Integrated Research Programme on Wind Energy

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Strategy roadmap open data access
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Definitions

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Contents

1. Executive summary

The report 'Strategy on access granting to data used in the IRPWIND and wind energy research projects in general' includes overview of the Open Access (OA) to data. This is one step further compared to open access publication. In EC FP7 open access publication was initiated (Clause 39 applied to several projects). Open access publication is now fully adopted in H2020. Open access publication is either in journals with only open access, in hybrid journals with both open access and paper version, and in non-open access journal but where Creative Commons allow publication in repository (maybe sometimes after embargo period). In fact, open access publication in repository also ensure copy of material if an open access publisher may stop.

The next step is open access data. Why go for an open access data strategy? There are two main reasons. 1) The research results published in journals should be possible to reproduce by other scientists. This is truly possible if relevant data used for a specific study can be shared at a certain level. 2) Another vital background for open access data is that when collection of data has been funded by public funding, either from the EC or several national funding bodies in the Member States, it is expected that data sharing will increase research and innovation potential, see Science 2.0 vision.

The present report is limited to wind energy research. The research institutes in IRPWIND focus on joint research among themselves and other research organisations as well as with the wind energy industries. One characteristic of wind energy is that there is strong business worldwide with rapid growth in recent three decades. The commercial aspects are clear and Intellectual Property a topic of high relevance. The roadmap on open data access strategy is for wind energy research.

EERA partners plan several actions to realize our ambition of being good role models such as to ensure a public list of available data sets through EERA, to support cross-cutting activity between the Sub-programs of EERA Joint Program to stimulate further data sharing and ensure relevant information on data bases and projects are exchanged. EERA also plan for the WindScanner Research Infrastructure Science2.0 within the next 1-2 years. WindScanner will provide novel data for research.

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1. Introduction/background

The IRPWIND will use existing data and will not do new, large measurements campaigns; hence the project relies on being granted access to measurements from other projects and have not included any cost of the data access in the budget. Instead i.e. budget for data assimilation and quality control (paramount for rational use of the data in benchmarking of numerical tools) is included. The partners strive for data to be open, but the granting of data access rests entirely with the owner (commercial entities, developing wind farms or manufacturers) of the data, which is a challenge to the overall objectives of the IPRWIND, which is to be an instrument to integrate the European wind energy community.

The IRPWIND will therefore develop a strategy on how to ensure better openness and access to data also for partners not having been previously involved in the specific projects. This will serve as a risk mitigation strategy. It will be investigated how to provide assistance in access (technics, procedure and legal) and assistance in understanding the provided data and the conditions under which these have been acquired. This strategy will be developed together with European industry, as the aim is to use the data to enforce European organizations with strong links to the European industry.

Data about wind turbines and wind energy consists of several key issues. Table 1.1 lists relevant topics in wind energy research. Figure 1.1 provides a simplified view of one turbine, yet many other aspects are relevant in wind energy studies as seen in Table 1.1 and data types in Table 1.2.

The data related to the various topics are very diverse, and often data from several topics are needed in combined form for a specific study.

Table 1.1. List of key topic in alphabetic order

- Cables, sub-stations and transformer
- Gear
- Generator
- Grid integration
- Hub
- Laboratory scaled investigation
- Meteorological conditions
- Nacelle
- Ocean conditions
- Rotor blades
- Soil conditions
- Substructure
- Terrain
- Tower
- Wind farm layout
- Wind tunnel

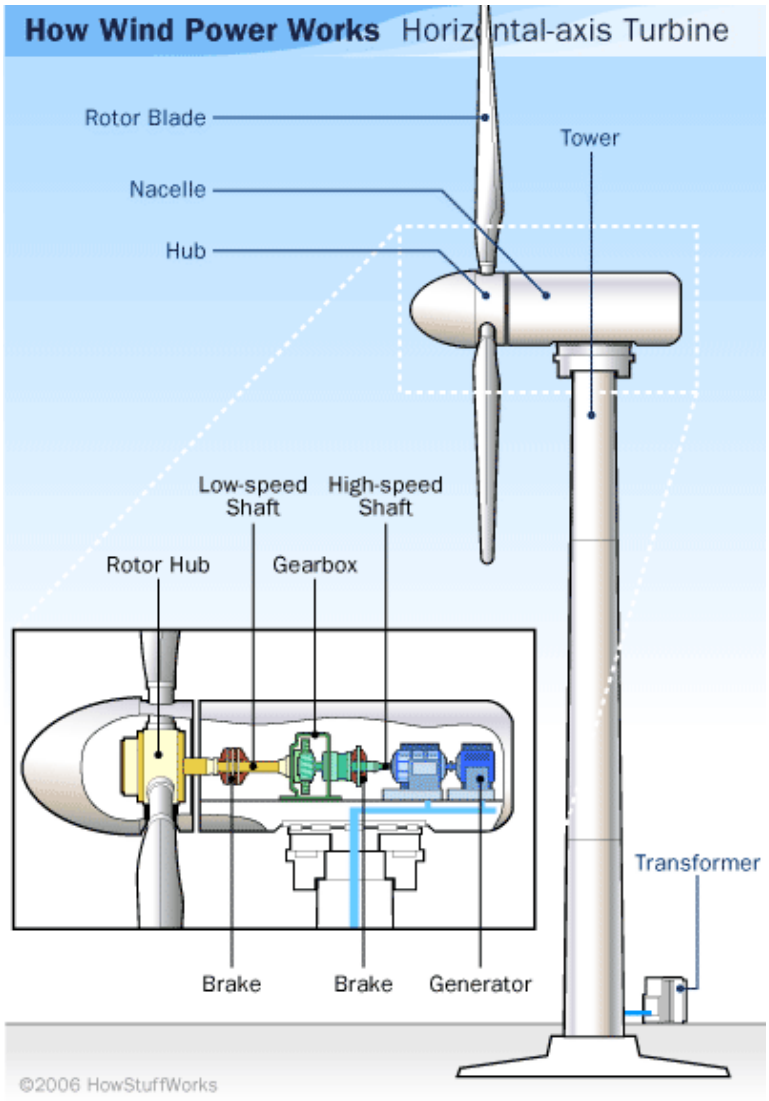


Figure 1.1 Simplified wind turbine. From HowStuffWorks 2006.

Table 1.2. Data related to wind turbines and wind energy

- Measurement data types (examples)
- Environmental data (wind, wave, current)
- Blade loads
- Torque, rpm, etc. in mechanical drivetrain
- Motions and loads on mechanical structure
- Operational data (status signals, rotational speed, pitch angle, yaw, power output etc.)
- Tension in mooring lines
- Voltage and current waveforms in electrical drivetrain (generator, converter, transformer) and at point of connection
- Time-series length and resolution
- Design data / Generic models

2. Motivation for scientists, industry and stakeholders

The need for open access of data has been a debated issue for long time. However, now is becoming actual due to recent EU Policy on data sharing motivation for open data access origins from the recent EC policy on data sharing.

The communication *'Towards better access to scientific information', COM(2012)401* states that The Commission will adopt establish open access to scientific publications as a general principle for all EU funded research projects in Horizon 2020. For research data the EC will develop a flexible approach that takes into account different scientific areas and business related interests. The Commission will continue to fund projects related to open access.

The European Commission's vision is that information already paid for by the public purse should not be paid for again each time it is accessed or used, and that it should benefit European companies and citizens to the full.

In other words, the method for optimising the impact of publicly-funded scientific research at European level (FP7 & Horizon 2020) and at Member State level is expected to occur through open access. The expected benefits are better and more efficient science (for the *Science 2.0* concept please see http://ec.europa.eu/research/consultations/science-2.0/background.pdf increase economic growth for the so-called *Innovation Union* (please see http://ec.europa.eu/research/innovation-union/index_en.cfm for details) and to achieve broader, faster, more transparent and equal access for the benefit of researchers, industry and citizens (please see the *Responsible Research and Innovation* (http://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation)). This is expected to benefit the European Research Area and beyond.

For wind energy the open data access may

- progress wind energy science faster accelerating the process from to market
- allow new scientific questions to be addressed
- reduce cost on data collection of some types of data
- increase collaboration between scientists and industry experts

Please note

- Science often has to be based on up to data
- Science always has to be based on robust, trustworthy, quality checked data

The traditional key performance indicator (KPI) for researchers is an index combining publication and citations (e.g. ISI H-index, Google Scholar index). Thus peer-reviewed publications in acknowledged journals are relevant. The Vancouver Protocol (see http://www.research.mq.edu.au/documents/policies/Vancouver.pdf) often is used to clarify co-authoring and other related topics to scientific publishing.

There is not similar tradition for recognition of research data available in database. Usually acknowledgements are provided about the data source in journal articles. There is no similar counterpart to the citation-index for (open) data.

3. Objectives and definitions

1.1 3.1 The Commission's objective

Modern research builds on extensive scientific dialogue and advances by improving earlier work. Moreover, the Europe 2020 strategy for a smart, sustainable and inclusive economy underlines the central role of knowledge and innovation in generating growth. Fuller and wider access to scientific publications and data therefore help to:

- build on previous research results (improved quality of results);
- foster collaboration and avoid duplication of effort (greater efficiency);
- accelerate innovation (faster to market = faster growth);
- involve citizens and society (improved transparency of the scientific process).

For these reasons, the European Union (EU) strives to improve access to scientific information and to boost the benefits of public investment in the research funded under the EU Framework Programme for Research and Innovation Horizon 2020.

3.2 Definition of Open Access (OA)

OA = online access at no charge to the user to peer-reviewed ***scientific publications*** and to ***research data***. Figure 3.1 shows OA for publication and research data combined.

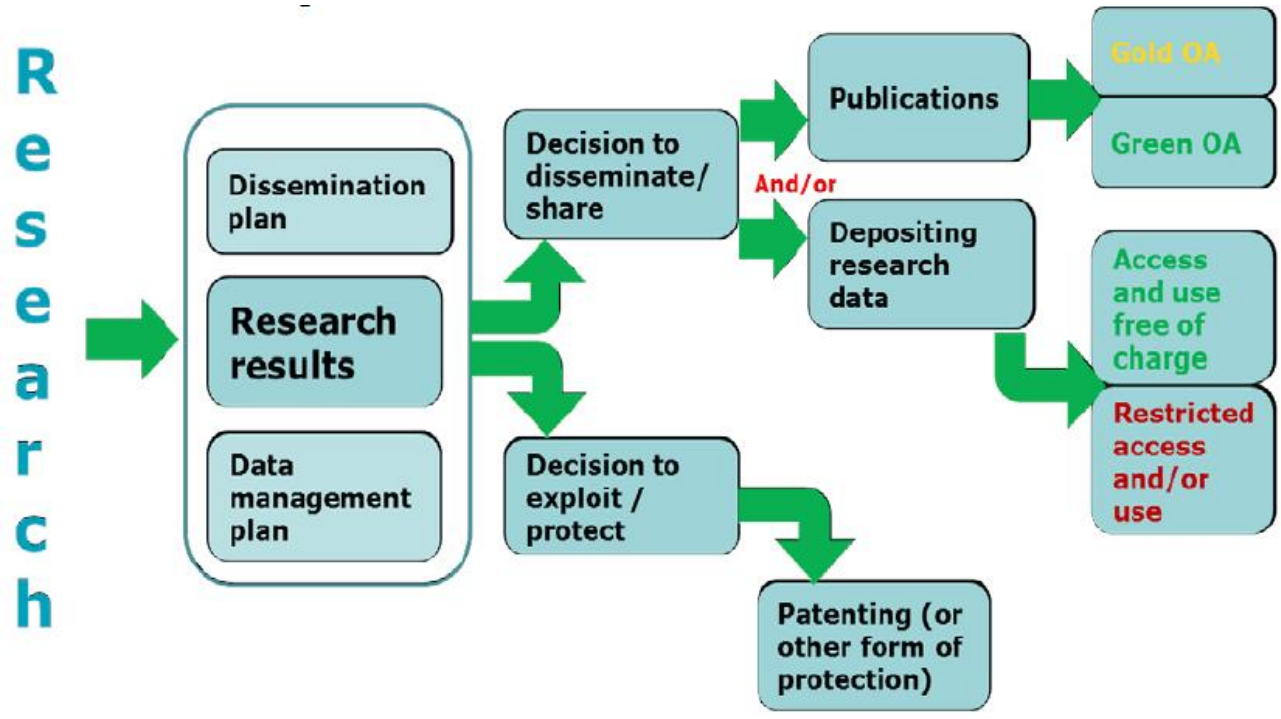


Figure 3.1 Graphic of Open Access for publication and research data. From http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-pilot-guide_en.pdf

There are two main ***OA scientific publishing*** business models:
1) Self-archiving: deposit of manuscripts & immediate/delayed OA provided by author ("Green OA")
2) OA publishing: costs covered & immediate OA provided by publisher ("Gold OA") e.g. 'Author-pay' model (APC) and others, e.g. sponsorship

Please note, OA is not an obligation to publish and OA is not at odds with patenting.

