REVIEW OF THE STRATEGIC WIND ENERGY ACTIVITIES IN SOUTH AFRICA

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ABSTRACT

Via its Integrated Resource Plan (IRP) for Electricity, the South African Government has set targets to generate electricity from a range of technologies including wind energy technology. The South African Wind Energy Technology Programme (SAWEP) Phase 1 aims to achieve two key strategic outputs that will guide South Africa on wind energy development. One of these outputs is the Wind Atlas for South Africa (WASA). The other output is the development of a Wind Energy Industrial Strategy for South Africa. Two pilot hybrid wind/PV mini-grid energy systems have been implemented in the rural areas of South Africa. These mini-grids were implemented to provide the learning and experience for wind and other forms of renewable energy based systems to compliment the grid connected electrification programme.

This paper provides a strategic review of wind energy activities in South Africa based on the strategic projects of SAWEP Phase 1, including projects that have a wind energy component such as the hybrid mini-grid energy systems and the two large grid connected projects that are currently in operation in South Africa.

1. INTRODUCTION

The uptake wind energy in South Africa depends on whether robust policies and regulations have been put in place. The South African Department of Energy's energy White Paper on Energy (1) is the most crucial document from which the various supporting mechanisms are then derived and sets out five policy objectives and then considers what they mean for demand sectors (energy users), supply sectors and crosscutting issues. However the White Paper does not set out implementation plans and targets for renewable energies in the country's energy balance. This weakness prompted the government to develop a white paper specifically for new and renewable energy (2).

To build on the Energy and Renewable Energy White Papers, the current iteration of the Integrated Resource Plan (IRP) for South Africa, (3), initiated by the Department of Energy after a first round of public participation in June 2010, led to the Revised Balanced Scenario (RBS) that was published in October 2010. It laid out the proposed generation new build fleet for South Africa for the period 2010 to 2030. This scenario was derived based on the cost-optimal solution for new build options (considering the direct costs of new build power plants), which was then "balanced" in accordance with qualitative measures such as local job creation. In addition to all existing and committed power plants, the RBS included a nuclear fleet of 9,6 GW; 6,3 GW of coal; 11,4 GW of renewables; and 11,0 GW of other generation sources.
Additional cost-optimal scenarios were generated based on the changes. The outcomes of these scenarios, in conjunction with the following policy considerations, led to the Policy-Adjusted IRP. The Policy Adjusted Integrated Resource Plan has allocated 10,3% to wind in the overall generation capacity, in third place after coal, 45,9%, and nuclear, 12,7%. Table 1 shows the rate at which wind energy schemes (wind farms) are planned to be developed (build rate) up to 2027.

Table 1: Build rate for wind energy

IRP 2010-2030 Policy Adjusted Scenario		
	Wind	
Year	Committed Built MW	New Built Options MW
2010	0	0
2011	200	0
2012	200	0
2013	300	0
2014	0	400
2015	0	400
2016	0	400
2017	0	400
2018	0	400
2019	0	400
2020	0	400
2021	0	400
2022	0	400
2023	0	400
2024	0	800
2025	0	1600
2026	0	400
2027	0	1600
2028	0	0
2029	0	0
2030	0	0

2. QUANTIFYING SOUTH AFRICA'S WIND RESOURCE

Over the years, several studies have been carried out to assess the wind energy potential of South Africa. As each study is completed in chronological order the magnitude of South Africa's wind resource has become more clear and more accurate, resulting in strategic plans being developed to exploit this resource.

