the dti

Department:
Trade and Industry
REPUBLIC OF SOUTH AFRICA

THE WIND ENERGY INDUSTRY LOCALISATION ROADMAP IN SUPPORT OF LARGE-SCALE ROLL-OUT IN SOUTH AFRICA

INTEGRATED FINAL REPORT

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- Department of Science and Technology (DST)
- Department of Energy (DOE)
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PROJECT BACKGROUND AND SCOPE

In 2010, the Council of Scientific and Industrial Research (CSIR) and Risø-DTU of Denmark undertook an "investigation into the development of a Wind Energy Industrial Strategy for South Africa", which was initiated and funded through the Global Environment Facility (GEF) South African Wind Energy Programme (SAWEP). The study involved an analysis of the global and domestic wind energy industry, as well as the review of the support mechanisms that could be employed to develop the sector further. This was all in reaction to the need and opportunities related to the development of the renewable energy and the associated green economy identified by the Presidency through the release of the **New Growth Path (NGP) Framework** (2010).

In 2011, government presented the **Green Economy Accord** reflecting one of the four outcomes of the social dialogue on the NGP. The Green Economy Accord sets out 12 green economy commitments signed by organised labour, business representatives, community constituents, and government. One of these commitments relates to the rollout of renewable energy that is envisaged to be used as a vehicle to promote rural socio-economic development. The Green Economy Accord set a target to create 50 000 green-related jobs by 2020 and achieve "an industry-wide localisation of at least 35% by 2016 (or such higher figure as government may mandate as a condition of any subsidy), and increase local content in the years to follow towards the aspirational target of 75%". The **National Development Plan (NDP) 2030** also later affirmed the need to develop the renewable energy sector.

However, much has changed since the completion of the CSIR and Risø-DTU 2010 study, particularly the rollout of the Renewable Energy Independent Power Producer Procurement Programme (RE IPPPP), which provides a regulatory framework and market that created opportunities for the development of the industry and business activities along its value chain. As a result, some overwhelming wind energy sector-specific questions need to be addressed in order to make possible the designing of a proper wind technology roadmap that suits the South African context and goals outlined in the aforementioned strategic documents. These include, inter alia:

- What is the size of the potential wind energy market?
- Are the economic opportunities leading to job creation and economic growth brought on by the growth of the wind energy industry in the country being fully realised?
- What is the optimum level of localisation of the industry in the country in the short to long term?
- What interventions and support need to be offered to achieve the optimum level of localisation of the industry?

In response to the above, the Department of Trade and Industry (the dti) has initiated the study aimed at investigating the optimum level of localisation that can be achieved in the wind energy industry and contribute to the alignment of industry and government interventions. The study is broken down into the following five components, that are all presented in this integrated report:

- Wind energy market profiling and sustainability assessment
- Wind energy industry value chain profiling
- Investigation into the localisation potential
- Finance and certification aspects analysis
- Wind energy localisation roadmap

ACRONYMS AND ABBREVIATIONS

AfDB	African Development Bank
AMEU	Association of Municipal Electricity Utilities
CO_2	Carbon dioxide
CSP	Concentrated Solar Power
DEA	Department of Environmental Affairs
DOE	Department of Energy
DTI	Department of Trade and Industry
ECOWAS	Economic Community of West African States
EIA	Environmental Impact Assessment
ERA	Electricity Regulatory Authority
eTM	eThekwini Municipality
excl	Excluding
FIT	Feed-in-Tariff
GDP	Gross Domestic Product
GW	Gigawatt
GWh	Gigawatt-hour
GWS	Global Windmapping Services
IPP	Independent Power Producer
IRP	Integrated Resource Plan
ISMO	Independent System and Market Operator
Km	Kilometres
kV	Kilovolts
kWh	Kilowatt-hour
KZN	KwaZulu-Natal
m	Metres
MCEP	Manufacturing Competitiveness Enhancement Programme
m/s	Metres per second
MFMA	Municipal Finance Management Act
MW	Megawatt
NERSA	National Energy Regulator of South Africa
NGP	New Growth Path
NPRS	National Poverty Reduction Strategy
O&M	Operation and Maintenance
OEM	Original Equipment Manufacturer
PFMA	Public Finance Management Act
POD	Point of Delivery
PPA	Power Purchase Agreement
Pty Ltd	Private Limited
PV	Photovoltaics

R	South African Rand
RE IPP	Renewable Energy Independent Power Producer
RE IPPPP	Renewable Energy Independent Power Producer Procurement Programme
RE	Renewable Energy
REFIT	Renewable Energy Feed-in-Tariff
REPCV	Renewable Energy Plan for Cape Verde
RFP	Request for Proposals
SABS	South Africa Bureau of Standards
SADC	Southern African Development Community
SARB	South African Reserve Bank
SAWEA	South African Wind Energy Association
GEF	Global Environment Facility
SAWEP	South African Wind Energy Programme
SSEG	Small Scale Embedded Energy Generation
UK	United Kingdom
UNEP	United Nations Environment Programme
UOS	Use-of-system
USA	United States of America
USD	United States Dollar
VAT	Value Added Tax
WASA	Wind Atlas for South Africa
WE	Wind Energy

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EXECUTIVE SUMMARY

In 2010, the Council of Scientific and Industrial Research (CSIR) and Risø-DTU of Denmark, on behalf of the Global Environment Facility (GEF) South African Wind Energy Programme (SAWEP), undertook an "investigation into the development of a Wind Energy Industrial Strategy for South Africa". The study involved an analysis of the global and domestic wind energy industry, as well as the review of the support mechanisms that could be employed to develop the sector further. However, much has changed since the completion of the CSIR and Risø-DTU 2010 study, particularly the rollout of the Renewable Energy Independent Power Producer Procurement Programme (RE IPPPP), which provides a regulatory framework and market that created opportunities for the development of the industry and business activities along its value chain. These developments necessitated the need for a more thorough investigation into the opportunities for localisation in South Africa's wind energy industry and specifically:

- The assessment of the size of the potential wind energy market
- The review of the extent to which economic opportunities leading to job creation and economic growth brought on by the growth of the wind energy industry are realised
- The identification of the optimum level of localisation of the industry in the country in the short to long term
- The formulation of interventions and support needed to be offered to achieve the optimum level of localisation of the industry

In response to the above, the Department of Trade and Industry (the dti) has initiated the study aimed at investigating the optimum level of localisation that can be achieved in the wind energy industry and contribute to the alignment of industry and government interventions. This report presents the output of this study, which is structured according to the following key components:

- Wind energy market profiling and sustainability assessment
- Wind energy industry value chain profiling
- Investigation into the localisation potential
- Finance and certification aspects analysis
- Wind energy localisation roadmap

WIND ENERGY MARKET PROFILING

Global demand for energy and other associated services to meet socio-economic development is on an increase (Intergovernmental Panel on Climate Change, 2012). Varied energy sources such as fossil fuels, nuclear and renewables have been utilised in different parts of the world in order to meet such rising levels of energy demand. Globally, fossil fuels continue to dominate the supply-side of the global energy markets; however, the penetration level of renewable energy technologies into the same markets is commendable. Wind power is no exception in this regard. Of late, there has been a significant growth in global wind markets steered by China, North America, and Europe. As of 2013, a total of 318GW of wind power capacity had been installed globally, which is expected to grow to about 600GW at the end of 2018.

SUB-SAHARAN AFRICA WIND ENERGY DEVELOPMENT POTENTIAL

While the global trend of installed wind power is commendable, the use of modern renewable energy sources such as wind and solar in Africa lags behind other regions. The continent's wind power, especially, is still very limited with an estimated 1.1GW installed capacity in 2011, constituting less than 1% of the continent's total installed electricity generation capacity. The majority of the continent's existing wind energy installed capacity is concentrated in the North Africa sub-region. In sub-Saharan Africa, East Africa boasts the biggest installed wind power capacity. By the end of 2013, seven countries within this sub-region had installed wind power capacity of up to 186MW. Other sub-regions such as Central Africa have made little or no progress at all.

Although Africa has experienced little progress in terms of harnessing wind energy in the past, the wind energy market growth over the coming years is forecast to be concentrated in Africa and other developing regions such as Latin America. Installed capacity for wind power in Africa is forecast to increase 12-fold over the next decade, in line with the global trends and technological innovations now characterising the wind market. Sub-Saharan Africa is no exception; there are a couple of countries within the region that have good wind resources and the much required policy platforms to expand the wind energy market.

In general, 18 countries within the region are reported to have high wind resources, 22 more countries have medium wind resources, and only five countries are believed to have a low wind resource potential. Some of the countries within the sub-Saharan Africa region that include among others, Ethiopia, Kenya, Madagascar, Mauritius, Mozambique, Rwanda, Tanzania, Cape Verde, Ghana, Liberia, Nigeria, and Zambia have developed energy and energy-related policies that not only refer to renewable energy, but set objectives for pursuing and developing the wind energy sector in particular. An indication of the countries with specific wind energy targets is provided in the next table.

Table 1: Sub-Saharan Africa countries grouped according to the policy environment and wind targets

Countries with specific wind energy targets - highly probable market	Countries with RE targets - probable market	Countries with no RE targets - least probable market
Mozambique (2 GW) Kenya (3 GW MW by 2030)* Ethiopia (772.8 MW by 2015)* Lesotho (6 GW by 2025) Nigeria (40 MW by 2025)* Mauritius (8% by 2025) Eretria (50%) Cape Verde (50% by 2020)	Namibia, Burundi, Djibouti, Madagascar, Malawi, Rwanda, Seychelles, Uganda, Zimbabwe, Benin, Cote d' Ivoire, Gambia, Ghana, Guinea, Liberia, Mali, Mauritania, Niger, Senegal, Gabon	Botswana, Swaziland, Comoros, Somalia, South Sudan, Tanzania, Zambia, Burkina Faso, Guinea-Bissau, Sierra Leone, Togo, Angola, Cameroon, Central African Republic, Chad, Congo Republic, Democratic Republic of Congo, Equatorial Guinea, and Sao Tome and Principe
8 countries	**20 countries**	**19 countries**

*Note: These countries do not have local content targets but their policies advocate for localisation strategies to be put in place

Considering the policy environment and targets set by various countries in sub-Saharan Africa, a number of future wind energy project roll-out scenarios can be formulated for the sub-Saharan Africa market segment basing on the wind energy targets as presented in the respective countries' energy and energy-related policies (refer to Table 1).

These can be developed based on the groups of countries indicated in Table 1 and described in more detail below: include:

- *Countries with Highly Probable Wind Energy Deployment*: Consists of countries whose wind energy targets were explicitly expressed in megawatt terms in the respective country policies. The majority of future wind power capacity in sub-Saharan Africa is forecast to come from this category. About 11.8GW of wind power capacity is envisaged to be installed by 2030.
- *Countries with Probable Wind Energy Deployment*: Consists of countries whose wind energy targets are expressed as shares or percentages of a specified baseline such as total installed electricity capacity. It is estimated that a total wind power capacity of 180MW would need to be installed by 2025 to reach the respective countries' wind energy targets
- *Countries with Remotely Probable Wind Energy Deployment*: Includes countries with broad renewable energy targets that are mostly expressed as shares/percentages of a specified baseline. Assuming potential wind energy deployment in these countries, a total wind power capacity of 536MW is envisaged to be installed by 2025.

Considering the above, three wind energy deployment scenarios were developed. Figure 1 illustrates that about 12.5GW of wind power capacity is estimated to be installed in sub-Saharan Africa over the next 15 to 16 years. The majority of that will come from countries that have set specific wind energy targets. Most wind projects are envisaged to be rolled out during the 2020-2025 period followed by the 2025-2030 period. Not much activity is anticipated during the 2017-2020 period.

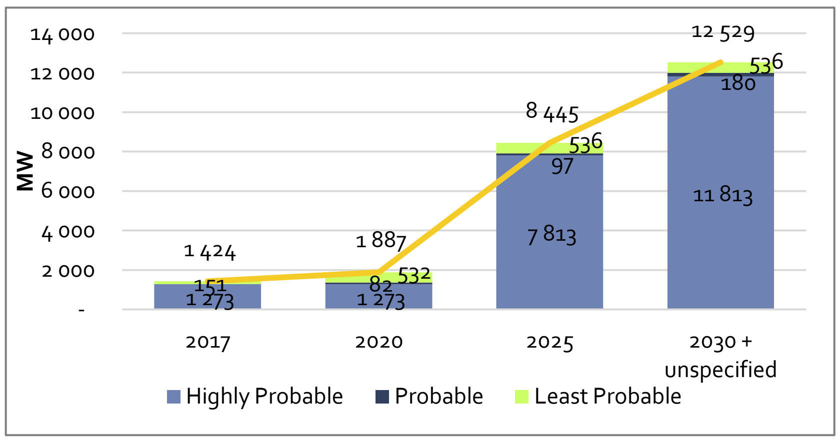


Figure 1: Envisaged wind energy roll-out in sub-Saharan Africa

South Africa's market and its potential

The average wind resource potential reported for South Africa is believed to be high. Locally derived atlases such as the WASA map shown in Figure 2 reveal the presence of high wind speeds along the coasts of the KwaZulu-Natal, Eastern Cape, Western Cape, and Northern Cape provinces. The atlases are consistent in showing that the Eastern, Western and Northern Cape provinces are the most favourable locations for wind energy projects. Importantly, however, not only is the country endowed with good wind resources, South Africa also boasts policies and programmes that are in support of the development of a utility-scale renewable energy sector.

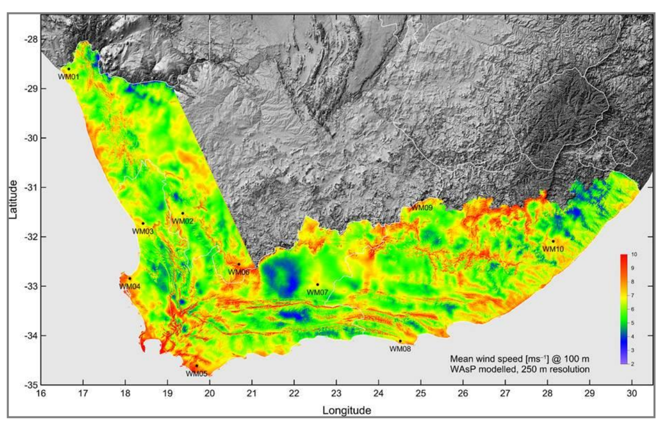


Figure 2: WASA Large Scale High Resolution Wind Resource map

The use of renewable energy, and particularly wind power, is well supported and articulated in a wide range of South African policy documents. These include the National Climate Change Response White Paper of 2011, the New Growth Path (NGP) Framework (2010), the Green Economy Accord, the National Development Plan (NDP), and the Promulgated Integrated Resource Plan (IRP) 2010-2030. All of these policies call for the diversification of the energy mix in the country and the greater usage of renewable energy sources in electricity generation.

Considering the structure of South Africa's utility sector and the electricity generation landscape, two distinct market segments for development of wind energy electricity generating capacity can be differentiated. The first one includes the Renewable Energy Independent Power Producer Procurement Program (RE IPPPP) that complements the government's policy framework and that was launched in 2011 by the Department of Energy (DOE). The second one refers to various opportunities for large-scale wind energy projects deployment outside RE IPPP, such as private power generation that requires wheeling and power generation for sale to the Independent System Market Operator (ISMO).

Potential wind energy deployment within the RE IPPPP market segment

In 2011, government promulgated IRP 2010. Since then, it has updated the plan and released the new version in November 2013; however, that version is yet to be approved, which means that it cannot yet be considered the new plan. The promulgated IRP set a capacity target of 9 200MW to be generated from wind power by 2030, which includes Eskom's Sere Wind project of 100MW. The draft IRP 2013, however, proposes to reduce the allocation to 4 360MW for the same time period.

Under the RE IPPPP, government has already committed to deploying 3 725MW of large-scale renewable energy projects by 2016 and has announced the intention to procure an additional 3 200MW of renewable energy projects by 2020. With the announcement of winning bids for the three rounds of the RE IPPPP, 1 984MW has already been awarded to 22 wind energy projects.

- Considering the Promulgated IRP 2010, this means that approximately 20% of the total wind energy installed capacity target has already been achieved and 7 116MW is still left to be allocated by 2030. Following the Promulgated IRP schedule, about 400MW of wind projects would be deployed per annum until 2024 and between 400MW and 1 600MW per annum thereafter, which shows that the market for wind energy components would be stable but possibly not significant to allow for development of the wind energy industry in the country beyond the current level.
- If the draft updated IRP were approved, the outstanding wind energy capacity available for allocation and deployment would be significantly reduced and be limited to 2 376MW. Under this scenario and considering the deployment schedule, no new allocations will be made between 2014 and 2021, which implies that for eight years there will be no market for wind energy manufacturers in South Africa. The opportunity for deployment of wind energy projects and development of the wind energy industry will only come up in the 2020s and will be limited to 320MW and 640MW per annum depending on the year.

Table 2 summarises the future potential roll out of wind energy projects in the country considering the promulgated IRP 2010 and the updated draft IRP. Overall, it is clear that the updated draft IRP assumes a considerably smaller allocation (almost three times smaller) of future installed capacities to be taken up by wind projects compared to the IRP 2010. It is understood that South African Wind Energy Associations (SAWEA) and other groups have called for a review of the Updated Draft IRP2010 targets.

Table 2: Potential future wind project roll out considering promulgated IRP 2010 and updated draft IRP

Indicator	IRP 2011	Updated IRP 2013
	MW	*MW*
2030 Wind Power Target	9 100 (excluding Sere Wind Farm)	4 360
REIPPPP Awarded (Round 1, 2, 3)	1 984	1 984
Total Capacity Remaining	7 116	2 376

Potential wind energy deployment outside the RE IPPPP market segment

Outside the RE IPPPP market, there have been limited developments in the large-scale wind power energy sector mostly as a result of stringent and limiting regulation. At the time of the study, two wind energy generators, Electrawinds/Fluopro JV and Darling National Demonstration Wind Farm, held a PPA outside of the RE IPPPP programme. While policy complexities make the municipalities entering into long-term PPAs with IPPs challenging, the dominance of Eskom as a single buyer is another aspect that continues to constrain the growth of the energy market.

The success of wind projects outside the RE IPPPP depends on how the regulatory landscape evolves in the future. Nonetheless, some municipalities such as eThekwini, Nelson Mandela Bay, City of Cape Town and Mossel Bay are already making progress in devising a favourable regulatory landscape to ensure the success of wind projects outside the RE IPPPP market segment. Depending on the future regulatory landscape (i.e. the adoption of ISMO Bill, effective and streamlined rules and regulations on a municipal level, provision of incentives to facilitate the growth of the market) that will affect the rate of deployment of large-scale wind energy project outside the RE IPPPP, it is estimated that potentially between 458MW and 6 870MW could be deployed in this market in the future.

Table 3: Wind Generation Potential outside of Eskom generation and RE IPPPP by 2030

Total electricity demand 2030 (GWh)	% of electricity generated by renewables excluding Eskom and RE IPPPP	Wind energy penetration (MW)		
		5%	10%	15%
401 268	5%	458 (Low)	916	1 374
	10%	916	1 832	2 748
	15%	1 374	2 748 (Medium)	4 123
	20%	1 832	3 664	5 496
	25%	2 290	4 580	6 870 (High)

Wind Energy Future Demand Scenarios

Considering all of the above, the potential for wind energy projects deployment will remain to be policy-led both in South Africa and sub-Saharan Africa.

- It was estimated that between 11.8GW and 12.5GW of wind energy projects could be deployed in sub-Saharan Africa by 2030 with the majority of these in the countries that have set specific wind energy targets.
- In South Africa, future roll out of wind projects is expected to be consistent until the mid-2020s if the government were to continue utilising the policy adjusted scenario in the IRP promulgated in 2011. A further 7 216MW would still need to be approved in order to meet the 2030 total wind capacity target of 9 200MW. However, the roll out of wind projects is expected to be significantly lower if the government

adopted the base case scenario modelled in the draft IRP 2013, since 46% of the target has already been awarded to projects. Only 2 376MW out of the entire target of 4 360MW would remain for future roll-out.

Overall, the combination of the potential wind energy project deployment scenarios in sub-Saharan Africa and South Africa suggests that between 16.6GW and 27.8GW of wind energy projects could be deployed by 2030 depending on the scenario considered. Regardless of the set of scenarios chosen, the biggest variation in terms of deployment potential will come after 2020; in the period up to 2020 the difference in opportunities for wind energy project roll-out will be relatively small and will range between 2.7GW to 7GW. The set of scenarios associated with the draft updated IRP will though render lower potential market size than that associated with the Promulgated IRP, which could be detrimental to the future development of the local wind energy industry. Therefore, the ability of the local industry to grow in the next few years may be jeopardised if the updated draft IRP is approved and the industry is left to rely on the demand created by sub-Saharan Africa only during that period.

Table 4: Envisaged wind energy projects roll out scenarios based on the Promulgated IRP 2010

Market Segment		2017	2020	2025	2030
Low level of participation outside RE IPPPP (5% of uptake outside Eskom and RE IPPPP and 5% of wind energy penetration (MW))					
Sub-Saharan Africa market penetration	Highly probable only	2 896	4 226	14 518	20 671
	Highly probable and probable	2 896	4 308	14 615	20 851
	Highly probably, probable and remotely possible	3 047	4 840	15 151	21 387
Medium level of participation outside RE IPPPP (15% of uptake outside Eskom and RE IPPPP and 10% of wind energy penetration (MW))					
Sub-Saharan Africa market penetration	Highly probable only	3 079	5 447	16 962	24 336
	Highly probable and probable	3 079	5 529	17 059	24 516
	Highly probably, probable and remotely possible	3 230	6 061	17 595	25 052
High level participation outside RE IPPPP (25% of uptake outside Eskom and RE IPPPP and 15% of wind energy penetration (MW))					
Sub-Saharan Africa market penetration	Highly probable only	3 217	6 363	18 793	27 083
	Highly probable and probable	3 217	6 445	18 890	27 263
	Highly probably, probable and remotely possible	3 368	6 977	19 426	27 799

Wind Turbine Manufacturing Industry

Composition of the Global Wind Turbine Manufacturing Industry

Globally, countries that boast the largest wind energy installed capacities are also the countries that account for the largest wind turbine manufacturing market share. These include, for example, China, the USA, Germany, Spain, Denmark, and India. However, while some of these top countries with the largest wind turbine manufacturing capacity remain the same, the market has seen some notable changes with respect to the position of selected Original Equipment Manufacturers (OEMs). For example, while the top seven positions among the global leaders have remained in the hands of the same group as that observed in 2009 (i.e. Vestas, Goldwind, Enercon, Siemens, GE Wind, Gamesa, and Suzlon), the market has seen three companies losing their top 10 ranking, thereby opening opportunities for new leaders such as Nordex, United Power, and Mingang.

Overall, a notable increase in the total installed wind power capacities compared to pre-2009 has been observed between 2009 and 2013. Between USD73 billion and USD94 billion was invested on an annual basis during that period, which added between 37GW and 45GW of wind power per annum. In 2013, wind turbine manufacturers sold about 37.5GW worth of key components, while the total added installed capacities were 36.3GW (REN21, 2014a) .

Due to the decrease in demand in the USA linked to policy uncertainty, decline of the European market, and increasing competition by low-cost gas energy in some markets, the wind energy market in 2013 shrunk compared to the previous years. This resulted in the fierce price competition and tightening of profit margins forcing the majority of turbine manufacturers to revisit their business strategies. In order to maintain their profitability, manufacturers focus on creating more flexible businesses, as well as revamping their supply chains with techniques such as lean production, component commonality, strategic supplier outsourcing, and just-in-time stocking - similar to the automotive industry structure and dynamics (REN21, 2014a) (Lawson, 2013).

Historically though, the global leaders in wind turbine component manufacturing have been emerging in those countries that created significant domestic demand for wind energy. As shown by example of Vestas and Denmark, Suzlon Group and India, Gold Wind and China, GE Wind and the USA, Gamesa and Spain, a successful and viable wind industry is built on local demand. Besides the government policy that stimulates the demand for wind power and assists in developing the local manufacturing capabilities, interventions that enable a faster growth of the local industry include, inter alia:

- Setting of local content requirements, provided they complement other policy measures and support tools
- Forming joint ventures with international companies
- Introduction of trade policies such as quotas and import tariffs to support local manufacturers

In terms of technology advancement within the global market, major strides in wind energy have been observed only in the last 10 years, which contributed to the marked increase in wind energy installed capacity. This specifically relates to advances in turbine designs that further resulted in an increased height of towers, length of blades, and overall wind turbine power capacity. While today's installed towers are typically 80m to 100m tall, wind turbine heights and blade sizes are further anticipated to increase in size in the future. Furthermore, the search for alternative materials to reduce volume and mass of components will continue. Strides have also been realised within the drivetrain component. Since 2008, the share of gearless or direct-drive turbines, with no gearbox monitoring system, has increased from 12% to 20% (IEA , 2013b) and the use of permanent magnet synchronous generators instead of coils is also trending in the markets.

South Africa's large-scale wind energy industry players

In South Africa, the wind energy value chain is dominated by the global industry players, although this trend is more evident along upstream activities and less so along downstream activities. Project developers in South Africa include both local and international companies. Developments within the market resulted in some local companies partnering with foreign companies and some even establishing joint ownership in some of the RE IPPPP wind energy projects.

The range of EPC companies involved in the wind energy project developments in the country is dominated by global leaders, who are also OEMs, which points to a relatively vertical nature of integration of the domestic wind energy industry. The leading countries in terms of OEMs represented in South Africa are China and Germany (two companies each), followed by Spain, India and Denmark with one apiece. Table 5 summarises the activity of the seven OEMs that have been active in the past three bid rounds of South Africa's RE IPPP Programme.

Table 5: Wind Turbine Manufacturers Supplying to RE IPPPP Projects

OEM	Number of Projects	RE IPPPP Rounds	Number of Turbines	Capacity Awarded (MW)	Market Share (BW 1, 2, and 3)
Vestas	8	1, 2, 3	235	514.6	25.9%
Nordex	4	1, 2, 3	175	422.5	21.3%
United Power	2	3	163	235	11.8%
Sinovel	2	1	18	52.4	2.6%
Acciona	1	2	46	135.2	6.8%
Suzlon	1	1	66	135	6.8%
Siemens	4	1, 3	~240*	488.9	24.6%
Total	**19**	**-**	**943**	**1 983.6**	**100%**

(Interviews, NERSA presentations & ESI-AFRICA.COM)

South Africa's Large Scale Wind Energy Project Economics

The capital investment that is required to design, procure, and construct wind energy projects in South Africa , as reflected in Bid Window 3, was valued at an average R7.9 million/MW in 2013. Of these, 55% comprised of expenses on wind turbine and its key components such as tower, blades, nacelle and hub; and the other 45% was comprised of Balance of Plant (BOP) expenses, as shown in the Figure 3.

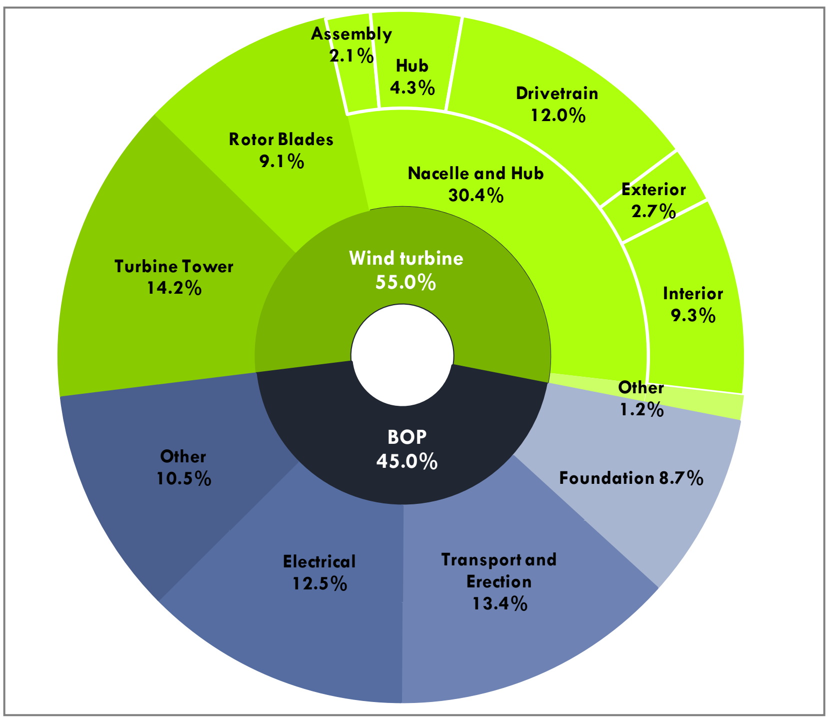


Figure 3: Bid Window 3 Wind Project Cost Breakdown (Calculations based on IPP Office data, 2014)

Wind turbines require steel, concrete, copper, fibreglass, adhesive, core, and other input materials to produce, with steel accounting for almost 90% of the total weight of materials used in production of wind turbines, which is mainly used to manufacture towers. At the same time, towers account for 14.2% of the total project value or 25.8% of the wind turbine value. It is followed by the nacelle and hub that make up 30.5% of the project value, or 55.5% of the wind turbine's cost. Expenditure on blades equates to 9.1% of the project value, or 16.5% of the wind turbine's value.

As far as BOP is concerned, which accounts for 45% of the wind energy project value, expenses on transport and erection appear to be the biggest single cost item included under BOP, constituting 13.4% of the project value. Expenses on electrical/grid connection (12.5% of project value) represent the second highest BOP cost item, followed by expenditure on foundation and civil works (8.7% of project value).

As shown in Table 6, the average local content for Bid Window 3 achieved by preferred bidders was 46.9%, three quarters of which was derived through localisation of the BOP and the rest through the procurement of wind towers from the local tower manufacturer. The local content in Bid Window 3 dropped slightly compared to that achieved by preferred bidders in Bid Window 2, which was partially attributed to the unfavourable exchange rate that increased the total cost of the project and subsequently reduced the share of the local content.

Table 6: Local content for preferred bidders of wind energy projects in Bid Window 1, 2 and 3

Local content indicators	Bid window 1	Bid window 2	Bid window 3
% of Project Value	27.4%	48.1%	46.9%
Total R value	R2 727 million	R4 817 million	R6 283 million
R/MW	R4.3 million/MW	R8.6 million/MW	R7.9 million/MW
Components localised	• Balance of Plant	• Towers • Balance of Plant	• Towers • Balance of Plant • Meteorological Masts • Anchor cages

(PPIAF, 2014; DOE, 2013b, data sourced from IPP Office, 2014)

Nonetheless, preferred bidders in Bid Window 3 were able to significantly reduce the average tariffs per kWh compared to the previous rounds (i.e. R0.74/kWh in BW3 vs R1.01/kWh in BW2 and R1.28/kWh in BW1 in April 2013 prices) and render a bigger number of jobs created during construction and operations. Wind projects in Bid Window 1, 2 and 3 are estimated to create a total of 1 810, 1 787 and 2 612 construction jobs respectively. The projects will also create a total of 2 461, 2 238 and 8 506 operations jobs over the entire life of the different wind projects.

Table 7: Aggregated Wind Sector Employment

Sector	Bid Window 1		Bid Window 2		Bid Window 3		Total
	Jobs	Job/MW	Jobs	Job/MW	Jobs	Job/MW	
Construction (18 months)	1 810	3	1 787	3	2 612	3	6 209
Operations (cumulative over 20 years)	2 461	4	2 238	4	8 506*	11	13 205

(PPIAF, 2014; inputs received from the IPPP office, 2014)

* Note: Job creation potential for Bid Window 3 projects during operations is calculated following a different methodology than that employed in the previous rounds

South Africa's wind turbine manufacturing industry analysis

Although the South African wind energy industry is constituted of many wind turbine OEMs with a significant global production footprint, it must be noted that the local manufacturing of key wind turbine components is still in its infancy and remains restricted to a few components. Imported components sourced through the global OEMs still dominate the market.

The review of the global dynamics suggests that vertical integration among OEMs is common among certain manufactures; at the same time, many OEMs tend to follow a hybrid model where they outsource production of certain components while retaining in-house capabilities only with respect to certain items where they have comparative advantages. Many of the OEMs have also been found to share suppliers.

Towers

Overall, among the three key components such as towers, blades and nacelle, towers tend to be the first localised as they are large, expensive and difficult to transport over long distances. As suggested by the local status of the industry in the country, this is also the case in South Africa. Local capabilities with respect to wind towers manufacturing lie with DCD Wind Towers, Gestamp Renewable Industries and Concrete Units.

- DCD Wind Towers and Gestamp Renewable Industries are producers of steel towers. Together, these two companies are capable of manufacturing 260 towers per annum (an equivalent of about 520MW – 780MW) and create sustainable employment opportunities for 300 people. Products of both of the companies achieve an average local content of about 80%. All the steel (which is deemed 100% local by the Department of Trade and Industry) and consumables are sourced locally; the internals, door segments, and flanges are currently being imported.
- Concrete Units is the manufacturer of precast segments for the 46m x 100m tall concrete towers of the Gouda Wind Farm developed by Acciona. The company can employ up to 216 people during the peak of production. However, considering the expertise of the domestic concrete construction industry, other companies in South Africa also have expertise in manufacturing complex precast segments that could potentially also play role in the supply chain for wind energy projects (for example, Murray & Roberts Concor and Southern Pipeline). However, the issue of certification may be a significant hurdle for the general concrete construction industry to enter into the wind energy industry with supply of locally designed and manufactured concrete towers; such a challenge could though be overcome by following an approach to manufacture pre-certified design.

Blades

Establishment of local capabilities in the manufacturing of blades is also relatively common among OEMs, provided the market has sufficient demand; however, blades manufacturing requires large investments and access to know-how. Furthermore, since it is extremely labour-intensive and requires precision processes, access to a skilled labour force is a prerequisite.

In South Africa, no blade manufacturing facility currently exists. Most of the OEMs with offices in South Africa have not considered establishing local blade manufacturing facilities as they perceive that the market is too small and highly uncertain for a viable blade manufacturing industry. However, the country has skills, expertise, and capability to manufacture blades for other applications, such as helicopters. In the past, Isivunguvungu Wind Energy Converter (I-WEC), a South African-based company, also produced 52m blades for 2.5MW wind turbines boasting a local content of about 80% with the main input material, fibreglass, being sourced locally. However, the company was officially liquidated in October 2013, having not participated in any of the RE IPPPP rounds.

A minimum capacity of 400MW per year per OEM is required to attract OEMs to set up local blade manufacturing facilities. However, this would imply that the actual size of the market would need to exceed 400MW to allow more than one blade manufacturer to enter the market to produce blades for their turbines. At this stage two companies could potentially establish local manufacturing capabilities: LM Wind Power and DCD. The successful local blade manufacturer will need to adopt a build-to-design business model, which implies manufacturing of blades for multiple OEMs according to their designs. This business model though would require having six to eight moulds and could significantly increase capital investment.

It is estimated that establishing one facility would require an investment of up to R490 million and 12 months for construction. A blade manufacturing facility would employ between 150 and 300 people and would manufacture blades with the local content of about 60%.

Nacelle

The manufacturing of the nacelle is among the least common activities localised by OEMs in new markets; however, it should be noted that many OEMs tend to establish in-house assembly facilities while procuring most of the components of the nacelle from the reputable suppliers. Some of these components are manufactured by companies that primarily service other industries, with the wind energy market accounting for a small portion of their orders. This applies to gearboxes and bearings, for example, which are critical items in the entire system as they affect reliability of the wind turbine.

In South Africa, there is no local company currently engaged in either the manufacturing or assembling of the nacelle components. I-WEC has been involved in the assembly of a 2.5MW wind turbine with a local content of 70%. The company had a manufacturing capacity to make 20 wind turbines per year, which was scaled up to 100 units per year. The company had already created 30 direct jobs for engineers, technicians and administrative staff, and was planning to create up to 400 jobs in the first five years of operation depending on market conditions; however, as mentioned earlier, it was liquidated and never participated in the RE IPPPP.

Overall, the potential for establishing nacelle manufacturing facilities in South Africa is limited by the complexity of the process that requires highly specialised labour and by the concerns over quality and high inputs costs. However, if certain barriers were addressed, the assembly of the nacelle would be the easiest step to take with the objective of establishing far greater local manufacturing capabilities associated with nacelle components. As indicated by DCD, nacelle assembly can be done in the company's existing facilities and it would take between six to 12 months to upscale them. The partial manufacturing and assembly would create an additional 50 to 250 permanent jobs, and critical skills in nacelle assembly will be required. A minimum demand of 100 units per year and a minimum margin of 15% would be required in order to make this business venture sustainable. However, as far as nacelle components are concerned, OEMs are not willing to risk their reputation by engaging with some of the local producers who can supply some of the bigger components. Certification issues have meant that most OEMs would prefer to work with component manufacturers they have a working relationship with, i.e. global manufactures, which means that the country would need to attract those in order to increase the potential for localisation of the nacelle components.

South Africa's industry competitiveness analysis

Overall, based on the feedback obtained from the industry participants and the review of various documents, South Africa's wind energy industry, considering its upstream and downstream activities, is characterised by a number of comparative advantages and disadvantages, which are summarised in Figure 4.

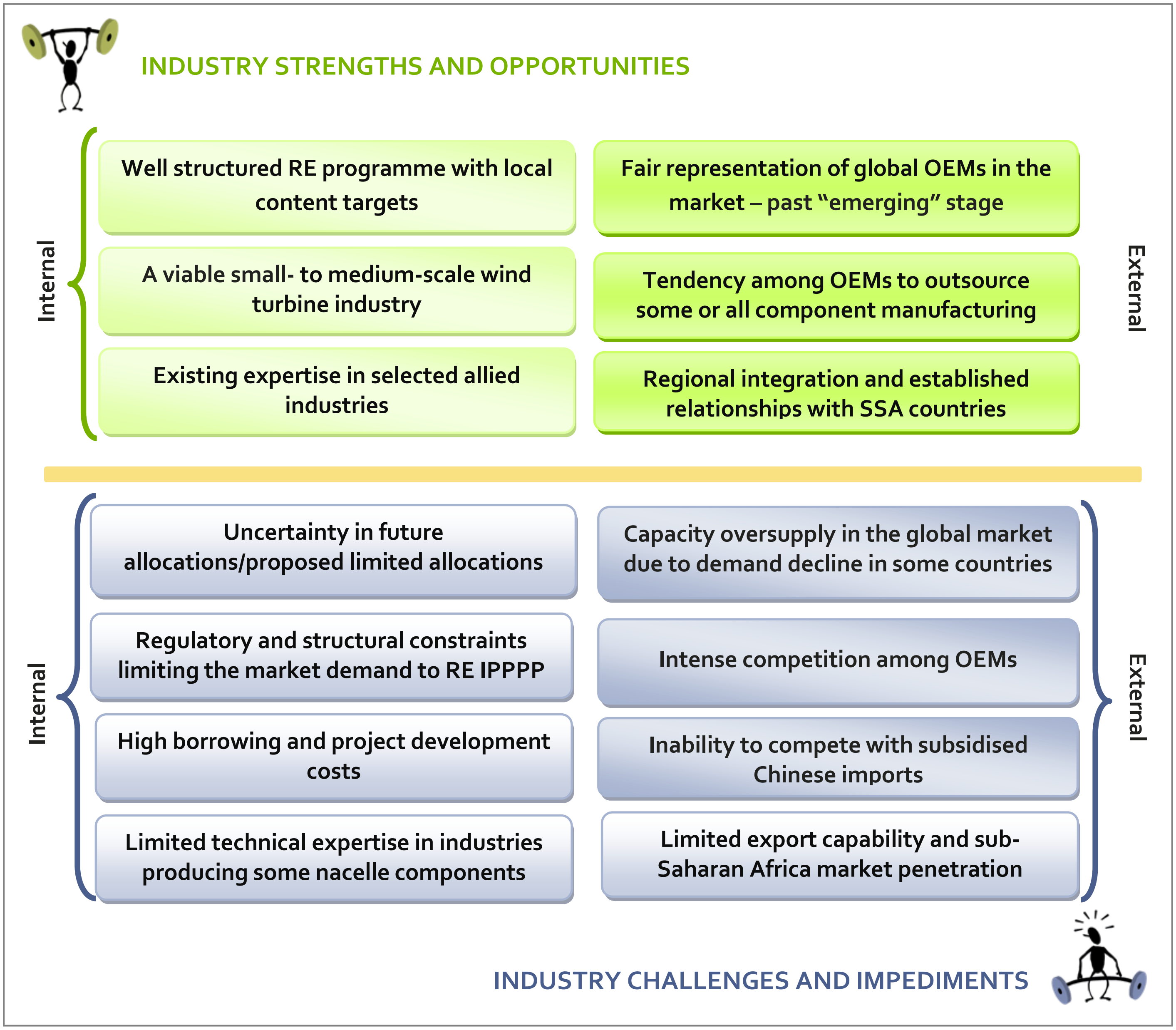


Figure 4: South Africa's industry comparative advantages and disadvantages

LOCALISATION POTENTIAL ANALYSIS

The investigation into the potential to localise wind turbine key component manufacturing in South Africa is focused on two sets of scenarios. One scenario had the Promulgated IRP (2010) annual wind energy technology allocations as a base and the other mplied annual allocations recommended in the Draft Updated IRP (2013). Both of these scenarios included opportunities presented by two additional market segments, i.e. outside RE IPPPP market segment and highly probable sub-Saharan Africa market segment, as described earlier.

The projections for sustainable installed capacity for each set of scenarios revealed that the main difference between Scenario 1 and Scenario 2 options is such that opportunities for establishment of local manufacturing facilities are created much earlier in the case of Scenario 1 – linked to Promulgated IRP (i.e. between 2015 and 2018) than in the case of Scenario 2 – linked to draft updated IRP (i.e. mainly between 2018 and 2024). Since the only difference between these scenarios lies in the annual allocated installed capacities under the RE IPPPP, it suggests that the adoption of the Draft Updated IRP (2013) will lead to a much slower development of the local wind turbine manufacturing industry than if the deployment of wind energy projects follows the Promulgated IRP (2010) allocations.

Furthermore, allocations suggested in Promulgated IRP (2010) will offer limited opportunities and in the case of the draft updated IRP (2013) no opportunities for establishment of new manufacturing facilities in the future, if considered without other market segments. Opportunity to penetrate the market outside RE IPPPP and tap into sub-Saharan Africa are the game changers, which both simply imply a significant increase in the potential annual installed capacities. Since some OEMs have indicated that they would not base their decision to establish local manufacturing facilities on sub-Saharan Africa and since the penetration of this market is still associated with some risks, the speed at which the regulatory environment related to the large-scale renewables deployment outside the RE IPPPP will most likely determine the rate and extent of the local wind turbine manufacturing industry development in the country. Alternatively, a far greater allocation of installed capacities under the IRP for wind energy projects that would match the projected annual demand considering both outside the RE IPPPP market segment and sub-Saharan Africa could also lead to the same outcome and be even more desirable considering the reduced risks.

Notwithstanding the above, the modelling of scenarios and localisation potential revealed the following opportunities:

- Depending on the scenarios, between one and five new tower manufacturing facilities could be established in South Africa. In the case of Scenario 1, such opportunities will be presented during the period between 2015 and 2018, provided that markets outside the RE IPPPP and sub-Saharan Africa are tapped into. In the case of Scenario 2 options, these new facilities will need to be built between 2018 and 2024. In any instance, their realisation could lead to the establishment of between 150 and 750 new sustainable jobs, when considering the steel tower technology.
- As far as blade manufacturing plants are concerned, further committing to the Promulgated IRP 2010 brings an opportunity to establish one facility with about 228 sustainable employment opportunities. Three to four blade manufacturing facilities are even envisaged if the potential from the outside RE IPPPP and the sub-Saharan Africa market segments is further unpacked.
- As far as nacelle and hub manufacturing is concerned, South Africa would most likely only be able to attract assembly facilities as manufacturing of certain components of nacelle is usually outsourced by OEMs to the global leaders in respective industries with only a few components being produced in-house. The structure of the nacelle assembly industry though is somewhat different to the blade and tower manufacturing industries, with limited opportunities made available for sharing existing facilities by OEMs with respect to assembly processes. As such, options that render opportunities for establishment of only one nacelle assembly facility are not realistic. Furthermore, assembly of the nacelle is a highly sophisticated process that requires access to specialised labour, which is not available in South Africa. Thus significant time will be required to transfer skills to the local labour force. Overall, regardless of the scenario considered, the potential for setting up local nacelle assembly facilities will

only arise if the high road option is considered for the market outside RE IPPPP and when the sub-Saharan Africa market segment is taken into account. In the case of Scenario 1, such opportunities will be possible to realise in the next few years, while in the case of Scenario 2, it will only be possible after 2018. Overall, between 400 and 1 200 jobs could be created in the process.

In summary, the biggest opportunity for developing the local wind turbine manufacturing industry lies in wind tower manufacturing, followed by blade manufacturing. Importantly, realisation of any of these opportunities will require as a minimum the unpacking of the market outside RE IPPPP and providing support to the industry for it to achieve global competitiveness. The penetration of sub-Saharan Africa will strengthen the local industry status and lead to greater industry growth; however, as was mentioned previously, reliance on this segment of the market is currently risky and cannot be considered an industry driver; therefore, increasing the local market through greater allocation under the RE IPPPP could be a more plausible alternative but would require policy revision.

FINANCE AND CERTIFICATION

Through its first three Bid Windows, the South African RE IPPPP has registered impressive achievements. To date, it has secured investment commitments to the value of R120 billion to build 3 922MW of new renewable energy generating capacity. The country's financial services sector has played a notable role in the success of the programme. It is highly liquid, offers long-term debt, understands project finance, and has experience with PPPs and private finance of public infrastructure.

Renewable energy projects under the RE IPPPP follow largely similar financing models and large infrastructure projects with limited recourse project finance remaining the dominant source of financing; although new and innovative solutions to project finance are also emerging. The type of a project or technology plays little role in the financing structure suggesting that the financing structure of wind energy projects does not differ from those of solar PV projects, for example.

As the programme matured and projects came online, the investor confidence increased and risk perceptions reduced. This resulted in the gearing ratio reaching 80:20, a notable change compared to 70:30 observed in Bid Window 1. Furthermore, projects approved under Bid Window 3 received longer debt tenors (i.e. 17/18 years compared to 15 years observed in Bid Window 1 and 2), secured lower project finance costs, and led to reduced shareholder return expectations.

Wind projects are following similar EPC and EPCM contracting models as employed in other parts of the world. The South African models are widely considered more robust as a result of the stringent requirements imposed by the funding agencies. Both contracting models are being employed by local developers; the choice being dependant mainly on in-house strengths and appetite for risk. In the medium to long terms, EPCM contracting can contribute to localisation as most of the engineering and construction management services will be available locally as the skills base grows. As it becomes increasingly difficult for wind projects to meet local content requirements in subsequent rounds of the RE IPPPP, one can expect a shift towards EPCM contracting as the preferred contracting mode.

Financiers are generally comfortable with the adoption of local standards, provided they are suitably adapted from their international counterparts, but are less comfortable when it comes to debt provision for wind projects that involve local components, especially when these involve critical components like the turbine and gearbox. For local companies intending to expand their manufacturing capabilities in South Africa, finance at a preferential interest rate is available under the industrial financing loan facilities component of the MCEP. Where large components such as turbines and blades are concerned, any new entrant has to first aim to obtain certification and develop a test or pilot facility in order to develop a track record that will enhance the chances of securing finance for projects. It is worthwhile noting for any new manufacturing entrant that the local wind turbine manufacturer IWEC was in possession of an A-Design Certificate for its turbine, but was still unable to conclude any bankable PPAs in the absence of a Type Certification and track record. The company had started production on a model of turbine that had not yet obtained any track record that adversely affected the ability to attract finance to sustain its operation.

Smaller scale projects outside of the RE IPPPP may present opportunities to develop a track record. In order to participate in the RE IPPPP, these companies must have a demonstrated track record and would have to undergo the expensive certification process.

LOCALISATION ROADMAP

KEY ASSUMPTIONS

As briefly described earlier and outlined in greater detail in the report, different requirements/conditions hold for the manufacturing or assembling of dissimilar wind turbine key components. The realisation of such requirements is critical in ensuring the attraction of both domestic and foreign manufacturing investment. The following table summarises the key assumptions used to develop the localisation roadmap.

Table 8: Key localisation assumptions

BLADES	Medium localisation potential
Key requirements for localisation	➢ Manufacturing of blades is either produced in-house or outsourced (build-to-design) ➢ Build-to-design/build-to-print model requires access to six to eight moulds in order to be economically feasible ➢ High-tech engineering capabilities and expertise in working with advanced composite materials ➢ 400MW pa per facility per OEM for a minimum period of five years
Cost and benefits	➢ CAPEX: R440 million - R490 million ➢ Job creation potential: 228 per facility ➢ Local content potential: 60% (Tier 2) ➢ Price increase: 5%
NACELLE ASSEMBLY	**Low localisation potential**
Key requirements for localisation	➢ A proprietary activity that is done only in-house by OEMs ➢ Specialised technical skills and equipment, especially for finishing and testing ➢ 400MW pa per OEM for a minimum period of five years ➢ 1 000MW of minimum total available installed capacity over a medium-term
Cost and benefits	➢ CAPEX: R70 million – R130 million ➢ Job creation: potential to create up to 230 jobs per facility ➢ Local content potential: 80% (Tier 2) ➢ Price increase: 10%-20% higher relative to that of a unit imported from overseas
NACELLE CASTINGS AND FORGINGS	**Low localisation potential without nacelle assembly Medium localisation potential without nacelle assembly**
Key requirements for localisation	➢ Outsourced to a local casting and forging industry or established proprietary facility ➢ OEMs are very particular about the quality of steel to be used; castings need to pass strict mechanical property tests and are submitted to non-destructive tests that mostly comprise

	ultrasonic and magnetic inspection methods ➢ Requires establishment of the local assembly facility first
Cost and benefits	➢ CAPEX: up to R60 million if facilities need to be expanded or established ➢ Local content potential: up to 90% (Tier 2) ➢ Price increase: 20% increase relative to that of imported products
NACELLE HOUSING	**Low localisation potential without nacelle assembly Medium localisation potential without nacelle assembly**
Key requirements for localisation	➢ Can be outsourced to an established composites manufacturing company ➢ Specialised skills required, especially in composite material handling ➢ Requires establishment of the local assembly facility first since the country currently doesn't have an export industry for nacelle covers
Cost and benefits	➢ CAPEX: limited or not investment required due to utilisation of existing composites manufacturing industry capabilities ➢ Local content potential: 80%- 90% (Tier 2) ➢ Price increase: 20% increase compared to imported products
NACELLE INTERIOR	**Low localisation potential without nacelle assembly Medium localisation potential without nacelle assembly**
Key requirements for localisation	➢ Generators: 500-700 units pa for one OEM and access to affordable rare earth elements (400MW to 450MW pa per OEM for a minimum period of five years) ➢ Power converter: 400MW pa per OEM for a minimum period of five years ➢ 1 000MW of minimum total available installed capacity over a medium-term ➢ Transformers: can be procured from the local manufacturer
Cost and benefits	➢ CAPEX: depends on the OEM and components to be localised ➢ Local content potential: 80% (Tier 2) ➢ Price increase: 20% on relation to imported products

Taking into account the local content that can be achieved with the manufacturing of selected wind turbine components, as well as the value of these components in the project cost structure, the following local content contribution figures can be estimated. It must, however, be noted that the contribution figures reported in the table are only for "quick reference" purposes as they assume constant component cost and do not account for the changes in the cost structure associated with the reduced transport costs.

Table 9: Localisation potential per component

Key component	% of Project Value*	Localisation potential	Local content to be achieved*	Local content contribution
Blades	9.1%	Medium	60%	5.5%
Nacelle Assembly	2.1%	Low	80%	1.7%
If local assembly is established:				
Rotor Hub	4.3%	High (hub)	38.7%	1.7%
Nacelle Drivetrain	12.0%	Medium to High (castings and forgings)	15.4%	1.9%
Nacelle Exterior	2.7%	Medium to High (composites)	90%	2.4%
Nacelle Interior	9.3%	Medium (generator, transformers, etc.)	84.4%	7.9%

Note: *Assuming constant 2013 prices and fixed exchange rate

OPTIMAL LEVEL OF LOCALISATION

The optimal level of localisation and achievable local content values that could become possible with the establishment of selected manufacturing capabilities are illustrated in Figure 5.

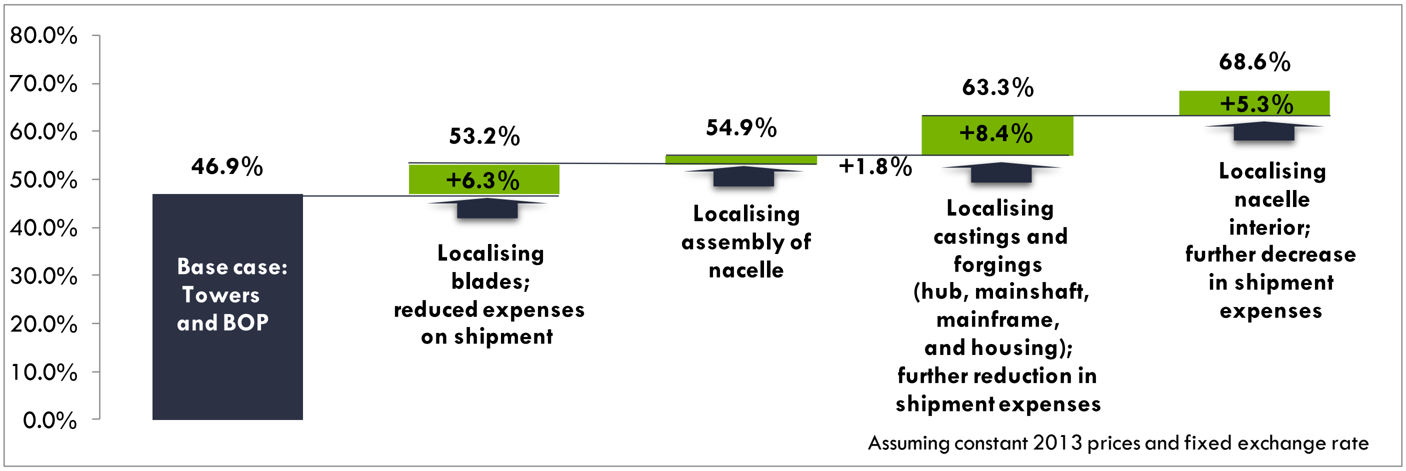


Figure 5: Optimal level of localisation considering identified potential (2013 constant prices and fixed exchange rates)

It is clear from the above that the local manufacturing of blades will increase the RE IPPPP Bid Window 3 local content by 6.3% with local content increasing from the current achieved 46.9% to 53.2%. Further localisation of the nacelle assembly and testing will add another 1.8% resulting in a total local content of 54.9%. Localisation of castings and forgings together with the nacelle housing will increase the local content to a total of 63.3%; while localising the selected nacelle interior components will also add another 5.3% resulting in an optimal local content of 68.6%.

SENSITIVITY TO EXCHANGE RATE FLUCTUATIONS

It must ,however, be noted that exchange rate volatility can have a notable impact on local content value due to the manner in which local content is calculated. As outlined in the table below, an optimal local content of between 64.5% and 73.2% is possible if the rand is to weaken/strengthen to levels between 20% and -20% respectively.

Table 10: Local content sensitivity to exchange rate fluctuations

Added local content	Exchange rate fluctuations								
	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Base case: Tower and BOP	52.4%	50.9%	49.5%	48.2%	46.9%	45.7%	44.5%	43.4%	42.4%
	5.6%	4.1%	2.6%	1.3%		-1.2%	-2.4%	-3.5%	-4.5%
Blades	58.7%	57.2%	55.8%	54.4%	53.2%	51.9%	50.8%	49.7%	48.6%
	5.5%	4.0%	2.6%	1.3%		-1.2%	-2.4%	-3.5%	-4.6%
Nacelle assembly	60.4%	58.9%	57.5%	56.2%	54.9%	53.7%	52.6%	51.4%	50.4%
	5.4%	4.0%	2.6%	1.3%		-1.2%	-2.4%	-3.5%	-4.5%
Castings, forgings and housing	68.3%	67.0%	65.7%	64.5%	63.3%	62.2%	61.1%	60.0%	59.0%
	5.0%	3.7%	2.4%	1.2%		-1.1%	-2.2%	-3.3%	-4.3%
Nacelle interior	73.2%	72.0%	70.8%	69.7%	68.6%	67.5%	66.5%	65.5%	64.5%
	4.6%	3.4%	2.2%	1.1%		-1.1%	-2.1%	-3.1%	-4.1%

LOCALISATION SCENARIOS

In order to achieve the optimal level of localisation, two localisation scenarios were defined, i.e. the low road and the high road local content scenarios.

- The *low road local content scenario* is constituted of the localisation of blades, which can be localised in the short term out of the already allocated annual demand capacity (400MW) for wind energy under the Promulgated IRP, which implies the establishment of one blade manufacturing facility.
- The *high road local content scenario* is made up of all the other outstanding components which include nacelle assembly and testing, castings and forgings, nacelle housing, and selected nacelle interior components. These can only be localised in the medium term and will require a significant increase in the market size of at least 1 000MW that would need to be sustained for a minimum period of five years. Under the current market conditions and within the current policy environment, this would only be possible with the penetration of the sub-Saharan Africa market segment. This scenario implies the presence of two to three OEMs with respect to blades manufacturing and at least two OEMs with local nacelle assembly plants.

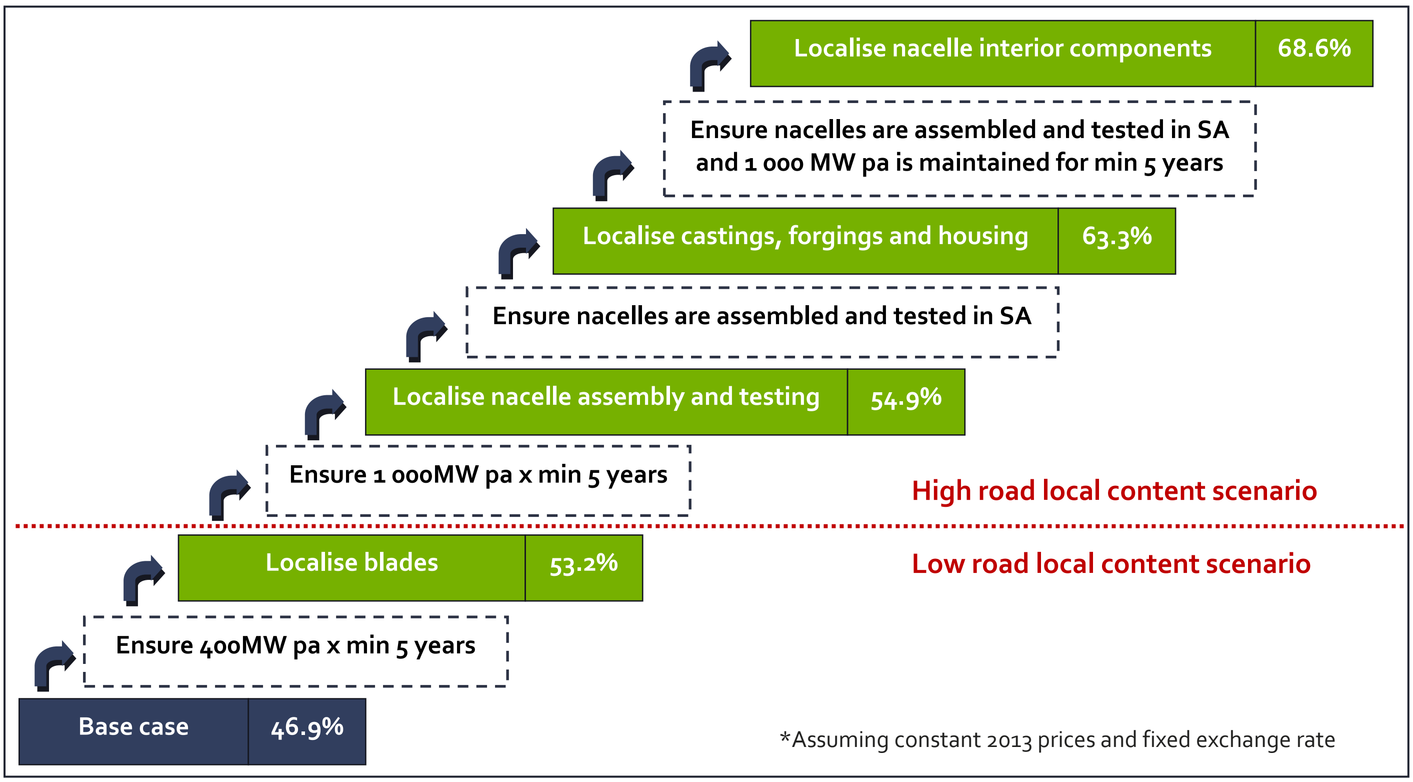


Figure 6: Local content roadmap

MACRO-ECONOMIC BENEFITS AND COSTS

The two localisation scenarios come with different macroeconomic costs and benefits:

- An estimated total investment value of R400 million and R1.8 billion will be required for the likely achievement of the low road and high road local content scenarios, respectively.

- Localisation will also increase the value of local production. Following the low road localisation scenario will result in the creation of about R1.2 billion of new business sales per annum in the manufacturing industries alone. Further achievement of a high road local content scenario will result in a total local production value estimated around R5.8 billion per annum.
- Further to increasing the value of local production, localisation also bears positive effects on the country's current account and subsequently trade deficit. With 1 218MW of annual installed capacity sustained over a minimum period of five years assumed under high road local content scenario, the optimum point of localisation in South Africa is projected to reduce the value of imported components for wind energy projects by more than 40%, hence circumventing the further widening of the current account deficit.
- Furthermore, achieving the optimal level of localisation could also create 3 213 sustainable employment opportunities in the manufacturing industries and a potential additional 4 104 jobs in the construction industries for the same period of time assuming that South Africa develops its domestic market beyond 1 000MW pa.

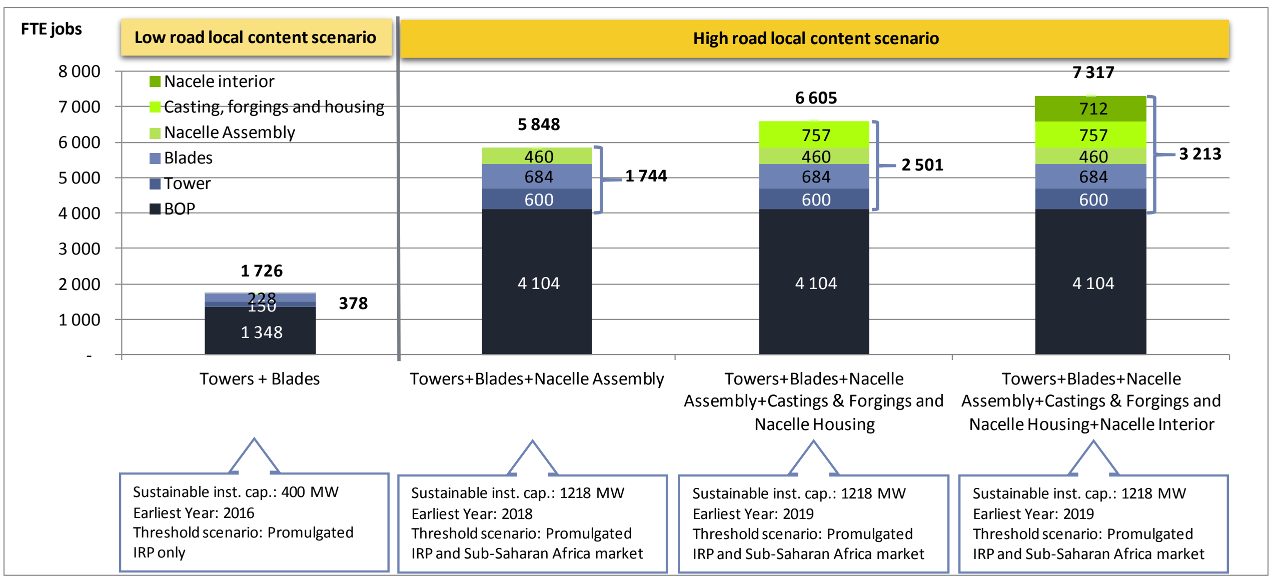


Figure 7: Localisation and employment creation

Despite the above-mentioned macroeconomic benefits, localisation will also come at a small premium mainly through increased costs incurred during production. Moving from the base case (RE IPPPP Bid Round 3) to the optimal level of localisation is likely to be accompanied by an estimated 0.9% increase in the total cost of each MW of wind energy to be developed. Considering the tariff for Bid Window 3 (R0. 74/kWh), this means that the increase in localisation would result in the tariff increase to R0.7466/kWh. This can be rounded off to R0.75/kWh, which means that the cost of localisation will be limited to R0.01/kWh. Importantly, the potential increase in project costs could be greater, however savings incurred through the reduced expenditure on shipping the components from overseas offsets much of the increase in component production costs.

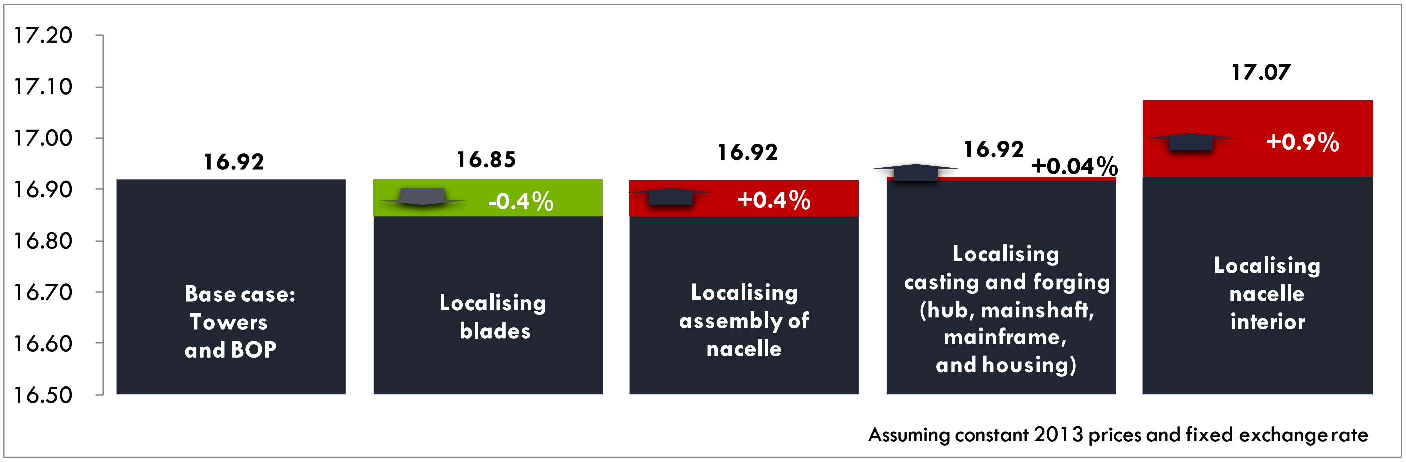


Figure 8: Cost of localisation and price implications

INDUSTRY DEVELOPMENT STRATEGY

The feedback received from different industry participants revealed that the RE IPPPP Bid Window 3 local content thresholds and targets were reasonable. For some, the thresholds were achievable and did not limit competition among potential participants. The targets were high enough to incentivise participants to achieve higher scores and stimulate competition among the project developers. However, most emphasised that any further increase in local content threshold will be highly challenging to respond to. It is clear that setting new thresholds and targets will need to be accompanied by a support programme to catalyse local manufacturing, and at the same time revise the manner in which local content thresholds are stipulated.

