Wind Atlas for South Africa (WASA)

A position report on:
Wind Energy Education at University Level
in South Africa
Insights from the 2016 Windaba workshop 2nd & 3rd November

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1. Introduction and scope of workshop

A one-and-a-half day workshop, as a product of the Wind Atlas for South Africa (WASA) project (http://www.wasaproject.info) and in support of the South African Renewable Energy Technology Centre (SARETEC), was held on 2nd and 3rd November 2016 at the Windaba 2016 conference in Cape Town, South Africa. The workshop was funded through the Danish Support to Renewable Energy Development at the Dept. of Energy. The aim of the workshop was to demonstrate how the results of the WASA can be used in tertiary (university-level) education, as part of a wider course on wind energy (or renewable energy in general) for students with an engineering or natural science background.

The workshop was entitled "Wind Energy Education at Universities in SA workshop". The full programme is given in Appendix C but the main sessions were:

- Wind Energy Training Overview
- WASA example in Wind Energy Education
- Teaching wind resources, wind energy planning and projects
- Data and materials for teaching
- WASA in university teaching – case studies
- Role of university education in the renewable energy future

The number of attendees at any one session varied as people moved between the conference and the workshop, but for most of the sessions there were approximately 20-25 people in attendance.

This report gives the status of wind energy education at university level in South Africa based on the experiences and knowledge expressed at the workshop. Additional input is given by DTU Wind Energy based on their experience, particularly with the Wind Energy Masters course.

2. Status: wind energy education in South Africa

Currently, besides wind energy courses as limited parts of graduate and post graduate studies, there are no formal and dedicated wind energy education bachelor degree and higher (National Qualifications Framework NQF level 7 and higher) in South Africa. The exceptions are the SARETEC technology centre which focusses on NQF 5+, and the DST Wind Spoke (Stellenbosch and Cape Town Universities) focussing on post graduate research. According to the South African Qualifications Authority (SAQA http://www.saqa.org.za) for NQF levels 7 and 8 (bachelors and honours) the Quality Council for Trades and Occupations (QCTO) can motivate for a qualification only in collaboration with a recognised professional body and the Council on Higher Education, in a process co-ordinated by SAQA.
From the presentations given and the attendees at the Windaba workshop the following activities were reported:

**Stellenbosch University:** Holds a 1-week course on the general aspects of wind energy, turbine technology and wind farm projects. Furthermore:

- The Centre for Renewable and Sustainable Energy Studies was established in 2007 to facilitate and stimulate activities in renewable energy study and research at Stellenbosch University.
- The Department of Science and Technology has been funding the Renewable and Sustainable Energy (RSE) Hub at Stellenbosch University since its establishment in August 2006. The aims of the RSE Hub are to develop human capital, deepen knowledge, and stimulate innovation and enterprise in the field of RSE. Currently the DST is still sponsoring the work of the Centre with an annual grant administrated by the National Research Foundation.
- Stellenbosch University was designated as the Specialisation Centre in Renewable Energy Technology as part of the Eskom Power Plant Engineering Institute (EPPEI). The research and teaching activities sponsored by Eskom focus on concentrating solar power (CSP) and wind energy and also includes the Eskom Chair in Concentrating Solar Power.
- The Sasol Technology group sponsored the new facilities for the Centre for Renewable and Sustainable Energy Studies as well as the work and facilities of the Solar Thermal Energy Research Group at Stellenbosch University.

**Nelson Mandela Metropolitan University (NMMU):** Gives short courses (1 week) similar to Stellenbosch that cover, in brief, all aspects of wind energy. The university also offers a Higher Level Certificate in Renewable Energy (entry after matriculation).

**University of Cape Town (UCT):** Wind Energy education at the Climate System Analysis Group at UCT is mainly carried out within masters and PhD projects. Wind energy education is also included, but not addressed by specific courses or programmes, at the Energy Research Centre (ERC) at UCT (quote from presentation: “The ERC is South Africa’s foremost energy research institution working at the intersection of energy and the environment. We are a multi-disciplinary centre that draws from skills sets as diverse as engineering, economics, history, statistics, political studies, and physics.”)