Diab's wind atlas: The first attempt at estimating South Africa's wind energy potential was done in 1995 by Diab, (4),who reviewed and assessed meteorological data that was sourced from the South African Weather Services. Diab concluded that wind power potential is generally good along the entire coast with localised areas, such as the coastal promontories, where potential is very good, i.e., mean annual speeds are above 6 m/s and power exceeds 200 W/m^2, that moderate wind power potential areas include the Eastern Highveld Plateau, Bushmanland, the Drakensberg foothills in the Eastern Cape and KwaZulu-Natal and areas with low wind power potential include the folded mountain belt (vast region of very complex and diverse terrain), the Western and Southern Highveld Plateau, the Bushveld basin, the Lowveld, the Northern Plateau, the Limpopo basin, Kalahari basin, the Cape Middleveld and the KwaZulu-Natal interior

DME/CSIR/ESKOM renewable energy resource database: As part of a larger scale project of the (then) Department of Minerals and Energy, ESKOM and the CSIR, compiled the South African Renewable Energy Resource Database (SARERED), (6). This wind atlas is based on the merging of two micro-scale analyses using Risø DTU's WaSP model. The input data was meteorological data that was obtained from the South African Weather Services. This wind atlas, for the first time, provided more detail as to the possible locations of areas of good and resources in South Africa but not of a quality that could be used for planning purposes.

African Development Bank's Africa wide assessment: Commissioned by the African Development Bank with the support of the Canadian International Development Agency, Helimax prepared a quantitative map of wind speeds for the African continent at a resolution of 50 km, (7). The main purpose of the project was to identify target countries for investment in wind energy by the private sector arm of the African Development Bank. In total eight countries were identified for priority investment by the Bank in wind energy projects: Tunisia, Morocco, South Africa, Mauritania, Madagascar, Cape Verde, Mauritius and Eritrea

Hagemann's wind atlas: A meso-scale wind map of South Africa at 10 m above ground was produced by Hagemann, (8), as part of his Doctorate research at the University of Cape Town. This study was based on the industry-recognised MM5 model. The study modelled wind speeds across the country at various heights above ground and carried out analyses for South African wind power penetration for low, central and high case scenarios with resultant wind electricity production of 20, 80 and 157 TWh/year respectively

3. CURRENT SOUTH AFRICAN WIND ENERGY MARKET AND INDUSTRY

At present only about 0.05% of South Africa's installed electricity generation capacity is derived from wind energy. This tiny amount can be divided into three categories:

- Large grid connected wind turbines (10.2MW)
- Small wind turbines (0.56MW)
- Borehole windmills (approx 22,000 units -12MW)

The large grid connected wind turbines are made up of:

- Eskom Klipheuwel (3.17MW)
- Darling (5.2 MW)
- Coega (1.8 MW)

Two wind/PV hybrid mini-grid energy systems in the Eastern Cape Province do add a small fraction, as do other isolated off grid turbines to South Africa's generation capacity. A number of small wind turbines has been installed in the country on premises connected to the grid but these are typically installed behind the electricity meter and do not feed in to the national grid. Small wind turbines are currently being manufactured by Kestrel Wind Turbines in Port Elizabeth. Kestrel Wind Turbines range in sizes from 0.6kW to 3kW. Adventure Power Pty (Ltd) manufactures an indigenous designed and manufactured medium sized 300kW wind turbine. This wind turbine is a direct-drive machine and is seen in Figure 2.

Figure 2: Adventure Power's 300kW wind turbine.

A range of wind farm developers and Eskom are currently developing wind farms in response to the South African Governments call to establish wind farms.

To support industry the South African Wind Energy Association (SAWEA) has been established and details of these wind farms can be found on their website www.sawea.org.za.

4. THE SOUTH AFRICAN WIND ENERGY PROGRAMME

In 2001 the then Minister of Minerals and Energy requested international assistance to establish a South African wind energy industry. The South African Wind Energy Programme (SAWEP) Phase 1 was formulated with funding to undertake projects from the Global Environmental Facility (GEF) and the Danish Government.

The goal of SAWEP Phase 1, (4), is to reduce greenhouse gas emissions generated by thermal power generation in the national inter-connected system. The project objective is to install and operate the 5.2 MW Darling wind farm and prepare the development of 45 MW combined wind farms. SAWEP is intended to contribute to South Africa’s national development objectives by diversifying power generation in South Africa’s energy mix; setting up a wind energy industry that could generate employment and by promoting sustainable development and making use of South Africa’s renewable and natural resources.