While the achievement of the low road local content is possible under the IRP, for South Africa to enter the high road local content scenario, it will need to address a number of challenges such as the small size of the domestic wind energy market, future market uncertainty, grid connection challenges, high cost of investment, and stringent certification requirement for components.

As a remedy to the listed impediments, a multi-stakeholder engagement approach that will see the Department of Trade and Industry working together with other government departments, structures and other respective sectors will be required. This is due to the fact that the interventions that could be deployed to overcome industry development constraints are not the sole responsibility of the DTI, but require decision-making authority from other departments or institutions. The interventions and support mechanisms that should be considered, as well as institutions responsible for their implementation are outlined below.

Intervention		Responsibility
Market Pull Interventions		
1	Make firm commitments with respect to extension of the RE IPPPP and increase wind energy annual allocations to allow for sustainable growth of the industry	DOE, Eskom, EPRI
2	Open up the market outside the RE IPPPP through ISMO	DOE, NERSA, and Eskom
3	Open up the market outside the RE IPPPP through private PPAs	NERSA, municipalities, commercial and

	Intervention	Responsibility
		industrial customers, private sector energy traders, National Treasury, DOE
4	Introduce REFIT or premium tariffs for small-scale utility projects	DOE
5	Introduce the scheme that would allow OEMs with South Africa-based manufacturing capabilities to claim the value of exported components as part of local content in wind energy projects developed in South Africa	DTI
	Demand Push Interventions	
1	Support the development of local utility-scale wind energy technology	Department of Trade and Industry, Industrial Development Corporation, Development Finance Institutions, Department of Energy
2	Attract OEMs with proven track record in wind turbine components manufacturing	DTI and IDC
3	Provide financial incentives for wind turbine component manufacturers	DTI
4	Increase customs duties on selected components of wind turbines	DTI
5	Provide favourable credit through government-run finance institutions and impose local content requirements as an eligibility criterion	DTI and DFIs
6	Update the manner in which local content evaluated to pose stricter rules on procurement of wind turbine components	DTI and DOE

SECTION 1: WIND ENERGY MARKET PROFILING

1. INTRODUCTION

This section is an introductory constituent of a broader study on wind energy industry localization potential in South Africa. As part of the major exercises constituting this stage of the study, secondary data sources were reviewed to make possible the strategic review of potential market and wind energy hotspots that may be targeted. Identification of market and hotspots is critical for the ultimate development of a customised, relevant and applicable wind energy industry roadmap for South Africa.

The basic aim at this stage of the study was to create a greater understanding of the wind energy potential and possible future roll-out of wind energy projects in the country and sub-Saharan Africa. This was done in order to understand the potential demand for components and services required in the establishment of large-scale wind energy projects in the next couple of decades.

To navigate there, the section begins first by looking at the global wind energy industry dynamics. It is followed by an assessment and a discussion on the sub-Saharan African market and its potential with respect to large-scale wind energy projects. This encompassed a review of electricity- and energy-related strategic documents of the sub-Saharan African countries that have the greatest potential for deploying large-scale wind energy projects. From sub-Saharan Africa, the analysis zoomed onto the South African market where both the current status and the potential of different wind energy market segments were analysed and discussed in detail.

The section concludes with formulation of different large-scale wind projects roll-out scenarios for both the South African and sub-Saharan Africa market contexts. Again, the combination of the potential growth of these market segments with regard to wind energy projects will inform the potential for development of the local wind energy industry and specifically the opportunities for optimal localisation in the short, medium, and long terms.

2. GLOBAL WIND ENERGY DYNAMICS

2.1 GLOBAL TRENDS IN RENEWABLE ENERGY

Global demand for energy and other associated services to meet socio-economic development is on an increase (Intergovernmental Panel on Climate Change, 2012). As many as 1.3 billion people worldwide are believed to still not have access to electricity, while another 2.6 billion people rely on traditional biomass for cooking and heating (REN21, 2014a). Varied energy sources such as fossil fuels, nuclear and renewables have been utilised in different parts of the world in order to meet such rising levels of energy demand. Amongst these sources, the global use and dominance of fossil fuels (coal, oil and gas) in both energy supply and specifically electricity generation has been overwhelming. As illustrated in Figure 2-1, fossil fuels still dominated the energy market in 2011, contributing 81.6% towards energy supply and producing 68% of the global electricity generation (IEA, 2013a). However, a structural change in electricity generation sources can be observed over the past few decades. While contribution of coal to energy supply and electricity generation has somewhat increased between 1973 and 2011, the use of oil to generate electricity has sharply declined and was substituted primarily by natural gas and nuclear. At the same time, consumption of other fuel sources has steadily grown. In 2011, contribution of renewables such as geothermal, solar, wind, biofuels, and waste, as well as heat towards electricity generation alone, has grown to 4.5% compared to a marginal 0.6% observed in 1973.

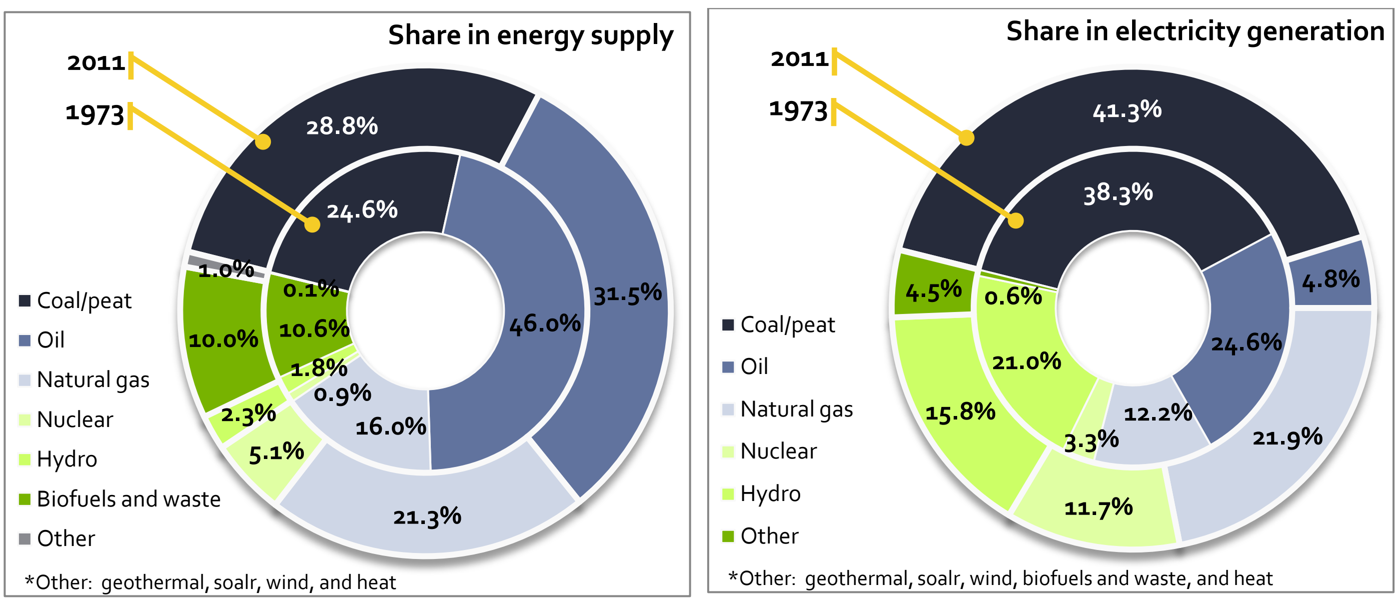


Figure 2-1: Shares of fuel in energy and electricity generation (IEA, 2013a)

Environmental concerns coupled with the need for energy security were among the major global drivers behind the diffusion of renewable energy technologies. The power generation sector is responsible for more than 40% of all carbon dioxide emissions from burning fossil fuels, and about 25% of total greenhouse gas emissions (GWEC & Greenpeace, 2012). As a result, recent developments in the global energy markets have witnessed an increased policy prioritisation of renewable energy as a means to reduce emissions, which are responsible for global warming and climate change.

By early 2014, 144 countries had renewable energy targets and 138 countries had renewable energy support policies in place; at the same time global investment in renewable energy increased by 17% to reach a record level of USD257 billion (REN21, 2014a) (IRENA, 2013a). Although significant in terms of value, this investment is, however, not sufficient for a clean energy transition in the electricity markets whose goal is to limit the increase in global temperature to two degrees Celsius (2°C) above pre-industrial levels and to avoid the worst impacts of climate change (Ceres, 2014). It is estimated that about USD800 billion of additional yearly investment will be required by 2030 to achieve the above target (IEA, 2014a).

In the last decade, new renewable energy sources such as wind, solar PV, concentrated solar thermal, geothermal and bio power have been on the rise with a commendable market adoption rate. As a result, energy generation using modern renewables has been increasing and progressing rapidly as indicated earlier. Globally, renewable energy generation grew 5.5% annually between the years 2006 and 2013, up from 3% annually between the years 2000 and 2006 (IEA, 2014a).

Total renewable power capacity reached 1 560GW in 2013, up about 14.5% from 2012 with hydropower claiming the largest share with an estimated 1 000GW and other renewables combined contributing about 560GW (REN21, 2013). Towards the close of the year 2013, renewable energy provided an estimated 26.4% of power towards the world's total generating capacity (REN21, 2014a). Some countries have shown remarkable achievements with respect to the use of renewables. In 2013, wind power alone met 33.2% of Denmark's electricity demand and 20.9% in Spain, while solar PV met 7.8% of total annual electricity demand in Italy (REN21, 2014a).

2.2 GLOBAL TRENDS IN WIND ENERGY

Table 2-1 gives a detailed breakdown of the contribution of different renewable technologies towards the aggregated renewable power capacity. It can be seen that wind power is the second-largest renewable energy technology worldwide, only preceded by hydropower.

Table 2-1: Global progress on renewable energy

Item	Unit	2004	2012	2013
New investment (annual) in renewable power and fuels	Billion (US$)	39.5	249.5	214.4
Renewable power capacity (total, not including hydro)	GW	85	480	560
Renewable power capacity (total, including hydro)	GW	800	1440	1560
Hydropower capacity (total)	GW	715	960	1000
Bio-power capacity	GW	36	83	88
Geothermal power capacity	GW	8.9	11.5	12
Solar PV capacity (total)	GW	2.6	100	139
Concentrating solar thermal power (total)	GW	0.4	2.5	3.4
Wind power capacity (total)*	GW	48	283	318
Countries with policy targets	#	48	138	144

(REN21, 2014a)

Wind power is one of the most dynamic renewable energy technologies with a global employment estimated around 800 000 jobs (IRENA, 2014a). Efficient electricity generation started growing in the 1970s in reaction to the oil crisis, particularly in countries exposed to fossil fuel price inflation with limited reserves of their own, such as

Denmark (IEA, 2014b). However, up until the 1990s, the market for wind energy remained low and stagnant; however deployment of wind energy technologies sharply accelerated in the last few years. The cumulative installed capacity of wind energy grew at an average annual rate of nearly 24% between the period 2000 and 2012 (IEA, 2013b). As a result of such accelerated growth, the wind power capacity at the close of 2013 equated to 318GW (Figure), which met an estimated 2.9% of total electricity demand globally (REN21, 2014a). As illustrated in Figure , wind power deployment has almost doubled between 2009 and 2013. It is predicted that the use of wind power will continue increasing in global cumulative production with total installed capacity forecasted to surpass 536GW by 2017 (IRENA, 2013a). Global onshore wind contributes a bigger capacity compared to the offshore wind energy market, which is still relatively small and represents a younger industry sector, less mature and relatively more cost intensive than land-based wind.

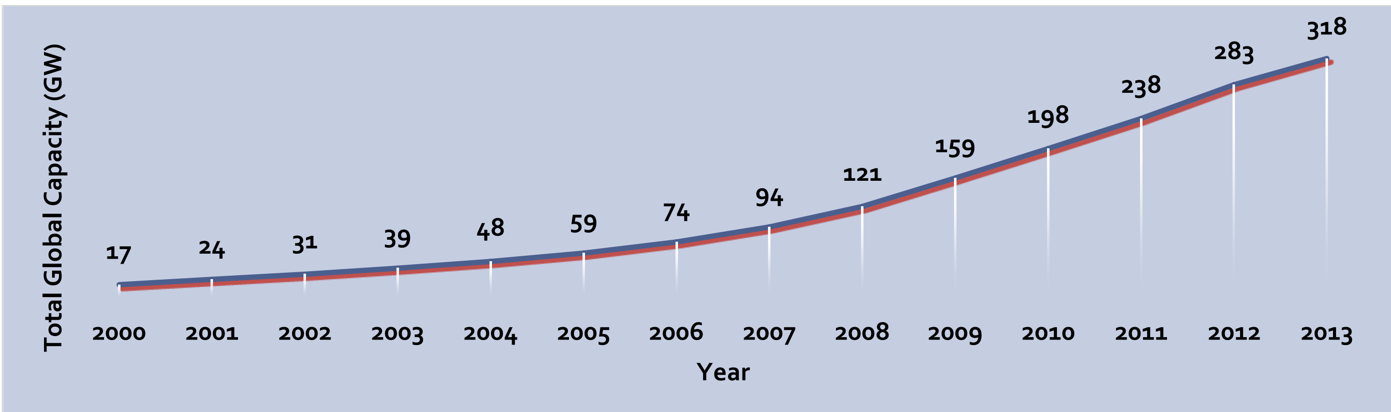
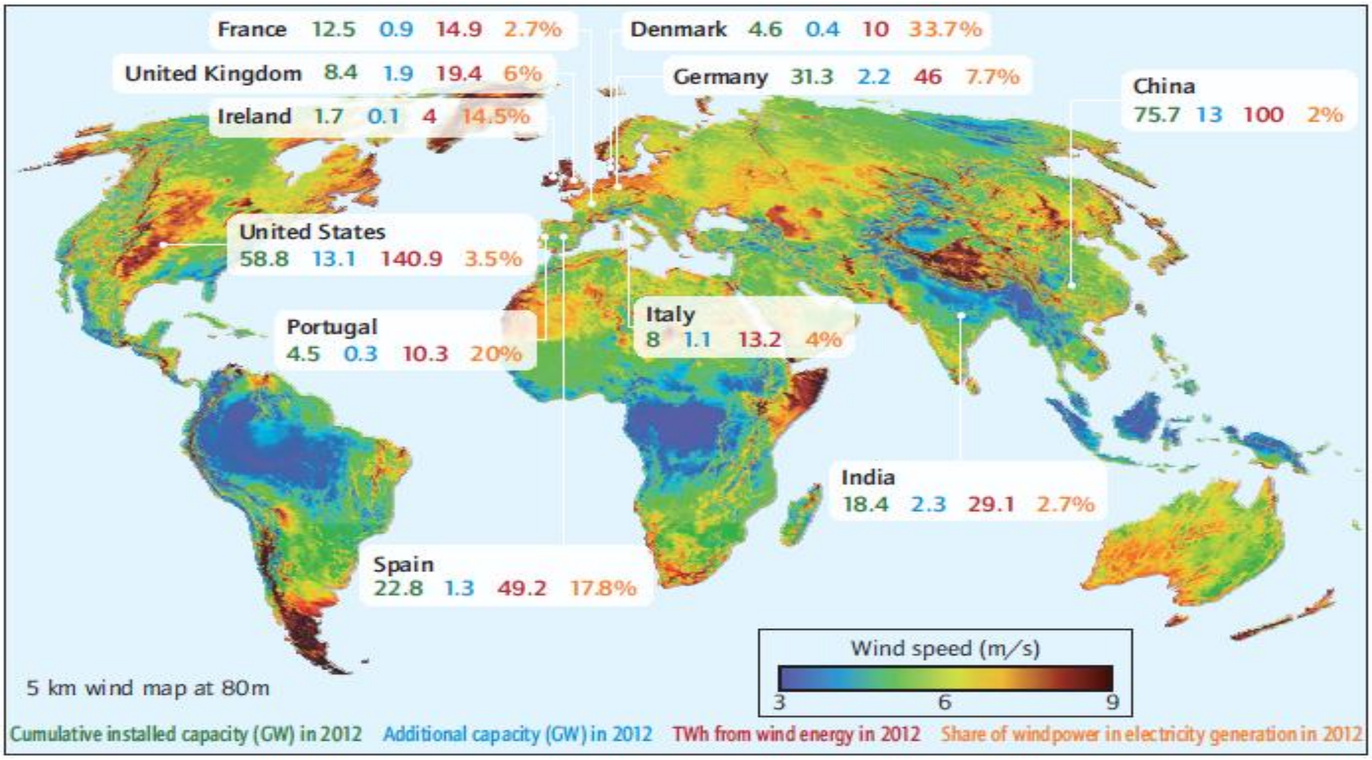


Figure 2-2: Wind Power Total World Capacity (REN21, 2014a)

Among some of the reasons that have resulted in the acceleration of the wind energy market in the past few years are falling capital costs and technological advances, which have enabled increased capacity while simultaneously improving the cost competitiveness of wind-generated electricity relative to other traditional energy sources such as fossil fuels. Capital costs declined primarily as a result of increased competition amongst wind energy industry participants, while technological advances resulted in greater yields from taller towers, longer blades, and smaller generators in low-wind-speed areas. Other reasons explaining the rise in the growth of the wind energy market have to do with the improvement in weather and wind forecasting methods, as well as the adoption by various countries of targets to reduce reliance on fossil fuels to diversify their energy supply mix and decrease their carbon footprint. Wind energy was forecasted to reduce carbon emissions by about 400 million tons in 2012 alone (GWEC & Greenpeace, 2012).

As outlined in Map 2-1, the top 10 wind energy producing countries, i.e. China, the United States of America (USA), Germany, Spain, India, United Kingdom, Italy, France, Canada, and Denmark, produced almost 85% of the world's aggregated capacity of 318GW in 2013. Importantly, China and the USA alone were responsible for almost half of the global wind energy capacity installed. By the end of 2012, 24 countries in the world had more than 1000MW of installed wind power capacity (i.e. 16 in Europe, four in Asia-Pacific, three in North America and one in Latin America); while six countries had more than 10 000MW of installed wind power capacity (China, USA, Germany, Spain, India and the UK) (GWEC, 2013). In terms of total wind power capacity per capita, countries such as Denmark, Sweden, Spain, Portugal and Ireland top the list.



Map 2-1: Global Wind Map, Installed Capacity and Production for lead countries (IEA, 2013b)

3. SUB-SAHARAN AFRICA MARKET AND ITS POTENTIAL

The review of the global wind energy industry dynamics indicated strong linkages between the growth of the domestic wind energy installed capacity and the state of development of the local wind energy manufacturing industries (e.g. China). As will be discussed later, some countries also used the opportunities presented by the domestic market to grow their manufacturing capabilities beyond the local demand and become prominent global wind turbine suppliers (i.e. Germany and Denmark). In this context, for the purpose of this study it will be important to consider not only the domestic wind energy landscape but also examine the opportunities presented by other African countries, as these could provide necessary economies of scale to develop a globally competitive industry in South Africa.

As such, the objective of this chapter is to review electricity- and energy-related strategic documents of the sub-Saharan countries with the purpose of identifying the potential for large-scale wind energy projects considering the available wind resource information and their government commitments. More specifically, the chapter presents the analysis of the following:

- Extent to which the development of renewable energy, and particularly wind energy, is iterated in the strategic government documents.
- Description of the vision, plans and commitments with regard to wind energy electricity generation capacity development in these countries.

3.1 GENERAL OUTLOOK

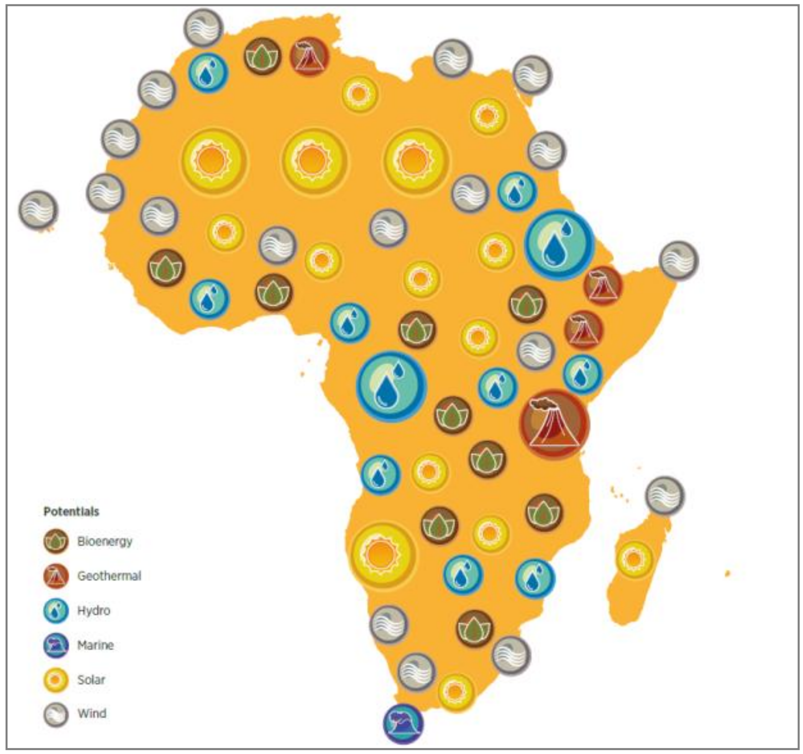
AFRICA

Generation of more power to meet current and future electricity demand remains a challenge for Africa. At present, there are over half a billion people in Africa without access to electricity (AfDB, 2013) with 30 of the continent's countries, specifically within Sub-Saharan Africa, believed to be experiencing daily power outages (IRENA, 2012). Rapid population growth coupled with the development and diversification of economies in Africa, though, entails increased levels of energy demand. It is estimated that the continent will need an extra 250GW of installed capacity between now and 2030 in order to meet the rising electricity demand (IRENA, 2012).

Africa's renewable energy power potential is substantially larger than the current and projected power consumption of the continent (IRENA, 2013b). This means that harnessing renewable energy sources presents a plausible solution to addressing some of the current power shortages and expected future demand to the extent that inter-grid connection can provide base load power. Although diverse renewable energy resources are rampant in Africa, as can be seen from Map 3-1, it may be argued that most countries in Africa have so far largely neglected modern forms of renewable energy technologies, including wind. Besides the traditional focus on fossil fuels, hydro power remains the most common renewable energy source in Africa, and specifically in sub-Saharan Africa (UNEP Finance Initiative, 2012).

As can be seen from Map 3-1, wind resource potential is best around the northern, eastern and some southern parts of the African continent. Despite such high wind resource potential, Africa's wind power is still very limited with an estimated 1.1GW installed capacity in 2011, constituting less than one percent of the continent's total installed electricity generation capacity (AfDB, 2013). Wind power has been developed at scale mostly within the North and East Africa sub-regions. At the end of 2011, over 98% of the continent's total wind power installed capacity (just over 993MW) was generated in only four countries: Egypt, Morocco, Tunisia and Carpe Verde (GWEC, 2012). This also means that the North African sub-region alone claimed a huge share of about 96% (AfDB, 2013). At the end of 2013, wind energy installed capacity in Africa grew to just over 1 145MW. Besides South Africa, these included (GWEC, 2013):

- Egypt (550MW)
- Morocco (291MW)
- Ethiopia (171MW)
- Tunisia (104MW)
- Cape Verde (24MW)
- Kenya (5MW)



Map 3-1: Distribution of identified renewable energy potential in Africa (IRENA, 2013b)

Installed capacity to harness wind energy in Africa is expected to increase 12-fold over the next decade, in line with the global trends and technological innovations now characterising the wind market (AfDB, 2013). The continent is tipped to emerge as a wind energy development hotspot, especially considering new developments in Ethiopia, Tanzania, and Mauritius, as well as commitments made in South Africa and Morocco (GWEC, 2013).

The sub-Saharan Africa wind market is beginning to awaken and this should come as a major boost for wind energy in Africa. Persistent droughts within sub-Saharan Africa pose a major functional risk for most hydro-power generation projects that most countries have often prioritised. There is also some pressure to reduce the reliance on fossil fuels as a power source due to the environmental ills resulting from heavy reliance on these sources. As a result, most African countries, especially within sub-Saharan Africa where most wind power laggards are placed, are beginning to look and strategise towards the use of alternative and sustainable renewable energy technologies like wind power.

SUB-SAHARAN AFRICA AND REGIONAL INTEGRATION

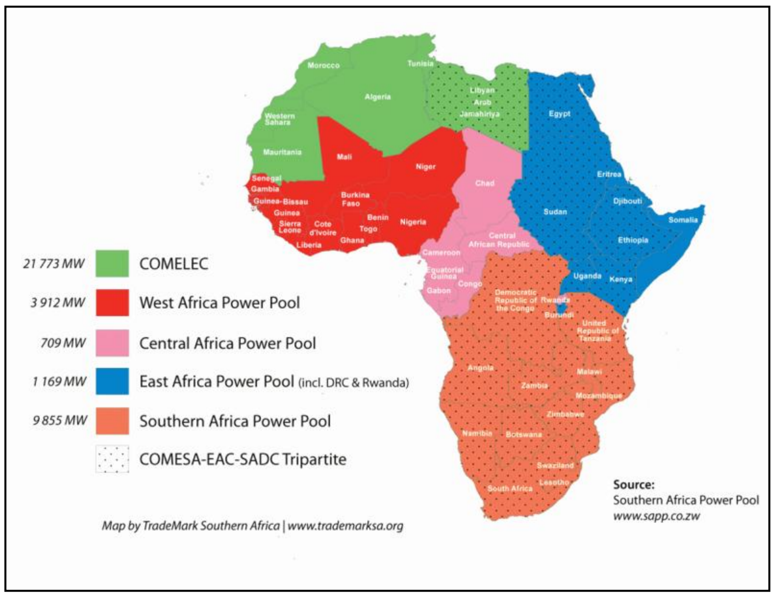
Sub-Saharan Africa consists of 49 African countries and has a combined population of over half a billion people, which is almost 8% of the total world population (KPMG, 2011). With a total landmass area around 19.5 million km², sub-Saharan Africa constitutes about 13% of the world's total land mass (KPMG, 2011). Excluding South Africa, the region has a combined electricity generation capacity of roughly 30GW with about a quarter of this installed capacity believed to be currently unavailable for generation due to a variety of reasons, mostly due to aging plants and lack of maintenance (UNEP Finance Initiative, 2012). Such low electricity generation capacity has resulted in the region having the world's lowest electricity access rate at only 24%, with rural rates plunging as low as 8% (Nedbank , 2013).

Currently, the majority of electricity within the region comes from fossil fuels and hydro power plants. Including hydro power, close to 66% of all new electricity generated in sub-Saharan Africa after 1998 came from renewable sources (UNEP Finance Initiative, 2012). The use of wind as a source of renewable energy in sub-Saharan Africa is still at the developmental stage. As will be seen in the forthcoming sections, most countries within the region have primarily utilised wind for water pumping projects rather than for utility-scale electricity generation projects.

Africa is divided into five Regional Economic Communities (RECs), which in turn encompass five power pools acting as specialised agencies of their respective RECs (refer to Map 3-2). Power pools were formed with an objective of optimising the use of energy resources and increasing cross-border electricity trade. The existence of such a power pool could be critical for the development of wind energy markets in Africa in general since it increases the opportunities for deployment of wind energy projects in any of the countries with interconnected utilities. This is particularly relevant for South Africa, which is the member of the Southern African Development Community (SADC) and the Southern African Power Pool (SAAP).

As indicated on Map 3-2, five power pools can be distinguished in Africa, with sub-Saharan Africa encompassing the following four:

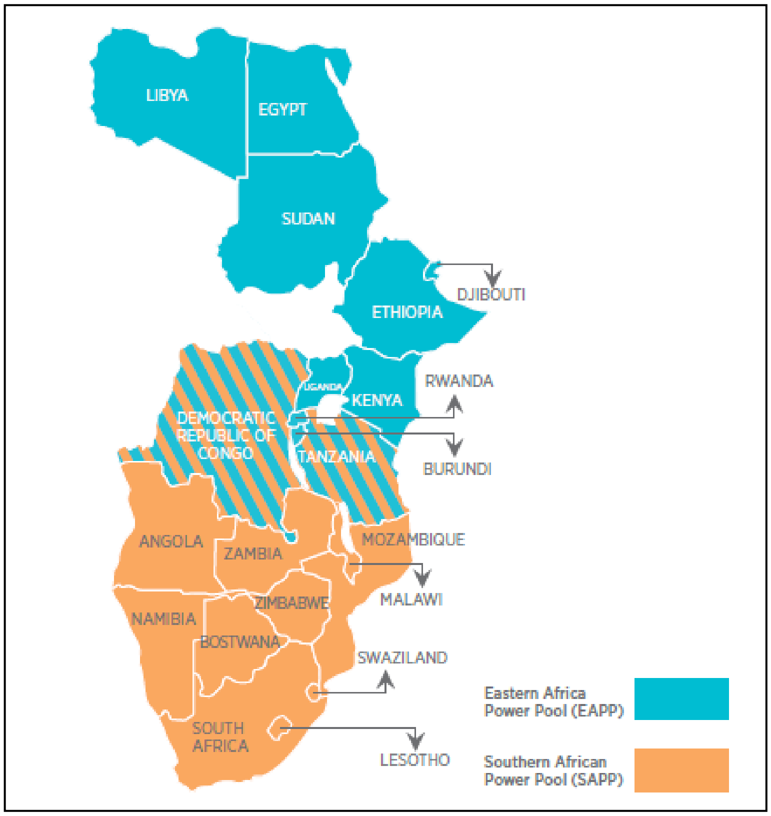
- the West Africa Power Pool (WAPP) formed by the Economic Community of West African States (ECOWAS)
- the Central Africa Power Pool (CAPP) formed by the Economic Commission for Central Africa States (ECCAS)
- the East Africa Power Pool that includes DRC and Rwanda (EAPP) formed by the Common Market for Eastern and Southern Africa (COMESA)
- the SAPP formed by SADC



Map 3-2: Africa power pools and their current generation capacities (TradeMark Southern Africa, 2012)

The EAPP and SAPP also form part of the Africa Clean Energy Corridor (ACEC) initiative, which was launched in 2013 at the Third Assembly of the International Renewable Energy Agency (IRENA).

The ACEC is aimed at facilitating the development of the renewable energy potential that is in abundance on the African continent (IRENA, 2014b). In order to realise the potential for renewables in Africa in general, a strong transmission grid is required, which will increase the ability of moving clean and low-cost renewable electricity to areas dominated by high-cost fossil fuels, improve reliability of electricity provision, and increase access to electricity stimulating the respective economies. As such, the ACEC will rely on the high-voltage transmission corridor from Egypt to South Africa.

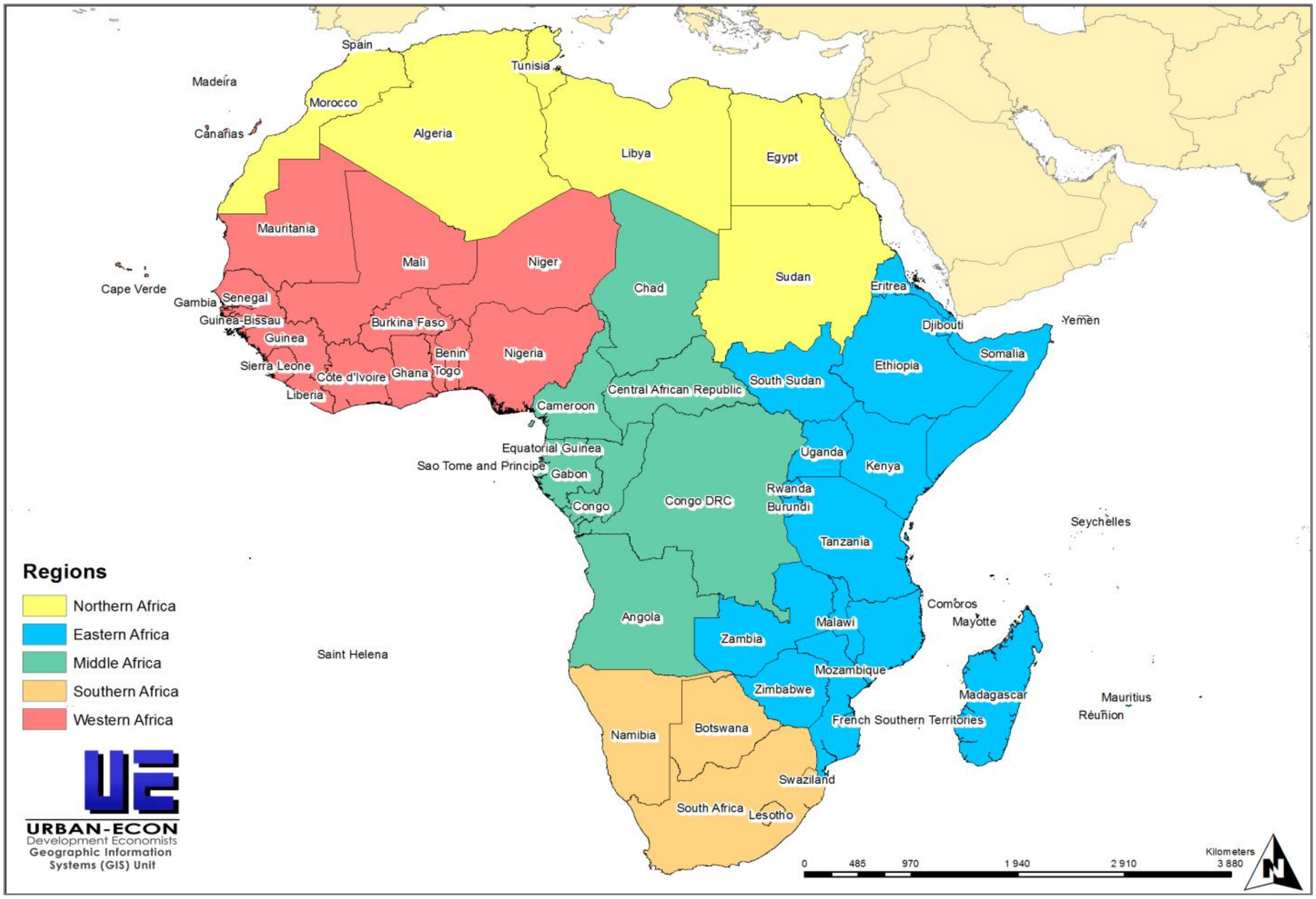


Map 3-3: The ACEC (IRENA, 2014b)

It is forecasted that by 2040 an additional 385GW of electricity generating capacity will be required in the four power pools encompassing mainly sub-Saharan African countries (i.e. 90GW in WAPP, 26GW in CAPP, 140GW in EAPP, and 129GW in SAPP) (IRENA, 2014b). At this stage, though, the majority of renewable energy generation capacity is envisaged to be derived from hydropower with wind and other renewable energy sources such as solar, geothermal, and biomass accounting for a marginal contribution (IRENA, 2014b). Detailed resource assessments are among the key constricting factors that prevented inclusion of the above-mentioned non-hydro renewable energy sources in the master plans in the past (IRENA, 2014b). The ACEC, though, provides the opportunity for countries and organisations such as IRENA to work together to address this shortcoming and review the master plans to provide greater consideration of non-hydro resources in their future generation capacity. Importantly, aside from hydro, wind is considered to be the second-best choice for providing solutions to some of the power sector challenges in sub-Saharan Africa.

However, the development of the ACEC is only at the inception stage, which means that much work still needs to be done to realise its vision, develop accurate resource data, review the power pools' master plans, and firm up on the commitments with respect to deployment of renewables in various countries. This means that determining the potential for wind energy project deployment in sub-Saharan Africa at this stage needs to rely on the country-specific energy plans, which are the focus of the next few sections.

The review of wind resources, policies, and wind power projects in sub-Saharan Africa presented in the next sections is done for all the four geographical sub-regions that constitute Sub-Saharan Africa, including Southern Africa, East Africa, West Africa, and Central/Middle Africa. For the purposes of this particular study, the geographical categorisation of sub-Saharan African countries followed that mostly utilised by many United Nations agencies, as shown below.



Map 3-4: Geographical sub-regions of Africa (United Nations, 2013)

3.2 SOUTHERN AFRICA WIND ENERGY PROJECT DEVELOPMENT POTENTIAL

Four southern African countries, excluding South Africa, were reviewed in this particular section[1]. These include Botswana, Lesotho, Namibia and Swaziland. These four southern African countries have a total area of roughly 1.5 million km² and an aggregated population around 7.5 million people (IRENA, 2011). Together, these four countries constitute almost 6% of sub-Saharan Africa's total size. With a population estimated around 2.2 million, Namibia has the highest number of inhabitants in this sub-region (excluding South Africa), followed by Lesotho with 2.1 million people (IRENA, 2011). In 2010, the four southern African countries had an estimated aggregate GDP of around USD33 billion with 45% and 37% of the total GDP coming from Botswana and Namibia, respectively (IRENA, 2011). As of 2010, the four southern African countries had a combined total installed electricity capacity estimated around 762MW (IRENA, 2011). Again, Botswana and Namibia constituted bigger shares of that combined electricity capacity, distributed as follows (IRENA, 2011):

- Botswana (292MW)

[1] Analysis of South Africa is provided later in the report.

- Namibia (264MW)
- Swaziland (130MW)
- Lesotho (76MW)

Wind energy resource potential (geographical distribution and areas of highest potential)

Wind energy resource mapping studies have been carried out in Lesotho and Namibia (Ram, 2006). In general, the wind resource potential in southern Africa is largely of medium potential. The IRENA wind resource potential map shows that Botswana, Lesotho and Swaziland have a medium wind resource potential, while Namibia has a high wind resource potential (IRENA, 2011).

- According to the Ministry of Minerals, Energy and Water Resources in **Botswana**, the country does not have a good wind resource and few sites with wind speed for viable wind-based power (Ministry of Minerals, Energy and Water Resources, 2009).
- While wind resource potential for the whole of **Lesotho** might be rated as of medium potential, there are some areas within that country that have proved to be endowed with good to excellent wind resources, especially in the north eastern parts of Lesotho around the Maloti-Drakensberg area. The possibility for exploiting the wind energy resource in Lesotho was assessed at three different sites, namely Lets'eng-la-Terae, Phahameng and Sani Top. Lets'eng-la-Terae showed greater wind resource potential with the estimated total annual energy production (AEP) for the case study wind farm at being 37.3GWh (Kingdom of Lesotho, 2003). The net annual energy production potential from a wind farm varies from 3.5GWh to 3.95GWh per wind turbine per year for a wind farm of 10 wind turbines (Kingdom of Lesotho, 2003).
- In **Swaziland**, wind resource mapping is ongoing with preliminary results indicating a mean average wind speed of 4m/s across the country, suggesting a moderate potential for wind energy use (REEGLE, 2014h). Reports highlight that the country's Ministry of Natural Resources and Energy is working in close collaboration with the National Meteorological Service to determine whether there is any realistic potential for effective utilisation of wind energy in the country, including long-term measurements on the Lubombo Plateau and a movable monitoring station for other areas of the country (REEGLE, 2014h).
- In **Namibia**, the Ministry of Mines and Energy reports that the country has a good wind resource and specifically that high-quality wind resources exist in coastal areas with mean wind speeds of 6m/s to 8m/s measured at 10m height above a flat water surface (Ministry of Mines and Energy , 1998).

Policies on renewables and targets

With regard to policies, there are no stand-alone renewable energy policies identified in any of the four countries under review. In most cases and for most of the countries, sections, strategies and plans relating to the adoption and promotion of renewable energy are usually included in the national energy plans. Botswana has some fiscal incentives meant to promote the use of renewables, while the governments of Lesotho and Swaziland have also referred to incentives and promotion of renewables. Whereas all of the countries' energy policies converse about renewable energy and devise different incentives to promote their use, it was, however, noted that lengthy discussions exclusively on wind energy were done in two out of the four countries in the region, specifically Namibia and Lesotho:

- Lesotho's 2003 Draft Energy Policy covers sections on some government strategies meant to promote the development of renewable energy within the country, including wind power.
- Namibia's White Paper on Energy Policy of 1998 recognises the importance of wind power as a source of renewable energy.

Formal wind energy sector development targets exist for Lesotho. Namibia had set renewable energy targets but these have since lapsed due to not being implemented within specified timeframes. The following table summarises these for the four southern African countries.

Table 3-1: Renewable energy targets in Southern Africa

Wind Energy Specific Targets		
Country	Target (MW)	Date
Lesotho	6 000	2025
Past Renewable Energy Target		
Country	Target (MW)	Date
Namibia	40 (Excluding hydro)	2011
No Renewable Energy Targets		
Botswana and Swaziland		

CURRENT AND PROJECTED STATE OF WIND ENERGY PROJECT DEPLOYMENT

Botswana and Swaziland have made no progress or commitments in terms of developing wind power. On the other hand, Lesotho and Namibia are reported as having made some announcements revealing wind power capacity they commit to add into their existing installed electricity generation capacity. A 25MW of wind energy capacity addition was announced for Lesotho (REN21, 2014b), while up to 450MW of wind energy capacity addition from five projects was announced for Namibia (IRENA, 2011). Only one country among these four is known to already have operational installed wind power capacity (World Wind Energy Association reveals that by the end of 2013, Namibia had 0.2MW of total installed wind power capacity (WWEA, 2013)).

3.3 EAST AFRICA WIND ENERGY PROJECT DEVELOPMENT POTENTIAL

Nineteen east African countries were reviewed that included Burundi, Comoros, Djibouti, Ethiopia, Eritrea, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, South Sudan, Uganda, Tanzania, Zambia, Reunion, and Zimbabwe. It should be noted that eight of these belong to the Southern African Development Community (SADC). Together, the countries have a total size of 8 864 453 km², which is about 36.5% of sub-Saharan Africa's land mass. These east African countries have a combined population size of about 366 million. In 2010, the countries had a total GDP estimated around USD188 billion[2]. Kenya contributed the most towards the region's aggregated GDP in 2010, with a recorded GDP of USD31.4 billion (IRENA, 2011).

[2] Excluding Djibouti and Somalia where GDP data for 2010 was not available

Installed electricity capacity within the sub-region is still very low. Based on the available information, the sub-region all together had a summed-up installed electricity capacity of around 11.8GW in the 2008-2010 period[3] (REN21, 2014b). Out of the 11.8GW of installed electricity capacity within the region, about half of that capacity (53%) was installed in three countries, i.e. Mozambique, Zambia, and Zimbabwe. The top five countries in terms of installed electricity capacity appear as follows:

- Mozambique (2 428MW)
- Zimbabwe (2 099MW)
- Zambia (1 680MW)
- Kenya (1 286MW)
- Tanzania (1 006MW)

WIND ENERGY RESOURCE POTENTIAL

The wind energy resource in east Africa is of medium to high potential. There is evidence revealing that the eastern parts of Africa are endowed with good wind resources suitable for viable wind power generation projects. As indicated in Table 3-2, half of east Africa's countries have good wind resources suitable for wind power, hence the high wind energy resource potential; while another half have a medium wind energy resource potential. There is no country within the east African region with poor wind speeds and subsequently a low wind energy resource potential. There is, however, no rating available from IRENA with regard to the wind energy resource potential for South Sudan and Seychelles, but due to the climatological setting of the two countries it can be confirmed with a high degree of certainty that both countries will have good resource potential (i.e. Reunion due to location in trade wind belt and South Sudan due to high ground in south and east of country). Nonetheless, as discussed further these countries seem to have good wind resources based on evidence gathered from other sources.

Table 3-2: Wind Energy Resource Potential in East Africa

Wind resource	Countries
High	Eight countries: Ethiopia; Eritrea; Kenya; Madagascar; Mauritius; Rwanda; Somalia; Tanzania
Medium	Eight countries: Burundi; Comoros; Djibouti; Malawi; Mozambique; Uganda; Zambia; Zimbabwe
Low	None
Unknown	Two countries: South Sudan; Seychelles , Reunion

(IRENA, 2011)

Six out of the reviewed countries within the region converse about the wind energy resource potential in their respective policy documents. The discussions on wind resource potential from most of these policy documents are in line with the ratings made by IRENA as discussed earlier and can be summarised as follows:

- To support the presence of a high wind energy resource potential in **Ethiopia** as discussed earlier, the country's 2012 Energy Policy acknowledges the high potential of available wind energy resources, estimated at about 1,035GW (Ministry of Water and Energy , 2012).

[3] Excluding South Sudan

- The 2009 Draft Long Term Energy Strategy adopted in **Mauritius** reveals that a wind mapping study executed in the country confirmed the presence of a high wind energy resource potential with some areas having annual average wind speeds of 8m/s at 30m above ground level (Ministry of Renewable Energy and Public Utilities, 2009).
- The 2008-2012 National Energy Policy and National Energy Strategy in **Rwanda** highlighted that a wind atlas was being developed and if the potential was shown to exist, the data were to be utilised for the development of wind energy projects (Ministry of Infrastructure , 2009).
- Energy policies in Malawi, Zambia and Zimbabwe both seem to highlight the low-to-medium potential of wind energy resources in these respective south-eastern African countries:
    - The National Energy Policy in **Malawi** confirms that the country's wind speeds range between 2m/s to 7m/s and might only be adequate for water pumping (Ministry of Energy and Mining , 2003).
    - In **Zambia**, the National Energy Policy highlights that large areas have annual average wind speeds (as low as 2.5m/s) and these might only be suitable for water pumping and not suitable for electricity generation. There are, however, selected areas where wind regimes are reported to be as high as 6m/s, particularly in the western province of Zambia (Ministry of Energy and Water Development, 2008).
    - The **Zimbabwe** National Energy Policy 2012 reveals that the country's average wind speeds of 3m/s are too low for significant power generation but can be used for water pumping as well (Ministry of Energy and Power Development, 2012).
- With regards to **Seychelles**, there is evidence revealing that the country has a high wind energy resource potential. Some sites on the island have been identified as having average wind speeds of 6.9m/s to 7.5m/s at 80m above ground; hence, the high potential for electricity generation from wind energy (REEGLE, 2014g).
- The government of **South Sudan** perceives wind power generation as a key investment for rural electrification (Ministry of Finance and Economic Planning , 2014) but due to its climatological setting it can be confirmed with a high degree of certainty that South Sudan will have good resource potential due to high ground in the south and east of the country, which separate areas of different land surface heating potential and winds associated with such settings.

POLICIES ON RENEWABLES AND TARGETS/WIND ENERGY GENERATION COMMITMENTS

Based on the information gathered, the following can be summarised with respect to existing energy policies and targets for wind or renewable energy generation in east Africa:

- One country (i.e. Djibouti) in the region is in the process of developing a renewable energy policy.
- Three countries (i.e. Malawi, Uganda, Zimbabwe) have renewable energy plans in their energy policies but do not prioritise the development of wind energy.
- Eight countries (i.e. Ethiopia, Kenya, Madagascar, Mauritius, Mozambique, Rwanda, Tanzania and Zambia) have policies that not only talk about renewable energy but also show interest in developing wind power.

In **Ethiopia**, the 2012 National Energy Policy inspires the promotion and enhancement of renewable energy technologies, including wind power, to meet decentralised electricity demands in rural areas (Ministry of Water and

Energy , 2012). The utilisation of renewable sources of energy, including wind power, is also strongly expressed in **Kenya**'s National Energy Policy adopted in 2014. The **Madagascar** Action Plan 2007-2012 emphasised the need to create Independent Power Producers and also to have an increased use of alternative and/or renewable energy sources, including wind energy to reduce dependence on oil products (Republic Of Madagascar, 2006). In **Mauritius**, a wind energy strategy is included in the Draft Long-Term Energy Strategy 2009-2025 as part of the Renewable Energy Development Strategy. While in **Mozambique**, the 2009 Policy for the Development of New and Renewable Energy identified wind as one of the key renewable energy resources available in the country (SNV, 2011). **Rwanda**'s 2008-2012 National Energy Policy and National Energy Strategy values the utilisation of renewable sources of energy, including wind power. In **Tanzania**, the country's Energy Policy adopted in 1992 highlights the country's interest in wind energy. **Zambia**'s 2008 National Energy Policy stipulates that in areas where the wind speed is above 5m/s, the wind regime should be used for electricity generation (Ministry of Energy and Water Development, 2008).

The following table summarises the commitment made by various countries in east Africa with respect to harnessing wind energy or other renewable energy sources for electricity generation. It indicates that five east African countries have wind energy generation specific targets, while eight other countries have targets set for general renewable energy technologies.

Table 3-3: Renewable Energy Targets in East Africa

Wind Specific Targets		
Country	Target	Date
Eritrea	50% electricity generation	-
Ethiopia	772.8 MW	2015
Kenya	500 MW, 1000 MW, 3000 MW	2017, 2022, 2030
Mauritius	6% & 8% targeted share of electricity generation	2020 & 2025
Mozambique	2000 MW	-
Renewable Energy General Targets		
Country	Target	Date
Burundi	2.1 % of final energy	2020
Djibouti	85% in total electricity generation	2015
Madagascar	75% in total electricity generation	2020
Malawi	7% & 10% of primary energy	2020 & 2050
Rwanda	5 MW	2017
Seychelles	5% in total electricity generation	2020
Uganda	61% of total energy consumption	2017
Zimbabwe	Bio-fuels and hydro specific	-
No Targets		
Comoros, Somalia, South Sudan, Tanzania, Zambia		

East Africa leads other sub-regions within sub-Saharan Africa in terms of total installed wind power capacity. By the end of 2013, seven countries within this sub-region harnessed wind energy on a medium- to large-scale, which roughly added up to 186MW and was distributed as follows:

- Eritrea (0.8MW)
- Ethiopia (171MW)
- Kenya (5. 45MW)
- Madagascar (1.2MW)
- Mauritius (1.1MW)
- Mozambique (0.3MW)
- Seychelles (6MW)

Burundi and Malawi are either planning or discussing the development of wind power. Malawi plans to construct isolated wind farms with total installed capacity of 120MW (IRENA, 2011), while the government of Burundi held discussions with a private company to develop 1.2MW of wind power around Bujumbura under a PPP arrangement (AfDB, 2009). Two other countries in east Africa, i.e. Djibouti and Tanzania, have some wind power capacity under assessment – 60MW in Djibouti and 100MW in Tanzania. Other countries in East Africa (i.e. Comoros, South Sudan, Rwanda, Somalia, Uganda, Zambia, Zimbabwe) have either insignificant or no installed wind energy projects identified.

3.4 WEST AFRICA WIND ENERGY PROJECT DEVELOPMENT POTENTIAL

West Africa is made up of 16 countries and these include Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone and Togo. Fifteen out of these 16 countries are Economic Community of West African States (ECOWAS) members, with Mauritania being the only exception. West Africa has a total area of 8 864 453 km², almost a quarter of sub-Saharan Africa. It has a total population above 308 million people, of which Nigeria alone constitutes half (51%) of that total population. West Africa had a combined GDP of about USD308.5 billion in 2010 (IRENA, 2011). Again, Nigeria dominated the sub-region in this regard, accounting for almost two thirds (63%) of the GDP generated in the sub-region. The dominance of Nigeria within west Africa is also evident in terms of electricity supply. Out of the total installed electricity capacity of about 11.7GW in west Africa as of the 2008-2010 period, more than half of that capacity was installed in Nigeria. Most of the countries in the sub-region have low installed electricity capacity. In 2010, only three countries within the region had electricity capacity above 1GW and these included:

- Nigeria (5 900MW)
- Ghana (2 111MW)
- Cote d'Ivoire (1 218MW)

The above-mentioned three countries alone contributed almost 79% of the sub-region's total installed electricity capacity.

WIND ENERGY RESOURCE POTENTIAL

West Africa's wind energy resource potential varies across countries. Based on the information presented in Table 3-4, six countries within the region have a high wind energy resource potential. The wind resource in seven other countries is of medium potential, while the remaining three countries have a low wind energy resource potential.

Table 3-4: Wind Energy Resource Potential in West Africa

Wind resource	Countries
High	Six countries: Cape Verde; Guinea, Mali; Mauritania; Niger; Nigeria
Medium	Seven countries: Benin, Burkina Faso, Cote d'Ivoire; Ghana; Senegal; Sierra Leone; Togo
Low	Three countries: Gambia; Guinea-Bissau; Liberia

(IRENA, 2011)

In Mauritania, it is reported that wind potential is considerable, with an annual average of 5m/s to 8m/s (GTZ, 2009). In Niger, windy areas suitable for wind power generation are located in the northern part of the country (IRENA , 2013). Ghana's 2011 Renewable Energy Bill confirms the presence of a medium-to-high wind energy resource potential. Wind speeds of between 5m/s to 8m/s at 5 meters above ground level with current exploitable wind potential well over 1,000MW are reported in Ghana (Ministry of Energy, 2011). In Liberia, the country's 2009 National Energy Policy notes that observations along its coastal regions suggest that there are potential prospects for the development of wind power (Ministry of Lands, Mines and Energy, 2009). In Burkina Faso, the potential for wind power development is reported to be limited with national average wind speeds ranging between 2m/s to 3m/s, and reportedly reaching a maximum of 4m/s to 5m/s in the northern parts of the country (UNEP RISO, 2013).

POLICIES ON RENEWABLES AND TARGETS/WIND ENERGY GENERATION COMMITMENTS

Four countries within the region (i.e. Cape Verde, Ghana, Liberia, and Nigeria) have policies in place that show the different governments' interest in developing wind power within these respective countries.

- The Renewable Energy Plan for **Cape Verde** (REPCV) identifies an enormous potential of RE in Cape Verde, dominated by wind energy (220MW) and other renewables (ECREEE, 2011).
- **Ghana**'s Strategic National Energy Plan 2006-2020 recommends the government to support the development of renewable energy for power generation, including wind energy technologies (Energy Commission Ghana, 2006).
- The use of renewables including wind power is also strongly emphasised in the **Liberia**'s National Energy Policy (Ministry of Lands, Mines and Energy, 2009).
- In **Nigeria**, the country's 2003 National Energy Policy emphasised the need to developing its wind energy resource and integrate it with other energy resources into a balanced energy mix (Energy Commission of Nigeria , 2003).

Three other countries within this region (i.e. Mauritania, Niger, Sierra Leone), have policies in place that support and promote the use of renewable energy in general without specific attention or mentioning of wind power.

- **Mauritania**'s Draft Energy Policy is reported as considering a tax reduction for RE equipment and investments in promoting a national production of renewable energy technologies (GTZ, 2009).

- **Niger** has a National Renewable Energy Strategy; however, its details are unknown since it is not accessible over the internet.
- **Sierra Leone**'s National Energy Policy and Strategic Plan prioritises other renewables besides wind energy.
- **Gambia** and **Guinea** have draft renewable energy policies in discussion.
- **Other west African countries** like Benin, Burkina Faso, Cote d'Ivoire, Guinea- Bissau, Mali, Senegal and Togo are reported as having some renewable energy fiscal incentives in place.

Most countries within the sub-region have renewable energy targets outlined in the table below. In fact, west Africa leads all other sub-Saharan African sub-regions in terms of setting up renewable energy targets. Two countries (i.e. Cape Verde and Nigeria) have set wind energy specific targets; 10 other countries have broad renewable energy targets; and only four countries in west Africa have no wind or renewable energy targets in place.

Table 3-5: Renewable energy targets in West Africa

Wind Specific Targets		
Country	Target	Date
Cape Verde	50% share in electricity generation	2020
Nigeria	40 MW	2025
Renewable Energy General Targets		
Country	Target	Date
Benin	36% & 37% share in total electricity generation	2015 & 2025
Cote d' Ivoire	5% (excl bio-mass) share in total electricity generation	2015
Gambia	35% & 48% share in total electricity generation	2020 & 2030
Ghana	10% share in total electricity generation	2020
Guinea	5% share in total electricity generation	2015
Liberia	30% share in total electricity generation	2015
Mali	10% & 25% share in total electricity generation	2015 & 2020
Mauritania	20% share in final energy consumption	2020
Niger	10% share in total electricity generation	2020
Senegal	15% share in total electricity generation	2015
No Targets		
Burkina Faso, Guinea-Bissau, Sierra Leone, and Togo		

CURRENT AND PROJECTED STATE OF WIND ENERGY PROJECT DEPLOYMENT

Combined, the reported total installed wind power capacity in west Africa is 41.4MW and distributed as follows:

- Cape Verde (25.5MW)
- Nigeria (10.2MW)
- Togo (5.7MW)

There are other countries in the sub-region that have also made some progress or commitments with regard to wind power. Mauritania announced 83MW to 150MW of wind capacity addition across four projects (IRENA, 2011). Senegal is assessing an addition of 151.8MW of total wind capacity (REN21, 2014b), while 200MW of installed wind power capacity providing about 400GWh per year was conservatively proposed in Ghana's Strategic National Energy Plan adopted in 2006 (Energy Commission Ghana, 2006). No wind power projects, commitments or plans were identified for the other nine west African countries such as Benin, Burkina Faso, Cote d'Ivoire, Gambia, Guinea-Bissau, Guinea, Liberia, Niger, and Sierra Leone.

3.5 Central Africa wind energy project development potential

This sub-region consists of nine countries including Angola, Cameroon, Central African Republic, Chad, Congo Republic, Democratic Republic of Congo, Equatorial Guinea, Gabon and, Sao Tome and Principe. Two of the countries, i.e. Angola and the Democratic Republic of Congo (DRC) also belong to SADC. Central Africa sub-region has a total area of 6 613 214 km², which is about 27% of sub-Saharan Africa as a whole. The sub-region has a population of around 129 million people with more than half of that population residing in the DRC alone. Angola leads the sub-region in terms of GDP. In 2010, the recorded GDP for the entire sub-region was around USD175 billion and 48% of that GDP was generated in Angola alone. Like the rest of sub-Saharan Africa sub-regions, installed electricity capacity within central Africa is low relative to current and anticipated electricity demand. Three countries in central Africa accounted for about 87% of the sub-region's total installed electricity capacity, including:

- Democratic Republic of Congo (2 475MW)
- Angola (1 155MW)
- Cameroon (1 106MW)

Wind energy resource potential

The wind energy resource potential in central Africa varies across countries. According to IRENA (2011), out of the nine countries in the sub-region, two have a low wind energy resource potential, four are of medium potential, and three other countries have a high potential.

Table 3-6: Wind Energy Resource Potential in Central Africa

Wind resource	Countries
High	Three countries: Cameroon; Chad, Democratic Republic of Congo
Medium	Four countries: Angola; Central African Republic; Congo Republic; Equatorial Guinea
Low	Two countries: Gabon; Sao Tome and Principe

(IRENA, 2011)

Wind mapping is currently underway in Angola in order for the government to identify particular areas with the biggest potential for wind power projects (Angola Ministry of Energy and Water, 2013). In Chad, significant wind potential lies in the country's central region, where wind speeds reach 7m/s to 7.5m/s (REEGLE, 2014a).

Policies on renewables and targets/wind energy generation commitments

Only one country within the sub-region mentions wind energy in their national policies. Chad's National Poverty Reduction Strategy (NPRS) adopted in 2000 promotes the use of alternative energy sources such as wind and solar energy to reduce desertification resulting from the extensive use of fire wood and subsequently ensure sustainable growth and poverty reduction (REEGLE, 2014a). Angola is currently developing a National Renewable Energy Strategy (Angola Ministry of Energy and Water, 2013), while a Renewable Energy Policy is also being prepared in

Cameroon (Kovac, 2012). Again, the government of Chad is also reported as being in the process of implementing a National Energy Policy, with considerations being given to renewable energy (REEGLE, 2014a). In terms of renewable energy targets, only one country within this sub-region currently has some active targets set. There is no country with known wind-specific targets in the sub-region.

Table 3-7: Renewable energy targets in Central Africa

Renewable Energy General Targets		
Country	Target	Date
Gabon	More than 70% share in total electricity generation	2016
No Renewable Energy Targets		
Angola, Cameroon, Central African Republic, Chad, Congo Republic, Democratic Republic of Congo, Equatorial Guinea, and Sao Tome and Principe		

CURRENT AND PROJECTED STATE OF WIND ENERGY PROJECT DEPLOYMENT

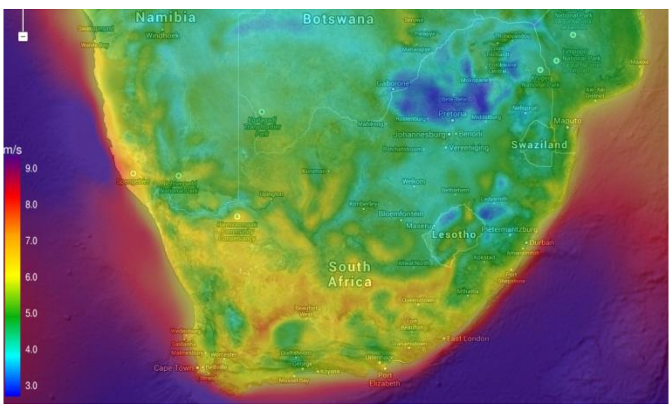
Central Africa lags behind the rest of sub-Saharan Africa in terms of installed wind capacity. The sub-region has no installed wind capacity except for a 2MW demonstration project developed with technical support from German firms and launched in Sao Tome and Principe's district of Caue in 2007 (REEGLE, 2014f). Besides that, the only other notable development within the sub-region in terms of wind power development is the 100MW of total wind capacity under assessment in Angola. No major initiatives with regard to wind power development were picked-up for the other seven remaining countries in central Africa.

4. SOUTH AFRICA'S MARKET AND ITS POTENTIAL

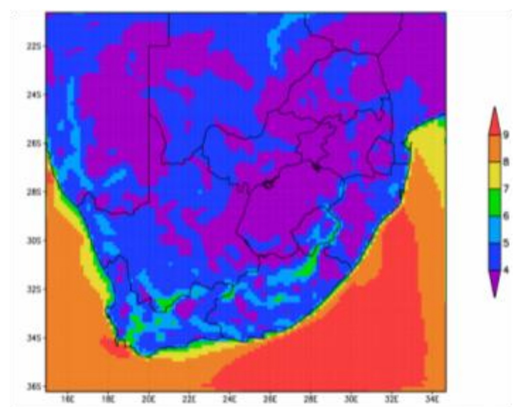
The purpose of this section is to determine the potential for large-scale wind energy project deployment in the country considering two prominent market segments, i.e. Renewable Energy Independent Power Producer Procurement Programme (RE IPPPP) and parties included outside RE IPPPP.

4.1 WIND ENERGY RESOURCE POTENTIAL

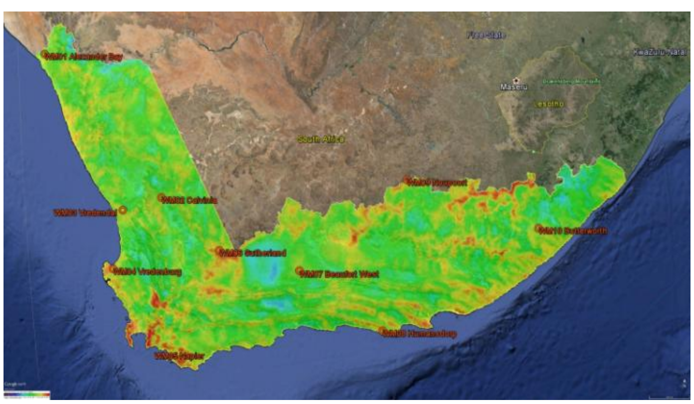
Several mesoscale models have been used to identify regions in South Africa where wind speeds are consistently high enough to be exploited. The three locally developed wind atlases (i.e. G7; WASA and EScience) as well as the Spanish Vortex all indicate that the most favourable regions are along the coasts of KwaZulu-Natal, Eastern Cape, Western Cape and Northern Cape provinces (see Figure 4-1). Deeper inland, large tracts of land in the Eastern Cape, Western Cape and Northern Cape provinces provide high potential. The three models that cover the entire country show a region of high wind speed in the northern region of the Eastern Cape just south of Lesotho. This is to be expected because of the high elevation of the region and the topography, often associated with an increase in wind speeds. A similar geographic feature causes the high wind speeds observed in the Cape Town Metro, Stellenbosch, and Paarl.



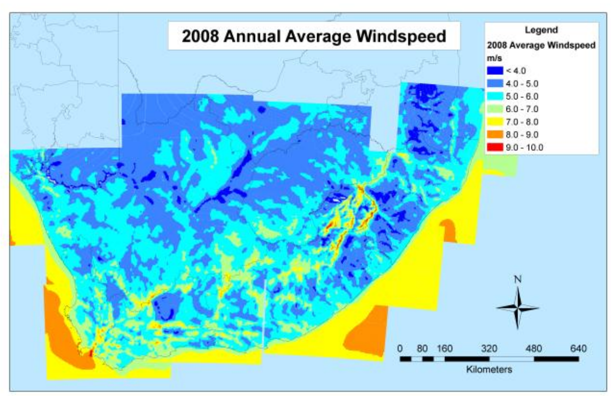
Vortex global wind atlas (www.vortex.es)



Dr K Hagemann wind atlas (www.g7energies.com)



WASA wind atlas (www.wasaproject.info)



EScience wind atlas (www.escience.co.za)

Figure 4-1: Meso-scale wind atlases of South Africa

The wind atlases depicted in Figure 4-1 in general indicate the regional wind climate at lower resolution (km scale resolution). The WASA project has subsequently developed the WASA Large Scale High Resolution Wind Resource map at a resolution of 250m (Figure 4-2). Unlike an atlas, the wind resource map depicts the local wind resource that a wind turbine would encounter at a particular location. It depicts the real wind resource (local wind climate) that is traceable to measured wind data. The WASA Large Scale High Resolution (250m) Wind Resource Map confirms that South Africa has an excellent wind resource that has been independently verified by WASA with the data, methods, and analysis that are publicly available.