The ERC has two Masters programmes:

- M.Sc. (Eng) in Sustainable Energy Engineering
- M.Phil. in Energy & Development Studies:
  - New & Renewable Energy Technologies
  - Energy systems analysis and planning
  - Climate change
  - Energy, poverty and development
  - Markets and governance
3. Status: wind energy education at the Technical University of Denmark (DTU)

As a university department, DTU Wind Energy offers a broad range of courses on wind energy from bachelor level, to masters, PhD and continuing education (on commercial terms). These have been developed over a number of years, and have grown from a number of individual courses as the interest from students has increased. With the exception of the latest development, an online e-learning masters course, they have not been in response to requests from industry but rather from the identification of future needs by experts in the research and education fields.

3.1 A brief outline of the DTU courses

*Individual courses at bachelor (B.Sc). level*
These include: an introduction to wind energy, manufacturing of advanced fibre composites, and the wind turbine racer (course and competition). These courses are taken by students as part of their broader education in an engineering discipline.

*Masters-level M.Sc. programs*
MSc in Wind Energy: This is a two-year masters programme dedicated only to wind energy, given by DTU Wind Energy in collaboration with DTU Electro. It is the flagship degree offered by the department and attracts many students from abroad. See section 0.

European Wind Energy Master (Erasmus Mundus): Students taking this carry out part of their studies at DTU and others at collaborating universities: TUDelft, UniOldenburg & NTNU.

Innovative Sustainable Energy Master (Nordic programme): Not dedicated to wind and in collaboration with KTH, Chalmers, Aalto and NTNU.

MSc in Sustainable Energy: A DTU education in collaboration with DTU Management Engineering with five specialisations – one of which is wind energy.

*PhD education and supervision*
The department offers 10-15 PhDs each year covering all aspects of wind energy.

*Continuing education of professionals*
These courses are primarily aimed at users of the WAsP software who work for companies, many of them wind farm developers.

*E-learning courses*
DTU Wind Energy also offers an online WAsP and HAWC courses and a Coursera MOOC course on general wind energy.

*Future digital e-learning masters in wind energy (over 2 years)*
This masters-level course will be run for the first time in autumn 2017 and is designed for distance learning by people in industry.

3.2 MSc in Wind Energy

The MSc in Wind Energy is built up around a core of compulsory courses, a selection of elective courses and a project. All courses are given in English and the programme attracts around 30 to 60 students a year and over 90% of the students are from outside Denmark. Statistically, about 40% find employment in private companies in Denmark, 35% in private companies outside Denmark, and 25% in academia around the world.

An overview of the courses is given below:

1st Semester
- Wind turbine technology
- Aerodynamics & aeroelasticity
- Measurement techniques

2nd & 3rd Semesters
- Aerodynamics and fluid mechanics
- Structural mechanics
- Construction and materials
- Power electronics & grid connection
- Control and regulation
- Prognostics and optimization
- Wind resources & loads on wind turbines
- Projects in aeroelasticity
- Planning & development of wind farms

MSc Thesis
- Often in collaboration with industry

3.3 Course in “Planning and development of wind farms”

The course, “Planning and development of wind farms” takes the student through the exercises necessary as if they were a wind farm developer, developing a feasibility study of a project to establish a wind farm. During the course, the students carry out their own desk-top case study of a wind farm project, producing both a report and a presentation of their project.

This course has particular and immediate relevance to the South African situation because:
- It uses directly the data from the WASA project both in educational examples for wind resource analysis and by students who choose to make their case study in South Africa.
- It provides the skills and knowledge for making wind resource assessments: these are activities that are well suited for local experts to carry out.
• Feasibility studies are also an area where local expertise is so beneficial that, with the right training, South African personnel are preferable to using foreign experts.
• As a part of the course outside experts, especially from wind farm developers, are invited in to give guest lectures. This gives the students confidence that the course is practically relevant to employment. The current activity in South Africa lends itself very well to being able to host such guest lectures.
• The students are taken on a study tour where a visit is made to a wind farm and they learn about its development and operation from the developer and/or the owner. With wind farms being established in South Africa there is plenty of opportunity for this to be a part of a South African course.

This course is further described in Appendix B.

