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Feito no Brasil? Made in South Africa?

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

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Abstract

How can local content requirements (LCR) boost technological capability for renewable energy? 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% domestic content in each installation since 2004. South Africa demands up to 45% domestic content in its recent program. The benefits of these requirements are heavily debated. The rationale behind LCR is that governments in developing countries intend to stimulate jobs in new industries and to accelerate technological development. This market intervention imposes a barrier for international manufacturers, as local manufacturing can push up the technology prices. Based on evidence from Brazil and South Africa, we find that LCR fall short as a single technology policy instrument. The Brazilian case shows that LCR incentivized the domestic production of low and medium technology content. These are the heavy parts, such as the towers, which are difficult to transport. Recently, parts of the nacelle, hubs and blades have increasingly been manufactured locally. High technology-intensive components, however, continue to be imported. Boosting local industries requires not just restrictive measure such as content requirements but, more importantly, it requires active support of technological capability.

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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 appeared in the renewable energy sectors. In the past, these interventions were common in the classical heavy industries like in the oil or automotive sectors. In the research literature, most economic research classifies those local content requirements as a protectionist distortion to free trade. Most of the economic research comes from the 1970s and 1980s. However, domestic content requirements are experiencing a revival in current policy making.

This research paper analyses the impact of domestic content requirements on renewable energy technology development in the cases of the Brazilian and South African wind energy industries. This paper shows that the technological upgrade and job creation impacts in the renewable sectors in Brazil and South Africa remain at the lower and medium technology levels. Both case studies show that the content requirements are not an effective industrial policy by themselves, but need a significant market size as well as complementary technology policy support. The Brazilian case is more mature, because renewable incentives programs, which require local content, came into place seven years earlier than those in South Africa.

The analysis contributes to the academic debate as to whether local content requirements are a harmful form of protectionism or an effective low carbon technology policy. To answer the research question, we interviewed 42 representatives from the Brazilian and the South African wind energy sectors. Through semi-structured interviews, we collected data on the technology components, which firms manufacture locally, and on employment generated in the wind industry. 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. Benefits vs. welfare losses: Controversy on local content policies in the research literature

Local content requirements are rules, set by the government, which determine the way foreign investors have to allocate their resources. Usually governments require that a certain amount of technological equipment be manufactured locally. There are different ways of determining local content, which can be calculated as the percentage of the project value, the value of the technological equipment, designation of specific technological components or a percentage of their weight (Grossman, 1981).

Specifying local content is a balancing act, because setting the requirements too high may deter investors and push technology prices up. Setting the requirements too low may exempt the desired technology upgrade and employment benefits. If content requirements target production from sophisticated industrial processes, the requirements usually target a percentage of the value added rather than physical units (Grossman, 1981).

The rationale of local content requirements is the attempt to extract the full benefits of technology transfer and job creation. LCR can narrow the gap in technological capability and market opportunities between developed and developing countries. Typically, firms in developed countries have mature technologies, but struggle to sell them on saturated markets, whereas the developing countries have immature technologies and offer new market opportunities The logic is that the protection schemes increase the production of domestic content in the receiving countries and reduces the output of the foreign country in its home country (Davidson et al., 1985). Another argument for local content requirements is that governments intent to correct a perceived gap between the private and social costs and benefits of the investment (Veloso, 2006).

Domestic content policies create winners and losers. Obliging firms to manufacture locally through compulsory requirements directs foreign investment towards local firms and local jobs in the receiving country, reducing the profit of the investing firm. Therefore, content policies are a popular and controversial policy instrument, which mostly appeals to governments in developing countries. Their intention is to ensure that the foreign investments contribute to local industry development.

The research literature reflects the controversy around the benefits and harm of local content requirement. The literature on industrial policy, which produces mostly individual country analyses, identifies three main aspects as successful implementation of local content requirements:

1. Technological upgrade refers to increasing in the technology content, which is manufactured locally, and increasing firm technological capability (Qiu and Tao, 2001).

2. Creation of national champions, which can be quantified in the number of firms which manufacture locally and eventually produce for export (Han et al., 2009).