SAWEP has been divided into six main outcomes to contribute to first lowering of identified barriers within a full-size project of a two-year period. Each component is associated with specific outputs and a set of activities.
(1) Increased public sector incremental cost funding, by assisting the Government of South Africa with detailing the most appropriate financial instruments that should be made available to stimulate commercial wind energy developments;
(2) Green power funding initialised, by assisting initiatives geared towards green power marketing and setting up and implementing Tradable Renewable Energy Certificates (TRECs) as well as implementing a green power guarantee scheme;
(3) Long-term policy and implementation framework for wind energy developed, by assisting the Government of South Africa;
(4) Wind resource assessment, by assisting interested public and private sectors entities with the generation of reliable wind energy data and other necessary information for wind energy development;
(5) Commercial wind energy development promoted, by assisting private sector developers with the (pre-) feasibility of a number of wind farms up to 45 MW installed capacity.
(6) Built capacity building and strengthened institutions, such as key government departments, public agencies, wind farm industry (e.g. South African Wind Energy Association) and independent private firms.

SAWEP Phase 1 also aims to achieve two key strategic outputs that will guide South Africa on wind energy development. One of these key strategic outputs is the Wind Atlas for South Africa (WASA) that is intended to play a significant role in providing information for potential investors for wind farms on areas that have opportunities.

The second key strategic output is the development of a Wind Industrial Strategy for South Africa. This will help determine the possibility of establishing a wind industry in South Africa. The Wind Industrial Strategy project aims to play a strategic role in paving the way for the gradual phasing in of wind energy in South Africa by informing the South African Department of Trade and Industry’s plans for the local manufacture of wind turbines and the associated components.

4.1 WIND ATLAS FOR SOUTH AFRICA (WASA)

The main objective of the new Wind Atlas for South Africa (WASA) is to develop and employ numerical wind atlas methods and develop capacity to enable planning of large-scale exploitation of wind power in South Africa, including dedicated wind resource assessment and siting tools for planning purposes.

The Global Environmental Facility and the Danish Government are co-funding the multi-year project to develop an accurate wind resource map for the coastal regions of South Africa. The wind resource assessment being done by the CSIR, University of Cape Town (UCT), South African Weather Services (SAWS), South African National Energy Research Institute (SANERI) and Risø-Danish Technical University (Risø-DTU).

Figure 3 shows the area in blue that is currently planned to be assessed to form the basis of the new wind atlas. Using meso-scale data and information site selection criteria were developed as to the locations of where the 10 wind measurement masts are to be erected. These sites are representative of terrain types, suitable for meso- and micro-scale modelling and geographically spread out evenly over the project area.

Figure 3: Area, in blue, of WASA domain

The data can be monitored on www.wasa.csir.co.za.
Wind forecasts are available on:
http://veaonline.risoe.dk/wasa.

Work to refine the model set up, terrain descriptions and parameterisation has been done based on the 1 year of measured WASA data available. Modelling and verification of the First Verified Numerical Wind Atlas has been completed according to project plans – data and guide how to use it is available on the WASA data download site:
http://wasadata.csir.co.za/wasa1/WASAData.

Disclaimer
It should be noted that any use of any WASA data is at own risk according to disclaimer on the web sites.

Figure 4 shows the first verified numerical Wind Atlas for South Africa.

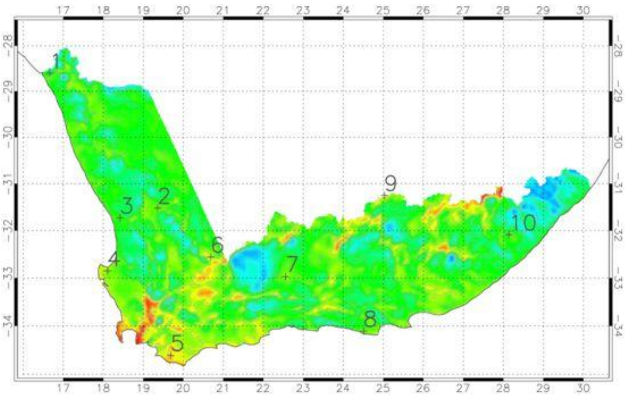

Figure 4: First Verified Numerical Wind Atlas for South Africa

4.2 WIND ENERGY INDUSTRIAL STRATEGY (SAWEP)

The CSIR and Risø-DTU of Denmark undertook this investigation into the development of a wind energy industrial strategy for South Africa and published a report, (11) that was delivered to the United Nations Development Programme. The objective of this investigation was to provide the necessary information for the South African Department of Trade and Industry to develop the official wind energy industrial strategy for South Africa.