3.4 A brief account of how the DTU masters course was formed

The Wind Energy MSc
The initiative for this course was taken by a staff member of the university, Jens Nørkær Sørensen, in 2001 and was a programme that was a collaboration between two university institutes: DTU Mechanical Engineering\(^1\) and DTU Electrical Engineering. A survey was carried out of the Danish industry's requirements and attitude towards such an education, with the result that industry did not see a need for a dedicated masters level course specifically on wind energy. The prevailing approach was that the industry was satisfied with employing graduates from the traditional disciplines (engineering disciplines such as mechanical, electrical, control, etc.) and that any specialisations they needed for wind energy would be undertaken by themselves. Despite this reticence from the industry, Jens Nørkær considered that the need was actually there and decided to proceed with establishing the Wind Energy Masters programme, with the support from the university management. However, due to the sensitivity of the result of the industry survey, it was considered that the course should have a special status and only be open to foreign students. The course language was therefore English and it continued to be closed for Danish students until 2005, when it was opened up for domestic applicants as well as foreign. The programme itself was built up around many of the existing courses already available at that time in DTU with only one dedicated course being created that was specific to wind energy. Over time, the curriculum has developed with wind specific courses, for instance the Wind Farm Planning and Development course that was introduced in 2007. This course, in turn, despite being created especially for the Wind Energy Masters attracts students from other masters-level educations, particularly the Sustainable Energy masters. This demonstrates the modular approach that DTU has, which enables a widespread use of the courses that are set up, ensuring an effective use of the resources employed.

The history of the Wind Energy Masters is a good illustration of the different time horizons between industry and university. The statistics show that a significant proportion of graduates from the masters are now employed by the industry, which demonstrates the value of having a

\(^1\) Jens Nørkær and his colleagues became part of the DTU institute of Wind Energy in 2009 and the masters programme now resides in DTU Wind Energy.
university system that is able to take a longer-term view than industry, and cater for the educational needs of society five or ten years ahead.

Other courses
The courses to train users of the WAsP program were developed by DTU Wind Energy and are given both in Denmark and around the world. WAsP Certification as a recognised achievement of a standard competence was introduced in about 2000 at the request of industry. The training courses were then adapted to an online format in 2013. As a result of the experience with the WAsP course online, the Coursera MOOC series of courses was developed in 2015, with development of the online Masters in Wind Energy starting in 2016.

4. South African employment target group(s) for universities

This section addresses what positions/areas/responsibilities universities are educating people for, where the “pull” for education is coming from, that is, what the needs are of employment sectors for graduates educated in aspects of wind energy.

4.1 Wind turbine manufacturing

At the workshop, there was much discussion about building a South African multi-MW turbine, as a forerunner to manufacturing such a turbine to create an industry for local employment. This is considered useful as a challenge, an exercise and a project but it is not realistic that a competitive industry can be built up in the timespan needed. The challenge for creating a domestic industry in wind turbine manufacturing is that South Africa "jumped in at the deep end" without the grass-roots growth in turbine manufacturing that there was in Denmark and Germany.

There could, of course, be a part to be played by South African industry as sub-suppliers of components to wind turbine suppliers but statements were made about the – perceived or otherwise – inferior quality and/or lack of track record of wind technology manufacturing in SA. Turbine manufacturers prefer to source their components from established OEMs in Europe and elsewhere. Localisation through the REIPPPP provides the biggest pull for wind energy technology manufacturing in South Africa and while currently the manufacturing of towers and foundations are sourced locally with further stimulus (e.g. with security of a guaranteed production run of e.g. 600 or more units, including blades nacelle/components) foreign OEMs could be tempted to invest. Also with Government support through e.g. DST TLIU for local manufacturing at OEM standard and certification, the Government could "exert more pressure" for OEMs to source from local wind energy technology manufacturing with the required OEM quality and certification. An important pre-requisite for any local manufacturing (component or turbine) would be the availability of the necessary testing and certification competencies at a South African level with international recognition.

It was therefore proposed better to concentrate on design, manufacturing of smaller turbines and their application. Need for an “African solution” to manufacturing industry: focus on e.g. 300 kW - 750kW size (e.g. Adventure Power http://www.adventurepower.co.za/products.php) which have the potential to be sited places where a 3MW machine cannot due to logistical reasons etc.
There are signs that some OEMs are looking at trying to move more manufacturing locally. There is the example of the Vestas Babylon wind turbine: part of the reason for using four small turbines on one tower is that it is more likely this size of turbine could have a higher local content than the single 2-4 MW machines.

The establishment of a test site for turbines could provide incentives for more turbine manufacturers to carry out more local activity.