3. Creation of local jobs, which are usually quantified as jobs per MW installed (Lewis and Wiser, 2007a; Veloso, 2006)

These positive impacts of local content requirements depend on the size of the market, the existent technological capability to absorb transferred technologies, and the technology prices. If the world market price exceeds the domestic price, LCR are more likely to fail (Grossman, 1981; Veloso, 2006). The literature on local content requirements applied in the wind energy sectors reflects the mixed impacts of LCR found in the older theoretical literature. Lewis and Wiser

(2007) analyze LCR in the wind energy sectors in twelve countries. The authors find that the successful implementation of content policies depends on the size and stability of demand in the home market, which is an important "testing ground" for new technologies and market strategies (Lewis and Wiser, 2007b). A solid feed-in tariff or tendering program, which creates a stable market, was crucial for the successful implementation of LCR in Spain and China. These countries succeeded in boosting local manufacturing industries, although the innovation benefit of the 'first mover' was missed out. Local content requirements successfully supported local wind turbine producers in Spain and China. Gamesa, Sinovel, Goldwind and other manufacturers emerged from local content policies and now operate globally (Han et al., 2009; Lewis and Wiser, 2007a)

Content requirements can backfire, as Rivers and Wigle (2011) find in their partial equilibrium analysis of the Canadian case, 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 (Rivers and Wigle, 2011).

The literature on trade economics generally argues against local content requirements. The main argument states that local content requirements are barriers that distort the free trade flow and cause overall welfare losses. This conclusion rests on the assumption that welfare derived from the self-clearing markets under the principle of non-intervention, might not necessarily hold for the case of highly regulated electricity markets. Early macroeconomic writing on content requirements in the 1980s identifies possible negative effects, because the extent of the requirements is not predictable (Grossman, 1981). Hollander (1987) and Vousden (1987) confirm the possibility of harmful effects of content requirements on final good producers. Nakanishi and Masayuki (1997) show that the wage differential between the countries is crucial in determining the direction of how benefits and losses are allocated. Rodrik (2004) makes 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. Rodrik (2004) 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, information and communication technologies or renewable energies occurred without massive industrial policy intervention (Rodrik, 2004). Local content requirements fall under these 'unorthodox' policy measures. Local content policies have been applied in various sectors in the past, and are particularly popular amongst those intending to catch up in the technology race. Local content requirements can be found in the early trade disputes in European industrial development (Cimoli et al., 2009), continuously in industrializing industries in the tobacco and in the automotive industries, and now the renewable energy industries recently.

Both perspectives fuel the debates in the international trade regime as to whether and to what degree domestic content requirements are acceptable.

Internationally, domestic content requirements have been dismissed in the General Agreement on Trade and Tariffs (GATT) 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 'are considered to be inconsistent with Article III. The World Trade Organization (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 assumption of a 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, 2013)

The WTO is considered to be more rigorous 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 yet become targets of trade disputes. 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). The key players in the game on local content requirements are typically three sets of primary actors: a) international firms, also referred to as original equipment manufacturers (OEM), b) the government who set the local content requirements, c) local firms. Secondary actors are trade unions and business organization lobbying for or against the content policies and governments from the OEM home countries that can object to the content policies and file trade disputes through the WTO.

