacturing. The interviewees mentioned the lack of skilled labor, especially in civil and electric engineering as a problem for regional development. The skills shortage in the rural area leads to appointments of skilled labor from the urban areas. This shortage has created a market for a dozen firms who specialize on training technicians on site. Another bottleneck is the lack of specialized laboratories for product tests and innovation. Therefore, universities and public laboratories need to expand their infrastructure to attend this demand and support R&D efforts together with the firms to advance the sector.

Job creation in the South African wind energy sector

The Brazilian auction system does not require estimates for job creation unlike the South African procurement system. The bidders provide those data to the government on the socio-economic development scorecards, which allow monitoring the proposed job creation closely. So far, there are only data available for the first bidding round, which has been closed.

Table 4 Proposed job creation in the wind energy sector under the 1st bidding window

Province	Jobs for South Africans		Jobs for Black South Africans		Total jobs	
	Construction	Operation	Construction	Operation	Construction	Operation
Eastern Cape	1049.0	43.5	719.2	25.4	1196.3	1090.3
Free State	0.0	0.0	0.0	0.0	0.0	0.0
Limpopo	0.0	0.0	0.0	0.0	0.0	0.0
Northern Cape	642.0	52.0	541.5	40.0	642.0	1040.0
North-West	0.0	0.0	0.0	0.0	0.0	0.0
Western Cape	167.4	15.6	108.2	7.6	198.6	420.0
Total	**1 858**	**111**	**1,369**	**73**	**2 037**	**2 550**

Source: own compilation based on DoE (2012)

Eight OEM have entered the South African market since the funding program began. A demonstration site in Darling generates 4,5 MW even before the start of the procurement program. The cookhouse wind farm in the Eastern Cape manufactured one tower locally. There is no longstanding OEM as in the Brazilian case. The most advanced local manufacturer is I-WEC. I-WEC is South Africa's only local blade manufacturer and has also successfully tested nacelle boxes. Yet, many turbine manufacturers use different designs, which IWEC cannot produce for them.[29] The leading Dutch blade manufacturer intends to invest into South Africa once there is a reasonable market size. The company just announced building a manufacturing plant in Pernambuco, Brazil, with 300 employees, and an investment volume of equivalent of 45 million Euros.[30]

So far, the South African local content requirements could be covered through the balance of plants, and will slowly increase to the tower, nacelle boxes and blades with increasing requirements in each auction. The total investment volume in local content during the first bidding round was 11.472 billion ZAR/ 1,147 billion EUR for all renewables in the program, which comes down to 7.854 million ZAR / 785 000 EUR per MW (DoE 2012). For 1415,52 MW of wind this makes roughly 1.1 billion Euros.

Our interview data showed that some OEMs are opening small offices, whereas others still fly in and out without work permits. The direct jobs in the OEM offices vary between one and 15 employees.

5. Conclusions

Our analysis showed that local content requirements did not achieve a boost local in production of high technology components yet. Compulsory requirements for domestic content in the Brazilian wind energy contributed to delaying the diffusion of wind energy technology, because of lacking production capability and high prices. Later, after the incentive system changed, the requirements became compulsory only for those firms who requested financial assistance. 60% of the value and 60% of the weight of a wind installation needed to be produced locally. These localization requirements resulted in incentivizing the domestic production of low technology content. First, these were mainly iron and concrete towers and basis, which are difficult to transport. Recently, parts of the nacelle, hubs and blades have increasingly been manufactured locally. More technology intensive components, like microchips, rotors and gearboxes continue to be imported. In sum, the domestic content requirements did not achieve to boost local production of high technology components. However, the auction system paved the access for international developers. Within ten years, the wind energy capacity increased from 30 MW in 2004 to currently 1.659,5 MW (September 2012), which translates into a reduction of carbon emissions of 115 097,6 tCO_2 tons, for 920 MW wind power generated in 2010.

Local content requirements promoted a low technology industry, which advanced quickly to medium content industry in Brazil. Nacelle, blade and hub manufacturing have created significant numbers of jobs through foreign investment in local factories. With WEG and Tecquis, two Brazilian manufacturers established themselves in the sector and likely to position themselves as suppliers for wind energy parks in other countries in the regions.

