The South African Antarctic Wind Energy Programme

SAAWEP - Towards Sustainable Research

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SANAP

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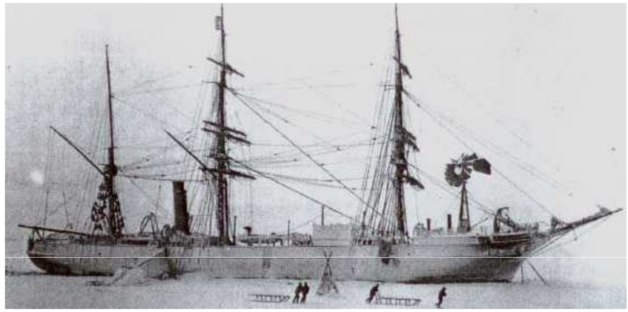
The beginning

- Utilising wind energy in Antarctica no novelty

- 1902 – Cpt. Scott onboard the Discovery
- 1959/60 – SANAE I base
- 1987 – Neumayer II base (GER)
- 2003 – Mawson base (AUS)
- 2007 – SANAE IV
- 2008 – Princess Elizabeth base (BE)
- 2009 – SANAE IV





Today

- An estimated total installed capacity of 1 MW
- Wind power penetration ratio: 100 %
- Largest wind farm: 660 kW
- 2010/2012 projects:

  - SANAE IV base adding 30 kW

  - Scott base (NL): 3 x 330 kW

  - Neumayer III adding 60 kW

Enercon 330 KW

Why a SAAWEP?

- The programme initiated by Dept. Electrical and Electronic Engineering, EML, commenced in 2007

- Funded by NRF and SANAP, managed by EML

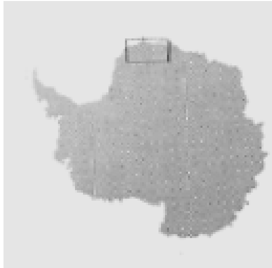
- A need driven by:
  - increasing fuel prices
  - reduction of green house gas emissions
  - fuel spillages
  - fossil fuel dependency
  - sustainable research
  - favourable wind conditions: 10 kW wind turbine may save 9800 L/a

Why a SAAWEP?

- Aim: To promote engineering research, to develop and to implement wind energy conversion technologies at SANAE IV and in South Africa

- Engineering research: materials, structural, transport and commissioning, snow accumulation, system control, etc.
- Development: Design, manufacture, laboratory tests, full scale testing, etc.
- Implement: Environmental impact, cargo, training, construction, performance evaluation, etc.
- Promote: http://research.ee.sun.ac.za/sanap

SANAE IV – The challenges



- The site

  (ice, snow and rocky)

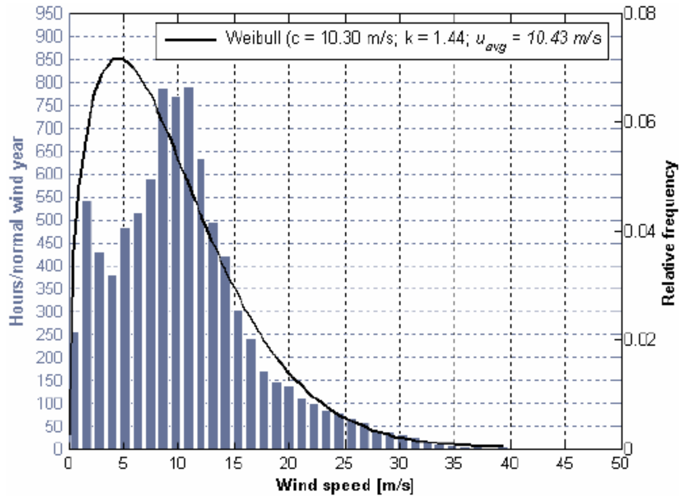
- High winds

  (average 10 m/s;

  max. 223 km/h @ 10 m AGL)

