



REIPPPP focus on wind

As at 31 December 2019

Purpose and outline of this report

The purpose of this report is to provide a high level "at a glance" overview of the Renewable Energy Independent Power Producers Procurement Programme (REIPPPP) with the focus on the contribution from wind power in particular.

The REIPPPP is located within the overall South African policy framework and notably in the:

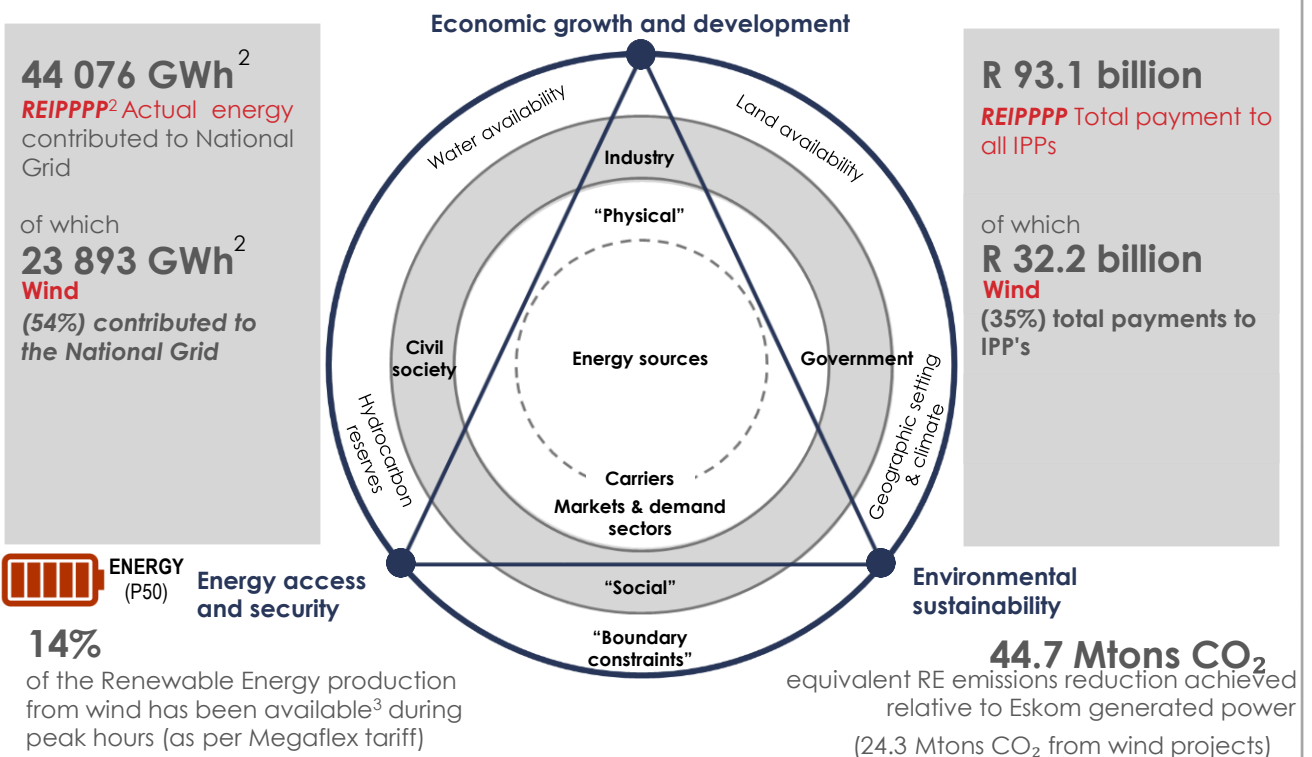
- Respective White Papers on Energy Policy (1998) and Renewable Energy (2003);
- The Electricity Regulation Act (2006) and National Environmental Management Act (1998);
- The South African National Development Plan (NDP);
- The Integrated Energy Plan (IEP); and
- The Integrated Resource Plan (IRP) 2010 for Electricity.