BNDES has demonstrated consequences for non-compliance. The institutional setup allows space for negotiation between the bank and the firms, which is not always beneficial and transparent. On the other hand, the bank creates a significant financial incentive through low interest rates, which legitimizes asking for compliance with their requirements in return. The bank approves both sites and financial support. EPE supports the bank with selecting the tender bids. The system is quite centralized, but mostly efficient. However, clear rules for everyone and more transparency in the implementation help avoid confusion and losses in the sector. If LCR become subject to individual negotiations between firms and the bank, this allows for rumors and uncertainty, which compromise the compliance.

Local content requirements do not work as isolated technology policy instruments, because they are not feasible for generating high technology content and innovation. LCR are prescriptive policy instruments, not supportive instruments. Therefore, they need to be combined with other instruments, which support the firms so that they are able to comply with the requirements. In the Brazilian case, there is a clear combination between the LCR and the cheap loans for the project. In South Africa, there is no clear financial incentive. The loans are near the usual market prices. Local content requirements become a barrier for investment without financial incentives, which even out the additional cost to produce locally.

Another important is factor for investment is the market size in the long-term. Clear signals to the sector of how much wind energy will be allocated in a determined time frame, allow the firms to calculate whether an investment will be worth it in the long term. LM's investment in Brazil was a clear example for that.

Local content requirements are not a suitable instrument for high technology development, which requires strategic and systemic support, skills development and R&D infrastructure. LCR leave enough room for the high technology components to be imported. High percentages in LCR, which include high technology components have the potential to destroy the industry and to keep foreign investors outside the market, as it happened to Nordex in Brazil.

To foster high technological development and innovation, LCR cannot come alone. They need further integration with other innovation policy instruments. In a second stage, the federal innovation agency (FINEP) in Brazil, the Technology Innovation Agency (TIA) in South Africa and other innovation mechanisms should come in and fund research in the area to attend the R&D needs, which became evident in the implementation in Brazil and will become evident in the South Africa in the near future.

The Brazilian Wind Energy Association recently established a network between universities, research laboratories, government officials and the firms. This is an important step into the direction towards better support for innovation in the sector.

There are four key recommendations from the Brazilian case for the South African decision-makers:

I) Create certainty about a significant market size in wind energy to attract foreign investment and create a basis for the successful implementation of the local content requirements.

II) Create incentives, which firms can respond to in order to deliver local content. The responsibility to fulfill the requirements cannot be only with the private sector. Some public support needs to come from the public side as well. Currently, there is no incentive for investment in the South African system.

III) Set clear rules and set up institutional mechanisms for a transparent process for the implementation of local content requirements to avoid situations as they happened in Brazil, where firms lost their accreditation.

IV) Embed the local content requirements into its wider scheme of innovation policies to support a knowledge base in the sector. This involves support through the technology agency, programs for skills development and higher education. A wind energy research network can be a start for joined efforts between universities, firms and public agencies.

In return, the South African case offers at least two important insights for Brazilian decision-makers.

Firstly, the Brazilian program has no provisions for social development and distribution of benefits, and job creation, which can be learned from the South Africa procurement program. Secondly, these provisions ask companies to provide information and allow to better understand the job creation potential and the community development benefits.

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Endnotes

[1] Between 2001 to 2003 there was the Proeólica, created by Resolution n. 24, 05 july 2001, the first program to incentive wind energy in Brazil, that aimed at the deployment of 1,050 MW of wind power connected to the National Interconnected System – SIN until 2003. It failed because the short-term investors had to get the benefits and a lack of appropriate regulation (Nogueira, 2011).

[2] PROINFA was created by the law n. 10.438, of 26 April 2002, revised and adjusted by the Law n. 10.762, of 11 nov. 2003 and regulated by decrees n. 4.541, of 2002 (MME, 2011c) e n. 5.025, of 2004 (Nogueira 2011).

[3] BNDES released 5.5 billion R$ for PROINFA for direct and indirect transfers through other banks.