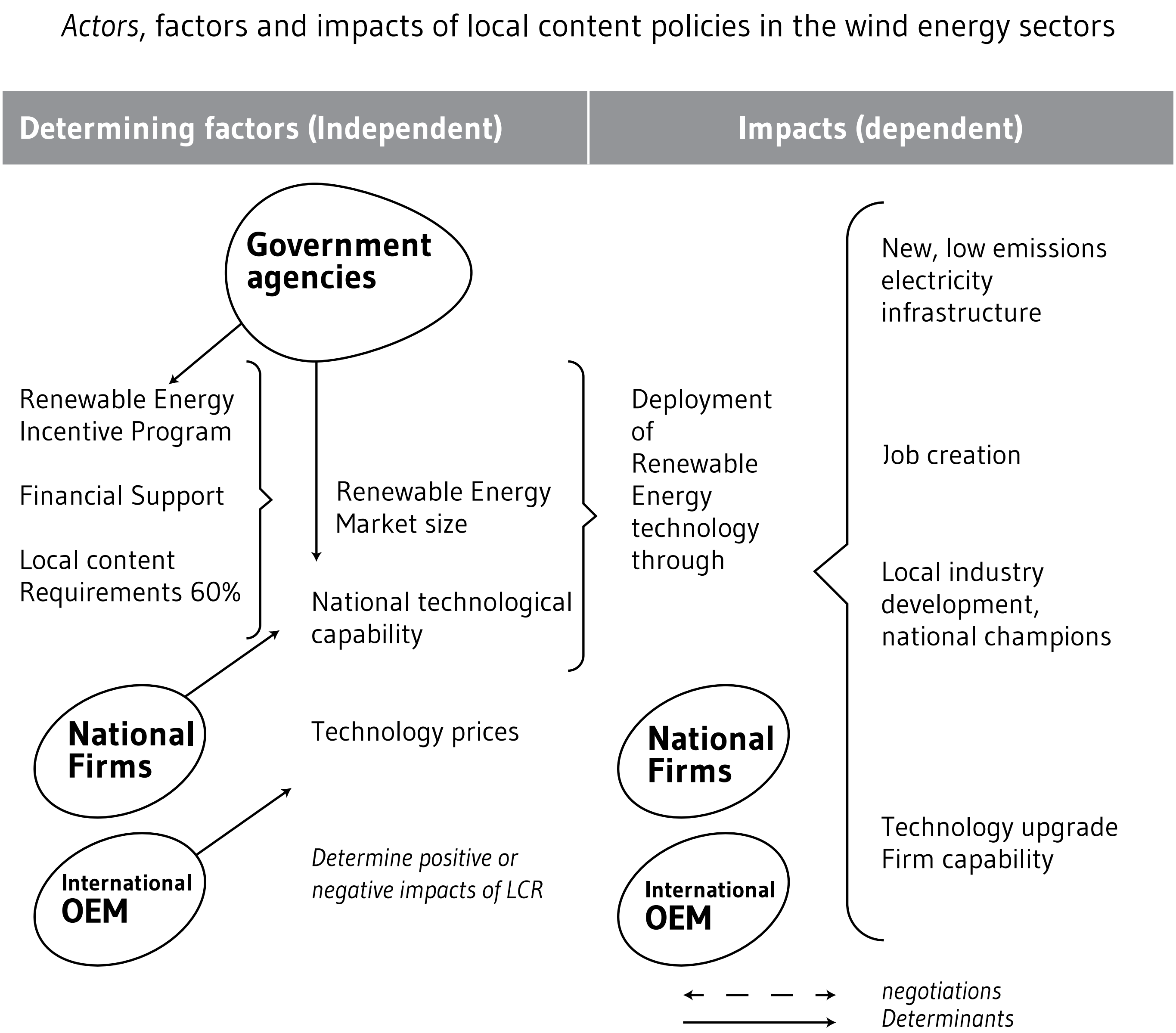
The research literature reflects well the controversy of local content requirements and confirms that harmful or beneficial impacts depend on the implementation and size of the economy. The argument for increasing benefits through free trade is not necessarily applicable for the electricity sector, which is highly regulated in the two countries we chose for the case studies. LCR are closely linked to the incentive schemes for renewable energy, which establish the market size.

We can summarize actors, determining factors for success and failure of local content policies and their impacts on renewable energy technology development, which were identified in the research literature, as follows:

Firstly, the renewable energy program incentivizes the production of clean electricity, either through a set price, quota or quantity, which the government determines. The incentive program is an important determinant of the success or failure of local content requirements, because it determines the size and the stability of the home market. Local content requirements are linked to the renewable energy program intent to create benefits for technological capability, job creation and industrial development. The market size, technological capability at national and firm levels and the technology prices affect the investment decisions of the international original equipment manufacturers (OEM) as well as the success of the LCR.

Secondly, the impacts of the local content policies can be identified through their impacts on technological capability at the firm level, local industry development through creating 'national champions', and job creation.

Figure 1 Framework Actors, factors and impacts



3. Methodology

The framework on actors, determinants and impact factors identified in the research literature guide the analysis, which assess the South African and Brazilian incentive programs and can provide insights on the possible success or failure of the content policies on technological development. We chose two case studies, because both policy processes begin in similar ways, but are implemented differently and have different impacts. The experiences shown in the Brazilian example can be useful for South African decision-makers. The analysis focuses mainly on the technology upgrade and carefully estimates employment impacts on the basis of newly collected and secondary data. The research methodology for this paper is a qualitative content analysis on the basis of data collected through 42 interviews. We sampled the principal actors including government representatives, representatives from international OEMs and local firms. We took the opportunity to interview firm representatives during the sectorial gatherings, like the Wind Power Brazil Conference and the AfriWEA, and Windaba Conferences in South Africa as well as individual visits. The interviews took between 20-60 minutes each. We collected interview data through structured questionnaires from the leading OEMs, local developers, government officials and experts (view appendices for questionnaire and list of interviewees). The interviewees were granted anonymity, as local content is an important competitiveness factor. The subsequent analysis section is structured in two parts. The first part focuses on the implementation of local content requirements in changing renewable energy incentive programs. The second part focuses on the impact of the programs on the technology and socio-economic benefits.