Internationally, energy policies are developed with an express intention that they lead to important industrial outcomes. Lund, (12), investigated the impacts of energy policies on industry growth in renewable energy. Lund showed that energy policies can significantly contribute to the expansion of domestic industrial activities in sustainable energy, including that for the wind-energy industry. Market deployment measures that enhance home markets will in most cases lead to growing industrial activities in that country even when the related industrial base is relatively weak. However, irrespective of the domestic market situation, investment or research and development support to strong industries in related fields may be a powerful way to help diversification into the wind-energy field and to generate new export opportunities.

Considering the whole value/supply chain of the wind-energy production may be useful to position and identify industrial strengths but also to focus the energy policy measures optimally, in particular when industrial impacts are important to policy makers. Market deployment actions would basically influence the downstream part of the supply chain more, but would also cause upstream impacts.

Research and technology development are more linked to the upstream side of the value chain, for example, components but vertical integration will most likely take place when global markets expand. Several exogenous factors, such as timing, target size, geography, amongst other factors, will influence both the industrial and policy positioning in practice. Lund also suggests a possible industry evolution path. A successful wind-energy industry expansion process leads to exports and foreign operations, and to a global industrial profile. This has been the case for many wind-energy companies and industry growth may happen through acquisitions, organic growth, mergers and other business processes.

Lewis and Wiser, (13), examined the importance of national and local policies in supporting the development of successful wind-turbine manufacturing companies by exploring the motivations behind establishing a local wind-power industry, and the paths that different countries have taken to develop indigenous large wind-turbine manufacturing industries within their borders. This is done through a cross-country comparison of the policy support mechanisms that have been employed to directly and indirectly promote wind technology manufacturing in 12 countries.

The South African policy and regulatory environment and support mechanisms were analysed. These support mechanisms are in place as per international "best practice". Independent Power Producers are the organizations that will operate wind farms that will be developed in South Africa. Gratwick and Eberhard, (14), analysed IPPs in Africa at country-level and at project-level to obtain insights into what mechanisms would be needed to make IPPs' success more likely.

Country-level mechanisms that the South African government would need to provide to make an IPP's success more likely include:

- Favourable investment climate in terms of stable macroeconomic policies and good repayment records in a legal system allowing for contracts to be enforced and laws to be upheld.
- A clear policy framework embodied in legislation that specifies a market structure, roles, and terms for private and public sector investments.
- Lucid, consistent and fair regulatory supervision improving general performance of private and public sector assets.
- Coherent power sector planning with energy security standards in place and clarified planning roles and

functions, as well as built-in contingencies to avoid emergency power plants or blackouts.
- Competitive bidding practices with a transparent procurement process to potentially drive down prices.

Project-level mechanisms that are likely to contribute to the success of IPP investments are:
- Favourable equity partners with preferably local investment as well as experience in developing country project risk, and expectations of a reasonable and fair ROE.
- Favourable debt arrangements including low-cost financing where the share of local capital softens the impact of foreign exchange differences, and flexibility in terms and conditions.
- Secure and adequate revenue streams through commercially sound metering, billing and collections by the utility, a robust Power Purchase Agreement, and security arrangements where necessary
- Credit enhancements and other risk management and mitigating measures including sovereign guarantees, political risk insurance, partial risk guarantees and international arbitration.
- Positive technical performance in terms of availability and capacity factors as well as sponsors that anticipate potential conflicts, like operations and maintenance or budgeting issues.
- Strategic management and relationship building where sponsors create a good image through political relationships, development funds, effective communications and well-managed contracts.