There are *not* two main ***OA research data*** business models!

This report focus on the roadmap on ***OA research data for wind energy.***

'Research data' refers to information, in particular facts or numbers, collected to be examined and considered as a basis for reasoning, discussion or calculation. In a research context, examples of data include statistics, results of experiments, measurements, observations resulting from fieldwork, survey results, interview recordings and images. The focus is on research data that is available in digital form.

Source
http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-pilot-guide_en.pdf

What is open data?

Openly accessible research data can typically be accessed, mined, exploited, reproduced and disseminated, free of charge for the user.

There are in the Guidelines on Open Access to Scientific Publications and Research Data in Horizon 2020 several topics addressed.

Questions to be considered

- What types and format of data will be created?
- How will the data be documented?
- Where will the data be stored?
  - Who is responsible for back-up?
  - How will access and security be controlled?
- What are the plans for preservation and reuse?

Furthermore, there is the Open Research Data Pilot in H2020. A novelty in Horizon 2020 is the Open Research Data Pilot which aims to improve and maximise access to and re-use of research data generated by projects. There is voluntary participation in the Pilot on Open Research Data. The Open Research Data Pilot applies to two types of data:

1) the data, including associated metadata, needed to validate the results presented in scientific publications as soon as possible;
2) other data, including associated metadata, as specified and within the deadlines laid down in the data management plan

http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-data-mgt_en.pdf.

Finally, the Commission has this recommendation to Member States. The Member States are encouraged to define policies for and implement:

- OA to publications
- OA to research data
- Preservation and re-use of scientific information
- E-infrastructures

It is advisable that the national activities have consistency between H2020 policy and MS policy through structured co-ordination of MS (National Points of Reference) at EU-level.

3.3 Data Management Plan

The Data Management Plan (DMP) has been introduced in the H2020 work programme as an instrument to promote open-access and open-data policies (Guidelines on Open Access to Scientific Publications and Research Data in Horizon 2020, version 1.0, 11 December 2013).
The pilot action on open access to research data defines open research data as those that can typically be accessed, mined, exploited, reproduced and disseminated free of charge for the user. The adoption of the H2020 open-data policies is regulated by the article 29.3 of the Model Grant Agreement.

A DMP describes how research data will be handled during the project and beyond.
'Data' includes the following types:

- the data, including associated metadata, needed to validate the results presented in scientific publications as soon as possible.
- other data, including associated metadata, as specified and within the deadlines laid down in the data management plan.

Research data should be: discoverable (identifiable by a Digital Object Identifier if possible), accessible (licensing terms), assessable and intelligible (ready for peer review), useable beyond the original purpose for which it was collected (preservation, documentation, accessing software included), interoperable to specific quality standards (facilitate exchange, compliant with available data processing software).

Open access to some research data may be excluded if this compromises the objectives of the project. Nevertheless the DMP should explain the reasons for not granting access to those data.

The first version of the DMP should be delivered in the first 6 months of the project. It is a live document that will be updated at least at mid-term and final reviews as more detailed information become available. New versions of the document will be released after major changes in datasets, changes in consortium data policies, etc.

Commission's Template

The Commission proposes an official template which should be adopted by the H2020 projects. The DMP should address the following items for each dataset and should reflect the current status of the consortium data policies:

Data set reference name
Identifier for the data set to be produced.

Data set description
Description of the data that will be collected or generated, its origin, nature and scale and to whom it could be useful, and whether it underpins a scientific publication. Information on the existence (or not) of similar data and the possibilities for integration and reuse.

Standards and metadata
Reference to existing suitable standards of the discipline. If these do not exist, an outline on how and what metadata will be created.

Data sharing
Description of how data will be shared, including access procedures, embargo periods (if any), outlines of technical mechanisms for dissemination and necessary software and other tools for enabling re-use, and definition of whether access will be widely open or restricted to specific groups. Identification of the repository where data will be stored, if already existing and identified, indicating in particular the type of repository (institutional, standard repository for the discipline, etc).

In case the dataset cannot be shared, the reasons for this should be mentioned (e.g. ethical, rules of personal data, intellectual property, commercial, privacy-related, security-related).
Archiving and preservation (including storage and backup)

Description of the procedures that will be put in place for long-term preservation of the data. Indication of how long the data should be preserved, what is its approximated end volume, what the associated costs are and how these are planned to be covered.

1.2 3. 4 OpenAIRE and OpenAIRE plus

OpenAIRE and OpenAIRE plus is new open access initiatives (Fig 3.2 shows website) https://www.openaire.eu/.

Fig. 3.2 OpenAIRE web-site.

1.3 3.5 IRPWIND and wind energy research in general

The strategy on access granting to data used in the IRPWIND and Wind Energy research projects in general is being formulated.

The plan is to develop strategy on data openness with data owners for technology advancement in IRPWIND and beyond, to assist in technical and legal issues, to describe data access procedures, to identify end-users and define data access levels in accordance.

Further, the possible development of 'model agreements' between data owners, IRPWIND and beyond will be investigated.

The present report includes a strategy roadmap.

4. Opportunities and challenges

The opportunities and challenges in applying OA for wind energy research data include legal, technical, economical and business aspects.

From the legal perspective one may use e.g. the EC Data Management Plan (DMP)

The purpose of DMP is to provide an analysis of main elements of the data management policy in a project. It will have to include information such as

- Data set reference and name
- Data set description
- Standards and metadata
- Data sharing
- If not to be shared could be due to ethical, rules of personal data, intellectual property, commercial, privacy-related, security-related
- Archiving and preservation
- Discoverable (e.g. DOI)
- Accessible
- Assessability and intelligible
- Useable beyond original purpose
- Interoperability

The OA must be effective, affordable, competitive and sustainable for researchers and innovative businesses to be useful.

Potential policy implications are that all science will be global.

EC provides further information at

- Horizon 2020: http://ec.europa.eu/programmes/horizon2020/
- Participant Portal: http://ec.europa.eu/research/participants/portal/
- Guidelines on Open Access to Scientific Publications and Research Data in Horizon 2020:

http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-pilot-guide_en.pdf

- Guidelines on Data Management in Horizon 2020: http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-data-mgt_en.pdf
- Open access (Science in Society site): http://ec.europa.eu/research/science-society/open_access
- Open access (Digital Agenda site): http://ec.europa.eu/digital-agenda/en/open-access-scientific-knowledge-0
- OpenAIRE: http://www.openaire.eu/
- You can also contact the European Commission's Open Access team at RTD-OPEN-ACCESS@ec.europa.eu

Challenges in data sharing

- *Science data owners*
  - typically are interested in postponing the public release of data until the end of the project (because scientists want to publish first results). Thus for the duration of the project the data would be restricted to participants.
  - typically scientists foresee time-consuming data handling for providing full meta-data, organising data and when data are shared to spend time helping others
  - typically scientists do not get scientific credits for data handling (e.g. as H-index for publication)
- *Industry data used for science*
  - often has purpose of benchmark/ validation. A subset of data is usually necessary. Individual negotiation for release of the data useful enough for the sake of benchmark/ validation with NDA.
  - moving technology from low TRL level to high TRL increase the confidentiality in general

Suggested actions

Science data owners
EERA partners could release relevant data (role models)
Scientists achieve scientific merit/credit on open data archive
Could scientific merit on OA be through Zenodo (see Figure 4.2)?

Industry data used for science
Industry experts could consider for which data 'win-win' could be achieved using open access

Zenodo – a general purpose repository and data archive

In FP7 the EC supported the development of Zenodo.eu – a repository that provides services for depositing publications and data, and which provides DOI's to all records. This means that it becomes easy to link to and cite resources that are deposited in Zenodo. Moreover Zenodo gives the depositor and project managers control of the resources deposited to Zenodo i.e.: Zenodo enables the project manager to establish a project space in Zenodo and authors/depositors can manage licenses, embargo periodes and access to their deposited resources. Zenodo is developed in collaboration with OpenAIRE.eu and CERN. CERN is also the daily operator of Zenodo and making sure that everything is safe, stable and sustainable.

In the model text below – Zenodo is added as a way that a general approach to managing data, making data available and linking those data to the grant and resulting publications can be done with little effort.

Scientific merit through DOI?

Figure 4.1 Zenodo web-site.

OA publications are more easily accessible than other journal articles.
OA software is used to large extent but commercial software also co-existing.
OA data – it sounds great and easy, however, what is the quality?

The need for quality assessment and metadata should be considered carefully for OA research data.

Trust in open data?

Quote:

No one trusts a model except the man who wrote it;
Everyone trusts an observation except the man who made it."!

Harlow Shapley

Harlow Shapley was an American astronomer (1885 – 1972), he said these words before the modelling industry has developed such like now!

1.4 4.1 The traffic light on OA research data

Fig. 4.2 Traffic light. From SusannaByriel.com

The OA research data traffic light indicates three (simplified) states.

Green is 'go' (but always look to both sides to double check)
Yellow is 'prepare' (soon able to go, but wait)
Red is 'stay' ('no go' and there is no soon changes expected to this situation).

In analogy,
'green' research data can be shared extensively,
'yellow' research data may be shared after Non-Disclosure Agreement or similar,
'red' research data are highly confidential according to the existing agreement and OA is unrealistic in the short term.

In the roadmap is considered mainly 'green' and 'yellow' data sets while 'red' are of less relevance in the context.

5. IRPWIND plans open data

IRPWIND WP6: Sharing data

- European added value is achieved by assimilating existing measurements from national projects, e.g. NOWITECH, Alpha Ventus (RAVE) and Egmond aan Zee (OWEZ).
- Confidentiality may be an issue for data owned by external parties, though IRPWIND will strive for as much openness as possible.
- No measurements will be prepared as part of WP6, hence data assimilation is about selecting, quality assuring and uploading measurement data from other projects to the database.
- Data in database shall be open, hence, selection and negotiations must be prepared so the owner of the data will accept this.
- Careful selection of data, and a clear value proposition for the data owner, is expected to ease negotiations and acceptance by owner.

6. Technology: data access, common password, distributed database and metadata

Currently most of the databases are hosted independently by different partners and their use is restricted to the duration of the project. Each database has to maintain its own user lists and administrators have to verify their identity. At the end of the project maintenance of the database is the obvious issue but also administration of the user accounts and validation of new ones has to be considered. Finally, data discovery in many separate databases is becoming a growing issue.

To allow data to be discovered by potential users, a solution would then be to build a Content Management System (CMS) of available databases, e. g. starting with the open access data from the H2020 or with the “green data”. The condition for the scheme to succeed is to define different types of data at different complexity levels, standard metadata and simple but secure data access process.

Also to reference data often located behind institutional firewalls, it is necessary to build standardized interfaces located outside firewalls where metadata, e.g. data type, geographical locations, availability period, rule for access, etc. can be harvested, indexed and stored in the centralized Content Management System.

In order to be able to cross reference different databases it is necessary to address both technical and legal issues:

- Designing model agreements between data owners for granting access to data as well as exchanging user’s personal information (e.g. name, email, association) necessary for the access control, needs to comply with national regulations and organizations IPR rules.
- Create a technical solution allowing integration/interfacing of existing data infrastructures, providing access rules and password protection (ideally using institutional accounts).

The central issue is to facilitate this sharing in a seamless and secure way by the underlying e-infrastructure. This could be achieved through existing European

Authentication and Authorization Infrastructure (AAI), i.e. eduGAIN and the National Research and Education Networks (NRENs). Thus, users can logon to the centralised CMS with the user credentials of their home institution.