Renewable Energy (RE) capacity for the programme is pursued from the different RE technologies identified in the IRP 2010, including onshore wind, solar photovoltaic (PV), concentrating solar power (CSP), biomass, biogas, landfill gas and small hydroelectric power plants. By the end of December 2019, the REIPPPP had successfully implemented seven bid windows⁴ from which it procured 6 422 megawatt (MW) from 112 independent power producers (IPPs). Of these, 36 are wind IPPs contributing 3 366 MW⁵.

South Africa is perhaps best known for its solar resource, but the recently developed Wind Atlas has also confirmed the country's exceptional wind resources. IPPs participating in the REIPPPP have been harvesting this clean energy resource very successfully, making a significant contribution to the country's energy needs, economic development and environmental sustainability in the process (refer the energy triangle, for wind IPPs under the REIPPPP, below).

This publication celebrates the contribution wind power has made and continues to make in South Africa's pursuit of a cleaner, cost effective electricity mix.

Key REIPPPP Energy Triangle¹ Facts: Wind Technology (for period 11/2013 – 12/2019)



Note 1. Source: World Economic Forum – Global Energy Architecture Performance Index Report (2013). **Note 2.** Actual energy supplied to the grid. **Note 3.** 15% since first operational wind IPP. Percentage figure correct as at end June 2016 as updated figures not available. **Note 4.** BW1, BW2, BW3, BW3.5, BW4 and smalls BW1 (1S2) and BW2 (2S2). **Note 5.** Includes 2 smalls projects with a capacity of 9 MW.

Wind technology basics

A wind turbine is a rotary device that extracts energy from the wind. The wind turns the blades (mechanical energy), which spin a shaft that connects to a generator and produces electricity (electrical energy). The mechanical energy can be used directly by machinery or the energy can be converted to electricity.

Wind resource potential in South Africa

Wind power was anticipated, by both the IRP and independent researchers, as the technology most likely to contribute significantly to the South African energy mix, because of technology maturity and established global capacity. South Africa furthermore offers exceptional wind resource potential throughout most of the country, but particularly along our extended 3 000 km coastline.

The country's wind resource has been comprehensively mapped in a **publicly available Wind Atlas** to support planning and wind power development.

The first phase of the project (focusing on Western Cape, parts of the Eastern Cape and Northern Cape Provinces) was initiated in June 2009 and concluded in April 2014, delivering a large-scale, high-resolution, measurement-based, verified numerical Wind Atlas for South Africa that is publicly available, free of charge, for planning and development of wind farms and off-grid electrification. The level of accuracy and granularity of the data have proven invaluable for wind power development, confirming that traditional climatology and global models underestimated resource potential in the country by as much as 5%.

During the second phase, WASA 2, five additional wind measurement stations were installed in the remaining parts of the Eastern Cape, and was extended to include Kwazulu Natal and the Free State Provinces. WASA 2 commenced in March 2013 and concluded in 2018.

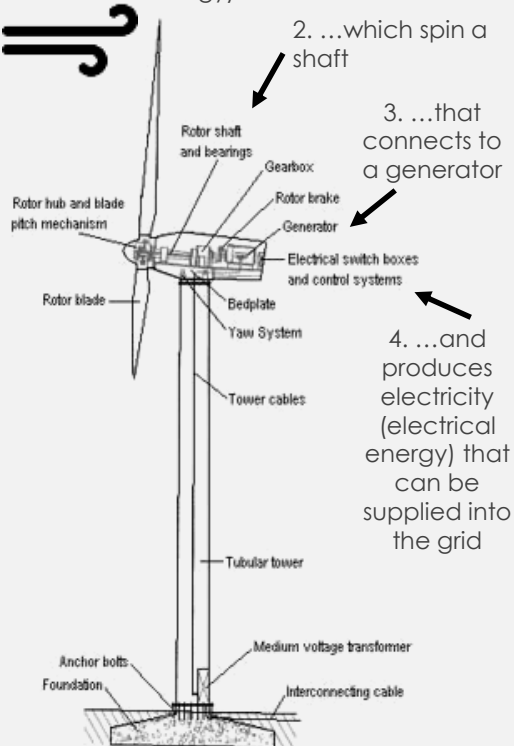
Four (4) additional measurement stations were erected in beginning of September 2018 in the Northern Cape Province under WASA 3. The measurements results of WASA 1-3, which cover an estimated 75% of South Africa's land cover will be used to extrapolate the prevailing wind conditions for the rest of South Africa.