The economics of wind projects were investigated, including the costs of the components of a wind turbine. According to Blanco, (15), the key parameters that govern wind-power costs are:
- Capital costs, including wind turbines, foundations, road construction and grid connection
- Variable costs, the most significant being the operation and maintenance of wind turbines
- The electricity produced
- The discount rate and economic lifetime of the investment.

Wind energy is a capital-intensive technology with capital costs being as much as 80% of the total cost of the project over its entire lifetime, with variations between models, markets and locations. The wind turbine constitutes the single largest cost component, followed by grid connection.

Discussions with South African wind industry stakeholders revealed that there was consensus that the cost distribution for European wind energy investments is similar to that for the average South African wind project. Hence, the capital cost breakdown as discussed above will be used for further analysis of an average South African wind-energy project.

4.3 ECONOMICS OF SOUTH AFRICAN WIND PROJECTS

One of the key factors affecting the development of a wind energy scheme is that of supply chains associated with the integration of a complete wind-energy scheme where it is seen that a turbine ex-work comprises 71% of total project value. Aubrey, (16), discussed the supply-chain challenges associated with the procurement of the components of wind turbine itself and presented a diagram that illustrates the components that make up a large 5MW wind turbine and their share of total wind turbine cost.

Further discussions with South African wind industry stakeholders revealed that there was consensus that the cost distribution as presented by Aubrey is similar to that for a South African wind project. Hence, the capital cost breakdown as described by Aubrey will be used for further analysis of a typical ex-works wind turbine for a typical South African wind-energy project. However, it should be noted from Aubrey's breakdown of a wind turbine that three components – the tower (26%), the rotor blades (22%) and the gearbox (13%) – make up approximately 60% of the value of a wind turbine. To assist in analysis of the economics of a South African wind-energy project, it is important to establish costs under South African conditions. In this context of developing a full wind-energy project it is useful to establish the average cost/MW of a project in South African currency.

Cost figures that have been sourced from a range of stakeholders in industry revealed the following range of costs/MW:
- US$2.5million/MW or ZAR19.5million/MW (average conversion rate in February 2012 of 7,8:1)
- €1.6million/MW or ZAR16.456million (average conversion rate in February 2012 of 10,28:1)

From these figures an average cost per MW is ZAR18million. Since this discussion relates to South African projects, further analysis will be in the South African currency, ZAR. Until more accurate costs are established the figure of ZAR18million/MW will be used in further analysis. Based on the weighting of the capital cost of a wind project from Blanco, (15), and Aubrey, (16), the weighting of the components that make up a turbine ex-works, the cost breakdown per MW for a South African wind project is presented in Table 2.

For every ZAR18million spent on developing 1MW of wind energy in South Africa, it will assist decision makers if it can be established how much of the ZAR18million could be spent in South Africa and under what scenarios such spending could happen. The financial structuring of a wind-energy project is a complex process and is not within the scope of work of this project.

Table 2: Cost breakdown of components/MW of a wind-turbine project

Item	% value	Cost (ZARmillion)/MW
Grid connection	12	2.16
Civil works	9	1.62
Other capital costs	8	1.44
Tower	18,7	3.366
Rotor blades	15,8	2.844
Rotor hub	1,0	0.18
Rotor bearings	0,86	0.155
Main shaft	1,36	0.245
Main frame	2,0	0.36
Gearbox	9,20	1.656
Generator	2,44	0.44
Yaw system	0,89	0.16
Pitch system	1,89	0.34
Power converter	3,56	0.641
Transformer	2,55	0.459
Brake system	0,93	0.167
Nacelle housing	0,96	0.162
Cables	0,68	0.122
Screws	0,74	0.133

4.4 SCENARIOS FOR LOCAL MANUFACTURE

Developing possible scenarios for a South African wind-turbine manufacturing industry an understanding is needed of the supply chain associated with the global wind-turbine industry. Supply chain management is essential to wind-turbine supply. The relationships between manufacturers and their component suppliers have become increasingly crucial, and have come under increasing stress in the past few years as global demand has required faster ramp-up times, larger investments and greater agility to capture value in a rapidly growing sector.