7. EERA partners as role models with subsection per partner

EERA partners are preparing start of open access data. EERA partners have been traditionally involved in numerous research activities where data were collected and thereby have overview of relevant data stored at own premises. The data comprise a mixture of own (institutionally funded) data, project funded data from national and international collaboration and data achieved partly from industrial collaboration. At this point in time a brief overview of major data sets is provided in following sub-sections.

Several actions to realize our ambition of being good role models are in preparation.

One is to ensure a public list of available data sets through EERA. Below is a presentation of various data sets that obviously will be added to this list. Other data sets that come to our knowledge will be added in continuous way to the list.

Another activity in preparation also among the EERA members is to have a cross-cutting activity between the Sub-programs of EERA Joint Program to stimulate further data sharing and ensure relevant information on data bases and projects are exchanged. As a start in JP Wind Conditions the web-site http://europeanwindprojects.eu/wiki/Main_Page has been initiated recently (August 2015). This will provide overview of projects within the Wind Energy JP's.

A third activity is strategy for Research Infrastructure Science2.0 roadmap within the JP Research Infrastructures where e.g. the WindScanner FP7 funded Preparatory Phase project now aims for the establishment a common European research infrastructure and the roadmap for this is in preparation. WindScanner will provide novel data for research.

7.1 DTU

At DTU Wind Energy the database WindData.com is available. Fig 7.1 shows website.

Fig 7.1 Database of Wind Characteristics: winddata.com

This online database contains four main categories of data:

1. **Time series of wind characteristics**.
   Raw time series sampled with ≥1 Hz,
   ≥60 sites & ≥200.000 hours;
   Including 7 offshore dataset.
2. **Time series of structural wind turbine response measurements**.
   Raw time series; >7 sites & >6500 hours,
   Including 2 offshore dataset.
3. **Wind resource data**, 10 (or 30) minute statistics,
   >40 sites & >1.000.000 hours,
   Including 2 offshore dataset.
4. **Wind farm production data**, 10-minute statistics for each wind turbine in the wind farm. 2 sites & 19.000 hours

We also list major data sets in 'Green' and 'Yellow' status below.

Green project - download of 10-min mean values

1. Lynghøjskolen – Wind data, Meteorological station at Lynghøjskolen public school in Roskilde for education of lower secondary classes.
   http://veaonline.risoe.dk/Rodeo/ProjectOverview.aspx?&Project=134&Rnd=894720
2. Risø turbulence - Turbulence data from a Metek sonic anemometer mounted at 60m on Risø's met mast.
   http://veaonline.risoe.dk/Rodeo/ProjectOverview.aspx?&Project=14&Rnd=58341

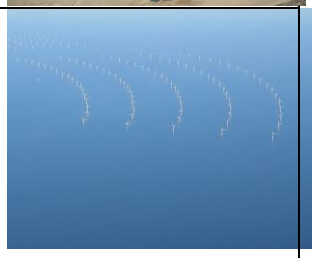
3. Soro IMECC – Soro data, DTU kemiteknik.
   http://veaonline.risoe.dk/Rodeo/ProjectOverview.aspx?&Project=109&Rnd=58341
4. Koltur – Wind data of a meteorological mast located at Faroe Islands, Koltur.
   http://veaonline.risoe.dk/Rodeo/ProjectOverview.aspx?&Project=25&Rnd=699536
5. Syðradalur, Kalsoy - Wind data of a meteorological mast located at Faroe Islands, Kalsoy.
   http://veaonline.risoe.dk/Rodeo/ProjectOverview.aspx?&Project=24&Rnd=340731

Yellow project – need NDA and personal registration

1. Boerglum phase2 – Wind data of a meteorological mast located at north Jutland, Denmark.
   http://veaonline.risoe.dk/Rodeo/ProjectOverview.aspx?&Project=44&Rnd=945845
2. Høvsøre public - Wind data of a 116m meteorological mast located at the DTU test center for large wind turbines, west Jutland, Denmark.
   http://veaonline.risoe.dk/Rodeo/ProjectOverview.aspx?&Project=157&Rnd=945845
3. Galathea Ship info - Galathea3 - Reaserch ship GPS data from the ship and meteorological data measured by DMI on the ship.
   http://veaonline.risoe.dk/Rodeo/ProjectOverview.aspx?&Project=51&Rnd=945845
4. Roedsan II – Offshore meteorological mast, Fehmarn belt project, data belongs to E.ON.
   http://veaonline.risoe.dk/Rodeo/ProjectOverview.aspx?&Project=110&Rnd=109466
5. Shetland Wind Stations - Wind Resource Measurement on the Isle of Shetland, data belongs to Vikingenergy UK.
   http://veaonline.risoe.dk/Rodeo/ProjectOverview.aspx?&Project=16&Rnd=750660

Full scale measurements

Name	Location	Sensors	Contact	Company	Date	Picture

Poseidon Demonstration – P-37	Out of Nakskov harbor (DK)	Wind: Sonic Waves: ADCP Turbines: SG on tower, blades, power Mooring: SG/load cells Other: platform inclinometers, accelerometers	Anders Yde	Floating Power Plant	Nov.2012-Oct.2013	
Envision PP2B	Thyborøn (DK)	Wind: met-mast Turbine: SG on tower, blades, power	Carsten W. Kock	Envision	2012-2014	
PSO 2010 - Rødsand II	south of Lolland-Falster (DK)	Wind: met-mast Turbine: SG on tower, blades, power	Gunner Chr. Larsen	DTU	Jan.-Feb 2013	
Wake meander	Risø Campus (DK)	Wind: met-mast, Lidar	Gunner Chr. Larsen	DTU	?	

Double wake	Risø Campus (DK)	Wind: met-mast, Lidar	Gunner Chr. Larsen	DTU	?	
Wake turbulence	Esbjerg (DK)	Wind: met-mast, Lidar	Gunner Chr. Larsen	DTU		
DAN-AERO MW	Esbjerg (DK)	Wind: met-mast Turbine: , pitot tube on blade, surface pressure tabs on blade		DTU/Siemens /Vestas/Dong /LM		
Blyth Wind farm, 2 x 2MW	Blyth, (UK)	Wind: onshore met.mast Turbine: Offshore with SG on tower, blades, power Wave: bouy winddata.com	Kurt S. Hansen	AMC Border Wind, OWTES, EU funded	2001-2003	

Benakanahalli database from India, contact Andreas Bechmann

Figure 1. Picture of the hill ridge taken from the south. 'Upstream' is to the right.

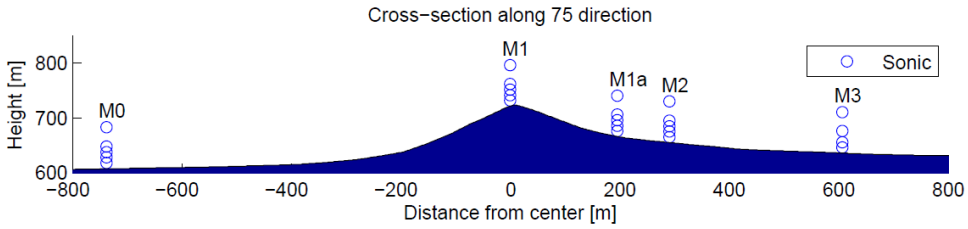


Figure 3. Cross-section of line 75)

Table 1. Overview of the instrumentation used from 2010-01-31 to 2010-04-30. S - Sonic anemometer, T - Thermometer, H - Hygrometer, R - Radiometer.

Mast. ID	10m	20m	30m	40m	75m	Other
M0	S,T,R	S,T,H	S,T	S,T	S,T	Tsoil, Pres, Rain
M1	S	S	S	S	S	
M1a	S	S	S	S	S	
M2	S	S	S	S	S	
M3	S	S	-	S	S	

Walney project is funded by EUDP.

Permission from Siemens and DONG energy is required before access to any of the data can be given.
There are measurements of 1) blade root moments, tower top moments, tower base moments, monopile mud level moments, 2) SCADA signals, 3) LIDAR wind measurements, Nacelle anemometer wind measurements and 4) Wave measurements.
Contact at DTU: Anand Natarajan

Scaled test

Name	Location	Sensors	Contact	Company	Date	Picture
he Bolund ment	Bolund, Roskilde fjord	Wind: cups & sonics	Andreas Bechmann	DTU	2007-2008	
Scale test of floating DTU 10MW RWT on TLP	Hørsholm (DK)	?	Henrik Bredmose	DTU	2015	

7.2 Fraunhofer IWES

RAVE alpha ventus

Germany's first offshore wind farm alpha ventus co-operates with the RAVE research initiative. Prior to the installation 4 of 12 wind turbines have been equipped with extensive instrumentation from the tips of the blades tips down to the piles in the seabed, More sensors are placed in the surrounding waters and at the off- and onshore substations. The close vicinity to the FINO1 station rounds off the setup for unique scientific offshore research options.

All measurement data from alpha is stored in a data base. In general access rights are limited only to members of the RAVE consortium. A few exceptions to limited sets of data have been granted to external (Non-RAVE) projects.

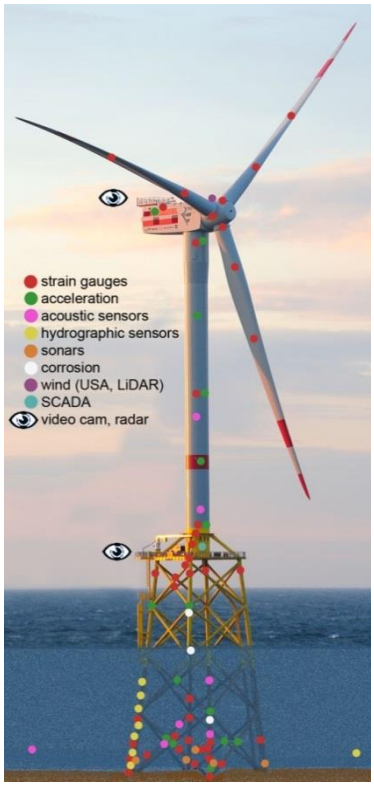


Figure 7.2: Instrumentation sketch of AV04 (Senvion 5M) © Fraunhofer IWES, photo © DOTI

200 m met-mast at Kassel

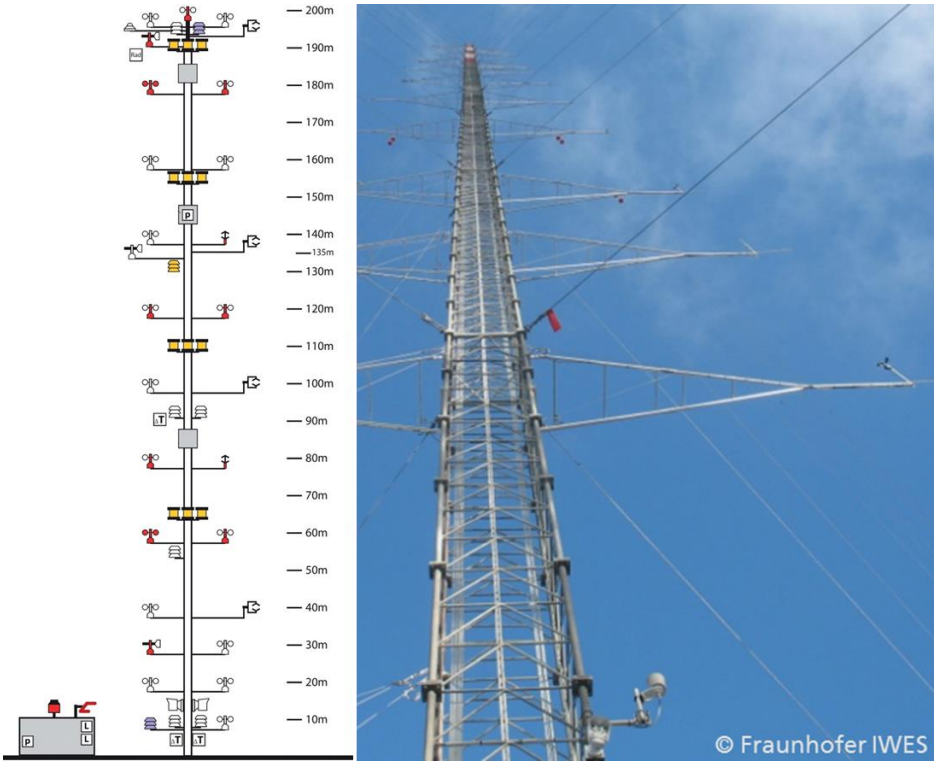


Fig 7.3 View of 200 m met mast near Kassel

Fraunhofer IWES operates a 200 m high research met mast in forested hilly terrain near Kassel. The IEC conform mast is equipped with first class cup anemometers, wind vanes, ultrasonic anemometers and further meteorological instruments - altogether about 40 sensors at 13 different
heights.