4. Analysis: Local content policies in changing incentive systems

Local content policies became a key ingredient in the wind energy incentive systems in Brazil and South Africa. However, the wind energy incentive systems had slow starts, because both countries rely largely on one energy source: hydro in the Brazilian and coal in the South African case. Power shortages in 2001 in Brazil and 2008 in South Africa pushed the government into diversifying their energy sources and 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. In South Africa, the feed-in tariff was abandoned before its implementation, whereas the Brazilian government 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 analyses the process of implementing local content policies embedded in the wind incentive programs, which refers to the determining factors and actors as described in figure 1.

Localization under a feed-in tariff in Brazil and South Africa

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 of 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. The feed-in tariff required a minimum of 60% of local components in the new wind installations. The government intended to stimulate a local industry through these requirements and offered a feed-in tariff. PROINFA for wind energy began to offer a price for 300 R$ (128 US$) per MWh of wind energy to power producers. The program aimed to to promote 3,300 MW of planned generation capacity consisting of 36% of Small Hydropower Plants, 43% wind and 21% of thermal biomass. Under PROINFA, Eletrobrás agreed to buy electricity from the wind power producers over 20 years.

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 producers into PROINFA was calculated over the total value of the park, considering services and equipment.

The objective of this localization 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 had the technological capability to produce local equipment in Brazil, and they had been operational since 1996. The 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] The firm installed most of the parks commissioned through PROINFA, because other firms struggled to fulfill the content requirements.[6] Yet, the newly created demand for locally produced wind turbines was higher than a single manufacturer could attend.[7] 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 of the Environmental Agency (IBAMA), delays in the environmental assessments, and the grid connection.[8] The market was too small and too instable for other international competitors to invest.[9] Yet, a single firm could not attend the demand for locally manufactured components. 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. Despite the delays, PROINFA contributed to 1,4 GW of the current 2 GW installed wind capacity in Brazil (Eletrobras 2006).

In South Africa, the power cuts in 2008 gave momentum for a policy process towards a feed-in tariff. In 2009, the National Energy Regulator (NERSA) announced guidelines for a renewable energy feed-in tariff (REFIT), which is supposed to guarantee the payment of a fix price per kwh produced through seven renewable energy technologies, including wind. The REFIT also made provisions for local content requirements as part of the accelerated shared growth initiative (ASGI-SA). ASGI-SA is an economic development program, which identified public expenditure on infrastructure. New electric energy power stations were one of the focus areas. 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 R35 million

(US$ 3,5 million) and a Black Economic Empowerment Contributor, 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 R35 million, 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 (n.d. 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. NERSA's efforts did not have the necessary political support from National Treasury and the Department of Energy. 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, 2011a)]. Instead, the Department of Energy announced a new program for renewable energy through procurement from independent power producers (REIPPPP). The REIPPPP 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 under competitive bidding

In South Africa, local content requirements remained a crucial component in the REIPPPP. The REIPPPP defines local content as "the total costs attributed to the Project at the Commercial Operation Date, excluding finance charges, land and mobilization fees of the Operations Contractor" (DOE, 2011b, p.8). Local content and localization appear almost interchangeably: "Localization […] is defined as the capital costs and costs of services procured for the construction of the Facility excluding finance charges, land and mobilization fees of the Contractor undertaking Operations" (DOE, 2011b). The procurement documents request close policy alignment with the industrial policy plans (RSA, 2010), and the Industrial Policy Framework, which comprises the ASGI-SA requirements, as well and the overall localization strategy (DST, 2008).

The government states the main purpose of the local content requirements repeatedly, as key to creating jobs through increasing local manufacturing (DOE, 2011b; DST, 2008). 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 more specific in the South African tender documents than in the Brazilian case.

In Brazil, 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 the form of a so-called reserve energy auction (Brazilian Decree 6.353/08) and other types of auctions. The auction system formally abolished local content as a compulsory requirement. Domestic content requirements, however, continued to apply to those firms who request financial support from BNDES. The bank's investment adds up to R$3,4 billion (1,45 billion US$) in 2011.[10] In fact, the domestic content requirements continued, because so far no firm has managed to install a wind farm without the support of the bank.[11]

The auction system made the sector more dynamic, and attracted large foreign investments. Between 2008 and 2009 the installed capacity increased about 79%. The first auction in 2009 contracted 1,9 GW for a price of R$ 148,39/MWh (63US$) over 20 years which was half of the initial feed in tariff. In the third auction the price dropped another third to about 100 R$ (42,77US$) per MWh. The energy regulator ANEEL capped the bidding price to a maximum of 117 R$ 117 (US$50) per megawatt-hour. The auctions allocated significant quantities between 500 MW and 1,8 GW between 2009 and 2012. Currently, 2,8 GW have been installed. The total contracted capacity adds up to a total of 8,7 GW by 2017.[12]

In South Africa, the REIPPPP intends to allocate 3,7 GW of renewable energy, including solar, wind, small hydro and biomass technologies. In the first two bidding rounds the Department of Energy allocated 562 MW and 634MW respectively to wind power, which makes 1,2 GW to be built by 2016. The projects allocated in the first bidding round are currently under construction. Prices dropped by 22% from the first to the second bidding round from R1140 (114,27US$) to R890 (89UD$) per MWh.