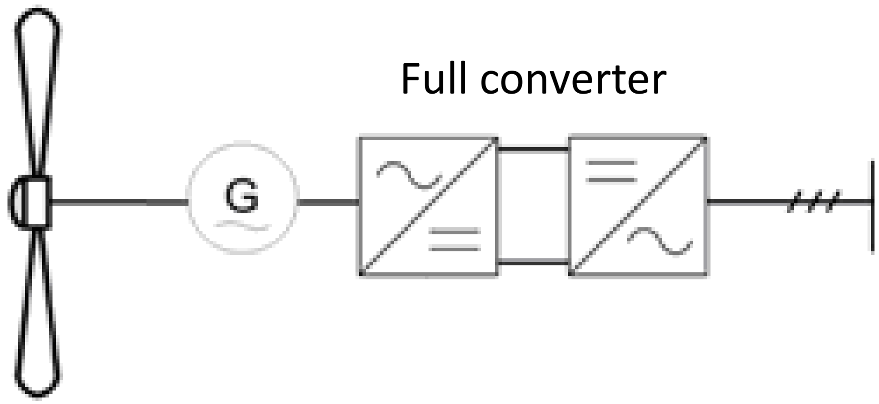
- Low temperatures

  (average -16 °C)



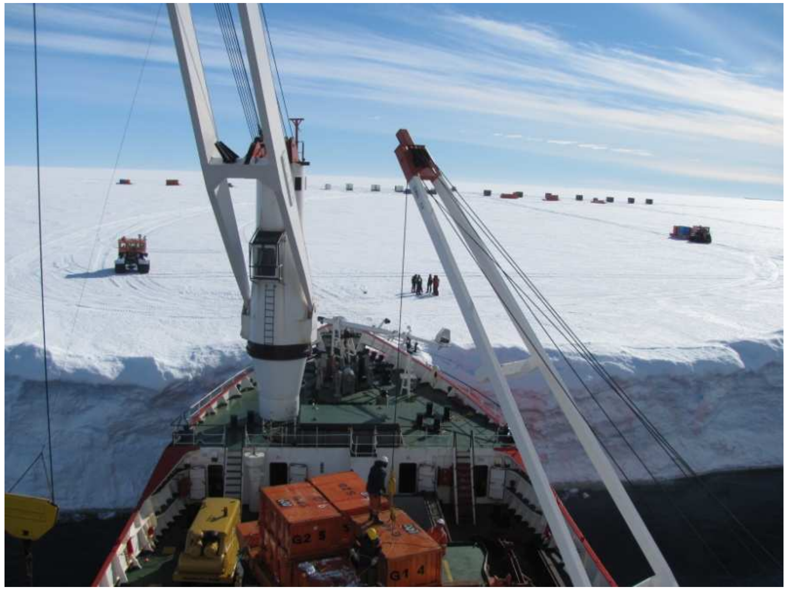
SANAE IV – The challenges

- SANAE IV power system: diesel fuelled multi-generator system supplying: **electricity**, **heat** and **water**
- Weak remote grid – voltage stability and frequency
- Wind and turbine integration



SANAE IV – The challenges

- Logistical and equipment constraints:
  - containers and transport
  - weight
  - limited construction methods e.g. crane size
  - limited site access



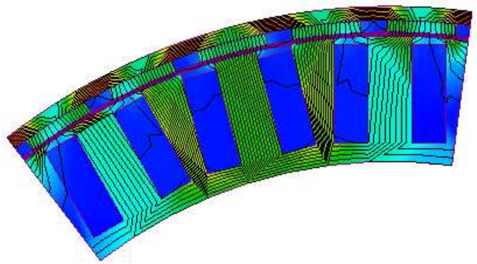
Wind turbine technology

- Distinguishing design properties:
  - Robustness
  - Minimum maintenance/lubricant dependent components
  - Standard components
  - Component material selection

- SANAE IV wind turbines:
  - Simplistic control/operation
  - Optimised direct drive PM generator technology
  - Exploring new direct drive, direct grid coupled technologies