All measurement data from the 200-m-mast is stored in a data base. The access to the predominantly project funded data is generally limited to project partners.

7.3 SINTEF

- NOWITECH/SINTEF data from scale test in semi-sub ocean bassin (in planning) and from floating test turbines (FELXWT) (in planning) (no slide)

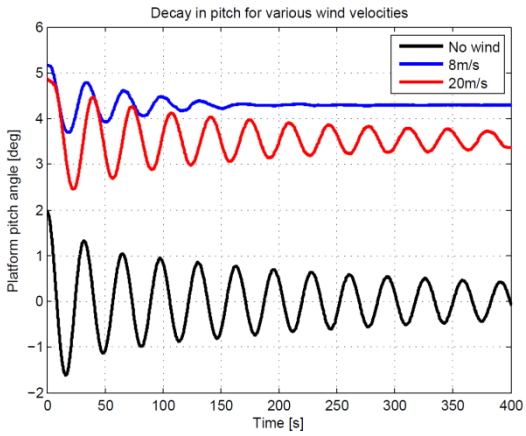
MARINTEK test of Semisubmersible Wind Turbine (Real-Time Hybrid Model Testing)
Contact: Dr Madjid Karimirad
Madjid.Karimirad@marintek.sintef.no

Objectives

- Model testing in moderate to harsh sea states: operational and survival
- Dynamic responses to investigate the structural integrity and performance:
  - Dynamic motions of floater
  - Acceleration and velocity of important locations such as nacelle
  - Bending moment and shear forces at important interfaces such as tower-floater interface
  - Loads on mooring lines
  - Shear force at selected sections of the floater such as pontoons/columns
- Calibration the numerical model (higher order wave loads, viscous effects, ..
- Capability of MARINTEK in advanced testing of offshore wind turbines

Tests in the towing tank
Instrumentation:

- Optical 6DOF motion measurements
- Accelerometers
- Gyros
- Internal shear force and bending moment measurements
  - Tower
  - At one column
- Mooring system top-tension
- Hybrid setup: 6 actuators + ...



- The natural period in heave, roll/pitch, are matching quite well the theoretical estimates.

- The focus was not on a proper modelling of the mooring for those tests (we rather focused on the hybrid setup).

Practical issues

- Tests will be performed during summer of 2015 (tentative)
  - the tests could be postponed to right after summer
- We need proper time to check the results (3-6 months)
  - The data will be ready i.e. early 2016
  - NOWITECH and MARINTEK agree to releaser the data
  - MARINTEK wants to publish some papers beforehand (i.e. as a PhD candidate is involved)

Benchmarking

- The as-built model will be documented (mass and moments of inertia), as well as the modelled mooring system and calibrated environment (waves)
- Experimental results are provided in Matlab format
- Measured quantities (will be reported in full-scale values)
  - Motions (6DOF, optical) and additional kinematic parameters as linear accelerations / angular velocities (locations to be confirmed)
  - Mooring line tensions
  - Shear force and bending moment at the tower base
  - Shear force and bending moment at one column base
  - Wind forces from the hybrid setup
- Types of tests (test program not defined yet, but here is an estimate)
  - Documentation tests (pull-out, inclination)
  - Decay without wind
  - Decay with wind
  - Static wind only tests
  - Dynamic wind only tests
  - Collinear wave and wind tests at below-rated, rated, and above-rated conditions.
  - Misaligned wave and wind.
- The type of sensors (brand/model) is in principle confidential, but we can communicate the measurement method (e.g. strain gauge, optical, etc…).

7.4 CENER

Windbench.net is a portal for the online management of benchmarking activities related to wind energy model development, verification and validation (V&V) [1]. It was first released in May 2013 as a prototype to manage the benchmarking activities of the IEA-Wind Task 31 "Wakebench" on wind farm (microscale) flow models [2][3]. It has also been adopted by EERA as part of the e-infrastructure research roadmap.

After a year of operation the site counts with an inventory of more than 20 models and 30 benchmarks, based on contributions from more than 50 users. A model evaluation protocol [4], developed in Task 31, rules the V&V process (Fig 7.5) and guides model users and developers on the requirements for conducting proper model evaluation with the support of Windbench.net as the main instrument for online documentation, reporting, networking and collaboration in this field.

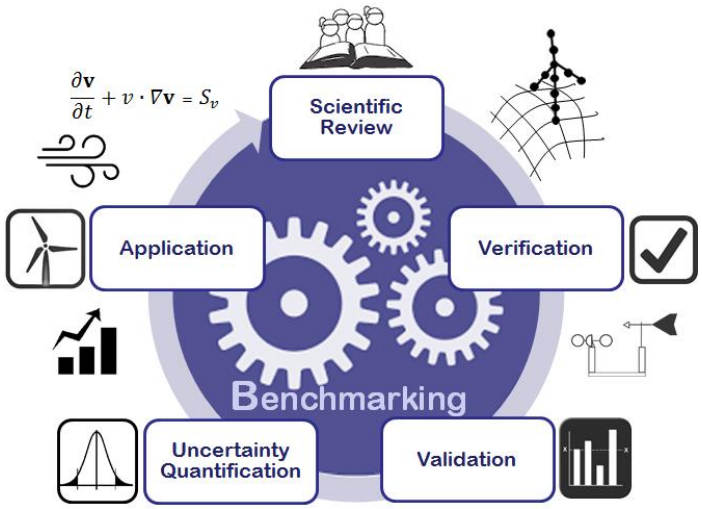


Fig 7.5 Schematic of the Windbench.net model evaluation workflow

The first version of the portal, based on Drupal open-source content management system, was designed to allow access control to data by the data owner, who can take different roles: model manager, benchmark manager, reviewer (for peer-review of benchmark results) or as benchmark participant submitting simulation results. Then, a benchmark is defined as a virtual research group where each participant has full control on administrating the access to the contributed data. This collaborative scheme aims at reconciling the different IPR constraints of the different user profiles of the platform, coming from industrial, governmental, research and academic institutions. The portal allows the data owner full control over a number of schemes for access control. This promotes trust from data providers and allows data to be easily moved from the private to the public domain when, for instance, the project results are published or when the data are old enough not be critical.

The portal continues its activities in the frame of the IEA-Wind Task 31, extending the modeling scope to meteorological (mesoscale) models and the evaluation framework to uncertainty quantification. As a result, the wind engineering community will interact more closely with the meteorological community in order to bridge the gap across the modeling scales while adopting a common model evaluation framework for verification, validation and uncertainty quantification (VV&UQ).

Adopting a common evaluation framework helps integrating models and communities together and results in a more comprehensive structure for multidisciplinary research that focus on the reduction of uncertainties with large impact on cost-of-energy reduction. Consistent with this philosophy the IRP-Wind project devotes WP6.2 to the setting up of Windbench.net for the benchmarking of offshore wind turbine design codes.

The Windbench e-infrastructure is also a logical partner of the WindScanner ESFRI European infrastructure for experimental research. Model developers and experimentalist will define procedures for the planning and design of experiments, from which strong sense benchmarks are obtained. These are engineering standards that define a comprehensive framework for model testing, the requirements for model intercomparison and a set of acceptance criteria considering the intended uses of the models. These benchmarks will be typically based on open-access datasets that can systematically be visited by model developers, software vendors and users to certify the adequacy of a model to its intended use. The generation of strong-sense benchmarks for flow models from experiments will be an important deliverable of the New European Wind Atlas (NEWA) project.

[1] Sanz Rodrigo J, Gancarski P (2014) WINDBENCH: Benchmarking of Flow Models for Wind Applications. https://www.windbench.net/, Last accessed on October 2014

[2] Sanz Rodrigo J, Gancarski P, Chávez Arroyo R, Moriarty P, Churchfield M, Naughton JW, Hansen KS, Machefaux E, Koblitz T, Maguire E, Castellani F, Terzi L, Breton S-P, Ueda Y, Prospathopoulos J, Oxley GS, Peralta C, Zhang X, Witha B (2014) IEA-Task 31 WAKEBENCH: Towards a protocol for wind farm flow model evaluation. Part 1: Flow-over-terrain models. Journal of Physics: Conference Series 524: 012105, doi:10.1088/1742-6596/524/1/012105

[3] Moriarty P, Sanz Rodrigo J, Gancarski P, Chávez Arroyo R, Churchfield M, Naughton JW, Hansen KS, Machefaux E, Maguire E, Castellani F, Terzi L, Breton S-P, Ueda Y (2014) IEA-Task 31 WAKEBENCH: Towards a protocol for wind farm flow model evaluation. Part 2: Wind farm wake models. Journal of Physics: Conference Series 524: 012185, doi:10.1088/1742-6596/524/1/012185

[4] Sanz Rodrigo J, Moriarty P (2014) Model Evaluation Protocol for Wind Farm Flow Models. First edition. IEA Task 31 Report to the IEA-Wind Executive Committee, September 2014, under review

7.5 CRES

Greek wind atlas is available at the site of the greek Regulatory Authority for Energy (RAE):

http://www.rae.gr/geo/index.php?lang=EN

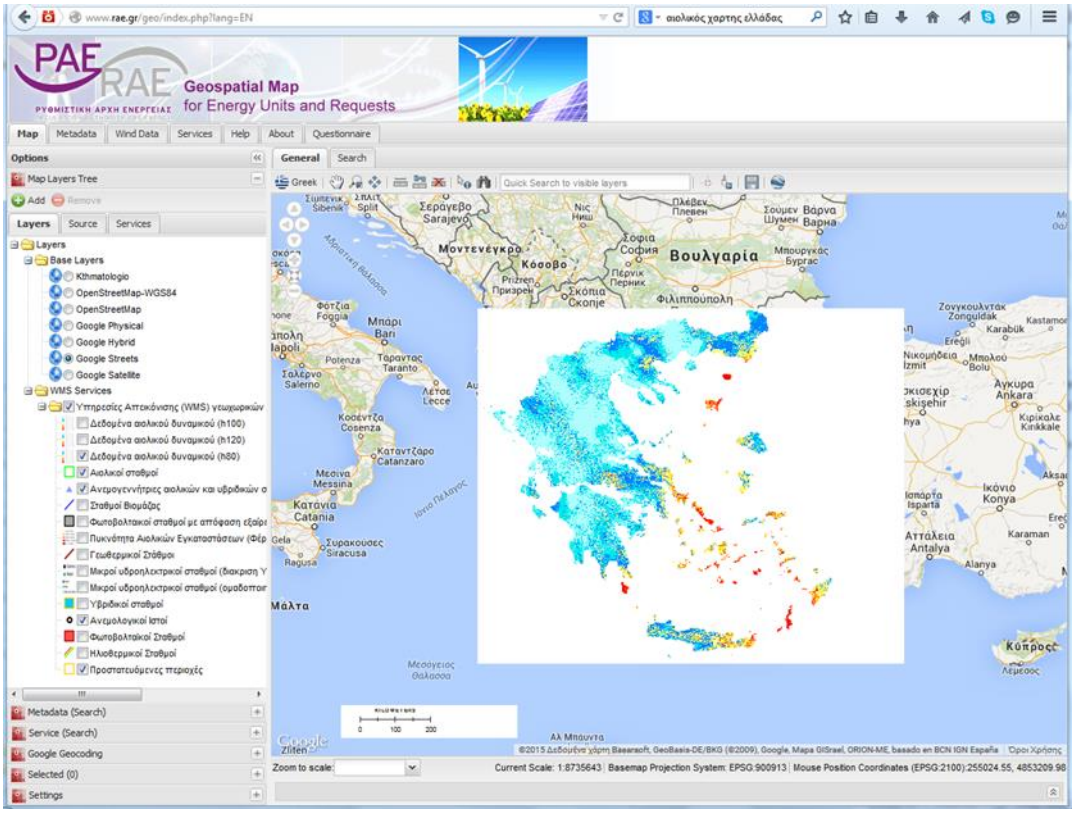


Fig 7.6 Greek wind atlas from RAE.