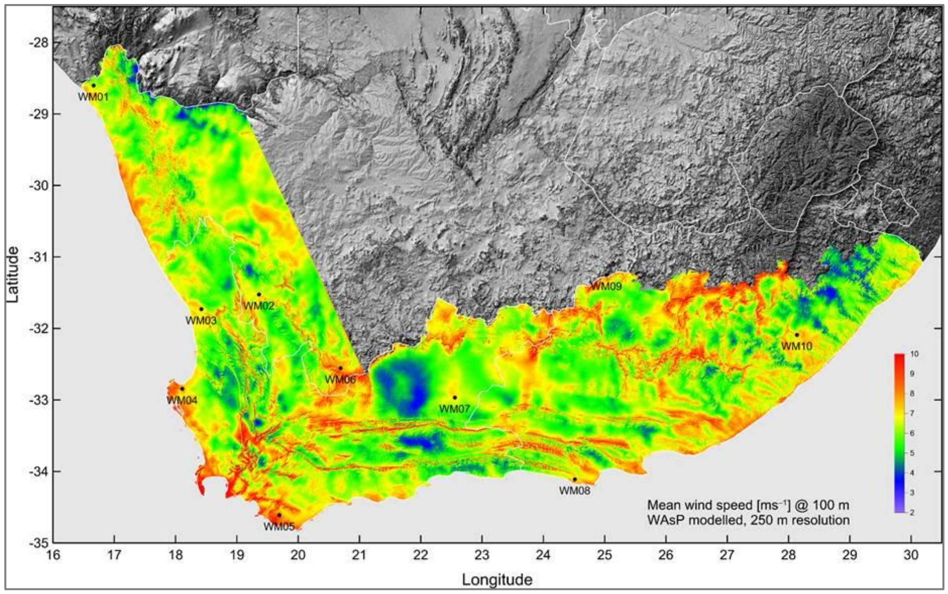
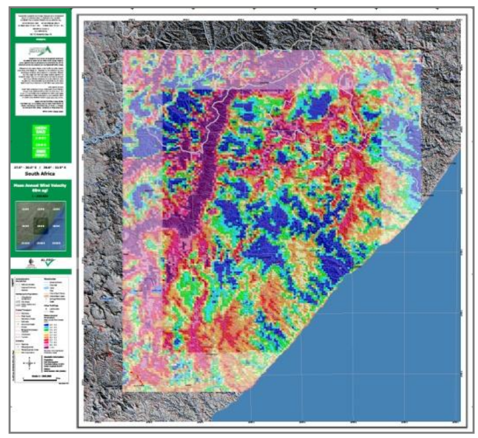


Figure 4-2: WASA Large Scale High Resolution Wind Resource map

In addition to the above mentioned atlases, the KwaZulu-Natal Wind Atlas has been developed to determine the mean wind speed of KZN and surrounding regions. A total of six wind maps were generated to cover the entire region. These GWS MESO wind maps give an overview of the wind quality which can be expected in the examined area. The maps are available at heights of 60m and 120m a.g.l and cover an area of approximately 200km x 300km (refer to example in Picture 4-1). The maps are publicly available for download on www.kzngreengrowth.co.za (KZN Green Growth).



Picture 4-1: KZN wind atlas map example (KZN Green Growth)

Coastal regions are in many instances prime locations for wind farms due to high wind speeds generated off shore, as well as constant and less variable sea breezes and land breezes. Several applications have been made for wind energy projects along the northern coast of the Northern Cape province between Alexander Bay and Port Nolloth. The Northern Cape province's low population density, especially along the coast, makes it an attractive proposition with a total of 1 500kW of energy generation in development. By contrast, the coast of KwaZulu-Natal is very densely populated making it more attractive for property developers rather than wind project development. This leads to a limited amount of land available for commercial wind farm projects and where it is available this would most likely be at a premium. Despite this there are wind project developments along the KZN province's northern coast where the population density is not as high as in the southern regions and most of the land is used for agricultural and industrial purposes.

There is sufficient correlation of wind speeds between the maps presented above to be used as a general prospecting tool. However, it must be noted that these are very high level data and that wind farm developers would possess data with higher levels of accuracy from ground-based measurement campaigns.

It is important though to distinguish between theoretical and practicable resource potential. Various physical and environmental constraints may prevent the maximum exploitation of the wind energy sources in any given area. These include, among others, terrain complexity, road access to potential sites, and proximity to grid infrastructure that determine economic feasibility of a wind project. K Hagemann's PhD thesis (2008) estimated that the integrated total wind potential in South Africa considering some of the constraining factors varied between 6GW for the pessimistic scenario using 60m hub height and 56GW for the optimistic scenario using 100m hub height. The extremely course resolution of this model makes the figures derived therefore at best conceptual. The criteria used to estimate this potential include, inter alia:

- Proximity to roads (minimum secondary)
- Proximity to transmission lines (>=66kV)
- Minimum capacity factor (2MW Vestas V80)
- Given hub height (60m, 80m or 100m)
- Density of 1 turbine per km^2 (accounts for siting issues)

Table 4-1: Total estimated wind resource potential in SA

Scenario	Max. roads distance	Max. transmission distance	Hub height	Min. capacity factor	Annual electricity generation		Capacity
Pessimistic	3 Km	3 Km	60 m	25%	10.0 TWh	8.7%	6 GW
Realistic	4 KM	4 Km	80 m	30%	80.5 TWh	35.1%	26 GW
Optimistic	5 KM	5 km	100 m	35%	157.2 TWh	68.5%	56 GW

(Hagemann, 2013)

Judging by the range of applications submitted to the Department of Environmental Affairs (DEA) for approval of wind energy projects, a minimum of 11.2GW could be deployed in addition to the projects that have already been approved for the RE IPPPP. Considering the information presented in the next table, the projects are largely concentrated in the three provinces, i.e. the Eastern Cape, the Western Cape, and the Northern Cape, which coincides with the areas of highest wind energy resource potential mentioned earlier.

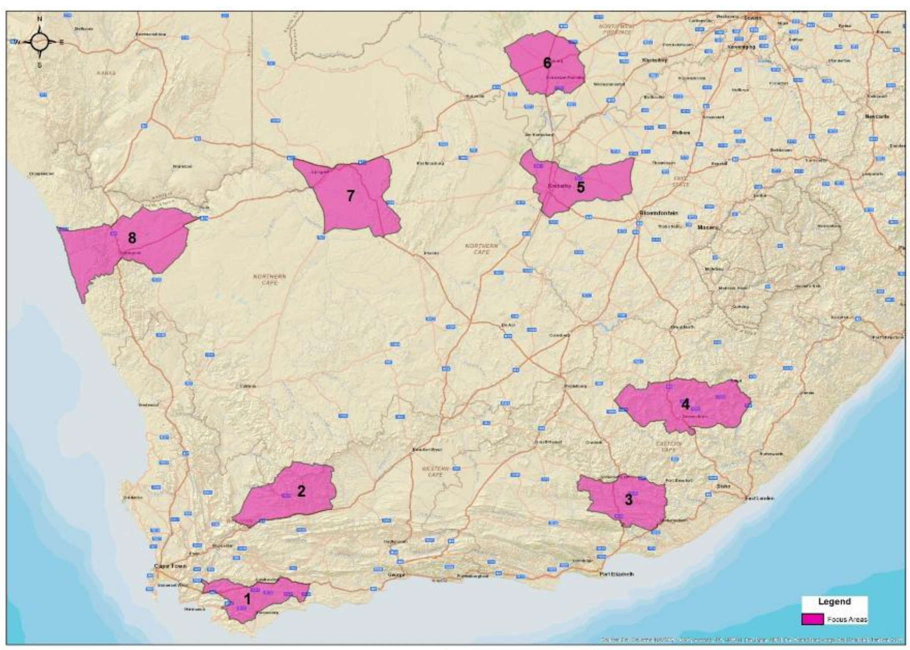
Table 4-2: DEAR wind energy projects applications excluding approved projects under RE IPPPP (MW, 2012)

Eastern Cape	4 431.7	Western Cape	4996.8
Blue Crane Route Local Municipality	1 948	Beaufort West Local Municipality	983
Buffalo City Metropolitan Municipality	70	Bergrivier Local Municipality	580
Camdeboo Local Municipality	200	Cederberg Local Municipality	19.2
Emalahleni Local Municipality	72	City of Cape Town MM	80
Gariep Local Municipality	80	Drakenstein Local Municipality	34.8
Great Kei Local Municipality	2.4	Hessequa Local Municipality	258
Inkwanca Local Municipality	829	Kannaland Local Municipality	0
Intsika Yethu Local Municipality	20	Laingsburg Local Municipality	1 050
King Sabata Dalindyebo	16	Matzikama Local Municipality	66
Kouga Local Municipality	240	Mossel Bay Local Municipality	546

Kou-Kamma Local Municipality	200	Overstrand Local Municipality	18
Lukanji Local Municipality	215	Saldanha Bay Local Municipality	923.8.
Makana Local Municipality	80.6	Swartland Local Municipality	256
Mhlontlo Local Municipality	0	Swellendam Local Municipality	315.8
Mnquma Local Municipality	39	Theewaterskloof Local Municipality	410
Nelson Mandela Bay Local Municipality	80	Witzenberg Local Municipality	380
Nelson Mandela Bay MM	236.2	**Northern Cape**	**1 336.1**
Nelson Mandela Metropolitan	37.5	Emthanjeni Local Municipality	0
Ngqushwa Local Municipality	66	Kamiesberg Local Municipality	7.2
Sakhisizwe Local Municipality	0	Karoo-Hoogland Local Municipality	150
Free State	**170**	KhΓi-Ma Local Municipality	0
Kopanong Local Municipality	170	Nama Khoi Local Municipality	151
KwaZulu-Natal	**170**	Renosterberg Local Municipality	50
The Big 5 False Bay Local Municipality	60	Richtersveld Local Municipality	120
uMhlathuze Local Municipality	110	Siyathemba Local Municipality	480
Mpumalanga	**99**	Ubuntu Local Municipality	197.9
Albert Luthuli Local Municipality	99	Umsobomvu Local Municipality	180
Grand Total		**11 204**	

Future extension of transmission lines infrastructure in the country is among the most critical physical constraining factors at the moment. In order inform and expedite investment in future grid infrastructure development by Eskom, as well as to streamline approvals, licensing, and permitting, the DEA has initiated the Strategic Environmental Assessment process for efficient an effective roll out of wind and Photovoltaic (PV) projects. It is aimed at "integrating environmental, economic and social factors to identify geographical areas (i.e. Renewable Energy Development Zones: REDZs) where in the medium to long term wind and solar PV development will have the lowest possible impact on the environment while yielding the highest possible social and economic benefit to the country" (CSIR, 2014).

At this stage, eight REDZ are being examined, which are presented on Map 4-1. The process is planned to be completed by the end of 2014, after which the REDZ will be submitted for Cabinet's approval. It should be noted though that this initiative has not been supported by all stakeholders and a number of concerns have been raised at Windaba 2013. Importantly, though,



Map 4-1: National wind and solar focus areas for proposed REDZ (DEA/CSIR, 2014)

if REDZ are approved they will not restrict development of wind energy projects in other parts of the country (CSIR, 2014).

4.2 GENERAL POLICY LANDSCAPE

The use of renewable energy, particularly wind power, is well supported and articulated in a wide range of South African policy documents. The **White Paper on Renewable Energy** adopted in 2003 set a 10 000GWh target for renewable energy contribution in final energy consumption in the country by 2013 (Department of Minerals and Energy, 2003). The use of wind power and other renewables in meeting the set target is explicitly expressed in the White Paper.

Since then, many other policies have been adopted in the country to promote the use of renewable energy in the electricity production energy mix.

- As a remedy to climate change and the associated consequences, the **National Climate Change Response White Paper** of 2011 supports the diversification of the energy mix through the adoption of renewables (The Government of the Republic of South Africa, 2011). The White Paper sets up a Renewable Energy Flagship Programme meant not only to promote the use of renewables but also to scale-up the adoption of renewable energy in the country.
- Renewable energy and development of the associated green economy was identified by the Presidency, through the release of the **New Growth Path (NGP) Framework (2010)**, as one of the key means to address socioeconomic imbalances in the country.
- Following the NGP, government went further to release the **Green Economy Accord** that reflects one of the four outcomes of the social dialogue on the NGP. Through this Green Economy Accord, government commits to the procurement and securing the supply of 3 725MW of renewable energy by 2016 (Ministry of Economic Development, 2011). To promote job creation, the Accord lays out how the government intends to promote localisation (of the manufacturing of components), research and development, and skills development in the renewable energy sector.
- South Africa's Vision 2030 as portrayed in the **National Development Plan** (NDP) further reveals the government's long-term commitment to contract more than 20 000MW of renewable energy by 2030 in order to cater for projected demand and a set-out electrification target of 95% (National Planning Commission, 2011). According to the plan, South Africa will need to meet about 29 000MW of additional power demand between now and 2030. However, about 40 000MW of new installed capacity needs to be built within the next 20 years since 10 900MW of old power capacity will be retired.
- Government has since adopted the Integrated Resource Plan (IRP) as a policy instrument that helps plan South Africa's electricity capacity until 2030. The first **IRP (2010-2030)** promulgated in 2011 envisaged establishing 17.8GW of renewable energy capacity by 2030 (Department of Energy , 2011). The IRP provides for 9 200MW of wind energy by 2030. To reach that target, 400MW of wind power would be connected to the grid every year until 2024 where the annual capacity targets change upwards.
- Since the IRP is a living plan that was expected to be continually revised, the Department of Energy (DOE) has since developed a **draft update of the IRP 2010-2030,** which was released in November 2013. The draft updated IRP, however, predicts a lower-than-expected increase in future demand for electricity due to the downgraded economic forecast. As such, it provides for a reduced wind power

capacity by 2030. Wind capacity was reduced from the initial 9 200MW, published in IRP 2011, to 4 360MW under the base case scenario (Department of Energy, 2013a). It remains to be seen how such a change in envisaged wind capacity will affect the wind market in general. Some are already of the opinion that the revision is likely to negatively affect the wind industry as it comes as a disincentive to potential investors who have been eyeing the potential policy-backed growth of the South African wind market.

To complement the government's policy framework that promotes and champions the effective use of renewable energy in the country, 2011 saw the DOE introducing a competitive bidding process called the Renewable Energy Independent Power Producer Procurement Program (RE IPPPP). This bidding system is meant to involve the private sector into the power generation industry, a sector that has been under state monopoly for decades. The RE IPPPP and other opportunities for large-scale wind project development in the country are discussed in the following sections.

4.3 OPPORTUNITIES FOR WIND PROJECT DEVELOPMENTS UNDER RE IPPPP

Considering the structure of South Africa's utility sector and the electricity generation landscape, two distinct segments can be differentiated, i.e. RE IPPPP and opportunities for large-scale wind energy projects outside RE IPPP, such as private power generation that requires wheeling and power generation for sale to the ISMO. This section discusses opportunities presented by the RE IPPPP.

In 2009, the government explored Feed in Tariffs (FITs) for renewable energy through the Renewable Energy FIT (REFIT) policy approved by the National Energy Regulator of South Africa (NERSA). REFIT programme Phase 1 and 2, though, were repealed in 2011 in favour of a competitive bidding system. According to some reports, there is no documented evidence showing the success of the REFIT programme in generating additional electricity capacity into the grid (PPIAF, 2014). In accordance with the IRP, a competitive bidding system known as the RE IPPPP was adopted in 2011. The first Request for Proposals (RFP) was published in August 2011. The RE IPPPP is a private bidding system for private sector players engaging in renewable energy.

Compliant bids are evaluated on the basis of price and economic development, with allocations of 70 and 30 points out of 100, respectively. Preferred bidders enter into a 20-year Power Purchase Agreement (PPA) with Eskom backed by the National Treasury, as well as an Implementation Agreement with the government through the DOE. The RE IPPPP was originally designed to contribute towards the target of achieving 3 725MW of renewable energy capacity by 2016 and to stimulate socioeconomic and environmentally sustainable growth. Since then, government announced the intention to source an additional 3 200MW of green power by 2020, which means that the total expected renewable energy installed capacity in the country would equate to 6 925MW.

CURRENT STATUS OF RE IPPPP

The programme is conducted in tender rounds known as Bid Windows, which initially envisaged would comprise of five rounds. To date, three bid windows have already been completed and a total capacity of 3 916MW has so far been allocated across different renewable technologies. The whole bidding process evolved as the rounds went by, resulting in increased competition and stricter requirements.

- In the first round, 53 bids for 2 128MW of power generating capacity for all renewable technologies were received. Only 28 bidders from wind, PV and CSP technologies were selected and awarded a total capacity of 1 416MW for a total investment of around R47.8 billion. The prices set in the first round were a bit higher relative to the other rounds, with the average tariff for wind energy projects being R1.14/kWh. All approved projects reached financial closure in November 2012.
- Round 2 was characterised by stringent requirements from the department meant to tighten the procurement process, thus invoking a greater competition among the bidders. This saw the reduction in amount of power to be acquired as well as the prices. The average tariff for wind projects fell below the R1 mark - dropping as far as R0.90/kWh. In general, 79 bids for 3 233MW were received. Of these, 19 were selected and awarded a total capacity of 1 044MW for a total investment of around R28 billion. These projects reached financial closure in May 2013.
- In Round 3, prices continued to fall and the total allocated capacity again declined compared to the previous rounds. Average tariffs for wind projects dropped down further to R0.74/kWh. A total of 93 bids worth 6 023MW of installed capacity were received but only 17 bidders were awarded preferred status. They represented a total capacity of 1 460MW for a total investment of almost R44.4 billion. There was a multi-stakeholder involvement in the three bid rounds that saw domestic and international project developers, sponsors and equity shareholders all taking part in this programme. In terms of project finance, the majority of debt funding came from commercial banks (R57 billion), followed by Development Finance Institutions (R27.8 billion) and lastly Pension and Insurance Funds (R4.7 billion) (PPIAF, 2014). It is further reported that 86% of debt would be raised within South Africa alone. Financial closure for these projects was extended to November 2014 from July 2014.
- Following the success of the third round, government had requested to submit additional bids for 200MW allocation for CSP projects by March 2014, i.e. Round 3.5. Three bids were received and at the time of compilation of this report, the DOE was still in the process of finalising the approvals. The financial closure for these projects is set for February 2015.
- Round 4 submissions took place on 18 August, 2014. However, the announcement of bidders has been postponed from the original date of October 2014. About 1 105MW is allocated for Bid window 4, of which 590MW is expected to be assigned for onshore wind.

Table 4-3 gives a snapshot of the current project status for all the renewable technologies considering the completed three bid rounds of the RE IPPPP. In terms of the total capacity allocated thus far, wind power leads among all other renewable technologies with a capacity allocation of 1 984MW, followed by Solar PV with 1 484MW. Overall, a total of 3 916MW has been allocated, which is higher than the 3 725MW planned to be built by 2016; however considering that CSP projects approved under Round 3 will take about two years to be built and the projects are still to reach financial closure, it is likely that they will only be built post-2016 and the actual installed capacity reached by 2016 will be smaller than that allocated under bid rounds.

Table 4-3: RE IPPPP project status as of Bid Window 1, Bid Window 2 and Bid Window 3

Technology	1st Bid Window		2nd Bid Window		3rd Bid Window		Total (MW)
	Capacity Allocated (MW)	*Projects Awarded*	*Capacity Allocated (MW)*	*Projects Awarded*	*Capacity Allocated (MW)*	*Projects Awarded*	
Wind	634	8	563	7	787	7	1 984
Solar photovoltaic	632	18	417	9	435	6	1484

Technology	1st Bid Window		2nd Bid Window		3rd Bid Window		Total (MW)
	Capacity Allocated (MW)	*Projects Awarded*	*Capacity Allocated (MW)*	*Projects Awarded*	*Capacity Allocated (MW)*	*Projects Awarded*	
Concentrated solar	150	2	50	1	200	2	400
Small hydro	0	0	14	2	0	0	14
Landfill gas	0	0	0	0	18	1	18
Biomass	0	0	0	0	16	1	16
Biogas	0	0	0	0	0	0	0
Total	**1 416**	**28**	**1 044**	**19**	**1 456**	**17**	**3 916**

Source: Derived from DoE Presentations and PPIAF, 2014

Several projects approved under Round 1 are already supplying power to the grid, while the majority are due for connection during the course of 2014 (Department of Energy, 2013b). At the time of writing this report (i.e. August 2014), at least two of the wind projects approved under Round 1 (i.e. the 138MW Jeffreys Bay Wind Farm and 65.4MW Hopefield Wind Farm) were already commissioned and supplying electricity to the grid. Regarding Round 2 projects, most of these are still under construction and are due for connection into the grid around the 2016-2017 period (Department of Energy, 2013b). Bid Window 3 procurement documents were released on May 3 2013 and preferred bidders were notified in October 2013. Once these projects reach financial closure, they are expected to be in operation by the end of 2017 with the exception of CSP projects tagged with an end of 2018 date.

WIND ENERGY PROJECTS APPROVED UNDER RE IPPPP TO THIS DATE (BID WINDOWS 1, 2, AND 3)

Wind energy projects approved under the three rounds equate to a total capacity of 1 984MW and are distributed across 22 projects with a total reported investment value of approximately R41.2 billion. All 22 wind projects are located in three out of the nine South African provinces. As shown in **Error! Reference source not found.**, the majority of the projects are in the Eastern Cape (12), followed by the Northern Cape (6) and lastly Western Cape (4).

Window 1		Window 2		Window 3	
#	**MW**	**#**	**MW**	**#**	**MW**
1	135	9	137.9	16	138
2	26.2	10	20.6	17	138
3	97	11	135.2	18	139
4	65.4	12	59.8	19	96
5	133.9	13	94.8	20	87
6	26.2	14	23.4	21	79
7	72.8	15	90.8	22	110
8	77.6				

Total Capacity Allocated per Bid Window		
Window 1	*Window 2*	*Window 3*
634 MW	563 MW	787 MW
Number of Wind Projects Awarded per Province		
Eastern Cape	*Northern Cape*	*Western Cape*
12	6	4
Total Wind Capacity Allocated per Province		
Eastern Cape	*Northern Cape*	*Western Cape*
1 003 MW	663 MW	318 MW

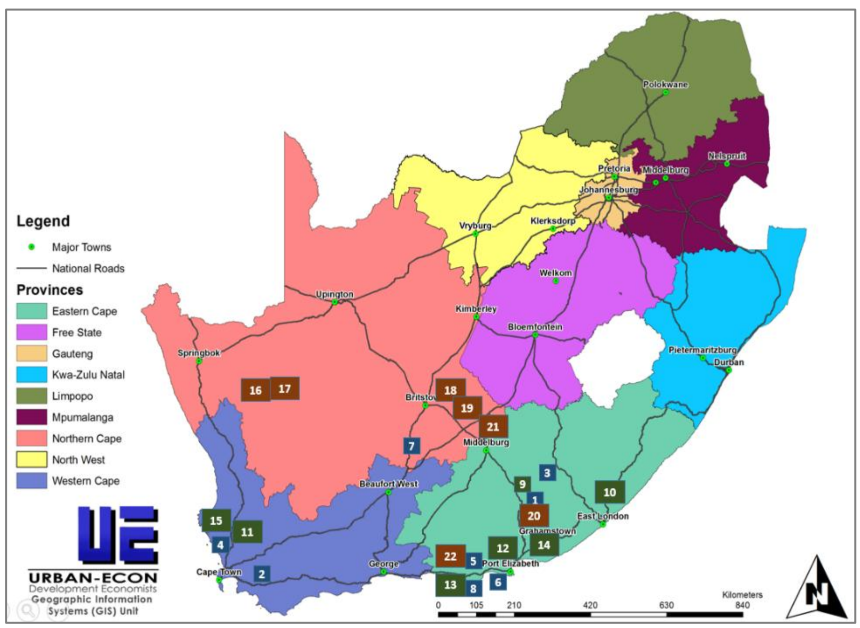


Figure 4-3: Spatial distribution of wind projects approved under RE IPPPP first three rounds

The next table presents detailed information on each of the 22 preferred wind projects. It shows that the town of Port Elizabeth located in the Eastern Cape has the most number of wind projects within the vicinity compared to any other towns in South Africa. The table reveals that the biggest wind project, so far, is the Longyuan Mulilo De Aar 2 North Wind Energy Facility in the Northern Cape with a total capacity of 139MW awarded during the Bid Window 3. The smallest wind project is the Chaba Wind Farm to be built in the Eastern Cape with a capacity of 20.6MW awarded during Bid Window 2. Bid Window 3 has the highest average wind project capacity (112.4MW), followed by Bid Window 2 (80.4MW), and lastly Bid Window 1 (79.25MW). All in all, the average project capacity awarded to wind power in all the three rounds combined is 90MW.

Table 4-4: RE IPPPP Wind Projects

RE IPPPP Window 1				
WF	*Wind Farm*	*MW*	*Closest Town*	*Province*
1	Cookhouse Wind Farm	135	Cookhouse	Eastern Cape
2	Dassiesklip Wind Energy Facility	26.2	Caledon	Western Cape
3	Dorper Wind Farm	97	Molteno/Sterkstoom	Eastern Cape
4	Hopefield Wind Farm	65.4	Hopefield	Western Cape
5	Jeffreys Bay	133.9	Jeffreys Bay	Eastern Cape
6	MetroWind Van Stadens Wind Farm	26.2	Port Elizabeth	Eastern Cape
7	Noblesfontein	72.8	Noblesfontein	Northern Cape
8	Red Cap Kouga Wind Farm - Oyster Bay	77.6	Port Elizabeth	Eastern Cape
RE IPPPP Window 2				
WF	*Wind Farm*	*MW*	*Closest Town*	*Province*
9	Amakhala Emoyeni (Phase 1)	137.9	Bedford	Eastern Cape
10	Chaba	20.6	Komga	Eastern Cape
11	Gouda Wind Facility	135.2	Gouda	Western Cape
12	Grassridge	59.8	Port Elizabeth	Eastern Cape
13	Tsitsikamma Community Wind Farm	94.8	Tsitsikamma	Eastern Cape
14	Waainek	23.4	Grahamstown	Eastern Cape
15	West Coast 1	90.8	Vredenburg	Western Cape
RE IPPPP Window 3				
WF	*Wind Farm*	*MW*	*Closest Town*	*Province*
16	Khobab Wind Farm	138	Loeriesfontein	Northern Cape
17	Loeriesfontein 2 Wind Farm	138	Loeriesfontein	Northern Cape
18	Longyuan Mulilo De Aar 2 North Wind Energy Facility	139	De Aar	Northern Cape
19	Longyuan Mulilo De Aar Maanhaarberg Wind Energy Facility	96	De Aar	Northern Cape
20	Nojoli Wind Farm	87	Riebeek East	Eastern Cape
21	Noupoort Mainstream Wind	79	Noupoort	Northern Cape
22	Red Cap - Gibson Bay	110	St Francis Bay	Eastern Cape

Envisaged future roll-out as per the IRP (2011) and the updated IRP (2013)

As indicated earlier, government has already announced the intention to procure an additional 3 200MW of renewable energy projects by 2020 in addition to the 3 725MW to be built by 2016. Roll-out of wind projects beyond that would be expected to follow the commitments made by government in the current and future revised IRPs.

In 2011, government promulgated IRP 2010. Since then, it has updated the plan and released the new version in November 2013; however, that version is yet to be approved, which means that it cannot yet be considered the new plan. Nonetheless, it should be acknowledged that the economic trajectory post promulgated IRP 2010 has shifted downwards and the envisaged new required capacities planned under IRP 2010 most likely reflect a very optimistic scenario. The upgraded draft IRP takes into account the poorer-than-expected performance of the domestic economy in the last few years and the new economic outlook, which means that it may reflect a more realistic scenario as far as future electricity demand is concerned. In this context, it is important to review both of the IRP versions to inform future wind project development scenarios.

Potential wind project developments following promulgated IRP (2011)

As highlighted earlier, a total wind power capacity target of 9 200MW was set for 2030 in the IRP promulgated in 2011. The 9 200MW target is inclusive of Eskom's 100MW Sere Wind Farm and 700MW committed build for wind projects at the time of promulgation of the IRP 2010. Considering that 1 934MW has already been awarded through the RE IPPPP, it can be suggested that approximately 20% of this target has already been achieved. This in turn means that if the target set in the promulgated IRP 2010 remains, an additional 7 116MW remains to be awarded to different wind projects in order to meet the 2030 total wind capacity target of 9 200MW. Furthermore, according to the promulgated IRP 2010, 2 000MW of wind projects were to be connected to the grid by 2016, which, considering the first three bid windows and the average construction period of wind projects will most likely be achieved by 2016 but could be extended to 2017. Nonetheless, this suggests that no major changes to the future allocations will need to be made and they are likely to follow the IRP, i.e. about 400MW of wind projects per annum until 2024 and between 400MW and 1 600MW per annum thereafter.

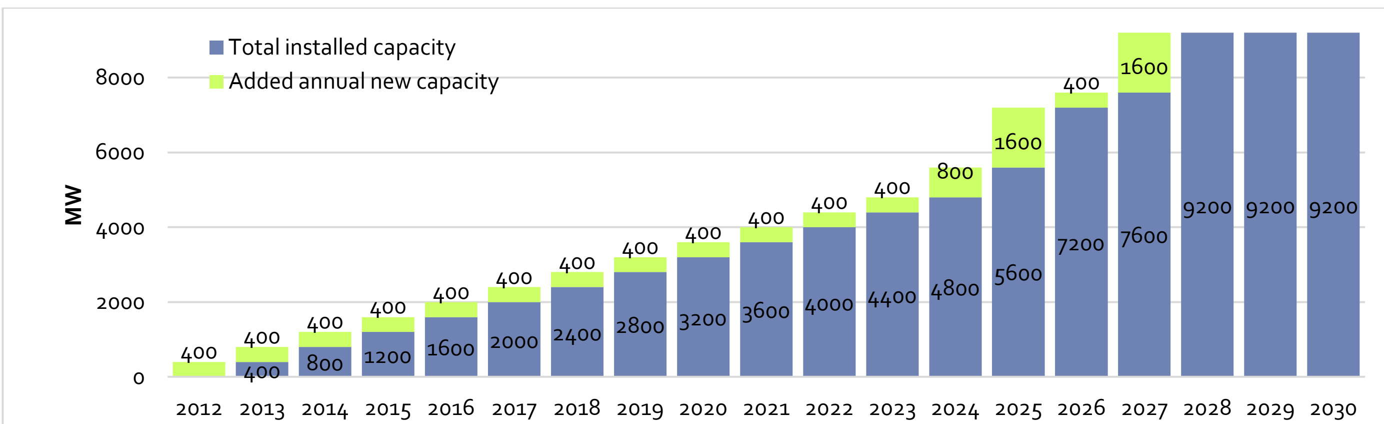


Figure 4-4: Envisaged future roll-out of wind power projects based on IRP promulgated in 2011

Potential wind project developments following updated IRP (2013) (including Sere Wind of Eskom)

The draft updated IRP (2013) suggests a number of scenarios that heavily contradict previous wind allocations. It already created significant concerns in the industry that negatively impacted on decisions of some of the industry players.

- If the updated IRP (2013) is passed and the government makes use of the proposed base case scenario, future roll-out of wind projects would be expected to decrease significantly due to the revised required new capacities and subsequently amended share of wind projects. The base case scenario assumes allocation of only 4 360MW to wind projects. A total wind power capacity of 1 984MW from 22 RE IPPPP projects should be connected to the grid by the 2016-2017. Therefore, the updated draft IRP suggests that only 2 376MW of wind power capacity remains to be awarded to different projects until 2030. The future roll-out of wind power projects would thus be envisaged to be considerably lower relative to that of the IRP promulgated in 2011.

- At the same time, it recommends to continue with annual procurement processes for 1 000MW of wind until the capacity is reached; however, it is unclear as to which capacity targets it refers. None of the scenarios included in the draft updated IRP (2013) reflect this recommendation as annual planned increases in wind energy generation capacity are below 1 000MW and none of the scenarios imply deployment of new projects until 2022. As suggested by the base case scenario, for example, and outlined in Figure 4-5, no new allocations will be made between 2014 and 2021, which implies that for eight years there will be no market for wind energy manufacturers in South Africa. This suggests that under this scenario the demand for wind energy project components in the near future will be limited to projects approved under Round 2 and only extend until 2017 while they are being built. Thereafter, no projects will be built until 2021, which would then need to come online in 2023. Importantly, the scenarios completely disregard the approved projects under Round 3, as the report was compiled at the time when no commitments were yet made, which means that they are already outdated.

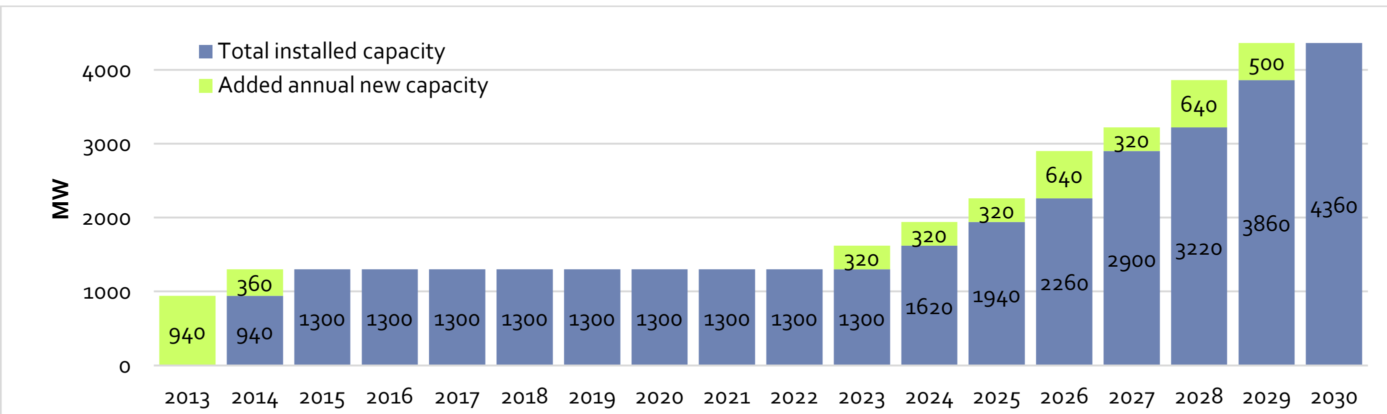


Figure 4-5: Envisaged future roll-out of wind power projects based on updated draft IRP released in 2013

Summary of promulgated IRP 2010 and updated draft IRP

The following table summarises the future potential roll out of wind energy projects in the country considering the promulgated IRP 2010 and the updated draft IRP. Overall, it is clear that the updated draft IRP assumes a considerably smaller allocation (almost three times smaller) of future installed capacities to be taken up by wind projects compared to the IRP 2010. It is understood that SAWEA and other groups have called for a review of the Updated Draft IRP2010 targets.

Table 4-5: Summary of potential future wind project roll out considering promulgated IRP 2010 and updated draft IRP

Indicator	IRP 2011	Updated IRP 2013
	MW	*MW*
2030 Wind Power Target	9 100 (excluding Sere Wind Farm)	4 360
REIPPPP Awarded (Round 1, 2, 3)	1 984	1 984
Total Capacity Remaining	7 116	2 376

4.4 WIND PROJECT DEVELOPMENT OUTSIDE OF ESKOM GENERATION AND THE RE IPPPP

The development of new wind power generation projects can also occur outside of Eskom generation and the RE IPPPP. This will largely be driven by:

- Independent Power Producers (IPPs) that manage to secure private Power Purchasing Agreements (PPAs) with commercial and industrial/mining customers or develop off-grid projects; and
- Local authorities that develop their own grid projects either themselves or provide a conducive regulatory environment for private IPPs to develop municipal grid-tied or off-grid projects.

The following sections investigate the above-mentioned options in greater detail. They provide scenarios for potential future project uptake and analyse the regulatory environment, current state of affairs, and general opportunities.

POTENTIAL FOR DEPLOYMENT OF WIND ENERGY PROJECTS OUTSIDE RE IPPPP

In order to estimate the potential for development of wind projects outside RE IPPPP and Eskom generation, a few assumptions were developed that allowed formulation of various scenarios. The following approach was followed:

- Firstly, total electricity demand by 2030 was sourced from the updated draft IRP (2013). The rationale for choosing the updated draft IRP despite it not yet being promulgated lies in the need to consider a more realistic scenario than the one presented in IRP 2010 promulgated in 2010, which was deemed to present overestimated electricity demand, considering recent economic growth rates.
- Secondly, five different assumptions for IPP electricity generation were created (i.e. 5%, 10%, 15%, 20%, and 25%) as scenarios of potential electricity generation capacity created outside of Eskom and the RE IPPPP.
- Thereafter, considering that the electricity generated outside Eskom and RE IPPPP can be produced using various technologies, three additional scenarios were considered that reflected the potential penetration of wind energy in generation capacities in this instance. These referred to 5%, 10%, and 15%.
- Lastly, the combination of 5% of uptake outside Eskom and RE IPPPP and 5% of wind energy penetration reflected a low scenario. The medium scenario assumes that 15% of new generation will come from outside Eskom or RE IPPPP, and that wind power will achieve a 10% penetration. The combination of 25% of uptake outside Eskom and RE IPPPP, and 15% of wind energy penetration reflected a high scenario.

Based on the above assumptions and as outlined in the table below, there is potential to develop between 458MW and 6 870MW of wind energy projects outside of Eskom generation and the RE IPPPP.

Table 4-6: Wind Generation Potential outside of Eskom generation and RE IPPPP by 2030

Total electricity demand 2030 (GWh)	% of electricity generated by renewables excluding Eskom and RE IPPPP	Wind energy penetration (MW)		
		5%	10%	15%
401 268	5%	458 (Low)	916	1 374
	10%	916	1 832	2 748
	15%	1 374	2 748 (Medium)	4 123

Total electricity demand 2030 (GWh)	% of electricity generated by renewables excluding Eskom and RE IPPPP	Wind energy penetration (MW)		
		5%	10%	15%
	20%	1 832	3 664	5 496
	25%	2 290	4 580	6 870 (High)

Regulatory environment determining potential for wind project deployment outside the RE IPPPP

The market comprising of opportunities presented outside Eskom generation and RE IPPPP includes private utilities or generators (i.e. IPPs), municipalities, electricity retailers, distributors or aggregators as well as consumers of electricity. The regulatory landscape is the key factor affecting the development of this market; however, other contributing factors include the drive towards a green economy to address climate change issues and create new jobs. Although grid infrastructure is necessary for the development of this market segment, the role-players interviewed indicated that at present this is not a major obstacle as the projects are not of the scale of those within the RE IPPPP and typically involve large power users, where intervention is only required at substation level and distributed grid systems that are independent of the Eskom grid.

ISMO Bill

The 1998 Energy White Paper (EWP) clearly sets out the direction and policy measures necessary to ensure the future and security of South Africa's electricity supply. Government will encourage competition, remove distortions, and encourage energy prices to be as cost-reflective as possible. It will also work towards an investor-friendly climate, restructure Eskom into separate generation and transmission companies and divide the power stations into a number of companies to enable competition in generation.

The EWP (1998) says that to improve efficiencies and reduce prices, government will have to consider giving customers the right to choose their supplier and encourage private sector participation and competition via IPPs in the generation sector and open access to the transmission system. According to the EWP (1998), the government also needs to allow licensed, privately owned distributors to co-exist alongside other public and private distributors to distribute their own generated electricity, subject to approval by the national energy regulator.

The National Development Plan 2030 (NDP) reflects the policy in the Energy White Paper and says legislation is required for transmission lines to provide for non-discriminatory open access and, where appropriate, to encourage competitive markets and greater opportunities for investors to provide innovative solutions. The NDP says that the economy urgently needs increased competition in electricity generation, that gas should be explored and new generation capacity should be divided between Eskom and IPPs.

For RE IPPs, Eskom remains the single buyer of electricity (with the exception of off-grid installation). The possibility for IPPs to sell electricity directly to third parties, particularly energy-intensive industries seeking to secure low-cost and consistent supply, is currently limited. Since Eskom has a monopoly on buying power in the country, consumers are not in a position to neither contribute to, nor benefit from, competition on the generation market. Private producers would not be able to compete on the price against Eskom's special purchase agreements with energy-intensive firms that offer substantial discounts. Nonetheless, while not able to compete on the price, IPPs' competitive advantage when compared to Eskom is in supplying clean and/or consistent energy supply.

In order to ensure an equitable electricity market, government proposed the establishment of the Independent System and Market Operator (ISMO). An ISMO Bill has been drafted with the objective of establishing an autonomous state-owned company mandated to undertake the development of the generation resource planning, purchasing of power from generation facilities, and enabling electricity trading at a wholesale level. Specifically, the ISMO has the objective of trading electricity on a willing buyer/willing seller basis, which may liberate trading of electricity. The ISMO Bill intends to provide for open and non-discriminatory access to the transmission grid, regulatory certainty to the buyer regarding cost recovery and a fair return on investment, as well as government support to underpin the risks associated with power purchase agreements.

Subject to passing the ISMO Bill, and thus enabling the trading of electricity on a willing buyer/willing seller basis, the costs and complexity of current wheeling arrangements will fall away. Aside from creating opportunities for establishing IPPs, this may also allow communities to become more involved in the renewable energy market (beyond their current equity stake in RE IPPPP projects) either through development of renewable energy projects on communal land or by forming partnerships with the private sector to establish projects for the utility-scale market by selling electricity to the market through the ISMO.

While the ISMO Bill has been discussed and agreed on by the Portfolio Committee on Energy on two occasions, it has been stalled in Parliament, being removed from the National Assembly Order Paper twice: in June and November 2013. In March 2014, the motion to revive the ISMO Bill was once again dismissed and it was later announced that it will be dealt with after elections on 7 May 2014. During the State of the Nation Address, President Jacob Zuma committed to bring the Bill back to Parliament so as to pass and implement its provisions.

Wheeling of power

Wheeling agreements allow two-way trade between a generator (the seller) and an off-taker (the buyer), using the network to transport the power produced. The seller and buyer sign a PPA and require a third party (i.e. owner of the network) to transport the electricity from the seller to the buyer – this is described as wheeling. This wheeled power is injected by the seller into the network and extracted by the buyer at the point of delivery (POD). A wheeling agreement defines the unique use-of-system (UOS) charges with the seller and network operator per project.

The Electricity Regulation Act (Act No. 40 of 2006) requires that the transmission or distribution function shall provide non-discriminatory network access to all users of the transmission and/or distribution system. Wheeling of power using Eskom or a distributor's network is thus allowed in South Africa. However, it is subject to the necessary regulatory approvals, and NERSA has drawn up guidelines and regulations covering the technical and charging aspects involved, namely "Rules on network charges for third party transportation of energy" (NERSA, 2011).

It is reported that the National Energy Regulator of South Africa (NERSA) will release a consultation paper in February 2015 outlining the possible regulatory framework for "distributed power generation". NERSA is also finalising a consultation paper on the revision of the existing third-party access, or wheeling rules. These regulations are necessary for those entities that want to build a power station in one area, but use Eskom or municipal infrastructure in order to consume that electricity in another location. NERSA expects this consultation paper to be published before the end of 2014.

Notwithstanding the above, NERSA's 2012 *Regulatory rules on network charges for the third party transportation of energy* state that "the application of UOS tariffs allows for the recovery of the fixed and Operation and Maintenance (O&M) costs, recovery of transmission losses as well as costs for ancillary services procured by the System Operator". Depending on where the power plant is located, the seller will incur UOS charges at each point of the network, hence the closer the seller is to the buyer the less it will cost to wheel electricity over municipal and/or Eskom networks.

The billing system in wheeling arrangements is another important aspect that should be considered. All metering should be of the bi-directional, 4-quadrant type in line with NRS 057. NRS 057 specifies procedures and standards to be adhered to by electricity licensees and agents in operating and servicing new and existing metering installations that are to be used for billing purposes. It is applicable to metering installations in their entirety, including all measuring transformers, wiring, cabling, metering panel construction, active and reactive meters, data loggers and associated test facilities.

POTENTIAL FOR PRIVATE PPAS

The major hurdle to development of private PPAs in the country in the past has been the policy and regulatory environment, i.e. with Eskom being the single buyer and no room for a "willing buyer, willing seller" model. In the last decade a space has evolved allowing for creation of an alternative model, which is based on a small voluntary market for renewable energy outside of the RE IPPPP and which has been made possible through a partnership with municipal structures. Nonetheless, through the discussion with the industry participants, companies entering the market face the following general challenges:

- Highly regulated market
- Large power users (industry and commercial) are required to have very long-term view on energy
- Difficult to secure bank funding for projects as loan tenure is normally longer than PPA duration
- Municipalities reluctant to give up some of their revenue from electricity sales
- Eskom competition – Eskom supplies large power users at highly discounted tariffs – The introduction of an ISMO will level the playing field by eliminating this potential bias
- Until grid parity is reached, customers reluctant to pay more for "green energy", therefore incentives are required to facilitate the growth of this sector

Within the current regulatory environment, there a few IPPs that have managed to secure PPAs outside of the RE IPPP. These are largely made up of PPAs with large power users in an embedded generation configuration. In recent times there have, however, been more and more short-term PPAs being signed with municipalities where the generator is able to provide the power at rates cheaper than Eskom's Megaflex tariff. The inability of municipalities to provide long-term PPAs due to policy and regulatory constraints has restricted the uptake of this market opportunity by private developers who face financing challenges with short-term PPAs.

Currently, only two wind energy generators, Electrawinds/Fluopro JV and Darling National Demonstration Wind Farm, hold long-term PPAs outside of the RE IPPPP (SAWEA, 2014) (AmatolaGreenPower, 2014) (DOE, 2014). Electrawinds/Fluopro JV has a PPA with Amatola Green Power, while Darling National Demonstration Wind Farm has a 20-year PPA with the City of Cape Town and Power Wheeling Agreement with Eskom.

Amatola Green Power is the first and currently the only private sector energy trader authorised by NERSA to buy and sell renewable energy in South Africa. Amatola Green Power is independent from Eskom and local municipalities, and trades in clean energy by connecting willing buyers to willing sellers as shown in Figure 4-6. Even though at this stage this alternative model remains limited to a single company only, it does open up the opportunity for IPPs to sell to customers outside of Eskom and demonstrates the potential for a voluntary market, especially in partnership with local governments, to further develop renewable energy in South Africa.

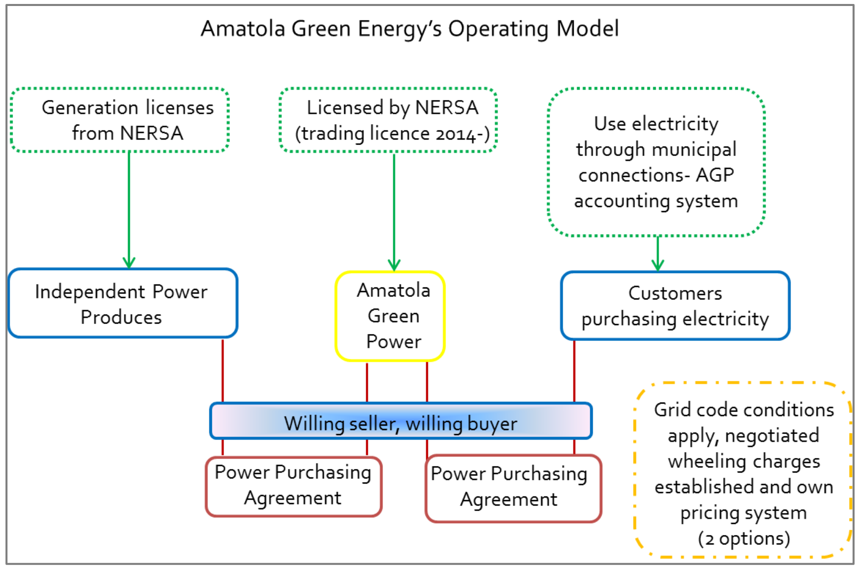


Figure 4-6: Amatola Green Energy Operating Model (Trade and Industrial Policy Strategies, 2014)

PPAs negotiated by Amatola Green Power are for periods between five and 20 years, on a "take-or-pay basis" (i.e. customers are required to purchase a certain amount of green energy and pay for the supplied electricity that they use or don't use). Binding PPAs offer to generators a guarantee of purchase of up to 50% of the contracted amount.

Key to ensuring sustainability of the business under this business model is the competitive pricing of the renewable energy and the partnerships with municipal institutions which make trading possible. Demand for renewable energy from industrial customers (i.e. outside of the RE IPPPP) and competitively priced supply have enabled the development of this market on a small scale. In the case of Amatola Green Power, the success of the business model has been based on the positive relationship between the company and the Nelson Mandela Bay Municipality, as well as the efficient and effective billing and accounting system set up by Amatola Green Power. Affordable wheeling rates have also contributed to the selling price remaining competitive.

Even though this alternative model remains limited to Amatola Green Power at this stage, more trading companies are set to enter the market in the near future. This demonstrates the potential for a voluntary market, especially in partnership with local governments, to further develop renewable energy in South Africa. From a policy perspective, recent developments around a voluntary market call for the South African Government to consider strategies to broaden consumer choice in electricity consumption and allow multiple electricity buyers. The introduction of an ISMO would also open the door for customers to choose their suppliers, i.e. Eskom or an IPP.

ROLE OF MUNICIPALITIES IN DEVELOPMENT OF PROJECTS OUTSIDE OF THE RE IPPPP

Municipalities can contribute to increasing the country's mix of renewable energy generation in the following ways:

- Develop their own projects outside the RE IPPPP through private public partnerships (PPPs)
- Attracting private developers through issuing of tenders for renewable energy procurement
- Making the policy environment conducive to attracting IPPs

Current state of affairs

Local government authorities can set up medium and large-scale electricity generating plants on their land and sell electricity through a wheeling arrangement with Eskom if they don't own the grid infrastructure. However, for the 178 municipalities in the country that supply power, this may not be an attractive option. Electricity rates in some cases amount to between 30% and 40% of municipalities' income streams. This is often their largest source of income and in small municipalities sometimes the only source of income. There are no incentives or mechanisms available to municipal distributors to procure and support the uptake of renewable energy on their grids without suffering a loss of revenue other than through PPP participation in project revenue.

The revenue loss aspect is an issue that municipalities will continue to face for the next few years, at least while the cost of procuring "green energy" remains higher than the Eskom Megaflex rate. If a municipality presently intends to support a green economy programme, it will ultimately have to pay for it by itself, either through an increased green tariff or taking on loss of revenues, as they are not enabled in any way at present, or by the proposed carbon tax policy. In terms of investing in their own renewable energy generation assets, municipal distributors do not pay company tax (with the exception of City Power, the only non-Eskom distributor registered as a (Pty) Ltd.), and therefore cannot use any of the existing tax incentives to support renewable or lower CO_2 emitting generation sources (AMEU, 2013). There are thus few attractive options available to municipalities intending to procure "green energy". One of these is CDM finance, provided that the projects meet the additionality requirements for CDM and fall under existing methodologies. A few municipalities have succeeded in obtaining additional financing through CDM for landfill gas-to-energy projects. Currently, though, the process may be too complex to pursue for many municipalities investigating projects that do not involve landfill gas-to-energy processes.

Despite the revenue aspect and policy complexities, some municipalities are leading the way when it comes to embracing renewable energy development. The most progressive of these are eThekwini Municipality, Nelson Mandela Bay Municipality, the City of Cape Town and the Mossel Bay municipality.

- EThekwini is looking at amending its bylaws that will allow for the signing of 20-year PPAs and setting of tariffs for embedded generators. Although restricted by the MFMA and its internal supply chain requirements, eThekwini has recently entered into short-term PPAs with a few IPPs. The municipality has also produced a wind resource map for the Ethekwini area to support development of wind energy projects in its jurisdiction.
- The Nelson Mandela Bay Municipality has entered into wheeling agreements with Amatola Green Power leading to Amatola Green Power being able to secure a few PPAs with local industry and entering into a PPA with Electrawinds, i.e. the generator. The Nelson Mandela Bay Municipality also launched a Small Scale Embedded Energy Generation (SSEG) initiative in 2013, which allows industry and residences to generate power using renewable energy technology (wind or solar PV). The renewable energy generated is then fed back into the residence or industry for its energy demands and the excess is fed back into the grid. This initiative is the first of its kind for a municipality in South Africa.
- The City of Cape Town has been purchasing green energy from the Darling Wind farm since 2006 and has a "Green Certificate".
- The Mossel Bay municipality in 2012 issued a tender for the procurement of renewable energy from IPPs and offered 20-year PPAs.

Future project development

Municipalities have an important role to play from both a sustainability energy development and energy security provision perspective. However, the different regulatory provisions need to be understood and explored in order to ascertain the financial viability and long-term sustainability of electricity derived from renewable energy resources, as provided through embedded generators and small-scale independent power producers.

As mentioned earlier, some challenges currently exist in the implementation of long-term PPAs between municipalities and embedded generators, or small-scale IPPs. These challenges range from the economic viability of the various projects to different policy and legal complexities. The legal and regulatory framework forms the foundation for building a sustainable embedded generator infrastructure. Effective and streamlined rules and regulations on a municipal level may help reduce installation costs and can significantly improve the market environment for renewable energy technologies.

Procurement of energy must be done in terms of the ERA and the New Generation Capacity regulations. Currently, long-term procurement has to comply with the New Generation regulations governed by the Department of Energy. However, shorter term procurement can happen subject to NERSA and Public Finance Management Act (PFMA) or Municipal Finance Management Act (MFMA) approval. Purchasing of power by municipalities is subjected to MFMA processes and NERSA approval of the tariff. Under the MFMA, municipalities can only procure power at a cost not exceeding the Megaflex rate that they receive from Eskom. Further, the municipality can enter into contract for a period of no longer than three financial years. Extending any agreement for a period of more than three years is a common barrier in implementing PPAs; however, according to Section 33 of the MFMA it is possible if due process is followed, albeit it would be tedious. According to Section 33 of the MFMA it is. The ability to enter into long-term PPAs with IPPs has a great impact on securing finance for projects by developers or IPPs. NERSA currently also holds the only right to license embedded generators making it a challenge for municipalities to enter into tariff agreements with embedded generators for the surplus energy they produce that may be fed into the municipal grid.

The current policy context with respect to purchasing power by municipalities over a long-term period is not clear. Thus far, Eskom has been designated as the central buyer of power from IPPs within the RE IPPPP. Municipalities can, however, enter into PPAs and a few municipalities currently have this in place, including eThekwini. The restriction in the contract period as mentioned above is not conducive to attracting developers. In order to enter into long-term PPAs, municipalities need to amend and add new bylaws without contravening their own supply chain management requirements.

5. LARGE-SCALE WIND ENERGY PROJECT ROLL-OUT SCENARIOS

Considering the information presented in the previous chapters, a number of future wind energy project roll-out scenarios can be formulated. These scenarios consider both the potential for wind energy project deployment in South Africa and outside its borders in sub-Saharan Africa. They will inform the future demand for wind energy project components, which in turn will assist in determining at the later stage of the study the potential for reaching economies of scale in developing local industry and subsequently achieving greater localisation.

5.1 SUB-SAHARAN AFRICA ROLL-OUT SCENARIOS

The roll out scenarios for sub-Saharan Africa are modelled around the wind energy targets as presented in the energy and energy-related policies for respective countries in the region, which were reviewed in the earlier chapters of this part of the report. Where country policies were not accessible and targets could not be ascertained, global wind energy sources such as REN21 and IRENA reports were used to complement the available information. The roll-out scenarios for the sub-Saharan Africa market segment were thus modelled using panels of countries with wind energy deployment targets and those whose renewable energy targets were known and relevant to the study. Three sets of roll-out scenarios were thus developed taking into account different countries' commitments to wind energy or renewable energy development.

HIGHLY PROBABLE WIND ENERGY DEPLOYMENT

The first scenario refers to highly probable deployment of wind energy projects in sub-Saharan Africa, which refers to countries whose wind energy targets were explicitly expressed in megawatt terms in their respective policies. This scenario included five countries, which can also be referred to as hot spots. The majority of future wind power capacity in sub-Saharan Africa is forecasted to come from this category.

Table 5-1 shows that about 11.8GW of wind power capacity is envisaged to be installed by 2030, assuming Mozambique would have met its wind target by then. At least 1.3GW of total wind power capacity is forecasted for 2020, and should further rise to 7.8GW over the 2020-2025 period, before reaching a peak of 11.8GW in 2030. The table also shows that there are currently no local content requirements set in the five countries that constitute the highly probable wind energy roll out scenario. It must, however, be noted that the national energy policies adopted in three of the countries (i.e. Ethiopia, Kenya and Nigeria) do advocate for the gradual establishment of local manufacturing capacity of renewable energy technologies through localisation strategies.

Table 5-1: Highly probable wind energy roll out scenario (specific wind energy targets)

Country	Wind Target (MW)	Target Date	Local Content Rule
Ethiopia	772.8	2015	No
Kenya	500	2017	No
	1 000	2022	
	3 000	2030	
Lesotho	6 000 (export focus)	2025	No
Nigeria	40	2025	No
Mozambique	2000	-	No
Future potential roll out			

2017	2020	2025	2030 + Unspecified
1 273 MW	1 273 MW	7 813 MW	11 813 MW

ADDITIONAL PROBABLE WIND ENERGY DEPLOYMENT

The second scenario refers to additional probable wind energy projects deployments in sub-Saharan Africa. It encompasses three countries, whose wind energy targets are expressed as shares or percentages of a specified baseline such as total installed electricity capacity. Since these targets were not expressed in MW terms, for this purpose of this study the targets needed to be converted from percentage base to installed capacity. Electrical capacity for the 2008-2010 period as presented in the IRENA Renewable Energy Country Profiles was used as a baseline to calculate the envisaged installed capacity in MW. It should be noted that this presents a conservative case, since future electricity demand in these countries will most likely increase compared to the 2008-2010 period, which means that the actual required installed capacity of wind energy projects would need to be greater than the figures calculated for the purpose of this study.

As outlined in the table below, it was estimated that a total wind power capacity of 180MW would need to be installed by 2025 to reach the respective countries' wind energy targets, assuming that Eritrea would have met its target by then. At least 82MW of that total capacity should be rolled out before 2020.

Table 5-2: Probable wind energy roll out scenario (percentage based wind energy targets)

Country	WE Targeted Share	Baseline (MW)	Assumed Target (MW)	Target Date
Mauritius	6%	739	44.34	2020
	8%	739	59.12	2025
Cape Verde	50%	75	37.5	2020
Eritrea	50%	167	83.5	-

Future potential roll out		
2020	**2025**	**2030 + Unspecified**
82 MW	97 MW	180 MW

ADDITIONAL REMOTELY POSSIBLE WIND ENERGY DEPLOYMENT

The third and final scenario refers to potential of wind energy projects deployment in countries with broad renewable energy targets that are mostly expressed as shares/percentages of a specified baseline. These countries, of which there are 18, required assumptions with respect to the installed capacities and the potential penetration of wind energy projects. Again, just like in the previous scenario, electrical capacity for the 2008-2010 period as presented in the IRENA Renewable Energy Country Profiles was utilised as the baseline, which enabled making an informed estimate of the minimum possible target. An estimate of a wind energy share, based on a variety of factors, is also utilised in this scenario. It took into account the following criteria:

- The wind resource potential relative to that of other renewable energy resources
- Renewable energy priorities specified by a country
- Past and present wind commitments

The estimated wind share was then used to approximate the minimum capacity to be generated from wind power given the renewable energy target. As shown in Table , a total wind power capacity of 536MW is envisaged to be installed over the next few coming years until 2025, with 151MW and 532MW being rolled out before the end of 2017 and 2020, respectively.

Table 5-3: Least probable wind energy roll out scenario (based on RE targets and assumed % share of wind)

Country	RE Targeted Share	Baseline (MW)	RE Assumed Target (MW)	Assumed Wind Share	Assumed Target (MW)	Target Date
Djibouti	85%	118	100.3	20%	20.1	2015
Madagascar	75%	246	184.5	25%	46.1	2020
Rwanda	-	-	5	50%	2.5	2017
Seychelles	5%	95	4.75	50%	2.4	2020
Benin	37%	92.3	34.2	10%	3.4	2025
Cote d'Ivoire	5%	1218	60.9	0	0	2015
Gambia	35%	53	18.6	0	0	2020
Ghana	10%	2111	211.1	20%	42.2	2020
Guinea	5%	331	16.6	0	0	2015
Liberia	30%	198	59.4	0	0	2015
Mali	25%	280	70	20%	14	2020
Niger	10%	230	23	30%	7	2020
Senegal	15%	548	82.2		125	2015
Gabon	70%	416	291.2	0%	0	2016
Burundi	2.1%	32	0.7	10%	0	2020
Malawi	7%	315	22.1		120	2020
Uganda	61%	515	314.2	1%	3.1	2017
Mauritania	20%	253	50.6		150	2020

Future potential roll out		
2017	**2020**	**2025**
151 MW	532 MW	536 MW

CUMULATIVE POTENTIAL FOR WIND ENERGY DEPLOYMENT IN SUB-SAHARAN AFRICA

Basing on the three potential roll-out scenarios presented above, about 12.5GW of wind power capacity is forecasted to be installed in sub-Saharan Africa over the next 15 to 16 years (refer to Figure 5-1). The majority of that will come from countries that have specifically set clear-cut wind energy targets and that therefore represent hot spots. A total wind power capacity of 1.4GW is forecasted to be installed in sub-Saharan Africa by 2017, and should slightly rise to 1.9GW over the 2017-2020 period; thereafter it will probably reach as far as

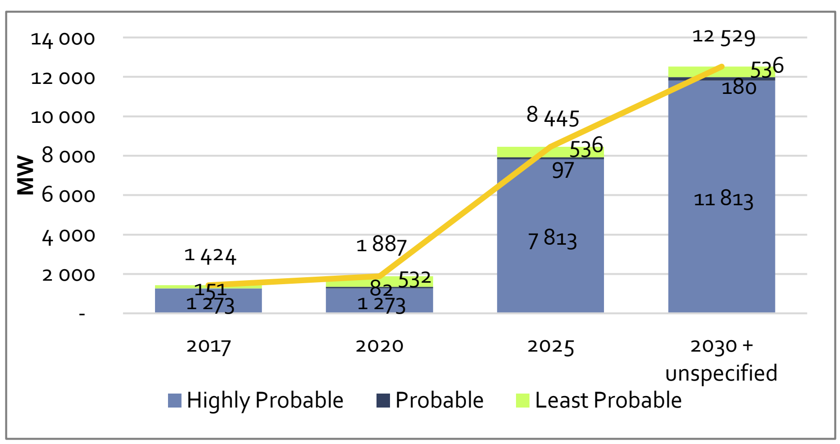


Figure 5-1: Envisaged wind energy projects roll-out scenarios in Sub-Saharan Africa

8.4GW by 2025. Most wind projects are envisaged to be rolled out during the 2020-2025 period followed by the 2025-2030 period. Not much activity is anticipated during the 2017-2020 period.

5.2 South Africa's roll out scenarios

The roll-out scenarios for wind energy in South Africa are largely dependent on the IRP and the RE IPPPP. As earlier highlighted, roll-out of wind energy projects in other market segments outside the RE IPPPP is still limited due to policy complexities that needs to be ironed out first; nonetheless, some opportunities are available particularly if the regulatory challenges and price competitiveness issues are addressed.

As can be seen from Table 5-4, the roll-out of future wind energy projects is high in the promulgated IRP 2010 context compared to that of the updated draft IRP 2013. The capacity awarded in the three RE IPPPP bid rounds of 1 984 already surpasses the envisaged roll out for wind projects by 2025 under the updated draft IRP scenario. Under the promulgated IRP 2010 scenario, 2 800MW is envisaged to be rolled out by 2020, 6 400MW by 2025 and 8 400MW by 2030. In addition to the above, it was estimated that between 458MW and 4 123MW could potentially be deployed in wind energy projects outside RE IPPPP through partnerships between PPAa, municipalities, and/or large power users.

Table 5-4: Envisaged wind energy projects roll-out scenarios in South Africa

Market Segment		2017	2020	2025	2030
IRP	IRP 2011 (MW)	2 000	3 200	5 600	9 200
	Draft IRP 2013 (MW)	1 300	1 300	1 940	4 360
Outside RE IPPPP/in addition to IRP	Low - 5% of uptake outside Eskom and RE IPPPP and 5% of wind energy penetration (MW)	23 (5% of 2030)	153 (1/3 of 2030)	305 (2/3 of 2030)	458
	Medium - 15% of uptake outside Eskom and RE IPPPP and 10% of wind energy penetration (MW)	206 (5% of 2030)	1 374 (1/3 of 2030)	2 749(2/3 of 2030)	4 123
	High - 25% of uptake outside Eskom and RE IPPPP and 15% of wind energy penetration (MW)	343 (5% of 2030)	2 290 (1/3 of 2030)	4 580 (2/3 of 2030)	6 870

5.3 Future demand per scenario

The combination of the potential wind energy project deployment scenarios in sub-Saharan Africa and South Africa presented above suggests that between 16.6GW and 27.8GW of wind energy projects could be deployed by 2030 depending on the scenario considered. Importantly, the majority of projects are expected to be rolled-out during the 2020-2030 period.

If the deployment of wind energy projects would follow the scenario outlined in the promulgated IRP 2010, the combination of sub-Saharan Africa market penetration and participation level outside the RE IPPPP in South Africa would offer opportunities for deployment of between 20.7GW and 27.8GW of wind energy projects by 2030. The biggest variation in terms of deployment potential will come only after 2020, while in the period up to 2020 the difference in opportunities for wind energy project roll-out will be relatively small and will range between 4.2GW to 7GW.

Table 5-5: Envisaged wind energy projects roll-out scenarios in sub-Saharan Africa and South Africa assuming promulgated IRP (2010)

Market Segment		2017	2020	2025	2030
Low level of participation outside RE IPPPP (5% of uptake outside Eskom and RE IPPPP and 5% of wind energy penetration (MW))					
Sub-Saharan Africa market penetration	Highly probable only	2 896	4 226	14 518	20 671
	Highly probable and probable	2 896	4 308	14 615	20 851
	Highly probably, probable and remotely possible	3 047	4 840	15 151	21 387
Medium level of participation outside RE IPPPP (15% of uptake outside Eskom and RE IPPPP and 10% of wind energy penetration (MW))					
Sub-Saharan Africa market penetration	Highly probable only	3 079	5 447	16 962	24 336
	Highly probable and probable	3 079	5 529	17 059	24 516
	Highly probably, probable and remotely possible	3 230	6 061	17 595	25 052
High level participation outside RE IPPPP (25% of uptake outside Eskom and RE IPPPP and 15% of wind energy penetration (MW))					
Sub-Saharan Africa market penetration	Highly probable only	3 217	6 363	18 793	27 083
	Highly probable and probable	3 217	6 445	18 890	27 263
	Highly probably, probable and remotely possible	3 368	6 977	19 426	27 799

If the wind energy roll-out proposed in the draft updated IRP (2013) was approved, the demand for wind energy project components will notably decrease compared to the previous set of scenarios outlined. It will especially affect the potential for project roll-out in the period up to 2020. Overall though, as indicated in the table below, assuming that the draft updated IRP is approved, the combination of the sub-Saharan African market potential and the potential for wind energy project roll-out outside the RE IPPPP will create the demand for wind energy project components to an equivalent of between 16.6GW and 23.0GW by 2030.