### 4.2 Wind resource assessment

This provides a definite opportunity for South African expertise, as this needs to be (partially) carried out locally, with a physical site review, topographical inputs, etc. In this regard, the WASA team presented “A training course in applying the products of the WASA project” (see presentation 3.1) at the workshop. The course material has been put together for trainers, planners, government employees and students of wind energy. It is not intended to be a wind resource assessment course, but it is for everyone who wants to know what a wind atlas is and how, where and when to properly make use of it. It can also be used as a basis for curriculum development of a holistic course on wind resource assessment and the importance of a wind atlas in the value chain.

### 4.3 Transmission system operator

The operation and expansion of the transmission system needs wind-trained electrical engineers and planners. The importance of integration into the grid must not be forgotten when looking at the needs for university level education. There was a general question posed at the workshop about the type of graduates that ESKOM should be employing for the future.

### 4.4 Wind farm developers

Wind farm developers require some degree-level skills. Anecdotal evidence indicates that those jobs that do open up are awarded to European candidates, because they have more relevant qualifications. A suggestion was made, similar to local content requirement, that a requirement could be made in the DOE REIPPPP for the technical “project development” work to done with the involvement of South Africans that could create the “pull” for wind energy graduates.

### 4.5 DoE REIPPPP Socio-Economic Development

It is expected that the government (Department of Energy, Department of Trade and Industry, etc.) will focus more and more on the REIPPPP and expect sustainable development spin-offs. It therefore makes sense for the industry to invest in, and acquire, the relevant technical skilled resources to assist with their SED community investment through development projects. This could certainly create a ‘pull’ for graduates with these skills.
5. Further information required

There did not appear to be an overview of exactly what wind energy education activities there were at South African Universities. Therefore, there should be a survey of activities so that opportunities and deficiencies can be identified. In addition, it will be beneficial to obtain an idea where different institutions can work together or complement one another, as wind energy studies cover a wide spectrum, from wind resource assessment, wind farm planning, wind turbine technology and finally integration of wind energy into the existing energy grid. It might be possible that some institutions have the potential to become centres of excellence in one or more aspects of wind energy and other institutions in other aspects.

In parallel, there should be a survey of potential job opportunities and sector needs so that more informed decisions can be made concerning the direction of university level education in South Africa.

6. Possible actions and recommendations

It seems unlikely that without activation of the “pull” factors that universities by themselves will undertake to provide bachelor/master degrees in wind energy. It is also considered that at this time, developing a dedicated master degree in wind energy is not appropriate. Furthermore, careful consideration is needed of the resources needed to implement ideas as it is clear that universities in South Africa are already under strain from a lack of resources.

Overall, SARETEC is ideally suited for and should concentrate on technician-level training as there is a clear need for these skills locally and this is what the organisation has been set up to do. Universities, on the other hand, are best suited for graduate and higher level wind energy education.

At the WindAc 2106 conference, there seemed to be an assumption that university research should be dictated by the industry needs, however, it should be remembered that university research should also look at a different time-horizon than industry-lead research as well as next generation innovation.

The following actions and recommendations, however, are suggested to provide the next steps for the universities in South Africa who have the desire and competencies to further their efforts within this area. It is recommended that these are taken up at the national level, to obtain political buy-in and support, rather than individual universities taking action on their own.

a) An exchange of students at masters’ level between Denmark and South Africa would provide a relatively straightforward means of gaining university experience. An investigation of possible exchange programmes should be made.
b) Short courses could be held, particularly ones that deal with wind energy at the implementation level. The DTU “Wind farm planning and development” course would appear very appropriate in this respect.

c) A promotion of eLearning courses should be made, as these require a minimum of additional resources.

d) A series of “Train the trainers” courses could be made that will provide inspiration to South African university lecturers and create a forum for developing education to suit the future needs.

e) South Africa needs to have more international co-operation at the university level, both within education but also within research.

f) There is a need to find out just what the requirements of the industry are and for this purpose, there needs to be engagement with industry at government level.

g) For Honours and Masters levels then the “Wind Spoke” UCT and Stellenbosch should be the starting point, through DST at the national level, as a place to anchor the next developments.

h) Due to the status of development in South Africa, the immediate requirement is for generalists, rather than specialists. Therefore education should focus on a “complete” package aimed at practitioners, from wind resource assessment through to grid integration, rather than research-level detail.

7. Conclusions

South Africa is undergoing an unprecedented growth in wind power capacity installation. There appears to be a political will to continue on such a path to “greening” the South African power system. Likewise, there is great drive and enthusiasm at South African universities to play their part in this. The question is, what part is most suitable to play?