[4] Formula to calculate the nationalization rate in PROINFA: Iv = (1 – x/y)*100

[5] Interviews No. 1, 2, 37

[6] Interviews No. 12,13, 21

[7] Interviews No. 31, 35, 36

[8] BNDES Annual Report 2011 http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Hotsites/Relatorio_Anual_2011/Capitulos/o_bndes_em_numeros/destaques/energia_eolica.html

[9] Correspondence No 33, 34, 31

[10] In the Brazilian case the responsible government organization is the Brazilian National Social and Economic Development Bank. The BNDES formula for localization is either by value (I_v): I_v = [1 – x/y*100], where: x – imported components value (including raw material) y – selling price; or by the weight (I_p): I_p = [1 – X_p/I_p]*100, where: X_p – weight of imported components, I_p - weight of the complete equipment (BNDES, 2007)

[11] Interviews No. 3, 6

[12] Correspondence No. 33, 34

13 Resolution CAMEX n. 37, 24/06/2009 – Brazilian Foreign Trade Chamber's Resolution raises import tax of 0 to 14% for wind turbines (Energia e mercados, 2012).

[14] 1% of the Net Operating Income from generation, 1% from transmission and 0.75% from distribution, and 0.25% from efficiency energy companies, according to the laws 11.465/2007 and 12.212/2010, that changes paragraphs I and III in article 1º of law 9.991/2000; 40 % of this amount goes to FNDCT and also 40% to R&D projects and 20% for MME (BRASIL, 2000).

[15] PROESCO is a financial support program for renewable energy Project, which finances 80 up to 100% of the Project up to R$ 100 million. Fundo Clima holds R$ 30 million from the mininistry of environment (MMA) and R$ 200 million from BNDES and supports Wind, biomas and solar energy projects (BNDES, 2012).

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[19] Interviews No. 6, 12, 13, 18, 21, 31, 32

[20] WTO (2013) Dispute Settlement: Dispute DS426, Canada- Measure related to the Feed-in Tariff Program http://www.wto.org/english/tratop_e/dispu_e/cases_e/ds426_e.htm

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[22] Correspondence 25, DTI Director Renewable Industries at Windaba, Cape Town October 2012

[23] Interviews No. 1,2, 12, 13

[24] Interviews No. 33, 6, 21

[25] Interviews No. 1, 21

[26] Interviews No. 1, 2, 3, 4, 6, 8, 9, 10,12, 13, 21, 31, 33

[27] Interviews No. 6, 8, 12, 21

[28] EPE (2012) Leilâo De Energia A5-2012 http://www.epe.gov.br/imprensa/PressReleases/20121214_1.pdf

[29] Interviews No. 7, 20, 24, 30

[30] Interview No. 20, LM Press release http://www.lmwindpower.com/Media/Media-Kit/Press-Releases/2012/10/Brazil

Annex

No.	Interviewee/correspondent	Organization
1	Former Employee	Wobben, Enercon
2	Director	Wobben Brasil
3	Representative	Alstom Brasil
4	Representative	Siemens Brasil
5	Representative	Siemens South Africa
6	Director	Acciona Brasil
7	Representative	Acciona
8	Representative	IMPSA Brasil
9	Representative	WEG
10	Representative	GE
11	Representative	ABB
12	Representative	Vestas
13	Representative	Gamesa
14	Representative	Sinovel
15	Representative	Sinovel
16	Representative	Sinovel
17	Representative	Goldwind
18	Representative	Iberdrola
19	Representative	Conco
20	Representative	LM Windpower
21	Representative	Suzlon Brasil
22	Representative	Suzlon South Africa
23	Representative	Darling Windfarm
24	Representative	Nordex
25	Director RE Industries	Department of Trade and Industry, SA
26	Director Localization	Department of Science and Technology, SA
27	Deputy Director General	Department of Energy, SA
28	Researcher	Council for Scientific and Industrial Research
29	Representative	DTI TIPS
30	Director	South African Wind Energy Association
31	Director	Brazilian Wind Energy Association
32	Director	Global Wind Energy Council
33	Representative	BNDES
34	Representative	BNDES
35	Representative	Energy Research Enterprise
36	Researcher	UFRJ COPPE
37	Researcher	UFRJ
38	Representative	Green Cape
39	Representative	German International Cooperation Brazil
40	Representative	German International Cooperation SA