Supply chain issues have dictated delivery capabilities, product strategies and pricing for every turbine supplier. Pullen *et al*, (17), provides an overview of the turbine component supply chain and illustrates the fact that the market is highly concentrated for multiple segments, including blades, bearings and gearboxes. These segments have high entry barriers based on the size of investment and manufacturing ramp-up time.

At the same time, controls, generators, castings and tower segments have lower entry barriers with a larger number of players It should be noted that three components – the tower (26%), the rotor blades (22%) and the gearbox (13%) – make up approximately 60% of the value of a wind turbine, with the rest of the components having different weightings to make up a complete turbine.

However, it should be noted that the South African industry has a high propensity to innovate, (18). Building on an existing aerospace industry where experience has been built over the years on manufacturing aircraft components out of composite materials, the same basic materials used in wind-turbine blades, South African industry has the know-how and ability to manufacture wind-turbine blades.

Manufacturing blades locally would further increase the local content of a wind-turbine system. Similar discussions and motivations can be put forward for most of the components in a wind-turbine system.

Finally, since South African industry has the propensity to innovate, this places South African industry in a strong position to leapfrog in wind-energy technology advances. For a typical South African wind-energy project the total cost is ZAR18million/MW.

Weightings have been allocated to the various costs that make up a wind-energy project, with the primary weightings being allocated to grid connection, civil works, other capital costs, tower, blades, gearboxes, generator, nacelle and the other components that make up a wind turbine. It is beneficial to the South African economy that as much of this ZAR18million/MW is spent in South Africa as possible.

Based on the above, four scenarios for the localisation of wind energy projects have been proposed and are:

- Scenario 1: Low-industrial content
- Scenario 2: Medium-low industrial content
- Scenario 3: Medium-high industrial content
- Scenario 4: High industrial content

Table 3 presents the four scenarios for the localisation of a wind-energy project for South Africa and the value of local spend/MW and the associated weighting of local content.

The Government of South Africa is seeking to unlock the country's potential for green growth by introducing renewable energy in a systematic way as part of the Integrated Resource Plan,(3), supported by energy sector reforms and policy developments. This would also contribute towards fulfilling international climate commitments.

The South African Department of Trade and Industry (DTI) is developing the official Sector Development Strategy for Solar and Wind Power, (19) for South Africa. This strategy document first sets out to discuss the global context of the solar and wind energy sector. It then examines both the current and potential states of the solar and wind industry in South Africa, focusing specifically on opportunities for South African manufacturers to participate in global supply or value-chains

5. RENEWABLE ENERGY INDEPENDENT POWER PRODUCER PROGRAMME

The Integrated Resource Plan outlines the required new generation capacity for the next 20 years. The IRP takesinto account the different energy carriers required to ensure that stability for the national energy supply, and renewable energy is part of this mix.

In accordance with the IRP, the Request for Proposal (RFP) published in August 2011 provides for the procurement of renewable energy up to 2016. The South African Government acknowledges that the country will suffer the challenge of energy constraints in the next few years. Thus, the procurement of alternative sources of energy from the private sector is motivated by the urgent need for new generation capacity to alleviate the current energy constraints.

Table 3. Scenarios for the localisation of wind-energy project spend

Scenario	Assumptions	% value	Local spend/MW
1. Low-industrial content	Grid connection, civil works, other capital costs, fully imported wind turbines	29	ZAR5.22 million
2. Medium-low industrial content	Grid connection, civil works, other capital costs, tower locally made, rest of turbine imported	47	ZAR8.46 million
3. Medium-high industrial content	Grid connection, civil work, other capital costs, tower, blades, generator and nacelle made locally, rest imported	66	ZAR11.88 million
4. High industrial content	Grid connection, civil works, other capital costs, most of turbine made locally, except for specialised items such as gearbox, rotor bearings	87	ZAR15.66 million

With significant numbers of the population currently unemployed, the government of South Africa also sees this procurement programme as an opportunity to grow the economy. It is accepted that the locations for these projects under this programme are driven by the availability of natural resources (wind, solar and water) but the intention is to maximise economic development wherever the projects are located.