The data were collected within the frame of national (Greek) projects. Information available is provided with a resolution of 150m.

Long term data (10 minute statistics) of meteorological masts that are operated by CRES in Greece are available upon a small fee, partly covering operation expenses and assuring quality of data.

Composite material data from the OPTIMAT BLADES project (ENK6-CT-2001-00552) provided by CRES are included in the OPTIMAT database, available from Knowledge Centre WMC (The Netherlands), at:

http://www.wmc.eu/optimatblades_optidat.php

On the same site all reports produced by CRES within the OPTIMAT BLADES project are also available.

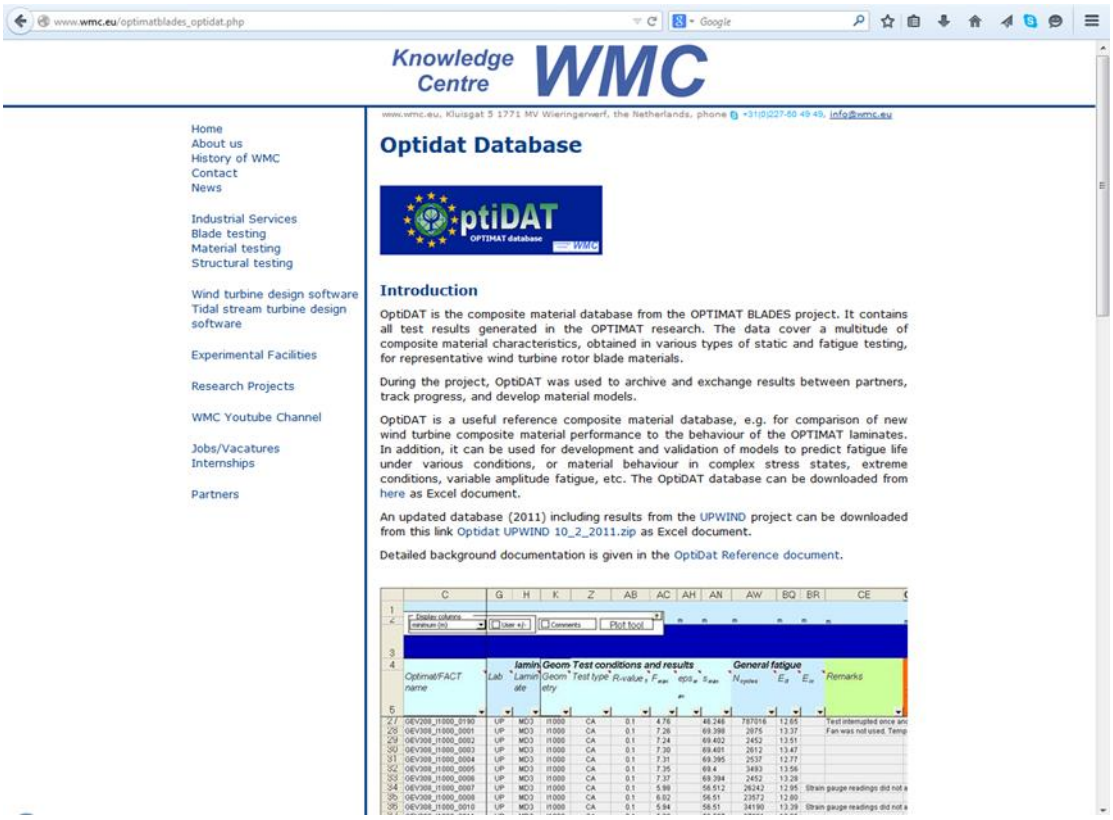


Fig. 7.7 WMC database intro website

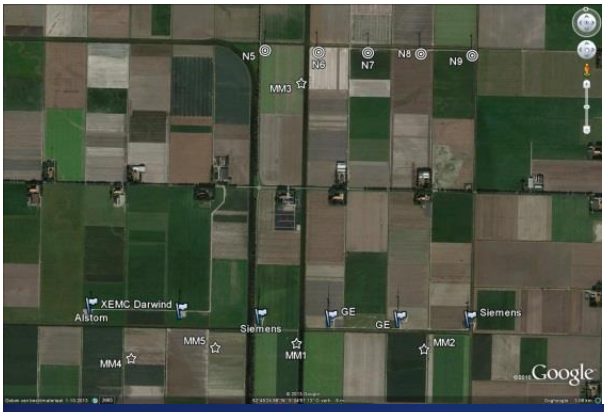
Regarding wind turbine measurement data, this should be considered as falling under the yellow project category, mainly because the data need to be processed and documented accordingly so as to be useful for other scientists. As such, mechanical load measurements on wind turbine operated at CRES wind farm in Lavrio collected within the frame of PROTEST project (http://www.protest-fp7.eu/) are available. However, data of the wind turbine components are not accompanying the measured data, since these are property of the manfacturer.

7.6 ECN

ECN has collaborated in a lot of research initiatives during the last 40 years with the aim and result of providing data sets to the research community. That started with the HAT25 research turbine at the Petten site. Various datasets are available from the period before 2000, such as airfoil measurements, measurements of noise from wind turbines, measurements from site conditions, measurements of anemometers in wind tunnels, etc.
Datasets that are available that have been measured since 2000 consist of the following datasets. These are characterized mostly as yellow – the data are not just publicly available on web-sites, but these data are shared as part of collaborative research projects and research initiatives.

1. MEXICO experiments – a 4.5m rotor in the largest European wind tunnel
2. Scale wind farm – 10 small-scale wind turbines in an array with 14 measurement masts
3. Full-scale wind farm – five 2.5MW wind turbines in the ECN wind turbine test site in the Wieringermeer
4. Wind measurements offshore at meteorological masts

ECN Wind Turbine Test Site Wieringermeer



ECN's test site is a unique facility and comprises a combination of a research wind farm, prototype test locations and a remote sensing validation facilities. The site is an onshore site near the lake IJsselmeer and consists of flat, agricultural terrain with single farm houses and rows of trees. The site has a favourable wind climate with an average wind speed of 8,3m/s at 100m height and a mean turbulence level of 8.1%; the main wind

direction is South West. The site comprises six prototype locations, which enables manufacturers to test, optimize and certify prototype turbines together with ECN. Manufacturers present on the site are GE, Alstom, XMEC Darwind and Siemens where the turbines have a rated power in the range 2M to 5MW, a hub height in the range 80m to 100m and a rotor diameter in the range 100m to 120m. Supporting facilities for the prototype locations are four IEC compliant meteorological masts (a fifth is located near the research farm), grid connection and data collection. All data are gathered in the test site control centre located in the measurement pavilion. In this pavilion various offices are available for the manufacturers, maintenance and instrumentation personnel can change cloths and a meeting room is present. On a daily basis data are transferred to the ECN headquarters in Petten.

The ECN Wind Turbine Test Site Wieringermeer comprises a research wind farm consisting of five Nordex N80 wind turbines. The turbines have a rated power of 2.5MW, a hub height and rotor diameter of 80m. They are numbered N5 to N9 and are oriented in a line from West to East with an interturbine separation of 3.8D. In between the first two turbines from West and directly South of the line an IEC compliant meteorological mast is present with a distance of 3.5D from N5 and 2.5D from N6. This mast has wind measurements at hub height and at the lower and higher tip end (H +/- 7/10 R). The research wind farm is crucial facility for the programme development of ECN and enables ECN to perform wind farm specific research. Innovative concepts are tested and measured data are used for model validation. Examples of the research are wind farm control strategies, power performance of wind turbines, LiDAR application, wake measurements for model validation, low cost load monitoring, innovative blade concepts, etc. Since the start of the test site, many European research projects have been executed at the Nordex wind turbines and the data of the Nordex wind turbines have been used in many international research projects.

ECN Scale farm

The ECN scale farm consists of ten permanent magnet, direct drive, pitch controlled wind turbines. The turbines have 10kW rated power, a rotor diameter of 7.6m and a hub height of 7.5m. It is essential that the researchers have full access to the hardware and software of the wind turbines. The scale farm has been designed in a way that allows ECN performing experiments without any risks for the environment as well as the turbines themselves. As a result, ECN will be able to adapt the controllers as well as the turbines for the dedicated experiments.
Inside and around the wind farm a network of fourteen measurement masts has been installed, which measure the wind velocity field from 3.6m to 19m height. This covers the rotor area and upto one rotor diameter above the rotor. The scales are indicated in Figure 1. The large number of meteorological masts within the wind farm permits to measure at the same time single, double, triple and quadruple wakes while simultaneously measuring the external conditions with three nearby 108m meteorological masts. The unusually densely spaced wind measurements gives the unique possibility to capture the complete wind field, which gives valuable additional information compared to the usual measurement of the wind speed at a single location. Furthermore, most of the wind measurements will be performed using 3D sonic anemometers thus capturing the three wind velocity vectors of the wind field.
The scale farm is located in ECN's large wind turbine test field in Wieringermeer in between the prototype turbines. The measurements are directly coupled to the existing

measurement network.
As a result, also the measurements of the three 108m high masts are coupled to the measurements. The scale wind farm and its surroundings are characterized by flat terrain, consisting of mainly agricultural area, with single farmhouses and rows of trees. The lake Ijsselmeer is located at a distance of 1 km East of the scale wind farm. Great care has been taken to ensure undisturbed inflow of the wind in the scale wind farm.

The data are available to researchers as part of collaborative research projects.

MEXICO Model Rotor Experiments

ECN with several European partners organised and coordinated in December 2006 a large model rotor experiment within the EU project Mexico. In this project detailed aerodynamic measurements were carried out on a wind turbine model with a diameter of 4.5 m, which was placed in the largest European wind tunnel, the LLF facility of the German Dutch Wind Tunnel, DNW with a size of 9.5 x 9.5 m2. Within the Mexico project it was not only pressure and load data which were measured but in addition detailed flow field data were taken with the Particle Image Velocimetry (PIV) technique.

In the IEA Wind Task MEXNEX(T), the accessibility of data was facilitated and a thorough analysis of the data has taken place. This included an assessment of the measurement uncertainties and a validation of different categories of aerodynamic models (rotor aerodynamics + near wake models, where the latter type of models form part of wind farm models as well).

The first phase of the project ended on June 1st, 2011, but in October 2011 an extension of the project (Mexnext-II) was approved by the IEA Executive Committee. Within this extension unexplored aerodynamic measurements on wind turbines (both in the wind tunnel as well as in the field) were analysed from a wide variety of sources. Thereto it should be realized that the use of measurements from a large number of

sources forms part of a sound scientific approach: Aerodynamic models need to be validated on a wide variety of turbines in order to assess the general validity of observations Moreover in Mexnext-II a second set of measurements was performed on the Mexico rotor in the LLF facility of the German Dutch Wind Tunnel, DNW. These 'New Mexico' measurements are sponsored by the ESWIRP program. The resulting database was found to be even more useful than the first database and it led to the third phase of Mexnext: Mexnext-III which runs from January 1st 2015 until December 31st 2017. The main aim of Mexnext-III is to analyse the New Mexico measurements, not forgetting other interesting experiments.

Measurement and Evaluation programme
Offshore Wind Farm Egmond aan Zee

NoordzeeWind carried out an extensive measurement and evaluation program as part of the project Offshore Windfarm Egmond aan Zee (OWEZ). On behalf of NoordzeeWind ECN has created and is maintaining a comprehensive database of measurements.

Infrastructure specification:
Measured meteorological and hydrological data

- A total of 5½ years of data, of which 3 years in the presence of the wind farm
- Continuous time series of 10-minute statistics (mean, standard deviation, minimum, and maximum)
- Measuring heights: -17m, -4m, 20m, 21m, 70m and 116 m above mean sea level

- Measured quantities: wind speed and direction, air and water temperature, relative humidity of the air, air pressure, precipitation, water level, current velocity and direction, tower accelerations, and wave height, period and direction
- Check the user's manual for additional information
- Other data (higher data rate or originating from wind turbines) available on request at NoordzeeWind

Online access to the public part of the OWEZ database:

- http://www.ecn.nl
- http://www.noordzeewind.nl
- http://www.offshorewind.nl

ECN collaborates in various projects where the ECN researchers provide information required for successful and effective use of the OWEZ database, e.g. information on the data collection, the data processing, and the data validation and analysis. There is also a restricted part of data connected to the OWEZ measurement campaign. The access to these data (turbine loads, maintenance, etc.) requires NDAs and permission from the operator and wind turbine manufacturer.