Table 5-6: Envisaged wind energy projects roll-out scenarios in sub-Saharan Africa and South Africa assuming draft updated IRP (2013)

Market Segment		2017	2020	2025	2030
Low level of participation outside RE IPPPP (5% of uptake outside Eskom and RE IPPPP and 5% of wind energy penetration (MW))					
Sub-Saharan Africa market penetration	Highly probable only	2 596	2 726	10 058	16 631
	Highly probable and probable	2 596	2 808	10 155	16 811
	Highly probable, probable and remotely possible	2 747	3 340	10 691	17 347
Medium level of participation outside RE IPPPP (15% of uptake outside Eskom and RE IPPPP and 10% of wind energy penetration (MW))					
Sub-Saharan Africa market penetration	Highly probable only	2 779	3 947	12 502	20 296
	Highly probable and probable	2 779	4 029	12 599	20 476
	Highly probable, probable and remotely possible	2 930	4 561	13 135	21 012
High level participation outside RE IPPPP (25% of uptake outside Eskom and RE IPPPP and 15% of wind energy penetration (MW))					
Sub-Saharan Africa market penetration	Highly probable only	2 917	4 863	14 333	23 043
	Highly probable and probable	2 917	4 945	14 430	23 223
	Highly probable, probable and remotely possible	3 068	5 477	14 966	23 759

6. CONCLUSION

Globally, fossil fuels continue to dominate the supply-side of the global energy markets; however, the penetration level of renewable energy technologies into the same markets is commendable. Wind power is no exception in this regard. Of late, there has been a significant growth in global wind markets steered by China, North America, and Europe. As of 2013, a total wind power capacity of 318GW had been installed globally. The installed capacity is further forecasted to grow from the current 318GW to just about 600GW at the end of 2018. It is not surprising to note that China, North America, and Europe are not only leading the rest of the world with regard to installed wind power capacity, but have also established a dominance over the wind turbine manufacturing industry in terms of market share.

While the global trend of installed wind power is commendable, it must, however, be noted that Africa lags behind other global regions in this regard. The continent's wind power is still very limited with an estimated 1.1GW installed capacity in 2011, constituting less than one percent of the continent's total installed electricity generation capacity. The majority of the continent's relatively little installed capacity is concentrated in the North Africa sub-region, implying the insignificance of sub-Saharan Africa's contribution to Africa's and the global pool of total installed wind power capacities. However, although Africa has experienced little progress in terms of harnessing of wind energy in the past, the wind energy market growth over the coming years is forecast to be concentrated in Africa and other developing regions such as Latin America. Installed capacity for wind power in Africa is forecast to increase 12-fold over the next decade, in line with the global trends and technological innovations now characterising the wind market.

With such a highly anticipated growth of the wind energy market in Africa, an investigation into the sub-Saharan Africa market segment shows that there is a huge potential for wind energy in the region as a whole. The average wind resource potential is generally of medium to high potential. Eighteen countries within the region are reported to have high wind resources, 22 more countries have medium wind resources, and only five countries are believed to have a low wind resource potential. Some of the countries within the sub-Saharan Africa region that include amongst others Ethiopia, Kenya, Madagascar, Mauritius, Mozambique, Rwanda, Tanzania, Cape Verde, Ghana, Liberia, Nigeria, and Zambia have developed energy and energy-related policies that not only talk about renewable energy but show interest in pursuing and developing the wind energy sector in particular. Some sub-regions have already made some tangible progress in terms of installed capacities. East Africa leads the rest of sub-Saharan Africa in terms of total installed wind power capacity. By the end of 2013, seven countries within this sub-region had installed wind power capacity of up to 186MW. Other sub-regions such as Central Africa have made little or no progress at all.

While the majority of southern African countries have on average a medium wind resource potential, for South Africa, the average wind resource potential is believed to be high. Locally derived atlases reveal the presence of high wind speeds along the coasts of the KwaZulu-Natal, Eastern Cape, Western Cape and Northern Cape provinces. The atlases are consistent in showing that the Eastern, Western and Northern Cape provinces are the most favourable locations for wind energy projects. Not only is the country endowed with good wind resources, South Africa also boasts policies and programmes that are in support of the development of a utility-scale renewable energy sector.

The use of renewable energy, and particularly wind power, is well supported and articulated in a wide range of South African policy documents. The IRP promulgated in 2011 set a capacity target of 9 200MW to be generated from wind power by 2030. The draft IRP 2013, however, proposes to reduce the allocation to 4 360MW for the same time period. In support of the energy policies, the DoE has since introduced a competitive bidding process, RE IPPPP and so far, 1 984MW has been awarded to 22 wind energy projects over the three bid windows.

Outside the RE IPPPP market, there have been limited developments in the wind power energy sector mostly as a result of suppressive regulation. A review reveals that two wind energy generators, Electrawinds/Fluopro JV and Darling National Demonstration Wind Farm, hold a PPA outside of the RE IPPPP programme. While policy complexities limit municipalities from entering into long-term PPAs with IPPs, the dominance of Eskom as a single buyer is another aspect that continues to constrain the growth of the energy market. The success of wind projects outside the RE IPPPP depends on how the regulatory landscape evolves in the future. Nonetheless, some municipalities such as eThekwini, Nelson Mandela Bay, City of Cape Town and Mossel Bay are already making progress in devising a favourable regulatory landscape to ensure the success of wind projects outside the RE IPPPP market segment. And it was estimated that potentially between 458MW in the low-case scenario, 4 123MW in the medium scenario, and 6 870MW in the high scenario could be deployed in this market in the future.

Considering all of the above, the potential for wind energy projects deployment will remain to be policy-led both in South Africa and sub-Saharan Africa.

- It was estimated that between 11.8GW and 12.5GW of wind energy projects could be deployed in sub-Saharan Africa by 2030 with the majority of these in the countries that have set specific wind energy targets.
- In South Africa, future roll-out of wind projects is expected to be consistent until the mid-2020s if the government were to continue utilising the policy adjusted scenario in the IRP promulgated in 2011. A further 7 216MW would still need to be approved in order to meet the 2030 total wind capacity target of 9 200MW. However, the roll-out of wind projects is expected to be significantly lower if the government adopted the base case scenario modelled in the draft IRP 2013, since 46% of the target has already been awarded to projects. Only 2 376MW out of the entire target of 4 360MW would be remaining for future roll-out.

To conclude, the potential for the establishment and growth of the local wind energy sector, which would allow for achieving a greater localisation, would be dependent on the future roll-out of wind energy projects in both South Africa and sub-Saharan Africa. It was estimated that between 16.6GW and 27.8GW of wind energy projects could be deployed in the region by 2030. However, most of the opportunities will be presented during the period between 2020 and 2030, which provides for sufficient number of years to develop local capabilities and ensure that the local industry is ready to meet the demand by then. However, the ability of the local industry to grow in the next few years may be jeopardised if the updated draft IRP is approved and the industry is left to rely on the demand created by sub-Saharan Africa only during that period.

SECTION 2: WIND ENERGY INDUSTRY PROFILING

1. INTRODUCTION

The purpose of this section is to outline the current state of the wind industry in South Africa and to create a comprehensive understanding of its development potential in the context of the global wind industry dynamics. For that purpose, the section starts with the review of the current state of the global wind industry with a specific objective of understanding its composition, current manufacturing capacities, investment, developmental drivers, and technological trends. Special attention is paid to identification of lessons that can be learnt and utilised for the development of a thriving and viable local wind industry in South Africa, based on the past experiences of various countries and industry leaders.

Following the review of the global industry, the section shifts the focus to the South African wind industry. It investigates the structure of the domestic wind industry and starts by introducing the local wind energy project economics with discussions centred around the country's large-scale wind energy projects based on the following sub-items:

- Key players
- Investment costs
- Cost breakdown structure
- Local content and labour

From there, the section goes on further to analyse the local current and potential manufacturing capabilities with a specific focus on key wind energy project components, such as turbine, tower, hub and nacelle. Having clarified the structure and key players active in the local wind industry value chain, the report concludes by analysing the competitiveness of the local wind industry.

The outcome of this section is the greater understanding of the local existing capacities to manufacture key wind energy components and the prerequisites for developing new capabilities and growing the local industry. The reference to the global wind industry also assists in informing the potential for the local wind industry expansion, as the knowledge of its current capabilities and utilisation levels, as well as general dynamics assists in developing a greater insight into the level of competitiveness of the industry in general and identification of market entry barriers.

2. GLOBAL WIND INDUSTRY CAPABILITIES AND TRENDS

This section outlines the key players, structure and features of the global wind turbine manufacturing industry. The section is aimed at providing the global context within which South Africa's wind industry is being developed and an understanding of the factors that are critical in the development of a local wind industry.

2.1 COMPOSITION OF THE GLOBAL WIND TURBINE MANUFACTURING INDUSTRY

COUNTRY LEADERS IN THE WIND TURBINE MANUFACTURING INDUSTRY AND RECENT TRENDS

Each and every year, the wind energy market continues to grow. Data available on the GWEC website shows that at the end of 2012 about 225 000 wind turbines were spinning around the world. About 23 640 of those wind turbines (i.e. more than 10%) were erected in 2011 alone.

Most of the countries with significant wind energy installed capacities are not only leading in terms of wind energy production, but also dominate the wind energy manufacturing industry. As outlined in Figure 2-1, countries such as China, the USA, Germany, Spain, and India account for the biggest market share in terms of both wind power installed capacities and wind turbine manufacturing. Over the years, though, the market shares of different countries with respect to wind power generation and manufacturing capabilities have shifted, which shows the relatively dynamic and competitive nature of this industry.

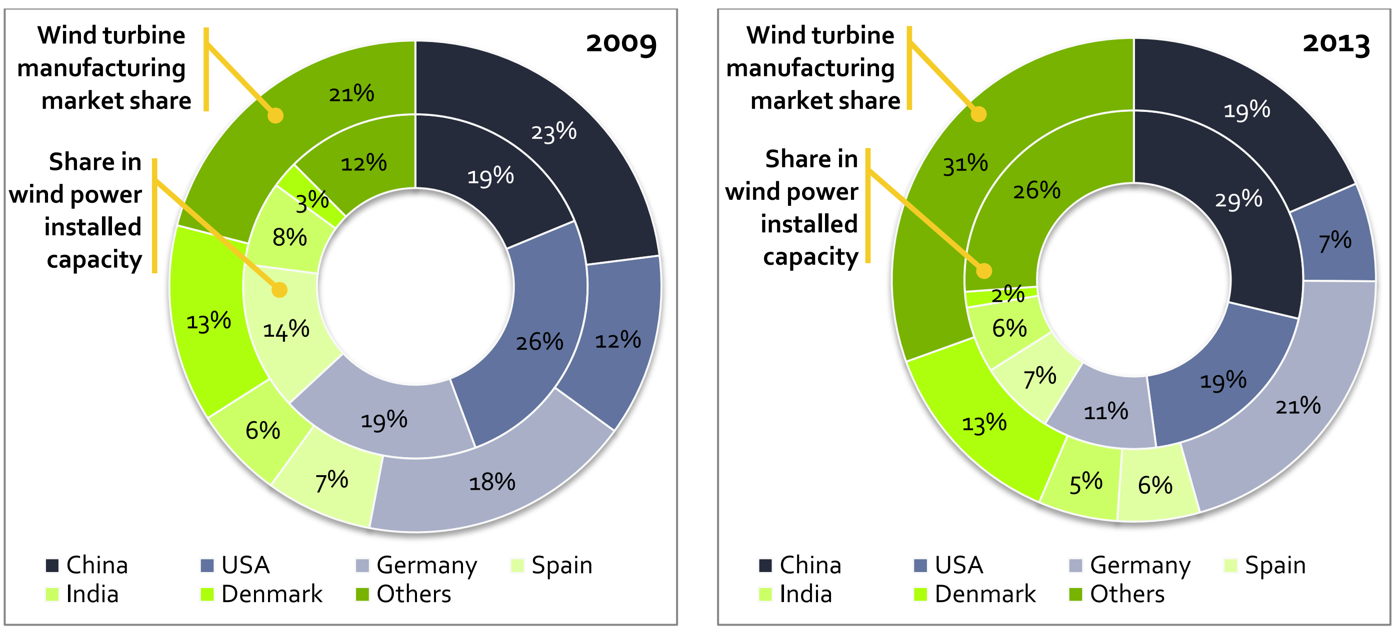


Figure 2-1: Wind Power Global Capacity and Market Shares of Global Wind Turbine Manufacturers (REN21, 2014a) (REN21, 2010)

The major trends in the composition of the wind energy from countries' participation perspective during the period between 2009 and 2013 include, inter alia:

- China overtaking the USA as the largest country with wind power installed capacity over the span of just four years and increasing its market share to the unprecedented 29% by 2013.
- Germany in turn overtaking China in terms of wind turbine manufacturing capacities, which was second in 2009.
- The entry of other countries both in terms of installed wind power and turbine manufacturing capacities, which led to the growth of their installed wind power capacities from 12% in 2009 to 26% by 2013; and of their wind turbine manufacturing market shares 21% in 2009 to 31% in 2013.
- The decrease both in terms of the wind turbine manufacturing market share and the wind power installed capacity share for countries such as the USA, Spain, and India. It should be noted that the USA was the country with the largest decline in market shares, which was attributed to the conclusion of the Tax Credit law at the end of 2012.

Denmark hosted the wind turbine manufactures with the largest market share globally, i.e. Vestas that accounted for 13% of wind manufacturing capacities in the world. On the other hand, China and Germany had the most number of leading global turbine manufacturers with significant individual market shares. As already alluded, the German companies enjoyed a bigger share of the wind turbine market in 2013 compared to that of any other country.

INDUSTRY LEADERS IN THE WIND TURBINE MANUFACTURING INDUSTRY AND RECENT TRENDS

Having looked at some of the top countries dominating the global wind power installed capacity and turbine manufacturing market, it is worthwhile looking at the market dynamics of individual companies involved in wind turbine manufacturing between the years 2009 and 2013. As illustrated in Figure 2-2, some notable changes characterise the market during this time period, with some Original Equipment Manufacturers (OEMs) losing their leading market share positions, some OEMs gaining market shares, and some emerging as new key players in the industry. The above, together with the fact that the industry has seen many new market entrants in the last few years, suggests that that the global wind industry is expanding and is nearing maturity. Recent developments show that the onshore wind market, in particular, is maturing with new market entrants creating massive competition for big players in the industry. Suppliers now tend to position themselves in specific market segments in order to preserve their competitive advantages and meet local requirements.

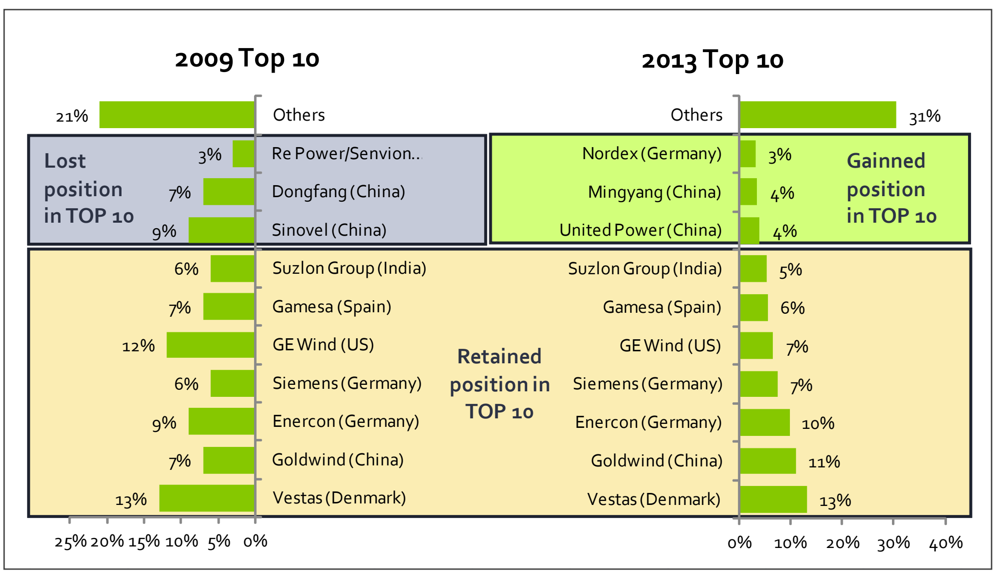


Figure 2-2: Leading wind turbine manufacturers in 2009 and 2013 by market share (REN21, 2014a) (REN21, 2010)

Economic growth and demand for electricity is shifting to new regions like Asia, Latin America and Africa, while Europe and North America that have traditionally been the wind industry's strongest markets are currently experiencing modest growth (Vestas, 2013). With global demand shifting, the maturing wind technology has also attracted more players, which is reflected in the rise of the market share of other manufacturers from 21% to 31% between 2009 and 2013 respectively. In the USA alone, besides the traditional global OEMs, the number of wind turbine manufacturers serving the USA market and installing more than 1MW increased from just five in 2005 to 25 in 2012 (U.S Department of Energy , 2013). With the growth in the number of market players and the shift from conventional markets to new emerging markets, the spatial distribution of wind turbine manufactures has also grown. For example, countries such as France and South Korea have seen the emergence of new wind turbine manufacturers (IEA , 2013b), while many existing wind turbine manufacturers have set up new manufacturing facilities in Brazil, with 11 manufacturing plants in operation by late 2012 and another one planned for construction by General Electric (REN21, 2013).

The growth in the market share of "other" turbine manufacturers is not the only notable market trend worth mentioning. As mentioned earlier, there has been a shift in the top 10 wind turbine manufacturers' rankings, with the following changes worth noting:

- In 2013, two Chinese companies, i.e. Dongfang and Sinovel, together with one German company, Re Power, lost leading positions in the industry, which they had enjoyed.
  - RE Power was acquired by Suzlon at the end of 2009.
  - The position of Sinovel was jeopardised by the investigation launched by the China Securities Regulatory Commission and other allegations that resulted in the decline of its orders and customer acceptance.
- At the same time, another two Chinese and one German company, i.e. Mingyang, Guodian United Power, and Nordex, have emerged as leaders in the industry. The global growth of Chinese turbine manufacturers has been based almost entirely on sales to the Chinese market (U.S Department of Energy , 2013).
- Companies such as GE Wind (the USA), Suzlon (India), and Gamesa (Spain) lost some market shares.
  - The low demand in the domestic US wind markets affected GE Wind's performance. The 11th-hour extension of the production tax credit ultimately sent the US wind sector into hibernation for the first six months of 2013, hampering GE's performance in the competitive rankings (Renewable Energy World.Com, 2014).
  - The 2012 Gamesa annual report attributes the company's poor performance to lower growth, due to macroeconomic and financial problems worldwide, and fiercer competition (Gamesa, 2012).
  - For Suzlon, the cascading impacts of the global financial crisis meant that the company had to operate in what it terms a radically altered business landscape (Suzlon, 2013). Moreover, the crisis crippled the company's business performance due to liquidity challenges that led to an underutilisation of its manufacturing capacities that ultimately resulted in lower sale volumes (Suzlon, 2013).
- The market share for Vestas (Denmark), the world leader in wind energy, remained unchanged during the analysed years, i.e. 2009 and 2012. The company, though, recently undertook a two-year restructuring process, which resulted in the closure of 12 factories and shedding of nearly a third of the company's workforce.

- Three other companies, Siemens, Enercon, and Goldwind gained market shares between 2009 and 2013. The biggest gain was recorded for Goldwind, whose market share rose from 7% in 2009 to 11% in 2013, making it one of the top-ranking wind turbine manufacturing companies in the world. The ascendance of Goldwind reflects China's commitment to adding significantly more wind power (Renewable Energy World.Com, 2014).

GLOBAL WIND TURBINE MANUFACTURING INDUSTRY CAPACITIES AND THEIR UTILISATION LEVELS

Between 2009 and 2013, the wind energy market has seen a notable increase in the total installed wind power capacities compared to pre-2009. Between USD73 billion and USD94 billion was invested on an annual basis between 2009 and 2013 that added between 37GW and 45GW of wind power per annum during the same period (refer to Figure 2-3).

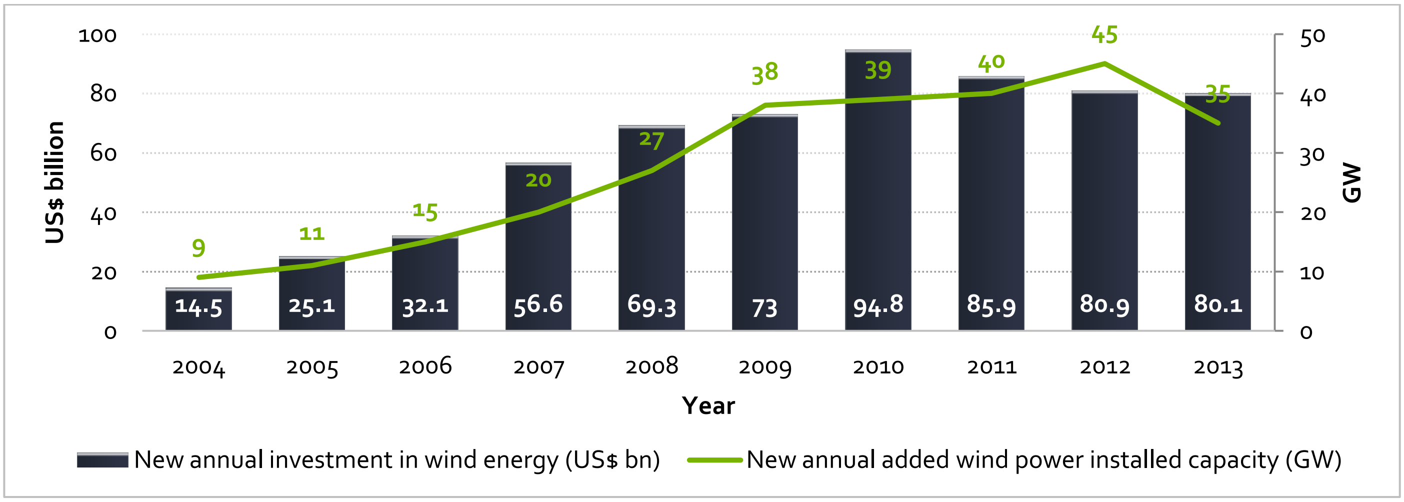


Figure 2-3: Global trends in wind power technology new investment (REN21, 2014a)

In 2013, wind turbine manufacturers sold about 37.5GW worth of key components, while the total added installed capacities were 36.3GW (REN21, 2014a). It should be noted, though, that the market for wind projects in 2013 was considerably smaller than in 2012. Amongst some of the reasons behind the decline observed in 2013 compared to 2012 were the drop in demand in the USA due to policy uncertainty, decline in the European market due to increasing market saturation and economic austerity measures, and increasing competition by low-cost gas energy in some of the markets (REN21, 2014a).

The above-mentioned trends have resulted in the oversupply in the wind turbine market that created fierce price competition and led to tightening of profit margins, which in turn resulted in some notable changes in the industry structure. In Europe, it is reported that wind energy market contraction resulted in German manufacturers Bard and Fuhrlander both filing for insolvency in late 2013, while Denmark's Vestas had to cut its staff by 30% (REN21, 2014a). Due to the shortage of new turbine orders, some of the USA factories were forced to lay off workers while others closed down (REN21, 2014a).

Recent development in the industry forced the majority of turbine manufacturers to revisit their business strategies with the main focus being the creation of more flexible businesses. In order to deal with various challenges and to maintain profitability, turbine manufacturers revamp their supply chains with techniques such as lean production, component commonality, strategic supplier outsourcing, and just-in-time stocking similar to the automotive industry structure and dynamics (REN21, 2014a) (Lawson, 2013). While vertical integration was considered to be a common business strategy prior 2010, manufacturers are now more inclined to follow a hybrid model.

The hybrid model involves outsourcing manufacturing of the majority of components of wind turbines while retaining control over design and manufacturing of key components, as well as final assembly. For example, Vestas sold its tower factory in Varde (Denmark) to long-term supplier Titan Wind Energy in 2012; at the same time Goldwind passed its blade manufacturing business Tianhe Balde to Sinomatech (Lawson, 2013). Outsourcing is particularly effective in the situation of high demand volatility, which negatively impacts on businesses that are vertically integrated. Some find solution in forming partnerships with specialist suppliers. For example, Mitsubishi (Japan) and Vestas (Denmark), as well as Areva (French nuclear supplier) and Gamesa (Spain) announced joint ventures for offshore turbine development (REN21, 2014a). Other examples include Gamesa working with ZF Wind Power, Bosch Rexroth, and Winergy on gearboxes, and Alsom partners with LM for blades (Lawson, 2013).

The increasing potential in the emerging markets that increase distances to markets and local content regulations adopted in some countries (for example the US, South Africa, Brazil, France and Canada) also force manufacturers to reconsider their entire supply chains from a geographical perspective (Lawson, 2013). For example, the need to become more flexible, extend geographical coverage and adhere to local content rules pushed Siemens to adopt a "Hub & Spoke" approach to balance global and local supply and achieve cost efficiency, quality, and security (RolandBerger, 2011). This configuration implies a) setting up local sourcing clusters for large items, which allow for achieving local content targets and flexibility, and b) establishing Clusters of Excellence for global or regional supply of other items that offer economies of scale, provide access to technology, and allow achievement of high quality products (RolandBerger, 2011). Furthermore, it appears that OEMs are becoming more acceptable of sharing a new manufacturing facility with competitors as it allows them to enter the market and remain competitive as orders from other OEMs assure optimal utilisation of the newly established manufacturing capacities (Lawson, 2013). An example of this is the first factory of LM Wind in Brazil that produces blades for Alstom and other manufacturers (Lawson, 2013).

Overall it is clear that the global wind turbine manufacturing industry is steadily moving from being highly vertically integrated towards building strategic partnerships, outsourcing non-core components to other companies, and remaining vertically integrated in specific core items. Flexibility and the need to adhere to the country-specific local content rules seem to be among the key factors shaping the structure of the wind turbine manufacturing industry.

Global Industry Development Drivers

> **"Empirically, the export success of wind turbine manufacturers from different countries has been found to positively correlate with domestic market sizes"** (Gosens, J. and Lu, Y., 2013)

Looking at the top wind turbine manufacturers and where they are based, it is clear that **domestic demand for wind energy is critical for the establishment of a viable local wind industry that becomes globally competitive**. In other words, a successful and viable wind industry is built on local demand. This is true for all the countries where the world's renowned wind turbine manufacturers originated. The countries that have succeeded in fostering a competitive domestic wind industry have provided a sufficiently large and stable domestic demand for wind turbines through government support and specifically making use of mandates, targets, or feed-in-tariffs. Countries such as the USA, Denmark, Germany, Spain, India, and China are notable examples.

At the same time, **sustained and predictable government support is another key driver for a viable wind industry**. Many governments have used their policies not only to create a domestic wind energy market but also to lure investments into the wind industry. This has worked well in attracting foreign investment as well stimulating local wind industry, which in some instances was supported through a protective tariff regime or another form of industry protection until companies have sufficiently matured.

Denmark

The success of the Danish company, Vestas, as the leading global wind turbine manufacturer, is deeply rooted in the early market developments of wind energy in Denmark - the pioneering country. By 2006, Denmark had 3.1GW of wind power, all of which made use of domestic wind turbines, i.e. Vestas (Lewis, 2007).

China

In China, the wind sector developed extremely quickly; starting with less than 1GW in 2005 to about 91.4GW installed capacity by end of 2013, with local turbine producers dominating the supply side. Development of Wind Concessions for government-selected sites auctioned off through a competitive bidding process, setting up local content requirements for wind projects developed in the country (70%), encouraging joint-ventures and technology transfers, subsidisation of wind energy R&D expenditure [4], as well as differential customs duties favouring domestic turbine assembly are among some of the policies that contributed to the development of the Chinese wind turbine manufacturing industry (Lewis, 2007).

The Chinese success story vividly shows that the speed of the development on the local supply side largely depends on the growth rate of the demand side. The global increasing market share of Chinese turbine manufacturers has been based almost entirely on sales to the Chinese market (U.S Department of Energy , 2013). In 2013 alone, the top 10 local Chinese turbine manufacturers dominated the Chinese wind market with 78% of the market share. Goldwind had a market share of 23.3%, accounting for nearly a quarter of the national market, followed by United Power with 9.23% (1 487MW), Ming Yang 7.9% (1 286MW), Envision 7.0% (1 128MW) and XEMC 6.5% (1 052MW) (GWEC, 2013). Six of these Chinese companies are already among the top 15 manufacturers globally (IEA , 2013b).

Table 2-1: Top ten 2013 manufacturers in Chinese Wind Energy Market

Manufacturer	New installations (MW)	Market Share (%)	Cumulative MW
Gold Wind	3 750	23.31	18 951
Guodian United Power	1 488	9.25	8 799
Ming Yang	1 286	7.99	5 543
Envision	1 128	7.01	2 421
XEMC	1 052	6.54	3 747

[4] Local Chinese turbine manufacturers received considerable amount of funds from domestic state-owned banks. Between the years 2010 and 2013, leading Chinese turbine manufacturers received more than USD 20 billion in cheap loans from the China Development Bank

Manufacturer	New installations (MW)	Market Share (%)	Cumulative MW
Shang Hai Electric	1 014	6.30	3 617
Sinovel	896	5.57	15 076
CSIC	787	4.89	2 061
Dong Fang	574	3.56	7 938
Windey	539	3.35	2 001

(GWEC, 2013)

The USA

Domestic demand for wind energy in the USA also brought about a thriving wind industry in the country. It took the country 25 years to reach 10GW of total installed capacity in 2006. Just two years later, though, in 2008, the USA doubled its capacity reaching 20GW, and then another two years to double it further to 40GW (GWEC , 2012c). As already highlighted, the documented growth of the USA's domestic wind market ensured a steady growth of the country's wind turbine manufacturing capacity with the number of wind turbine manufacturers serving the US market and installing more than 1MW increasing from just five in 2005 to 25 in 2012. As of 2012, the American turbine manufacturer GE Wind was the dominant supplier of wind turbines to the USA's domestic market, accounting for 40% (18 873MW) of the 48 770MW of installed USA wind energy capacity (greentechmedia, 2012).

Germany

In 2013, Germany's installed wind power capacity reached 34.7GW (REN21, 2014a). German companies such as Enercon, Nordex, and Siemens continue to do well in terms of global market share, claiming about 21% of the market in 2013 (REN21, 2014a). In 2006, when the country had 20.6GW of wind power installed capacity, the domestic manufacturers accounted for 55% of installed turbines (Lewis, 2007).

Spain

In Spain, feed-in-tariffs and government concessions drove the demand for wind power upwards; however, realisation of the opportunities created by these policies was attributed to government facilitating the development of the local wind turbine manufacturing industry through the incorporation of local content regulations in wind turbines installed in the country, provision of incentives and offering support in Research and Development activities through its main public R&D organisation (Lewis, 2007). By 2006, domestic turbine manufactures accounted for 76% of Spain's wind power installed capacity of 11.6GW (Lewis, 2007). It is largely the result of the above policies that allowed Spain's Gamesa to become globally competitive (Lewis, 2007).

India

The development of the local market in India was largely stimulated by India's Electricity Act of 2003, which required all state-level energy regulatory commissions to encourage electricity distributors to procure a specified minimum percentage of power generation from renewable energy sources (Lewis, 2007). This led to the formulation of states-specific renewable energy targets. A national certification programme for wind turbines and customers, and excise duties that favoured importing of wind turbines components over complete machines, further assisted in the development of the local manufacturing industry. By 2006, 52% of India's wind power installed capacity of 6.2GW at that time was developed using domestically manufactured wind turbines (Lewis, 2007). In 2013, with a total installed wind power capacity of 20.2GW and a proposed capacity addition of 15GW, India has become a major manufacturing hub. By the end of 2012, 19 manufacturers had a consolidated annual production capacity of over 9.5GW (GWEC , 2012c).

Brazil

In Brazil, the development of the wind energy market was driven by the government's Decennial Energy Expansion Plan (PDE 2022) that set a goal of 17GW of installed wind capacity to be reached by 2022, as well as the Programme of Incentives for Alternative Electricity. The latter was divided into two phases. The first included provision of fixed tariffs and guaranteed grid access, as well as set a local content requirement (i.e. "nationalisation index") at 60% for equipment, which was calculated by weight and created demand for locally produced wind turbine towers (IRENA, 2013a). The second phase set a target of 10% of power consumption to be derived from renewables and introduced a reverse price auction competitive bidding system; while local content was no longer a requirement for participation in the programme, it was a necessity if developers planned to access funding from the Brazilian National Development Bank (BNDES), which came at a lower cost (IRENA, 2013a).

Out of 81 wind farms operating in Brazil, 80 have been developed with funding received from the BNDES (U.S Department of Commerce, 2014). While there are no explicit local content requirements for participation in Brazil wind energy auctions, BNDES' wind project financing requirements creates a *de facto* local content requirement for the Brazilian wind energy market. Wind project developers have to meet the set local content requirements in order to qualify for low-cost credit from the BNDES.

- As part of the local content requirements in order for developers to qualify for subsidised funding, wind turbine models which incorporate a gearbox must demonstrate that the gearbox, generator and other specified components are produced locally (Melo, 2013).
- In terms of wind turbines that make use of a gearless drivetrain, local production of certain parts of the generator, the nacelle and inverter is also required (Melo, 2013).
- Wind turbines are further required to be certified by BNDES, meeting at least three of the following four criteria (Power Engineering International , 2013):
  - manufacturing of towers in Brazil, with at least 70% of the local-made steel plates or domestically reinforced concrete
  - manufacturing of blades in the country in their own plant or that of a third party
  - assembly of the nacelle in their own plant
  - assembly of the hub with a domestic dye-cast in Brazil

It should also be noted that Brazil has not only relied on local content requirements to develop and expand its local wind industry; in fact, the country has also employed other trade policy instruments like quotas and import tariffs. The country originally introduced a ban on imported turbines below 2MW, which was later revised downwards to below 1.5MW. The country also maintains a 14% import tariff on wind turbines and other wind turbine component parts (U.S Department of Commerce, 2014).

In light of the above, the Brazilian wind industry and its supply chain have become firmly established with nine international manufacturers so far opening facilities in the country (GWEC, 2013). The success story of Brazil's wind industry growth is further reinforced by the claim that the second largest manufacturer of wind blades in the world, Tecsis, is a Brazilian company (U.S Department of Commerce, 2014). The recent market developments have, however, resulted in some top OEMs like Vestas and Suzlon losing market shares within the Brazilian wind energy market as a result of failing to meet the stringent BNDES financing requirements (Bloomberg, 2013). Both companies are reported as having been unable to secure contracts to supply wind turbines to Brazilian wind energy projects for a period of at least 18 months (Power Engineering International , 2013). This goes to show how stringent the local content requirements are in Brazil.

DEVELOPMENT OF THE GLOBALLY COMPETITIVE WIND MANUFACTURING INDUSTRY REQUIRES GOVERNMENT POLICY THAT A) STIMULATES THE DEMAND FOR LARGE-SCALE WIND ENERGY AND B) FACILITATES ESTABLISHMENT OF LOCAL MANUFACTURING CAPABILITIES.

From the above, it is evident that government policy that stimulates the demand for wind power and assists in developing local manufacturing capabilities are the ideal combination that enables the establishment of the globally competitive industry. Many countries have opted to make use of **local content requirements**; however, the successful use thereof is conditional and needs to be complemented with other policy measures and support tools. Local content requirements can have the desired effect, but only when governments offer a stable, long-term, fixed volume policy and clear incentives for wind power generation (GWEC , 2012c). The proportion of required domestic content needs also to be gradually phased in.

At a micro level, the use of acquisitions and joint ventures with global wind industry giants is clearly documented in the available literature as another key driver for establishing a thriving wind industry. Siva Group of India acquired WinWind Oy, a Finnish manufacturer of wind turbines. Other available evidence reveals that the Chinese local production only yielded sizeable results after joint ventures with international companies were set-up and some Chinese industry giants decided to buy licences for modern wind turbines in Europe or even gave design contracts to German wind turbine designers (GIZ & CRSES, 2011). Some of the companies even set up joint R&D facilities with overseas companies in order to broaden their knowledge base and increase their technology portfolio.

2.2 GLOBAL INDUSTRY TECHNOLOGICAL TRENDS

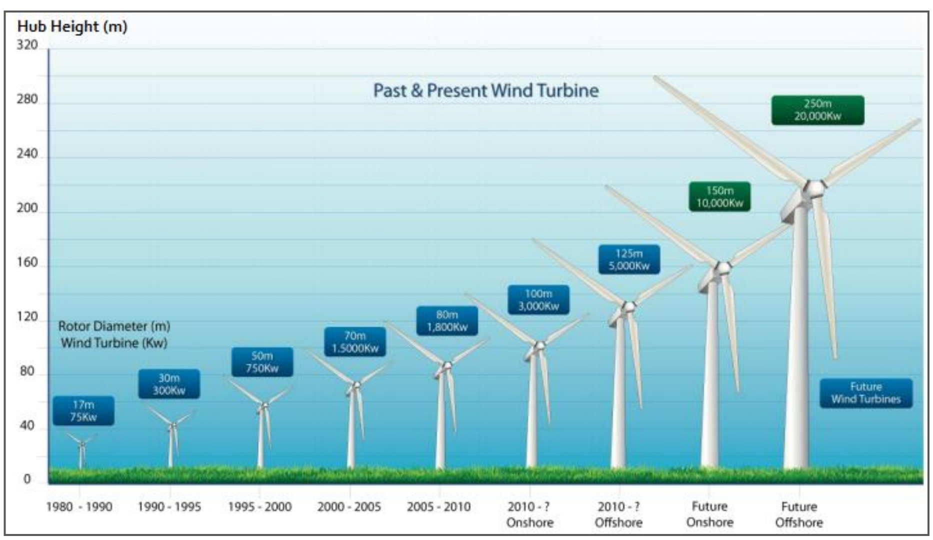


Figure 2-4: Growth in size of typical commercial wind turbines (SBC Energy Institute , 2013)

Over the past 30-odd years, the developments in wind energy technologies allowed wind power to become a viable power source and to enter the electric power mainstream. Until the 1970s, wind power was mainly used to supply mechanical power for grinding grain and pumping water. Increasing fuel prices in the USA and Europe in the 1980s stimulated investment in wind energy technologies and laid the foundation for industry development, particularly in pioneering countries such as the USA, Denmark and Germany. The market boomed in the 1990s , with Spain, India and China entering the scene; however, deployment of wind energy at that time was still relatively sparse. Major strides in wind energy technology though have been observed only in the last 10 years, which contributed to the marked increase in wind energy installed capacity. This specifically relates to advances in turbine designs that further resulted in an **increased height of the tower, length of the blades, and power capacity**, as illustrated in Figure 2-4.

Increased turbine sizes have resulted in wind turbines reaching higher altitudes with stronger and more stable winds, while the increased blade length now allows for a larger swept area and higher reach which provides for greater energy capture. This is solely because average wind speeds at 100m can be up to 50% higher than that at a height of 15m; and simultaneously, a 10% increase in wind speed would lead to about 33% more generation (E.ON, 2013). A 20% increase in blade length is also believed to result in a power increase of about 44% (E.ON, 2013). As a result, advances in component sizes have facilitated the maximization of energy capture over a range of wind speeds while simultaneously reducing the cost per unit of capacity. Such technological trends are vital since they enable the erection of wind farms in areas traditionally perceived as having low-to-medium wind resource potential.

Advances in blade design have not only resulted in longer blades but have also led to the emergence of **flexible rotors** designed for lower wind speeds often made with better materials with higher strength-to-weight ratios and advanced control strategies (IEA , 2013b). Improved blade efficiency helps to capture more energy at lower wind speeds, thus allowing for the installation of wind turbines in lower-wind-speed areas, which are often closer to consumption centres than the best "windy spots" (IEA , 2013b).

Blade manufacturers have also sought to **reduce material volume and mass**. Over the past decades, different aspects of rotor blade technology have been investigated. Steel rotors were tried but rejected as too heavy, aluminium was deemed too uncertain in the context of fatigue endurance, and the wood-epoxy system developed by the Gougeon brothers in the US was employed in a number of small and large turbines (EWEA, 2004). The blade manufacturing industry has, however, been dominated by fibreglass polyester and recently there is an increased prominence of carbon fibre reinforcement in large blade design (EWEA, 2004). Although carbon fibre costs about 10 times as much as fibreglass, the use of lighter blades reduces the load-carrying requirements for the entire supporting structure and saves total costs far beyond the material savings of the blades alone (U.S Department of Energy , 2008).

While today's installed towers are typically 80m to 100m tall, **wind turbine heights and blade sizes are further anticipated to increase in size in the future**. The size of offshore turbines is anticipated to be even higher than that of onshore wind turbines, which may be limited by constraints in the construction process. The largest designs are intended for offshore also because of the reduced wind shear and reduced turbulence. OEMs such as Areva, Siemens and REpower are believed to have announced plans to construct offshore wind turbines with rotor diameters exceeding 130m (up to 154m) which are likely to become the standard (SBC Energy Institute , 2013). Nevertheless, improved technology within the onshore wind industry is also yielding significant increases in wind turbine height. The use of concrete towers in some onshore wind projects has seen the achievement of hub heights of 90m and even beyond.

Other important trends have been around the **drivetrain component improvements**. Since 2008, the share of gearless or direct-drive turbines, with no gearbox monitoring system, has increased from 12% to 20% (IEA , 2013b) and the use of permanent magnet synchronous generators instead of coils is also trending in the markets. With the gearbox removed, the aerodynamic generator drives the generator directly. The simplicity of the system and the avoidance of a gearbox as a maintenance item coupled with reductions in capital cost, drive train losses, downtime and maintenance cost are definite advantages of the direct drive system.

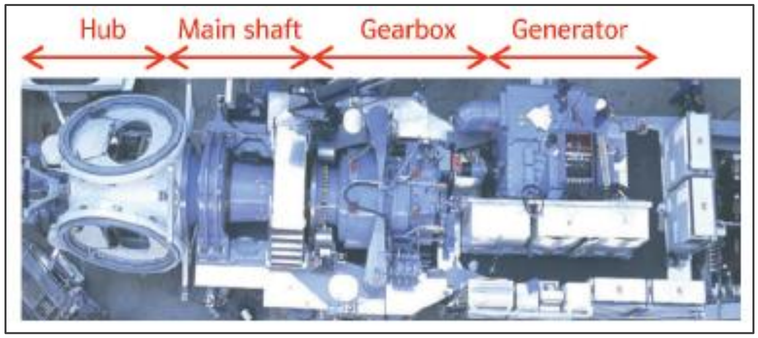


Figure 2-5: Drivetrain

Enercon has been the most high-profile OEM to commit to direct drive technology almost since the start of its significant market presence in the early 1990s (EWEA, 2004). Over the past few years, direct-drive technology has mainly been popularised by the Chinese OEM Goldwind, which has become the world's largest manufacturer of Permanent Magnet Direct Drive (PMDD) wind turbines. As of December 2011, Goldwind's global accumulative wind turbine installed capacity had reached 12,806.05MW (Goldwind, 2012). In future, hydraulic drive-train designs, in which a hydraulic system replaces the mechanical gearbox, are also a possibility (IEA , 2013b).

Overall, the future advances in wind energy technology are expected to continue focusing on improving the capacity factor and reliability of wind turbines, which is a significant shift considering that during the first two decades of the industry, the spotlight was on increasing nameplate capacity. As such, the areas of potential technology improvements are expected to include, among others, the following (NREL, 2012) (Wiser et al, 2011):

- Advanced tower concepts, such as novel designs for taller towers to eliminate the need for cranes for high heavy lifts, new materials (i.e. fibreglass) , advanced structures and foundations, and different designs such as space frame construction or panel sections
- Advanced or enlarged rotors with reduced turbine loads and use of light-weight advanced materials
- Advancements in drivetrains, i.e. fewer gear-stages or direct drives, medium or low speed generators, distributed gearbox typologies, permanent magnet generators, medium-voltage equipment, new materials, etc.

3. SOUTH AFRICA'S LARGE-SCALE WIND ENERGY PROJECTS' ECONOMICS

This section profiles the state of development of South Africa's wind energy industry. The section gives an overview of the key wind energy players involved in the first three bid rounds of the RE IPPPP. The section also gives an outline of other key economical wind industry features that have so far characterised the three bid windows, such as investment costs, project cost breakdown structures, local content and labour structures.

3.1 WIND ENERGY INDUSTRY KEY PLAYERS

Different wind industry stakeholders, both local and international, are involved in the 22 wind energy projects approved under the first three RE IPPPP rounds. These include about seven OEMs, 13 project developers and more than 10 Engineering, Procurement, and Construction (EPC) contractors.

- Project developers whose projects were approved under three RE IPPPP bid windows comprise of both local and international companies. The split between domestic companies and companies that were formed through joint ventures or partnerships with global players is almost equal. Among the preferred bidders, there are seven companies that started in South Africa, such as Biotherm, RedCap, Umoya Energy, MetroWind, Rainmaker Energy, Blue Falcon, and African Clean Energy Developments. Project developers with global footprints that are involved in developing wind energy projects in South Africa include Mainstream Renewable Power (Ireland), Tata Power - an Indian company in joint venture with Exxaro forming Cennergi - Innowind that is owned by Electricité de France Energies Nouvelles (EDFEN) (France), GDF Suez (France), Longyuan Power (China), and Gestamp (Spain) that owns the majority stake in Coria (PKF) Investments. Some top international utility companies like Italy's Enel Green Power are also involved in project development and ownership.
- EPC contractors also comprised of both local and international companies. Most of these EPCs are, however, international companies with subsidiary companies in South Africa. Some of the notable international companies involved in the wind energy projects are Longyuan (China), Iberdrola (Spain) and Acciona (Spain).
- The OEMs involved in the local industry are all companies with the global status, including Vestas (Denmark), Suzlon (India), Nordex (Germany), Sinovel (China), United Power (China), Acciona (Spain), and Siemens (Germany).

The industry in South Africa is relatively vertically integrated. Some OEMs like Vestas, Suzlon, Acciona, and Nordex are not only supplying wind turbines by themselves or through their subsidiaries, but are also involved in EPC. Some of the wind projects are being undertaken on a turnkey EPC basis and will have their own project planning (ESI Africa , 2014). There is also vertical integration amongst some of the project developers such as the Chinese company Longyuan, which is involved as both a project developer and an EPC contractor. Other companies like Gestamp are also involved as project developers and plan to commence with the manufacturing of turbine towers.

Figure 3-1 outlines the market shares of various project developers and OEMs. The figure reveals that seven project developers were awarded projects to the cumulative capacity above 100MW. Mainstream Renewable Power is the leading project developer both in terms of the number of wind energy projects and aggregate capacity awarded. This international company, with a branch in South Africa, was awarded four wind energy projects, one in Bid

Window 1 and three in Bid Window 3, with a total capacity of 489MW. Innowind was awarded three wind energy projects, while African Clean Energy Developments, Cennergi, Red Cap and Longyuan Power & Mulilo Renewable Energy each received two wind energy projects. The rest of the project developers received approvals for one project each. In terms of capacity awarded, the partnership between Longyuan Power and Mulilo Renewable Energy got the second biggest share (235MW) after Mainstream Renewable Power. The other project developers that received a sizeable share of capacity include Cennergi (233MW), African Clean Energy Developments (222MW), Red Cap Investments (188MW), Blue Falcon (135MW), and Innowind (104MW).

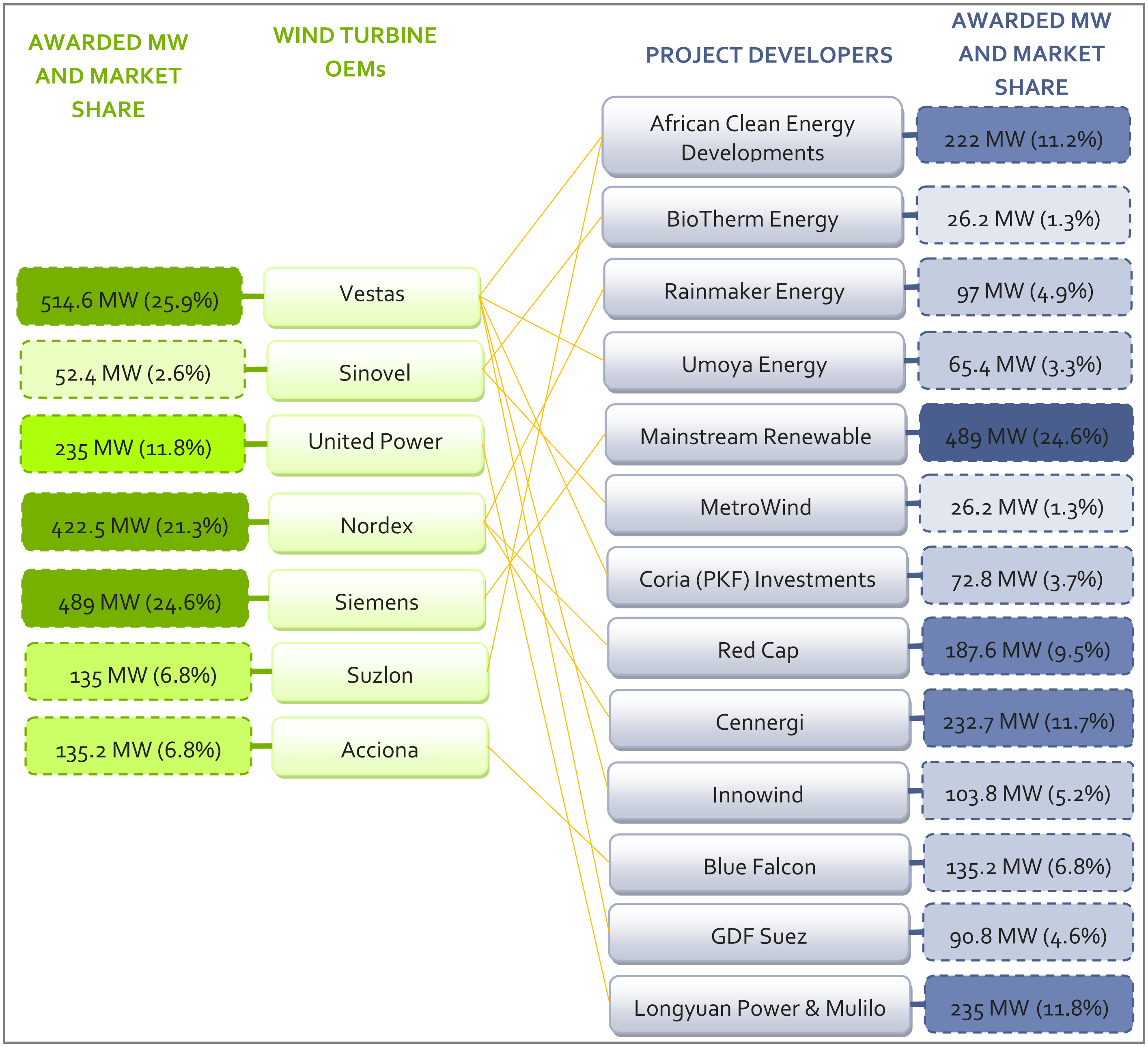


Figure 3-1: Project developers and OEMs involved in the approved RE IPPPP wind energy projects

The top global OEMs are well represented in the South African wind energy market. The first three rounds of the RE IPPPP wind projects have been able to attract global wind turbine manufacturers from across the board. The leading countries in terms of OEMs represented are China and Germany, both with two companies, followed by Spain, India and Denmark with one apiece.

As indicted in Figure 3-1 and Table 3-1, Denmark's Vestas holds the largest market share in the country at this stage (26%), having been contracted to supply wind turbines for eight of the projects with a total nameplate capacity of about 515MW. It is followed by Siemens (24.6%), which was contracted as OEM in all four of Mainstream Renewable Power's wind projects with a total capacity of about 489MW. Nordex comes third holding 21.3% of the market share at this stage with contracts to supply wind turbines to four projects with a total capacity of around 423MW. Both Chinese companies, United Power and Sinovel, were contracted to supply wind turbines to two projects each, with a total capacity awarded of 235MW and 52.4MW respectively. Acciona and Suzlon received one project each. Acciona is supplying turbines with a total capacity of 135.2MW, which is almost the same with Suzlon's total capacity of 135MW. All in all, Sinovel received the least capacity as it was contracted to supply wind turbines to two medium-scale wind projects.

Table 3-1: Wind Turbine Manufacturers Supplying to RE IPPPP Projects

OEM	Number of Projects	RE IPPPP Rounds	Number of Turbines	Capacity Awarded (MW)	Market Share (BW 1, 2, and 3)
Vestas	8	1, 2, 3	235	514.6	25.9%
Nordex	4	1, 2, 3	175	422.5	21.3%
United Power	2	3	163	235	11.8%
Sinovel	2	1	18	52.4	2.6%
Acciona	1	2	46	135.2	6.8%
Suzlon	1	1	66	135	6.8%
Siemens	4	1, 3	~240*	488.9	24.6%
Total	**19**	**-**	**943**	**1 983.6**	**100%**

(Interviews, NERSA presentations & ESI-AFRICA.COM)

*Note: it is known that 60 turbines are only for Siemens' RE IPPPP Round 1 wind project; the number of turbines to be used in the other three wind projects in RE IPPPP Round 3 is still unknown, but it was estimated that each project would have a similar number of turbines as Round 1.

Considering the above, the following key characteristics of South Africa's wind energy industry can be highlighted:

- All the seven OEMs supplying turbines to the first three RE IPPPP wind projects in South Africa are international companies that import the wind turbines from their overseas factories.
- About 763 wind turbines are being supplied into the market for the 19 approved wind projects.
- Vestas has the biggest market share (25.9%) based on the total capacity of projects they are supplying. Siemens is second with a market share of around 24.6%. Nordex is third with a market share of 21.3%.
- Only two OEMs, Vestas and Nordex, participated in all three RE IPPPP rounds so far while Siemens took part in two of the rounds. The other four OEMs have only participated in one of the closed Bid Windows.
- Combined together, the German companies, Nordex and Siemens, have the biggest market share of 45.9% which is almost half of the market, followed by Denmark's Vestas.

All in all, it can be established that the wind energy industry in South Africa is currently dominated by international companies. Such dominance is predominantly in wind turbine supply, construction, operations and ownership of wind projects.

3.2 INVESTMENT COSTS, COST BREAKDOWN STRUCTURE AND LOCAL CONTENT

Wind energy project costs

Wind energy projects are highly capital intensive with large upfront funds required for the construction and installation of the turbines. This differs with other conventional energy technologies such as natural gas power plants where Operational and Maintenance (O&M) costs constitute the bigger share of the cost structure. For wind technology, project costs tend to vary, depending on many factors which include, among others, turbine prices, wind farm sizes, complexity of the site and the likely extreme loads, and other macro economical local market conditions such as labour.

As would be seen in the forthcoming sections, turbine costs make up the single largest component of the capital expenditure (CAPEX) required for wind installation. Turbine prices (in Euros), as measured by the Bloomberg New Energy Finance Wind Turbine Price Index, are down nearly 30% from peak prices in 2008 (World Energy Council , 2013). Sharp increase in demand that resulted in supply constraints on turbines and components (including gear boxes, blades and bearings) prior 2008, as well as higher commodity prices, particularly for steel and copper have all contributed to the growth in wind turbine costs during that period (IEA , 2013b). Since 2009, though, project costs have been on a decline, primarily due to the greater competition among manufacturers, decline in the commodity prices, and opening up of capacities (IEA , 2013b).

Of late, there has been a growing split in the market emerging between the prices paid for older turbine models versus the newer ones. Older model turbines continue to decline in price while newer models have become more expensive, reflecting the premium paid for the increased efficiency offered by new turbines (World Energy Council , 2013). Newer models are targeted specifically at lower resource areas as they are able to extract more energy from lower speed winds than older models. Such higher efficiency can result in a lower levelised cost of electricity (LCOE). Globally, certain markets, such as Brazil and parts of Latin America, continue to be dominated by older, less expensive models due to availability of high quality wind resources (World Energy Council, 2013).

In South Africa, wind project investment costs varied across the three RE IPPPP rounds, which can be seen from information presented in Table 3-2 that gives a snapshot of the general investment cost and average tariffs for the 22 wind projects approved during the three RE IPPPP bid rounds.

Table 3-2: Investment and operational costs for RE IPPPP wind projects

Bid Round	Capacity Allocated (MW)	Total Investment (Project Cost) (R'ml)	Investment cost (R/MW)	Average Tariff (R/kWh)	
				Nominal prices	April 2013 prices
1	634	13 312	20 996 845	1.14	1.28
2	562.5	10 897	19 372 444	0.9	1.01
3	787	16 969	21 561 626	0.74	0.74

(PPIAF, 2014)

INFORMATION BOX: PROJECT COST AND TOTAL VALUE COST DEFINITIONS

Total investment or **total project cost** is defined as "the total capital expenditure, forecast as at the signature date, to be incurred up to the commercial operation date by the seller in the design, construction, development, installation and/or commissioning of the project".

Total project value is defined as "the capital costs and costs of services procured for the construction of the facility, excluding finance charges, land costs mobilisation fees for the Operations contractor and the costs payable to the distributor, NTC and/or a contractor for the distribution connection works or the transmission connection works".

(Department of Energy, 2014a)

Based on Bid Window 3 (latest) cost structure, it can be seen that wind energy projects cost on average around R21.6 million/MW to develop. Globally, onshore wind investment costs ranged between USD1.1 million/MW and USD2.6 million/MW in 2013 (IEA , 2013b), which translates into about R8.6 million/MW to R20.3 million/MW[5]. This though shows that the costs of developing wind energy projects in South Africa remains on the upper side of the range, which can be attributed to the emerging nature of this industry in the country. Nonetheless, compared to other renewable energy technologies, it is slightly greater than that of Solar PV, which stands at around R18.7 million/MW, but way below that of Concentrated Solar Power (CSP), which comes at around R89.7 million/MW. It is also higher than the costs observed in Bid window 1 and Bid Window 2. This could be explained by the higher exchange rate that had to be applied in Bid Window 3 and the fact that the figures presented reflect nominal values.

Importantly, the average tariff of wind projects in South Africa has been dropping from R1.14/kWh in Bid Window 1 to R0.75/kWh in Bid Window 3 in nominal prices. In April 2013 prices, the average tariff in Bid Window 3 has dropped by a staggering 42.7% compared to that of Bid Window 1. Globally, LCOE of onshore wind projects varied between USD0.047/KWh and USD0.117/KWh (World Energy Council , 2013), which translates into about R0.36/kWh and R0.91/kWh. This means that the latest prices are in line with the global averages, although they are positioned in the upper half of the range.

Wind energy projects cost breakdown

Wind projects awarded the status of preferred bidders in Bid Window 3 valued at R16 969 million as suggested earlier. However, the actual project value of the seven preferred bidders was R13 315 million, which excludes finance charges, land mobilisation costs, and other associated expenses (IPP office , 2014). The latter can be divided into actual expenditure on goods and services procured for the construction of the facility, which in turn can be grouped under two major categories such as a Wind Turbine and a Balance of Plant (BOP). Table 3-3 provides the aggregated cost breakdown structure of preferred bidders in Bid Window 3 and allows for the comparison thereof with other two sources.

Table 3-3: Wind Energy Project Cost Breakdown

CSIR 2010		Bid Window 3 (2013)	
Component	**%**	**Component**	**%**
Wind Turbine	64%	Wind Turbine	55%

[5] Assuming an average exchange rate of R7.8/US$ for 2013

CSIR 2010			Bid Window 3 (2013)		
Component		%	Component		%
BOP	Grid connection, 12%	36%	BOP	Foundation, 8.7%	45%
	Civil Works, 9%			Electrical, 12.5%	
	Other Capital Costs, 15%			Transport & Erection, 13.3%	
				Other (Design and Non-EPC Costs), 10.5%	
TOTAL		**100%**			**100%**

(CSIR, 2010; calculations based on the IPP Office data, 2014)

Based on the three sources listed in Table 3-3, it can be established that turbine costs account for most of the capital cost. However, it is clear that the split between the wind turbine and BOP among the sources referred to in Table 2-4 differs, although it should be noted that it could be attributed to the variance in the ways certain item costs were classified. Nonetheless, while the figures reported by the CSIR (2010), which were based on European trends at that time, suggest that the wind turbine accounts for 64% of the project value and the rest constitutes BOP, the latest information collected from Bid Window 3 depicts a slightly different picture.

As can be seen from Table 3-3, wind turbines account on average for 55% of the project costs in Bid Window 3 with BOP having a higher share than that observed in the CSIR (2010) study. The cost breakdown structures presented by the latter source referred to projects developed in Europe, which suggests that care should be taken in comparing them with the empirical data collected from Bid Window 3. However, it can be suggested that BOP in South Africa accounts for a greater share of project costs than what was estimated in 2010 by the CSIR.

A more detailed analysis of cost breakdown of wind energy projects is presented in Figure 3-2, which is based on the data derived from Bid Window 3 preferred bidders.

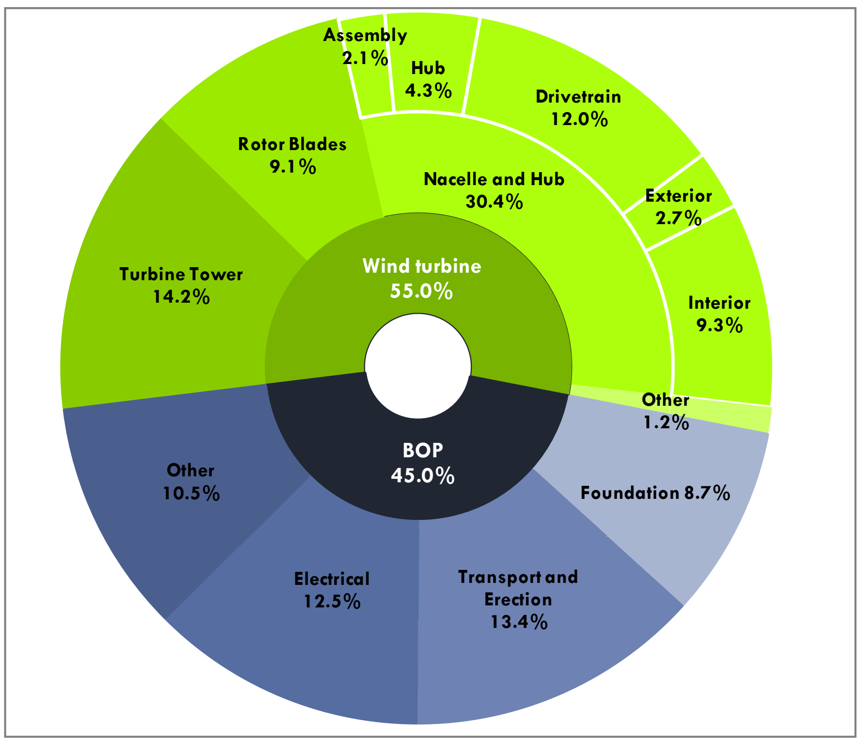


Figure 3-2: Bid Window 3 Wind Project Cost Breakdown (Calculations based on IPP Office data, 2014)

For the purposes of this study, wind turbine components were classified into broad key component categories which include turbine tower, blade, nacelle and hub, and other. The nacelle component was further sub-divided into hub, nacelle drivetrain, nacelle interior, and nacelle exterior as per the Department of Trade and Industry (DTI) key component categorisation. Another sub-category, 'nacelle assembly' is also included in the breakdown in order to illustrate the share of costs that goes into the assembling of the various components making up a nacelle. Overall, the following can be highlighted with respect to the cost structure related to **key components** that as suggested earlier account for 55% of the project value:

- The **nacelle and hub** unit constitutes the most expensive key component in the cost breakdown structure of a wind energy project. The information from Bid Window 3 projects shows that this unit accounts for approximately 30.5% of the overall cost of a wind energy project. Within the nacelle and hub unit, a drivetrain that comprises of a main shaft, a gearbox, and rotor bearings represent the biggest cost item (12.0% of the total project capital cost). It is followed by the nacelle interior that includes components such as generator, transformer, power converter, brake system, yaw system, and mainframe, which all account for about 9.3% of the total project value. Hub accounts for about 4.3% of the project's capital costs, with nacelle exterior or housing representing the smallest cost item of the nacelle and hub unit and accounting for 2.7% of the project value.
  A further breakdown of items using various secondary sources (refer to Table 3-4) suggests that the gearbox is the largest cost item in nacelle and hub unit. Alone, the gearbox accounts for 9.6% of the wind project's capital expenses. The power converter (2.7%), transformer (2.0%), generator (1.8%), mainframe (1.5%), main shaft (1.5%) and the pitch system (2.8%) are some of the components of the nacelle which constitute a considerable cost value in the nacelle's total costs. Nacelle assembly accounts for about 2,1% of the project value.

Table 3-4: Detailed cost breakdown of key components

Key components	Sub-components		Share	
Tower	Tower		14.2%	**14.2%**
Blade	Blade		9.1%	**9.1%**
Nacelle + Hub	Nacelle Assembly		2.1%	**2.1%**
	Hub	Rotor hub	1.5%	**4.3%**
		Pitch system	2.8%	
	Nacelle - Drivetrain	Main shaft	1.5%	**12.0%**
		Gearbox	9.6%	
		Rotor bearings	0.9%	
	Nacelle - interior	Generator	1.8%	**9.3 %**
		Transformer	2.0%	
		Power converter	2.7%	
		Brake system	0.7%	
		Yaw system	0.7%	
		Mainframe	1.5%	
	Nacelle - exterior	Nacelle housing	2.7%	**2.7%**
Other	Other	Screws/cables	1.2%	**1.2%**
TOTAL			**55.0%**	

(Calculations based on CSIR, 2010 and other sources)

- **Turbine** tower is the second biggest cost item of the wind energy project from a key component perspective. As suggested by the data reflecting project cost breakdown of Bid Window 3 preferred bidders, turbine towers account for about 14.0% of the project value. It should be noted though, that from the perspective of sub-components, wind towers are the largest cost items that exceed expenditure on a drivetrain.
- **Blades** account for about 9.1% of the project capital expenditure as suggested by Bid Window 3 preferred bidders' aggregated data.

As far as **BOP** is concerned, which accounts for 45% of the wind energy project value, expenses on **transport and erection** appear to be the biggest single cost item included under BOP constituting 13.3% of the project value. Expenses on **electrical/grid connection** (10.5% of project value) represent the second highest BOP cost item, followed by expenditure on **foundation and civil works** (8.7% of project value).

Local content composition

Table 3-5 shows the level of local content achieved for each of the three bid rounds that have so far been concluded under the RE IPPPP.

Table 3-5: Local content for preferred bidders of wind energy projects in Bid Window 1, 2 and 3

Local content indicators	Bid window 1	Bid window 2	Bid window 3
% of Project Value	27.4%	48.1%	46.9%
Total R value	R2 727 million	R4 817 million	R6 283 million
R/MW	R4.3 million/MW	R8.6 million/MW	R7.9 million/MW
Components localised	• Balance of Plant	• Towers • Balance of Plant	• Towers • Balance of Plant • Meteorological Masts • Anchor cages

(PPIAF, 2014; DOE, 2013b, data sourced from IPP Office, 2014)

The following can be summarised from the table presented above:

- In **Bid Window 1**, an average local content of 27.4% was achieved, which equated to about R2.7 billion or R4.3 million being spent in South Africa for every MW of wind energy projects awarded to the preferred bidder status in that round.
- In **Bid Window 2**, the local content percentage increased dramatically largely due to the inclusion of towers into local procurement. As indicated, about 48.1% of local content was achieved by preferred bidders for wind energy projects in Bid Window 2, which equated to about R4.8 billion of total local spend, or R8.6 million for each megawatt of awarded installed capacity.
- The average local content of preferred bidder for wind projects in **Bid Window 3** was 46.9%. This is expected to result in the local spend of R6.3 billion, considering the total installed capacity awarded for that round equates to about R7.9 million of local procurement per megawatt of wind energy projects developed. The lower local content percentage in Bid Window 3 compared to Bid Window 2 could be partially attributed to the higher exchange rate on imported components, which inflated the total project value and reduced the share of the local content. At the same time, the lower value of local content per MW of installed capacity approved in Bid Window 3 compared to Bid Window 2 could be partially attributed to the greater competition among project developers that resulted in reduced margins and subsequently local costs.