Thus, the target for local content in the bidding programmes is increasing progressively as seen in the current Window 2 of the IPP's. In some of the technologies the current target is as high as 60%, while the minimum 40% South African Equity Participation remains unchanged. This certainty in requirements should surely encourage project developers to relocate their manufacturing capacities to South Africa so that the additional target of growing local employment opportunities and up scaling skills is achieved.

The Minister of Energy has determined that 3725 megawatts (MW) to be generated from Renewable Energy sources is required to ensure the continued uninterrupted supply of electricity. This 3725 MW is broadly in accordance with the capacity allocated to Renewable Energy generation in IRP 2010-2030.

Table 4 summarises the winning wind farm bids for Rounds 1 and 2. It can be determined that in future bids there is only 642.51MW available for IPP's.

Table 4: Summary of Rounds 1 and 2 bids

Round 1 Project Name	**MW**
Dassiesklip Wind Energy Facility	26.19
MetroWind Van Stadens Wind Farm	26.19
Hopefield Wind Farm	65.40
Noblesfontein	72.75
Red Cap Kouga Wind Farm – Oyster Bay	77.60
Dorper Wind Farm	97.0
Jeffreys Bay	144.86
Cookhouse Wind Farm	135.0
Total	644.99
Round 2 Project Name	**MW**
Gouda Wind Facility	135.2
Amakhala Emoyeni (Phase 1) Eastern Cape	137.9
Tsitsikamma Community Wind Farm	94.8
West Coast 1	90.8
Waainek	23.4
Grassridge	59.8
Chaba	20.6
Total	562.5
TOTAL FROM 2 BIDS	**1207.49**

6. DISCUSSION AND CONCLUSION

Based on the policy and regulatory documents that carious South Africa Government Departments have put in place to support a renewable energy industry a model has been developed that relates the different stakeholders with their respective roles as well as to indicate the collaboration and partnerships between the various stakeholders from country level to project-level. In Figure 6, the different groupings of stakeholders are represented in different colours:

- Government departments – Blue
- Government Implementation Agencies – Red
- Private sector stakeholders - Green.

This model illustrates the stakeholder and function relationships from a country-level down to a project-level. Each organisation, as depicted on the left, operates within its specific mandate and due to the complex nature of developing wind farms collaboration between the various government departments and partnerships with industry stakeholders is needed to meet project objectives.

The South African government has established the necessary and robust framework for the establishment of a wind energy industry in South Africa. The effectiveness of the various policies, regulations and strategies will be visible in the short to medium term.

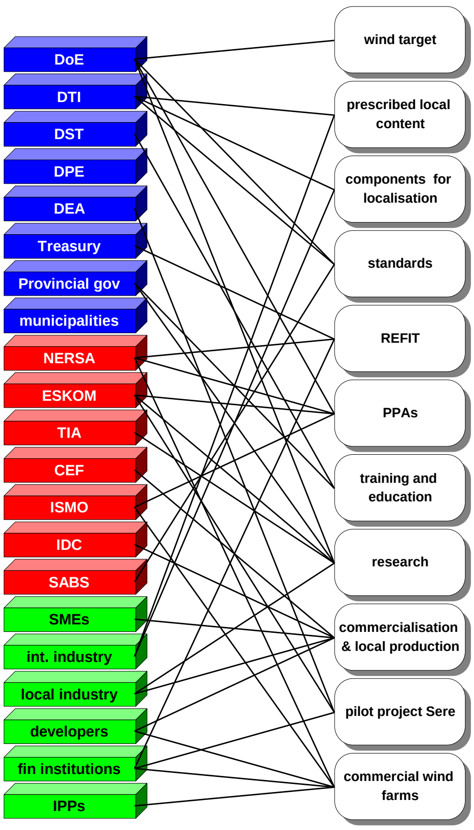

Figure 6: Stakeholder and function relationships

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Presenter: The paper is presented by Stefan Szewczuk