Financial support

The main changes in terms of local content between PROINFA and the auction system is that the local content became compulsory only for those developers who required financial support from the BNDES. BNDES can finance 80% of the project, at 0.9% interest rate, through its subsidiary *Special Agency for Industrial Financing* (FINAME). FINAME finances projects through various funding lines. The alternative energy line finances projects worth over 10 million Reais (R$), (42,7 million US$) 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.[13] This fund has not yet been used much for wind energy (BNDES, 2012).

BNDES's financial support mechanisms create a clear incentive for the use of wind energy, despite the obligation to fulfill local content. Only one company plans to bring its own funding through a Chinese development bank, for a park in Aracajú.

BNDES began a certification system (CFI) of the main global wind turbine producers, which received financial support for wind energy parks. BNDES finances most of the wind parks, with a payback rate of 16 years. A minimum of 60% local content in value and weight are the basic criteria[14] 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.

A tower, which is 100% locally produced, can already meet 40% of localization of the whole turbine.[15] The towers are usually made of concrete or steel and average 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.[16]

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 (7,5 million US$).[17] The DBSA approved approximately R9,6 billion (9,6 million US$) for 896.5MW capacity installed under the REIPPPP.[18]

Local content requirements do not link to any of the financial schemes of these banks, as in 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). These interest rates do not compare to the 0,9% offered by BNDES and allows us to conclude that the South African REIPPPP lacks a clear financial incentive.

Institutional arrangements for implementing and enforcing local content

BNDES is the designated implementation agency, which is a public enterprise under 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 parks, 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 led 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, 2011b). The Department of Trade and Industry has developed the requirements with support from TIPS and other consultants, but is not responsible for overseeing 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 summary, we find major differences in the market size allocated through the incentive scheme. The Brazilian case demonstrates that the international investment took off with the allocation of a significant market size. The South African program, in turn, makes small and short-term provisions for wind energy.

The financial schemes differ significantly. The Brazilian scheme provides cheap loans conditioned on the provision of local content, whereas the South African scheme provides market rates loans and makes content requirements compulsory independently from access to loans.

The institutional setting differs as the BNDES has a powerful and centralized mandate for the implementation of the financial scheme, content requirements and project approval. In South Africa, the mandate to enforce compliance with the content requirements sits with Department of Energy, independently from the finance of the projects.

In terms of existing technological capability, Brazil already had an OEM based in the country that could provide local content. In South Africa, the industry starts from scratch, with the exception of a local manufacturer who does not qualify for the REIPPPP, because the Department requires two years of experience in original equipment manufacturing, which the start-up firm could not prove.

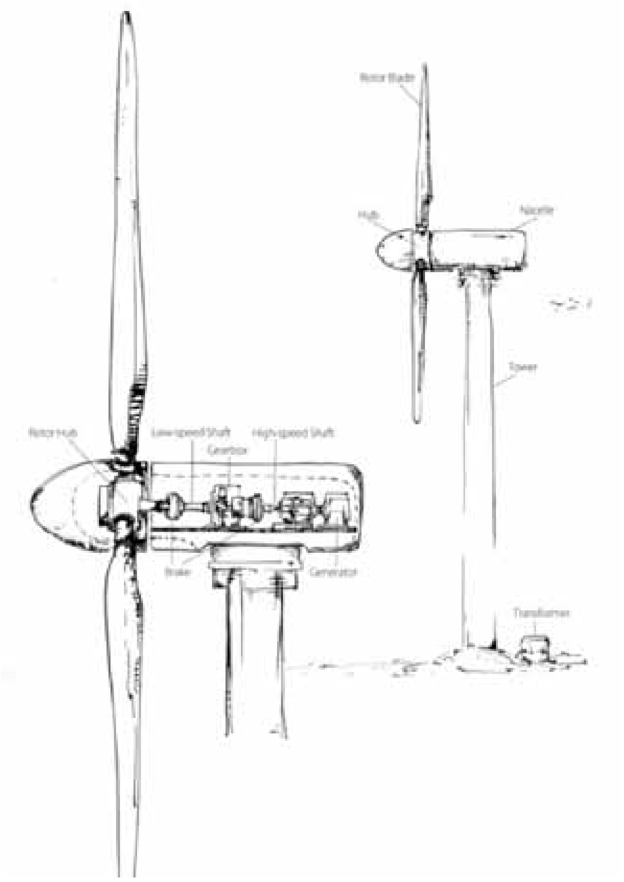
Locally produced wind turbines and industrial development

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.[20] 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.