The drive to expand wind turbine design at South African universities should be encouraged as an example of the application of engineering science, but it seems unlikely and currently inappropriate to expect to focus on education suitable for domestic wind turbine manufacturing. Instead, the need is more for education in the planning, project feasibility and implementation arenas, as these are where domestic knowledge is essential and also an area where, anecdotally at least, it seems that developers are needlessly using foreign resources.

Furthermore, the overall picture obtained through the Windaba 2016 workshop was that there is a need for more co-ordination and co-operation between the universities in South Africa, so that core competencies can be exploited. This needs to be done in parallel with a meaningful interaction with industry to both discover and foster the domestic needs. Both these activities require action at the national level.
A. Workshop attendees

Significant contributors to educational discussions:
Sean Poulsen, PhD student, Nelson Mandela Metropolitan University
Johan de Koker, University of Johannesburg
Daniël Struwig, project engineer, Wind Prospect Africa

Other attendees were from:
Lesotho University
SARETEC
Global SA Management
ENS
DTU
Darling Wind Farm
CUT (electrical engineering)
West Coast 1 wind farm
CSIR
Stellenbosch University
CPUT – renewable energy
Legal advisor from Vestas
Journalist
University of Johannesburg
B. DTU’s Planning and development of wind farms

General description of the course

The DTU course “Planning and Development of Wind Farms” takes place over a three week period, where students are encouraged to participate each day. The first week is taken up with lectures in a traditional format interspersed with exercises and tutorial sessions. The session on societal aspects takes a different format with students taking part in a role play exercise. During the second and third weeks, the students form teams of three or four and apply what they have learnt in the first week to a form of feasibility study for a specific wind farm project. This exercise is intentionally designed to reflect the process a wind farm developer uses to assess the feasibility of a potential wind farm location.

The students are evaluated using three techniques:
- A report delivered by each team on the wind farm project of their choice
- A presentation made by the group and given in front of a panel of examiners and their peers
- A written exam, consisting of twelve questions covering the whole course. The time allowed is one hour.

The general course objectives are: “The student is provided an overview of the steps in the planning and management of the development phase of a new wind farm. The student is introduced to wind resource assessment and siting, wind farm economics and support mechanisms for wind energy. An overview over the various environmental impacts from wind farms is offered.

The course is a general competence course in the study plan for M.Sc. in Wind Energy.”

The course is based around the five cornerstones of wind farm project development:
- Wind resource
- Environment and public acceptance
- Grid connection
- Project economy
- Political support

Resources

The taught part of the course is based on the above five topics, with a heavy emphasis on the wind resource analysis. The course is taught by three main lecturers from DTU Wind Energy, with a few individual sessions being taken by outside speakers from industry. For a course of 80 students, three assistants are also employed who are generally students who have previously taken the course and who have shown a good aptitude for not only the course but also for understanding the challenges of teaching. Further use of additional resources (e.g. PhD students) may be used to grade the exams and the students’ reports.
**Group work**

The group work in the project is a fundamental component for both pedagogical reasons and for giving students a flavour of the manner of work a developer undertakes. The group work entails carrying out a desk-top feasibility study of a potential wind farm project that the group chooses themselves. A necessary part of this is the wind resource analysis and thus wind measurement data should be available. DTU Wind Energy has a database of wind data from sites around the world that is made available to the students. The Wind Atlas for South Africa database is perfectly suited to this manner of project and each year a handful of groups choose to make their project based in South Africa. South Africa also has the advantage that the working language is English and thus there is a lot of useful documentation (e.g. completed environmental impact assessments) available on the internet.

The quality of the students’ reports is generally high: the best would be very suitable pre-feasibility studies from actual developers. An example of presentation slides from a group is shown below.

**Site visit**

A visit to a wind farm is made during the course which provides the students with the opportunity to not only see some wind turbines but also to learn about the specifics of a particular project. The wind farm visited differs from year to year but always includes some presentations by particular stakeholders in the project. The project developer gives a talk about the planning and development process of the wind farm and highlights some of the challenges faced. In addition to this, other stakeholders are also invited to make presentations, and examples are: the wind farm owner, the local planning authority, O&M maintenance companies, environmental consultants and specialists in noise measurements. All these aspects combine together with the site visit to give the student an experience that shows that what they learn on the course has very practical applications.