1. Wind turns the blades (mechanical energy)

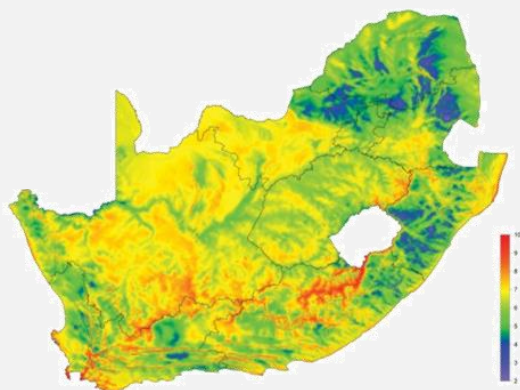
2. ...which spin a shaft

3. ...that connects to a generator

4. ...and produces electricity (electrical energy) that can be supplied into the grid



Wind Atlas of South Africa (WASA), large scale high resolution wind resource map



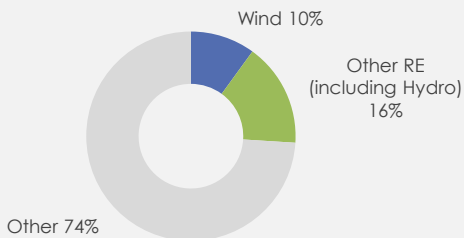
Mean wind speed (ms⁻¹) @ 100m WASP modelled, 250 m resolution



www.wasaproject.info or wasa.csir.co.za

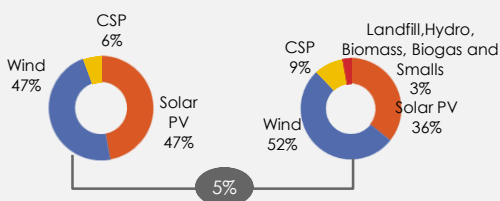
IRP 2010, 2030 electricity mix

Technology capacity share (%)



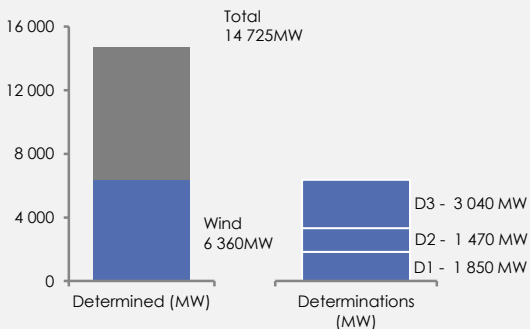
Technology capacity share

Planned versus procured (%)



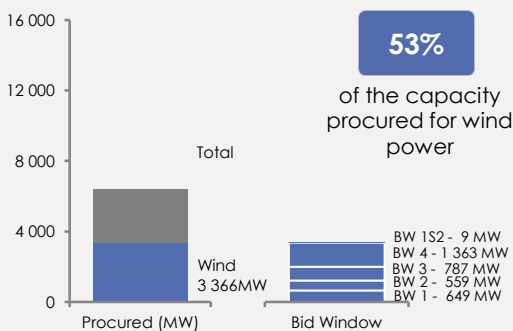
Capacity determined³

Wind as share of total determined



Capacity procured⁴

Wind as share of total procured



Wind power in South Africa's electricity plan to 2030

In terms of South Africa's Integrated Resource Plan, wind power is expected to contribute 10% towards the country's power capacity by 2030. This will require 9 200 MW⁵ wind power to be constructed between 2010 and 2030.

The Minister of Energy has to date determined 6 360 MW of wind power to be procured from Independent Power Producers, targeting full operation by 2025. The determinations have thereby already given effect to 69% of the capacity planned for 2030.

Wind power has taken a slightly larger share of the planned procured RE portfolio than expected. Currently, wind represents 52%² of the RE technology mix, i.e. exceeding plans by 5%. Technology price developments and steep downward price trends contributed to make wind even more competitive. The slight divergence from the IRP 2010 is informed by technology, price and system requirements and follows from the four ministerial determinations made to date.