Wind turbine technology

Electromagnetic design



- Electrical design
  - PM generator directly coupled, no gearbox
  - Magnets NdFeB
  - Integration: 3ph 400VAC, full converter

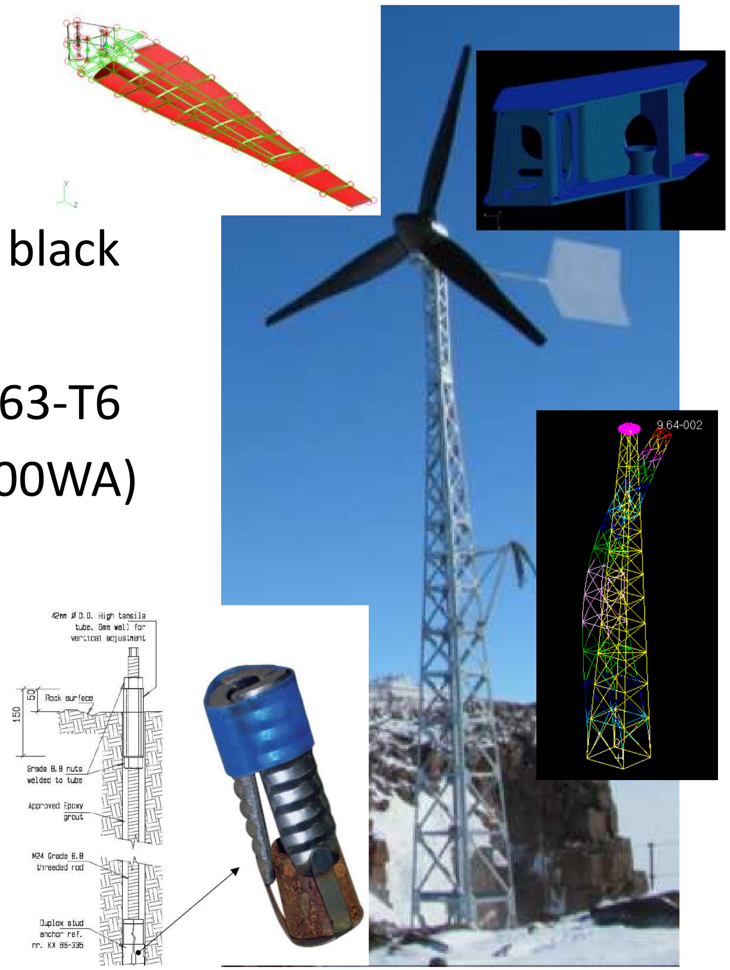
Generator rotor

Stator

Converter

Wind turbine technology

- Mechanical design
- Wind turbine:
  - Blades and nose cone: 3.6 m, GFRP, 70 m/s, black
  - Nacelle: Steel SABS 300WA
  - Tail: Steel SABS 300WA, aluminium SABS 6063-T6
  - Tower: 12 m, tilting, free-standing lattice (300WA)
  - Survival: 70 m/s and -40 °C to +20 °C



- Foundation:
  - Base plate anchored with rock bolts

Wind turbine technology

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- Control design

  - operation: 15 kW, 4 m/s to 12 m/s @ 12 m AGL

  - Rotor speed and power control: combined RC braking (electrical), furling and stalling (mechanical)

  - Yaw: passively with tail

  - Power quality and integration: maximum power tracking (anemometer) and converter

SAAWEP future

- New generator technology development
- Mechanical design optimisation to fit electrical design constraints - manufacturing time and costs
- Up scaling: 15 kW → 50 kW wind turbines
- Grid studies
- Possible expansion to Southern Ocean Islands

Conclusion

- Utilising wind energy in Antarctic is increasing
- Every project has unique challenges e.g. foundations
- The SAAWEP needs Mechanical Engineers
- SAAWEP expansions:

  - consulting

  - Southern Ocean Islands

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