Typical example projects:

- Wind forecasting (short term) and wind resource (long term) assessment
- Wind turbine/farm wake studies; impact on the mean wind as well as the turbulence
- Studies on the interaction between wind, waves and currents
- Assessment of the wave and the current climate
- Wind turbine loads characteristics and model validation
- Operation and maintenance related research
- Installation modelling
- Environmental assessments and research

Offshore Wind Measurements

ECN is performing a four year meteorological measurement program on the Dutch part of the North Sea, requested by the Ministry of Economic Affairs. The goal is to collected better wind data that can be used in the preparations of new offshore wind farm in the area that are allocated by 'Nationaal Waterplan'. The available wind is one of the most important variables when calculating the expected revenues of these future power plants, therefore it is of great importance to collect more reliable wind data. This will lead to more certainty and less risks for investors reducing the costs. At several platforms in the North Sea wind measurements are done, but these are not accurate enough for offshore wind energy. The heights on which is measured is often too low and the frequencies are also too low. Via the website www.windopzee.net you will find more information and get access to the different measurement positions at the Dutch part of the North Sea.

Locations:

- Meteorological Mast IJmuiden (MMIJ)
- Lichteiland Goeree (LEG)
- Meteomast OWEZ (MM OWEZ)

- Metocean buoy 1 Borssele wind farm zone (BWFZ)

By order of the Ministry of Economic Affairs, the Netherlands Enterprise Agency makes information available about the soil, wind and water conditions of wind farm sites to commercial parties. They can use this information as input for their tender for the Wind energy at sea SDE+ tender. (www.rvo.nl/sde)
The Netherlands Enterprise Agency has issued a contract for the MetOcean buoys in the Borssele wind area. You will find the data checked with regard to quality of the MetOcean buoys on this website.

7.7 EWEA

EWEA welcomes the European Integrated Programme on Wind Energy Research (IRPWIND) efforts to develop a strategy on how to ensure better openness and access to data. This strategy will be developed together with European industry, as the aim is to use the data to enforce European organizations with strong links to the European industry.

The success of the wind energy industry relies on the industry ability to drive down Levelized Cost of Energy (LCoE) and push for a higher percentage of renewable energy in the European grid.

One way to bring down the costs is to build cross-sectorial collaboration and share the best practices. This includes industry-to-industry collaboration both with the supply chain (vertically) and with companies in more direct competition (horizontally). In addition, open dialogue between industry-to-academia and industry-to-government should work as a catalyst to reduce costs and boost innovation. Thus there is an incentive for European wind energy industry to evolve structures that allows knowledge transfer and data sharing in order to continue excellence in the global market. However it should be noted that compliance with the EU competition rules is needed in order to protect competitiveness.

The conflicts of interest evolving around the issue on data sharing vs. data protection is a continuing topic for discussing. There is no one-solution to approach the dilemmas but the industry is taking crucial steps towards cluster collaboration and effective cost reduction on research and innovation (R&I) topics.

One example of this is the successful establishment of the commercial foundation LORC Test Centre in Denmark. The centre was founded in 2009 by some of the biggest players in the green offshore energy industry – Vestas, Vattenfall, Siemens, Dong Energy etc. LORCs ambition is to become a leading centre for knowledge, innovation, testing, and demonstration of green offshore technology internationally. LORC works to design and construct state-of-the-art test facilities that are directly useful for the industry. The goal is to boost the competitiveness of green offshore energy. Activities include innovation, testing and demonstration of existing technological solutions within deep water foundations, wind turbine drive trains, and production methods such as welding techniques.

Another example the SEASTAR **Alliance**. SEASTAR Alliance is a new collaborative industry group within the European offshore wind industry that was formed to strengthen industry cooperation on key challenges in offshore wind in the Northern Seas. It has launched its program of work as a value adding industry group, bringing national successes and opportunities for cooperation to the European forefront. The alliance aims to encourage international cooperation and knowledge sharing within the industry, and it intends to use connections in both the industry and in governmental bodies to pursue cost reduction, knowledge sharing and offshore grid development.

One of the programs that SEASTAR Alliance aims to bring to a European level is the UK's Cost Reduction Monitoring Framework (CRMF). Developers here were encouraged to share examples of their experiences in 'Developer Days' where under Chatham House rules, project directors of offshore wind developments spoke in an open forum, which has since received support to become a regular event that helps identify and share best practice in offshore wind development. The CRMF also saw developers share cost data under an anonymous framework, which allowed ORE Catapult to identify an 11% cost reduction in UK offshore wind developments for the period 2010-2014.

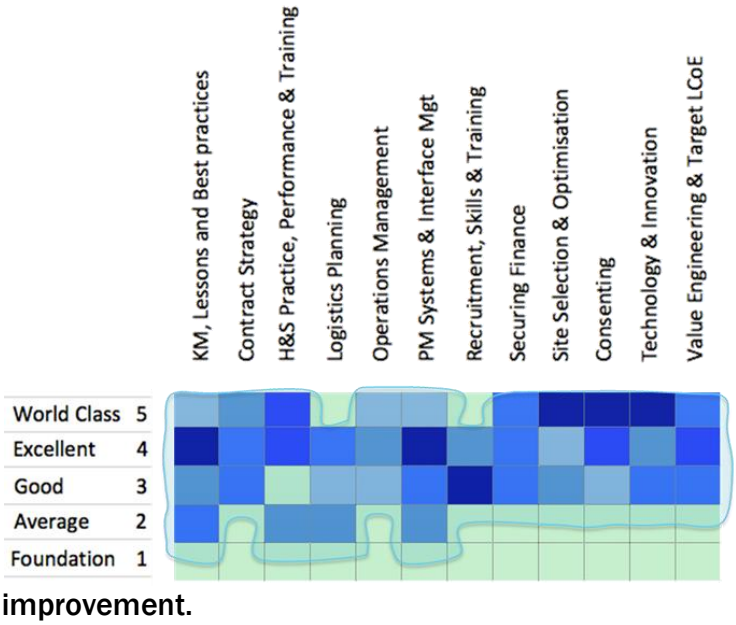


Diagram: Based off survey data from project directors, the river diagram demonstrates the areas where industry feels it is performing well, and where improvements could be made. For example, the deep blue, top, narrow portion of the river under 'Consenting' would illustrate that industry feels this is an area of excellence, compared to the wider portions of the river with the deep blues in middle of the river demonstrating less confidence in 'PM Systems and Interface Mgmt', and an area of improvement.

The above examples serve as a proof that industry is moving towards collaboration and sharing of knowledge, data and best practice.

For the future EWEA would welcome a forum where the wind energy industry and EU institutions could come together and exchange views on future priorities for R&I topics.

EWEA, being the wind energy industry representative, could facilitate future discussions on an open access data strategy through activities with industrial and scientific members jointly working towards a solution on how to approach the dilemmas on data sharing.

Supported by:

8 Roadmap

The roadmap shows three types of data: 'Green', 'Yellow' and 'Red'. The main topic regarding open access data strategy is to change the situation from 'Yellow' to 'Green'.

The 'Keys' to unlock are several.

1. Firstly, a motivation for the data owner to consider 'Green' as attractive is very important. In case no benefit or limited benefit is expected and/or extra work is associated with releasing data, this will hinder the process. The motivation for the wind industry as a whole to actively engage in the 'open access data' may be aided by EWEA, the European Wind Energy Association.
2. Secondly, legal agreements need to be clear and not overwhelmingly complicated. Thus a possible 'model agreement' or extension to approved NDA (Non-Disclosure Agreement) could be starting point.
3. Thirdly, the technical issues should be clarified and solved. A distributed data system appears more appealing than a centralized. Only metadata should be collected centrally.

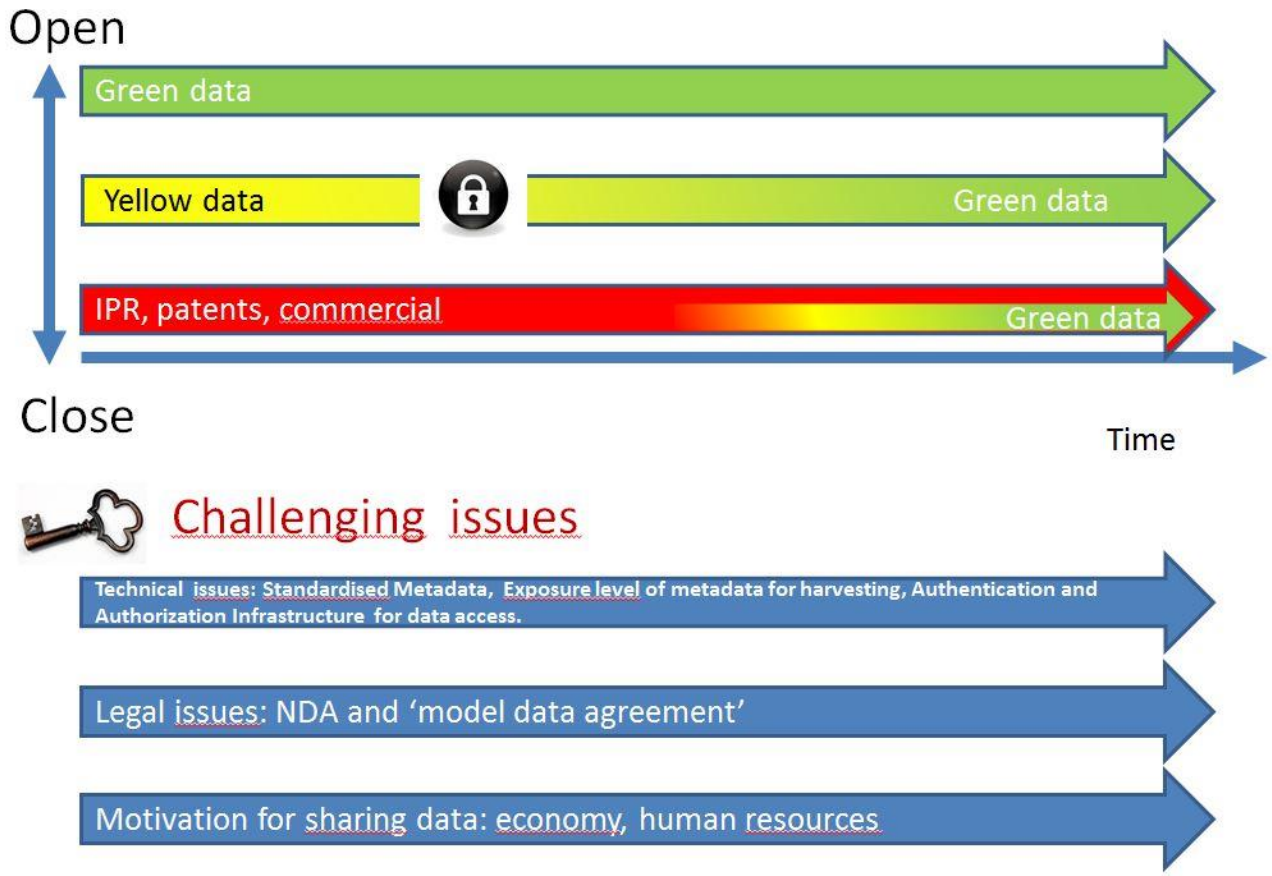


Fig 8.1 Roadmap for open access data.

As example of more detailed structure on Data provision and licensing procedures, the Wakebench Model Evaluation Protocol (Sanz Rodrigo and Moriarty, 2014) list guidelines that may be used to remove barriers on data accessibility.