Offering an increasingly cost competitive energy alternative

In line with international experience, the price of renewable energy is increasingly cost competitive with conventional power sources. The REIPPPP has effectively captured this global downward trend with prices decreasing in every bid window (BW). Energy procured by the REIPPPP is progressively more cost effective and rapidly approaching a point where the wholesale pricing for new coal- and renewable-generated electrical energy intersects.

Average wind energy tariffs¹

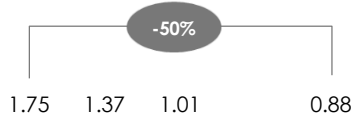
R/kWh



Average



Per bid window

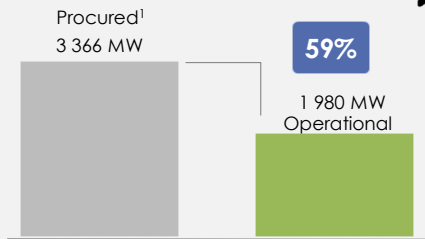


The price for wind power has dropped by 50% to R0.88/kWh (in April 2019 terms), with the BW4 price directly comparable with the per kWh price of new coal-based electrical generation.

Note 1. Fully indexed price, inflation adjusted (2019). **Note 2.** Numbers rounded. **Note 3.** Determined wind capacity excludes contribution from smalls projects. **Note 4.** Procured capacity includes contribution from smalls projects – 2 projects with a capacity of 9MW. **Note 5.** Includes 8 400 MW new build, 700 MW committed build and 100 MW from Eskom's Sere wind farm.

Procured¹ vs operational

Wind capacity (MW)



3 366

Megawatts

from

36

IPP projects



Carbon emission reductions

Projected using P50 (Mton CO₂)

Projected (P50)

12.1

Mton CO₂ / annum



59%

Wind contribution to total

Realised (12 month period)



53%

6.4 Mtons CO₂

Carbon emission reductions ITD

of which

44.7

Mton CO₂

24.3 Mtons CO₂

from wind power



Wind power procured

By the end of December 2019, 3 366 MW¹ of wind power had successfully been procured under South Africa's REIPPPP.

The South African portfolio includes some of the largest wind power plants in the world, with the average project size for the 36 wind IPPs being 93.5 MW. The collective wind capacity will deliver an annual projected energy output of 11 886 GWh³. This is enough to power 3.6 million households² annually.

By the end of December 2019, 22 wind IPPs had started commercial operation, contributing 1 980 MW capacity to the national power system.

Contributing to cleaner energy

The power generated by renewable energy sources contributes to the national objectives for a cleaner energy mix. The 112 IPP projects that have already been procured are expected to reduce the CO₂ emissions annually by 20.5 Mtons (using P50³ figures). Of this, the 36 wind IPPs are projected to contribute a reduction of 12.1 Mtons CO₂ (59%).

Over the past 12 month period alone (ending December 2019) the operational wind projects have reduced CO₂ emissions by 6.4 Mtons (already 53% of the total 12.1 Mtons annual P50 projection for wind IPPs).

Since the first REIPP started commercial operation at the end of 2013, 44 076 GWh have been generated, reducing carbon emissions by 44.7 Mtons. Of this, wind projects have contributed 23 893 GWh and reduced carbon emissions by 24.3 Mtons.

Note 1. Procured capacity includes 9 MW procured by smalls projects in smalls BW1 (1S2). **Note 2.** Based on an annual usage for an average South African home of 3 319 kWh. **Note 3.** Projected annual energy contribution – P50 refers to probabilities for annual energy production which are expressed as P values. A P50 figure is the level of generation that is forecasted to be exceeded in 50% of years over a 10 year (or sometimes 20 year) period.