As mentioned earlier, total project value of preferred bidders in Bid Window 3 equated to about R13 315 million, of which R6 283 million in total, or R7.9 million/MW, would be spent on procurement of South Africa's goods and services. As indicated in Table 3-6, the above-mentioned local content per MW was largely derived from BOP components that account for three quarters (74.8%) of the local spend per MW of wind energy installed capacity as of Bid Window 3 data. The rest, or 25.2%, of the local content, was derived from expenditure on key components and specifically on turbine towers.

Table 3-6: Local content breakdown per component for Bid Window 3 preferred bidders of wind energy projects

Category	Key Component	Average local content % per component	Local content R'million/MW	Local content breakdown	
Wind Turbine	Tower	79.9%	R 1.9	24.2%	25.2%
	Blades	-	R 0.0	-	
	Hub	1.4%	R 0.0	0.1%	
	Nacelle- Drive Train	2.2%	R 0.0	0.6%	
	Nacelle- Exterior Fittings	-	R 0.0	-	
	Nacelle- Interior Fittings	0.4%	R 0.0	0.1%	
	Other	7.9%	R 0.0	0.2%	
Balance of Plant	Foundation	100.0%	R 1.5	18.6%	74.8%
	Transport and Erection	57.2%	R 1.3	16.4%	
	Electrical	82.5%	R 1.7	22.0%	
	Other	79.7%	R 1.4	17.9%	
TOTAL		**46.6%**	**R7.9**	**100.0%**	

(Calculations based on data sourced from the IPP Office, 2014)

Considering the information presented in Table 3-6, the following can also be highlighted:

- With respect to **key components**:
  - Among the wind turbine key components, turbine towers are currently the only components that are primarily manufactured locally. About 80% of turbine tower costs out of the total project value is being spent locally. Components that are imported include flanges, ladders, and other parts. It must also be noted that the local content and investment costs reported in this section are for steel towers since these were the only ones utilised during Bid Window 3. In Bid Window 2, there was one company that made use of locally manufactured concrete towers.
  - Blades are currently not manufactured in South Africa; therefore, these components are not localised at this stage.
  - With respect to nacelle and hub, small opportunities for localisation are currently explored with an average of 1% of the total local content being added through the procurement of some items locally. However, these are mainly manufactured by OEMs outside South Africa and thus are currently imported. Items that are being procured locally for some projects include for example transformers.
- With respect to **BOP**:
  - As mentioned, BOP currently accounts for the largest share of the local procurement spend associated with the establishment of wind energy projects; however, only expenditure on foundation or civil works is fully localised.
  - With regard to transport and erection costs, only 57.2% of these expenses are currently attributed to local spend. The rest is directed towards expenditure on services of international companies that have the machinery and expertise in transporting and lifting wind turbine components, as well as the cost of sea freight.

- Expenses on electrical and grid connection are primarily localised with about 17.5% being spent on goods and services procured from outside South Africa. These include speciality components such as transformer oils.
- Other expenses comprise of project management, contingencies, commercial costs, etc., which are also primarily localised. But considering that many of the project developers are international companies and all involve international OEMs in the process, a portion of these expenses is spent on procurement of foreign expertise and goods.

3.3 WIND ENERGY PROJECT LABOUR REQUIREMENTS

INFORMATION BOX: PERSON-MONTH AND JOB DEFINITIONS

Person-month refers to a total of 160 hours worked by an employee (Department of Energy , 2014a).

Job refers to a total number of person months for the construction measurement period and the operating measurement period divided by 12 months; employment for 12 months equals one job (Department of Energy , 2014b).

Table 3-7 gives a snapshot of the estimated employment to be created in the 22 wind projects that have so far been approved under the RE IPPPP.

Table 3-7: Aggregated Wind Sector Employment

Sector	Bid Window 1		Bid Window 2		Bid Window 3		Total
	Jobs	Job/MW	Jobs	Job/MW	Jobs	Job/MW	
Construction (18 months)	1 810	3	1 787	3	2 612	3	6 209
Operations (cumulative over 20 years)	2 461	4	2 238	4	8 506*	11	13 205

Bid Window 3 Job Specifics			
Sector	Person Months	Lifecycle Jobs	Annualised Jobs
Construction	31 343	2 612	1 741
Operations	102 069	8 506	425

(PPIAF, 2014; inputs received from the IPPP office, 2014)

* Note: Job creation potential for Bid Window 3 Projects during operations is calculated following a different methodology than that employed in the previous rounds

As indicated in Table 3-7, wind projects in Bid Window 1, 2 and 3 will create a total of 1 810, 1 787 and 2 612 construction jobs respectively. The projects will also create a total of 2 461, 2 238 and 8 506 operations jobs over the entire life of the different wind projects.

Looking at the job per megawatt ratios, about three construction and four operations jobs are created respectively per megawatt of wind project build considering data provided for Bid Window 1 and Bid Window 2. While the average number of construction jobs per MW remains the same for Bid Window 3 as for the earlier bid windows, the situation with operational jobs differs significantly. As suggested, about 11 jobs per MW are expected to be created during the entire operational period of wind energy projects approved under Bid Window 3. This could be as a result of the different models used to calculate job effort for the three bid windows.

It is important to also note that reported jobs for the operational period at least for Bid Window 3 refer to the entire life cycle of the project, i.e. they refer to the total number of person-years to be created over a 20-year operational period, rather than the number of jobs that will be sustained on an annual basis. A conversion of operational jobs reported into annual sustainable jobs suggests that wind energy projects approved under Bid Window 3 will sustain about 425 employment positions for 20 years, which equates to about 0.54 jobs/MW.

4. SOUTH AFRICA'S WIND TURBINE MANUFACTURING INDUSTRY ANALYSIS

This section examines the current status and capabilities of the domestic wind turbine manufacturing industry with a focus on the key components such as wind towers, blades, and nacelles and hubs. The section outlines the structure of the industry, with particular emphasis on the different local and global companies engaged in the manufacturing and supplying of key wind turbine components in South Africa. The chapter also includes discussions on areas around industry capability, both existing and potential.

4.1 WIND TURBINE COMPOSITION AND INDUSTRY INTEGRATION

A few years back, most common large-scale onshore wind turbines had a rated capacity of between 1MW and 3MW with rotor diameters ranging between 60m and 90m (U.S Department of Energy , 2008). In 2012, the average size of wind turbines was 2.5MW with rotor diameters of 100m (EWEA, 2012).

The composition of the typical large-scale wind turbine is illustrated in the next figure.

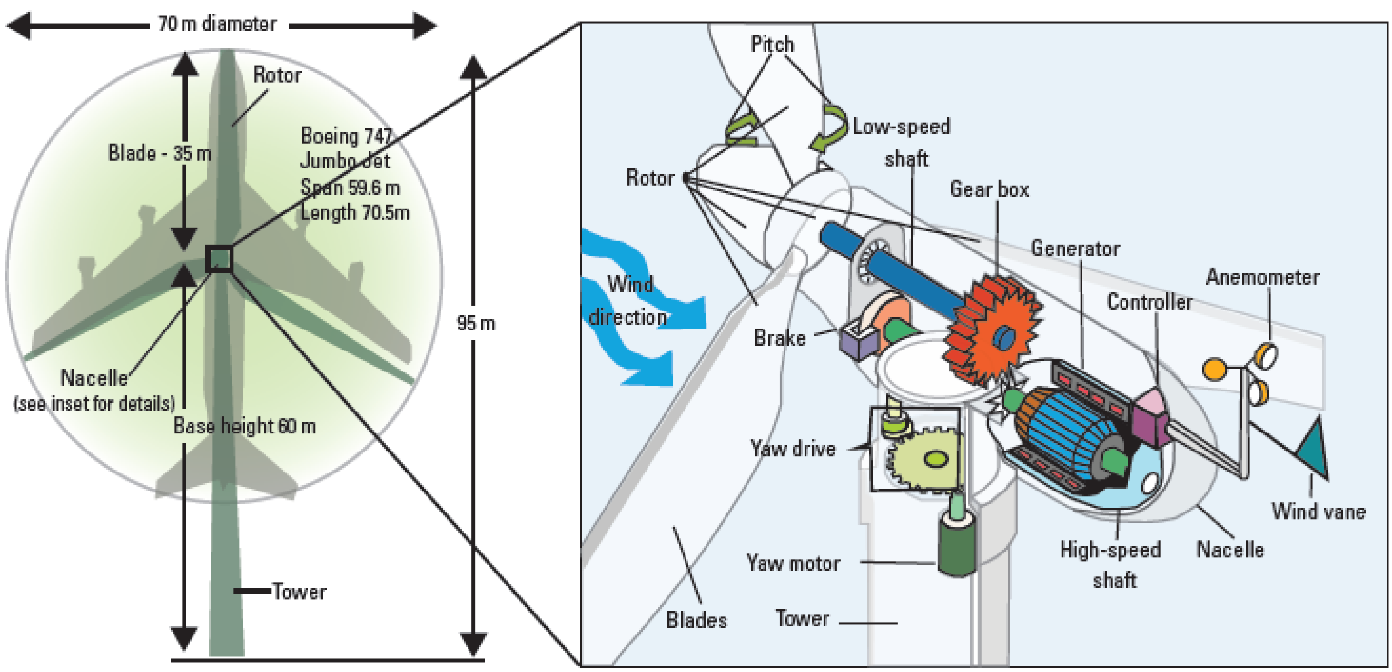


Figure 4-1: Composition of a typical large turbine and key components (Wilburn, 2011)

A typical wind turbine comprises of about 8 000 components and require a variety of materials to manufacture. Manufacturing of key items such as turbine tower, rotor, and nacelle requires steel, concrete, aluminium, copper, fibreglass, adhesives, and other miscellaneous materials. On average, about 540 tons of materials are required to manufacture a 3MW wind turbine (Wilburn, 2011). As suggested in figure 4-2, though, steel by far accounts for the biggest share in weight of a wind turbine. It is followed by fibreglass and concrete.

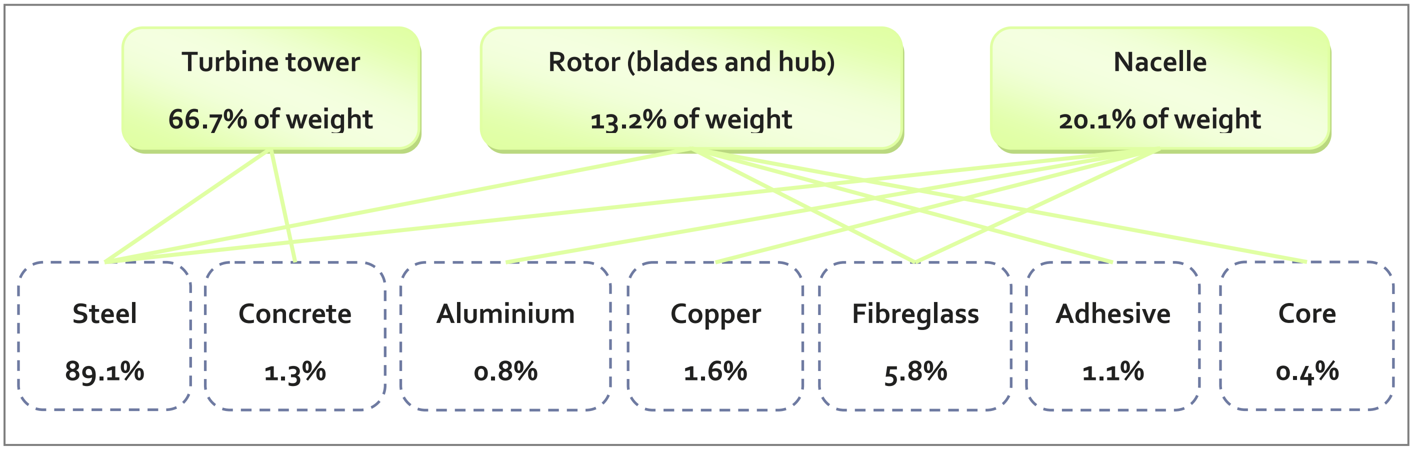


Figure 4-2: Main materials used in manufacturing of wind turbines and their shares in total weight of a wind turbine (U.S Department of Energy , 2008)

Wind turbines are manufactured by Original Equipment Manufacturers (OEMs), which design, assemble, and brand their products. As was mentioned earlier, OEMs adopt different business models that allow them to remain competitive and capitalise on their comparative advantages. Some OEMs are highly vertically integrated and tend to develop proprietary wind turbine designs, manufacture blades and towers in-house, and assemble the nacelle themselves. Other OEMs tend to outsource manufacturing of key components to the outside suppliers retaining design and assembly in-house. Different business models adopted by OEMs lead to varying degrees of vertical integration among them (refer to Figure 4-3):

- Enercon, Gamesa, Suzlon and Sinovel tend to be relatively high vertically integrated with in-house manufacturing capabilities including varying combination of such components such as blades, generators, towers, castings, control, and gearboxes
- GE, Nordex, Repower, Goldwind, and Acciona show lower levels of vertical integration and make use of a wide range of key suppliers with only certain key components being manufactured in house, which are also designed to cater for only a portion of their orders with the rest being outsourced

	Blades	Gearbox	Generator	Castings & Forgings	Tower	Overall
Goldwind	○	○	○	○	○	Very Low
Repower	◔	○	○	○	○	Very Low
Acciona	◔	○	○	○	○	Very Low
Clipper	○	●	○	○	○	Low
Nordex	◑	○	○	○	◑	Low
GE	○	◑	◑	○	○	Low
Dongfang***	◕	○	◑	◑	○	Moderate
Vestas	◕	○	◔	◑	◑	Moderate
Siemens	◕	●	◑	○	○	Moderate
Gamesa	◕	◑	◑	◑	◑	High
Mitsubishi	●	◕	◕	○	◑	High
Suzlon	◕	◔	◕	●	◑	High
Enercon	◕	n/a*	◕	○	◕	Very High
Sinovel**	○	●	◑	◕	●	Very High

○ = 100% outsourced
◔ = Some internal production, mostly outsourced
◑ = Equally internally and externally sourced
◕ = Internal, but may 2nd source in some cases
● = 100% internal. May sell on merchant basis

Figure 4-3: Levels of vertical integration among some OEMs (Poncin et al, 2012)

The following paragraphs provide some background into the composition of the key components and manufacturing strategies adopted by some of the global OEMs.

TURBINE TOWER

Wind turbine towers provide the support system for the turbine blades and nacelle; they also serve as conduits for electrical and electronic transmission and grounding (Wilburn, 2011). Various construction technologies for wind turbine towers exist internationally, mainly tubular steel, precast concrete, hybrid (concrete and steel), and slip-formed concrete. Out of these, tubular steel towers are the most widely used tower technology. These turbine towers generally comprise of three or four tubular steel sections coated with paints and sealants, the base or foundation, flanges and bolts, cables, platforms, ladders, lighting, and lifts to provide access for maintenance.

The most widely used steel tower configurations for onshore wind projects include steel sections and a concrete base, where about 98% of the tower's weight comprises of steel and the rest primarily of concrete (U.S Department of Energy , 2008). Steel sections are manufactured using plated sheets that are cut, rolled into conical shape and then welded into rings (AWEA, 2011). Rings are then welded together and painted (AWEA, 2011). Overall, depending on the design, a turbine tower accounts for up to 67% of the weight of the turbine (Energy Alternatives India, 2010). The use of pre-stressed concrete in tower construction is becoming more frequent; however these trends are mainly observed in off-shore applications.

Globally, **towers together with blades are among the first key components that tend to be localised** as they are large, expensive, and difficult to transport. Manufacturing of towers is also less sophisticated than that of blades, for example, which offers opportunities for establishing local capabilities using existing expertise in the respective countries. As a result, OEMs tend to be less vertically integrated in tower production than in production of other key components, such as blades (UNITC, 2009). Nonetheless, some OEMs still manufacture towers in-house and others outsource their production to their key suppliers. In the USA, for example, out of a sample of 15 manufacturers of wind towers in 2009, only two were OEMs that established local facilities while the rest were US companies supplying towers to other OEMs (UNITC, 2009). However, as suggested in Figure 4-3, 100% in-house production of towers was done by Sinovel only, while the rest of the OEMs either sourced towers from their key suppliers or equally produced it in-house and outsourced.

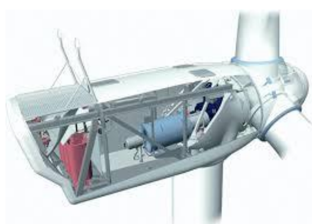
BLADES

A total electrical output of a wind turbine is partially reliant on the efficiency at which air is able to move across a turbine blade. As such, the design and the configuration of the blades, as well as surface quality of each blade, are important factors affecting the overall performance of a wind turbine. As such, manufacturing of wind turbine blades is a highly sophisticated production process requiring high-tech engineering capabilities and expertise in working with advanced composite materials, similar to that of the aerospace industry.

Most wind turbines include three blades, which are generally between 30m and 55m long (AWEA, 2011). Aside from the length, the design and material used to manufacture blades determines the total weight of the blades. Rotor blades are primarily made of fibreglass-reinforced plastic (about 78% of the total weight) mixed with epoxy adhesive (15% of weight), and the lightweight core that is usually made up of balsa wood or polymer foam (5% of weight) (Wilburn, 2011) . On average they account for about 7.2% of the total weight of the wind turbine (U.S Department of Energy , 2008).

Setting up a **blade manufacturing plant requires large capital investments and access to know-how**, making it a relatively difficult niche market to enter. At the same time, manufacturing of blades is highly labour intensive to produce as rotor blade manufacturing usually involves layering of glass fibre by hand and manually rolling out the polyester in the laminates, which is extremely difficult to automate. As was the case with wind turbine towers, some OEMs tend to design and manufacture these in-house and others outsource production of all blades to other companies, such as LM Blades. Most of the top OEMs, though, as indicated in Figure 4-3, manufacture blades internally and only occasionally outsource them. In the USA, for example, out of a sample of 10 blade manufacturing plants, six were set up by OEMs and the other four were established by the US companies to supply to the OEMs (UNITC, 2009). Many of the OEMs though tend to develop their own designs and outsource manufacturing to their specifications to other companies (UNITC, 2009). The latter approach creates opportunities for establishing local facilities that become preferred suppliers of blades to a variety of OEMs; however, such a business model requires significant investment into a different range of moulds.

Nacelle and Hub



The hub connects the blades to the main shaft, which in turn forms part of the nacelle. The nacelle contains equipment required to convert and negate energy. Aside from the main shaft, the nacelle includes components such as the housing that protects machinery from the external environment, a gearbox, a generator, bearings, castings, mechanical breaks and other items. The hub is manufactured using ductile iron, while most of the components of the nacelle are manufactured using steel and to a lesser degree aluminium, fibreglass, and copper. The hub and pitch drives are constructed primarily of steel. Overall, the nacelle accounts for about 20.1% of the total turbine weight, while the hub takes up about 6% of the weight.

Manufacturing strategies with respect to the nacelle components differ to that observed with respect to blade and tower manufacturing. **Most OEMs focus on assembly of the nacelle and tend to limit their manufacturing to selected components of the nacelle only**, while sourcing the other parts from preferred suppliers. As indicated in Figure 4-3, generators, followed by gearboxes, are among the most common items of nacelle that are usually produced in-house by OEMs.

- Castings and Forgings industries provide for a sizeable number of nacelle components. Forged parts may include among others main shafts, gear blanks and bearing rings; while cast parts include the rotor hub, mainframe, forward housing or frame, gearbox housing and bearing housings. Before being sold off, Vestas' global castings and forgings factories manufactured nacelle components such as hubs, main shafts, and main frames. Suzlon does all the manufacturing of forged and cast parts in-house. However, as indicated in Figure 4-3, the majority of OEMs tend to outsource manufacturing of forged and cast parts. OEMs such as Gamesa, Dongfang and Sinovel engage in both outsourcing and in-house manufacturing.
- Gearboxes are considered to be among the most critical and most mechanically advanced components in wind turbines, with the primary focus being directed towards ensuring reliability of the entire system. The international gearbox market is highly concentrated with three European companies such as Winenergy that is part of Siemens (40% of the market), Hansen – part of Suzlon (30% of the market), and Movenats supplying multiple OEMs and controlling a significant share of the market back in 2009 (UNITC, 2009) (Wind Directions, January/February 2007). As suggested by Figure 4-3, Siemens and Clipper were the only companies in 2012 that relied completely on in-house manufacturing capability of gearboxes, while GE, Vestas, and Mitsubishi, while having in-house capabilities, also sourced some gearboxes from other suppliers. While companies manufacturing gearboxes for other applications can potentially enter the market, it can take up to several years to tool up and test for specific turbine sizes (Wind Directions, January/February 2007). The gearbox is easily the most maintenance-needy component in a turbine and elimination of the gearbox seeks to reduce maintenance and reliability issues. In this context, gearless systems have been seen to increase their share in the market, particularly in off-shore applications, which may impact the structure of this industry in the future.
- Bearings are used for the main shaft, gearbox, and pitch and yaw control. Manufacturing of bearings is done by companies that also supply to the heavy industry with the wind energy market accounting for a small fraction of their order. Requirements for bearings used in wind turbines though are such that only a few companies globally have the capabilities to produce them (UNITC, 2009). These include, for example, the Swedish company SKF and the German FAG.
- Generators usually come in three types: doubly fed induction generators (DFIGs), direct-drive annular generators (DD-Annular), and Permanent Magnet Generators (PMGs). The profile of the generator manufacturing industry is less concentrated compared to the gearbox market. As indicated in Figure 4-3, some of the OEMs, such as Enercon and Suzlon tend to rely on in-house capability; others either manufacture them in-house or source from outside suppliers such as Weier, Elin, ABB, LeroySomer, Loher, Siemens, Indar (part of Gamesa), and Cantarey. Generators can be manufactured in a standard format or, alternatively, they can be custom-made according to the specific needs of the respective OEM. The larger capacity generators tend to be mostly design-specific to a given wind turbine model with intellectual property residing with either the OEM or the generator manufacturer.

4.2 TURBINE TOWERS LOCAL MANUFACTURING CAPABILITY

This section profiles the current setup of the wind turbine tower industry in South Africa. The section dwells on both the current and potential manufacturers key to this industry.

GENERAL INDUSTRY PROFILE

Wind turbine towers to the South African market have mainly been sourced from Chinese and other Asian manufacturing companies. The wind tower manufacturing industry in South Africa (for utility-scale turbines) has only started to develop in recent months and it is still in its infancy.

DCD WIND TOWERS

DCD Wind Towers is a local South African private limited company which is part of the DCD Group. Their parent company, DCD Group, was established in 1946 and currently has a portfolio of subsidiary companies spread across different sectors with a turnover above R250m. Besides DCD Wind Towers, nine other subsidiary companies under the DCD Group are established in South Africa that include, among others, DCD Rindrollers that specialises in seamless forged products and DCD Heavy Engineering.

The domestic industry is currently represented by two local companies, DCD Wind Towers and Gestamp Renewable Industries:

- DCD Wind Towers was established in 2013 and recently commissioned a wind turbine tower manufacturing facility worth R300m in the Coega Industrial Development Zone situated within the Nelson Mandela Metropolitan Municipality near Port Elizabeth, in the Eastern Cape Province of South Africa.
- Gestamp Renewable Industries is a renewable energy industrial division of a Spanish conglomerate called Corporación Gestamp. The corporation is a diversified company, globally renowned for its specialisation in renewable energy through Gestamp Renewables. Gestamp Wind, one of Corporación Gestamp's business units, has already been involved in the country's RE IPPPP where it is a lead developer in the Noblesfontein Wind Farm Project approved under Bid Window 1. Gestamp has got a 60% stake in the Noblesfontein Wind Farm Project which will have a 72.8MW installed capacity. Gestamp Renewable Industries commissioned a tower manufacturing facility in Atlantis in the Western Cape Province with a total investment value of around R308m[6] in the last quarter of 2014.

TARGET MARKET ANALYSIS

DCD Wind Towers targets the local South African wind industry market and has no plans, currently in place, to expand into export markets. The company currently produces towers and anchor cages. DCD Wind Towers also already manufactured a set of 4 X 50.3m blades for a 2.5MW turbine, but a stable market is required to support this business model. It has also assembled a nacelle, making use of a number of components sourced locally. The company can manufacture other wind turbine components such as the main shaft, door sections for the tower, flanges, and rings for gears and slewing rings. On top of that, DCD Wind Towers can also do the machining and the assembly of rotor hubs.

The company currently supplies wind towers to Vestas and Nordex, two international companies that have been involved in the RE IPPPP. According to the company, the price and quality of their towers and anchor cages products

[6] The total value of the investment is €22m, expressed in rand terms using an exchange rate of €1/R14

compares well to that of global leaders. The company's total order to date stands at 122 towers and fifteen anchor cages, with a market share distributed as indicated below.

Table 4-1: DCD Current Market Share

RE IPPPP Round	Total Number of Towers	Component	Components Supplied	Market Share (%)
1	317	Towers	0	0%
		Anchor cages	0	0%
2	237	Towers	122	51%
		Anchor cages	15	6%
3	370	*Towers*	*82% (expected)*[7]	*22% (expected)*
		Anchor cages	-	-

(Study survey, 2014)

As can be seen from Table 4-1, the company's market share in the South African wind energy market is relatively small. The company did not supply any products during Round 1 of the RE IPPPP and claimed a sizeable market share in Round 2 where they supplied about 51% of the total turbine towers used and 6% of the anchor cages. The company's expected market share for Bid Window 3 is way below that of Bid Window 2, with the market share expected to fall from a high of 51% down to 22%.

Although the company is eager to participate in export markets, mainly in sub-Saharan African countries like Namibia and Mozambique, the unavailability of export credit schemes means that OEMs cannot order their tower products for use in markets outside South Africa. According to the company, OEMs insist on receiving export credits in order to expand the local manufacturing for exports. Besides the reluctance of OEMs to source local products for use in the export market, the availability of highly subsidised and cheaper towers from China also impedes DCD Wind Towers' participation in export markets. As a result, the company currently targets and only supplies the domestic market, where it has a comparative advantage in terms of local content and relatively lower logistical costs as a result of its proximity to wind farms.

LOCAL MANUFACTURING CAPABILITIES

The manufacturing capacity for DCD Wind Towers per annum is 110 towers and 200 anchor cages. DCD Heavy Engineering has an annual production capability of 60 foundation bases while that of DCD Ringrollers stands at 400 tower flanges. DCD's manufacturing capacity of 110 towers per annum, which equates to about 220MW of wind energy projects demand assuming a 2MW wind turbine, is not sufficient to meet the current demand in the market. This could possibly be one of the reasons why many Project Developers and EPC contractors import Chinese and Asian towers.

INFO BOX

DCD Wind Towers can manufacture 110 towers and 200 anchor cages; DCD Ringrollers - 400 tower flanges, and DCD Heavy Engineering – 60 foundation bases.

Data received from DCD shows that the company's manufacturing capacities are not being utilised in full at the present moment. DCD Wind Towers' current capacity utilisation is almost 40% below its wind tower manufacturing capacity. The company will be producing 66 towers in 2014 and 70 towers in 2015 instead of the 110 towers that it

[7] Still needs to reach financial close

can manufacture per annum. In terms of anchor cages, the company's current capacity utilisation is almost 93% below capacity as it will only be producing 15 anchor cages in 2014 instead of the 200 anchor cages that it can manufacture per annum.

If the company were to increase the capacity, it would need an annual minimum demand for 300 towers and a margin of about 15% to justify investment into expansion. Other key prerequisites for upscaling would include the availability of financial assistance and skills, a supportive regulatory environment and the availability of local R&D facilities. The company also notes that upscaling the current facilities would take about 18 months and would also result in a price increase of between 10% and 20%. In order to sustain the tower manufacturing business, DCD Wind Towers will need a stable wind market with a minimum demand of 250 turbine towers per year for the next 10 years, which is an equivalent of about 500MW of installed capacities.

Gestamp Renewable Industries' manufacturing facility is set up to produce 150 towers per annum.

LOCAL CONTENT PARTICULARS

DCD Wind Towers has a relatively large local content for its tower manufacturing (about 80% as suggested by Bid Window 3 data). All the steel and consumables are sourced locally; however, the internals, door segments, and flanges are currently being imported. The company cites the issue of costs, availability and quality as the major reasons behind it currently importing components such as the internals, door segments, and flanges. Information gathered from the company reveals that imported flanges are 50% cheaper compared to those produced locally.

EMPLOYMENT INTENSITY PARTICULARS

Currently, DCD Wind Towers employs 100 people while the other DCD Group subsidiary companies like DCD Heavy Engineering and DCD Ringrollers employ 300 people each. If the company is to upscale its wind tower manufacturing facility in order to achieve a targeted manufacturing capacity of 300 towers per annum, it will generate 50 more permanent jobs within a period of five years.

Gestamp Renewable Industries will create more than 200 jobs for the local labour once it achieves full operational capacity.

TURBINE TOWER MANUFACTURING INDUSTRY OUTLOOK

Information gathered during interviews with some of the OEMs with subsidiary companies in South Africa shows that some of the companies (for example, Generec Engineering and Elgin Engineering) have looked into the feasibility of setting up local manufacturing facilities for some of the wind turbine components such as the turbine towers. For most of these companies, setting up local manufacturing facilities is conditional and dependent on the local market commitments, that is, whether they will be able to get their projects awarded. In order for the companies to set up a viable local tower manufacturing facility, they would need to produce and sell a minimum of around 100 to 150 units of towers every year or rather be awarded a long-term commitment of developing at least 400MW worth of turbine towers a year.

All in all, it is envisaged that the commissioning of Gestamp's Atlantis tower manufacturing facility will further boost the country's overall tower manufacturing industry both in terms of production capacity and employment. With two major industrial players, the local tower manufacturing industry will have a production capacity of 260 wind turbine towers per year (an equivalent of over 500MW of installed capacity) and will create around 300 permanent jobs as outlined in Table 4-2. The addition of Gestamp Renewable Industries into the South African local wind tower manufacturing sector increases the country's total industry production capacity and employment.

Table 4-2: South Africa Tower Manufacturing Industry Overview

Tower Manufacturer	Status	Production Capacity (towers/per year)	Jobs Created
DCD Wind Towers	Operating	110	100
Gestamp Renewable Industries	Envisaged	150	200
Total		**260**	**300**

(Study survey, 2014; http://www.gestampsolar.com/)

LOCAL TURBINE TOWER MANUFACTURING INDUSTRY BACKWARD LINKAGES

As mentioned earlier, steel is primarily used in manufacturing conventional large-scale wind towers. In South Africa, among the local steel manufacturers, only **ArcelorMittal** is currently active in the supply chain of locally manufactured turbine towers. The majority of other steel companies in South Africa are believed not to be directly involved in supplying components to the utility scale wind industry market. Overall, there is a large presence of imports from Asia that dominate this particular market segment. Price competitiveness, logistics, and limited local capacities are some of the reasons explaining the continued dominance of Asian imports in this market.

INFO BOX

Seven and eleven tons of heavy plates are required for manufacturing of steel towers. Current capability in South Africa only lies with ArcelorMittal that can manufacture seven ton heavy plates, but plans to invest in manufacturing capability for eleven ton heavy plates.

ArcelorMittal has a local competitive advantage in supplying heavy plate material for wind towers. Currently, one can claim that the company has a default monopoly in the supply of heavy plates within the domestic turbine tower market. ArcelorMittal's biggest local competitor in the general steel production market, Highveld Steel, is not currently pursuing the heavy plate production targeted at utility scale wind energy projects. As a result, ArcelorMittal is only being exposed to fierce competition from Asian imports.

ArcelorMittal, which is also a member of SAWEA, currently supplies the plate materials to DCD Wind Towers, with about 2 200 plates having been supplied to date (Study interview; 2014). It also produces rebars and foundation rings used in wind turbine foundations; as well as fastners used in both the foundation and the tower. However, there are other local rebar producers that can supply the market. ArcelorMittal also has a capacity to produce castings and rotor blades, but establishing these capabilities have not yet been pursued by the company.

According to ArcelorMittal, at present, it can only manufacture plates up to seven tons in weight, which account for about 50% of the total tower steel requirements with the rest comprising of plates as heavy as 11 tons. The lead time it takes the company to produce a plate is 10 weeks and the type of the contract normally determines the time it stocks.

Table 4-3 shows that ArcelorMittal's Vanderbijlpark plant, which manufactures heavy plates for wind towers, currently employs 300 people and is operating about 50% below its full capacity. With a total manufacturing capacity of 25 000 tons per month, current production at the plant is below 12 000 tons per month. The company is not supplying to any export wind markets but has in-house incentives, for example export rebates, meant to promote the competitiveness of its customers engaging in export markets. ArcleorMittal suggested that its manufactured products are highly price competitive with inputs supplied from Europe as they are able to produce those 35% cheaper than the price of European imports. However, ArcelorMittal is unable to compete with Chinese imported materials that are generally heavily subsidised.

Table 4-3: ArcelorMittal Vanderbijlpark Steel Mill's Current State

Indicator	Status
Employment	300 people
Manufacturing Capacity	Can manufacture only plates up to 7 tons
	25 000 tons per month
Manufacturing Capacity Utilisation	Below 50%
Local Content	The plate is manufactured locally so its 100% local content. 20% their input raw materials are imported
Price Competitiveness	Imports from Europe are about 35% expensive while those from China are price competitive
Competitors (Heavy Plate Material)	No local competitors. Competition is mainly from Chinese imports
Wind Export Markets	None so far. The company currently prioritises the domestic market but has got export rebates meant to support manufacturers who are participating in export markets.

(Study interview; 2014)

The inability of ArcelorMittal to supply 11 ton heavy plates has limited the market for the company as tower manufacturers prefer to source materials from the same supplier for quality monitoring purposes. ArcelorMittal is thus currently investing R25m into plant upgrades in order to be able to supply the heavier plates required for wind towers and increase its capability to serve the wind turbine manufacturing industry. With no special skills required in the production of the planned 11 ton heavy plate materials, apart from those that ArcelorMittal already has, the planned facility upgrade will result in a number of attributes for the company:

- ArcelorMittal will be in a position to supply the heavy 11 ton plate material, something that will increase the company's supply share as it will probably contribute roughly 95% of wind tower up from their current 50%.
- It will result in the local supply of steel materials that are currently being imported.
- The upgrade will create employment for an additional 10 to 20 people.

Concrete Towers

Although the wind turbine tower industry is currently dominated by steel towers, the local and global use of other tower technologies need not be overlooked. Concrete tower technology advocates assert that steel towers are not cost-effective above 90m to 100m, mainly due to the inherent limitation in tower diameter (tower sections need to be transported by road, limiting its maximum diameter to road width), which creates stiffness issues and requires deeper foundations (Renewable Energy World.Com, 2012). On the contrary, concrete towers are believed not to have this limitation, as larger diameter concrete towers can be built on-site or made up by smaller precast semi-circular sections. Just like steel towers, concrete towers also need to be designed and tailored for a specific turbine model under a specific wind regime. The design of the tower needs to be done by the OEM since they are the entity with the understanding of the specific loads that the system will be supporting; and the towers can be manufactured in-house or sub-contracted to an external company. The design has to be certified by a third party to make sure that it will last throughout the lifespan of the wind turbine. In the case of South Africa, it is further affirmed that concrete towers have the potential to create more jobs along its value chain compared to those of other technologies such as steel towers.

The use of pre-cast concrete towers in Acciona's Gouda Windfarm project in Cape Town, South Africa, serves as a successful example of full-scale application of concrete towers locally. Acciona's RE IPPPP Bid Window 2 wind energy project located north of the town of Gouda with a total capacity of 138MW made use of 46m x 3m wind turbines placed on concrete towers with a hub height of 100m (Aveng Group & Acciona, 2012). This same technology is and has been widely deployed in Spain, Brazil, Mexico and Poland over at least the last 5 to 8 years with other notable OEMs such as Gamesa and Enercon also making use of the same technology for on-shore applications. Enercon regularly uses precast concrete mobile factories for remote wind parks.

In this particular regard, the South African concrete construction industry through a local precast company, **Concrete Units**, has proven its capability to successfully manufacture concrete tower for wind energy projects as evidenced by the concrete tower units supplied to the Gouda Windfarm. Concrete Units is a South African precast company based in Cape Town. The company upgraded their factory in Airport Industria Cape Town in 2014 for the manufacture of the precast segments for the 46m x 100m tall concrete towers of the Gouda Wind Farm. Numerous jobs were created in the process. At peak of production (the build-up period from start of production to peak was four months), Concrete Units employs about 216 people.

Apart from this specific completed example, similar capabilities and expertise exists within the South African concrete construction industry with proven examples of similarly complex precast manufacture by Murray & Roberts Concor (Gautrain precast segments and Coega harbour dolosse) and Southern Pipeline (Gautrain tunnel segments). However, the issue of certification may be a significant hurdle for the general concrete construction industry to enter into the wind energy industry with supply of locally designed and manufactured concrete towers. The hurdle seems to be more related to perception than reality, since the industry has well developed systems to ensure quality, safety, and longevity of concrete structures such as third-party design evaluations, the compulsory requirement of professional registration through the Engineering Council of South Africa for anyone attempting structural design, as well as the application of professional indemnity insurance which again is backed by well-developed international design codes and standards. A faster alternative would be to construct according to pre-certified designs as per the Acciona Windpower-Concrete Units example.

4.3 Blades local manufacturing capability

This section provides an overview of the local blades manufacturing industry. With no capacity blade manufacturing activity currently characterising the South African utility-scale wind turbine market, discussions in this particular section are mainly centred on the potential manufacturers and also on one past local manufacturing venture which did not succeed.

General industry profile

South Africa does not have established manufacturing plants producing blades for large-scale wind turbines. However, the country has skills, expertise, and capability to manufacture blades for other applications, such as helicopters. Recently, Paramount Group announced that they (though acquired ATE South Africa) will restart the production of main and tail rotor composite blades for Russian Mi-17 and Mi-24 series of helicopters, which has so far has been controlled by Russian Helicopters (www.paramountgroup.biz).

The only South African-based company, Isivunguvungu Wind Energy Converter (I-WEC) which is partially owned by DCD Wind Towers, and produced 52m blades, was officially liquidated in October 2013, having not participated in any of the RE IPPPP rounds. Production of blades by I-WEC was done on a limited scale and is believed to have been meant for use with in-house produced wind turbines. As can be seen from Table 4-4, the blades were competitive both in terms of price and quality. It boasted a local content of about 80% with the main input material, fibreglass, being sourced locally.

Table 4-4: I-WEC Blade Manufacturing Profile

Item	Description
Established	2011
Liquidated	October 2013
International Technology Partner	Aerodyn Energiesysteme Gmbh
Blade Size	52m
Other wind turbine components produced	2.5 MW wind turbine
Price and Quality	On par with landed cost of American and European manufacturers
Quality	Quality in line with international certifications. Blades passed static load testing, as well as a resin frequency tests
Local Content	80% local content with fibreglass being sourced from Sartex - a German company based in Paarl, Western Cape; balsa wood and resin could not be sourced locally.

(Study interview; 2014)

As it stands, the South African wind energy market is dominated by OEMs who in most cases make use of their own imported proprietary rotor blades. The global trend in the rotor blade industry involves manufacturing blades both in-house within large OEMs as well as by independent manufacturers (Andersen, 2014). More than 30 independent rotor blade manufacturers exist in the global markets; however, the external sourcing of blades by OEMs is dominated by the Danish market leader LM Wind Power and the three Chinese blade manufacturers Huiteng Windpower, Zhongfu Lianzhong, and Sinomatech Wind Power (Andersen, 2014). LM Wind Power, a member of SAWEA, is one key potential industry player currently investigating the establishment of a blade manufacturing facility in South Africa. Historically, LM Wind Power has supplied blades to at least nine leading OEMs and these include Acciona, Gamesa, GE Energy, Goldwind, Nordex, Repower, Siemens, Suzlon and Vestas.

Target market analysis

Information gathered during the interviews shows that LM Wind Power has invested significant time and resources in identifying and securing a blade manufacturing facility in South Africa. LM Wind Power, which manufactures blades as well as brakes and other components, identified the Coega in the Eastern Cape Province as their preferred site.

The RE IPPPP with a decent market size attracted the company to consider establishing a manufacturing facility in South Africa as they saw themselves entering a wind market of at least 800MW per year. The company's plans to open a facility in South Africa were, however, put on hold due to the uncertainty in future allocations linked to the draft updated IRP. As a result, the company continues to supply blades to the local market by importing them from facilities located in other parts of the world.

With regards to the sub-Saharan Africa market, LM Wind Power is supplying blades to wind projects in Nigeria, Kenya, and Tanzania. The company envisages a definite increase in sub-Saharan Africa's MW demand for wind power in the near future but maintains that they will not base their business decision to invest in South Africa on the possibility of growth in the sub-Saharan Africa market. In terms of competition, aside from the vertically integrated turbine manufacturers with proprietary blades, the USA's blade manufacturer TPI Composites is the company's biggest competitor in South Africa and also within sub-Saharan Africa.

Prospects for establishing local capabilities

Most of the OEMs with offices in South Africa have not considered establishing local blade manufacturing facilities, as they perceive that the market too small for a viable blade manufacturing industry. A minimum capacity of 400MW per year per OEM is required to attract OEMs to set up local blade manufacturing facilities. However, this would imply that the actual size of the market would need to exceed 400MW to allow more than one blade manufacturer to enter the market to produce blades for their turbines. The other alternative is for the manufacturers to set up a local facility with the aim of supplying multiple OEMs, which would require having six to eight moulds and significantly greater investment. This option would require a demand of about 500MW per annum.

Given the current players in the industry and information received during interviews, at this stage two companies could potentially establish local manufacturing capabilities. These are LM Wind Power and DCD. According to LM Wind Power, the Coega blade manufacturing facility that they have been investigating would require about €32-€35 million of investment, which equates to approximately R440-R490 million and would take around 10 to 12 months to construct. The critical issue with regards to the establishment of local manufacturing facilities pertains to the market commitments. Both companies would want to be assured of a viable investment by means of the availability of a sustainable installed capacity. The companies would each want a minimum demand of between 400MW to 800MW worth of projects or, rather, 450 blades per year for one OEM. In terms of local content, LM Wind Power has highlighted that they will most likely source about 60% of the inputs required locally. Major inputs such as fibreglass can be sourced locally, hence the price of the locally manufactured blades would not be more expensive relative to the price of imported blades.

Table 4-5: Potential Local Blade Manufacturers

Item	LM Wind Power	DCD
Industry Organisation	SAWEA	SAWEA
Nature of Investment	Establishing a new facility	Establishing a new facility
Investment cost	R448m- R490m[8]	-
Timeframe required	12 months	12 months
Prerequisites to ensure viability	400 MW - 800MW per annum market	Minimum margin of 15% and a minimum demand of 450 blades per year for one OEM
Local content	At least 60%	-

[8] The total value of the investment is €32m-€35m, expressed in rand terms using an exchange rate of €1/R14

Item	LM Wind Power	DCD
Number of jobs to be created	300 direct & 300 indirect	150

(Study interview; 2014)

Wind turbine blade manufacturing is a labour intensive industry, hence a large number of jobs have been proposed if the companies are to establish local manufacturing facilities. For DCD, a blade manufacturing facility would result in an additional 150 permanent jobs, whereas for LM Wind Power, such a facility would result in 300 direct jobs (mostly skilled positions) and another 300 indirect jobs. For one of the companies, financial assistance, a favourable regulatory environment and critical skills in composite manufacturing are also some of the prerequisites for establishing a new facility.

4.2 NACELLE AND HUB LOCAL MANUFACTURING CAPABILITY

This section gives a profile of the different key actors engaging in the partial manufacturing of components and assembly of the nacelle unit within the South African market. Because of the local industry's current limited capacity to manufacture and assemble the nacelle components, the section also investigates potential manufacturers and assemblers.

GENERAL INDUSTRY PROFILE

The supply of nacelle units to the South African market is dominated by wind turbine OEMs who import the units from their overseas factories. The international wind turbine OEMs have dominated the supply side of the market and compete amongst themselves. At present, there is no international wind turbine OEM that has established either an assembly or a manufacturing facility for nacelle components in South Africa.

The majority of the OEMs operating in South Africa have entered South Africa in lieu of the opportunities presented by the RE IPPPP and are represented in the country through subsidiary companies acting as local representatives. Only Siemens, one of the global wind turbine OEMs operating in South Africa, has interest in other industries in the country and as such has local manufacturing facilities producing products for other sectors.

In the past, the now liquidated I-WEC has been involved in the assembly of a 2.5MW wind turbine with a local content of 70%, which was derived from components outlined in Table 4-6. Initially, I-WEC had a manufacturing capacity to make 20 wind turbines per year but this was scaled up to 100 units per year. The company had already created 30 direct jobs for engineers, technicians and administrative staff, and was planning to create up to 400 jobs in the first five years of operation depending on market conditions.

Table 4-6: Source of Inputs for I-WEC's 2.5MW Wind Turbine

Component	Local Content	
Nacelle	30%-35%	Local content made up of machine frame, nacelle cover, assembly and machine parts
Mainframe	80%-85%	Unknown
Generator	100%	Intended to source from Ingeteam that in turn planned to produce locally
Gearbox and gear-train	0%	Imported because of licence requirements
Pitch system	0%	Imported from Moog
Power converter, cable and other electrics	80%-100%	Capacity exists locally; Actom and Siemens

Component	Local Content	
Brake system	0%	Imported
Rotor hub	25%-30%	Unknown
Rotor bearings	0%	Imported

(Study interview; 2014)

Target market analysis

As already highlighted, there hasn't been any commercial manufacturing or assembling of nacelle components that has taken place within the South African industry. A requirement for many specialised components coupled with the in-depth R&D required for the nacelle unit to work correctly can be singled out as some of the reasons that have constrained the growth of this industry. As a result, the manufacturing of nacelle components and the assembling thereof, has mainly been left to the international wind turbine OEMs. Many of these OEMs are also supplying turbines to the sub-Saharan Africa market.

Localisation of some of the nacelle components has so far been limited. The wind turbine OEMs who are doing most of the assembling often prefer to work with component manufacturers with a track record. According to some of the OEMs interviewed, they are not willing to risk their reputation by engaging with some of the local producers who can supply some of these bigger components. Certification issues have meant that most OEMs would prefer to work with component manufacturers they have a working relationship with.

Prospects for establishing local capabilities

Based on the interviews conducted, DCD is one of the local companies that has considered venturing into the manufacturing and assembling of nacelle components. Nacelle assembly can be done in the company's existing facilities and it would take between six to 12 months to upscale them. The partial manufacturing and assembly would create an additional 50-250 permanent jobs, and critical skills in nacelle assembly will be required. A minimum demand of 100 units per year and a minimum margin of 15% would be required in order to make this business venture sustainable.

Information gathered from the interviews also revealed that South Africa has some capability to manufacture gearboxes and gear trains for the wind turbine. IWEC held discussions with Land Systems Gear Ratio (LSGR), manufacturers of specialised gear-train products, primarily for military vehicles, and also for mining and earthmoving equipment, industrial machinery and traction locomotives. The company would have needed a commitment of 100 units a year to justify investment in wind turbine gearboxes and gear-trains.

Interestingly, some of the interviewed people suggested following the model used in developing the local automotive industry to kick start the local turbine manufacturing. This implies focusing on the establishment of assembly plans rather than trying to concentrate on manufacturing some of the specialised components that go into the nacelle. Some of the OEMs have considered establishing local nacelle assembly plants but have since concluded that such a venture is not economically viable and politically correct at this stage due to the small size of the market and the lack of policy clarity around future projects. While components could be imported and then assembled locally, the viability of such a facility would be in jeopardy due to the fact that finishing of the assembly would need to be done overseas due to the skills requirements and will thus need for the unit to be shipped to a locality outside South Africa and then transported back again, which will be highly costly and time consuming.

Overall though, the potential for establishing nacelle manufacturing facilities in South Africa is limited by the complexity of the process that requires highly specialised labour and by the concerns over quality and high inputs costs. At this stage, manufacturing of nacelle units in South Africa is perceived by many to be unviable. Except for the insufficient market size, the key market entry barriers applicable to the establishment of manufacturing of selected components are summarised below:

- General barriers applicable to most key components of nacelle:
  - Long distance from any existing assembly factories/requires localisation of nacelle assembly activities first
  - High degree of path dependency with OEMs reluctant to engage new component manufacturers
  - Large order volumes required to make facility economically viable
  - Rigorous quality requirements
  - Access to technical skills and expertise
- Component-specific barriers:
  - Nacelle Assembly:
    - Proprietary activity with 400MW required for one OEM
    - Testing and certification that requires access to specialised equipment and skills
  - Gearbox
    - Capital-intensive
    - Increasing trend to use gearless drives
    - Requires several years to tool up and test for specific sizes
    - Highly concentrated global market
  - Generator
    - Rare earth materials required for certain generator types
  - Castings and Forgings
    - Achieving cost competitiveness in a global market
    - Ability to efficiently handle the heavy, large-scale components

5. SOUTH AFRICA'S INDUSTRY COMPETITIVENESS ANALYSIS

This section gives a detailed synopsis of the South African wind energy industry. The section outlines the competitive advantages as well as the challenges and impediments hindering the development of the local industry. The section also covers a discussion of the opportunities for integration within this particular sector.

Overall, based on the feedback obtained from the industry participants and the review of various documents, South Africa's wind energy industry, considering its upstream and downstream activities, is characterised by the following comparative advantages and impediments:

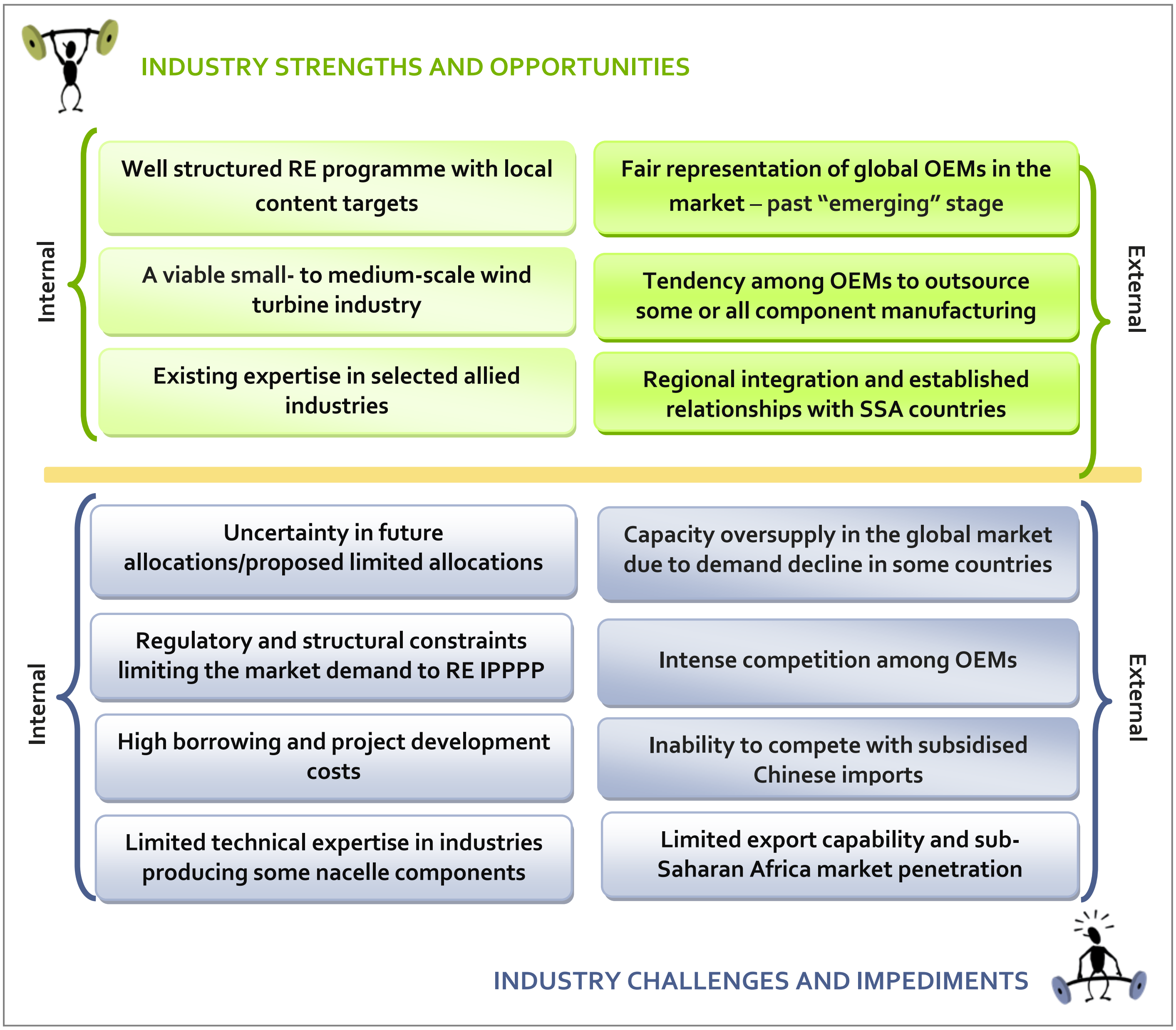


Figure 5-1: South Africa's industry comparative advantages and disadvantages

- **Well-structured renewable energy programme with local content targets**: For most of the stakeholders involved in the development of wind energy projects internationally, the potential of the South African wind energy market relative to that of sub-Saharan Africa is incomparable mainly because of the RE IPPPP. The scale of capacity volumes in South Africa is more programme-focused, whilst that of other sub-Saharan African countries is more project-oriented. As a result, the introduction of the RE IPPPP has attracted a mix of leading global wind energy stakeholders across the value chain. With such a programme in place, one can only envisage the continued development of the broader local wind energy market with some spill over effects on the manufacturing side. Local content targets should also persuade the already present global manufacturers to establish local manufacturing facilities as was the case in, for example, Brazil and China. These, however, need to be used realistically in a manner that will not restrain potential investments into the wind energy markets.
- **A viable small to medium scale wind turbine industry**: South Africa already has a thriving small to medium scale wind turbine manufacturing industry. The presence of a small to medium size wind turbine manufacturing sector is an opportunity which could possibly be utilised as a stepping stone into utility scale wind turbine manufacturing. Most of the companies involved in this sector are active in export markets with some of the companies already supplying wind turbines to sub-Saharan African countries like Lesotho and Botswana. Some are active in the international markets, exporting turbines to countries as far as the United States. One of the companies is currently in talks with the government of Tanzania where they are looking into the possibility of establishing a small wind turbine manufacturing facility.

  Some of these companies, for example Winglette and Adventure Power, have also considered entering the large scale wind turbine manufacturing market but it was not feasible due to various market entry barriers. Winglette has designed a 1.2MW wind turbine, and Adventure Power is manufacturing 300kW wind turbines that use the same technology as that in the large-scale market. Their wind turbine uses a 32m tower and 16m long blades. These companies believe they can develop a capability to manufacture large wind turbines, which would be competitive on the global market both in terms of price and efficiency. The companies maintain that the people, know-how and technology to develop large size wind turbines are already present in South Africa. What is needed are the investment and sustainable markets. According to the feedback received, scaling up of current manufacturing facilities would take about one to five years, and according to one of the companies, they would need an investment of about R300m-R400m. For the venture to be sustainable, the companies would require a minimum demand of a unit per week or rather a privileged capacity of around 200MW to 500MW per year. In terms of local content, components and materials such as fibreglass, generators, steel and electronics will be sourced locally whilst the magnets for the generator can be imported from China.

  While transitioning of small to medium scale wind manufacturers established in South Africa into manufacturers of large-scale wind turbines might be more challenging than appears from the feedback received from the companies (i.e refer to IWEC case study and the bankability requirements outlined in the Finance and Certification section of the report), the above suggests that the country does possess certain skills and expertise that could be used to develop the industry further.

- **Regional integration initiatives within the sub-Saharan African region**: South Africa is strategically positioned to supply wind turbine components to countries within sub-Saharan Africa. The possibility of strong south-south trade agreements should not be overlooked. Currently, there are a few projects taking place within sub-Saharan Africa relative to the region's wind resource potential and high demand for power. Some of the OEMs interviewed during this study have only supplied wind turbines to sub-Saharan African countries such as Kenya, Tanzania, Ethiopia, Senegal and Ghana. They are also monitoring developments in countries such as Namibia and Mozambique.

  Basing on the wind energy demand scenarios for sub-Saharan Africa modelled for this study, it can be argued that there are some export market opportunities within the region especially considering that most wind projects are envisaged to be rolled out during the 2020-2025 period. Such a timeframe allows for the establishment and capacitation of local wind turbine component manufacturing companies that could possibly tap into some of these regional markets. Some of the OEMs and project developers already serving in the sub-Saharan market have subsidiary companies in South Africa, hence if institutions allow, it would be easier for them to set up manufacturing facilities in the country and supply some of their products to these countries.

  There are also opportunities embedded within the regional integration initiatives both within the SADC sub-region and in the broader sub-Saharan Africa region. Regional integration initiatives such as the Southern African Power Pool (SAAP) and the Africa Clean Energy Corridor (ACEC) provides opportunities for the country to tap into the energy markets of most of the southern African countries together with some of their east African counterparts.

- **Fair representation of key wind energy stakeholders with a global presence**: South Africa's RE IPPPP attracted a number of companies with a global presence. These include, among others, project developers, EPC contractors, utilities and investors – bringing forth diversity and depth into the local wind energy market. Achieved notable global representation can be seen as an opportunity for the development of the local industry. The presence of large OEMs in the country implies that the country has access to know-how and the technology, what is now needed are the institutions to encourage these international companies to either partner with the local industry or alternatively establish new manufacturing facilities. South Africa could possibly learn from their international experiences, either good or bad.
- **Established expertise in allied industries:** Considering the multiplicity of materials and components that go into a wind turbine, the probability of backward integration among the companies that are part of the wind industry value chain cannot be ruled out. At present, there hasn't been any documented backward integration within the local wind industry that has taken place. This is mainly because of the limited activity currently characterising this particular industry which is still in an infancy stage. Nonetheless, opportunities exist especially within the steel and composite material industries. With the amount of steel that goes into a wind turbine, there is an opportunity for turbine tower manufacturers to merge, acquire or partner with steel suppliers within the country. Potential manufacturers for blades could also merge, acquire or partner with manufacturers of composite materials such as fibreglass. Potential manufacturers and assemblers of nacelle units could also merge or acquire businesses that are focused on manufacturing the single components required, for example the generator or gearbox.

Other opportunities have to do with the presence of a wind industry organisation such as SAWEA, which has attracted membership from key actors involved in local wind energy projects. Such an industry organisation could possibly be utilised as a platform for the government to engage with the wind energy stakeholders. Government's constant engagement with the private sector can assist in addressing some policy and regulatory impediments mentioned earlier in the report. This will smooth the playing fields and bring forth informed policy decisions that are critical for wind energy industry development. Other opportunities have to do with the current high demand for power and the pressure to reduce environmentally unsustainable power generation technologies such as coal-fired power.

SECTORAL DEVELOPMENT CHALLENGES AND IMPEDIMENTS

- **Uncertainty in future allocations/Proposed limited allocations**: According to some of the companies interviewed, the commitments that the South African government can make, not about volumes, but in terms of certainty, needs to be improved. For most of these companies, they perceive there are a lot of policy inconsistencies, which impede the development of the industry. The companies need real commitments that would enable them to make long-term plans. It has been recommended that in order for the government to guarantee longevity within the industry, it needs to do away with future bid uncertainty. Information gathered from the interviews reveals that the companies involved in wind projects are aware of what is going to unfold in the RE IPPPP until Round 5, but further than that, no one knows what will happen.

  Furthermore, according to most companies interviewed, the volume out of the RE IPPP Programme is too small to justify establish local manufacturing capabilities and sustain component manufacturing within the country. For most of the international component manufacturers, one can only set up a sustainable manufacturing facility if they have a long term guaranteed capacity of 400MW to 500MW per year to themselves. With the current 600MW annual allocations, it is claimed that such capacity is only rational for one OEM to establish a manufacturing facility and cater for the whole domestic industry, a market arrangement that is not feasible.

- **Regulatory and structural constraints limiting the market demand to RE IPPPP**: Some of the key stakeholders involved in wind energy projects have raised concerns about the structure of renewable energy programmes in the country. According to them, there is centralisation of programmes, everything is done at the national department level and there is either limited or no involvement of the municipalities, with Eskom being the sole buyer. As a result, such centralisation is believed to be restraining the development of wind energy projects in the country. There are also other regulatory issues that have also been put forth. One example is that of the Western Cape, where one project developer has criticised the guidelines for wind energy development that were established by the provincial department. The guidelines are believed to be restrictive on where one can site a wind turbine. For example, the guidelines stipulate that you cannot put a wind turbine on a hilltop, yet that is where the best winds are. Other regulatory constraints, particularly around the issue of EIAs, have been raised. One major concern has been that of the Department of Agriculture not accepting that wind farms can co-exist with agriculture. Other issues cited also include the transport laws that prohibit the transportation of materials during the day, hence causing delays in project completion.
- **High borrowing and project development costs**: Many stakeholders involved in wind projects have indicated that interest rates charged by South African banks is too high relative to that of international financial

institutions. According to one project developer, credit from a South African bank will be serviced with an interest rate of around 11% yet that of international financial institutions is only around 6%. Besides the high cost of borrowing, there are also concerns around the higher investment costs in South Africa. High labour and transport costs are some of the major items contributing to the higher investment costs. Labour unrest within the country has also added up as another disincentive for investment in local manufacturing facilities. High volatility of the exchange rate has also raised concerns among the different stakeholders involved in the wind energy industry.

- **Limited technical expertise in industries producing some nacelle components**: There are some wind turbine components, especially the nacelle interior components, which require significant technical knowledge in manufacturing these, and South Africa does not yet have the sufficiently skilled labour to meet this challenge. Major skills transfer initiatives will need to be implemented to sufficiently educate and equip the local industry.
- **Capacity oversupply in the global market due to demand decline in some countries**: Capacity oversupply in the global wind turbine market has resulted in thin profit margins forcing some of the OEMs to restructure and shut down some of their factories in order to focus on key strategic global bases. Much focus is now placed on the export market compared to the domestic market. As a result, the constrained global demand leaves most of the OEMs without an appetite to invest in local manufacturing facilities. The arrangement has been to import from their other existing overseas factories or from more price competitive sources such as China.
- **Intense competition among OEMs**: Intense competition among OEMs has also resulted in thin profit margins that have forced some of the companies to downscale production.
- **Inability to compete with subsidised Chinese imports**: Information gathered from the interviews reveals that some of the imported Chinese components like wind turbine towers are 20% to 30% cheaper relative to the price of locally manufactured components. As a result, there has not been a drive among potential manufacturers to further develop the local manufacturing capacity since the end products are price uncompetitive relative to the Chinese components. Although the components will have a competitive advantage in terms of local content within the domestic market, these will, however, tend to perform poorly in the export markets where there is no policy protection - an impediment that restricts most OEMs' interest in pursuing the establishment of local manufacturing facilities and consider sub-Saharan African market segments.
- **Limited export capability and sub-Saharan Africa market penetration**: The majority of the South African based companies that are already producing some of the wind turbine components have not been actively engaged in export markets, yet the wind industry is perceived an export industry.

6. Conclusion

The development of the wind energy manufacturing industry globally has been largely driven by government policies that on one hand created demand for wind energy power and on the other hand established an environment conducive for the growth of local manufacturing capacities (i.e. though domestic regimes that offer protection for local industries and incentivise investment). Countries that boast the largest wind energy installed capacities are also the countries that account for the largest wind turbine manufacturing market share. These include, for example China, the USA, Germany, Spain, Denmark, and India.

Over the past few years, i.e. between 2009 and 2013, significant changes in the wind turbine manufacturing industry have been observed. While the top countries with the largest wind turbine manufacturing capacity remain the same, the market has seen some notable changes with respect to the position of single OEMs. Onshore wind market has reached the stage of maturity with the industry now being characterised by fierce competition. As a result, some of the leaders of the market in 2009 (i.e. Repower, Dongfang and Sinovel) had lost their market share by 2013, while other companies have gained global leadership positions (i.e. Nordex, United Power, and Mingang). The top seven positions among the global leaders though has remained in the hands of the same group as that observed in 2009, i.e. Vestas, Goldwind, Enercon, Siemens, GE Wind, Gamesa, and Suzlon, although their rankings inside the top seven have changed.

In South Africa, the current industry is dominated by the global industry players, although this trend is more evident along upstream activities and less so along downstream activities.

- Project developers in South Africa include both local and international companies. Developments within the market resulted in some local companies partnering with foreign companies and some even establishing joint ownership in some of the RE IPPPP wind energy projects.
- The range of EPC companies involved in the wind energy project developments in the country is dominated by global leaders, who are also OEMs (i.e. Vestas, Suzlon, Acciona, and Nordex), which shows that the local industry is relatively vertically integrated.
- Local manufacturing of key wind turbine components is still in its infancy and remains restricted to a few components. Such a setting has attracted a large number of OEMs from overseas countries, and these have dominated the supply of wind turbine components into the South African wind energy market. The biggest share of the local market belongs to Vestats (26%), followed by Nordex (21.3%) and United Power (11.8%).

The capital investment that is required to design, procure, and construct wind energy projects, as reflected in Bid Window 3, was valued at an average R7.9 million/MW in 2013. Of these, 55% comprised of expenses on wind turbine and its key components such as tower, blades, nacelle and hub, and the rest of BOP. Wind turbines require steel, concrete, copper, fibreglass, adhesive, core, and other input materials to produce, with steel accounting for almost 90% of the total weight of materials used in production of wind turbines, which is mainly used to manufacture towers. At the same time, towers account for 14.2% of the total project value or 25.8% of the wind turbine value. It is followed by nacelle and hub that make up 30.5% of the project value or 55.5% of the wind turbine's cost. Expenditure on blades equates to 9.1% of the project value or 16.5% of the wind turbine's value.

In Bid Window 3, the average local content achieved by preferred bidders was 46.9%, three quarters of which was derived through localisation of the Balance of Plant and the rest through the procurement of wind towers from the local tower manufacturer, DCD Wind Towers. The local content in Bid Window 3 dropped slightly compared to that achieved by preferred bidders in Bid Window 2, which was partially attributed to the unfavourable exchange rate that increased the total cost of the project and subsequently reduced the share of the local content. Nonetheless, preferred bidders in Bid Window 3 were able to significantly reduce the average tariffs per kWh compared to the previous rounds (i.e. R0.74/kWh vs R1.01/kWh and R1.28/kWh in April 2013 prices) and render a bigger number of jobs created during construction and operations.

As mentioned above, local capabilities with respect to key components have so far been established in the manufacturing of turbine towers by DCD Wind Towers. Another local company, Gestamp Renewable Industries, will soon be commencing their tower manufacturing activities in Atlantis in the Western Cape Province. No blade manufacturing facilities currently exist in the country. This is also true for the nacelle, where, like in the case for blades, there is no local company currently engaged in either the manufacturing or assembling of the nacelle components.