Assessing local technology 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 2: Technology components in the wind energy turbine [21]



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[22], transformer, low-speed shaft, high-speed shaft, gearbox, brakes and generator

There are 15 manufacturers that supply most of the components for 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 1 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 Grand 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.[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. Wobben produces mainly nacelles, blades and towers locally and exports blades to Europe and other parts of the world. Tecsis emerged as a local manufacturer mainly for blades. Dutch LM made an investment decision to open a local manufacturing base in Brazil for blades. The other OEM focused their local manufacturing efforts mostly on nacelle boxes, components and hubs. Towers come mostly from steel manufacturers. The main components, which are produced locally as a result of 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.[24] Additional civil engineering firms' supply locally produced towers mainly made of metal and steel, rather than 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).

Not all firms managed to produce local content fast 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.[25] 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.[26] 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).

Eight OEM have entered the South African market since the funding program began. A demonstration site in Darling has been generating 5 MW as a demonstration project 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.[27] The leading Dutch blade manufacturer LM intends to invest into South Africa once there is a reasonable market size. The company just committed to build a factory in Pernambuco, Brazil, with 300 staff, and an investment volume of equivalent of 45 million Euros.[28]

So far, the South African local content requirements could be covered through the balance of plant in the first bid round.[29] The balance of plant refers to infrastructural components of a wind park excluding the turbine and its elements. In the second round the content increases to include the tower, which can be built in concrete on site, or by steel manufactures. The requirements of 60% in the third round demands locally manufactured nacelle boxes and blades, which deterred some investors from bidding, as they will not be able to provide this equipment locally at a competitive price.[30] It is unclear how the Department will enforce compliance with the content requirements.

Low carbon development impacts

Estimating the developmental impacts, especially in terms of job creation is difficult, because of the lack of reliable data. In this section we present existing estimates and our own data, which we collected through interviews. We follow the framework in figure 1 on the impacts, which consist mainly of avoided emissions, job creation, local industry development and technological capability upgrade.

In Brazil, 119 turbines run and avoid about 2397 t of CO2 per year (Abeeólica, 2013). However, 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 (Energia, 2012; Simas, 2012). The local content requirements obliged international OEMs to invest into ten manufacturing sites. Tecsis, the local manufacturer for blades, recovered from bankruptcy in 2010 and invests in a second factory in Bahia. The international renewable energy agency IRENA recognizes the Brazilian market already as one of twelve mature markets, although it only emerged over the last three years as the fastest growing market in Latin (GWEC and IRENA, 2012).

The best winds for electric energy generation are in Northeastern Brazil and those are likely to improve with climate change (Pereira et al., 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 distribution of income and 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 is concentrated. Some 40% of the firms, however, invested in branches, factories or even headquarters in the Northeast, because most of their operations are in this region.[31]

Figure 3 Regional distribution of wind energy manufacturers in Brazil

The estimates for job creation in the sector vary. Simas and Pacca (2011) calculate emissions reductions and job creations for three scenarios:

a) 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.

b) The second scenario estimates a capacity of 10 GW with 129 million tons of CO2 and generates over 143 000 jobs, 85% in manufacturing and installation.

c) The most optimistic scenario 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 add up to 14,2 GW. Wind energy makes up 484 projects with a total capacity 11,9 GW by 2017, which is close to scenario b.

Brown (2011) investigated the development impacts in the state Ceará, which hosts the highest concentration of wind parks in all states and add 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, 2011, p. 353ff). These consist of 7091 manufacturing jobs and 42 543 construction and maintenance jobs (roughly 50 000 jobs overall), 85% of these in construction and maintenance, and 15% in skilled manufacturing.

The Brazilian Wind Energy Association calculates 15 jobs per MW, which adds up to 12 000 newly created direct and indirect jobs since 2009. The estimate for 2020 is a total of 280 000 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 2 746 direct jobs in the Original Equipment Manufacturers (OEM) in the 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 in 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.

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. So far, there is only data available for the first bidding round, which has been closed.