REIPPPP energy generation

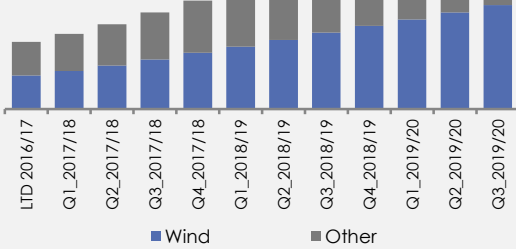
Energy ITD (GWh)



Gradual commissioning of 22 wind projects

54%

Wind of Total



Energy Generation ITD

44 076 GWh

of which

23 893 GWh

from wind power



Energy supplied

The first REIPP reached COD, supplying power to the grid, in November 2013. Since inception², 44 076 GWh of energy has been generated by renewable energy sources from the 64 projects that are operational.

Wind power is contributing 23 893 GWh – more than half of all renewable energy produced to date³. Of this energy, 1 692 GWh was generated during this reporting quarter (October to December 2019).

The energy generated over the last 12 months (September 2018 to December 2019), from limited operations by the 22 projects that have reached COD, was 6 349 GWh.

Energy supplied to the grid

Energy generated (GWh)



Projected generation for active Wind projects (P50)

11 853 GWh/a

Total Realised Past 12 month period
6 349 GWh

Q

1 692 GWh

Operational Projects 6 660 GWh/a

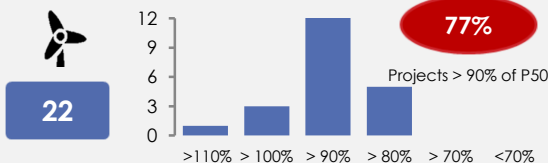
This 6 349 GWh represents 95% of the annual projected energy production by all the operational Wind IPPs (P50¹ for the 22 operational IPPs is 6 660 GWh). All these 22 projects have been operational for more than 1 year.

Achievement of P50¹ projections

No. of projects



Projects in COD > 1 year



Individually, four (4) of these 22 wind projects (18%) have exceeded their P50¹ projections, while 77% of the IPPs achieved greater than 90% of their P50¹ projections. Five (5) projects fall short of achieving greater than 90% of their P50¹ projections.

Note 1. Projected annual energy contribution. **Note 2.** Total renewable energy generated by IPPs since the first project became operational. **Note 3.** As at December 2019.

Committed investments

Bid window 1 to 4, 1S2 & 2S2 (Rand billion)



209.7

Rand billion

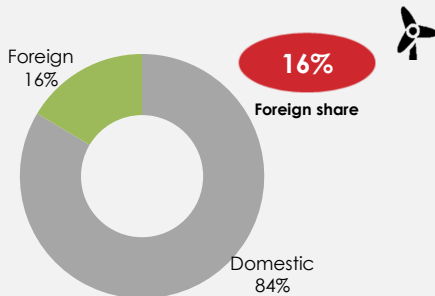
Committed (**total project costs¹**) for IPP development in BW 1, 2, 3, 3.5, 4, 1S2 & 2S2

of which

R80.6 billion from wind power

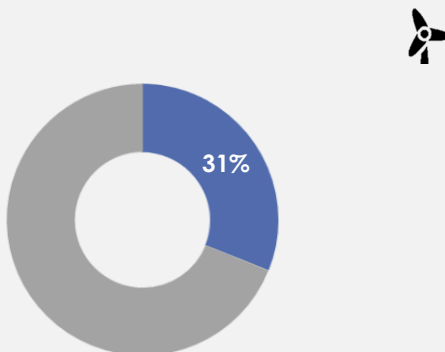
Foreign equity and financing share

Bid window 1 to 4, 1S2 & 2S2 (percentage)



Shareholding by black South Africans

Active projects³



Investment attracted for wind power

Wind IPPs have attracted significant investment, in the development of these projects, into the country. The total investment (total project costs¹), of all projects under construction and projects in the process of closure⁴, is R209.7 billion of which R80.6 billion is for onshore wind IPPs.

The expected project value for these wind projects is R59.8 billion and at end Dec 2019, R38.1 billion had been actually been spent.