The review of the global dynamics suggests that vertical integration among OEMs is common among certain manufactures; at the same time, many OEMs tend to follow a hybrid model where they outsource production of certain components while retaining in-house capabilities only with respect to certain items where they have comparative advantages. Many of the OEMs have also been found to share suppliers.

Overall, among the three key components, towers tend to be the first localised as they are large, expensive and difficult to transport over large distances. As suggested by the local status of the industry in the country, this is also the case in South Africa. Establishment of local capabilities in manufacturing of blades is also relatively common, provided the market has sufficient demand; however, blades manufacturing requires large investments and access to know-how. Furthermore, since it is extremely labour-intensive and requires precision processes, access to a skilled labour force is a prerequisite. The same applies to the manufacturing of the nacelle, although many OEMs tend to establish in-house assembly facilities while procuring most of the components of the nacelle from the reputable suppliers. Some of these components are manufactured by companies that primarily service other industries, with the wind energy market accounting for a small portion of their orders. This applies to gearboxes and bearings for example, which are critical items in the entire system as they affect reliability of the wind turbine.

To conclude, South Africa has already established some capability in wind tower manufacturing. Further growth of this industry and establishment of local manufacturing capacities in blade and nacelle assembly might be possible, but will not only require sufficient demand but will also need access to skilled labour, technology, and quality materials. The interviews conducted during the study suggested that establishment of local rotor blades manufacturing facilitates will require up to 800MW of demand for one manufacturer that could then supply to a variety of OEMs provided they have invested into various moulds. At the same time, assembly of the nacelle would require a demand of about 400MW for one OEM, but access to skilled labour is envisaged to be among the main obstacles that could impede realisation of opportunities in the near future, provided the necessary demand thresholds are achieved.

SECTION 3: LOCALISATION POTENTIAL ANALYSIS

1. INTRODUCTION

The purpose of this section is to present various localisation potential scenarios with a focus on the opportunities presented for the establishment of local key component manufacturing facilities. It starts with the outline of the methodology followed in determining the potential sustainable installed capacities and concludes with the estimate of the potential number of new manufacturing facilities that could be established in South Africa considering various scenarios and options. A potential number of jobs that could be created if the opportunities were realised is also outlined.

2. SCENARIOS AND METHODOLOGY

This section gives an overview of the scenarios considered and methodology followed in determining the future localisation potential. It also includes the description of assumptions describing the minimum capacity required to justify the establishment of specific key component manufacturing plants and their creation potential.

SCENARIOS

As indicated in Section 1: Wind Market Energy Profiling, two sets of scenarios were created. The first set was linked to the promulgated IRP (2010) and the second set was based on the updated draft IRP (2013). Both sets of scenarios also included options related to the potential markets that could be penetrated, such as RE IPPPP only, various options for penetrating market outside the RE IPPPP, and sub-Saharan African market.

The following tables provide a more detailed description of each set of scenarios the following should be noted:

- With respect to the potential outside the RE IPPPP in South Africa, the low, medium and high road scenarios described in Section 1 were applied.
- Potential demand from the SSA market is only considered for the highly probable wind energy deployment option described in Section 1: Wind Market Energy Profiling. This is mainly because the highly probable option reflects the majority of the estimated potential demand for wind energy in the sub-Saharan Africa region that was derived from the specific wind energy targets expressed in megawatt terms in policies of five sub-Saharan African countries (i.e. Ethiopia, Kenya, Lesotho, Nigeria, and Mozambique). More specifically, out of the 12.5GW of wind energy project deployment potential identified for sub-Saharan Africa based on their policies and renewable energy targets, the highly probable option accounted for 11.8GW or 94.4%.

Table 2-1 shows eight demand scenarios to be utilised for this localisation road map study based on the promulgated IRP 2010 allocation for wind energy projects, as well as the selected set of options for potential outside the RE IPPPP in South Africa and in sub-Saharan Africa.

Table 2-1: Promulgated IRP 2010 based scenarios - set of options for Scenario 1

Scenario options		Description
1a	Promulgated IRP only	• Based on the Promulgated IRP 2010
1b	Promulgated IRP and outside RE IPPPP potential - low	• Based on the Promulgated IRP 2010, PLUS • 5% of uptake outside Eskom and RE IPPPP and 5% of wind energy penetration

Scenario options		Description
	Promulgated IRP and outside RE IPPPP potential - medium	• Based on the Promulgated IRP 2010, PLUS • 15% of uptake outside Eskom and RE IPPPP and 10% of wind energy penetration
	Promulgated IRP and outside RE IPPPP potential - high	• Based on the Promulgated IRP 2010, PLUS • 25% of uptake outside Eskom and RE IPPPP and 15% of wind energy penetration
1c	Promulgated IRP and SSA potential-highly probable	• Based on the Promulgated IRP 2010, PLUS • Potential demand from the SSA countries whose wind energy targets are explicitly expressed in megawatt terms
1d	Promulgated IRP, outside RE IPPPP potential - low, and SSA potential	• Based on the Promulgated IRP 2010, PLUS • 5% of uptake outside Eskom and RE IPPPP and 5% of wind energy penetration, PLUS • Potential demand from the SSA countries whose wind energy targets are explicitly expressed in megawatt terms
	Promulgated IRP, outside RE IPPPP potential - medium, and SSA potential	• Based on the Promulgated IRP 2010, PLUS • 15% of uptake outside Eskom and RE IPPPP and 10% of wind energy penetration, PLUS • Potential demand from the SSA countries whose wind energy targets are explicitly expressed in megawatt terms
	Promulgated IRP, outside RE IPPPP potential - high, and SSA Africa potential	• Based on the Promulgated IRP 2010, PLUS • 25% of uptake outside Eskom and RE IPPPP and 15% of wind energy penetration, PLUS • Potential demand from the SSA countries whose wind energy targets are explicitly expressed in megawatt terms

Table 2-2 presents eight demand scenarios to be utilised in the study based on the allocations for wind energy projects outlined in the Draft Updated IRP 2013 and the selected set of options for potential outside the RE IPPPP in South Africa and in sub-Saharan Africa.

Table 2-2: Draft Updated IRP 2013 based scenarios - set of options for Scenario 2

Scenario options		Description
2a	Draft updated IRP only	• Based on the Draft Updated IRP 2013
2b	Draft updated IRP and outside RE IPPPP potential – low	• Based on the Draft Updated IRP 2013, PLUS • 5% of uptake outside Eskom and RE IPPPP and 5% of wind energy penetration
	Draft updated IRP and outside RE IPPPP potential – medium	• Based on the Draft Updated IRP 2013, PLUS • 15% of uptake outside Eskom and RE IPPPP and 10% of wind energy penetration
	Draft updated IRP and outside RE IPPPP potential – high	• Based on the Draft Updated IRP 2013, PLUS • 25% of uptake outside Eskom and RE IPPPP and 15% of wind energy penetration
2c	Draft updated IRP and SSA potential-highly probable	• Based on the Draft Updated IRP 2013, PLUS • Potential demand from the SSA countries whose wind energy targets are explicitly expressed in megawatt terms
2d	Draft updated IRP, outside RE IPPPP	• Based on the Draft Updated IRP 2013, PLUS

Scenario options		Description
	potential - low, and sub-Saharan Africa potential	• 5% of uptake outside Eskom and RE IPPPP and 5% of wind energy penetration, PLUS • Potential demand from the SSA countries whose wind energy targets are explicitly expressed in megawatt terms
	Draft updated IRP, outside RE IPPPP potential - medium, and sub-Saharan Africa potential	• Based on the Draft Updated IRP 2013, PLUS • 15% of uptake outside Eskom and RE IPPPP and 10% of wind energy penetration, PLUS • Potential demand from the SSA countries whose wind energy targets are explicitly expressed in megawatt terms
	Draft updated IRP, outside RE IPPPP potential - high, and SSA potential	• Based on the Draft Updated IRP 2013, PLUS • 25% of uptake outside Eskom and RE IPPPP and 15% of wind energy penetration • Potential demand from SSA countries whose wind energy targets are explicitly expressed in megawatt terms

METHODOLOGY

The derivation of the future localisation potential with respect to the establishment of key component manufacturing facilities in South Africa followed a four-step approach described below.

- **Stage One**: This stage involved conversion of the installed capacity targets set for specific years and each scenario, as outlined in Chapter 5.3 of Section 1: Wind Market Energy Profiling (i.e. 2017, 2020, 2025, and 2030), into annual projected deployment of wind energy projects. Where annual deployment targets were available, for example in the case of promulgated IRP and Draft Updated IRP, they were used as annual projections; otherwise, the added new installed capacities during a specific period were equally allocated for each year.
- **Stage Two**: The computed annual required installed capacities projections data was formulated into sustainable installed capacities by means of utilising the lowest annual demand values for the five-year time periods (period minimum). This was done based on the assumption that any new facility would need to have access to minimum sustainable installed capacities for at least five years to justify investment in its establishment and thus make it economically viable. This approach is conservative as it eliminates the years that could have a sharp increase in demand but that could not be sustained for a period of at least five years and therefore would not be practical to consider.
- **Stage Three**: Having computed the required annualised sustainable installed capacities using the aforementioned scenarios, the demand thresholds for establishment of different key component manufacturing facilities in South Africa were then determined based on the data drawn from the interviews conducted during the study. Since information received from different industry players sometimes varied, minimum and average thresholds were determined. It was augmented with the assumptions concerning estimated number of jobs to be created by each facility.
- **Stage Four**: Having both the annualised sustainable installed capacities data, the average demand thresholds, and jobs per new facility ratios, the next step involved calculation of the potential for establishment of new facilities in the country with the specific reference to towers, blades and nacelle manufacturing or assembly. Yielded results provide insight into the future periods when localisation of

certain key components in the country will become possible considering various scenarios and specifically sustainable installed capacities associated with these scenarios. It also allows the estimation of the potential number of new jobs that could be created if the demand is addressed and such facilities are established.

DEMAND THRESHOLDS

Table 2-3 outlines the current manufacturing capacity in the local wind industry. The table also shows the average demand thresholds that need to be satisfied for the potential manufacturers to establish new manufacturing facilities for the different wind turbine key components, and the number of jobs that would possibly be created per facility.

Table 2-3: Key Components Supply Assumptions

Key Component	Current Manufacturing Capacity	Required Demand per New Facility	Jobs per Facility
Tower	235 MW	280MW	150
Blades	0 MW	400MW	228
Nacelle + Hub	0 MW	400MW	400

*Note: The figures reported in the first row applies only to steel tower manufacturing facilities. Concrete tower manufacturing facilities are likely to create a different number of jobs.

From the table above, it can be seen that current manufacturing capacity only exists in the turbine tower manufacturing sector, as discussed in Section 2 of this report. There is currently no manufacturing of rotor blades and assembly of nacelle taking place in the country, although selected companies have considered establishing local plants. Generally, turbine tower manufacturers would demand a manufacturing capacity of 280MW per year in order to set up a tower manufacturing facility. On average, blade manufacturers would require a bigger manufacturing capacity relative to that of tower and nacelle manufacturers. In order to establish a single manufacturing facility, blade manufacturers on average would demand a minimum of 400MW of manufacturing capacity; while the potential with respect to nacelle lies in establishing an assembly facility for which an average of about 400MW worth of procured wind turbines will be required.

A tower manufacturing facility with a manufacturing capacity of 280MW is estimated to create around 150 jobs while a blade industry with a manufacturing capacity of 400MW is estimated to create about 228 jobs. Jobs in the nacelle manufacturing sector are somehow a bit complex to estimate since the industry is predominantly assembling and sub-assembling and thus the level of activity differs. For the purposes of this study, a nacelle and hub assembly facility with an operating capacity of about 400MW is estimated to create around 400 jobs.

3. ANNUAL DEMAND PROJECTIONS

This section presents the wind energy annualised demand projections for different set of scenarios based on the annual demand projections for the RE IPPPP, outside the RE IPPPP, and the SSA wind energy markets. It first presents the projections for the set of Scenario 1 which is based on the promulgated IRP 2010 figures, and then the set of Scenario 2 options, which has daft updated IRP allocations at its core.

SET OF SCENARIOS LINKED TO PROMULGATED IRP

This sub-section illustrates eight sets of demand projections for the 2015-2030 time period based on the different scenarios with the projected annual allocations outlined - the promulgated IRP 2010 policy document being the common assumption for all options.

Scenario 1a: Promulgated IRP only

Figure 3-1 illustrates the annual projected wind energy installed capacity demand based on the Promulgated IRP 2010 policy document. It shows that this scenario assumes a constant demand for the 2015-2023 period with 400MW of capacity added per annum. Installed capacity is envisaged to rise in 2024 and 2025, by 800MW and 1600MW of added capacity respectively, before dropping to its previous level of 400MW in 2026. A surge in installed capacity demand is seen for the year 2027, reaching a high of 1 600MW; where after no additional allocations for wind energy projects are envisaged.

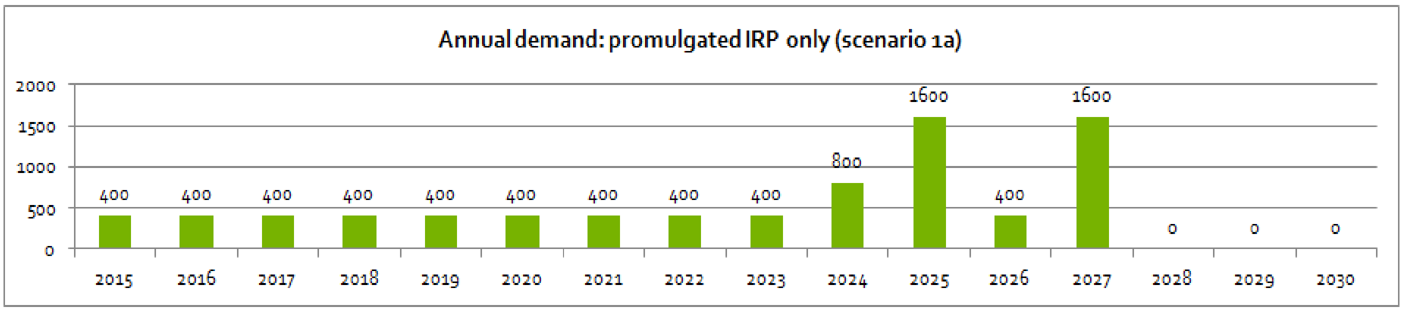


Figure 3-1: Scenario 1a Wind Energy Installed Capacity Projections

Scenario 1b: Promulgated IRP and outside RE IPPP potential

Figure 3-2 shows three different demand projections based on a combination of future potential annual installed capacity derived from the Promulgated IRP 2010 together with that of low, medium, and high road assumptions linked to the potential market penetration outside the RE IPPPP in South Africa.

As would be expected, the projected annual installed capacities under Scenario 1b set of options are greater than that for Scenario 1a. Although different demand values are computed across the three options, it should, however, be noted that the general trend is the same.

The general projected trend shows a steady demand for the 2015-2017 period, which is then followed by a significant increase during 2018-2020, before a slight decline in demand projected for the 2021-2023 period. Demand is forecast to increase during 2024 and 2025 before dropping to its 2021-2023 level. Another significant rise in demand is forecasted for the year 2027 before a sharp decline anticipated for the 2028-2030 time period.

Projections based on the scenario 1b-high option envisage demand to be at its highest of 2 058MW in year 2025 and 2027. Maximum demand in the other two options, medium and low, is marked at 1 875MW and 1 631MW respectively; while the minimum demand in all options at least between 2015 and 2027 does not drop below 408MW.

Considering the above, adding the potential for wind energy projects deployment that could be realised outside the RE IPPPP has a huge bearing on the total demand as this gives a further boost to the aggregate levels of wind energy deployment and subsequent demand for various project components, an arrangement that is most likely to attract manufacturing investment. The above, though, also shows that the greater the potential for renewable energy to penetrate the outside RE IPPPP market and the greater the uptake of wind energy in this regard, the more attractive the local market becomes. For example, in the case of Scenario 1b-high option, the potential annual installed capacities of wind energy projects in the country could double during the period between 2018 and 2023 and remain sustainable for that period.

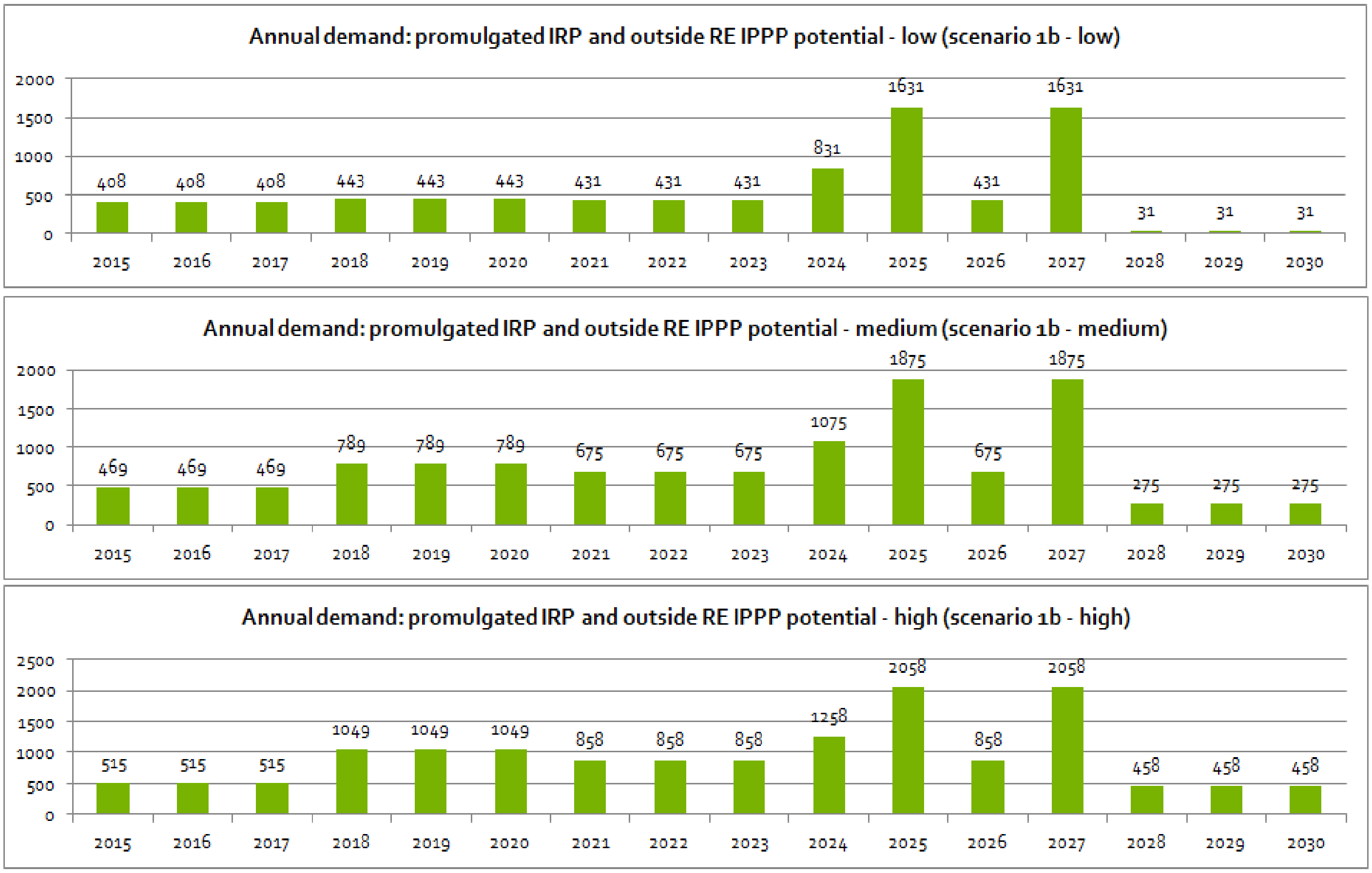


Figure 3-2: Scenario 1b Wind Energy Installed Capacity Projections

Scenario 1c: Promulgated IRP and Sub-Saharan Africa potential

Figure 3-3 shows the projected annual demand for the 2015-2030 time period based on a combination of potential demand from the Promulgated IRP 2010 and that of the SSA market.

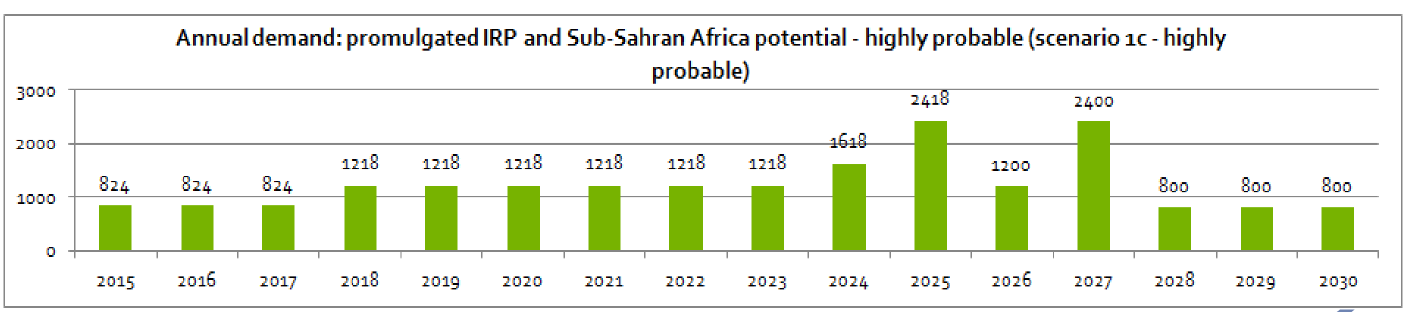


Figure 3-3: Scenario 1c Wind Energy Installed Capacity Projections

The addition of the potential demand from the SSA market is of great significance with the lowest projected annual demand now marked at 800MW and the maximum demand estimated at around 2 418MW during year 2025. Project demand is envisaged to be around 824MW per year during the period 2015-2017, and should rise to 1 218MW per year over the period 2018-2023 before further rising to a record high of 2 418MW in 2025. Demand is projected to decline in year 2026 before taking an upsurge in 2027 followed by a record low of 800MW per year characterising the 2028-2030 period.

The above shows that considering the highly probable deployment of wind energy projects in Sub-Saharan Africa and the demand created by the promulgated IRP 2020 only, the potential demand for the local industry would increase between two to three times during various years between 2015 and 2030. However, considering that some respondents indicated that they are unlikely to base their investment decision on the potential created in sub-Saharan Africa, care needs to be taken when examining this scenario.

Scenario 1d: Promulgated IRP, outside RE IPPPP potential and sub-Saharan Africa potential

Figure 3-4 shows the projected demand from the Promulgated IRP combined with that of the different market penetration options outside the RE IPPPP and highly probable deployment of wind energy projects envisaged for sub-Saharan Africa.

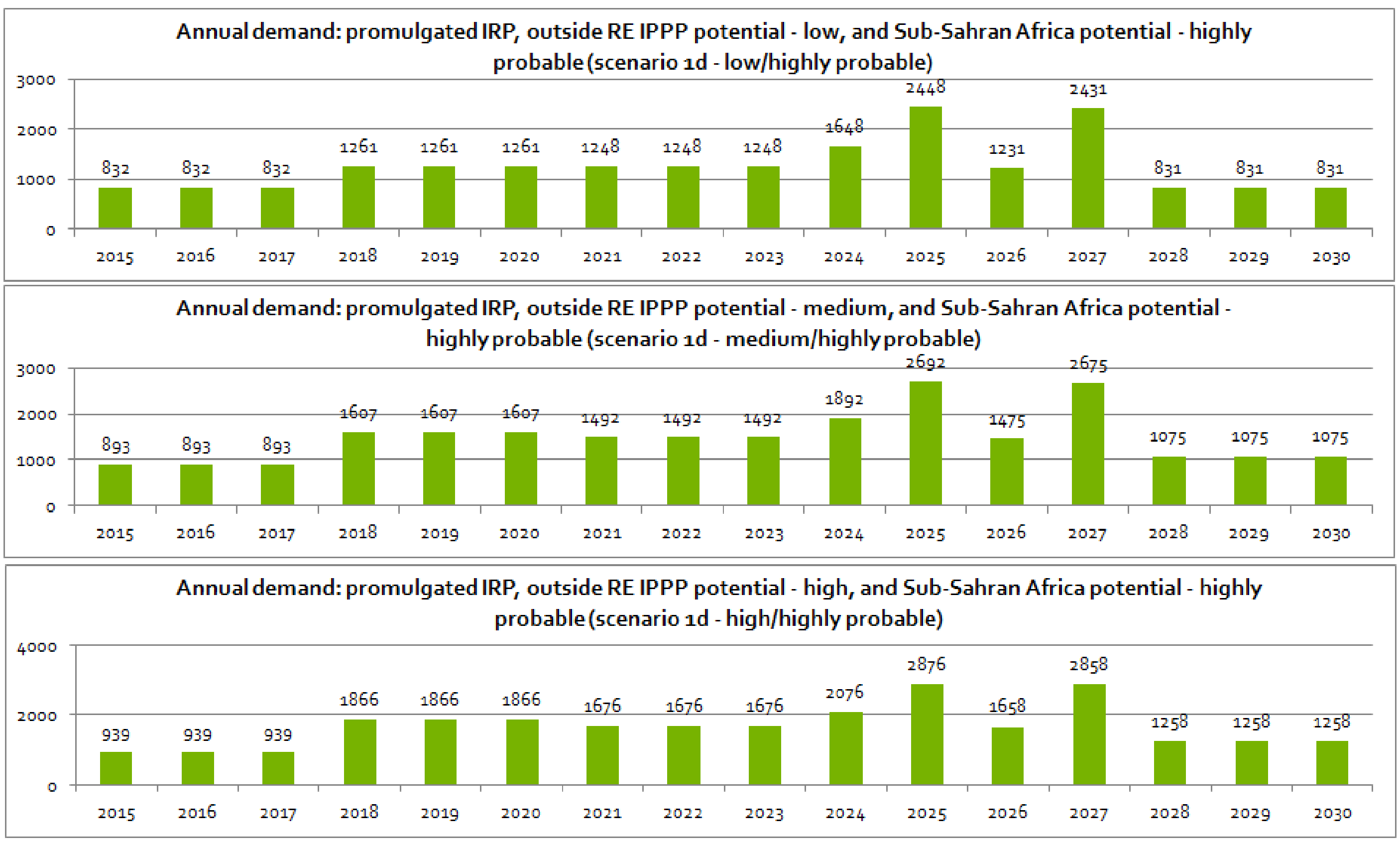


Figure 3-4: Scenario 1d Wind Energy Installed Capacity Projections

The additional projected demand from the market outside the RE IPPPP together with that from the sub-Saharan Africa market segment has a huge bearing on the aggregated demand. In the case of the low road option for deployment of wind energy projects outside the RE IPPPP, the projected annual installed capacities will vary between 832MW and 2 448MW, with at least 831MW being sustained for the entire period between 2015 and 2030. The other two options offer greater annual demand projections, with the scenario including the medium road option for the outside RE IPPPP offering annual demand variations between 893MW and 2 692MW, and the scenario including the high road option for the outside RE IPPPP assuming wind energy installed capacities in South Africa and sub-Saharan Africa to increase by between 939MW and 2 76MW per annum between 2015 and 2030.

SET OF SCENARIOS LINKED TO DRAFT UPDATED IRP 2013

This sub-section illustrates eight sets of demand projections for the 2015-2030 time period based on the different scenarios with the annual allocations outlined in the Draft Updated IRP 2013 policy document being the constant.

Scenario 2a: Draft updated IRP only

Figure 3-5 illustrates the forecasted wind energy demand based on the Draft Updated IRP 2013 policy document. As dicussed in Section 1: Wind Market Energy Profiling, this scenario assumes a much lower total allocation for wind energy projects than Promulgated IRP 2010; importantly, it assumed that the demand for wind energy installed capacities will only be created post 2024 and will vary between 320MW and 640MW per annum.

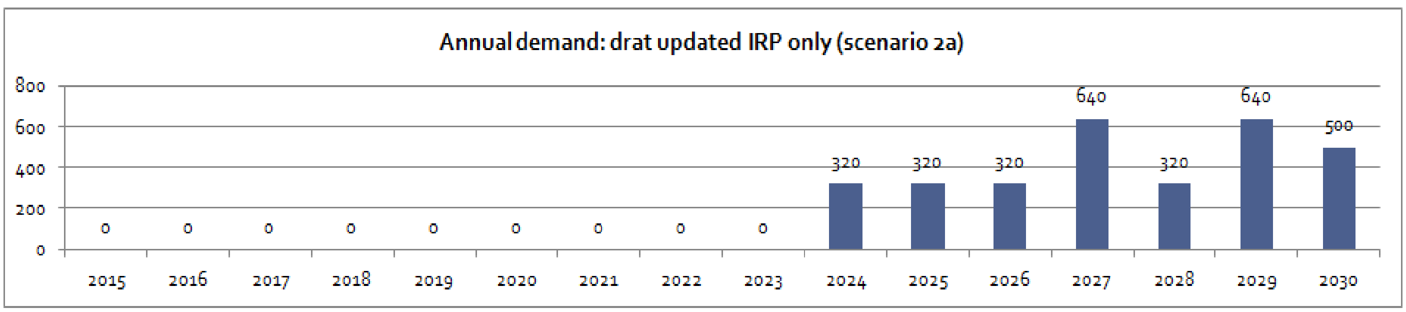


Figure 3-5: Scenario 2a Wind Energy Installed Capacity Projections

Scenario 2b: Draft updated IRP and outside RE IPPP potential

Figure 3-6 shows three different annual installed capacities projections based on a combination of demand derived from the Draft Updated IRP 2013 together with that of low, medium and high road options related to penetration of the market outside the RE IPPPP in South Africa.

The scenario 2b-medium and high options shows the importance of realising the potential outside the RE IPPPP market for wind energy industry development. In both scenarios, the outside RE IPPPP market would generate significant demand for the period from 2018 going forward. In all the three options presented, demand is envisaged to be high over the 2024 to 2030 period and range between 351MW and 1 098MW per annum.

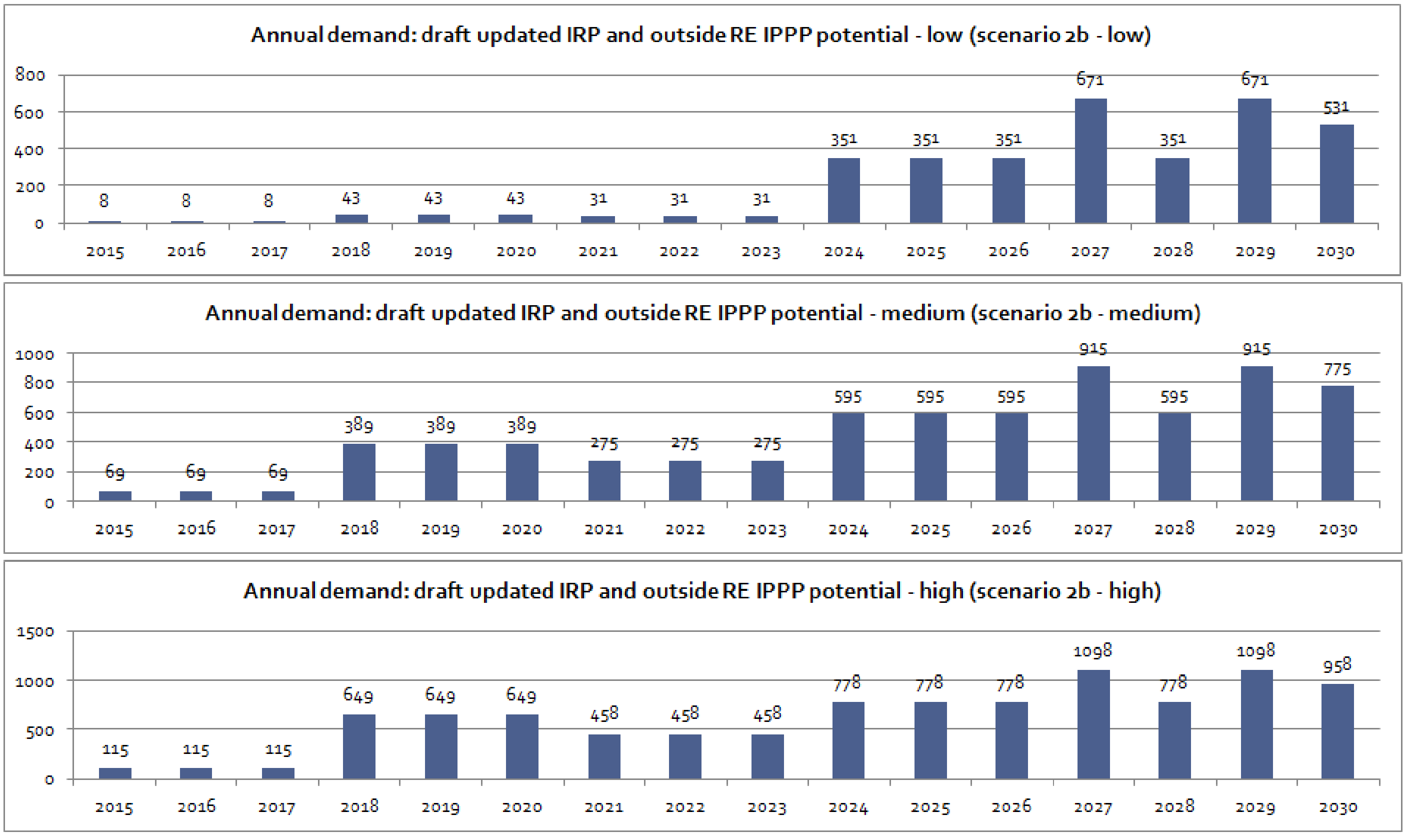


Figure 3-6: Scenario 2b Wind Energy Demand Projections

Scenario 2c– Draft updated IRP and sub-Saharan Africa potential

Figure 3-7 shows the projected annual demand for the 2015-2030 time period based on the combined demand from the Draft Updated IRP 2013 and the SSA market potential.

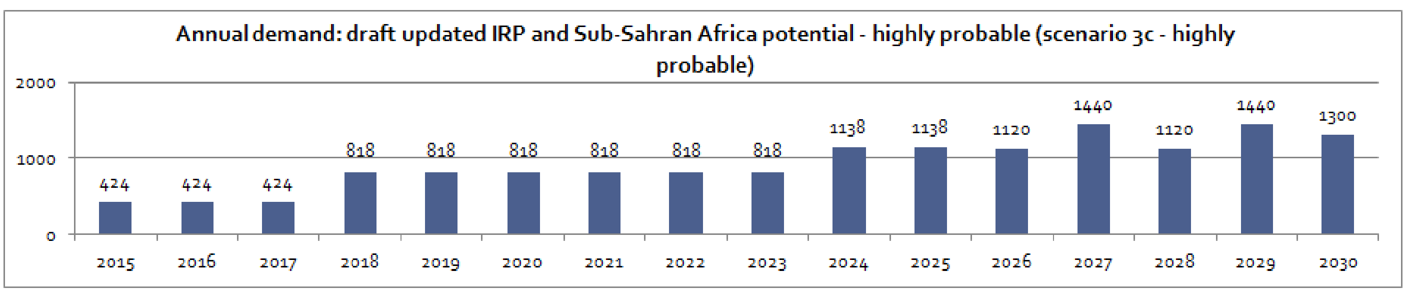


Figure 3-7: Scenario 2c Wind Energy Demand Projections

The addition of the potential for wind energy project deployment associated with the sub-Saharan African market significantly increases the aggregated demand for the analysed period. It implied an annual demand of 424MW during 2015-2017, which then doubles to 818MW per annum until 2023, and grows further to above 1 100MW per annum until 2030.

Scenario 2d– Draft updated IRP, outside RE IPPPP potential and sub-Saharan Africa potential

Figure 3-8 illustrates the projected demand from the Draft Updated IRP 2013 combined with that of different options for the market outside the RE IPPPP and highly probable option for sub-Saharan Africa. The figure shows significantly higher aggregated demand figures resulting from combining the demand potential from the three wind energy markets compared to other options considered under Scenario 2, but nonetheless lower than those presented under Scenario 1.

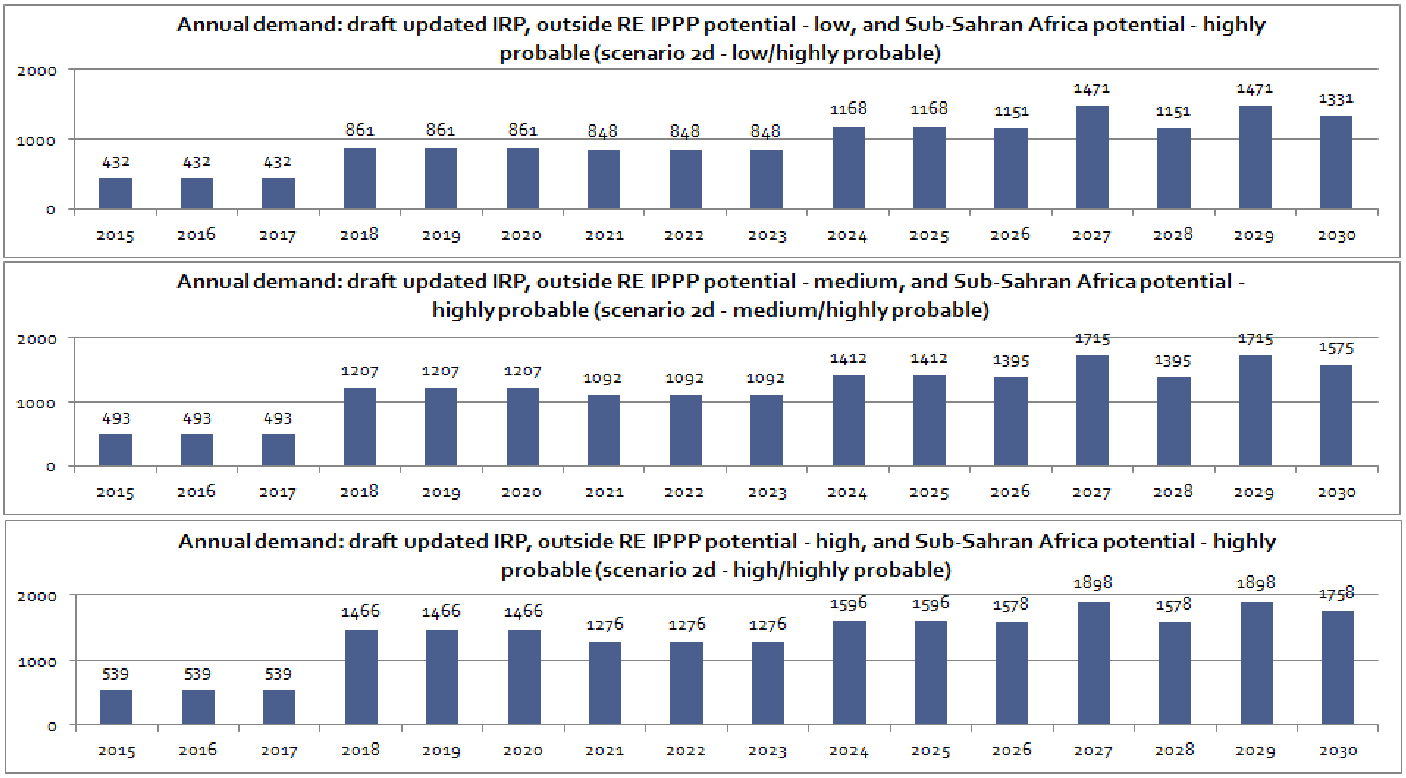


Figure 3-8: Scenario 2d Wind Energy Demand Projections

All the three scenario options illustrated in Figure 3-8 imply that the highest annual demand for wind project deployment will be during the period from 2024 to 2030. Overall, it is clear that these three options of Scenario 2d imply a relatively small demand during 2015-2017 and a large sustainable annual demand from 2018 onwards, which largely, is above 1GW.

4. SUSTAINABLE DEMAND PROJECTIONS

This section presents the sustainable installed capacities expectations developed for the scenarios and their options adopted for this study. As indicated earlier in this section, the sustainable installed capacities expectations are formulated using the minimum annual demand projection figures over a five-year time period.

When reviewing the figures provided in this section, the demand expressed in MW for each year reflects the minimum installed capacity over the future five-year period that starts in a specific year. For example, if a scenario suggests that in year 2018 the sustainable installed capacities will be 500MW, it means that for the period between

2018 and 2022 (i.e. five years), a minimum of 500MW of wind energy projects is planned to be deployed on an annual basis.

The increase in demand for year 2019 compared to 2018, would imply that the next five years starting from 2019 will provide greater sustainable installed capacities than 500MW. At the same time, a decline in sustainable installed capacities for year 2019 would mean that over the period between 2019 and 2023, the projected installed capacity for at least one year would drop below 500MW. The above approach allows determining the years, when the opportunity for establishing new manufacturing plants would be economically viable, i.e. would have sufficient orders, might be presented and when the demand would be to the extent that some of the previously established plants might have to downscale or close down.

Scenarios linked to Promulgated IRP

Figure 4-1 illustrates the projected sustainable installed capacities for various options considered under Scenario 1, which in turn has Promulgated IRP 2010 figures as the constant assumption.

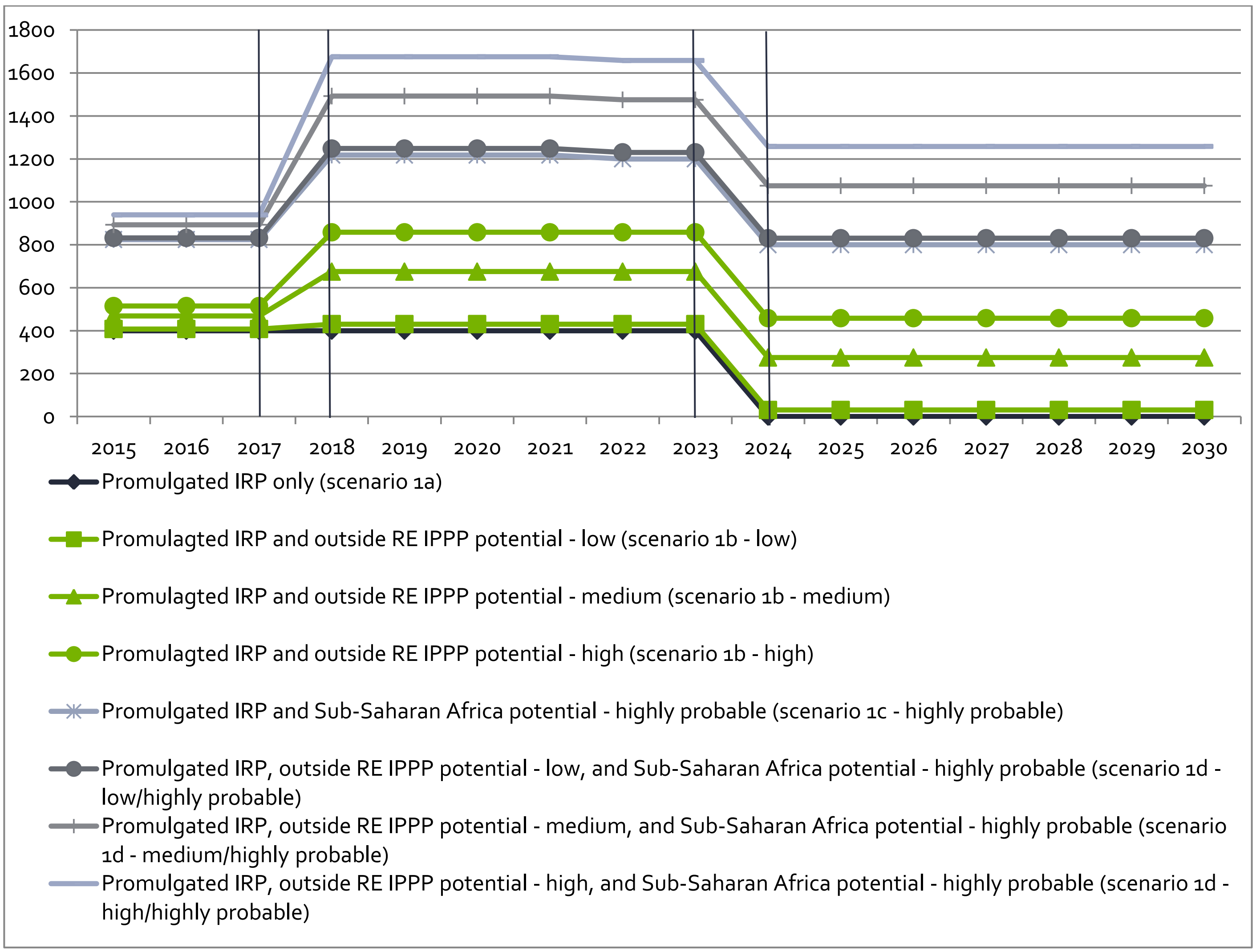


Figure 4-1: Sustainable installed capacities expectations based on Scenario 1 options

The Promulgated IRP only (scenario 1b) option has the least projected sustainable installed capacities. These are however almost similar to those of scenario 2b, for the promulgated IRP combined with the outside RE IPPPP potential- low. The Promulgated IRP 2010 has an annual sustainable installed capacity of 400MW stretching from 2015 to 2023. From 2023 going forward, there are no sustainable installed capacities, as the projected installed capacities are expected to drop to zero making any investment in manufacturing capacities after 2024 a highly risky endeavour. However, with the added estimate of installed capacities for other markets, i.e. outside the RE IPPPP and sub-Saharan Africa, the annual sustainable installed capacity for all years up to 2023 grows and importantly, these options also offer opportunities for maintaining the demand beyond 2023.

The entire period between 2015 and 2030, considering the information presented in the figure above, can be broken down into five distinct time periods or phases regardless of the annual sustainable installed capacity estimations, and these can be presented as follows:

- ***Phase 1 (2015-2017)*** is characterised by constant sustainable installed capacity. The Promulgated IRP 2010 only has an annual sustainable installed capacity of 400MW. When the Promulgated IRP 2010 is combined with outside the RE IPPPP market potential, the annual sustainable installed capacity increases from 400MW to between 408MW and 515MW. When combined with that of the sub-Saharan African market potential, the sustainable installed capacity increases to around 800MW. When the sustainable installed capacity potential from all the three wind energy market segments is combined together, annual sustainable installed capacity during this period increases to margins of between 830MW and 940MW.
- ***Phase 2 (2017-2018)*** is characterised by a sharp increase in sustainable installed capacity in almost all of the options considered under Scenario 1, except for the baseline scenario, i.e. the Promulgated IRP 2010 only. Such an increase is largely attributed to the assumption of the larger penetration of wind energy technologies outside the RE IPPPP market, which implies among others a positive resolution on the ISMO bill, and sub-Saharan market.
- ***Phase 3 (2018-2023)*** is associated with the highest annual sustainable installed capacity for the analysed period of between 2015 and 2030, which in turn means that the industry is expected to boom during this period. While annual sustainable installed capacity for scenario 1a (i.e. Promulgated IRP 2010 only) remains constant at 400MW, combining RE IPPPP potential and realising opportunities in the market outside the RE IPPPP, increases the sustainable installed capacity to a range of between 430MW and 860MW. Combining scenario 1a and the potential from the sub-Saharan African markets increases annual sustainable installed capacity to around 1 200MW. Annual sustainable installed capacity combining potential from all the three wind energy markets is as high as between 1 240MW and 1 680MW.
- ***Phase 4 (2023-2024)*** is characterised by a reduced sustainable installed capacity compared to the previous period.
- ***Phase 5 (2024-2030)*** is associated with the sustainable installed capacity volumes that are to reach their record lows with respect to each scenario considered. With low annual sustainable installed capacity characterising the South African wind energy market, the holding pattern in this period shows the significance of the sub-Saharan African market potential and to a lesser degree the outside RE IPPPP market as they offset some of the sharp declines experienced in other market segments.

Considering the above, the following years are worth mentioning:

- 2015 – start of the analysed period
- 2018 – sharp increase in sustainable installed capacity compared to the previous years
- 2024 – sharp decline in sustainable installed capacity for all options, with all options except for those considering the sub-Saharan African market segment to drop below the pre-2018 period

SCENARIOS LINKED TO DRAFT UPDATED IRP 2013

Figure 4-2 shows different trends from those shown in Figure 4-3. Considering that the only difference between the set of options included under Scenario 1 and those included under Scenario 2 are allocations for wind energy projects for the RE IPPPP, it is already clear that the adoption of the draft Updated IRP (2013) scenario will result in a different industry development trajectory than that predicted under the Promulgated IRP (2010).

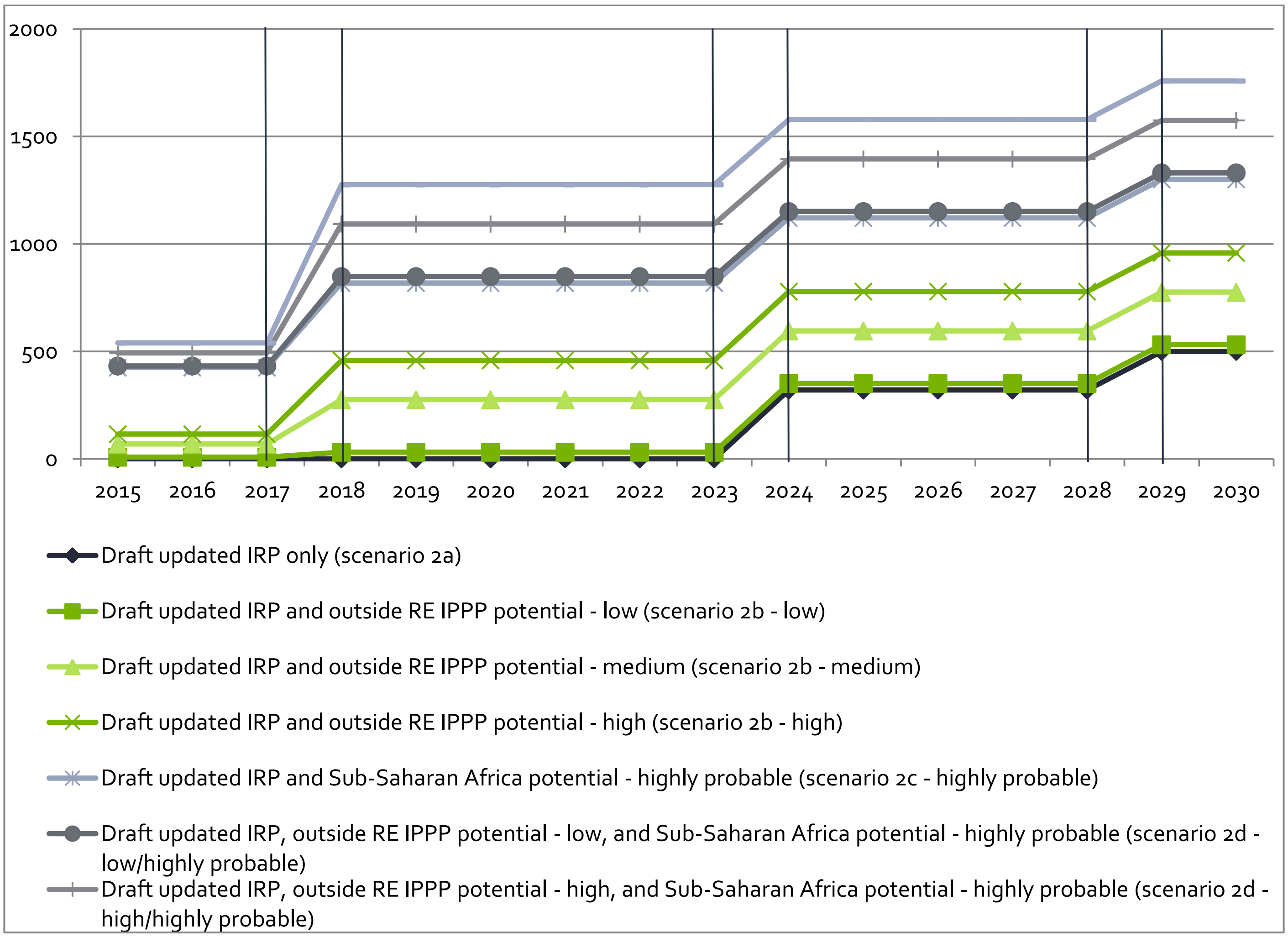


Figure 4-2: Sustainable installed capacity expectations based on Scenario 2 options

As illustrated in figure 4-2, unlike in Scenario 1 options where the sustainable installed capacity is expected to peak during the period between 2018 and 2023, Scenario 2 options suggests that the annual sustainable installed capacity for wind energy project deployment will be increasing over time up until 2030. At the same time, it is projected that the sustainable installed capacity levels achieved under Scenario 1 options during the period between 2018 and 2023 will only be close to reaching during the period of 2024 to 2028 and will be reached only after 2029. This suggests that the entire set of options for Scenario 2 would most likely result in the local industry development lagging by about six to seven years, compared to the respective options devised for Scenario 1. The set of options for Scenario 2 also emphasise the significance of the other wind energy market segments such as the outside RE IPPPP and the sub-Saharan African markets for the creation of sustainable installed capacity during the period up to 2024, which also makes it a more risky set of options.

The general trend shown in the figure can be characterised into seven distinct time periods or phases, and these can be presented as follows:

- ***Phase 1 (2015-2017)*** is characterised by relatively low sustainable installed capacity compared to those of the other periods. There is insignificant sustainable installed capacity projected to come from the two market segments in South Africa; thus the majority of the volumes are envisaged to be drawn from the sub-Saharan Africa potential.
- ***Phase 2 (2017-2018)*** is associated with the rise in sustainable installed capacity in the outside RE IPPPP and sub-Saharan African market segments. Sustainable installed capacity from the Draft Updated IRP 2013 remains zero.
- ***Phase 3 (2018-2023)*** is characterised by constant sustainable volumes. Although the sustainable installed capacity from the Draft Updated IRP 2013 remains at zero, the potential from the outside RE IPPPP and sub-Saharan Africa dominates the period. Combining the demand created from Draft Updated IRP with that of the outside RE IPPPP increases the annual sustainable installed capacity from zero to a range of between 30MW and 460MW, while combining the Draft Updated IRP with the sub-Saharan Africa potential yields an increase of sustainable installed capacity to 818MW. Combination of all three market segments offers annual sustainable installed capacity of between 850MW and 1280MW depending on the level of penetration of wind energy in the outside RE IPPPP niche market.
- ***Phase 4 (2023-2024)*** is associated with a growth in sustainable demand in all the three market segments above compared to the levels observed during 2018-2023 under respective options.
- ***Phase 5 (2024- 2028)*** is characterised by increased constant sustainable volumes. While sustainable installed capacity per year for the Draft Updated IRP is projected to be around 320MW, it should, however, be noted that combining the sustainable installed capacity from the Draft Updated IRP with the potential from the outside RE IPPPP and the sub-Saharan African market segment will yield an aggregated sustainable installed capacity of between 1 150MW and 1 580MW per year.
- ***Phase 6 (2028-2029)*** and **Period 7 (2029-2030)** render a further increase in annual demand compared to the previous years. However, the demand projected for these periods cannot be guaranteed to be sustained for five years as no information on the installed capacities beyond 2030 were available.

Considering the above, the following years are worth mentioning:

- 2015 – start of the analysed period
- 2018 – sharp increase in sustainable installed capacity compared to the previous years
- 2024 – further increase in sustainable installed capacity compared to the previous years
- 2029 and 2030 – further projected growth in installed capacities

5. LOCALISATION SCENARIOS

This chapter describes the potential for establishment of new manufacturing facilities for key components of wind energy projects considering the demand threshold outlined in Chapter 2 of this section and the projected sustainable installed capacity figures presented in the previous chapter. The information is presented for each of the three key components, i.e. towers, blades, and nacelle.

While the opportunities for establishment of various manufacturing plants presented in the following sections are linked to the sustainable installed capacity projections, other factors will also impact realisation thereof and thus should be considered. With respect to turbine tower manufacturing plants, these include the following:

- Partnerships forged between OEMs and key suppliers as well as the manufacturing models adopted by them
- Local subsidies and incentives available for manufacturers
- Access to trained and available labour
- Provision of adequate training facilities and programmes for wind energy engineers, technicians and factory personnel
- Future trends in turbine manufacturing technologies
- Availability and pricing of core input materials in South Africa, i.e. castings, forging, fibreglass, balsa, foam, adhesives, etc.
- Installed quality control measures among the suppliers of key input materials in South Africa
- Ability of the local manufacturing facilities to adopt "lean manufacturing" techniques that would reduce labour intensity of the process, while improving the levels of manufacturing precision and process control
- Improved quality control measures among the suppliers of key inputs, specifically forging, casting and bearings

TURBINE TOWERS LOCALISATION POTENTIAL

The following tables outline the potential for establishment of new turbine tower manufacturing plants in South Africa depending on the options and scenarios considered. They take into account the fact that one steel turbine tower manufacturing facility is already operational in South Africa, which is assumed to be able to absorb about 235MW worth of wind tower orders per annum.

Opportunities for establishment of new facilities brought by different sustainable installed capacity scenarios

Table 5-1 outlines the envisaged opportunities for establishment of new turbine tower manufacturing plants in South Africa considering different scenarios and options. It specifically outlines the years and the number of new facilities that could be established during those years given the projected sustainable installed capacity.

Table 5-1: Modelled opportunities for establishment of new turbine tower manufacturing plants

Scenarios and options		2015	2018	2024	2029
Scenario 1 options linked to Promulgated IRP					
1a	Promulgated IRP only	0	0	0	0
1b	Promulgated IRP and outside RE IPPPP potential - low	0	0	0	0
	Promulgated IRP and outside RE IPPPP potential - medium	0	1	0	0

Scenarios and options		2015	2018	2024	2029
	Promulgated IRP and outside RE IPPPP potential - high	0	2	0	0
1c	Promulgated IRP and SSA potential	2	1	0	0
1d	Promulgated IRP, outside RE IPPPP potential - low, and SSA potential	2	1	0	0
	Promulgated IRP, outside RE IPPPP potential - medium, and SSA potential	2	2	0	0
	Promulgated IRP, outside RE IPPPP potential - high, and SSA potential	2	3	0	0
Scenario 2 options linked to Draft Updated IRP					
2a	Draft updated IRP only	0	0	0	0
2b	Draft updated IRP and outside RE IPPPP potential - low	0	0	0	1
	Draft updated IRP and outside RE IPPPP potential - medium	0	0	1	0
	Draft updated IRP and outside RE IPPPP potential - high	0	0	1	1
2c	Draft updated IRP and SSA potential	0	2	1	0
2d	Draft updated IRP, outside RE IPPPP potential - low, and SSA potential	0	2	1	0
	Draft updated IRP, outside RE IPPPP potential - medium, and SSA potential	0	3	1	0
	Draft updated IRP, outside RE IPPPP potential - high, and SSA potential	1	2	1	1

From the above, the following can be highlighted:

- With respect to Scenario 1, which has Promulgated IRP(2010) at its core:
  - Scenario 1 a and Scenario 1b – low outside RE IPPPP market penetration do not offer opportunities for establishment of new manufacturing facilities in South Africa, as the sustainable installed capacity for turbine towers is such that can sustainably sustain only the existing DCD Wind Towers plant. This scenario also creates unfavourable conditions for the establishment of the second wind tower manufacturing plant that was planned by Gestamp Renewable Industries.
  - Opportunities for setting up new turbine tower manufacturing plants arise only if the potential for wind energy penetration in the outside RE IPPPP market segment reaches medium or high road, or if sub-Saharan Africa market segment is brought into consideration.
  - If the tower manufacturers were to only focus on the potential created in South Africa, the opportunity to set up new tower manufacturing plants will only arise in 2018 assuming the ISMO Bill is adopted in the near future and regulations regarding wheeling arrangements are resolved. In these instances, the medium road options for penetration of the market outside the RE IPPPP would create an opportunity to establish one additional tower manufacturing plant in the country, while the high road option will offer an opportunity to set up two new additional tower manufacturing plants by 2018. Thereafter, though, the sustainable installed capacity will not be sufficient to justify establishment of new facilities.
  - If manufacturers of turbine towers also consider the potential brought by sub-Saharan Africa and specifically the five countries that have already set wind energy targets, the opportunities for establishment of new turbine tower manufacturing plants in South Africa as a regional hub would already present themselves in 2015.
  - Inclusion of highly probable sub-Saharan Africa potential appears to be a game changer as far as the potential for setting up new tower manufacturing facilities is concerned, as the combination of all three market segments offers opportunities for establishment of between three to five tower manufacturing plants in South Africa between 2015 and 2018.
- With respect to Scenario 2, which assumes RE IPPPP to follow Draft Updated IRP allocations:

- The potential for establishment of turbine tower manufacturing plants in South Africa considering the options presented under Scenario 2 offers a completely different picture to that observed with respect to options under Scenario 1. This is particularly applicable to the years, when opportunities for establishment of new plants will arise.
- It is clear that the opportunities for setting up new tower manufacturing plants will be spread over a much greater period under Scenario 2 options than that compared to Scenario 1.
- Option 2a, which considers only opportunities derived from RE IPPPP does not offer any potential for establishing new tower manufacturing plants, which is similar to that observed in Scenario 1.
- Options that consider the potential for market penetration outside RE IPPPP, though, create opportunities for establishment of new tower manufacturing facilities only in 2024 – six years after the opportunity created by similar options under Scenario 1. Furthermore, it is likely that none of these options will also offer opportunities for establishment of two new tower manufacturing plants, which was possible in the case of high road option in Scenario 1.
- Addition of the sub-Saharan African market potential does present opportunities for the establishment of between three to four tower manufacturing plants during the analysed period. However, unlike in the case of Scenario 1 when these opportunities could already be realised during the 2015-2018 period, Scenario 2 assumes that their realisation will be spread over a longer term with the two plants being constructed by 2018 and another one or two by 2024.

- Overall, the following can be highlighted:
    - Unpacking the potential of the outside RE IPPPP and sub-Saharan African market segments are integral for the successful development of the local turbine tower manufacturing industry. These market segments are expected to bring the necessary demand to justify the establishment of between one and three additional tower manufacturing facilities. Without these markets, the wind turbine manufacturing industry in South Africa is bound to retain its current status quo and stagnate.
    - It is clear that retaining the wind energy allocations as per the Promulgated IRP 2010 is integral to facilitating an earlier establishment of new tower manufacturing plants in the country. Approval of the baseline scenario presented in the Draft Updated IRP could result in the expansion of the local tower manufacturing industry being postponed by three to six years.

Job creation potential linked to the opportunities for establishment of new facilities

Table 5-2 outlines the potential number of jobs that could be established if the opportunities presented for establishment of new steel tower manufacturing facilities were realised. The trends observed with respect to job creation potential mirror that described for the plants themselves. It can be highlighted though, that depending on the option considered, Scenario 1 will be associated with the creation of between 150 and 750 new sustainable employment opportunities in the turbine tower manufacturing industry. Importantly, however, these jobs are expected to be created three to six years earlier than that suggested by options under Scenario 2. Again, it must be noted that the volumes of jobs reported in Table 5-2 relate only to steel tower manufacturing plants. The number of jobs to be realised from the local manufacturing of concrete towers should be different to the volumes reported as it is likely to be slightly greater.

Table 5-2: Estimated number of new jobs to be created with the realisation of modelled opportunities for establishment of new turbine tower manufacturing plants

Scenario 1		2015	2018	2024	2029
Scenario 1 options linked to Promulgated IRP					
1a	Promulgated IRP only	0	0	0	0
1b	Promulgated IRP and outside RE IPPPP potential - low	0	0	0	0
	Promulgated IRP and outside RE IPPPP potential - medium	0	150	0	0
	Promulgated IRP and outside RE IPPPP potential - high	0	300	0	0
1c	Promulgated IRP and SSA potential	300	150	0	0
1d	Promulgated IRP, outside RE IPPPP potential - low, and SSA potential	300	150	0	0
	Promulgated IRP, outside RE IPPPP potential - medium, and SSA potential	300	300	0	0
	Promulgated IRP, outside RE IPPPP potential - high, and SSA potential	300	450	0	0
Scenario 2 options linked to Draft Updated IRP					
2a	Draft updated IRP only	0	0	0	0
2b	Draft updated IRP and outside RE IPPPP potential - low	0	0	0	150
	Draft updated IRP and outside RE IPPPP potential - medium	0	0	150	0
	Draft updated IRP and outside RE IPPPP potential - high	0	0	150	150
2c	Draft updated IRP and SSA potential	0	300	150	0
2d	Draft updated IRP, outside RE IPPPP potential - low, and SSA potential	0	300	150	0
	Draft updated IRP, outside RE IPPPP potential - medium, and SSA potential	0	450	150	0
	Draft updated IRP, outside RE IPPPP potential - high, and SSA potential	150	300	150	150

BLADES LOCALISATION POTENTIAL

The following tables outline the potential for establishment of new blade manufacturing facilities and creating associated jobs in South Africa considering different scenarios and options. At the moment, South Africa does not have a rotor blade manufacturing plant; therefore, any projected developments in this industry will reflect its emergence.

Opportunities for the establishment of new facilities brought by different sustainable installed capacity scenarios

Table 5-3 outlines the potential roll out of new rotor blade manufacturing plants in South Africa considering the sustainable installed capacity created by a combination of different market segments.

Table 5-3: Modelled opportunities for establishment of new rotor blades manufacturing plants

Scenarios and options		2015	2018	2024	2029
Scenario 1 options linked to Promulgated IRP					
1a	Promulgated IRP only	1	0	0	0
1b	Promulgated IRP and outside RE IPPPP potential - low	1	0	0	0
	Promulgated IRP and outside RE IPPPP potential - medium	1	0	0	0
	Promulgated IRP and outside RE IPPPP potential - high	1	1	0	0
1c	Promulgated IRP and SSA potential	2	1	0	0
1d	Promulgated IRP, outside RE IPPPP potential - low, and SSA potential	2	1	0	0
	Promulgated IRP, outside RE IPPPP potential - medium, and SSA potential	2	1	0	0
	Promulgated IRP, outside RE IPPPP potential - high, and SSA potential	2	2	0	0
Scenario 2 options linked to Draft Updated IRP					
2a	Draft updated IRP only	0	0	0	0
2b	Draft updated IRP and outside RE IPPPP potential - low	0	0	0	1
	Draft updated IRP and outside RE IPPPP potential - medium	0	0	1	0

Scenarios and options		2015	2018	2024	2029
	Draft updated IRP and outside RE IPPPP potential - high	0	1	0	1
2c	Draft updated IRP and SSA potential	1	1	0	1
2d	Draft updated IRP, outside RE IPPPP potential - low, and SSA potential	1	1	0	1
	Draft updated IRP, outside RE IPPPP potential - medium, and SSA potential	1	1	1	0
	Draft updated IRP, outside RE IPPPP potential - high, and SSA potential	1	2	0	1

From the above, the following can be highlighted:

- With respect to Scenario 1, which has Promulgated IRP(2010) at its core:
    - In Scenario 1a, the current capacity allocations from the Promulgated IRP are sufficient enough to draw the services of one blade manufacturer who can manufacture and supply blades to some of the OEMs active in the South African wind energy markets.
    - If the potential of the market outside the RE IPPPP is to be taken into account, the high road scenario for the South African market allows for setting up of two blade manufacturing facilities, one in 2015 and the other in 2018.
    - If manufacturers of blades also consider the potential brought by sub-Saharan Africa and specifically the five countries that have already set wind energy targets, opportunities are created for setting up three blade manufacturing facilities between 2015 and 2018.
    - If all the three market segments are considered, there are opportunities to set up between three to four blade manufacturing facilities between 2015 and 2018.
- With respect to Scenario 2, which assumes RE IPPPP to follow Draft Updated IRP allocations:
    - Again, as was the case with tower manufacturing plants the potential for establishment of blade manufacturing plants in South Africa considering the options presented under Scenario 2 offers a completely different picture to that observed with respect to options under Scenario 1.
    - Just like in the case of the wind turbine tower manufacturing facilities, it is also clear that the opportunities for setting up new blade manufacturing plants will be spread over a much greater period under Scenario 2 options compared to those in Scenario 1.
    - Addition of the market outside the RE IPPPP will provide an opportunity for setting up blade manufacturing facilities between 2018 and 2029.
    - If manufacturers of blades also consider the potential brought by sub-Saharan Africa and specifically the five countries that have already set wind energy targets, three blade manufacturing facilities could be established in the country between 2015 and 2029.
    - Considering all the three market segments can result in a potential of establishing up to four blade manufacturing facilities.
- Overall, the following can be highlighted:
    - Establishment of new blade manufacturing facilities in South Africa can be possible if the government sticks to the Promulgated IRP 2010.
    - Scenario 2 will offer opportunities for the establishment of blade manufacturing facilities at later periods than Scenario 1, which again shows that it is generally associated with a much slower growth potential of the local wind turbine manufacturing industry than Scenario 1.