**Plan of the course**

An example of the plan of the first week of the course, taken from 2017, is shown below.
# 46200 Course plan 1st week, 2 – 6 January 2017

**Venue:** DTU Lyngby, Building 306, Aud 31

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<th>Time</th>
<th>Monday</th>
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<tr>
<td>10:00 - 11:15 EIA4 Wind turbine noise. Bo Søndergaard, SWECO</td>
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C. Programme for workshop.

Wind Energy Education at Universities in SA workshop

A product of the Wind Atlas for South Africa (WASA) project
in collaboration with the South African Renewable Energy
Technology Centre (SARETEC)

2 - 3 November 2016
Room: 2.64 – 2.66,
Cape Town International Convention Centre, CTICC.
Co-Located with Windaba 2016

The WASA project drivers and partners

The project is an initiative of the South African Government – Department of Energy – and co-funded by:
- UNDP-GEF through the South African Wind Energy Programme (SAWEP)
- Royal Danish Embassy

Project Steering Committee:
- DoE (chair), DEA, DST, UNDP, Danish Embassy, SANEDI

Executed by:
- The South African National Energy Development Institute (SANEDI)

Implemented by:
- CSIR, UCT, SAWS, and DTU Wind Energy (formerly Riso DTU)
Programme – Wednesday afternoon

Wednesday 2 Nov 2016, 14:00-15:30
Registration, tea/coffee

Opening address

1. Wind Energy Training Overview
   1. Wind Energy Training and Education at SARETEC
   2. Wind Energy Education at DTU, Denmark
   3. Wind Energy Education at UCT, South Africa
   4. Wind Energy Education at Stellenbosch University, South Africa

Wednesday 2 Nov 2016, 16:00-17:30

2. WASA example in Wind Energy Education
   1. What is a wind atlas and where does it fit into the wind energy sector?
   2. How a state-of-the-art wind atlas is made: the example of the Wind Atlas for South Africa
   3. How an extreme wind atlas is made

Programme – Thursday morning

Thursday 3 Nov 2016, 09:00-10:30

3. Teaching wind resources, wind energy planning and projects
   1. Presentation of "A training course in applying the products of the WASA project"
      • Principles of wind resource analysis
      • Measurements and modelling on several scales
      • Wind Farm Planning and Development
   2. Experiences, best practice, pitfalls, challenges

Thursday 3 Nov 2016, 10:30-11:00

4. Data and materials for teaching
   1. The WASA project: how to access the data
   2. Public domain resources
   3. DTU Wind Energy resources
Programme – Thursday (continued)

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<td>5. WASA in university teaching – case studies</td>
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<td>1. How UCT is using the WASA for teaching</td>
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<td>2. Examples of using WASA in education: Students’ case studies</td>
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<td>3. Exemples of using WASA in education: Master thesis</td>
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<td>4. Other case studies from South Africa</td>
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<td>6. Role of university education in the renewable energy future</td>
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<tr>
<td>1. Position report on educational possibilities for wind energy in South Africa</td>
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<td>2. Feedback and discussion</td>
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<td>3. The way forward</td>
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Closing address

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<th>Thursday 3 Nov 2016, 16:00-17:30</th>
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<td>6. Role of university education for wind power ... cont’d</td>
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D. Workshop Presentations

List of the workshop presentations:

- Presentation 6.1 Position report and conclusion.pdf
- Presentation 5.2 - How DTU uses WASA for teaching Student example.pdf
- Presentation 5.1 - How UCT uses WASA for teaching.pdf
- Presentation 4.3 - DTU Wind Energy resources.pdf
- Presentation 4.2 - Public domain resources.pdf
- Presentation 4.1 - How to access the WASA data.pdf
- Presentation 3.2 - Experiences, best practice, pitfalls, challenges.pdf
- Presentation 3.1 - WASA Training Presentation Slides.pdf
- Presentation 2.3 - Extreme Wind Atlas.pdf
- Presentation 2.2 - State of the art wind atlas.pdf
- Presentation 2.1 - What is a wind atlas.pdf
- Presentation 1.4 - Wind energy education at Stellenbosch.pdf
- Presentation 1.3 - Wind Energy Education at UCT.pdf
- Presentation 1.2 - Wind Energy Education at DTU_Denmark.pdf
- Presentation 1.1 - Wind Energy Training at SARETEC.pdf
- 1 Introduction and programme.pdf

The workshop presentations can be accessed here:
http://www.wasaproject.info/docs/WASA_Training_Workshop_Presentations