Wind IPPs have attracted R13.2 billion in foreign investment (debt and equity) in the seven bid windows (BW1 – BW4, 1S2 and 2S2), of which R12.1 billion is foreign equity. Whilst retaining shareholding for South Africans is a priority, the associated influx of foreign investment and funding is also of significance to the economy. The NDP (Outcome 11) set a target of a R230 billion increase in FDI (facilitated by the dti) by 2019.

Equitable shareholding in wind IPPs

South African (local) equity shareholding across BW1 to BW4, 1S2 and 2S2 equates to 48% (R11.1 billion) of total equity (R23.2 billion). Black South Africans own, on average, a 31% share of wind projects that have reached financial close.

Shareholding by black South Africans has been secured across the value chain.

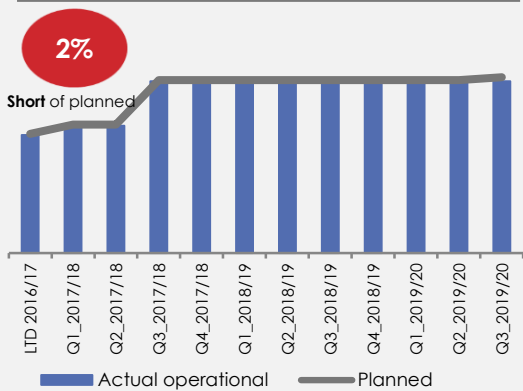
Black people in local communities also hold ownership in the IPP projects operating in or nearby their vicinities. On average, black people in local communities own 10% of IPPs at financial close.

Note 1. Total Project Costs means the total capital expenditure to be incurred up to the commercial operations date in the design, construction, development, installation and/or commissioning of a project, which is equal to the total debt and equity related to a project as reported at commercial close. **Note 2.** Project Value means the total project cost that involves the capital costs and costs of services procured for the construction of a project, but excludes finance charges, land costs, mobilisation fees to the operations contractor and the costs payable to the distributor, national transmission company and/or a contractor for the distribution or transmission connection works. **Note 3.** Active projects are projects currently in construction (or in operation) i.e. BW1, BW2, (16 of 17 projects) BW3, BW3.5 and BW4. **Note 4.** BW3 (one project), and 1S2 and 2S2 have not yet reached financial close.

REIPPPP operational capacity



Capacity (MW)



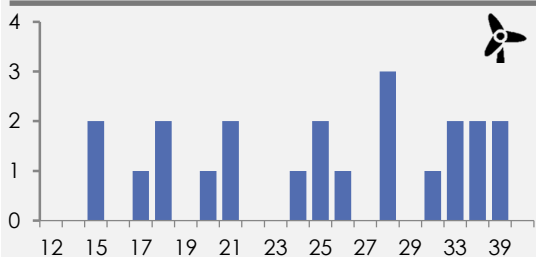
Wind power delivering capacity quickly

By the end of Q3 2019/20, 23 projects with a capacity of 2 026MW were scheduled to have reached commercial operations. Actual achievement has been 22 projects delivering 1 980 MW (98% of the scheduled plan and a shortfall of 47MW).



Distribution of lead times

Construction (in months) for completed projects

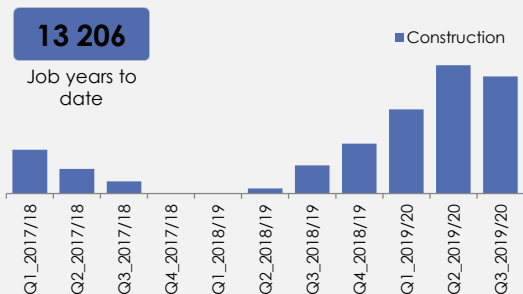


A few IPPs that have started operation have done so below the contracted capacity. As a result there is a 14.7 MW shortfall between contracted and delivered capacity for active 1 projects at the end of Dec 2019.

Average lead time for the 22 projects to reach commercial operation was 793 days (2.2 years). Lead times across the portfolio varied from 15 to 39 months.