Table below lists seven levels of accessibility shorted in ascending order of restriction level, from open-access to fully private data. Level-0 open-access data will typically come from publically funded projects and institutions, freely distributed on public websites for an unlimited duration. On the other hand, level-6 private proprietary data that won't be disclosed outside of the organization boundaries. Intermediate levels require some form of data licensing agreement between the owner and the recipient of the data. Level 1 is related to the distribution of public data available after paying a fee and typically requires no distribution to third parties. Level 2 is associated to registered members of a data provider service who have access after acceptance of certain terms and conditions. Levels 3 to 5 are related to the provision of data for the carrying out of activities within the project. At level 3 the consortium agreement of the project will be sufficient to limit the access of the data to the boundaries of the project. Levels 4 and 5 restrict the access to a group (work package or task participants within a project) or just one individual/organization by enforcing a bilateral non-disclosure agreement (NDA) between the owner and the recipient.

Table: Data accessibility levels and typical sources and licensing terms. From WindBench.

	Level	Definition	Source	Duration	License
0	Open-access	Data freely available from a web-based database	Public website, journals	Unlimited	*Green* or *Gold* open-access
1	Public	Available to the public after paying a fee	Public websites, journals	Unlimited	*Hybrid* open-access, Copyright
2	Members-only	Available to registered users of a service, association, etc	Private website	Membership	Terms and conditions
3	Project-based	Available for project members	Private website	Project	Consortium agreement
4	Group-based	Available for a group within a project	Private website	Task	NDA
5	Individual-based	Available for a delegate of the owner within a project	Private communication	Task	NDA
6	Private	Only the owner has access	Fully private	Task	Unlicensed

Sanz Rodrigo J, Moriarty P (2014) Model Evaluation Protocol for Wind Farm Flow Models. First edition. IEA Task 31 Report to the IEA-Wind Executive Committee, September 2014, under review

9 Summary

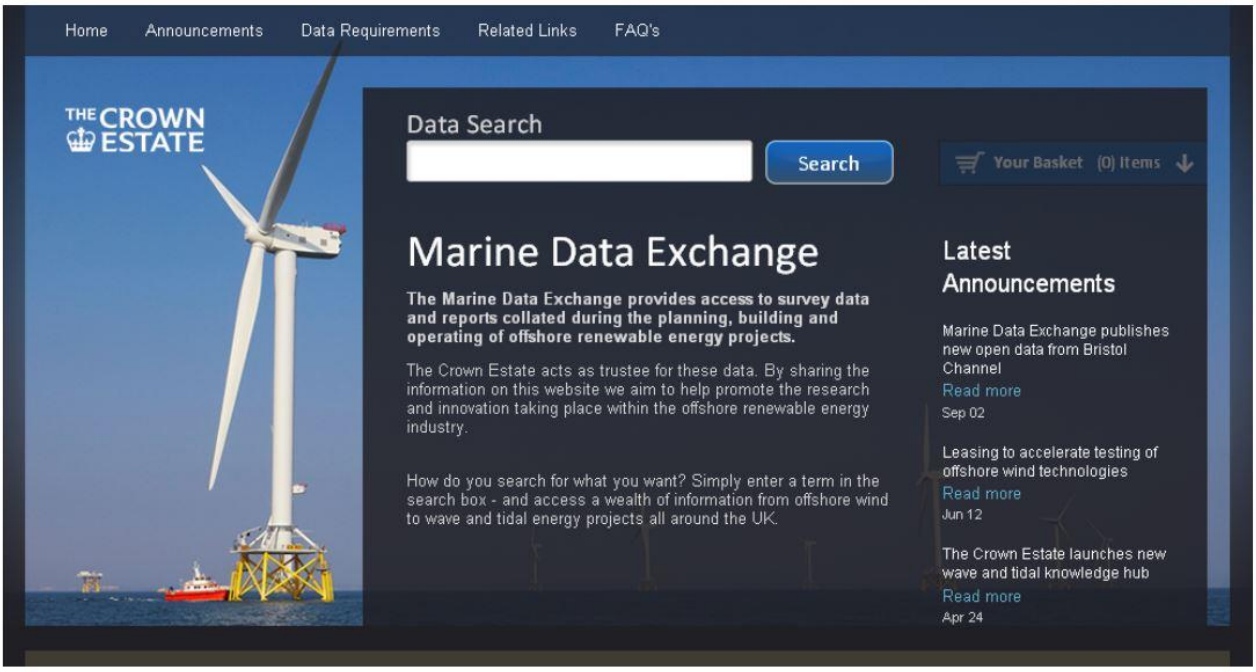
The report is a first draft on ‘Strategy on access granting to data used in the IRPWIND and wind energy research projects in general’.

The open access data is at its start, and much work lies ahead.

Importantly, the EERA partners agree to act as role models. This hopefully may inspire the wider wind energy community including industry companies to engage actively in the future process.

2. Appendix A: List of relevant accessible data to date from other sources

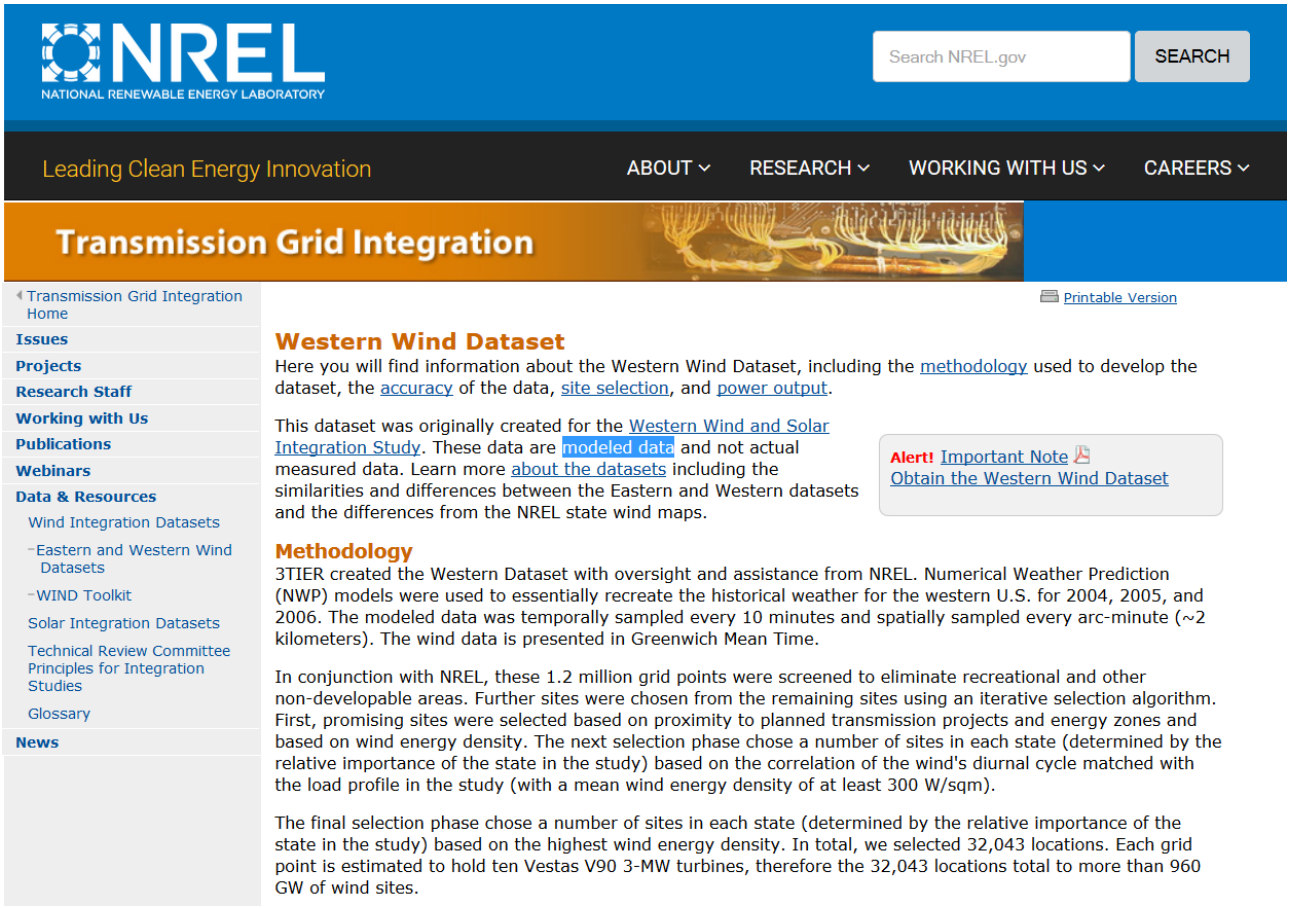
Marine Data Exchange from the Crown Estate



http://www.marinedataexchange.co.uk/

Wind Atlas South Africa

US Wind Integration Datasets: NREL.
http://www.nrel.gov/electricity/transmission/western_wind_methodology.html