Table 2 Proposed job creation in the wind energy sector under the 1st bidding round in South Africa

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)

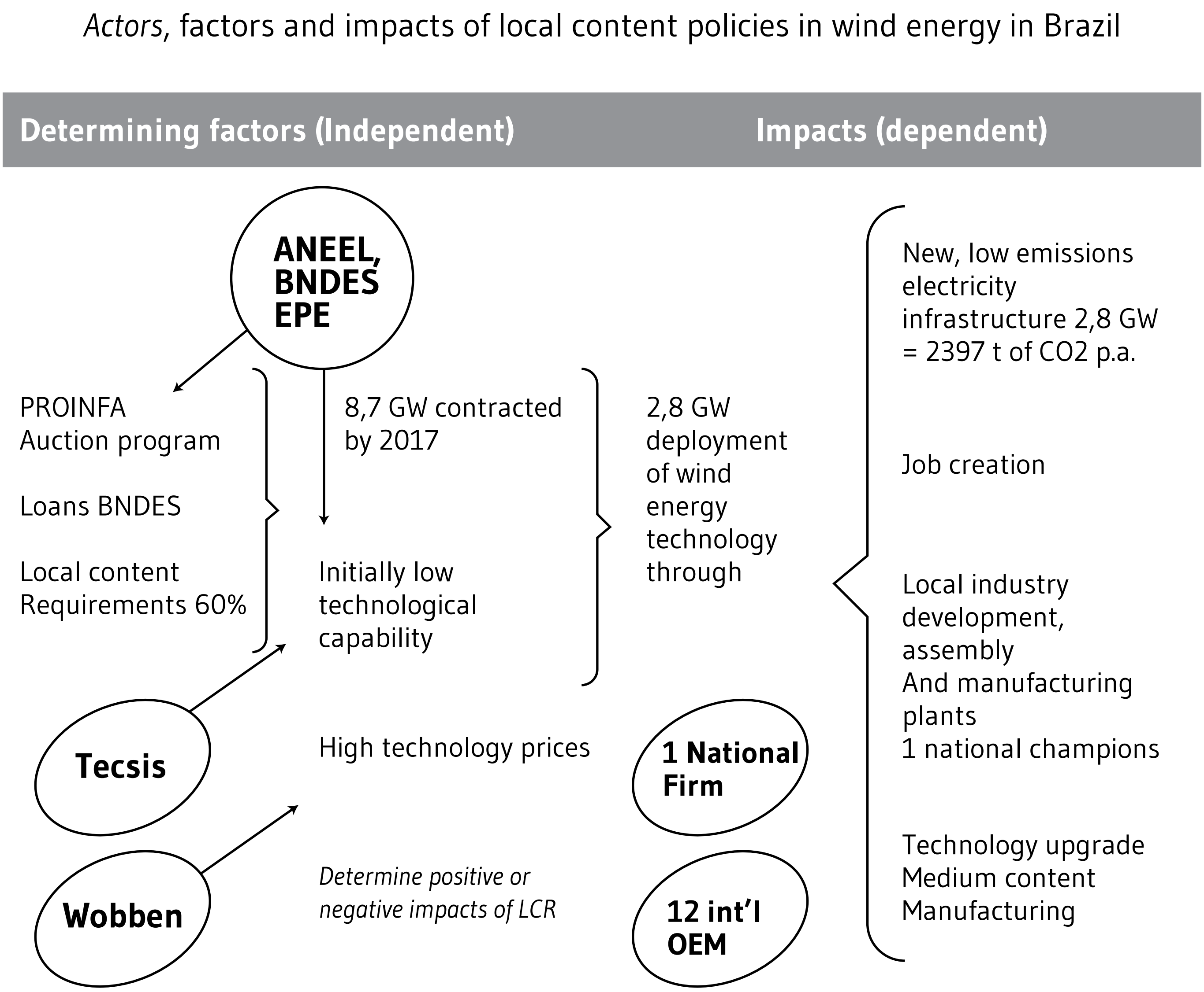
Our interview data showed that some OEMs are opening small offices, whereas others still have employees from their homeland flying in and out of South Africa. The direct jobs in the OEM offices vary between one and 15 employees.

So far, the local content requirements have not added major technological capability, as the local content in the first and second rounds can be mainly covered through the balance of plant and the tower.

The only local manufacturer, I-WEC, is in the process of liquidation. The company did not fulfill the necessary two years experiences to qualify for the REIPPP program, which closed the market access for the company. The agreement to install wind turbines in Saldanha Bay with ArcelorMittal, became obsolete when a major partner pulled out of the business. The company struggled to find risk capital investment from the IDC, a government department or any commercial bank, without a power purchase agreement. Its manufactured turbine equipment sits unused in Cape Town’s harbor.