Employment opportunities

Actual (Job years) (active projects¹)



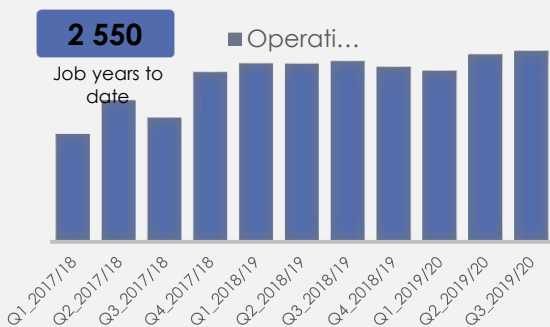
Employment creation

During the construction of REIPPPs, numerous employment opportunities are being created. Active RE projects (projects that have commenced construction¹) delivered 39 312 job years² (for SA citizens) of which 13 206 of these employment opportunities were for the construction of wind IPPs. The active wind IPPs have committed to create 11 358 job year opportunities for SA citizens during the construction phase.

The construction phase offers a high number of opportunities over shorter durations, while the operations phase requires fewer people, but over an extended operating period.

Operations employment

Actual (Job years) (active projects¹)



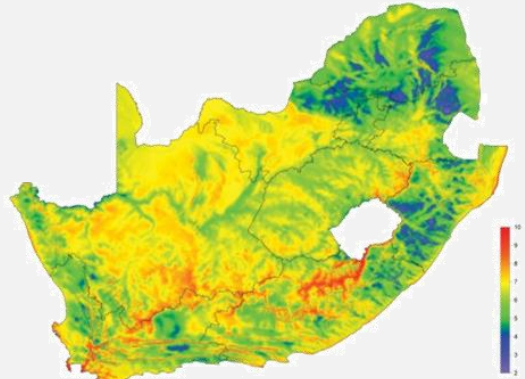
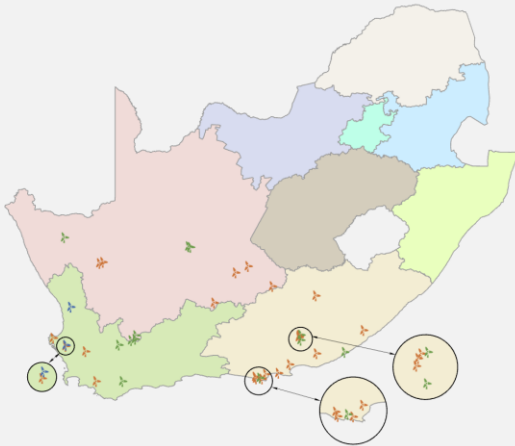
The 22 wind IPPs that have successfully reached commercial operations to date have reported 2 550 job years for SA citizens. Over the operational life of the full wind portfolio (BW 1 to BW4, 1S2 and 2S2), 32 140 job years are expected to be created for SA citizens.

Note 1. Actuals tracked against Active projects – referring to all projects that have commenced construction i.e. currently BW1, BW2, (16 of 17 projects) BW3, BW3.5 and BW4. **Note 2.** The equivalent of a full time employment opportunity for one person for one year. **Note 3.** The 22 projects planned to deliver 1 995 MW, but only achieved 1 980 MW.

Geographic distribution



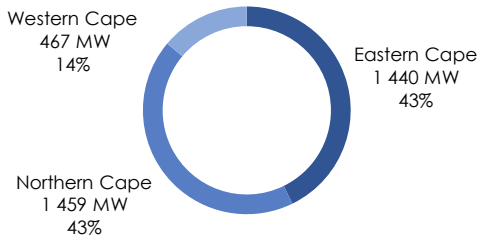
Wind Atlas of South Africa (WASA), Large Scale High Resolution Wind Resource map



Wind IPPs are largely located along the coastal regions of the Eastern Cape and Western Cape provinces, based on the strong wind flows along these shores. Surprisingly, a large share of wind IPPs are located in the Northern Cape. Northern Cape and Eastern Cape together make up 86% of the capacity with 1 459 MW and 1 440 MW located respectively in each province. The Eastern Cape has the highest number of wind projects at 16, while the Northern Cape has 12 projects and the Western Cape has 8.