Job creation potential linked to the opportunities for establishment of new facilities

The following table outlines the potential number of jobs that can be created with the establishment of new blade manufacturing facilities in the country under different scenarios and options considered. It shows that Scenario 1 options will offer opportunities for the establishment of between 228 and 456 new jobs during the period between 2015 and 2018. In the case of scenario 2, the same number of jobs could potentially be created on a sustainable basis; however, these opportunities can only be realised when the potential from either the outside RE IPPPP or SSA market segments is taken into consideration.

Table 5-4: Estimated number of new jobs to be created with the realisation of modelled opportunities for establishment of new blades manufacturing plants

Scenario 1		2015	2018	2024	2029
Scenario 1 options linked to Promulgated IRP					
1a	Promulgated IRP only	228	0	0	0
1b	Promulgated IRP and outside RE IPPPP potential - low	228	0	0	0
	Promulgated IRP and outside RE IPPPP potential - medium	228	0	0	0
	Promulgated IRP and outside RE IPPPP potential - high	228	228	0	0
1c	Promulgated IRP and SSA potential	456	228	0	0
1d	Promulgated IRP, outside RE IPPPP potential - low, and SSA potential	456	228	0	0
	Promulgated IRP, outside RE IPPPP potential - medium, and SSA potential	456	228	0	0
	Promulgated IRP, outside RE IPPPP potential - high, and SSA potential	456	456	0	0
Scenario 2 options linked to Draft Updated IRP					
2a	Draft updated IRP only	0	0	0	0
2b	Draft updated IRP and outside RE IPPPP potential - low	0	0	0	228
	Draft updated IRP and outside RE IPPPP potential - medium	0	0	0	0
	Draft updated IRP and outside RE IPPPP potential - high	0	228	0	228
2c	Draft updated IRP and SSA potential	228	228	0	228
2d	Draft updated IRP, outside RE IPPPP potential - low, and SSA potential	228	228	0	228
	Draft updated IRP, outside RE IPPPP potential - medium, and SSA potential	228	228	228	0
	Draft updated IRP, outside RE IPPPP potential - high, and SSA potential	228	456	0	228

NACELLE AND HUB LOCALISATION POTENTIAL

The following sections outline the potential for setting up local nacelle assembly capabilities.

Opportunities for establishment of new facilities brought by different sustainable installed capacity scenarios

Table 5-5 outlines the potential for setting up nacelle assembly facilities in the country.

Table 5-5: Modelled opportunities for establishment of new nacelle assembly plants

Scenarios and options		2015	2018	2024	2029
Scenario 1 options linked to Promulgated IRP					
1a	Promulgated IRP only	1	0	0	0
1b	Promulgated IRP and outside RE IPPPP potential - low	1	0	0	0
	Promulgated IRP and outside RE IPPPP potential - medium	1	0	0	0
	Promulgated IRP and outside RE IPPPP potential - high	1	1	0	0
1c	Promulgated IRP and SSA potential	2	1	0	0
1d	Promulgated IRP, outside RE IPPPP potential - low, and SSA potential	2	1	0	0
	Promulgated IRP, outside RE IPPPP potential - medium, and SSA potential	2	1	0	0
	Promulgated IRP, outside RE IPPPP potential - high, and SSA potential	2	2	0	0

Scenarios and options		2015	2018	2024	2029
Scenario 2 options linked to Draft Updated IRP					
2a	Draft updated IRP only	0	0	1	0
2b	Draft updated IRP and outside RE IPPPP potential - low	0	0	1	0
	Draft updated IRP and outside RE IPPPP potential - medium	0	0	1	1
	Draft updated IRP and outside RE IPPPP potential - high	0	1	1	0
2c	Draft updated IRP and SSA potential	1	1	1	0
2d	Draft updated IRP, outside RE IPPPP potential - low, and SSA potential	1	1	1	0
	Draft updated IRP, outside RE IPPPP potential - medium, and SSA potential	1	1	1	1
	Draft updated IRP, outside RE IPPPP potential - high, and SSA potential	1	2	1	0

From the above, the following can be highlighted:

- With respect to Scenario 1, which has Promulgated IRP(2010) at its core:
  - Scenario 1 a, Scenario 1b – low outside RE IPPPP market penetration and Scenario 1b – medium outside RE IPPPP market penetration offers opportunities for the establishment of one new nacelle assembly facility in South Africa in 2015 considering the annual sustainable installed capacity figures. However, as was previously stated, assembly of the nacelle requires access to skilled labour with the adequate expertise in this industry. Furthermore, while manufacturing of towers and blades can be done by a facility for a number of OEMs per their specifications, assembly of the nacelle could be more difficult to outsource as most OEMs prefer to do this in-house. This means that the projected demand would need to be taken up by one OEM producing nacelle for its own projects, which might not be practical and feasible since it would imply that this OEM would need to have the biggest share of the market. The above means that practically, the realisation of these opportunities will most likely not be possible in the near future and the establishment of local nacelle assembly facilities could potentially only be realised of there is a demand for at least two facilities.
  - In the context of the above, opportunities for the establishment of local nacelle assembly facilities might only arise if the market reached the high road option with respect to the outside RE IPPPP segment or if OEMs start to target the sub-Saharan African market and decide to establish a local assembly facility with an aim of exporting the majority of the locally produced nacelle to sub-Saharan Africa. In these instances, establishment of assembly facilities could already be possible in the next three years but still required significant investment in up-skilling the local labour.
- With respect to Scenario 2, which assumes RE IPPPP to follow Draft Updated IRP allocations:
  - The arguments applied for Scenario 1 are also valid for Scenario 2. The only difference though is that the potential for establishment of nacelle assembly facilities would only be practical after 2018.

Job creation potential linked to the opportunities for establishment of new facilities

As indicated in the table below, the sustainable installed capacity created through different options and scenarios would offer opportunities for setting up new nacelle assembly facilities and creating between 400 and 1 200 new jobs depending on the option pursued. As in the cases with towers and blades, Scenario 1 options imply creation of these jobs much earlier than Scenario 2 options. However, these opportunities, as mentioned earlier, are linked to the demand side projections only and do not take into account the specific characteristics of the industry itself, which requires access to highly skilled labour to finish assembly of the nacelle and which might be challenging to source in South Africa in the immediate future. This means that the realistic ability of the industry to set up local nacelle assembly facilities in the immediate future, i.e. in 2015, will only be possible in a few years' time, i.e. closer to 2018.

Table 5-6: Estimated number of new jobs to be created with the realisation of modelled opportunities for establishment of new nacelle assembly plants

Scenario 1		2015	2018	2024	2029
Scenario 1 options linked to Promulgated IRP					
1a	Promulgated IRP only	400	0	0	0
1b	Promulgated IRP and outside RE IPPPP potential - low	400	0	0	0
	Promulgated IRP and outside RE IPPPP potential - medium	400	0	0	0
	Promulgated IRP and outside RE IPPPP potential - high	400	400	0	0
1c	Promulgated IRP and SSA potential	800	400	0	0
1d	Promulgated IRP, outside RE IPPPP potential - low, and SSA potential	800	400	0	0
	Promulgated IRP, outside RE IPPPP potential - medium, and SSA potential	800	400	0	0
	Promulgated IRP, outside RE IPPPP potential - high, and SSA potential	800	800	0	0
Scenario 2 options linked to Draft Updated IRP					
2a	Draft updated IRP only	0	0	400	0
2b	Draft updated IRP and outside RE IPPPP potential - low	0	0	400	0
	Draft updated IRP and outside RE IPPPP potential - medium	0	0	400	400
	Draft updated IRP and outside RE IPPPP potential - high	0	400	400	0
2c	Draft updated IRP and SSA potential	400	400	400	0
2d	Draft updated IRP, outside RE IPPPP potential - low, and SSA potential	400	400	400	0
	Draft updated IRP, outside RE IPPPP potential - medium, and SSA potential	400	400	400	400
	Draft updated IRP, outside RE IPPPP potential - high, and SSA potential	400	800	400	0

6. CONCLUSION

The investigation into the potential to localise wind turbine key component manufacturing in South Africa focused on two sets of scenarios. One scenario had the Promulgated IRP (2010) annual wind energy technology allocations as a base and the other scenario implied annual allocations recommended in the Draft Updated IRP (2013). Both of these scenarios included opportunities presented by two additional market segments, i.e. outside RE IPPPP market segment and highly probable sub-Saharan Africa market segment.

The projections for sustainable installed capacity for each set of scenarios revealed that the main difference between Scenario 1 options and Scenario 2 options is such that opportunities for establishment of local manufacturing facilities are created much earlier in the case of Scenario 1 (i.e. between 2015 and 2018) than in the case of Scenario 2 (i.e. mainly between 2018 and 2024). Since the only difference between these scenarios lies in the annual allocated installed capacities under RE IPPPP, it suggests that the adoption of the Draft Updated IRP (2013) will lead to a much slower development of the local wind turbine manufacturing industry than if the deployment of wind energy projects follows the Promulgated IRP (2010) allocations.

Furthermore, it was revealed that allocations suggested in both Promulgated IRP (2010) and Draft Updated IRP (2013) will unlikely offer opportunities for establishment of new manufacturing facilities in the future. Opportunity to penetrate the market outside RE IPPPP and tap into Sub-Saharan Africa are the game changers. Since some OEMs have indicated that they would not base their decision to establish local manufacturing facilities on sub-

Saharan Africa and since the penetration of this market is still associated with some risks, the speed at which the regulatory environment related to the large-scale renewables deployment outside RE IPPP will most likely determine the rate and extent of the local wind turbine manufacturing industry development in the country.

Notwithstanding the above, the modelling of scenarios and localisation potential revealed the following opportunities:

- Depending on the scenarios, between one and five new tower manufacturing facilities could be established in South Africa. In the case of Scenario 1, such opportunities will be presented during the period between 2015 and 2018, provided that markets outside the RE IPPPP and sub-Saharan Africa are tapped into. In the case of Scenario 2 options, these new facilities will need to be built between 2018 and 2024. In any instance, their realisation could lead to the establishment of between 150 and 750 new sustainable jobs, when considering the steel tower technology.
- As far as blade manufacturing plants are concerned, further committing to the Promulgated IRP 2010 brings an opportunity to establish one facility with about 228 sustainable employment opportunities. Three to four blade manufacturing facilities are even envisaged if the potential from the outside RE IPPPP and the sub-Saharan Africa market segments is further unpacked.
- As far as nacelle and hub manufacturing is concerned, South Africa would most likely only be able to attract assembly facilities as manufacturing of certain components of nacelle is usually outsourced by OEMs to the global leaders in respective industries with only a few components being produced in-house. The structure of the nacelle assembly industry though is somewhat different to the blade and tower manufacturing, with limited opportunities made available for sharing existing facilities by OEMs with respect to assembly processes. As such, options that render opportunities for establishment of only one nacelle assembly facility is not realistic. Furthermore, assembly of nacelle is a highly sophisticated process that requires access to specialised labour, which is not available in South Africa. Thus significant time will be required to transfer skills to the local labour force. Overall, regardless of the scenario considered, the potential for setting up local nacelle assembly facilities will only arise if the high road option is considered for the market outside RE IPPPP and when sub-Saharan Africa market segment is taken into account. In the case of Scenario 1, such opportunities will be possible to realise in the next few years, while in the case of Scenario 2, it will only be possible after 2018. Overall, between 400 and 1 200 jobs could be created in the process.

To conclude, the biggest opportunity for developing the local wind turbine manufacturing industry lies in wind tower manufacturing, followed by blade manufacturing. Importantly, realisation of any of these opportunities will require as a minimum the unpacking of the market outside RE IPPPP and providing support to the industry for it to achieve global competitiveness. The penetration of sub-Saharan Africa will strengthen the local industry status and lead to greater industry growth; however, as was mentioned previously, reliance on this segment of the market is currently risky and cannot be considered an industry driver.

SECTION 4: FINANCE AND CERTIFICATION

1. INTRODUCTION

The purpose of this section is to outline how financing of renewable energy projects, with specific reference to wind energy projects, occurs in South Africa. It examines the funding mechanisms and funding structures involved, the role the different finance entities have played in the RE IPPPP, how this role has evolved since the start of the programme and is likely to evolve in the future. It also examines how risk is allocated within a wind energy project and the impact that local content has on this. Further to the above is the discussion over the linkages between certification requirements and the cost of compliance, and whether the challenge of ensuring all equipment components are certified so as to meet proper international operating standards and production guarantees, can be met to the satisfaction of all industry partners.

2. RENEWABLE ENERGY PROJECT FINANCING IN SOUTH AFRICA

To date, 64 large-scale renewable energy projects have been awarded preferred bidder status in Bid window 1, 2 and 3. Of the approved projects, 22 projects represent wind energy projects with a total investment value of over R40.6 billion (PPIAF, 2014). Financing of large-scale renewable energy projects in South Africa, whether wind or solar PV, for example, follows the same approach and makes use of similar models; therefore, the following paragraphs outline the general information regarding the key role players and financing structures. Where applicable, though, the analysis differentiates wind energy projects from other RE IPPPP projects.

Funding sources and lenders

Financing of renewable energy projects in South Africa within the RE IPPPP largely follows **conventional project finance models** that are similar to those applied in large infrastructure project and does not differentiate among technologies. For example, financing models employed for solar photovoltaic and wind energy projects are largely the same with commercial banks avoiding technology risks altogether. Most of the projects approved under Bid Window 1, 2, and 3 have been **project financed**, i.e. relied solely on limited recourse financing and specifically the cash flow to be generated from the project that are ring-fenced from those of the sponsor. A small number of projects have been financed through the balance sheet, or **corporate financed** (PPIAF, 2014). The latter included two wind projects with a total nameplate capacity of 199MW, which were financed by the Italian utility Enel. It should be noted that corporate financing has emerged only in Bid Window 3.

INFORMATION BOX: PROJECT FINANCE AND CORPORATE FINANCE

Project finance -"the raising of finance on a Limited Recourse basis, for the purposes of developing a large capital-intensive infrastructure project, where the borrower is a special purpose vehicle and repayment of the financing by the borrower will be dependent on the internally generated cash flows of the project". (HSBC, 2012)

The term **project finance** is usually referred to as off-balance sheet funding; while on balance sheet funding is referred to as a **corporate finance** transaction. Project Finance is different from conventional balance sheet funding where the lender looks at the balance sheet strength of the corporation. The lenders have virtually no recourse on the project assets or on the sponsors of the project and can only rely on the project cash flows. (Deloitte, 2012)

Financing of the utility scale projects in the country is done by means of attracting both foreign and domestic investors, with the latter dominating the current market. Domestic investors or financiers primarily comprise of development finance institutions (DFIs) and commercial banks, but also incorporate venture capitalists and asset management companies.

A variety of financial mechanisms are offered for financing of renewable energy projects in South Africa, which primarily include senior debt financing, equity financing, subordinate debt financing in the form of "mezzanine" debt provision, hedging, risk management, and carbon credit transactions by means of pre-purchasing carbon credits. There is also an emerging trend towards the use of more sophisticated products such as project bonds or credit wrapped bonds, the securitisation of future cash flows, and political risk insurance to provide a portion of the necessary finance. For example, in 2013, CPV Power Plant No.1 Bond SPV (RF) Ltd - a Soitec affiliate - issued a ZAR 1-billion bond to South African institutional investors on the Johannesburg Stock Exchange (JSE) to finance the construction of a 44MW Concentrated Photovoltaic power plant. The key features of the bond are that it offers a fixed coupon rate of 11% over a 15-year period based on an amortizing profile, which gives it a modified duration of seven years. One South African bank also marketed a conduit structure where bank loans under the RE IPPPP will be packaged into JSE-listed securities (Trade and Industrial Policy Strategies, 2014).

Considering the closed Bid Windows, about two-thirds of funding provided for RE IPPPP projects since the start of the programme was **debt funding**, with the highest proportion observed in Round 2 and the lowest in Round 3 (PPIAF, 2014). About a quarter of investment costs was covered by pure equity and shareholder loans, while the rest came from corporate finance (PPIAF, 2014).

The major debt providers and the level of participation in terms of number of projects and value of funding provided in the RE IPPPP are shown in Table 2-1. A large portion of the Industrial Development Corporation (IDC) and the Development Bank of Southern Africa (DBSA) debt was used to finance equity investments (e.g. BEE shareholder contributions).

Table 2-1: Major debt providers in the RE IPPPP

Lender	No. of projects per lender	Total Value (R billion)
Nedbank	23	17.6
Standard Bank	17	16.3
ABSA	14	15.6
RMB/First Rand	11	16.5
Investec	4	3.8
IDC	22	13.1
DBSA	20	12.2
Old Mutual	8	3.4

(PPIAF, 2014) (Arista Capital Advisors, 2014)

From the above, the following can be highlighted:

- The majority of debt was financed by South Africa-based institutions, with South Africa's commercial banks accounting for the biggest portion of the RE IPPPP lending (R69.8bn). Among the **local commercial lenders**, Nedbank, Standard Bank, RMB and ABSA account for almost 60% of initial debt provided by domestic institutions. Nedbank accounts for the biggest individual share in terms of rand value of debt financed (PPIAF, 2014). Nedbank, with 23 projects, also ranks first in terms of the number of projects that it was involved in, followed by Standard Bank (17), ABSA (14), and RMB (11) (PPIAF, 2014). In Bid Window 3, ABSA and Nedbank were among the most active commercial banks providing debt financing for the majority of projects.

- **DFIs** rank second (R25.3 bn) among the local institutions in terms of the value of lending provided to RE IPPPP projects approved under Bid Window 1, 2 and 3. The IDC and the DBSA are the only two local DFIs who are also financiers of RE IPPPP projects. The IDC participated in 22 deals and the DBSA in 20 deals, mostly in arranging vendor financing for black economic empowerment and community participation. (PPIAF, 2014) (Arista Capital Advisors, 2014).
- **Life funds**, such as insurance and pension funds, accounted for about 5% of local lending provided to projects approved under Bid Window 1,2 and 3. They were mainly represented by Old Mutual, Sanlam, and Liberty (PPIAF, 2014).

Equity financing is generally provided by private investors, insurance companies, asset management companies, and DFIs. In South Africa, Old Mutual, the IDC, German Investment and Development Corporation - DEG, Netherlands Development Finance Company - FMO, and sponsors such as Enel, Mulilo, Mainstream, and Theme were among the most prominent equity financiers who took shareholding in the approved projects (PPIAF, 2014). Most of the commercial banks do not get involved in the equity space particularly as far as BEE financing is concerned due to the risks involved and leave this niche market for DFIs; however, Standard Bank was one of the exceptions.

Project finance structure, costs, and returns

Project financing is largely an exercise in the equitable allocation of a project's risks between the various stakeholders of the project. Project finance among the wind projects in the first two Bid Windows of RE IPPPP was typically structured according to 70:30 or 75:25 debt to equity ratios. In Bid Window 3, though, project gearing levels increased to 80:20. This trend clearly illustrates the increasing confidence among the financial institutions in the programme and renewable energy projects as an asset class, as construction of many projects that reached financial closure in Bid Window 1 and Bid Window 2 has been successfully completed and projects coming online.

The split between debt and equity is largely related to the risk profile of the project, which is a function of a number of factors including track record and guarantees of technology providers, profile of sponsors, as well as experience and financial strength of Engineering Procurement and Construction (EPC) and Operating and Maintenance (O&M) companies. The less comfortable the lenders are with the above and subsequently a greater risk perceived by them the greater the amount of equity support the sponsors will have to provide.

Debt financing costs between development finance institutions and commercial banks do not differ significantly as the former try to match the rates offered by the latter. In Bid Window 3, projects were financed on a long-term project finance basis with debt tenors or initial term length of a loan reaching up to 18 years from Commercial Date of Operation (COD), illustrating an increase by one to three years from 15 years observed in the first two Bid Windows (Study interviews, 2014). Financing costs are generally linked to the Johannesburg Interbank Agreed Rate (JIBAR), with the exception of the IDC that charges rates linked to R186 bonds. The premiums charged by financial institutions above JIBAR varies from bank to bank and depends on the project itself. In Bid Window 3, projects were largely financed at an interest rate of between 350 to 400 basis points above JIBAR (PPIAF, 2014). This showed a slight decrease compared to the financing costs observed in bid Window 1 and Bid Window 2, where financing costs ranged between 400 and 500 basis points over JIBAR (PPIAF, 2014). The drop in financing costs was largely attributed to the decline in tariffs and more mature nature of the market. Overall, financial institutions have become more comfortable with the RE IPPPP with investor confidence growing and risk perceptions decreasing.

The change in **equity returns** between Bid Window 3 and Bid Window 1 and 2 has also been observed. In Bid Window 1 and Bid Window 2, equity returns ranged primarily in the late teens to mid-twenties. In Bid Window 3, however, the average equity returns dropped to the early teens and it is reported that some of the corporate funded projects were even lower which would have contributed to the decrease in the overall average. This supports the observations that the competition among project developers is increasing, driving profit margins for contractors' down and demanding lower developer premiums.

Project finance and local content requirements

Except for the IDC which required a minimum of local towers to be part of the EPC package, other financial institutions do not specify criteria for the local content and particularly for the location of manufactured components such as nacelle, blades, or towers for projects submitted under Bid Windows 1, 2, and 3. At the same time, local content requirements do not yet have a direct effect on cost of financing, as the risk is typically passed onto the EPC contractor. The most important criteria that financial institutions apply when evaluating projects include, inter alia:

- Location of site
- Availability of site , i.e. lease options or purchase agreement signed
- Quality of resource
- Grid connection
- Technical partner and technical service agreements signed
- Track record and financial strength of major equipment suppliers
- Technical certifications
- Access to equity finance
- Track record of sponsors building a project
- O&M contracts
- Bid compliance status, including satisfaction of economic development criteria

Aside from the local content and economic development criteria, a company intending to develop a wind project outside of the RE IPPPP is still subject to the same rigorous criteria as set out above when applying for finance. The developer has to have concluded a bankable long-term Purchasing Power Agreement (PPA) before a project is considered for funding. The development finance institutions are willing to consider financing of new technologies in this case on the strength of a PPA. The importance of signing a long-term PPA is shown by the failure of IWEC to secure funding from a DFI because it could only secure a three-year agreement, which made the PPA unbankable and caused the withdrawal of the project funders.

The assessment of the likelihood the company to be operating in the next medium to long term is among the integral factors that affect the decision of the financial institutions to support the project or not. Generally, for the major components such as a wind turbine, the top manufacturing brands are well known and their international certification and track record give comfort to the lender.

Some of the financial institutions interviewed also noted the skewed local content of some deals arising from the price of the wind turbine. Deals involving higher priced turbines had a lower local content value than those involving cheaper turbines. Hence, we also find that some turbine manufacturers are arguing for split thresholds between turbine and balance of plant as the cost of manufacture, cost of R&D and reputational risk concerns make it unlikely that they can reduce their prices drastically to compete with lower priced manufacturers. The wind EPC contracts already have a split EPC structure, as outlined further in the chapter, so this is not seen as an increasing administrative burden to financiers and DOE.

3. PRINCIPLES OF CONTRACTUAL ARRANGEMENTS

The PPA is the main source of revenue for developers and for the commercial banks financing Independent Power Producers (IPPs) to ensure debt repayment and adequate return on investment[9]. Most notably, the PPA is used to divide and allocate risk between all involved parties.

- On the one hand, the agreement is underwritten by the National Treasury should Eskom default on the terms of the agreement. This includes the possible situations such as when Eskom fails to connect renewable energy projects to the grid and when the utility fails to pay for the generated electricity. The DoE also has separate contracts with the project companies in order to offer recourse for project investors in the event that Eskom fails to meet its obligations under the PPA. Under the Direct Agreement between the DoE and the lenders of the project, the DoE, underwritten by the National Treasury, commits to taking on payments due to the project company should Eskom default on payments (Trade and Industrial Policy Strategies, 2014). This government backstop of the PPA has earned the RE IPPPP procurement programme significant credibility with international investors (Trade and Industrial Policy Strategies, 2014). Should there be a dispute between IPPs and Eskom over terms not being met in the PPA, the responsibility of mediating the conflict falls on the National Energy Regulator of South Africa (NERSA).
- On the other hand, should the project company fail to generate the contracted energy, the lenders are asked to step in and find a replacement project company, if feasible. If not, the allocation for that project could be put up for bid in subsequent Bid Windows. In the case of IPPs, defaulting on supplying the agreed amount of electricity due to weather instability or plant degradation or destruction, the liability falls on the IPP and the renewable project's financiers. In this case, commercial lenders include comprehensive insurance to cover the loss and protect the developer, as part of the project finance. Should there be a case when the IPP is unable to generate electricity caused by a fault in the construction of the plant, the liability falls on the contractor as agreed in the EPC contract.

Lenders normally require the **EPC Contracts** to include a fixed completion date, a fixed completion price, no or limited technology risk, output guarantees, liquidated damages for both delay and performance, security from the contractor and/or its parent and restrictions on the ability of the contractor to claim extensions of time and additional costs (DLA Cliffe Dekker Hofmeyr, 2012). The major advantage of the EPC Contract over the other

[9] In addition to the PPA, some wind projects may also derive a source of revenue from carbon credits. At least 15 South African wind projects are registered with the CDM Executive Board.

possible approaches is that it provides for a single point of responsibility. In the case of wind projects, the turbine supplier would normally be expected to provide the turnkey EPC wrap. However, within the current RE IPPPP some of the manufacturers of the wind turbines have successfully avoided taking the turnkey responsibility by entering into a supply contract and a balance of plant contract (i.e., the foundation works, civils and erection etc.) instead of an EPC Contract. Separating the EPC contract into a supply and BOP contracts are associated with a number of risk for the project company. Unlike a standard EPC Contract, the project company cannot look only to a single contract or to satisfy all the contractual obligations (in particular, design, construction and performance). Under a split structure, there are at least two entities with those obligations. Therefore, a third agreement, a coordination and interface agreement or wrap around guarantee, is often used to deliver a single point of responsibility despite the split.

The **EPCM contract** is essentially a design and construction management contract, which implies no construction activities undertaken by the EPCM contractor. An EPCM contract is a professional services contract under which the contractor will not accept primary responsibility for carrying out of the works. The contracting structure under an EPCM solution is fundamentally different to that adopted under a typical EPC solution. Unlike the EPC solution, it will usually be the Sponsor, not the contractor that will enter into contractual relations with the contractors, service providers and plant and equipment suppliers responsible for delivery of the works (Norton Rose Fullbright, 2013). An EPCM solution is associated with a substantially more onerous risk profile from a Sponsor perspective, when compared with the EPC structure (Norton Rose Fullbright, 2013). In order to attract project finance the Sponsor will need to demonstrate an appropriate allocation of risk between the Sponsor and the EPCM contractor and also demonstrate to potential lenders how the risks retained by the Sponsors will be managed (i.e. through use of cost overrun facilities etc.) (Norton Rose Fullbright, 2013). The EPCM contractor usually accepts full responsibility for the final design and for it meeting specific technical and performance requirements, it will also usually be responsible for coordinating the design produced by other parties (Norton Rose Fullbright, 2013) .

When choosing between EPC and EPCM contracts, the preferred option depends on the following (Norton Rose Fullbright, 2013):

- The securing of the single point of responsibility EPC solution may expose the Sponsor to inflated pricing which may have an impact on project affordability and which may not be considered by the Sponsor to offer value for money.
- There may be a general lack of appetite in the market to take on the project in question on a turn-key EPC basis. As already discussed, wind turbine manufacturers prefer a split EPC to full turnkey EPC.
- The Sponsor has a good track record in project delivery and has a large internal management resource and as a result prefers to adopt the EPCM structure to significantly reduce overall cost and increase equity returns. For example, a company like Enel Green Power possesses these resources to contract on an EPCM basis and it is one of the reasons that they can ensure an overall project cost that is cheaper than developers employing an EPC contracting strategy.

EPC and EPCM contracting strategies are common to wind projects all over the world. Some developers have commented that the situation in South Africa is more robust in terms of risk allocations and this has arisen from the more stringent requirements imposed by the lenders in South Africa. In the medium- to long-terms, EPCM contracting can contribute to localisation as most of the engineering and construction management services will be available locally as the skills base grows. As it becomes increasingly difficult for wind projects to meet local content requirements in subsequent Rounds of the RE IPPPP, one can expect a shift towards EPCM contracting as the preferred contracting mode.

An **operations and maintenance agreement** governs the operation and maintenance of the facilities between the project company and the EPC contractor. In the case of many wind projects, the project company will enter into a fixed short-term O&M Agreement with the manufacturer and supplier of the wind turbine generators, during which the appointed operator will train the staff of the project company. The project company will take over operation of the facility on expiry of the O&M Agreement and will perform all O&M functions except for some support functions being retained by the manufacturer. Some wind energy developers have set up their own maintenance and operations companies to operate their facilities, for example BioTherm Energy. In these circumstances, the O&M Contract will be replaced with a Technical Services Agreement (TAC), under which the project company is supplied with the know how necessary for its own employees to operate the facility. The operations and maintenance space is seen as one of the avenues to boost local content. In the short-term this would require development and upskilling of local expertise.

4. CERTIFICATION

In the wind industry, DNV GL and TÜV Rheinland are generally highly regarded bodies for development of standards, specifications, and guidelines. They issue Type certificates following extensive evaluation of wind turbine components and systems. The process involved in issuing such a certification is illustrated in Figure 4-1. The costs of obtaining such a certification will run into millions of rand.

The description of the IEC Type Certification System is based on IEC 61400-22:2010, "Wind Turbines – Part 22, Conformity Testing and Certification:, which is an update/revision of the IEC Certification System described in IEC WT 01 "IEC System for Conformity Testing and Certification of Wind Turbines, Rules and Procedures". The Type Testing module comprises the following elements:

- Safety and Function Tests
- Load Measurements
- Power Performance Measurements
- Blade Tests
- Other Tests including Gearbox Field Test

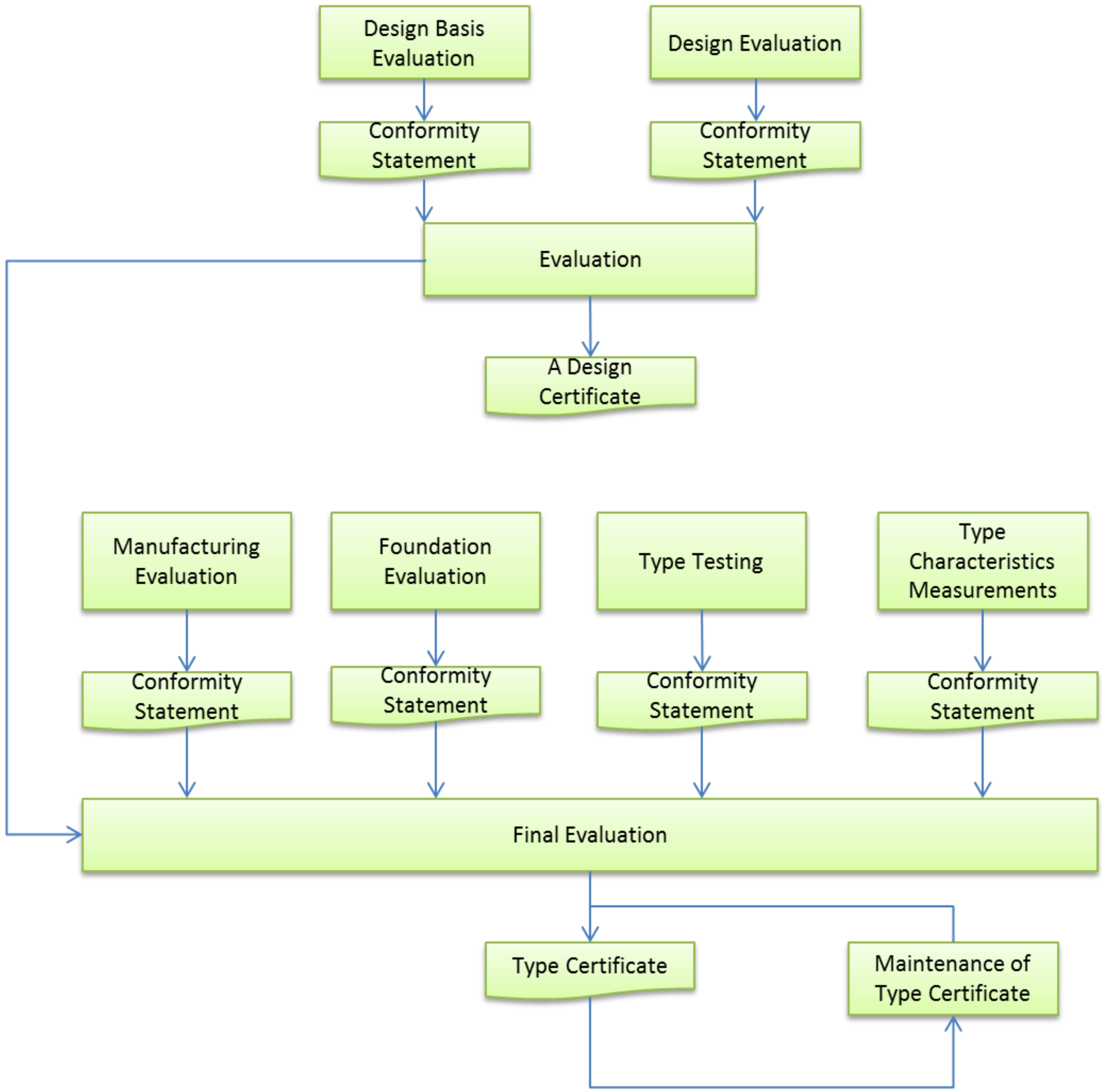


Figure 4-1: A Design and Type Certification Process Adapted (DNV , 2011)

A new design by a manufacturer will need to go through a certification process before it can be considered for financing. Even then a track record will be required before it becomes a bankable product. The new design will typically receive an A-Design certification. It will only become eligible for a Type Certification once the product enters "serious" production, i.e. production on scale and is piloted on an actual site. Part of the certification process entails evaluation of the manufacturing facility and on the field evaluation.

Financiers are comfortable with Type Certification and as indicated through interviews will not be averse to local standards and guidelines adapted from international standards and guidelines such as IEC 61400. They, however, will have to consider track record and will require two to three years of operational track record of critical wind turbine components before projects involving a local major component is even considered for funding. Even then the risk profile will be significantly different from an established component with an existing track record. To mitigate this risk, finance and insurance charges will undoubtedly increase.

It is worthwhile noting for any new manufacturing entrant that the local wind turbine manufacturer IWEC was in possession of an A-Design Certificate for its turbine, but was still unable to conclude any bankable PPAs in the absence of a Type Certification and track record. The company had started production on a model of turbine that had not yet obtained any track record that adversely affected the ability to attract finance to sustain its operation. In order for the company to have received a Type Certification, it would have had to enter "serious" production mode and set up a pilot project or test facility. In addition to the lessons learnt from the IWEC experience, the new entrant will also be faced with the high initial costs of obtaining certification.

5. Conclusion

Through its first three Bid Windows, the South African RE IPPPP has registered impressive achievements. To date, it has secured investment commitments to the value of R120 billion to build 3 922MW of new renewable energy generating capacity. The country's financial services sector has played a notable role in the success of the programme. It is highly liquid, offers long-term debt, understands project finance, and has experience with PPPs and private finance of public infrastructure.

Renewable energy projects under RE IPPPP follow largely similar financing models and large infrastructure projects with limited recourse project finance remaining the dominant source of financing; although new and innovative solutions to project finance are also emerging. The type of a project or technology plays little role in the financing structure suggesting that the financing structure of wind energy projects does not differ from those of solar PV projects, for example.

As the programme matured and projects came online, the investor confidence increased and risk perceptions reduced. This resulted in the gearing ratio reaching 80:20, a notable change compared to 70:30 observed in Bid Window 1. Furthermore, projects approved under Bid Window 3 received longer debt tenors (i.e. 17/18 years compared to 15 years observed in Bid Window 1 and 2), secured lower project finance costs, and led to reduced shareholder return expectations.

Wind projects are following similar EPC and EPCM contracting models as employed in other parts of the world. The South African models are widely considered more robust as a result of the stringent requirements imposed by the funding agencies. Both contracting models are being employed by local developers; the choice being dependant mainly on in-house strengths and appetite for risk.

Financiers are generally comfortable with the adoption of local standards, provided they are suitably adapted from their international counterparts, but are less comfortable when it comes to debt provision for wind projects that involve local components, especially when these involve critical components like the turbine and gearbox.

There is still a growing appetite within the sector to participate in future rounds. It is expected that commercial banks will sell down more of their debt to secondary capital markets and position themselves for ongoing debt exposure in future RE IPPPP rounds.

For local companies intending to expand their manufacturing capabilities in South Africa, finance at a preferential interest rate is available under the industrial financing loan facilities component of the MCEP. Where large components such as turbines and blades are concerned, any new entrant has to first aim to obtain certification and develop a test or pilot facility in order to develop a track record that will enhance the chances of securing finance for projects. Smaller scale projects outside of the RE IPPPP may present opportunities to develop a track record. In order to participate in the RE IPPPP, these companies must have a demonstrated track record and would have to undergo the expensive certification process.

SECTION 5: LOCALISATION ROADMAP

1. INTRODUCTION

This section of the study unveils the localisation scenarios to guide the potential expansion of South Africa's current nascent wind energy manufacturing industry. The different localisation scenarios are built on the assumptions regarding potential installed capacities and thresholds applicable to the establishment of certain manufacturing facilities in South Africa or procurement of machinery and equipment from the local industry. Key to this section is the presentation of the roadmap, which outlines the potential localisation of key wind turbine components such as the blades, nacelle assembly, castings and forgings, nacelle housing, and selected nacelle interior components. Also included in this section are discussions on the macroeconomic impact of localisation. As part of the impact analysis, macroeconomic variables relating to employment, trade balance, cost of localisation and value creation, especially around the aspect of local production, are unpacked and assessed. The section concludes by recommending industry development strategies for the purposes of enabling an efficient and effective roll out of the wind energy industry in the country.

2. LOCALISATION SCENARIOS

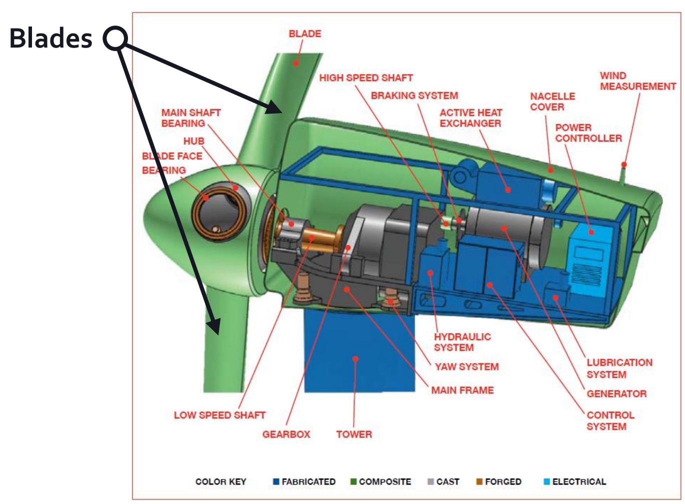
This chapter outlines the likely optimal local content to be realised in South African in large-scale wind energy projects following the localisation of different sets of key components.

2.1 ASSUMPTIONS

Different requirements/conditions hold for the manufacturing or assembling of dissimilar wind turbine key components. As highlighted in the following paragraphs, there are a set of component-specific prerequisites necessary for the establishment of manufacturing/assembling facilities. The realisation of such requirements is critical in ensuring the attraction of both domestic and foreign manufacturing investment.

BLADES	*MEDIUM localisation potential*

- <u>Conditions/requirements:</u>
  - Manufacturing of blades is either produced in-house or outsourced to independent blade manufactures through build-to-design or build-to-print strategy
  - Build-to-design/build-to-print model requires access to six to eight moulds in order to be economically feasible
  - High-tech engineering capabilities and expertise in working with advanced composite materials
  - 400MW pa per facility per OEM for a minimum period of five years



(AWEA, 2011)

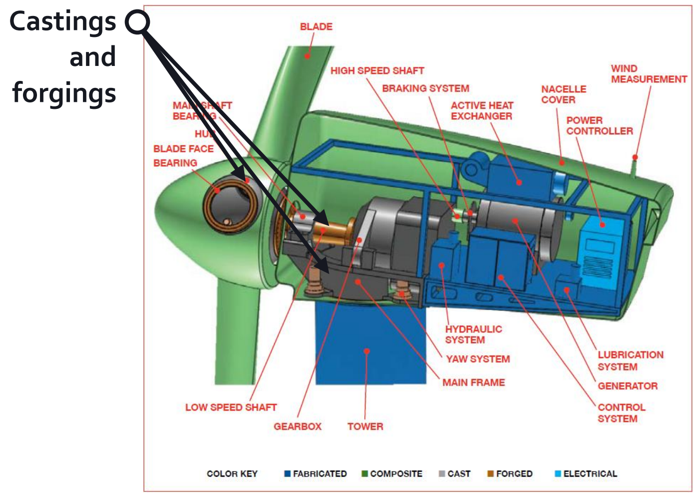
- <u>Cost and Benefits:</u>
  - CAPEX: R440 million - R490 million
  - Job creation potential: 228 per facility
  - Local content potential: 60% (Tier 2) from locally procured fibreglass, adhesives, and labour
  - Price increase: 5% (the price of the locally manufactured blades would not be more expensive relative to the price of imported blades)
- <u>Localisation potential:</u>
  - There is a medium localisation potential for the blade industry in South Africa considering that most of the stated prerequisites are already present. Importantly, due to the RE IPPPP, there are already a number of wind turbine OEMs and blade manufacturers active in South Africa that have access to the required technology, know-how, and who have credentials to attract investors if required.

NACELLE ASSEMBLY	***LOW localisation potential***

- <u>Conditions/requirements:</u>
  - This is a proprietary activity that is done only in-house by OEMs, i.e. assembly facilities are not shared among OEMs
  - Specialised technical skills and equipment, especially for finishing and testing
  - 400MW pa per OEM for a minimum period of five years
  - 1 000MW of minimum total available installed capacity over a medium-term
- <u>Costs and Benefits:</u>
  - CAPEX: R70 million – R130 million
  - Job creation: potential to create up to 230 jobs per facility
  - Local content potential: 80% (Tier 2) with the majority of the labour drawn from local expertise with a few exceptions for highly technical tasks that would require foreign expertise at least until local labour can be adequately unskilled
  - Price increase: 10%-20% higher relative to that of a unit imported from overseas
- <u>Localisation potential:</u>
  - The biggest constraining factor for the localisation of nacelle assembly is the proprietary nature of such activities that requires the market that would not only assure a sustainable order book for an OEM but also accommodate more than two OEMs at a time.
  - Localisation of nacelle assembly is a critical point that needs to be overcome to unlock the opportunities to localise the manufacturing of other nacelle components without provision of other support mechanisms

NACELLE CASTINGS AND FORGINGS

LOW localisation potential without local assembly
MEDIUM localisation potential with local assembly

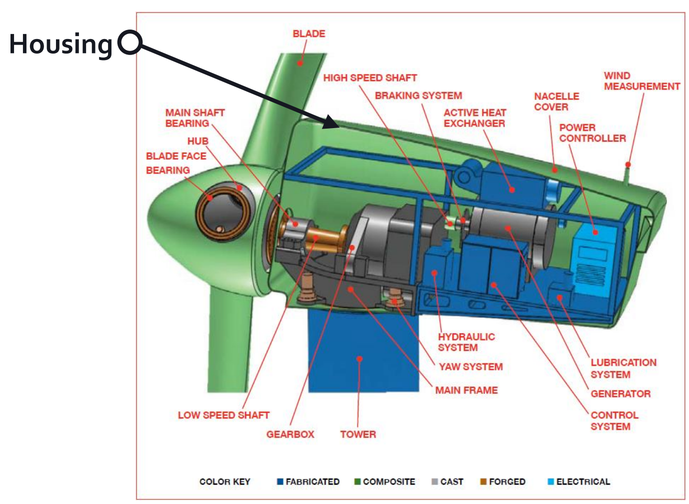


(AWEA, 2011)

- Conditions/requirements:
  - Outsourced to a local casting and forging industry or established proprietary facility
  - OEMs are very particular about the quality of steel to be used; castings need to pass strict mechanical property tests and are submitted to non-destructive tests that mostly comprise ultrasonic and magnetic inspection methods
  - Requires establishment of the local assembly facility first as South Africa does not have an existing export industry for the parts
- Costs and Benefits:
  - CAPEX: limited investment requirements if the local castings and forgings industry capability is utilised and/or additional investment of up to R60 million if facilities need to be expanded or established
  - Local content potential: up to 90% (Tier 2) due to local metal content and local labour
  - Price increase: 20% increase relative to that of imported products, particularly from the Asian countries
- Localisation potential:
  - Low potential if a local nacelle assembly facility is not established or other support mechanisms are provided, but medium potential if a nacelle assembly facility is established due to the availability of quality steel coupled with the existence of an established foundry industry in South Africa

NACELLE HOUSING

LOW localisation potential without local assembly
MEDIUM localisation potential with local assembly



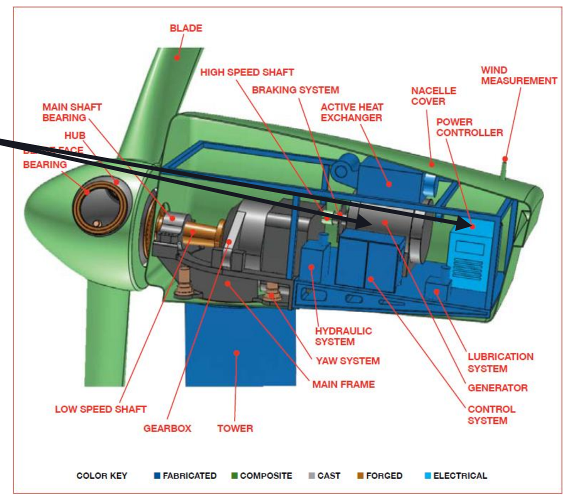
(AWEA, 2011)

- Conditions/requirements:
  - Can be outsourced to an established composites manufacturing company
  - Specialised skills required, especially in composite material handling
  - Requires establishment of the local assembly facility first since the country currently doesn't have an export industry for nacelle covers
- Costs and Benefits:
  - CAPEX: limited or not investment required due to utilisation of existing composites manufacturing industry capabilities that draws from experience and expertise of the South

African aerospace and automotive industry
    - Local content potential: 80%- 90% (Tier 2) due to procurement of fibreglass and adhesives from local producers or suppliers and local labour
    - Price increase: 20% increase compared to imported products, particularly from the Asian countries
- <u>Localisation potential:</u>
    - Low potential in the absence of the local nacelle assembly facility but medium potential otherwise

NACELLE INTERIOR	*LOW localisation potential without local assembly* *MEDIUM localisation potential with local assembly*

Selected nacelle interior



(AWEA, 2011)

- <u>Conditions/requirements:</u>
    - Generators: 500-700 units pa for one OEM and access to affordable rare earth elements (400MW to 450MW pa per OEM for a minimum period of five years)
    - Power converter: 400MW pa per OEM for a minimum period of five years
    - 1 000MW of minimum total available installed capacity over a medium-term
    - Transformers: can be procured from the local manufacturer
- <u>Costs and Benefits:</u>
    - CAPEX: depends on the OEM and components to be localised
    - Local content potential: 80% (Tier 2)
    - Price increase: 20% on relation to imported products
- <u>Localisation potential:</u>
    - Low potential in the absence of the local nacelle assembly facility but medium potential otherwise

The following table summarises the local content potential for wind turbine components mentioned above. The table also illustrates the possible local content contribution to be achieved following the localisation of the respective wind turbine key components. It must, however, be noted that the contribution figures reported in the table are only for "quick reference" purposes as they assume constant component cost and do not account for the changes in the cost structure associated with the reduced transport costs. Precise additions (contributions) to local content figures are presented in the next sub-section.

Table 2-1: Localisation potential per component

Key component	% of Project Value*	Localisation potential	Local content to be achieved*	Local content contribution
Blades	9.1%	Medium	60%	5.5%
Nacelle Assembly	2.1%	Low	80%	1.7%
If local assembly is established:				

Key component	% of Project Value*	Localisation potential	Local content to be achieved*	Local content contribution
Rotor Hub	4.3%	High (hub)	38.7%	1.7%
Nacelle Drivetrain	12.0%	Medium to High (castings and forgings)	15.4%	1.9%
Nacelle Exterior	2.7%	Medium to High (composites)	90%	2.4%
Nacelle Interior	9.3%	Medium (generator, transformers, etc.)	84.4%	7.9%

Note: *Assuming constant 2013 prices and fixed exchange rate

2.2 Localisation scenarios

The following paragraphs outline the potential local content percentages that could be achieved with the localisation of certain components of large-scale wind turbines. They also present the scenarios under which achievement of the specific local content value could be viable.

Optimal localisation levels and sensitivities to exchange rate

Figure 2-1 illustrates the optimal level of localisation that can be achieved in South Africa assuming that all the conditions for localisation highlighted earlier have been met for each of the main components. The local content potential is presented based on constant 2013 prices and a fixed exchange rate.

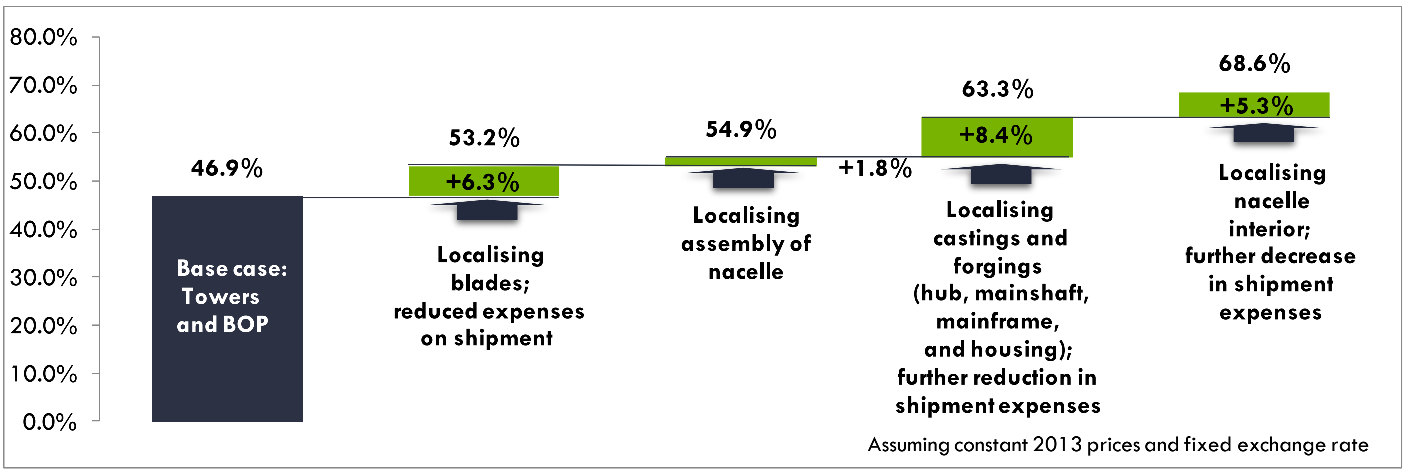


Figure 2-1: Optimal level of localisation considering identified potential (2013 constant prices and fixed exchange rates)

From **Figure 2-1** above, the following can be established:

- Localisation of manufacturing of blades will increase the local content by 6.3% compared to that achieved under RE IPPPP Bid Window 3. Local content will increase from 46.9% to 53.2%.
- Further localisation of the nacelle assembly and testing will add another 1.8% resulting in a total local content of 54.9%.
- Localisation of casting and forging components together with the nacelle housing will yield the biggest local content addition of 8.3% taking the local content to a total of 63.3%.
- Localising the selected nacelle interior components will also add another 5.3% resulting in an optimal level of localisation tagged at 68.6%.

It should be noted that localisation of the above-mentioned components and specifically blades, castings and forgings, and nacelle interior components, has an effect on the transport expenditure component of wind projects, which forms part of the project's BOP. As indicated in **Figure 2-1**, localising the above components reduces expenses on shipment of these components from overseas, which in turn results in the increased local content of the transport and erection cost item of the project's BOP. In other words, the increasing localisation as depicted in **Figure 2-1** leads to savings on transport costs that subsequently decreases the "import" value attached to transport and erection cost item, and contributes to an increase in local content of the associated cost item and the project in general.

The local content values presented earlier are provided in constant 2013 prices and assuming a fixed exchange rate. Exchange rate volatility can have a notable impact on local content value due to the manner in which local content is calculated. As indicated by South African Bureau of Standards (SABS), local content is "expressed as a percentage of the bid price" and is calculated using the following formula:

$$LC = \left(1 - \frac{X}{Y}\right) * 100, \text{ where}$$

- X is the imported content in rand
- Y is the bid price in rand excluded Value Added Tax (VAT)

It is highlighted that "prices referred to in the determination of X must be converted to rand by using exchange rate published by the South African Reserve Bank". Therefore, it shows that the manner in which local content is computed is sensitive to exchange rate fluctuations. This creates a significant challenge for local content calculation and specifically for setting specific local content targets. The majority of wind turbine components currently being used in all local wind energy projects are imported from overseas markets; therefore, fluctuations in exchange rates would render different local content values.

Table 2-2 shows the sensitivities of the derived and potential local content values to exchange rate fluctuations - a weaker rand results in a lower local content while a stronger rand yields a much higher local content.

Table 2-2: Local content sensitivity to exchange rate fluctuations

Added local content	Exchange rate fluctuations								
	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Base case: Tower and BOP	52.4%	50.9%	49.5%	48.2%	46.9%	45.7%	44.5%	43.4%	42.4%
	5.6%	4.1%	2.6%	1.3%		-1.2%	-2.4%	-3.5%	-4.5%
Blades	58.7%	57.2%	55.8%	54.4%	53.2%	51.9%	50.8%	49.7%	48.6%
	5.5%	4.0%	2.6%	1.3%		-1.2%	-2.4%	-3.5%	-4.6%
Nacelle assembly	60.4%	58.9%	57.5%	56.2%	54.9%	53.7%	52.6%	51.4%	50.4%
	5.4%	4.0%	2.6%	1.3%		-1.2%	-2.4%	-3.5%	-4.5%
Castings, forgings and housing	68.3%	67.0%	65.7%	64.5%	63.3%	62.2%	61.1%	60.0%	59.0%
	5.0%	3.7%	2.4%	1.2%		-1.1%	-2.2%	-3.3%	-4.3%
Nacelle interior	73.2%	72.0%	70.8%	69.7%	68.6%	67.5%	66.5%	65.5%	64.5%
	4.6%	3.4%	2.2%	1.1%		-1.1%	-2.1%	-3.1%	-4.1%

The following conclusions can be drawn from the table above:

- For the base case scenario, i.e. the local content achieved under Bid Window 3, the weakening of the rand to between 5% and 20% would result in the local content dropping from 46.9% reported by IPP project office to between 45.7% and 42.4%. Considering that the average exchange rate during 2013 was R9.67/USD, the weakening of rand by 15%, for example, would result in the exchange rate dropping to about R11.12/USD - the rate that has been breached earlier in 2014. Therefore, it could be argued that if the Bid Window 3 projects were to be approved in 2014, the local content would have been lower than 46.9% report in 2013.
- With the increase in the local content through localisation of certain components, the potential local content value that could be achieved will clearly depend on the strength of rand against major currencies. For example:
  - The local content that could be achieved through localisation of blades could vary between 58.7% and 48.6%, depending whether the rand strengths or weakens in the future.
  - A 20% decrease in the exchange rate (i.e. strengthening of the rand) will result in an optimal local content as high as 73.2%, whilst a 20% increase in exchange rate of the rand (i.e. weakening of the rand) reduces the optimal local content to about 64.5%.
- Importantly, as the localisation of components increases the degree of local content sensitivity to exchange rate fluctuations weakens slightly. This is as a result of the reduced share of imported components' value, as these are directly linked to exchange rates.
- Overall, it should be highlighted that achievement of 75% local content for the large-scale wind energy projects would be challenging. If it was achieved through strengthening of the rand, it would need to drop by more than 20% than the 2013 level, i.e. below R8.0/USD. Importantly, the Green Accord set a target of achieving 75% localisation "in the manufacture of components for renewable energy generation sector". Since the above local content value refers to the entire large-scale wind energy project that includes localisation of BOP, reaching the target for wind turbine components only will at this stage be unfeasible. The maximum local content that could be reached with respect to wind turbine components manufacturing only will range between 29.1% and 37.8% depending on the exchange rate.

ACHIEVEMENT OF OPTIMAL LEVEL OF LOCALISATION

Only the scenarios linked to the Promulgated IRP 2010 will be looked at in this particular sub-section. The Draft IRP is not considered in detail mainly because it has not been approved and most of all the current planning relies on the Promulgated IRP 2010 since it remains the official document. However, as was mentioned earlier in the report, it is clear that if the Draft IRP was to be promulgated the development of the industry will slow down. The Draft IRP prevents industry growth in the short-to-medium terms since the annual demand capacity allocated to wind energy projects are not sufficient to localise the industry in the next 15 years. In most of the scenarios linked to the Draft IRP, the localisation of wind turbine components become possible only if:

- The outside RE IPPPP market reaches high road scenario, and/or
- The sub-Saharan Africa market segment is considered

The following figures based on scenarios linked to the Promulgated IRP 2010 illustrate in detail the following items:

- The projected sustainable installed capacity per scenario

- The required volumes of demand to enable localisation
- The earliest year when localisation can be achieved
- The likely number of manufacturing facilities to be established

Localisation of blades and achievement of 53.2% LC

- With a threshold demand of 400MW pa required for the establishment of one blade manufacturing facility, the current demand capacity allocated for wind energy in the Promulgated IRP 2010 is sufficient enough to enable the setup of one blade manufacturing facility that would follow the build-to-design/build-to-print business model.
- Establishment of the blade manufacturing facility can be as early as 2016.
- While the Promulgated IRP provides opportunities for establishment of only one blade manufacturing facility in the country, significant increase in annual installed capacities which within the analysed scenarios are feasible through tapping into other market segments such as the outside RE IPPPP (high road) and sub-Saharan Africa can result in an increase in the number of local blade manufacturing facilities; hence, yielding forth more employment opportunities and increased competition within the market.

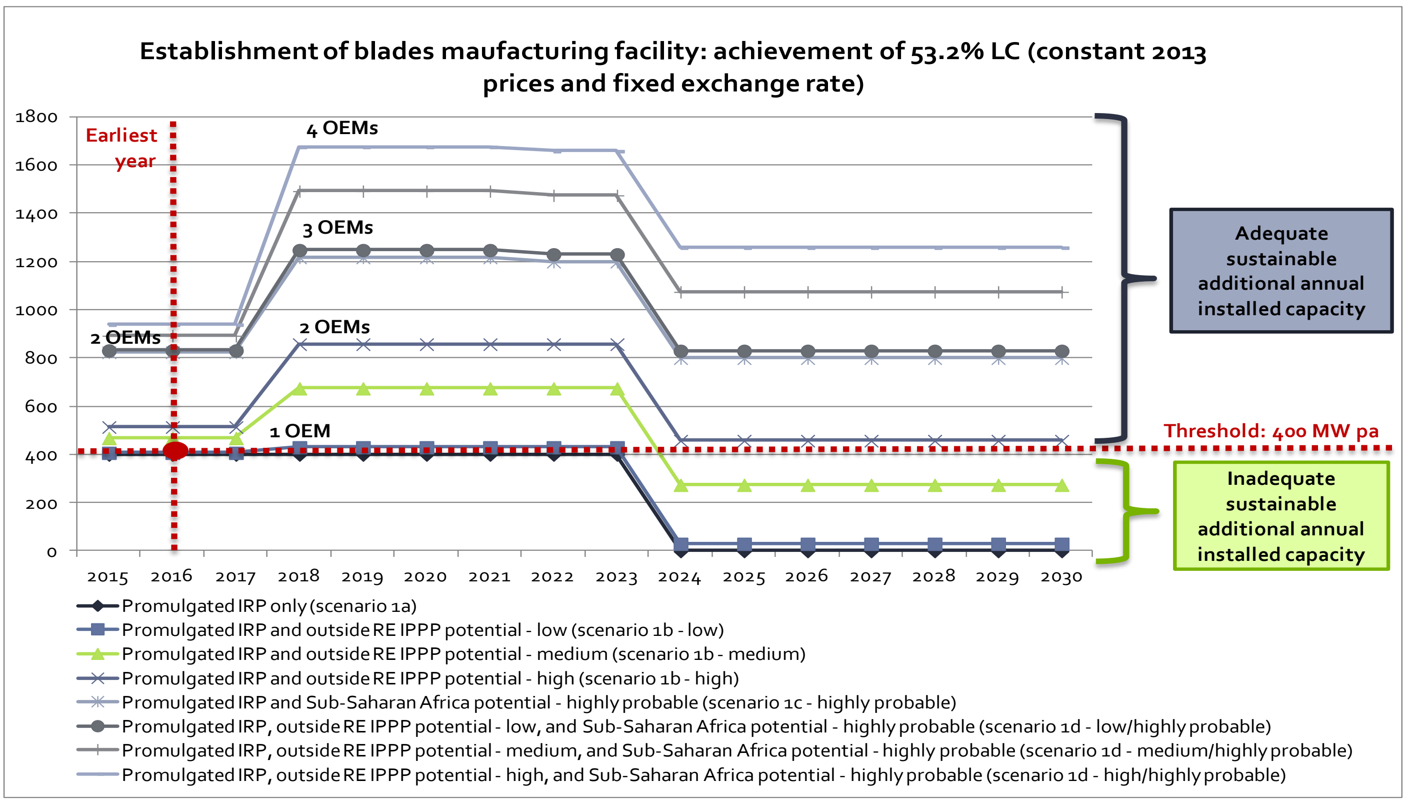


Figure 2-2: Localisation of blades and achievement of 53.2% LC

Localisation of nacelle assembly and testing and achievement of 54.9% LC

- The current demand from the Promulgated IRP is not sufficient to attract investments into establishment of local nacelle assembly facilities. As already highlighted, this is mainly because the available annual installed capacities of 400MW would allow the establishment of assembly plants by only one OEM, which is an unfeasible arrangement considering that it would need to imply that only one OEM continuously succeeds in the future bidding rounds and that the industry becomes monopolised. As a result, there should be enough annual installed capacities to sustain at least two OEMs. According to the scenarios shown in Figure 2-3, even if extra installed capacity was to be generated from other local market segments outside the RE IPPPP, it will still be inadequate for the establishment of local nacelle assembly facilities.

- Tapping into the sub-Saharan Africa market could potentially provide the necessary demand that would justify the establishment of a nacelle assembly facility in South Africa with the view of it becoming a gate into Africa. However, realisation of sub-Saharan Africa market opportunities cannot be assured at this stage, considering the fact that there is no guarantee that South Africa will enjoy a lion's share in the respective sub-Saharan African countries.
- The game changer in this particular case is to increase the annual installed capacities for wind energy above the threshold demand of 1000MW.
- Increasing the annual capacity demand for wind energy to a minimum of 1000MW can result in the establishment of nacelle assembly facilities as early as 2018.
- Having a demand capacity of 1 218MW as per scenario 1c can result in two to three OEMs establishing nacelle assembly facilities in the country. In order to circumvent some oligopolistic market structures, two nacelle facilities instead of the possible three would rather be recommended in order for the remaining demand capacity to cater for other OEMs, a move that levels the playing field as a result of continual competition.