NREL
NATIONAL RENEWABLE ENERGY LABORATORY
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Transmission Grid Integration
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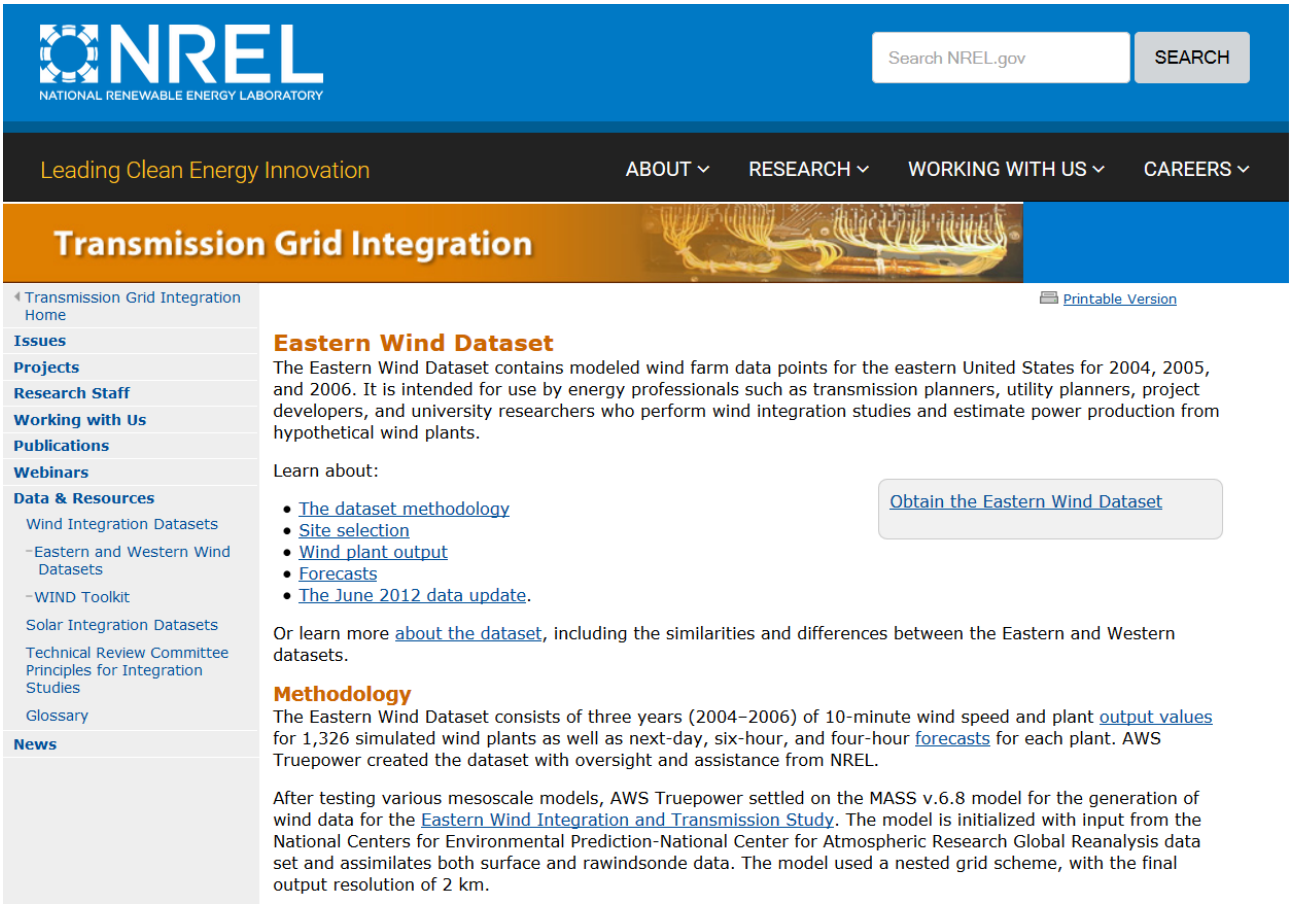
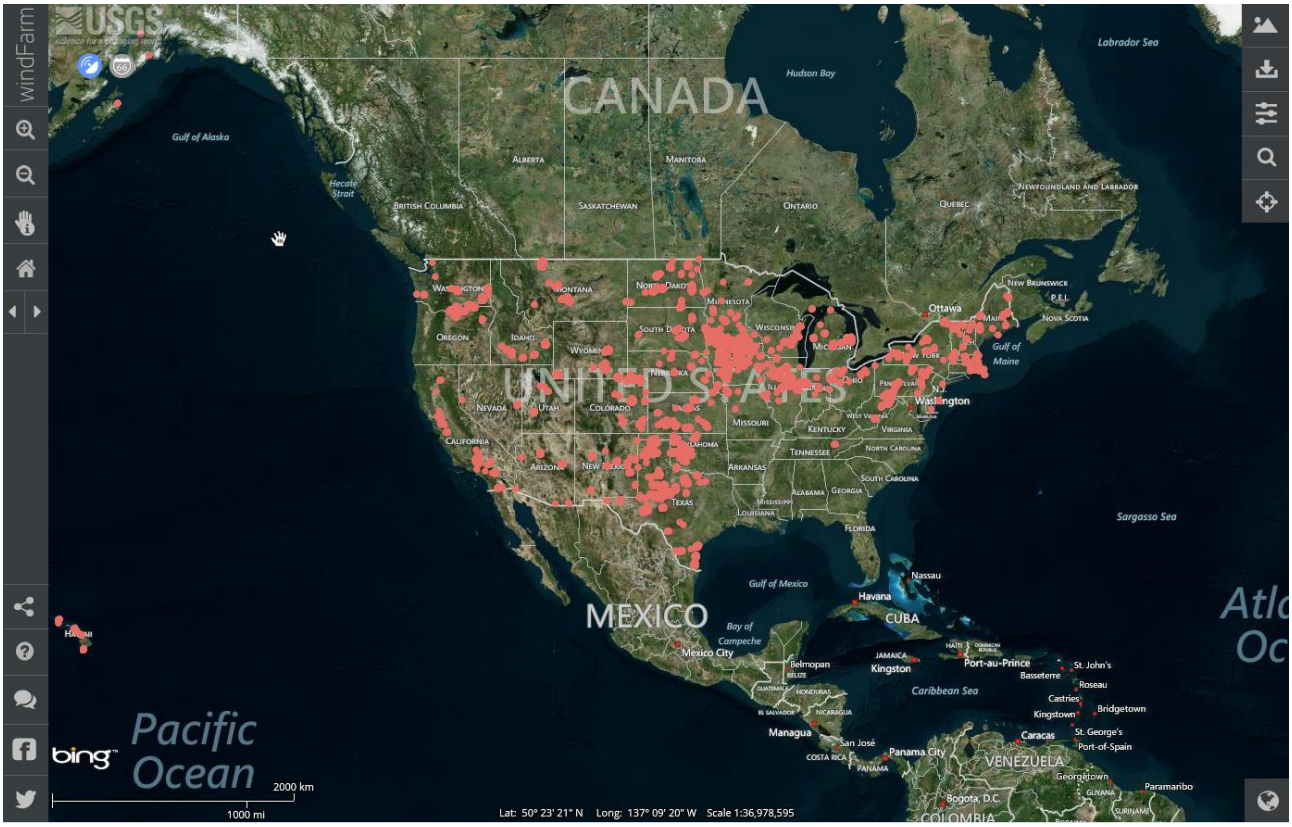
Publications
Webinars
Data & Resources
Wind Integration Datasets
Eastern and Western Wind Datasets
WIND Toolkit
Solar Integration Datasets
Technical Review Committee Principles for Integration Studies
Glossary
News
Printable Version
Western Wind Dataset
Here you will find information about the Western Wind Dataset, including the methodology used to develop the dataset, the accuracy of the data, site selection, and power output.
This dataset was originally created for the Western Wind and Solar Integration Study. These data are modeled data and not actual measured data. Learn more about the datasets including the similarities and differences between the Eastern and Western datasets and the differences from the NREL state wind maps.
Alert! Important Note
Obtain the Western Wind Dataset
Methodology
3TIER created the Western Dataset with oversight and assistance from NREL. Numerical Weather Prediction (NWP) models were used to essentially recreate the historical weather for the western U.S. for 2004, 2005, and 2006. The modeled data was temporally sampled every 10 minutes and spatially sampled every arc-minute (~2 kilometers). The wind data is presented in Greenwich Mean Time.
In conjunction with NREL, these 1.2 million grid points were screened to eliminate recreational and other non-developable areas. Further sites were chosen from the remaining sites using an iterative selection algorithm. First, promising sites were selected based on proximity to planned transmission projects and energy zones and based on wind energy density. The next selection phase chose a number of sites in each state (determined by the relative importance of the state in the study) based on the correlation of the wind's diurnal cycle matched with the load profile in the study (with a mean wind energy density of at least 300 W/sqm).
The final selection phase chose a number of sites in each state (determined by the relative importance of the state in the study) based on the highest wind energy density. In total, we selected 32,043 locations. Each grid point is estimated to hold ten Vestas V90 3-MW turbines, therefore the 32,043 locations total to more than 960 GW of wind sites.



US Wind Farm database: US Geological Survey
http://eerscmap.usgs.gov/windfarm/

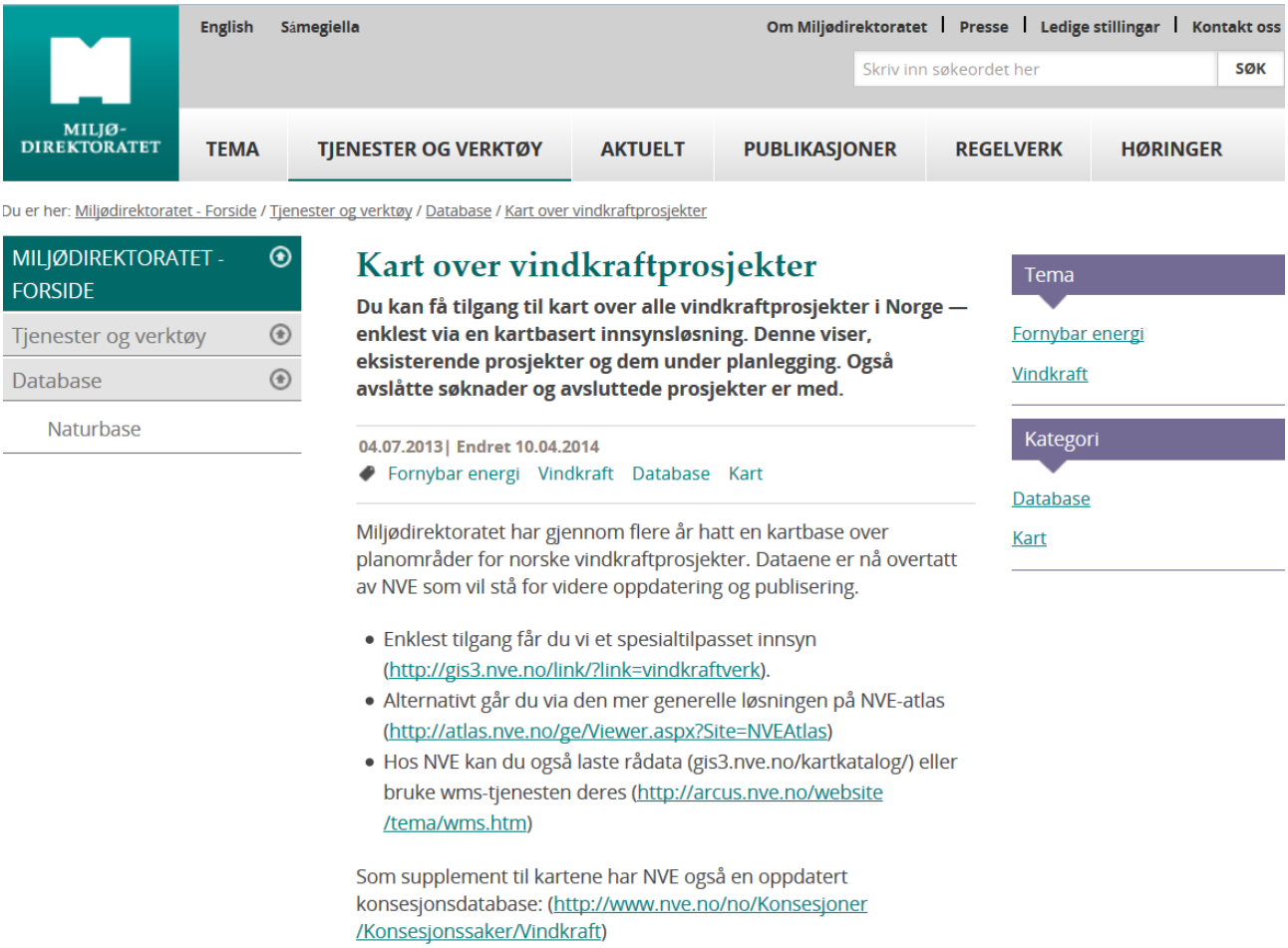


4C Offshore

Partly commercial database of wind farms, all offshore.

The Wind Power.net

Norwegian map of all wind power projects, including those in the pipeline: http://www.miljodirektoratet.no/no/Tjenester-og-verktoy/Database/Kart-over-vindkraftprosjekter/



Danish Energy Agency: Register of wind turbines.
Includes downloadable Excel tables of monthly wind power output per turbine. A map in GIS format can be found on vindinfo.dk.

DANISH ENERGY AGENCY

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Facts and figures

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Register of wind turbines

The register of wind turbines is a national database which contains all Danish power producing wind turbines. The register has information on location, size and output for each wind turbine.

Data from the register in Excel format

The register data are available in Excel format.
The table contains site and power output data of all wind turbines. The data are organized in two groups: one of operating and one of decommissioned wind turbines.

Data on operating and decommisioned wind turbines (as at end of January 2015). Uploaded 26/02/15.

Data for the production are under consolidation. Therefore, there might come corrections.

On www.vindinfo.dk there is among other things map of Denmark's wind turbines.

Regular data updating

The Danish Energy Agency updates the data once a month in conformity with reports received from the power distribution companies and Energinet.dk (grid service provider).

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WIND POWER OUTPUT MONTHLY DATA

- 2011
- 2010
- 2009
- 2008
- 2007
- 2006
- 2005
- 2004
- 2003
- 2002

NordPool, and other TSO's to be checked

SPARTA

System Performance, Availability and Reliability Trend Analysis
https://ore.catapult.org.uk/our-projects/-/asset_publisher/fXyYgbhgACxk/content/sparta

SPARTA is a major new collaborative project between ORE Catapult, The Crown Estate and offshore wind farm owner/operators.

The project will create a database for sharing anonymised offshore wind farm performance and maintenance data. Owner/operator participants will be provided with robust and reliable benchmarked data for the first time, helping to identify operational improvements and cost reduction opportunities at both company and sector-wide levels.

The potential benefits of SPARTA are substantial and long term:

- Reduction in **equipment failures** which cost the UK offshore wind industry around £150m in 2012.
- A 0.1% industry-wide improvement in **availability** arising as a consequence of SPARTA against the 2012 offshore wind-generated volume of 7.5TWh, could equate to an increase in income of £10m.

Owner/operators Centrica, RWE, SSE, Statkraft, Statoil, Vattenfall, ScottishPower Renewables and EDF have already committed to support the project by actively participating in a steering group to ensure that the key output - monthly reporting - provides valuable data which will inform future operational and maintenance decisions.

SPARTA (System Performance, Availability and Reliability Trend Analysis) is the first joint project under an agreement between ORE Catapult and The Crown Estate signed in November 2013. Together, the two bodies have committed to initial development costs in excess of £850,000.

FINO1,2,3

http://www.fino-offshore.de/en/