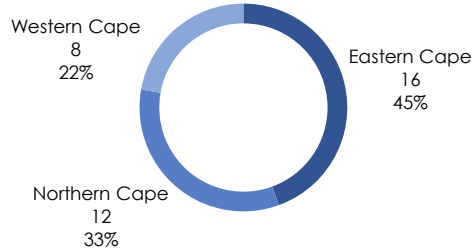
Share of wind capacity

Provincial distribution of capacity (MW)



Share of wind projects

Provincial distribution of projects (#)



Province	Provincial totals		Technology share	
			OW	Other RE
Eastern Cape	Number of projects	17	16	1
	Capacity procured (MW) ¹	1 509	1 440	70
	Capacity online (MW) ²	1 066	997	70
Northern Cape	Number of projects	59	12	47
	Capacity procured (MW) ¹	3 621	1 459	2 162
	Capacity online (MW) ²	2 125	664	1 460
Western Cape	Number of projects	14	8	6
	Capacity procured (MW) ¹	606	467	139
	Capacity online (MW) ²	452	319	134
Other Provinces	Number of projects	22	0	22
	Capacity procured (MW) ¹	685	0	685
	Capacity online (MW) ²	332	0	332

Note 1. 16 of 17 BW3 projects and 1 of 2 BW3.5 projects (the remainder have not yet signed), 1S2 and 2S2 projects have not yet signed.

Note 2. Excluding projects in early operations.

OW – Onshore Wind, Other RE includes PV – Photovoltaic, BM – Biomass, LG – Landfill Gas, SH – Small Hydro, CS – Concentrated Solar

Glossary of icons

These icons are used in the document to represent the following concepts:

ENERGY (P50)



Energy (kWh, MWh or GWh) production / generation projected with a 50% probability that it will be achievable for the established capacity

CAPACITY



Generation capacity (kW, MW or GW) i.e. the rated output capability of the power plants



Investment



Job creation

Renewable energy source | technology type:

SOLAR



Solar CSP
(Concentrated Solar Power)



Solar PV
(photovoltaic)

WIND



Wind generation

HYDRO



Small hydro

BIO



Biomass

WASTE



Landfill gas / waste to energy

Colour convention used [RGB]

Colours used to denote technologies



Solar PV [220 | 89 | 36]



CSP [245 | 149 | 1]



Wind [82 | 109 | 176]



Landfill, hydro, biomass, biogas
(when treated as a group e.g. IRP)
[209 | 40 | 46]



Hydro [151 | 167 | 208]



Landfill [152 | 154 | 172]



Biogas [180 | 179 | 146]



Biomass [155 | 187 | 89]

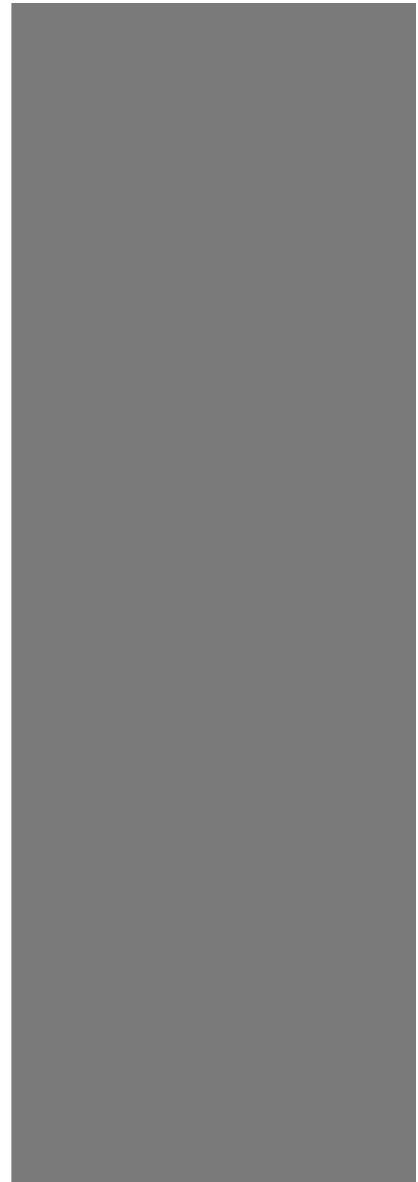
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