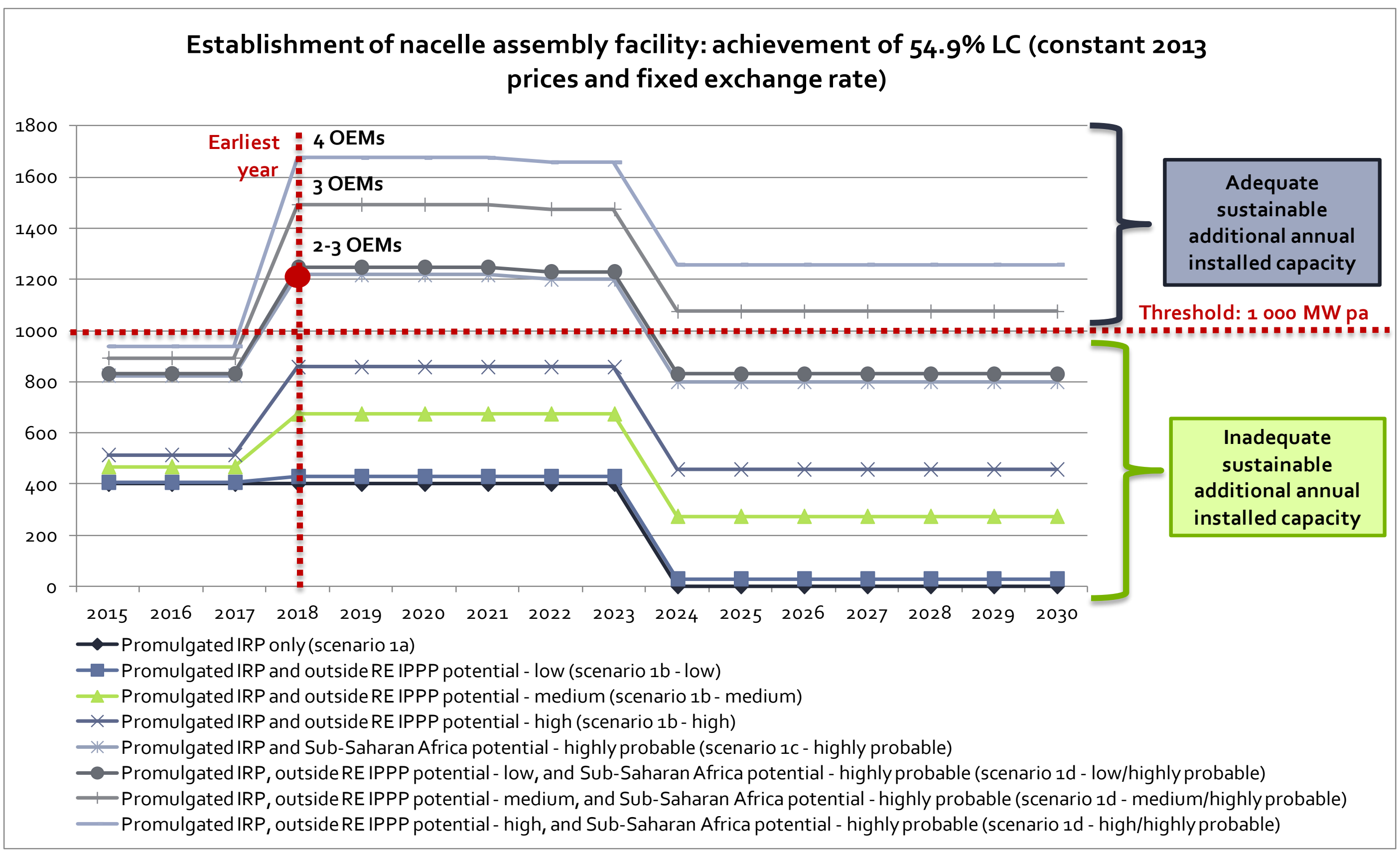


Figure 2-3: Localisation of nacelle assembly and achievement of 54.9% LC

Localisation of castings, forgings and nacelle housing and achievement of 63.3% LC

- The localisation of castings, forgings, and nacelle housing is dependent on the establishment of a local nacelle assembly facility; hence the required threshold demand of 1000MW.
- The game changer is to increase the annual capacity demand allocated to wind energy in the Promulgated IRP 2010 above the 1000MW threshold. The other option is to utilise demand from other market segments such as the outside RE IPPPP and sub-Saharan Africa. The latter option is more complicated than the former.
- Because the allocated capacity for wind energy in the Promulgated IRP 2010 is not sufficient enough to allow for local nacelle assembling, it is thus currently not feasible to pursue localisation of castings, forgings, and the nacelle housing.
- If the required demand capacity of 1000MW is met, castings, forgings and the nacelle housing can be localised as early as 2019.

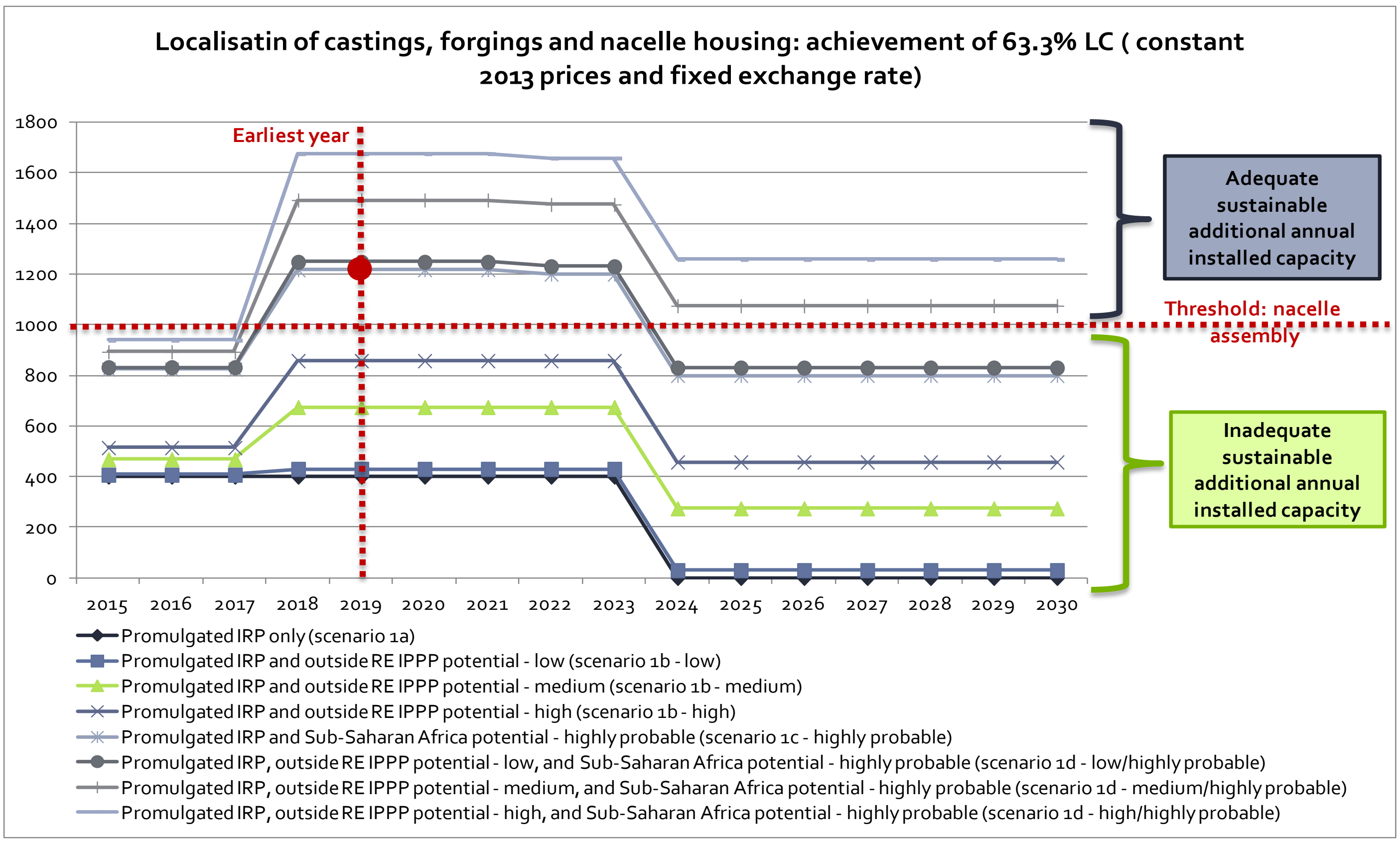


Figure 2-4: Localisation of castings, forgings and nacelle housing and achievement of 63.3% LC

Localisation of selected nacelle interior components and achievement of 68.6% LC

- Localisation of nacelle interior components such as a generator, transformer, and power converter is feasible only if there is a locally established nacelle assembly facility. Currently, the capacity allocated to wind energy in the Promulgated IRP 2010 is not adequate enough to allow for local manufacturing activities of the different nacelle interior components.

- The localisation of nacelle interior components is dependent on the establishment of a local nacelle assembly facility hence the required threshold demand of 1000MW. As with the nacelle assembly and castings and forgings, the game changer is to increase commitments with respect to the annual installed capacities to wind energy above the 1000MW threshold. Albeit the embedded complexities, the other option is to utilise demand from the other market segments such as sub-Saharan Africa.
- If the required demand capacity of 1000MW is met, some of the nacelle interior components such as generators, transformers, and power converters can be localised as early as 2019 and this will increase the local content from 63.3% to 68.6%.

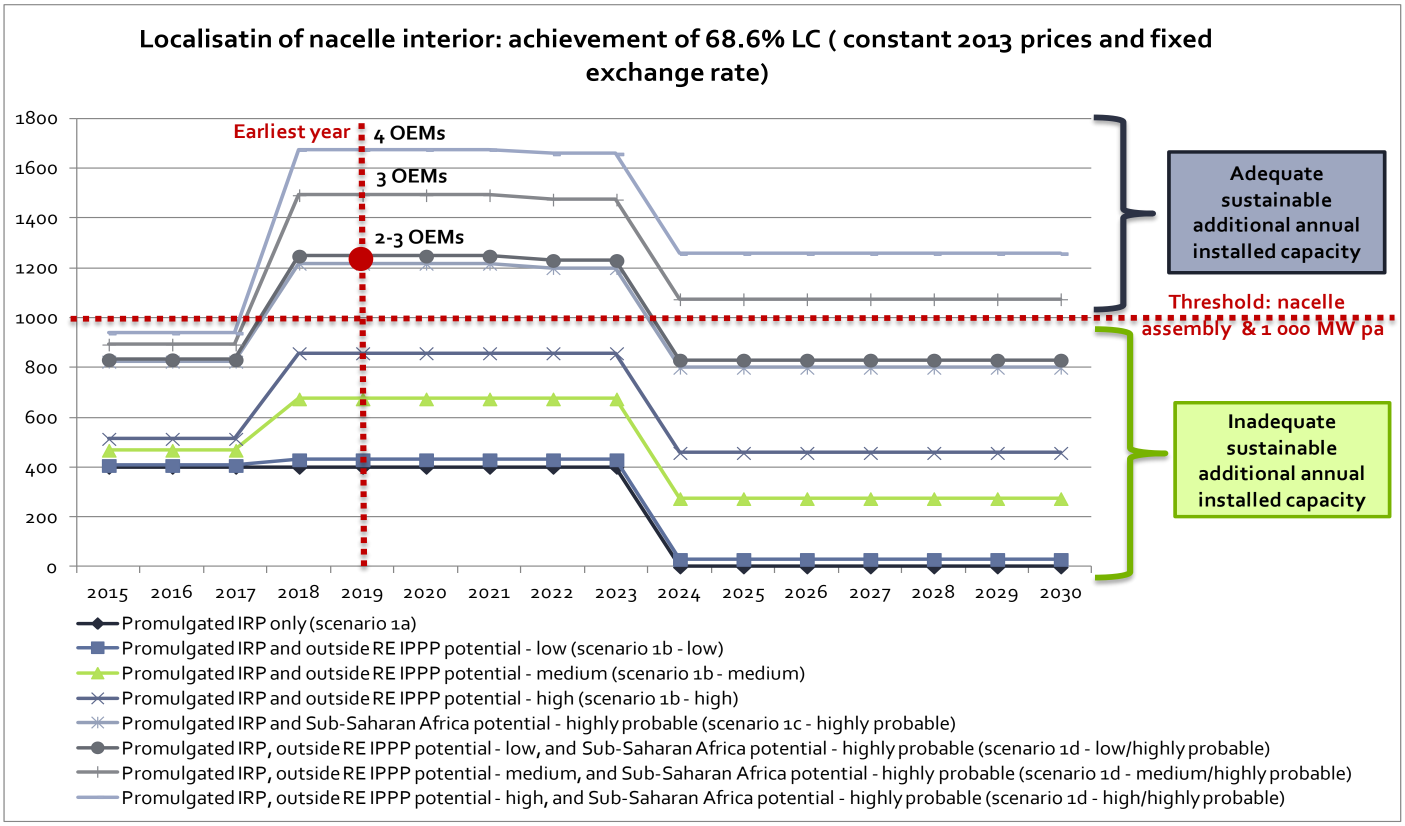


Figure 2-5: Localisation of selected nacelle interior components and achievement of 68.6% LC

LOCAL CONTENT ROADMAP

From the above, it can be noted from the various figures that the current demand capacity for wind energy in South Africa is inadequate to facilitate a formidable industry localisation. The envisaged annual installed capacities indicated in the Promulgated IRP are only adequate for the establishment of a blade manufacturing facility; localisation beyond that becomes unfeasible within the current scenario. There is a need to drastically increase the commitments and annual installed capacities for wind energy in order to attract manufacturing investment in nacelle assembly plants. While it makes a small contribution towards the local content, its role is to unlock localisation opportunities for other components such as castings and forgings, nacelle housing, and other selected nacelle interior components that could add between 13% and 17% of local content. In a nutshell, chances for increased localisation and possible local content achieved will be much higher following the establishment of local nacelle assembly facilities.

Considering the above, low and high road local content scenarios can be defined from the wind energy industry in South Africa, as outlined in the next figure.

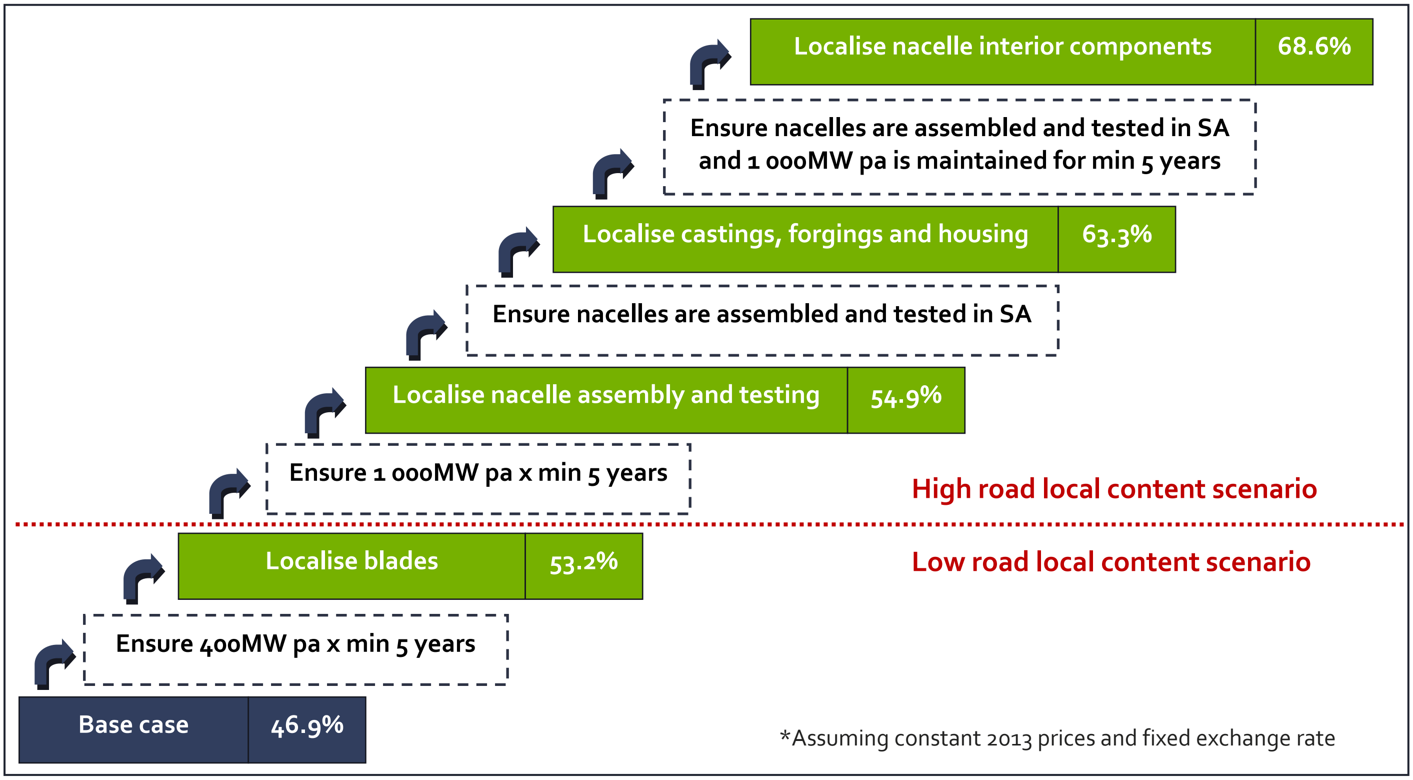


Figure 2-6: Local content roadmap

- The low road is constituted of the blades which can be localised in the short term out of the already allocated annual demand capacity (400MW) for wind energy. This scenario implies a presence of only one blade manufacturer.
- The high road is made up of all the other outstanding components which include nacelle assembly and testing, castings and forgings, nacelle housing, and selected nacelle interior components. These will need to be localised in the medium to long term and will require an increased annual demand allocation of at least 1000MW. This scenario implies the presence of two to three OEMs with respect to blades manufacturing and at least two OEMs with local nacelle assembly plants.

According to the roadmap presented in the following figure, blades will need to be localised first, followed by nacelle assembly which will then result in the further localisation of castings, forgings, nacelle housing, and selected nacelle interior components. Following this roadmap will see the achieved local content increasing from the current 46.9% to 68.6%, assuming constant 2013 prices and fixed exchange rate or a local content of between 64.5% and 73.2% assuming varying exchange rates.

3. IMPACT ANALYSIS

This sub-section discusses economic benefits and costs associated with the localisation of specific wind turbine components. The items to be covered are discussions around the issues related to investment, employment, local production, trade balance, and the cost of localisation.

MACROECONOMIC BENEFITS

Establishment of the local wind energy industry will require significant investment as many of the manufacturing facilities, and specifically blades manufacturing, are highly capital intensive. Realisation of a low road local content scenario will require investment of up to R490 million by the blades manufacturer; while achievement of a high road local content scenario that also implies the establishment of more than one blade manufacturer will require investment of up to R1.8 billion. As indicated by OEMs interviewed during the study, financing of these projects will be done by OEMs themselves using their balance sheets or other financing mechanisms. Importantly, OEMs do not require external funding for these projects but again and again emphasises the need by government to create security in the programme and increase annual allocations. Some of the support mechanisms could improve the attractiveness of the local market as an investment destination for wind turbine manufacturing facilities, such as tax rebates and export credits; these though are discussed in greater detail further in the section.

Despite the large investment requirements, the largest benefits from a macro-economic perspective will be associated with the operational period of the facilities. Figure 3-1 illustrates the potential business sales or turnover that could be derived on an annual basis under low road and high road local content scenarios.

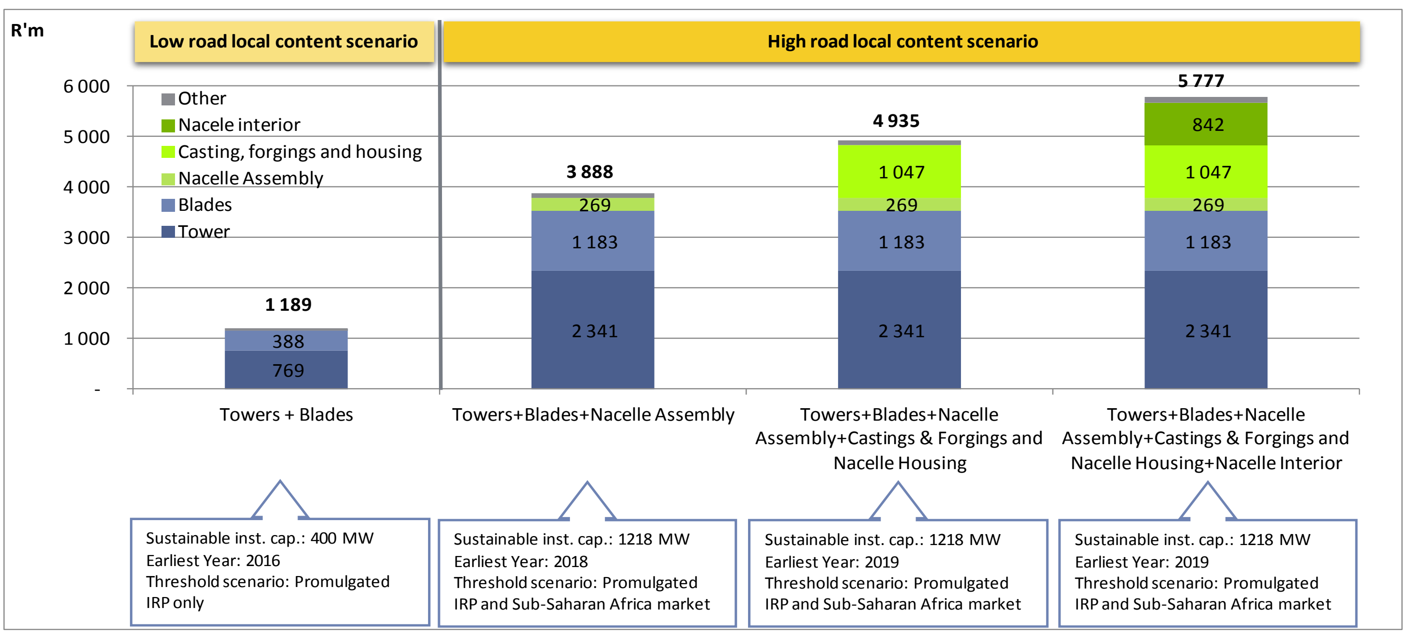


Figure 3-1: Projected annual business sales to be derived from increased local production of components

The following can be drawn from the above figure:

- Under the low road local content scenario, which is also linked to the Promulgated IRP that assumes 400MW allocation of wind energy for more than five years in the future, the roll out of wind energy projects in the country will result in the creation of about R1.2 billion of new business sales per annum in the manufacturing industries alone (i.e. excluding BOP component). The established blade manufacturing facility will contribute approximately R388 million to that total local production volume and turbine towers – R788 million.
- Achievement of a high road local content scenario, which under the reviewed market options implies increasing the annual installed capacity from 400MW to 1 218MW (i.e. as per the Promulgated IRP and sub-Saharan Africa market scenario) will result in a drastic increase in annual production and growth of the local wind energy manufacturing industry:
  - With the localisation of nacelle assembly, an almost 327% increase in local production value could be achieved, i.e. increase from R1.2 billion to R3.9 billion per annum. Establishment of nacelle assembly facilities will contribute only about R269 million towards the total new business sales, i.e. 6.9% of the total local production among manufacturing industries stimulated by the large scale wind energy projects. This scenario implies simultaneous increases in the number or capacities of tower and blade manufacturing facilities. As indicated, an additional R2.3 billion per annum will be generated from manufacturing of turbine towers and a further R1.2 billion per annum will be generated from manufacturing of blades.
  - As already noted, establishing local nacelle assembly facilities will unlock opportunities for other local manufacturing facilities specialising in the production of other components such as castings, forgings, and nacelle covers. This will lead to an increase in the value of local production derived from roll-out of large-scale wind energy projects in the country and in Africa from around R3.9 billion to about R4.9 billion per annum.
  - Realisation of manufacturing opportunities related to selected nacelle interior components will add another R842 million of new business sales, increasing the value of local production from around R4.9 billion to almost R5.8 billion per annum.
- Depending on the geographical distribution of projects, i.e. between South Africa and sub-Saharan Africa, the achievement of a high road local content scenario could lead to the increase in local production through expenditure on BOP to between R2.4 billion (if annual installed capacities in South Africa do not exceed 400MW) and R7.4 billion (if annual installed capacities in South Africa increased to 1 218MW).

Further to increasing the value of local production, localisation also bears positive effects on the country's current account and subsequently trade deficit. For a country like South Africa, which recorded a current account deficit of R197.2 billion for the year 2013 and value of imported merchandise of R999.2 billion - the highest values post the 2008-crisis (SARB, 2014), localisation should reduce the value of merchandise imports and lessen the trade deficit.

Depending on the perspective taken, Figure 3-2 shows:

- The rate of savings on imports that can be realised following localisation of various wind turbine components under different scenarios, assuming that all wind energy projects rolled-out under each scenario are established in South Africa, or

- The opportunity costs associated with the unrealised potential of growing a globally competitive wind energy industry in South Africa, assuming the potential presented not only in south Africa through a promulgated IRP but in the sub-Saharan Africa market

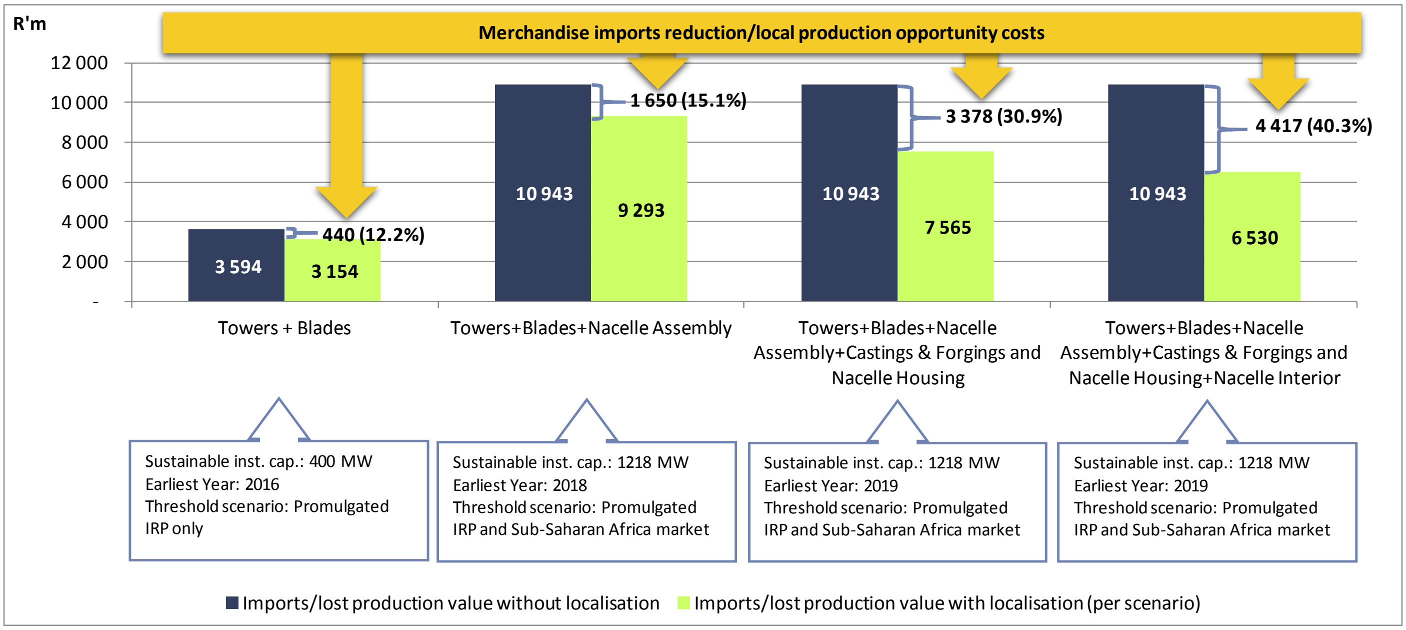


Figure 3-2: Impact of localisation on import reduction or increase in merchandise exports

Based on the above, the following key points can be highlighted:

- As indicated earlier, the current 400MW allocated for wind energy can result in the establishment of a local blade manufacturing facility, which would contribute to the reduction of imports (merchandise and services) by 12.2% per annum. That is, the projected import value of R3.6 billion will be reduced to about R3.2 billion, which would allow avoiding the possible widening of the current account deficit by R408 million per annum.
- Should the sustainable installed capacity for wind energy grow to around 1 218MW, the establishment of nacelle assembly facilities together with the increased manufacturing of blades, towers and localisation of BOP is projected to result in opportunity costs of R1 650 million per annum, if the local wind energy industry starts largely targeting the sub-Saharan Africa market. If the above-mentioned installed capacities are rolled-out in South Africa, the localisation of the nacelle assembly coupled with an increase in blade and tower manufacturing industries' output would circumvent the widening of the trade account deficit by about R1 650 million per annum. This reflects a possible 15.1% reduction of the value of imports (merchandise and services) associated with the roll-out of large-scale wind energy projects.
- Further localisation of other components dependent on the availability of a local nacelle assembly facility such as castings and forgings, the nacelle cover, and selected nacelle interior components would be associated with an opportunity cost to the value of R4 417 million per annum. The majority of this amount reflects the new business sales that could be derived from the export of locally manufactured products to sub-Saharan Africa, which could positively impact the current account deficit. If all the

projects were all rolled-out in South Africa, this figure (R4 417 million per annum) would reflect the annual value that could be retained in the national economy, which equates to about 2.2% of the current account deficit.

Considering the above, it is thus critical to reiterate the point that South Africa needs to increase the current capacity allocated to wind energy in the IRP 2010 in order to attract key nacelle assembly manufacturing facilities and develop local wind energy manufacturing capabilities to positively impact the current account and stimulate domestic economy. The setting up of nacelle assembly facilities have industry expansion possibilities, which in the short to medium terms will result in significant import reduction for wind turbine components. With 1 218MW of annual installed capacity sustained over a minimum period of five years, the optimum point of localisation in South Africa is projected to either reduce the value of imported components for wind energy projects by more than 40% or increase industry's exports, hence circumventing the further widening of the current account deficit.

JOB CREATION POTENTIAL

One of the major macroeconomic benefits of localisation pertains to the subject of job creation, and specifically highly skilled and skilled employment positions. As can be established from the following figure, localisation of various wind turbine components has the potential to create hundreds of sustainable employment opportunities.

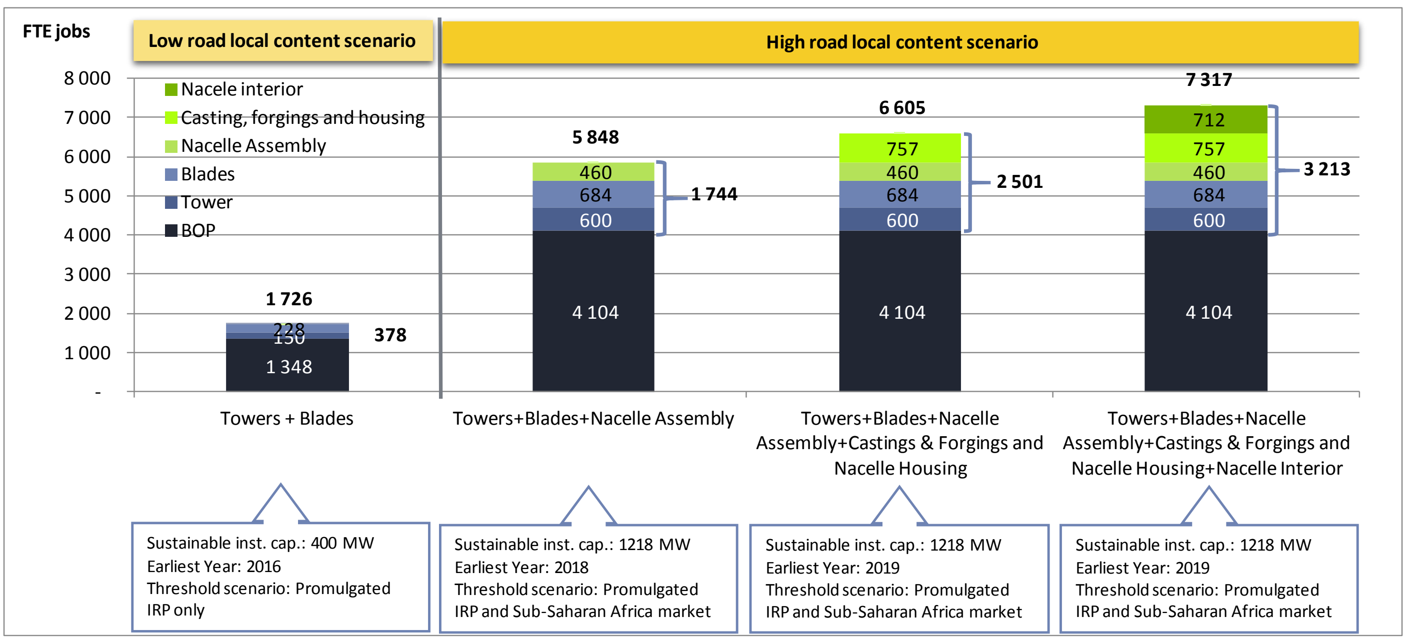


Figure 3-3: Localisation and employment creation

As outlined in **Figure 3-3**, employment opportunities can be divided among those that are created through BOP procurement, i.e. mainly construction activities, and those that are created from manufacturing of selected wind turbine components.

The potential for job creation through BOP procurement will largely depend on the roll-out of large-scale wind energy projects from a geographic perspective: the greater the roll-out of wind energy projects in South Africa the bigger the job creation potential. Overall, under the considered roll-out scenarios up to 4 104 jobs could be created in the construction and associated industries in the country on an annual basis.

The potential for job creation that lies in the manufacturing industries is slightly smaller than that through the BOP procurement; however it is more significant from the perspective of skills development and household income generation. Importantly, it is clear that the volumes of sustainable jobs created in the wind energy manufacturing industries can escalate over time in response to amplified localisation resulting from increased annual installed capacities of wind energy projects. In summary, the following can be established from **Figure 3-3**:

- A sustainable installed capacity of 400MW as per the Promulgated IRP only scenario can result in the establishment of one blade manufacturing facility which would likely contribute to creation of around 228 sustainable jobs. Major manufacturing jobs at this stage will be limited to tower (150) and blade (228) production with a projected total of 378 sustainable jobs. An additional 1 348 jobs could be created through construction activities following a low road local content scenario, thus increasing the total number of annual jobs to 1 726.
- Realisation of high road local content scenario will create the following benefits to the economy from an employment perspective:
    - The establishment of new local nacelle assembly facilities, increase in the number of local blade and tower manufacturing facilities will increase the total number of sustainable manufacturing jobs from 378 in the case of the low road local content scenario to 1 744. Nacelle assembly production activities will likely contribute 460 sustainable jobs and the employment within the tower and blade manufacturing industries will increase to 600 and 684 sustainable jobs, respectively. Also at this stage, the number of sustainable jobs within the BOP related sectors will increase from 1 348 to around 4 104; however, considering that projects that allow achievement of the installed capacity thresholds may be roll-out in sub-Saharan Africa not all of these construction jobs would be localised in South Africa.
    - Following the establishment of local nacelle assembly facilities, realisation of opportunities presented through localisation of nacelle housing, castings and forgings will add an extra 757 sustainable jobs to the employment pool, taking the total number of sustainable manufacturing jobs to an estimated 2 501.
    - Localisation of nacelle assembly facilities could also result in the creation of 712 more sustainable jobs within the nacelle interior components manufacturing industries resulting in an estimated 3 213 total number of sustainable wind turbine manufacturing related employment opportunities. This will likely increase the total number of sustainable jobs to 7 317.
- Overall, it is clear that increasing the sustainable annual installed capacities for large-scale wind energy projects from the current 400MW to around 1 218MW as depicted in the Promulgated IRP and sub-Saharan Africa market (threshold) scenario will likely result in a 750% increase in the number of sustainable manufacturing jobs, with the number of sustainable manufacturing jobs surging from 378 to 3 213.

COST OF LOCALISATION AND PRICE IMPLICATIONS

This sub-section investigates the relationship between localisation and the general cost of wind energy projects, providing an insight in the potential premiums that might be paid by the local project developers as they increase the local content of their projects. Using constant 2013 prices and fixed exchange rate, the potential implications on the project values per MW are outlined in the following figure.

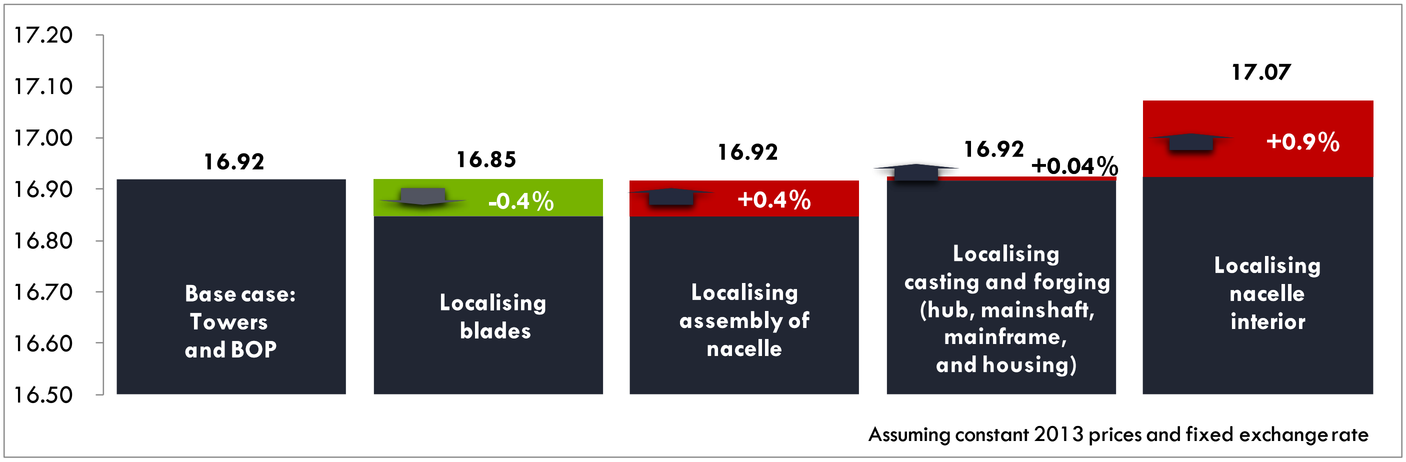


Figure 3-4: Cost of localisation and price implications

From **Figure 3-4** above, the following can be noted:

- The localisation of blades will likely result in a 0.4% decrease in the total wind energy project value per MW. According to some of the potential blade manufacturers that were interviewed, the cost of locally manufactured blades is not going to differ significantly with that of imported blades. Most of the key inputs such as glass fibre can be sourced locally, hence the reason of the price competitiveness of the locally manufactured blades. Nonetheless, a small premium of 5% was considered for the purpose of this study. While the locally produced blades are expected to be slightly more expensive than imported blades, the savings on transportation are expected to offset the increase in prices of blades and reduce their total costs, when considering production and transportation. Transporting blades from overseas factories is expensive due to volumes and distance; therefore, localisation of blades will most likely lead to slightly cheaper local blades relative to the imported ones.
- According to potential manufacturers, the price of locally assembled nacelle units is likely to be slightly higher than that of imported units. Assuming a 20% increase in nacelle assembly costs, establishment of nacelle assembly plants will likely result in an estimated 0.4% increase in the total value per MW of wind energy projects developed. The cost is likely to increase from R16.85 million/MW to around 16.92 million/MW; however, due to the savings achieved through localisation of blades, such an increase will only offset the savings on transportation costs and result in the project value being on par with that of the base case.
- Localisation of the nacelle housing, as well as cast and forged parts of the nacelle is envisaged to result in negligible (0.04%) increase in the project value per MW of wind energy developed. Although it was assumed that localisation of the above-mentioned components will most likely come at a premium of

about 20%, the negligible increase in project value per MW is attributed to the savings on transportation costs – similar to the situation with the blades manufacturing localisation option.

- Localisation of nacelle interior components such as generators, transformers and power converters is likely to result in an estimated 0.9% increase in the project value per MW of wind energy to be developed. The cost is projected to increase from around R16.92 million to about R17.07 million per MW. As in the previous case, an anticipated reduction in transport (freight) costs is likely to offset the increase in costs of these components limiting the escalation of project costs per MW.

All in all, moving from the base case to the optimal level of localisation presented by the high road local content scenario is likely to be accompanied by an estimated 0.9% increase in the total cost of each MW of wind energy to be developed. The cost of rolling-out of wind energy projects could be increased by a much higher rate (~3.6%) if it was not for the savings on shipment that is made available through localisation. Following a forecast 0.9% increase in the total cost of each MW of wind energy to be developed, as a result of localisation, one would also expect the tariff not to increase by more than 0.9%. Considering the tariff for Bid Window 3 (R0. 74/kWh), this means that the increase in localisation would result in the tariff increase to R0.7466/kWh. This can be rounded off to R0.75/kWh, which means that the cost of localisation will be limited to R0.01/kWh.

4. INDUSTRY DEVELOPMENT STRATEGY

This chapter outlines the proposed strategy for the development of the wind industry in South Africa based on the analysis of the current challenges and opportunities, as well as the feedback received from key industry stakeholders during interviews and an online survey. Topical issues around the broader local content subject, wind turbine manufacturing industry growth impediments and government support mechanisms are discussed in detail.

ON THE LOCAL CONTENT

The feedback received from the different wind industry value chain stakeholders shows that the RE IPPPP Bid Window 3 local content thresholds and targets were reasonable. For some, the thresholds were achievable and did not limit competition amongst potential participants. The targets were high enough to incentivise participants to achieve higher scores and stimulate competition among the project developers.

Most of the local content committed in the latest bid window would be realised from BOP components and locally manufactured towers. Under the current circumstances, any **further increase in local content threshold is seen by many industry players to be highly challenging to respond to**, raising their concerns over the competitiveness of the programme.

For many of the industry players, the currently available options for localisation have been fully utilised thus making it difficult to ensure bid compliance if the local content threshold is to be further revised upwards without any complementary localisation taking place. For some, this would entail compromising on the quality of the wind energy projects to be executed in the country as more inferior components and cheaper component suppliers will be opted. According to one project developer, as the local content threshold is increased by the government, project developers will start considering using Asian turbine suppliers, which would allow them to increase local content without significantly altering the local procurement practices. For example:

- It was argued that procurement of turbine components from the Asian equipment suppliers would allow project developers to reduce the costs of imported materials as their prices are much lower than that of the European suppliers. This would result in the lower import value of projects.
- Much of the current local content value for projects comes from civils, towers, cables, local transportation and erection activities, and foundations, which the Asian OEMs would also procure locally and at the same costs.
- As a result, the portion of the total project value that will be localised relative to the value of imported components would be greater, thus giving the project a higher local content percentage.
- Therefore, in order for the project to be competitive and reach the increased local content figures, project developers would have to go with the cheaper equipment manufacturers in order to reduce the overall cost of the project and benefit from the automatic increase in local content proportion, without actually increasing local content procurement.

Depending on the potential savings that could be achieved through the procurement of the cheaper wind turbine components from the Asian countries, the potential for the "artificial" increase in the local content value could be notable. Information contained in the Table 2-2 that was presented earlier in the section and that showed sensitivities of local content value to exchange rate fluctuations could also be used to estimate the potential change in local content as a result of the lower costs of imported material. As such, considering the base case scenario that implies the procurement of BOP and towers components only, the decline in costs of imported materials (which has the same price implication as the strengthening of the rand or decrease in the exchange rate), could have resulted in the local content increase to the value of 52.4%. This is only marginally smaller than the 53.2% that could be achieved if the blades are localised, but if the price of imported components stays the same and exchange rate remains unchanged. Thus, it is clear that **setting new thresholds and targets needs to be accompanied by a support programme to catalyse local manufacturing, and at the same time revise the manner in which local content thresholds are stipulated**.

For the majority of OEMs and project developers, any further increase in local content targets would need to be accompanied by the **localisation of rotor blades**. These are the most feasible wind turbine components that could be localised beyond the current status and are also the most common type of wind turbine components, manufacturing of which is located proximal to markets due to associated high transportation costs if located large distances away from the market. Industry players raise the following concerns though with respect to further increase in local content threshold levels and localisation of blades.

Industry players, though, advise to exercise caution when increasing local content with the purpose of stimulating establishment of local blade manufacturing facilities and consider the hurdles inherent to this particular type of investment. Many OEMs manufacture blades in-house, which are specific to the different models of turbines they have in their portfolio. Even if one independent blade manufacturer (e.g. LM Blades) establishes a manufacturing facility and offers a few select blades, industry players maintain that the current local content criteria will result in projects focusing on the turbines that fit the available blades only. The range of turbines that assist project developers in winning bids by allowing higher local content will therefore be significantly limited. This means that any local factory to be established will need to support a large number of blade moulds. The factory would require flexibility in moving a large number of blade moulds on and off the production line, which would require a large space and greater investment.

IMPEDIMENTS TO LOCAL WIND TURBINE MANUFACTURING INDUSTRY GROWTH

A number of key barriers believed to be limiting the growth of the wind energy manufacturing industry in the country have been identified through the interviews and the survey. These include:

- On the market size and certainty:
  - The relatively smaller size of the domestic wind energy market, i.e. an average of 400MW pa while more than 1GW pa is required to notably change the industry prospects
  - Future market (RE IPPPP) uncertainty as there is no long-term certainty in future annual allocations, a setback which does not support further investment in local production capability
  - Lack of what others term "a local content rebate scheme" under the RE IPPPP, which would allow local manufacturers to achieve economies of scale necessary to justify investment in local production capabilities
  - Grid connection risk delaying financial close and therefore uncertainty of predictable returns on investment
- On industry competitiveness aspects:
  - Premium paid through localisation, i.e. products are more expensive than imported machinery and equipment
  - Complex certification requirements and a lack of proven track record for potential local component manufacturers
  - Complex financial support for upcoming businesses
- On local content measurements:
  - Lack of split local content targets over the percentage shares of BOP and the wind turbine components

PROPOSED INTERVENTIONS AND MECHANISMS TO ADDRESS CHALLENGES

A number of government support mechanisms and interventions can be recommended in order to catalyse the growth of the local wind turbine manufacturing industry. The following paragraphs present recommendations to address the challenges mentioned earlier and to create an environment conducive for successful growth and development of the wind energy industry in the country. The proposed recommendations are divided into two groups, such as:

- **Market-pull interventions and support mechanisms** that refer to policies and incentives that aim at increasing the market size for wind energy projects that would make it attractive for investment in domestic manufacturing capabilities
- **Industry-push interventions and support mechanisms** that facilitate industrial development in the wind energy sector by creating a conducive environment through protection mechanisms, local content requirements, and other measures

It is important to note that considering the interventions proposed further and institutions responsible for their implementation, it is clear that the **development of the wind energy industry in the country will only be possible**

through a multi-stakeholder engagement approach. The efforts of the Department of Trade and Industry alone, whose mandate is to assist in developing local manufacturing capabilities, will not be sufficient to incentivise and stimulate the domestic wind turbine manufacturing industry. It will need to be complemented by the support of other government departments and institutions such as the Department of Energy, National Energy Regulator of South Africa, and the local development finance institutions such as the Industrial Development Corporation. Engagement of the above institutions with the private sector will also be paramount to the success of the industry development and growth. As such, one of the first recommendations that could be offered is to **create regular forums** where the decision-makers of the above-mentioned institutions are able to meet and discuss the needs, opportunities, challenges, and practical solutions for the development of the industry going forward.

Focus area: Market-pull interventions and support mechanisms

One of the challenges that have been identified that impede the development of the local wind energy industry is the uncertainty regarding future allocations for wind energy projects and the insufficient volume of allocated capacities under the RE IPPPP. In response to this, the study considered other potential target markets such as the market outside the RE IPPPP and the sub-Saharan Africa market, which face their own challenges. The following list of proposed interventions includes market pull measures that should be considered to open up new market opportunities or firm up on the existing market.

Intervention:	Make firm commitments with respect to extension of the RE IPPPP and increase wind energy annual allocations to allow for sustainable growth of the industry
Responsibility:	*Department of Energy, Eskom, EPRI*
Requirements:	*Review of the IRP and ministerial determination of additional allocations for wind energy projects for the next five years (minimum)*
Timeframes:	*Can be implemented in the short-term*

At the moment, the IRP allows allocation of only 400MW of wind energy projects per annum until 2030 with the aim to have 9.2GW of installed capacity by 2030. However, it is uncertain whether such allocations will even be realised, as government has not made any commitments with respect to the future bid window allocations. Moreover, a greater focus on nuclear power and shale gas raises further concern over the future of the renewable energy programme.

Most of the industry players recommend a 1000MW per annum capacity within a 10 year fixed plan, which should be updated after a five year period. From an investment point of view, factory set ups can only be justified if the market will exist for at least as long as the agreed loan repayment period. As a result, the government should continue its procurement of renewable energy projects through an increase in the determination of wind capacity set by the DOE and other involved stakeholders, post RE IPPPP Bid Window 5 (2015). The industry would also want to see the DOE announcing further bidding windows post 2015 in order to do away with the current market uncertainty. This will ensure the continued development of wind projects in South Africa and an increase in the demand for international suppliers to set up manufacturing and assembling facilities in South Africa.

In summary, stimulating the local wind energy industry without having to rely on the other market segments such as the outside RE IPPPP and sub-Saharan Africa would require government and specifically the DOE to perform the following:

- First of all, to make firm commitments with respect to the RE IPPPP that would provide assurance to the industry players
- Secondly, revising the energy mix and either allocating far greater share of installed capacities to wind energy up to 2030 that would increase annual allocations or revising the annual allocations upwards to allow for the industry to develop at a much faster pace and over a shorter but still sustainable period than 20 years planned in the IRP

Intervention:	**Open up the market outside the RE IPPPP through ISMO**
Responsibility:	***Department of Energy, National Energy Regulator of South Africa, and Eskom***
Requirements:	***Adoption of the ISMO Bill***
Timeframes:	***Can be implemented in the medium- to long-terms***

There is a need to open market segments for procurement of wind energy in South Africa outside the RE IPPP to increase annual wind energy installed capacities to such an extent that it would create a business case for OEMs to consider establishing their manufacturing facilities in South Africa. As already highlighted earlier, the establishment of the Independent System and Market Operator (ISMO) could be one of the means to unlock other local wind energy market segments which might assist in propelling the sustainable wind energy demand required for wind industry manufacturing investments.

The ISMO Bill has been drafted with the objective of establishing an autonomous state-owned company, mandated to undertake the development of the generation resource planning, purchasing of power from generation facilities, and enabling electricity trading at a wholesale level. Specifically, the ISMO has the objective of trading electricity on a willing buyer/willing seller basis which may liberate trading of electricity. The Independent System and Market Operator (ISMO) bill provides for open and non-discriminatory access to the transmission grid, regulatory certainty to the buyer regarding cost recovery and a fair return on investment, and government support to underpin the risks associated with power purchase agreements.

At this moment, the exact scope of the power system that will be controlled by the ISMO has not been fully defined, and it could include municipal distribution systems. Implementation of the opportunities created by the bill will require significant investment in grid infrastructure. Apart from the cost, though, development and implementation of the entire system will take considerable time, which means that realistically the deployment of wind energy projects in this instance could only be possible in the medium- to long-terms.

Intervention :	**Open up the market outside the RE IPPPP through private PPAs**
Responsibility:	***NERSA, commercial and industrial customers, municipalities (for example, through SALGA), private sector energy traders, National Treasury, Department of Energy***
Requirements:	***Conducive policy and regulatory framework***
Timeframes:	***Short to medium term***

In order to create a business case for OEMs to consider establishing their manufacturing facilities in South Africa, there is a need to open market segments for procurement of wind energy in South Africa outside the RE IPPP to increase the potential market size for the OEM. Providing an enabling environment for IPPs to be able to conclude bankable private PPAs is one of the ways that this can be done.

The major hurdle to development of private PPAs in the country in the past has been the policy and regulatory environment, i.e. with Eskom being the single buyer and no room for a "willing buyer, willing seller" model. NERSA can be instrumental in de-regularisation of the market by granting of more licenses to private sector energy traders. Currently, only one license has been issued to Amatola Green Power. An inter-agency task team,comprising of key stakeholders like NERSA, SALGA, National Treasury, Department of Energy, commercial and industrial customers and private sector energy traders, needs to be formed in order to coordinate energy policies and legislation.

The inability of municipalities to provide long-term PPAs due to policy and regulatory constraints has restricted the uptake of this market opportunity by private developers who face financing challenges with short-term PPAs. Municipal structures need to adopt a long-term view with regard to growing the private PPA market and not view it as a dent to municipal coffers. In order for municipalities to attract developers, the following needs to be done:

- Facilitation of wheeling through municipal network
- Offer longer term PPAs - currently only under Megaflex for 3 years
- Introduction of competitive tariffs for small scale embedded generators
- Issue tenders for the procurement of RE incorporating long term PPA

Until grid parity is reached, customers are reluctant to pay more for "green energy", therefore government should look to incentivise the first 2 to 3 years of private PPAs to facilitate the growth of this sector. The private PPA market can be unlocked in the short to medium term if a conducive policy and regulatory framework can be created.

Intervention:	**Introduce REFIT or premium tariffs for small-scale utility projects**
Responsibility:	***Department of Energy***
Requirements:	***Revision of the small -scale utility projects***
Timeframes:	***Only possible to implement in the medium-term due to regulatory constraints***

Feed-in tariffs (FITs) and fixed premium models are price-driven incentives that stimulate production of electricity from renewable energy sources. Both of these incentives ensure that project developers are assured of profitability of the development of renewable energy projects, as they offer guaranteed price of premium for a long period for electricity generated by the utility and fed into the grid. Such schemes also imply no cap or quota on the amount of electricity that is to be generated.

Having witnessed a steady decrease in the bid price for the wind projects over the last three bidding rounds, the challenge according to some of the industry stakeholders will now be a balancing act of trying to keep the continued interest of international sponsors in South Africa and the returns it can offer from renewable energy investments, and still getting a good price for the electricity paid for by South African citizens. Some of the stakeholders believe now is the right time for the government to issue a Renewable Energy Feed-In Tariff (REFIT) or adopt fixed premium models for the projects, which can be based on the experience gathered from the previous three bidding rounds when setting the feed-in tariff.

In order to maintain a balance between the current competitive bidding system and the required REFIT system, it is recommended that the government continues with the RE IPPPP but also considers introducing REFIT for small scale utility projects (e.g. wind energy projects with a total capacity of 5MW to 10MW capacity). The tariff for the REFIT programme could be set up by using the RE IPPPP tariff for large scale wind projects as a base and adding a premium. By so doing, this will enable smaller, less well capitalised local developers to participate in the programme. This again can be a platform to promote the use of locally manufactured utility scale wind energy technology thus resulting in the building up of the much needed track record for certification purposes.

Although this could guarantee the longevity of the local wind energy markets and have already been proven to stimulate wind energy industries in other countries (i.e. Denmark, Germany, and Span), the implementation of this intervention is only possible in the medium-term due to regulatory constraints. Last but not least is that if implemented, local content requirements will need to be included as one of the criteria under which project developers will be eligible for REFIT or fixed premiums.

Intervention:	**In order to tap into the sub-Saharan Africa market potential, introduce a scheme that would allow OEMs with South Africa-based manufacturing capabilities to claim the value of exported components as part of local content in wind energy projects developed in South Africa**
Responsibility:	***Department of Trade and Industry***
Requirements:	***Adoption of an applicable scheme***
Timeframes:	***Short- to medium-term***

In order to increase the market for potential domestic wind turbine manufacturers and provide OEMs with sufficient incentive to establish their manufacturing facilities in South Africa, government could consider introducing "a local content rebate scheme" that would allow these manufacturers to credit the value of exported components as created local content. This could considerably increase the local content value of the locally manufactured components, thus increasing the local content of the projects themselves allowing achievement of higher thresholds.

Introduction of such a scheme could potentially be a game changer if also accompanied by a sharp increase in local content thresholds and other incentives. Such manufacturers would no longer need to rely only on South Africa's market to provide sufficient annual installed capacities to justify investment in the establishment of local capabilities but would also allow tapping into the potential market segments such as sub-Saharan Africa. Importantly, this scheme could also encourage wind turbine OEMs to setup manufacturing capabilities for production of components that are not only meant for consumption within the domestic market but also targeted for foreign markets where the respective OEMs are already active. That way, South Africa is likely to become a gateway into the sub-Saharan African wind energy market for most of the OEMs that are already active in the country.

Industry-push interventions and support mechanisms

The rate of development of the domestic wind energy manufacturing industry will not only depend on the success of the implementation of the proposed market-pull interventions, but will be reliant on the support measures provided by government aiming at industrial development itself. The review of the development of industries in other countries highlighted that countries such as China, Spain, Denmark and Brazil have successes in the development of domestic industries not only because they created considerable domestic demand for wind turbines, but also because they supplemented it with specific financial and tax incentives for product development and manufacturing. In light of the above, the following paragraphs provide recommendation that could be introduced in South Africa in addition to those aimed at growing the markets.

Intervention:	Support the development of local utility-scale wind energy technology
Responsibility:	*Department of Trade and Industry, Industrial Development Corporation, Development Finance Institutions, Department of Energy*
Requirements:	*Enabling market conditions*
Timeframes:	*Can be implemented in the medium-to-long-terms*

South Africa has a great tradition on innovation. The country has a well-established ship-building, casting and forgings, automotive, and aerospace industry that suggests that it has the necessary skills and expertise to ensure quality of products, although skills development and training will most likely still be required. Such a foundation though could potentially offer opportunities for establishment of partnerships or joint venture between the local businesses and foreign OEMs. South Africa also boasts of a viable small to medium scale wind turbine manufacturing industry. The potential for the small scale market to support the development of the large scale one is widely documented with respect to the manufacturing of some wind turbine components e.g. towers, where production of smaller towers in the same facility as larger towers could help improve the overall viability of local production in both sectors (Department of Trade and Industry & World Wildlife Fund, 2013). The same is likely to be true for the larger castings required in turbine hubs and nacelles.

The case of I-WEC is one example supporting the notion that South Africa has potential to come up with globally competitive utility scale wind turbine technologies. The only missing link is government support. Some of the small to medium scale local wind turbine manufacturers interviewed for this study clearly highlighted that they have the know-how as well the desires to venture into the utility scale wind energy markets but they lack the required support to do so. There is a need for support mechanisms to help potential local wind turbine manufacturers with capital, markets and an enabling policy environment. For many of these manufacturers, issues pertaining to track record, certification and financing stand in their way.

Intervention:	Attract OEMs with proven track record in wind turbine components manufacturing
Responsibility:	*Department of Trade and Industry and the Industrial Development Corporation*
Requirements:	*Enabling market conditions*
Timeframes:	*Short- to medium-term due to market size constraints*

At present, the local small to medium wind industry does not boast of manufacturing capabilities that would allow for the establishment of new OEMs. As earlier noted, even if the country were to support a new OEM in the wind turbine components manufacturing industry, its products would need to undergo a stringent certification process and would need to acquire a reliable track record before local financiers decide to take projects using this company's components through financial closure. Certification comes at a high cost and it may take years before all conditions for certification are met. Following certification, there is also no guarantee that a manufacturer will enjoy success under the prevailing market conditions.

Considering the above and the maturity of the global wind energy industry, the most practical and effective strategy that the country should adopt is to attract OEMs with a proven track record in manufacturing and deployment of projects using their wind turbine components. Such foreign OEMs have already dealt with the certification challenges and have obtained necessary track record; therefore, they would not face the challenges that a new manufacturer would be required to overcome.

The other option that could be considered is for South Africa to purchase a foreign OEM outright. Such an option though would most likely lead to structural changes in the industry and should be carefully considered before pursuing.

Intervention:	*Provide financial incentives for wind turbine component manufacturers*
Responsibility:	*Department of Trade and Industry*
Requirements:	*Amendment to relevant acts*
Timeframes:	*Short-term*

Government should consider various options for provision of financial incentives for new wind turbine component manufacturers. Some options that could be considered include, inter alia:

- Attractive tax breaks and tax holidays
- Favourable accelerated depreciation

Intervention:	Review customs duties on selected input materials and components of wind turbines
Responsibility:	*Department of Trade and Industry*
Requirements:	*Amendment to customs acts*
Timeframes:	*Short- to medium-terms*

Taxes on imported goods are widely used to protect domestic manufactures as they raise the price of imported goods reducing the competition for local producers. It would be advisable to consider introducing protection policies such as customs duties on selected wind turbine components that offer the biggest opportunities for localisation. In the near future, such customs duties could be imposed on blades as it has already been determined that such components could be established in the country. Once the market grows and potential to enter high road local content scenario becomes feasible, government could consider imposing customs duties on complete nacelle components.

On the other hand, in order to simulate local manufacturing and improve competitiveness of the locally produced components, government could also review import duties imposed on materials and inputs that would not be possible to source domestically for one reason or another. Reduction in import duties on such inputs would reduce production costs of the local manufacturing facilities, and subsequently improve price competitiveness of locally manufactured components.

Intervention:	**Provide favourable credit through government-run finance institutions and impose local content requirements as an eligibility criterion**
Responsibility:	***The Department of Trade and Industry and Development Finance Institutions***
Requirements:	***Access to funds/state budget allocations for such credit line***
Timeframes:	***Immediate***

For companies intending to expand their manufacturing capabilities into South Africa, finance at a preferential interest rate is available under the industrial financing loan facilities component of the MCEP. A working capital facility of R50-million, over a term of up to four years, is available to qualifying manufacturers. Access to finance for large international manufacturing companies such as the blade manufacturer LM Blades, is not seen as a hurdle to investment in South Africa. The major wind turbine and blade manufacturing companies have strong balance sheets and are also able to attract private equity investors on the strength of their existing track record. Market demand conditions, government policy clarity and financial support mechanisms such as no/smaller import duties being imposed on the imported portion of raw materials in their manufacture feature higher than sourcing of funds in an investment decision.

Nonetheless, considering the lessons learnt from the successful development of the wind energy industry in Brazil, it is recommended that government establishes a fund or provides highly favourable credit (low-interest loans) from the state budget for project developers that can be accessed under the condition that projects developed achieve a certain level of local content per wind turbine component.

Intervention:	**Update the manner in which local content is evaluated in order to pose stricter rules on procurement of wind turbine components**
Responsibility:	***Department of Trade and Industry and the Department of Energy***
Requirements:	***Government departments (the DTI and the DOE) need to closely communicate on this matter***
Timeframes:	***Immediate***

Because of the flaws embedded in the manner in which local content is computed and also considering how exchange rate volatility impacts local content as outlined earlier in the section, wind industry participants advocate for an update in the manner in which local content is evaluated. The following is recommended:

- The computation of the local content is divided into wind turbine components and BOP, and separate thresholds and targets are assigned for these two groups of cost items. That way, project developers will not be able to "artificially" inflate the local content value and the "real" local content on the wind turbine would be identifiable. It is critical that the BOP component should be retained and not be dropped out so that project developers continue to utilise local companies for BOP.
- Normalise and use a fixed exchange rate just for the purposes of calculating local content.
- In order to promote the development of local wind turbine components manufacturing industries which have a lesser impact on local content but result in massive job creation (for example, nacelle assembly), wind energy components manufacturing employment measurement needs to also be integrated into the Economic Development Balance Scorecard. The current assessment is limited to job creation

assessment only for the construction and operations phases of the wind energy project only. Following such an inclusion, the weights allocated to different components in the scorecard will need to be subsequently revised.

- Regarding the unit of measure used to calculate local content, most of the wind industry players that took part in the study insist that the current **"percentage of component per project cost" unit should be upheld**. However, there are some industry players who are of the opinion that the unit of calculation should be more inclined to supply side rather than the project per se. Rather than focusing on local content as a percentage of the project cost, proponents of employment creation would want the focus to be directed on job creation in the value chain (man-months created in sourcing/manufacturing of the component locally). It is argued by some that while the value of certain component is small, their production is highly labour-intensive. A good example is that of assembly, where one facility would employ as many people as a blades manufacturing facility, but its potential contribution to the local content is almost three time smaller than that of blade manufacturing.

5. CONCLUSION

This section presented the localisation roadmap that could be followed in South Africa in order to develop the local large-scale wind manufacturing industry. The localisation scenarios presented in the section revealed that the local manufacturing of blades will increase the RE IPPPP Bid Window 3 local content by 6.3% with local content increasing from the current achieved 46.9% to 53.2%. Further localisation of the nacelle assembly and testing will add another 1.8% resulting in a total local content of 54.9%. Localisation of castings and forgings together with the nacelle housing will increase the local content to a total of 63.3%; while localising the selected nacelle interior components will also add another 5.3% resulting in an optimal local content of 68.6%. It must ,however, be noted that exchange rate volatility can have a notable impact on local content value due to the manner in which local content is calculated. An optimal local content of between 64.5% and 73.2% is possible if the rand is to weaken/strengthen to levels between 20% and -20% respectively.

In order to achieve the optimal level of localisation, two localisation scenarios were defined in this section and these include the low road and the high road local content scenarios. The low road is constituted of the blades which can be localised in the short-term out of the already allocated annual demand capacity (400MW) for wind energy under the IRP, which implies the establishment of one blade manufacturing facility. The high road is made up of all the other outstanding components which include nacelle assembly and testing, castings and forgings, nacelle housing, and selected nacelle interior components. These can only be localised in the medium-term and will require a significant increase in the market size of at least 1000MW that would be sustained for a minimum period of five years. This scenario implies the presence of two to three OEMs with respect to blades manufacturing and at least two OEMs with local nacelle assembly plants.

The two localisation scenarios come with different macroeconomic costs and benefits.

- An estimated total investment value of R400 million and R1.8 billion will be required for the likely achievement of the low road and high road local content scenarios, respectively.
- Localisation will also increase the value of local production. Following the low road localisation scenario will result in the creation of about R1.2 billion of new business sales per annum in the manufacturing

industries alone. Further achievement of a high road local content scenario will result in a total local production value estimated around R5.8 billion per annum.

- Further to increasing the value of local production, localisation also bears positive effects on the country's current account and subsequently trade deficit. With 1 218MW of annual installed capacity sustained over a minimum period of five years assumed under high road local content scenario, the optimum point of localisation in South Africa is projected to reduce the value of imported components for wind energy projects by more than 40%, hence circumventing the further widening of the current account deficit.
- Furthermore, achieving the optimal level of localisation could also create 3 213 sustainable employment opportunities in the manufacturing industries and a potential additional 4 104 jobs in the construction industries for the same period of time assuming that South Africa develops its domestic market beyond 1 000MW pa.
- Nonetheless, localisation will also come at a premium mainly through increased costs incurred during production. Moving from the base case (RE IPPPP Bid Round 3) to the optimal level of localisation is likely to be accompanied by an estimated 0.9% increase in the total cost of each MW of wind energy to be developed. Importantly, the potential increase in project costs could be greater, however savings incurred through the reduced expenditure on shipping the components from overseas offsets much of the increase in component production costs.

While the achievement of the low road local content is possible under the IRP, for South Africa to enter the high road local content scenario, it will need to address a number of challenges such as the small size of the domestic wind energy market, future market uncertainty, grid connection challenges, high cost of investment, and stringent certification requirement for components. As a remedy to the listed impediments, a multi-stakeholder engagement approach that will see the Department of Trade and Industry working together with other government departments, structures and other respective sectors will be required. This is due to the fact that the interventions that could be deployed to overcome industry development constraints are not the sole responsibility of the DTI, but require decision-making authority from other departments or institutions. The interventions and support mechanisms that should be considered, as well as institutions responsible for their implementation are outlined below.

Intervention		Responsibility
Market Pull Interventions		
1	Make firm commitments with respect to extension of the RE IPPPP and increase wind energy annual allocations to allow for sustainable growth of the industry	DOE, Eskom, EPRI
2	Open up the market outside the RE IPPPP through ISMO	DOE, NERSA, and Eskom
3	Open up the market outside the RE IPPPP through private PPAs	NERSA, municipalities, commercial and industrial customers, private sector energy traders, National Treasury, DOE

	Intervention	Responsibility
4	Introduce REFIT or premium tariffs for small-scale utility projects	DOE
5	Introduce the scheme that would allow OEMs with South Africa-based manufacturing capabilities to claim the value of exported components as part of local content in wind energy projects developed in South Africa	DTI
	Demand Push Interventions	
1	Support the development of local utility-scale wind energy technology	Department of Trade and Industry, Industrial Development Corporation, Development Finance Institutions, Department of Energy
2	Attract OEMs with proven track record in wind turbine components manufacturing	DTI and IDC
3	Provide financial incentives for wind turbine component manufacturers	DTI
4	Increase customs duties on selected components of wind turbines	DTI
5	Provide favourable credit through government-run finance institutions and impose local content requirements as an eligibility criterion	DTI and DFIs
6	Update the manner in which local content evaluated to pose stricter rules on procurement of wind turbine components	DTI and DOE

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