The figure below summarizes the main findings from the analysis according to the framework of analysis. Findings from Brazil are marked in bold.

Figure 3: Overview: Actors, factor and impacts of local content policies in South Africa and Brazil



5. Conclusions

Our analysis showed that local content requirements have not yet achieved a boost in local production of high technology components.

In the Brazilian case, the local content requirements contributed to establishing an industry for components for local and medium technology content. The market size in the auction system and the cheap BNDES loans created an incentive for foreign investors to invest into local manufacturing. The bank's central role proved advantageous for efficient project implementation and approval of finance. The enforcement of content policies, however, caused confusion in the sectors, as they depended on individual negotiations between the bank and the firms. Clear rules for all is one of the lessons that can be learned for future implementation of content requirements.

The content policies raised a national champion in blade manufacturing and created at least 4000 jobs. The content requirements did not support high technology manufacturing or innovation. Support for innovation and R&D will be an urgent next step for the Brazilian decision makers.

The South African case demonstrates that there are still many uncertainties on the positive or negative impacts of LCR. The renewable energy program has no clear financial support through cheap loans, which would support investment into local manufacturing. The narrow bidding windows and requirements for experience make it difficult for new firms to come in. The limit to support installations with a minimum capacity of 5MW makes it difficult for small start ups to get into the market. The market size is relatively small and the national technological capability is limited, which increases technology prices and makes it increasingly difficult to invest into a local industry.

The desired technological upgrade has not yet happened in the first two bidding rounds. It is questionable if it will happen, as investors might be deterred from the local content requirements of 40-65% in the future bidding rounds, given the small market size. If the investments arrive nevertheless, the South African labor market will benefit with significant job creation. In order to sustain a new local wind manufacturing industry, however, the government will have to provide a more comprehensive incentive scheme, which embeds the local content requirements into a wider innovation policy framework. This framework will have to support the knowledge base in the sector and support small firms and innovators with risk capital.

6. References

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7. 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 Interview No.1, 13

8 Interviews No. 31, 35, 36

9 Interviews No. 13, 4

10 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

11 Correspondence No 33, 34, 31

12 Data from Abeeólica 13th August 2013 URL http://www.abeeolica.org.br/pdf/Boletim-Dados-ABEeolica-julho-2013-Publico.pdf

13 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).

14 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 (Iv): Iv = [1 – x/y*100], where: x – imported components value (including raw material) y – selling price; or by the weight (Ip): Ip = [1 – Xp/Ip]*100, where: Xp – weight of imported components, Ip - weight of the complete equipment (BNDES, 2007)

15 Interviews No. 3, 6

16 Correspondence No. 33, 34

17 Mail and Guardian. 2012. The green industry's driving force. Special Reports. 22 August 2012. URL: http://www.mg.co.za/article/2012-08-22-the-green-industrys-driving-force

18 Business Report. 2012. DBSA approves R10 billion for renewables. 22 October 2012. URL: http://www.iol.co.za/business/companies/dbsa-approves-r10bn-for-renewables-1.1408467#.UJFD4kLwiCQ

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

20 Correspondence 25, DTI Director Renewable Industries at Windaba, Cape Town October 2012

21 drawing: kerstinunger.com

22 Electric components: Wind detection sensor, automatic operation control, generator

23 Mechanical components: cranes, speed control, refrigeration system for oil and water, principal axis, blades rotor, hydraulic systems, support structure, disc break etc. (Montezano, 2007).

24 Interviews No. 1,2, 12, 13

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

[26] Interviews No. 33, 6, 21

[27] Interviews No. 1, 21

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

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

[30] Interviews No. 4, 19, 7, 24

[31] Interviews No. 4, 25

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

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

Annex 1

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
41	Representative	I-WEC
42	Representative	Tecsis

Annex 2

Interview Questions for OEM

- Since when is your company active in Brazil/South Africa?
- Are your products certified as local content?
- If yes, which components do you sell as local content?
- If not, why not?
- Did local content requirements have a negative or positive impact on your business? Why?
- Did the prices change? If yes, how?
- Which parts do you import?
- Which other countries do you supply?
- How many employees work in you company here in Brazil/ South Africa?
- How many work in manufacturing, sales, administration, construction?
- Quantos deles sao da equipe tecnica, venda, administradora?
- Did these numbers change over time?
- Is your company doing R&D activities in Brazil/ South Africa?
- Why? Why not?